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Different seismic signatures of fractures slip and their correlations with fluid pressures in in-situ rupture experiments

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The recent observations of non-volcanic tremors (NVT), slow-slip events (SSE), low- (LFE) and very-low (VLF) frequency earthquakes on seismogenic faults reveal that unexpected, large, non-linear transient deformations occur during the interseismic loading of the earthquake cycle. Such phenomena modify stress to the adjacent locked zones bringing them closer to failure. Recent studies indicated various driving factors such as high-fluid pressures and frictional processes. Here we focus on the role of fluids in the different seismic signatures observed in in-situ fractures slip experiments. Experiments were conducted in critically stressed fractures zone at 250 m-depth within the LSBB underground laboratory (south of France). This experiment seeks to explore the field measurements of temporal variations in fluid and stress through continuous monitoring of seismic waves, fluid pressures and mechanical deformations between boreholes and the ground surface. The fluid pressure was increased step-by-step in a fracture isolated between packers until a maximum value of 35 bars; a pressure analog to ones known to trigger earthquakes at crustal depths. We observed in the seismic signals: (1) Tremor-like signatures, (2) Low Frequency signatures, and (3) sudden and short ruptures like micro-earthquakes. By analogy, we suggest that fluid pressures may trigger these different seismic signatures in active faults.