鉱物脈の姿勢情報を用いた沈み込み帯地震発生域での応力および岩石強度推定：延岡衝上断層周辺付加体での例

Variations in stress, driving pore fluid pressure ratio and rock strength using orientations of mineral veins along Nobeoka Thrust, southwestern Japan

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The crustal stresses and pore fluid pressures at depth are difficult to quantify directly, and the downhole measurements of in-situ stress are generally limited to a few km depth (e.g., Zoback and Healy, 1992, JGR 97, 5039-5057). The Nobeoka Thrust, southwestern Japan is an on-land example of an ancient megasplay fault and provides an excellent record of deformation and fluid flow at seismogenic depths. In this study, we present (1) temporal stress changes for the seismic period of the Nobeoka Thrust and (2) spatial heterogeneity of the fluid driving pressure ratio P* by using the mineral veins around the fault zone in the Nobeoka Thrust.
The Nobeoka Thrust is a major fault bounding the northern and southern Shimanto belt of the Cretaceous-Neogene accretionary complex in Kyushu, southwest Japan. The hanging wall rock of the thrust is composed of phyllitic shales and sandstones from the Eocene Kitagawa Group, and the footwall strata of the Eocene to early Oligocene Hyuga Group are composed of a mélange of shale matrix with sandstone and basaltic blocks deformed in a brittle manner (Kondo et al., 2005, Tectonics 24, TC6008). The Kitagawa Group rock of the hanging wall and the Hyuga Group rock of the footwall experienced heating to maximum temperatures of about 320 degrees centigrade and about 250 degrees centigrade, respectively (e.g., Kondo et al., 2005).
Many quartz veins that filled mode I crack can be observed in the hanging wall and footwall of the Nobeoka Thrust. We applied the inversion method proposed by Sato et al. (2013, Tectonophysics 588, 69-81) to estimate stress regimes by using the mineral vein orientations. The normal faulting stress regimes are detected from the veins in the hanging wall and footwall. The orientations of stress axes estimated from the veins in the hanging wall are similar to those in the footwall. The orientation of the σ_3-axes in the estimated stress regime is parallel to the slip direction of the Nobeoka Thrust. The detected normal faulting stress regimes mean the post-seismic stress after the faulting of the Nobeoka Thrust.
The estimated lower bound of the maximum fluid pressure P* are 0.16-0.19 and 0.29-0.46 in the hanging wall and footwall, respectively. The hanging wall has smaller P* compared to the footwall in the Nobeoka Thrust. We propose the two possible explanations for the spatial variation of P*. Firstly, the spatial variation of pore fluid pressure P_f affect directly the spatial variation of P* around the Nobeoka Thrust. Secondary, P* are controlled by the mechanical properties of the hanging wall and footwall. Laboratory experimental studies on rocks from the exhumed Shimanto belt along the Nobeoka Thrust indicate that phyllitic shale of hanging wall is stronger than mélange of footwall. The results are consistent with logging data (Hamahashi et al. 2013, G-cubed 14, 5354-5370) and the spatial variation of P* inferred from development of mode I cracks.

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