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Cryohydrogeology and associated carbon transport resulting from deep permafrost degradation

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Deep permafrost holds both ice and organic matter, which comes available for transport and degradation when it warms and subsequently thaws. Currently continuous permafrost areas undergo warming with deepening of the active layer and increase in the number and size of taliks in the transition towards a more discontinuous permafrost system. Both processes will propagate deep groundwater flow. As a consequence, it is expected that more organic matter will be available for transport via groundwater flow towards surface water where it can degrade and enhance CO_2 and CH4 fluxes towards the atmosphere. At the same moment, timing of peak flow and magnitudes of base flow in nearby streams and rivers will shift. This will likely have profound socio-economic consequences when these areas are part of the source areas of important river systems such as the Yellow river or Lena river.
Cryohydrogeological processes are central in this process whilst it is not well known how water and solutes are transported through thawing permafrost. Numerical models are hardly constrained by field- and/or laboratory measured parameters that control coupled energy- water-, and solute transport in thawing permafrost. We address the question as to how organic matter will be released and transported by the reactivation of groundwater flow and the consequent deepening of groundwater flow paths that are to be expected in areas of permafrost degradation.
Sediment samples with known grain size, organic matter and pore ice content, will be thawed under controlled conditions. The breakthrough of meltwater and dissolved solutes will be monitored which will be related to spatial variation in pressure, moisture content and temperature inside the sample. This laboratory technique will allow to run a series of experiments using a range of sediment types in which the grain size, organic matter content and moisture content is controlled during the preparation of the soil sample. When the effect of these soil variables is known, the second step will be using field samples from different world wide permafrost locations (e.g. North Sweden, Tibetan Plateau) for validation. The project has recently started and the preliminary results will be presented.
The outcomes are expected to create insight in parameters which can be used for permafrost hydrogeology modelling of remote field sites to get a better understanding of future climate feedback due to changes in carbon release and degradation.

Keywords: Cryohydrogeology, Laboratory measurements, Carbon transport.