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When mobilized organic matter and glacial suspended sediment meet: effects of adsorption, photo- and biodegradation

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The thawing of permafrost is leading to increased export of organic matter into aquatic ecosystems that was previously stored within frozen peatland soils. This organic matter has been found to be reactive to microbial and photochemical processes, so that permafrost thaw is expected to lead to an increased production of greenhouse gases. Being able to predict the fate of these increased loads of terrestrial organic carbon in aquatic systems is therefore important from a climate change perspective. In a previous study we suggest that terrestrial organic compounds susceptible to photodegradation are also prone to adsorb to mineral particles. Whereas photodegradation stimulates CO_2 production, adsorption has the potential to remove organic matter from the water column and store it in the sediment. Warming at high latitudes involves both permafrost thaw and glacial melt. Glacial runoff streams often contain high loads of suspended sediment. As these minerogenic particles are transported downstream the aquatic continuum, they can eventually mix with water containing high concentrations of freshly released organic matter, and act as an adsorbent.

In order to predict CO_2 production from mobilized permafrost organic matter, we need to study the bioavailability of this material before and after alteration by physical and chemical processes such as photodegradation and adsorption to mineral particles. In this study, we compared the effect of adsorption to glacial suspended sediment to that of photodegradation on the dissolved organic matter composition of surface water collected from a thawing peat plateau in northern Sweden. We used optical measurements and mass spectrometry to evaluate changes in the composition of the organic matter and employed a three-month incubation to determine its bioavailability. Initial results from optical measurements indicate that while chromophoric compounds in general were removed by both photodegradation and adsorption, humic-like fluorescent compounds were more susceptible to photodegradation than adsorption. UV-irradiation increased bioavailability of the organic matter, whereas pre-treatment by adsorption to mineral particles slightly decreased bioavailability compared to the control. Results from this study will help advance our understanding of interactive effects between physico-chemical processes and microbial degradation at an increasingly relevant interface where melting permafrost meets glacial meltwaters.