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Deformation textures in the principal slip zone of the Chelungpu fault, Taiwan, and its implication for stress change during the seismic cycle

Li-Wei Kuo (1), Vladimir Luzin (2), Kou-Fong Ma (1), and En-Chao Yeh (3)

(1) Department of Earth Sciences, National Central University, Taoyuan city, Taiwan, (2) Australian Nuclear Science and Technology Organisation, Australia, (3) Department of Earth Sciences, National Taiwan Normal University, Taipei city, Taiwan

Thermal pressurization is postulated for fault lubrication during seismic ruptures and leads catastrophic natural disasters. One recent example includes the active Chelungpu fault resulted in 1999 Mw 7.6 Chi-Chi earthquake in Taiwan. Efforts to improve seismic hazard assessment in such a region require a quantitative understanding of fault dynamics during earthquake generation. The principal slip zone (PSZ) of the active Chelungpu fault, showing rapid shear heating of fault gouge, might preserve stress magnitude accommodated the thermal pressurization during the earthquake. Here we conduct in situ neutron texture analysis for determining both recent and ancient histories of rocks because deformation events like earthquakes are imprinted in the crystallographic grain orientation. Overall, 12 samples collected from the fresh fault core, which represent almost continuous scan across the fault, were analyzed with the neutron experiment on KOWARI, Australia. Two distinguished types of the preferred orientation were found: (1) the textures with c-axis orientations predominantly parallel to bedding planes, which are found in the most of sedimentary rocks, are compaction-related and this is observed for the most analyzed samples; (2) the textures of sample 5 and 10, which are identified as Chi-Chi PSZ, demonstrate quite different deformation history with different orientation of the principal stresses that plausibly resulted from thermal pressurization process within the PSZ. Integrating these observations with the multiple stress inversion method, we obtain the change in stress field and it magnitude related to the end of the fault rupture. Since thermal pressurization process is proposed as a widespread process for earthquake generation and propagation, we suggest that the investigation of gouge orientation of a fault offers the opportunity to study the stress drop and recovery during the seismic cycle.