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Applied Seismic Anisotropy for the Characterisation of Temperate Ice

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A combination laboratory and field measurements and modelling techniques were used to determine the effects of different ice characteristics on compressional wave velocity and anisotropy.

Ultrasonic data demonstrated variation in anisotropy along the core and with measurement frequency. Anisotropy variation with depth was attributed to ice, pore and crack characteristics over distances of few metres. Variation in velocity with frequency was attributed to pore fluid communication according to existing models, suggesting frequency dependent velocity dispersion occurs in the frequency range typically used in ultrasonic studies. Variation in anisotropy with frequency was tentatively attributed to frequencies being influenced by core characteristics at different scales and higher frequencies travelling along non straight wave paths.

Cross Borehole measurements showed no velocity trend with frequency and low anisotropy, which were attributed to anisotropy, which varies over small spatial scales, averaging out across the survey area, indicating that areas of a glacier that appear to be isotropic may be masking small areas of high anisotropy suggesting more complex stress histories. Three layers could be identified characterised by water content and porosity.

Combining LPO and VRH models provided a more accurate representation of compressional wave velocities than using models individually and highlighted the need to take pore geometry and spatial distribution, and cracks need to be taken into account in modelling. The modelling also suggested the possibility of determining a range of ice characteristics from a simple multi-frequency ultrasonic velocity study.