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Combining geochemical and geophysical parameters to characterize permafrost degradation at Abisko, Sweden: implications for iron-organic carbon interactions

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Between 30 and 80% of soil organic carbon (OC) in permafrost environments can be stabilized by interactions with mineral surfaces or metals such as iron. Iron-OC interactions may be modified by changing hydrological conditions upon permafrost thaw resulting in local subsidence. The challenge is to identify the early stage of thermokarst landforms, and to quantify the influence of thermokarst development on Fe and OC released in soil pore water upon thawing. We monitored the soil water content (SWC), soil temperature and soil electrical conductivity (EC) together with the chemical composition of the soil pore water along a gradient of thermokarst development and subsequent permafrost degradation at Abisko, Sweden (palsa-bog-fen). More specifically, we combined geophysical parameters (elevation, active layer depth, SWC and soil EC) and physico-chemical parameters (pH and soil pore water EC) at the profile and slope scales, with concentrations of Fe and dissolved organic carbon (DOC) in soil pore water at the profile scale. The results highlight that (i) at the profile scale, elevation, active layer depth and SWC are relevant geophysical criteria to discriminate between palsa, bog and fen; (ii) permafrost degradation leads to the mobilization of Fe and DOC in soil pore water; (iii) at the slope scale, landscape areas can be classified as palsa, intermediate or fen based on the three geophysical criteria and this can be used to derive the conditions for the mobility of Fe and DOC. These data support that physical degradation of permafrost and subsequent changes in SWC with thermokarst landform development from palsa to fen likely influences the geochemical conditions for the stability of Fe-OC interactions.

Session

- **ID:34 - The Arctic Critical Zone under threat: processes, fluxes and challenges**

Session Conveners:

Antonello Provenzale (Institute of Geosciences and Earth Resources / National Research Council of Italy, Italy); **Xiaofan Yang** (Beijing Normal University, China); **Piotr Owczarek** (University of Wroclaw, Poland)

Session Description:

The Critical Zone (CZ) is the living skin of our planet, extending from the top of vegetation canopy through soil and groundwater to unweathered bedrock, and it represents the life-support system of terrestrial ecosystems. Currently, climate and land-use change, soil erosion and water/air pollution affect the CZ in complex and disrupting ways. The Arctic, in particular, is changing at a high pace, with temperature increasing much faster than the global mean. Permafrost is thawing, the Active Layer is deepening and wildfires affect vast high-latitude areas. The Arctic CZ (ACZ) is heavily impacted by all these processes, and it is exposed to new pressures that can lead to potentially irreversible modifications. For this reason, we believe it is of utmost importance to monitor, measure and model the ACZ in all its components (soil, water, microbiota, vegetation, fauna, including geo/biodiversity) in a range of different environments, quantifying what is happening and estimating what could happen in the future and what prevention and adaptation measures could be implemented. For such reasons, the recently IASC-funded ACZON proposal “Towards an Arctic Critical Zone Observation Network” is devoted to explore and implement common strategies for monitoring, measuring and modelling the changing Arctic Critical Zone in a coordinated way. The proposed session is aimed at collecting the results of the initial activities of ACZON, to further develop and extend them, exploring the possibilities for a longer-term endeavor. In particular, we welcome contributions devoted to:

- 1. Effects of permafrost thaw, active layer deepening, changes in talik properties and temperature increase on ACZ carbon pools, fluxes, and processes
- 2. Interplay between the changing hydrological cycle and the modifications in the ACZ.
- 3. Weathering processes in the ACZ, landslides, and other geomorphological change
- 4. Formation of new CZ in deglaciating areas and changes in the ACZ along deglaciation chronosequences.
- 5. Current and past dynamics of large Arctic wildfires and their impact on ACZ.
- 6. Dynamics of newly-formed wetlands, lakes and ponds and their interplay with ACZ processes. Reconstructing lake and catchment biogeochemistry and geo/biodiversity using lake sediments as integrators of ACZ variability.
- 7. Long-term changes in the geo/biodiversity of the ACZ and related environments, associated with the effects of temperature increase, hydrological modifications and permafrost thaw.