Taking the Temperature of Earthquakes

Despite centuries of research, we still do not understand some of the most fundamental aspects of earthquakes including how they start, how they propagate, and why they stop. Grain-scale processes that control fault strength can be studied in lab experiments, but we are limited in making ties to field observation by our inability to pinpoint earthquake structures in natural fault zones. Here, I discuss using coseismic temperature proxies to map earthquake slip in the field, elucidate grain-scale strength at those temperatures, and estimate how energy is partitioned during earthquakes.

During earthquakes, faults heat up due to their frictional resistance. Sometimes, the temperature rise during earthquakes makes the rocks hot enough to melt. However, solidified frictional melt (pseudotachylyte) is uncommon in the rock record, and other paleoseismic temperature proxies have only recently been established. The dearth of pseudotachylyte led researchers to hypothesize that faults get very weak during earthquakes, and hence do not produce much heat. If faults dramatically weaken during slip, there are important implications for how earthquakes propagate, and hence why some earthquakes grow to be very large. I use a new sub-solidus temperature proxy, biomarker thermal maturity, to identify temperature rise on faults in a variety of tectonic settings. With results from this new temperature proxy, we revisit some outstanding questions in fault mechanics such as: Where does earthquake slip occurs in a fault zone? Can creeping faults host earthquakes? Does lithology control rupture propagation? How is energy partitioned during earthquakes? and, How strong are faults during earthquakes?