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Frost quakes – the sound of a dynamic cryosphere and a convenient source for passive surface wave imaging of permafrost

Rowan Romeyn^{1,2}, Alfred Hanssen^{1,2}, Andreas Köhler^{1,3}, Bent Ole Ruud^{2,4}, Helene Meling Stemland^{2,4}, and Tor Arne Johansen^{2,4,5}

¹Department of Geosciences, University of Tromsø – The Arctic University of Norway, 9037 Tromsø, Norway

²Research Centre for Arctic Petroleum Exploration (ARCEX)

³NORSAR, 2007 Kjeller, Norway

⁴Department of Earth Science, University of Bergen, 5007 Bergen, Norway

⁵The University Centre in Svalbard (UNIS), 9171 Longyearbyen, Norway

A class of short-duration seismic events were recorded on dense, temporary geophone arrays deployed in Adventdalen, Svalbard in spring and autumn 2019. A similar class of events have also been detected in seismic records from the SPITS seismic array located on Janssonhaugen in Adventdalen, that has been in continuous operation since the 1990's. In both cases, estimated source positions are dominantly local and cluster around frost polygon, ice-wedge geomorphologies. Correlation with periods of rapidly cooling air temperature and consequent thermal stress build-up in the near surface are also observed. These events are consequently interpreted as frost quakes, a class of cryoseism. The dense, temporary arrays allowed high quality surface-wave dispersion images to be generated, that show potential to monitor structure and change in permafrost through passive seismic deployments. While the lower wavenumber resolution of the sparser SPITS array is less suited to imaging the near-surface in detail, the long continuous recording period gives us a unique insight into the temporal occurrence of frost quakes. This allows us, for example, to better understand the dynamic processes leading to frost quakes by correlating temporal occurrence with models of thermal stress in the ground, constrained by thermistor temperature measurements from a nearby borehole.