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# Spatial and temporal controls on streamflow generation in a high arctic catchment: How does water accumulate along the valley floor?

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Spatial and temporal patterns of runoff generation are poorly understood in watersheds throughout the world, though this is particularly true in Arctic watersheds underlain by permafrost. Approximately 24% of land in the northern hemisphere is underlain by continuous or discontinuous permafrost. In these regions of the world, the presence of permafrost, along with rapidly changing climatic conditions, has posed a challenge to understanding watershed processes. Previous work on runoff generation in catchments underlain by continuous permafrost has been conducted at small spatial scales (single hillslope studies) and relatively large spatial scales (hydrograph analysis at the catchment outlet). The disparity in spatial scales makes it difficult to determine individual sources of streamflow at the watershed outlet.

This study aims to answer two questions: 1) what features of the watershed contribute the largest portions of streamflow to the watershed outlet? 2) How does the spatial variation of streamflow generation vary from high flow to low flow conditions? We conducted five synoptic campaigns, in which discharge, specific conductance, and temperature were measured at 16 different locations along the main stream of the valley floor of a low-gradient arctic watershed in northern Alaska. Our sampling efforts spanned a wide range of flow conditions (28 L/s - 286 L/s). Results show that watertracks (diffuse zeroth order streams) and a second-order tributary, account for 14-52% and 45-80%, respectively, of discharge accumulated along the studied reach. Portions of the study reach uninfluenced by either watertracks or tributary streams accounted for the remaining 0-13% of accumulated discharge, suggesting that diffuse groundwater inputs are small, but quantifiable within the study reach. Interestingly, several areas of the reach appeared to be gaining water during some sampling efforts, while losing water during others, suggesting a time-dependent bi-directionality of SW-GW interaction. Discharge contributions from watertracks, tributaries, and groundwater show no relationship to the total discharge at the watershed outlet, suggesting a more complicated relationship with antecedent moisture conditions across the watershed (a venue of ongoing investigation). This work elucidates fundamental runoff generation processes, uses inexpensive and translatable methodologies, and is the first work of its kind to be applied to a catchment underlain by continuous permafrost.