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Transport and frictional properties of fault rocks in shallow and deeper drilling cores of the Chelungpu Fault

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1999 Chi-Chi earthquake in Taiwan provides a change to integrate the study of dynamic fault motion during a large earthquake. One of the significant points is that the difference of seismic behavior between northern and southern part (northern part: fast velocity and large displacement, southern part: 1 m/s of velocity and displacement of a few to several meters). Shallow drilling project penetrating into activated Chelungpu fault also revealed marked different fault structures between northern and southern part. Fault boundary was located between conglomerate and fine grained foliated fault breccia in the northern core, on the other hand, thick clayey fault gouge was developed among siltstones in the southern core. This structural contrast may explain the different seismic motion between north and south. Therefore we measured transport and frictional properties in laboratory test using shallower and deeper core samples. Permeability of fault gouge and fault breccia in northern part of shallow core showed large sensitivity to effective pressure (Pe), which decreased from 10^{-14} m^2 at 0 MPa of Pe to 10^{-19} m^2 at the 150 MPa of Pe. Permeability and porosity sensitivity of fault rocks were larger than those of surrounding sedimentary rocks. Thick foliated fault breccia in southern part showed that permeability of 10^{-18} m^2 at 150 MPa of Pe. Internal structures and transport properties of fault zones suggested that thermal pressurization might occur at depth in the north because of lower permeability of the fault zone. On the other hand, in the southern part, permeability of lower boundary of conglomerate (10^{-13} m^2 – 10^{-14} m^2) was high enough that thermal pressurization may not occur, and high-velocity behavior of fault gouge may be dominant to the seismic fault motion. Permeability of core sample was not so much different from those of surface samples, especially in fault rocks. This implies that we can apply transport properties of surface rocks for the evaluation of physical properties at depth.

Keywords: Chi-Chi earthquake, fault, permeability, frictional properties