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Natural and experimental evidence of past seismic faulting from Clay-Clast Aggregates occurrence

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Spherical aggregates named Clay-Clast Aggregates (CCAs) have been reported from recent investigations on both retrieved clay-bearing fault gouges from shallow depth seismogenic faults and rotary-shear experiments conducted on clay-bearing gouge at seismic slip-rates.

We have conducted additional high velocity rotary-shear experiments and low velocity double-shear experiments. From these two types of friction experiments, we demonstrate that a critical temperature depending on dynamic P-T conditions is needed for the formation of CCAs. This temperature corresponds to the transition of water from liquid to vapor or to critical, that induces gouge pore fluid expansion and therefore a thermal pressurization of the fault.

We compared natural CCAs obtained by the Taiwan Chelungpu fault Drilling Program (TCDP) from a gouge layer recognized as the last slip surface of the Mw 7.6 1999 Chi-Chi earthquake, and CCAs obtained from our high velocity experiments.

EDX-SEM element mapping, SEM and TEM observations show strong similar characteristics of the two types of CCAs with a concentric well-organized fabric of the cortex, and reveals that their development may result from the combination of electrostatic and capillary forces in a critical reactive medium during the dynamic slip-weakening.

The formation of CCAs appears to be related to the shearing of a clay-rich granular material that expands and become fluidized. Accordingly, the occurrence of CCAs in natural clay-rich fault gouges constitutes new unequivocal textural evidence for shallow depth thermal pressurization and consequently for past seismic faulting.