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Stress analysis on various deformation features in on-land accretionary complexes: Shimanto Belt, Shikoku, SW Japan

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At an accretionary subduction zone, sediments are deformed by underthrusting, accretion, and earthquake. Corresponding deformation features are identified in on-land accretionary complexes such as tectonic melanges, shear veins, underplating faults, out of sequence thrusts, and localized faults with pseudotachylyte. Those deformation features are formed under different stresses and stages. Furthermore, those changes in stress and stages of deformation reflect change in physical properties and fluid pressures along subduction interface, which is strongly related to architecture and strength of accretionary wedges and seismic behavior. The purpose of this study is to understand the time-spatio changes in deformations and stress along subduction interface from on-land accretionary complexes.

The study areas are Yokonami melange (Cretaceous) and Mugi melange (Cetaceous and Paleogene). Both are in Shimanto Belt, Shikoku, Southwest Japan. They are composed mainly of sandstone blocks and black shale matrix with minor basalt, chart and tuff. The localized slip zones, the Goshikino-hama fault for Yokonami melange and the Minami-awa fault for Mugi melange, are identified at the northern boundary of the melange zones. Shear veins are well developed both in the melange zones. Slicken lines and slicken steps are well preserved on the shear vein surfaces. In the Mugi melange, underplating faults at the bottom of the oceanic basements are well exposed. Fluidization was reported along the underplating fault.

For stress analysis, we used Multiple inverse method (MIM, Yamaji, 2000) and Hough inversion method (HIM, Yamaji, 2006). Examined deformation features are 1) shear veins in Yokonami melange, 2) faults at the Goshikino-hama fault, 3) shear veins in Mugi melange, and 4) underplating fault in Mugi melange. Comparing between MIM and HIM, we found that the MIM provided a better result on the basis of misfit analysis. Therefore, we use stress from MIM. Further, we use one stress for each deformation feature with the smallest misfit in the following discussion.

To compare the results of stress, the stress orientations are reconstructed by rotations of fault planes to be horizontal because the averaged orientation of foliation is varied between deformation features and those fault planes would be horizontal at the time of deformation. The obtained stresses are as following. 1) A low angle N-S compression with 0.32 of stress ratio for shear veins in Yokonami melange, 2) a low angle NE-SW compression with 0.22 of stress ratio for the Goshikinohama fault, 3) a low angle NNE-SSW compression with 0.05 of stress ratio for shear veins in Mugi melange, and 4) a low angle E-W compression with 0.45 of stress ratio for underplating fault, where stress ratio is defined as ($sigma_2$ - $sigma_3$)/($sigma_1$ - $sigma_3$). The orientations of stresses for 1), 2) and 3) are similar to each other. On the other hand, the stress orientations and stress ratio for 4) is completely different from others.

Effective frictional coefficient (M') was also examined by the lowest ratio between normal and shear stresses on fault planes as suggested by Angelier (1989). M' are related to frictional coefficient M and fluid pressure ratio lambda as following equation.

M' = M(1 - lambda)

Obtained effective frictional coefficients for each deformation feature are 1) 0.11-0.48, 2) 0.49-0.79, 3) 0.14-0.35, and 4) 0.05-0.23. M' for the Goshikino-hama fault is relatively high, indicating decrease of fluid pressure at the time of fault activity. Others have relatively low M'. Shear veins have a much of precipitated quartz and calcite. Those minerals suggests that large amount of fluid are existed for the deformation. The lower M' for underplated fault can be explained by the fluidization along the fault that was reported by previous study.

Keywords: paleostress, subduction zone, accretionary complex, melange, underplating fault, effective frictional coefficient