



Foreshocks occurrence and their links to nucleation during experimental earthquakes

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Over the past decades, the increasing number of seismological observations and the improvement of data quality have allowed to better detect foreshock sequences prior to large earthquakes. However, due to strong spatial and temporal variations of foreshock occurrence, their underlying physical processes and their links to earthquake nucleation are still under debate. Here we address these issues by using precursory acoustic activity recorded during laboratory earthquakes (stick-slip instabilities) as a proxy to foreshock activity preceding natural earthquakes.

Laboratory earthquake experiments were performed in saw-cut Indian metagabbro under upper crustal stress conditions ranging from 30 to 90 MPa confining pressure. Using a high-frequency monitoring system and calibrated piezoelectric acoustic sensors we continuously record particle velocity field at 10 MHz sampling rate during the experiments. Based on a trigger logic we identify acoustic emissions (AE) within continuous data. From P-wave arrival-time data and from spectral analysis we are able to estimate the following seismological parameters for each AE: location, absolute magnitude, stress-drop and size. Our preliminary observations show that: (i) Regardless of the confining pressure, we always observe a sharp acceleration of the number of AE before failure. The higher the confining pressure, the shorter the time-scale of this acceleration phase, which follows an inverse Omori law; (ii) The locations of the recorded AE draw patterns that reveal seismic and aseismic patches over the fault surface. Zones of precursory acoustic activity shrink with confining pressure; (iii) AE preceding failure migrate toward the nucleation zone and (iv) Even though our observations show that AE precursory activity can arise by both cascading failure and preslip mechanisms, AE source parameters and locations suggest that aseismic preslip is the prevalent mechanism. Finally, we find a simple empirical scaling law for foreshock time series in all our experiments, which involves applied stress and time to failure only.