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Rupture Propagation of Microearthquakes

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Recent studies into source-time functions of small earthquakes have shown that also some of the ML<3 events display complicated waveforms indicating multiple episodes of rupturing. This observation points to important role of stress transfer at very short time scales and to triggering effects between subsequent earthquakes. I analyzed records of swarm earthquakes from NW-Bohemia/Vogtland to find occurrence of double/multiple events. Their relative source time functions obtained by deconvolving the empirical Green's function consist of several single pulses whose delay times differ among stations. This indicates different origin times and hypocenter coordinates of individual single sub-events. I apply waveform modeling with the use of EGFs to find the parameters of individual sub-events, which build up the composite event. The P- and S- waveforms of a composite event are modeled as a sum of waveforms of several simple events with different moments, origin times and hypocenter coordinates. To construct the waveform of each simple event composing the multiple event a waveform of a colocated small event as an empirical Green's function is used. Assuming similar focal mechanisms of the sub-events and of EGF, the method searches for coordinates and origin times of the sub-events and for their relative seismic moments. The relative position and timing of the sub-events give insight into individual rupture episodes and possible triggering effects between subsequent sub-events. This helps us to understand the causal relation between the sub-events and yields constraints to the process of rupture growth and velocity of rupture propagation.

More than fifty composite events have been identified in the magnitude range from 1.2 to 3.3 and more than one-half of them were successfully modeled as double or triple events. The separation of sub-events ranges up to 100 ms in origin time and 250 m in space. A comparison of the relative position of the sub-events with the focal mechanisms indicates that most of them represent individual rupture episodes of a single earthquake. The space-time separation of these plane-distributed sub-events corresponds to a (rupture) velocity of about 3 km/s, a value typical for rupture propagation at large earthquakes.