



The hydrological system of Tellbreen, a cold-based valley glacier on Svalbard, investigated by using a systematic glacio-speleological approach

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Determining the routing of meltwater through glacier systems is of paramount importance as the configuration of drainage networks can have critical role to play in glacier response to meteorological forcing and can strongly influence ice dynamics. Many existing studies have focused on hydrological systems within temperate or polythermal glaciers, and as a result, hydrological models of drainage pathways within glaciers are typically based on data from temperate or polythermal glaciers only. By contrast, little is known about the hydrological systems of cold glaciers, although they form a significant proportion of the total glacier population in the climate sensitive region of the High Arctic. However, these cold glaciers do not fit into existing models of glacier hydrological processes and investigations of meltwater pathways, storage and release in cold glaciers are strongly required in order to improve our current understanding.

Therefore, this study used a systematic glacio-speleological approach to investigate conduit systems within the tongue area of Tellbreen, a small cold-based valley glacier in central Spitsbergen. The main aims were to (1) investigate the presence and formation of supra-, en- and subglacial drainage channels, (2) gain more knowledge about the complexity of the drainage systems, and (3) discuss its implications for hydrological system of cold or polythermal glaciers.

Using glacio-speleological techniques, we explored three conduit systems and one moulin within the tongue area of Tellbreen. Over 600 m of channel length were surveyed and mapped in plan, profile and cross-section view to analyse the configuration of the drainage system. Furthermore, glaciological and sedimentological features exposed within the conduits and on the glacier surface were recorded, as these can provide an insight into the origin and evolution of the drainage system.

The investigations revealed that cold-based glaciers can exhibit a complex and arborescent drainage network with supra-, en- and subglacial components formed by cut-and-closure processes (incision of surface streams followed by roof closure). Surface-to-bed drainage occurs via moulins. Furthermore, we observed that water is stored within the glacier and released gradually all year round, forming a proglacial icing in the winter months. The presence of an icing and the observed complexity of the drainage network within Tellbreen suggests that existing models and understanding of the hydrology of cold glaciers needs to be re-evaluated.