Observation of the Microstructural Evolution of Polar Firn under Compression in a MicroCT

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ABSTRACT

The aim of this work is to understand how compression impacts the densification of polar firn. We applied a compressive load using a Material Testing Stage in a microcomputed X-ray tomograph (microCT) located in a cold room at -10 ℃ to samples taken at ~ 10 m intervals along the length of 80 m firn core extracted at Summit, Greenland in July 2017. Each sample was intermittently compressed in increasing strain increments at a strain rate of $\sim 8 \times 10^{-5}$ s^{-1}. Several features are noteworthy. First, densification along the whole length of the firn core is accompanied by decreases of the specific surface area, and both total and open porosities with increasing strain. Second, during densification an increase of structure thickness, a measure of the particle or grain aggregate size, occurs with increasing strain. Third, the decreases of the structure model index and surface convexity index that occur with increasing strain imply that the consolidation of particles occurs with increasing strain. Finally, as might be expected, the effect of a compressive load decreases with increasing depth.

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