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Small-scale deformation steps in a rifting environment at Bárðarbunga Volcano, Iceland

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The 2014 volcano-tectonic episode at Bárðarbunga volcano in Iceland represented a unique opportunity to study an active rifting process in the field. Indicated by the temporal and spatial evolution of seismicity and observed surface deformation, a lateral dyke propagated in the subsurface for over 45 km. At the surface above the dyke, divergent rifting and substantial graben subsidence was observed in the field and measured by GPS and InSAR. We deployed a set of seismometers in vicinity to the subsiding graben, with the closest instrument right at the graben shoulder. We analyse seismic events from this dataset and infer static displacement and tilt steps in the ground motion, showing that the rifting process comprises discrete steps, as the upper crust deforms through repetitive low-magnitude failure events. Our obtained deformation rates are in accordance with the ones estimated from GPS measurements, suggesting that any aseismic component is small at the scales captured in this study. A stress drop analysis of these events reveals that the uppermost crust in the rift zone is exceptionally weak, explaining the lack of shallow seismicity observed on conventional seismic networks.