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Retrogressive thaw slumps along permafrost coasts transform organic matter before release into the Arctic Ocean

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Changing environmental conditions in the Arctic have profound impacts on permafrost coasts, which erode at great pace. Although numbers exist on annual carbon and sediment fluxes from coastal erosion, little is known on how terrestrial organic matter (OM) is transformed by thermokarst and –erosional processes on transit from land to sea. Here, we investigated a retrogressive thaw slump (RTS) on Qikiqtaruk - Herschel Island in the western Canadian Arctic. The RTS was classified into an undisturbed, disturbed and nearshore zone and systematically sampled along transects. Collected sediments were analyzed for organic carbon (OC), nitrogen (N), stable carbon isotopes (δ13C-OC) and ammonium. C/N-ratios, δ13C-signatures and ammonium concentrations were used as general indicator for OM degradation. Permafrost sediments from the RTS headwall and mud lobe sediments from the thaw stream outlet were incubated to further assess OM degradation and potential greenhouse gas formation during slumping and upon release into the nearshore zone. Our results show that OM concentrations significantly decrease upon slumping in the disturbed zone with OC and N decreasing by >70% and >50%, respectively. Whereas δ13C-signatures remain fairly stable, C/N-ratios decrease significantly and ammonium concentrations increase slightly in fresh slumping material. Nearshore sediments have low OM contents and a terrestrial signature comparable to disturbed sites on land. The incubations show that carbon dioxide (CO2) forms quickly from thawing permafrost deposits and mud debris with ~2-3 mg CO2 per gram dry weight being cumulatively produced within two months. We suggest that the initial strong decrease in OM concentration after slumping is caused by a combination of OC degradation, dilution with melted massive ice and immediate offshore transport via the thaw stream. After stabilization in the slump floor, recolonizing vegetation takes up N from the disturbed sediment. Upon release into the nearshore zone, larger portions of OM are directly deposited in marine sediments, where they further degrade or being buried. The incubations indicate that CO2 is rapidly produced upon slumping and potentially continues to form within the

nearshore zone that receives eroded material. We conclude that coastal RTS systems profoundly change the characteristic of modern and ancient permafrost terrestrial OM during transit from land to sea - a process which is likely linked to the production of greenhouse gases. Our study provides valuable information on the potential fate of terrestrial OM along eroding permafrost coasts under the trajectory of a warming Arctic.