

Impact of abrupt permafrost thaw on mineral elements release: case study in Peel Plateau, west Canadian Arctic.

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Abstract.

Abrupt thaw events in ice-rich permafrost regions lead to local landscape degradations (subsidence) known as thermokarst structures, which expand with present-day warming in the Arctic. Among these events, Retrogressive Thaw Slumps (RTS) expose deep material to erosion in addition to gradual permafrost thaw. The resulting eroded material comprises a mixture of organic-rich active layer and generally more mineral-rich deep perennially frozen permafrost. Exposing mineral-rich permafrost to weathering agents such as water is known to be a source of soluble elements release to local streams. However, soluble mineral element release may also influence mineral-organic carbon interactions within the resulting eroded material, thereby affecting the permafrost carbon feedback. More in-depth quantification of mineral element release from eroded material is needed for more precisely assessing the potential contribution of thermokarst-induced soluble element release to the carbon balance in these regions.

Here we selected seven RTS structures from Peel Plateau, west Canadian Arctic, spanning a range of headwall height (2 to 25 m) and exposed land surface area (5 000 to 300 000 m²): we investigate RTS-affected permafrost soil profiles and sediments transported downstream from these disturbances. The organic carbon content, mineralogy, total elemental content and soluble element fractions were determined in soils at the slump headwall (active layer, Holocene permafrost, and Pleistocene permafrost) and in downstream eroded material (mud, and debris).

The data support that RTS development is responsible for horizontal transfer of materials downstream from deep Pleistocene permafrost. Indeed, based on (i) a similar mineralogy comprising weatherable mineral phases, (ii) similar total content in Ca, K, Al and Sr, and (iii) similar soluble content in Ca, K, Mg, Na, downstream mud and debris are shown to be mainly fed by Pleistocene permafrost materials.

The soluble element fraction from downstream eroded material is significantly higher than the one from previously thawed active layer soils. These soluble mineral elements may directly interact with organic carbon found in these mixed materials which were displaced by RTS and are now part of a new active layer developed on eroded materials.

Keywords: abrupt permafrost thaw, thermokarst, mineral element release.