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Insights into the formation of naled ice structures at Isunnguata Sermia, West Greenland, using aqueous geochemistry

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In many glacial settings, winter water outflows of emerging melt create stratified domed ice structures from successive freezing called naledi (also named icings or aufeis). These naledi are accretions of layered ice, typically on 1-10 m scale, that form where consistently flowing water meets sufficient cold air for freezing [1,2]. In previous studies, principally on Svalbard, the chemistry preserved in naled ice has been successfully characterized by analysing freeze-on deposits in early spring [3,4,5]. The overwinter solute flux captured in naledi differs significantly from early spring output, so the naledi is able to record distinct hydrochemical regimes. The glaciers of Svalbard represent smaller glacier hydrologic systems, with less storage capacity than the glacial outlets of the Greenland Ice Sheet (GrIS). It is therefore possible that the chemical signatures and formation mechanisms in GrIS outlet naledi may represent longer-term water storage and/or different formation mechanisms. As naledi store acute age-depth profile information, they can be used to measure and interpret both subtle and important changes in chemical and biological signatures through time.

Our research team have sampled water and accreted ice from the forefield of Isunnguata Sermia, a western outlet glacier of the GrIS. Samples of accreted ice (formed in summer) and naled ice (formed over winter) were collected over four seasonal research campaigns, over a 3 year period, during research intervals designed to capture late summer/post-melt and late winter/early spring accumulations, including the first eruption of subglacial water in spring. We present geochemical analyses of major cations (Na^+, K^+, Ca^{2+}), major anions (Cl^-,SO_4^{2-}, HCO_3^-) and trace elements (Fe^{3+}, Al^{3+}) from a range of water sources, which illustrate seasonal changes in chemistry and water source/flow paths. These results form the first conceptual model of winter-time subglacial water routing at Isunnguata Sermia, and naledi formation at this site.

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