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Examining Crystal Fabric Develoment in Ice: Cryo EBSD, Deformation Experiments and the Link to En-glacial Reflectivity

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Over the past few years, cryogenic electron back-scatter diffraction (Cryo-EBSD) has been increasingly used to examine micro-structures in both natural and experimentally deformed ice samples on a micron-scale. Experiments that investigate grain size-sensitive behavior require working on fine-grained ice. These samples present a number of experimental challenges. Issues that present particular difficulties include stable mounting of ice samples, transport of mounted samples and producing a planar, frost-free and damage-free surface. Recent work at the new Otago Ice Deformation Lab has led to the development of a number of experimental methods that help overcome these challenges and enable routine EBSD analysis of fine-grained ice. A brief outline of these experimental methods and some EBSD results from variably deformed ice samples will be presented.

Shear deformation experiments on polycrystalline ice are being conducted in order to further explore the relationships between deformation, processes of recrystallization, and the development of anisotropic fabrics that lead to en-glacial seismic reflections. Self-contained, refrigerated deformation units fitted with digital controllers and hardware have been designed for unconfined deformation experiments on polycrystalline synthetic ice. Methods of analysis, from time-lapse photography to random-point tracking, are being employed for monitoring strain in real time. Various methods have been explored for monitoring the development of anisotropic fabrics in ice during progressive deformation. Ultra-sonic transducers can be used to monitor wave velocity changes in various orientations in materials under strain. These experiments have been designed with the objective of quantifying the relationship between deformation fabrics and en-glacial seismic reflectivity observed in thick grounded ice sheets.