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Healing process of the Chelungpu fault and identification of activated slip layer by ChiChi earthquake in Taiwan

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Earthquakes occur repeatedly with certain time intervals on same fault. Such earthquake recurrence is explained by the strain buildup and release hypothesis, which leads to the concept of seismic cycle. To buildup the stain after releasing the strain by earthquake slip, it is required that fault zones strengthen between earthquakes. The strength of fault is recovered with porosity decrease by mechano-chemical processes: (i) Rapid deposition of minerals in cracks and pores; (ii) Mineral sealing in cracks and pores; and (iii) Pressure solution. These processes change properties in fault zone by mass transfer as well as healing fault zone. Healing and the relevant material changes in fault zone play a key role in evolution of a fault. These mechanisms are verified by microstructural observation, which remain as structures in fault zone as fractured structures are recorded. Observations and chemical analysis of fault zone enables us to infer history of faulting and healing of the fault. Identification of slip zone by recent earthquake is also important to understand slip mechanism with combining seismic data and geological data. In addition to detailed observation, calculation of grain size in each layer helps us to examine the latest slip zone. In this presentation, we discuss slip and healing history by detailed description of microstructures, results of chemical analysis and grain size analysis in the Chelungpu fault in Taiwan and identify latest slip zone.
The Chelungpu fault is an active fault occurred big earthquake (magnitude 7.7) in Chi-Chi, central Taiwan, in 1999. Taiwan Chelungpu fault Drilling project (TCDP) drilled two vertical holes (hole A and B) and one side-track hole from hole B (hole C). Pressure solution has been observed in the drilled samples from hole B through the Chelungpu fault. Rapid deposition of nano-scaled quartz grains has reported in samples recovered from drilled hole C penetrated to Chelungpu fault. This sample from hole C preserve whole structures including a possible primary slip zone and other old slip zones. Based on the detailed observation, we divided 12 cm fault zone of hole C into thin 16 layers. All layer are gouge composed of quartz, feldspar and clay minerals. Three gouge layers showing random fabric are obvious, suggesting that rapid slip occurred no less than three times in this fault zone. The layer showing random fabric at most bottom of the fault zone has sharp boundaries. Grain size analysis in the layer shows highest dimension on the fractal distribution and the layer has small quartz grains less than tens nanometer. Comparing our results as above and previous studies, possible slip layer activated by ChiChi earthquake is the bottom layer showing random fabric. As for healing process, pressure solution is widely observed, while rapid deposition and mineral sealing locally appeared. The intensity of pressure solution is larger with far from the bottom of fault zone. It seems that pressure solution is a main healing mechanism in the Chelungpu fault zone and slip layers are localized at bottom of this fault zone.

Keywords: Chelungpu fault zone, ChiChi earthquake, Fault healing process