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Complex rupture processes at the Bárðarbunga caldera, Iceland

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The unrest of the Bárðarbunga volcanic system in summer 2014 has been accompanied by a significant increase in seismicity, which was localized both at the caldera rim and along segments of a major, laterally-propagated dyke. The seismic activity was exceptional for the region, with more than 60 events of magnitude Ml larger than 5.0 recorded in the first three months of activity, which is still ongoing. Our aim here is to provide an explanation of the sustained seismicity at the caldera rim. We rely on regional broadband recordings to perform an inversion of source parameters and to model the source processes for the largest events (above Ml 5.0) in the sequence. Full moment tensor inversion and moment tensor clustering reveal that most events can be classified in two types, which can be well modeled by the superposition of a common sub-vertical compensated linear vector dipole (CLVD) and a normal faulting, which has a different orientation for the two types of events. The analysis of the earthquake source is further extended to smaller magnitudes, by using a waveform correlation approach; this confirms similar rupture processes for weaker events. An apparent discrepancy among seismological observations at local and regional distances, in terms of origin times and radiation patterns, suggest a complex rupture process, composed of different phases. Whereas local data are useful to track the nucleation phase, characterised by a shear failure, regional data can be used to assess the mechanism responsible for the most energetic signal, where the non-DC component becomes more relevant. The combined analysis of local and regional data revealed that, at least during the first phase of the sequence, the type of rupture is conditioned by the location of the rupture nucleation. When the rupture is initiated at the northern rim, the normal faulting component of the moment tensor strikes almost North-South; instead, if the rupture starts at the southern rim, the normal faulting component has an East-West striking. Our analysis is here used to simulate, test and discuss different proposed complex collapse models.