Coseismic gouge graphitization and its signatures in the active fault zone of the Longmenshan fault, China

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Faults accommodate deformation by aseismic (slip rates << 0.1 mm/s) and seismic (average slip rate ~1 m/s) slip. The frictional dissipation during seismic slip, especially for moderate to large in magnitude (M > 6) earthquakes, should result in bulk temperature increase of the fault slipping zone. One moderate to large magnitude earthquake (M>6) nucleates in the Earth's crust every three days, but the geological record of ancient fault slip at m/s seismic velocities (as opposed to sub-seismic slow-slip creep) remains debated because of the lack of established fault-zone evidence of seismic slip. Here we sheared carbonaceous-bearing fault rocks from the Wenchuan earthquake Fault Scientific Drilling project-1 (WFSD-1) in the laboratory and compared to natural active slipping-zone materials. By means of in-situ synchrotron X-ray diffraction, micro-Raman spectroscopy and focused-ion beam transmission electron microscopy, we found graphitization process likely occurred during the 2009 Wenchuan (Mw 7.9) earthquake, and detected graphite grains similar to those found in the active principal slip zone only in experiments conducted at seismic velocities. The experimental evidence presented here suggests that high temperatures pulses associated to seismic slip induce graphitization of carbonaceous material. Importantly, the occurrence of graphitized carbonaceous fault-zone materials of WFSD-1 shows us the signatures of multiple coseismic events.

Keywords: gouge graphitization, Wenchuan earthquake, WFSD

