

Biomarkers heat up during earthquakes: new geological evidence of earthquake slip in the rock record

Why do faults fail where they do, when they do? The rock record can provide details about the rupture process that are unavailable to other methods, such as seismology. In particular the fault frictional strength during slip is an important unknown parameter that is needed for a complete understanding of earthquake dynamics, and a crucial ingredient in predictive failure models. Because faults get hot during rapid slip due to friction, thermal signatures in the rock record can provide evidence of earthquakes. The most widely accepted thermal signature is frictional melt (pseudotachylyte), but these rocks are rare and cannot provide information when faults are heated to temperatures below melting. We have developed a new thermometer that utilizes the thermal alteration of organic biomarkers that apply to any fault hosted in sedimentary rock with sufficient organic material. We present results from field examples, including the fault that potentially hosted the 2011 Tohoku–Oki earthquake, and explore the implications of these results for earthquake processes.