Development of internal and permeability structures of thrusts in the western foothills of Taiwan

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Analysis ofinternal structures and permeability structures of fault zones is important to understand kinematical processes of earthquakes and fluid flow processes at depth. There are a lot of reports in the past about internal structures and permeability structures of different fault zones. The result was, that each fault has its own character but it is difficult to compare the results of one fault to the those of other faults. If we could compare internal structures and transport properties of several fault zones that are placed in the same tectonic environment and contain the same rock components but have different accumulation of displacement or depth of growth, we could evaluate the fault deformation process or permeability difference of the fault zones.

In the present study, internal structures and measured hydraulic properties (permeability, porosity and specific storage) of three fault zones, Chelungpu fault, Shuangtung fault and Shuilikang fault, are described. These three faults are located in the western foothills of Taiwan. From the geological data and vitrinite reflection data, Shuilikang fault shows the largest accumulated displacement while Chelungpu fault shows the smallest displacement among these three faults. Furthermore, Shuilikang fault might have maintained the internal fault structure of the earthquake's epicenter.

Chelungpu fault in the Jifeng area is composed of a 2-3mm thick clayey fine fault gouge in the center zone, an approximately 10mm thick foliated fault gouge and fault breccia, which has a thickness of more than 10 m. The internal structure of the shallow part of a core,penetrating Chelungpu fault, was compared to the internal structure seen around the center of fault zone. Structures found in the core and outcrop showed similarities.

At Shuangtung fault in Shuangtung area, black foliated material, that implies heat generation, was identified in the center of the fault zone. An approximately 4 m thick clayey foliated fault gouge was developed as well. At the boundary between thick fault gouge and fault breccia, similar black material was also developed.

Permeability, porosity and specific storage of fault rock was measured by using intra-vessel oil apparatus at Kyoto University. One-pressure cyclic tests at room temperature were done in all samples. Confining pressure was increased up to 200MPa and nitrogen gas was used as a pore fluid. Permeability was measured by differential pressure - flow rate constant method. Dependence of porosity on effective pressure was calculated from the pore volume change of rocks during effective pressure change. Pore volume change was estimated by detecting the pore pressure change. Specific storage was evaluated from the porosity change to effective pressure change and the porosity.

The permeability, porosity and specific storage of fault rocks in Chelungpu fault are shown as follows. All fault rocks decreased in permeability with increased effective pressure. Initial permeability (effective pressure = Pe = 5MPa) showed values of 10-15 m^2 and at Pe = 100 MPa, permeability was decreased to 10-16 ~ 10-17 m^2. Fault gouges showed lower permeabilities than fault breccias. Though initial porosity has large difference between the different rock types, porosity of all rocks was decreased by about 3% at Pe = 100 MPa. Specific storage also showed pressure sensitivity that decreased from 10-9 Pa-1 at initial Pe (3 MPa) to 10-10 Pa-1 at 100 MPa and there was no difference between fault gouge and fault breccia.

At a shallower part, fault rocks show lower permeability than the surrounding sedimentary rocks, though from a certain depth this relationship changes reversely. This result indicates, that until a certain depth, faults could act as sealing layers. Also the in-situ results at this site suggest, that faults could act as seal layers and possibly disturb the consolidation process of sediments.