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Analysis of cold glacier ice with active- and passive-source seismics

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The investigation of glaciers and ice sheet with seismics has received more and more attention in recent years to investigate basal properties, to determine ice thickness, and to characterize physical properties of the ice column. Here I will concentrate on the investigation of physical ice properties with seismics.
Seismic wave velocities in firn and ice are influenced by density, temperature and a preferred crystal orientation fabric (COF). The velocity gradient is strongest within the firn column and can be derived from diving waves using the Herglotz-Wiechert inversion or by dispersion curve inversion of Rayleigh and Love waves. The derived velocity profiles can be linked to the density by empirical equations or used to derive Poisson's ratio. Anisotropy within firn and ice can have different reasons: (i) large scale structures like crevasses with a preferred orientation, (ii) thin layers within the firn with varying density, or (iii) a preferred orientation of the hexagonal ice crystals. Reflections from abrupt changes in COF have been observed in data from Greenland and Antarctica. Reflection seismics and measurement within boreholes have been used to derive anisotropic seismic velocities in ice and shear-wave splitting has been observed from icequake signals.
I will present an overview of recent studies and methods to investigate and derive ice properties from active- and passive-source seismic measurements.