

Limited changes of pore fluid pressure during seismic cycles around megasplay faults in subduction zones

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Pore fluid pressure (P_f) is of great importance in understanding earthquake mechanics. The temporal buildup of pore fluid pressure during the seismic cycles may promote temporal changes in fault strength. High pore pressure that is close to lithostatic pressure is observed around faults in the co-seismic period (i.e., where the pore fluid pressure ratio, $\lambda_v = P_f / \sigma_v > 0.9$; σ_v : vertical stress). The distribution of high pore fluid pressure is likely to be time-dependent, varying over the seismic cycles. Previous hydrological research has suggested that the fluid loss due to the formation of extensional deformation structures (e.g., extension cracks and normal faults) during the post-seismic period increases the fault strength and creates drainage asperities along the plate interface. Here we focus on the fluid migration around the megasplay fault due to extensional crack formation. We examined 1) loss of pore fluid pressure and 2) amount of fault strength recovery by the extension crack formation during the post-seismic period by analyzing extension quartz veins exposed in the Nobeoka Thrust, southwest Japan. The Nobeoka Thrust is an on-land example of the modern splay fault at shallow depths in the Nankai Trough, contains quartz veins that enable a good understanding of fluid pathways in the hanging wall of the subduction zone. The poro-elastic model of extensional quartz vein formation indicates that the extensional crack formation only releases up to ~5% of the total pore fluid pressure at ~8 km depth. While the pore pressure around the Nobeoka Thrust was close to lithostatic pressure during the entire seismic cycle, the estimated effective frictional coefficient along the Nobeoka Thrust after this small fluid loss due to extensional crack formation does not exceed 0.1. Hence, the pore fluid pressure reduction due to post-seismic extensional cracks contributes little to the increase in fault strength of the megasplay fault.

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