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Proglacial icing Rieperbreen: tracking the source of water with natural and artificial tracers

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Proglacial icings, extrusive ice bodies forming during winter adjacent to many glaciers in the Arctic, have long been related to warm-based glacial conditions and the discharge of subglacial meltwater throughout the year. These paraglacial features, however, also occur in front of cold-based glaciers, such as the Rieperbreen proglacial icing in Central Spitsbergen. During the accumulation season of 2017, the icing formed about 1km from the glacier terminus in the main meltwater channel cutting through the frontal moraine complex. Due to Rieperbreen being cold based, the icing is not supplied by subglacial meltwater. The aim of this study is to determine the origin of water feeding the icing.

Ground-penetrating radar surveys conducted in winter 2017 revealed the existence of two springs forming the icing. Natural tracers were used in order to test the contribution of possible water sources feeding the springs, such as water from a lake, rain, snowmelt, ice melt or groundwater. Spring water samples were analysed for major ion concentrations as well as δD and δ^{18}O. Artificial (dye) tracers were employed to detect flow paths in the proglacial area.

δD and δ^{18}O values of spring samples are in good agreement with the Local Meteoric Water Line. Light isotopic values and deuterium excess $>10‰$ suggest parental water derived from precipitation fallen during winter. The lake located within the frontal moraine complex exhibits markedly lower isotopic values than spring samples and its water is hence dismissed of forming the icing. Given the isotopic signature and high chloride concentration of spring water, the origin is believed to be snowmelt generated during warm spells in winter. Fractionation in the snow pack and freezing effects result in meltwater depleted in heavy isotopes and d excess slightly deviating from the LMWL. No dye emerged from the upper spring during a 7-day experiment series, indicating water routed through a slow flow path before surfacing and forming the icing. Negative Oxidation-Reduction Potential shows that meltwater is kept from freezing in an anoxic, pressurized channel assumed present underneath the lateral ice cored moraine.