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Sediment archives from the Arctic Ocean provide evidence for massive remobilization of permafrost carbon in Siberia during the last glacial termination

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Environmental archives and carbon cycle models suggest that climate warming during the last deglaciation (the transition from the last glacial to the Holocene) caused large-scale thaw of Arctic permafrost, followed by the release of previously freeze-locked carbon. In addition to changing oceanic circulation and outgassing of CO_2 trapped in the deep glacial ocean, organic carbon (OC) release from thawing permafrost might have contributed to the rise in atmospheric CO_2 by 80 ppmv or ~200 Pg C between 17.5 and 11.7 kyr before present (BP). The few Arctic sediment cores to date, however, lack either temporal resolution or reflect only regional catchments, leaving most of the permafrost OC remobilization of the deglaciation unconstrained.

Our study explores the flux and fate of OC released from permafrost to the Siberian Arctic Seas during the last deglaciation. The Arctic Ocean is the main recipient of permafrost material delivered by river transport or collapse of coastal permafrost, providing an archive for current and past release of OC from thawing permafrost. We studied isotopes (Δ^{14}C-OC, δ^{13}C-OC) and terrestrial biomarkers (CuO-derived lignin phenols, *n*-alkanes, *n*-alkanoic acids) in a number of sediment cores from the Siberian Shelf and Central Arctic Ocean to reconstruct source and fate of OC previously locked in permafrost.

The composite record of three cores from the Laptev, East Siberian and Chukchi Seas suggest a combination of OC released by deepening of permafrost active layer in inland Siberia and by thermal collapse of coastal permafrost during the deglaciation. Coastal erosion of permafrost during the deglaciation suggests that sea-level rise and flooding of the Siberian shelf remobilized OC from permafrost deposits that covered the dry shelf areas during the last glacial. A sediment core from the Central Arctic Ocean demonstrates that this occurred in two major pulses; i) during

the Bølling-Allerød (14.7-12.9 kyr BP), but most strongly ii) during the early Holocene (11-7.6 kyr BP). In the early Holocene, flooding of 80% of the Siberian shelf amplified permafrost OC release to the Arctic Ocean, with peak fluxes 10-9 kyr BP one order of magnitude higher than at other times in the Holocene.

It is likely that the remobilization of permafrost OC by flooding of the Siberian shelf released climate-significant amounts of dormant OC into active biogeochemical cycling and the atmosphere. Previous studies estimated that a pool of 300-600 Pg OC was held in permafrost covering Arctic Ocean shelves during the last glacial maximum; one can only speculate about its whereabouts after the deglaciation. Present und future reconstructions of historical remobilization of permafrost OC will help to understand how important permafrost thawing is to large-scale carbon cycling.