Resolving earthquake fault zone dynamics from Taiwan Chelungpu-fault Drilling Project (TCDP) and Borehole Seismometers

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The high quality dense strong motion data deployed priori to the occurrence of the destructive 1999 Chi-Chi earthquake provided the most comprehensive studies on the mechanism of a damaging event. The general consistent feature in spatial slip distribution of the fault as a large slip of ~12m at the northern portion of the fault from fault models and geological observation suggest the importance in the understanding of physics of faulting with large slip. And, the success drilling Taiwan Chelungpu-fault Drilling project (TCDP) shed the light on the understanding of the earthquake energy partition by revealing the very fine grain (~nm) fault gouge with slip thickness in a scale of mm for a single event. Pervious studies from Taiwan Chelungpu-Fault Drilling Project borehole seismometers (TCDPBHS) observed occurrence of isotropic events below the primary slip zone, which were explained as events with explosive/implosive mechanism driven by the fluid within a complete stress drop regime capped by a low permeability primary slip zone. It suggests the significant role of fluid in the fault zone. TCDPBHS is a 7-level three-component vertical borehole seismic array installed in Hole-A of the Taiwan Chelungpu-Fault Drilling Project (TCDP) in July 2006. This array covers a depth range from 946 to 1274 m at intervals of 50–60 m that crosses the main fault of the 1999 M_W 7.6 Chi-Chi earthquake at a depth of 1111 m. Through almost a decade of observation of TCDPBHS, significant and intriguing features had been discovered. We observed constant duration events within event cluster with various magnitudes. This constant duration may arise either because all events in a cluster are hosted on the same isolated seismogenic patch, or because the events are driven by external factors of constant duration, such as fluid injections into the decollment. It may also be related to the earthquake nucleation size. Through yearly observation of TCDPBHS, we also reveals the fault zone might have influenced by distant earthquakes through dynamic triggering, which resulted in the changes in velocity and stress on anisotropy. Through the fault zone in-situ borehole seismometers after a large earthquake, we could give a first-hand close-in observation of fault zone behavior and its temporal evolution.