Estimation of pore fluid overpressures for tensile cracking at depth of shallow slow earthquakes

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Pore fluid pressure P_f is important for understanding slow earthquake mechanics. In this study, we estimated the pore fluid pressure during the formation of foliation-parallel quartz veins filling mode I cracks in the Makimine mélanges, eastern Kyushu, SW Japan. In the coastal region of the Makimine mélanges (Late Cretaceous Shimanto accretionary complex of SW Japan; temperature = 300–350°C, Palazzin et al., 2016), the mélange preserves quartz-filled shear, foliation-parallel veins and tension vein arrays. We applied the stress tensor inversion approach proposed by Sato et al. (2013) to estimate stress regimes by using foliation-parallel vein orientations. The estimated stress is a reverse faulting stress regime with a sub-horizontal σ_1-axis trending NW–SE and a sub-vertical σ_3-axis, and the driving pore fluid pressure ratio P^* ($P^* = (P_f - \sigma_3) / (\sigma_1 - \sigma_3)$) is ~0.1. When the pore fluid pressure exceeds σ_3, veins filling mode I cracks are constructed (Jolly and Sanderson, 1997). The pore fluid pressure that exceeds σ_3 is the pore fluid overpressure ΔP_f ($\Delta P_f = P_f - \sigma_3$). To estimate the pore fluid overpressure, we used the poro-elastic model for extension quartz vein formation (Gudmundsson, 1999). P_f in the case of the Makimine mélanges are ~280 MPa (assuming depth = 10 km, density = 2750 kg/m^3, tensile strength = 5 MPa and Young's modulus = 7.5–15 GPa). The normalized pore pressure ratio λ^* ($\lambda^* = (P_f - P_h) / (P_l - P_h)$, P_l: lithostatic pressure; P_h: hydrostatic pressure) is ~1.03 ($P_f > P_l$).

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