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Vulnerability of subsea permafrost organic matter to degradation after thaw

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Subsea permafrost contains a potentially large and vulnerable organic carbon pool that might be or become a source of greenhouse gases to the atmosphere. While organic carbon stocks and vulnerability of terrestrial permafrost are increasingly well constrained, the dynamics of subsea permafrost remain highly uncertain due to limited observational data from these hard-to-access systems. Based on a unique set of drill cores from the near-coastal Laptev Sea, we here assess the vulnerability of subsea permafrost organic matter to degradation after thaw. To that end, we combine biomarker analyses of organic matter above and below the in-situ thaw front with incubation of subsea permafrost material in the laboratory. Biomarker degradation proxies based on the lignin phenol composition of organic matter (acid/aldehyde ratios of syringyl and vanillyl phenols; 3,5-dihydroxybenzoic acid/vanillyl ratio) suggest an overall low degradation state of lignin compared to terrestrial permafrost deposits and marine sediments in the region, and no systematic change across the thaw front. These lignin-based proxies are mostly sensitive to degradation under oxic conditions, i.e. before organic matter burial in subsea permafrost deposits, and less to degradation under anoxic conditions that prevail at the thaw front of subsea permafrost. Lignin phenol proxies will therefore be complemented by other biomarker degradation proxies sensitive to degradation under anoxic conditions, as well as by first data from incubation of subsea permafrost material under cold, anoxic conditions. Together, these data will enhance our understanding of organic matter in subsea permafrost, its vulnerability to degradation after thaw and the potential for greenhouse gas emissions from this system.