

Structures and Stress State around TCDP Drilling Site: Insight from Core-Log Integration

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Change of stress state and fluid pressure for seismic faulting and interseismic deformation is the key to understanding rupture mechanism and healing process in the context of earthquake cycle. Continuously retrieved cores and an extensive suit of downhole physical loggings from the Taiwan Chelungpu-fault Drilling Project (TCDP) and surface outcrops along the Chi-Chi rupture allow us to study the role of stress state and fluid pressure in the development of regional structures and coseismic deformation.

Core-log integration gave profound results aiding in illustrating the lithologic column, deformation structure, and architectural pattern of fault zones along the TCDP borehole. Ten fault zones including thrust faults, strike-slip faults and backthrust are recognized and are classified as the Chelungpu Fault System (<1250 m) and the Sanyi Fault System (>1500 m). According to their deformation textures, fault zones can be categorized as distinct fracture deformation, clayey-gouge deformation, and soft-rock deformation. The first one is dominant within the Chelungpu Fault System and the other two prevail in the Sanyi Fault System.

The slip zone of the Chi-Chi earthquake contains clay-coating aggregates in the isotropic massive black gouge. With 3D dilation of hydrofracturing above the isotropic layer, it suggests thermal pressurization as the slip-weakening mechanism. The characteristic behaviors of sandwiched gouge materials (black gouge-foliated gouge-black gouge) for seismic faulting are investigated by ellipsoid reconstruction of quartz grains and anisotropy of magnetic susceptibility. The shape of grain and AMS ellipsoids illustrates the change of geometry from prolate to oblate when closed to the gouge zone from wall rocks. Highly random distribution of grain long-axes on slip plane and smaller intersect angle between magnetic foliation and slip plane for black gouge indicate that the black gouge experienced more compression than foliated gouge.

Data of in-situ stress shows that stress regime of strike-slip faulting and normal faulting exists currently after the Chi-Chi earthquake and horizontal stresses have permutated around the Chi-Chi rupture zone. Combining paleostress analysis on nofilling faultslip data and experimental results of rock mechanics, the stress state of seismic rupturing are reconstructed. Integration of stress states from coseismic and post-seismic stages illustrates that the stress regime after earthquake can vary from

reverse faulting, strike-slip faulting to normal faulting, depended on the magnitude of stress drop. Present top of overpressure is predicted to be around 1300m, where is consistent to the change of lithology and vein distribution, by applying the concept of disequilibrium compaction to sonic log of shale. Vein precipitation on reverse faults above 1300m and current hydrostatic fluid pressure along entire TCDP borehole could be the consequence of seismic pumping during coseismic stage.