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Long-term destabilization of retrogressive thaw slumps (Herschel Island, Yukon, Canada)

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Retrogressive thaw slumps (RTS) are a common thermokarst landform along Arctic coastlines and provide a large amount of material containing organic carbon to the nearshore zone. The number of RTS has strongly increased since the last century. They are characterized by rapidly changing topographical and internal structures e.g., mud flow deposits, seawater-affected sediments or permafrost bodies and are strongly influenced by gullies. Furthermore, we hypothesize that due to thermal and mechanical disturbance, large RTS preferentially develop a polycyclic behavior.

To reveal the inner structures of the RTS several electrical resistivity tomography (ERT) transects were carried out in 2011, 2012, and 2019 on the biggest RTS on Herschel Island (Qikiqtaruk, YT, Canada), a highly active and well-monitored study area. 2D ERT transects were conducted crossing the RTS longitudinal and transversal, always reaching the undisturbed tundra. Parallel to the shoreline, and crossing the main gully draining the slump, we applied 3D ERT which was first measured in 2012 and repeated in 2019. The ERT data was calibrated in the field using frost probing to detect the unfrozen-frozen transition and with bulk sediment resistivity versus temperature curves measured on samples in the laboratory.

The strong thermal and topographical disturbances by gullies developing into large erosional features like RTS, lead to long recovery rates for disturbed permafrost, probably taking more than decades. In this study we demonstrate that ERT can be used to determine long-lasting thermal and mechanical disturbances. We show that they are both likely to prime the sensitivity of RTS to a polycyclic reactivation.