Dendritic Ice Crystals in Stagnant Water Cavities on Temperate Mountain Glaciers

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Supra- and englacial hydrology has received much scientific attention in the past decades, yet not much is known about a certain type of tubular holes several meters deep, filled with mostly stagnant water. Sporadic remarks in older literature about large, dendritic ice crystals found repeatedly and abundantly within such cavities led to their rediscovery on small Tschingelgletscher in the Swiss Alps in July 2019. For this thesis, 18 trips to ten Swiss Alpine glaciers have been made in 2021, investigating the geometry, frequency, and spatial distribution of 174 supraglacial hydrological features, gathering depth and temperature data in combination with an underwater video system for in-situ documentation.

Stagnant water-filled holes were found to be abundant on temperate mountain glaciers, often in great numbers and in a variety of shapes and occasionally deeper than what is expected by differential melting processes. A classification scheme was developed, mostly based on geometrical and some hydrological properties. Most tubular holes seem to originate from inactive moulins and crevasses, with some arguable being remnants of relict englacial conduits uncovered by surface ablation. As such, these easily detectable surface features might be used as proxies for englacial meltwater pathways.

Many water cavities featured a thin superficial ice lid akin to primary and secondary ice on lakes. Beneath the surface, a multitude of ice crystal features was found, at times forming complex, decimeter-scale lattice structures of plates, needles, and dendrites within one night. These near-surface freezing phenomena derive from a negative surface radiation balance, as well as intergranular water flow through the weathering crust. Only once could large single crystals at the cavity walls be documented in situ, yet in combination with a characteristic wall ice structure, three hypotheses on the origin of supercooled water deep within temperate glaciers are presented.

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