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Hydrogeochemical dynamics of a talik aquifer beneath the Kuuguluk River, Salluit, Nunavik (Québec, Canada)

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Rapid Arctic warming is accelerating permafrost degradation and altering hydrological connectivity in northern environments, with important consequences for groundwater resources and carbon cycling. This study presents the first integrated hydrochemical and isotopic characterization of the Kuuguluk River and its potential subriver talik aquifer in Salluit, Nunavik (Québec), based on samples collected during a field campaign in October 2024. Major ion chemistry indicates predominantly Ca–HCO_3 facies with low mineral saturation indices in surface water and shallow groundwater, consistent with recent meteoric recharge and limited water–rock interaction. Elevated tritium concentrations confirm the dominance of modern recharge pathways through the active layer and talik system. In contrast, deeper groundwater exhibits higher solute concentrations, enhanced sediment/rock–water interactions, and slightly lower tritium values, indicating a longer residence time. Although modern recharge dominates the system, radiocarbon-depleted signatures of dissolved inorganic and organic carbon in deeper groundwater suggest interaction with aged carbon pools, potentially mobilized through permafrost thaw. Dissolved radon (^{222}Rn) measurements provide direct field evidence of groundwater discharge into the river, and radon-based mass balance calculations suggest increasing downstream groundwater contributions, corroborating the hydraulic connectivity previously indicated by the hydraulic gradients measured in piezometers. By employing a geochemical and isotopic approach, this study provides new field-based constraints on groundwater–surface water interactions in a continuous permafrost setting. Continued multidisciplinary monitoring and modelling will be essential to assess the long-term sustainability of talik aquifers as drinking water sources under ongoing climate warming.