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Characterization of mobilized sediments and organic matter in retrogressive thaw slumps on the Peel Plateau, NWT, Canada

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The Peel Plateau in northwestern Canada hosts some of the fastest growing “mega slumps”, retrogressive thaw slumps exceeding 2000 m² in area. The region is located at the former margin of the Laurentide ice sheet and its landscape is dominated by ice-rich hummocky moraines. Rapid permafrost thaw resulting from enhanced warming and increases in summer precipitation has been identified as a major driver of sediment mobilization in the area, with some of the largest slumps relocating up to 10⁶ m³ of previously frozen sediments into fluvial networks. The biogeochemical transformation of this thawed substrate within fluvial networks may represent a source of CO₂ to the atmosphere and have a large impact on downstream ecosystems, yet its fate is currently unclear. Concentrations of dissolved organic matter are lowered in slump-impacted streams, while the particle loads increase. Here, we aim to characterize the mobilized material and its sources by analyzing active layer, Holocene and Pleistocene permafrost, debris (recently thawed, still at the headwall) and slump outflow samples from four different slumps on the Peel Plateau. We use sediment properties (mineral surface area, grain size distribution), carbon isotopes (¹³C, ¹⁴C) and molecular markers (solvent-extractable lipids, lignin phenols, cutin acids, non-extractable compound classes analyzed by pyrolysis-GCMS) in order to assess the composition and quality of the mobilized sediment and organic matter and thereby improve our understanding of their fate and downstream effects. Preliminary results show that organic matter content and radiocarbon age in debris and outflow from all four slumps are dominantly derived from Holocene and Pleistocene permafrost soils with a smaller influence of the organic-rich active layer. Degradation proxies based on extractable lipid and lignin biomarkers suggest Holocene and Pleistocene permafrost organic matter to be more matured than the fresh plant material found in the active layer, while debris and outflow samples show a mixed signal. For the non-extractable organic matter, aromatics and phenols make up the largest fraction of all samples. Lignin markers are almost exclusively found in the active layer samples, which also contain a larger proportion of polysaccharides, while N-containing compounds and alkanes make up the remaining 2-25 % with

no obvious patterns. Active layer soils also have the highest median grain sizes, whereas Pleistocene permafrost soils consist of much finer mineral grains. Samples collected at the slump outflow are significantly more homogeneous (i.e., showing a narrower grain size distribution) than any of the other samples. We thus infer that both organic matter degradation and hydrodynamic sorting during transport play a role within these slump features; determining their relative magnitudes will be crucial to better assess potential feedbacks of these increasingly abundant “mega slumps” to changing climate.