Climat et Impacts 2022 https://premc.org/climat-impacts-2022/

Coupling of geochemical and geophysical measurements to characterize iron and organic carbon co-mobility upon permafrost thaw in an Arctic peatland in Abisko, Sweden.

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Permafrost region covers 24% of the Earth's total area and holds 1460-1600 Pg of carbon. A significant portion of this carbon (1035 ± 150 Pg) can be found in top three meters of the soil. With the degradation of permafrost due to the increase in air temperature in high latitudes (0.6 °C over the last 30 years), soil organic carbon (OC), which was previously frozen, is becoming more and more vulnerable to mineralization resulting in the reinforcement of the global warming through the release of greenhouse gases. Between 30 and 80% of soil organic carbon in permafrost environments can be stabilized by interactions with mineral surfaces or metals such as iron. These interactions are conditioned by the hydrological regime of the system. Upon permafrost thaw, soils are destabilized and a portion of the surface collapses resulting in local subsidence. This affects the hydrological conditions and hence OC-mineral interactions. 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 precisely, the measurement and sampling strategies aimed at coupling 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 while characterizing Fe and dissolved organic carbon (DOC) concentrations 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 5 : Dynamique des glaciers et des pergélisols de hautes latitudes/altitudes : évolution récente et archives paléoenvironnementales et géoarchéologiques / The dynamics of high latitude/altitude glaciers and permafrost: recent evolution and palaeo-environmental and geoarchaeological archives