Repeated coseismic injection of pulverized fault rocks and infiltration of fluids including meteoric and sea-waters within fault damage zones

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In the past decades, increasing geological evidence has emerged that faults and shear zones within the middle to upper crust play a crucial role in controlling the architecture of crustal fluid migration and seismic faulting process. It is also well known that fluid can be released by dehydration reaction caused by seismic frictional heating during large earthquakes within both intracontinental faults and subduction zones that contain abundant hydrous minerals (Lin et al., 2003, 2013). Such rapid dehydration reaction would induce a sudden increase in fluid pressure that would simultaneously act to reduce the effective normal stress and markedly weaken the dynamic strength of seismogenic faults during seismic faulting, thereby facilitating seismic slip during large earthquakes. For an integrated multidisciplinary study on the assessment of activity of active faults involving active tectonics, rock-fluid interactions, geochemistry and geochronology of active fault and seismogenic fault zones, recently, a new project of "Drilling into Fault Damage Zone" has being conducted by Kyoto University on the Nojima Fault again after 20 years of the 1995 Kobe earthquake.

In this presentation, I will review the previous studies and report the recent progresses on the fluid infiltration concerning with coseismic faulting and recent activity on two seismogenic faults that recently triggered the large earthquakes, one from the active faults of the Longmen Shan Thrust Belt that triggered the 2008 M_w 7.9 Wenchaun earthquake in the Sichuan basin, China, the other is the Nojima Fault that triggered the 1995 M_w7.2 Kobe earthquake. Circulating fluids deposit fine-grained sediments including clay and carbonate material and pulverized rock materials into cracks within the fault zones. Such crack-fill fine-grained materials, calcite veins, and oxidized/weathered open cracks have well been observed in the drill cores, from both the Nojima Fault and the active faults of the Longme Shan Thrust Best. 3D micro-X-ray scanning data and powder X-ray diffraction analyses show that the fault core zone contains a numerous of veinlets which are composed of fine-grained materials, carbonate material and clay minerals. Isotopic analyses of carbonate material within the fine-grained materials and calcite veins reveal that the calcite veins are sourced from typical meteoric and seawater. ^{14}C dating ages of 10 calcite vein samples range from 35.0 to 58.4 kyr B.P. Geological, petrological, stable isotopic, and ^{14}C data suggest that these crack-fill fine-grained materials and calcite veins and brown open cracks were developed by the repeated infiltration of O_2- and CO_2-bearing meteoric and seawater downward into the deep fault zone during the last 35–60 kyr. We propose a seismic fault suction-pumping model to interpret the infiltration of subsurface waters being carried down into the deep fault zone by rapid potential change during episodes of seismic faulting.

References

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