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Tracking permafrost soil degradation through sulphur biogeochemical tracers

João Canario (1,3), Margarida C. Santos (1), Gonçalo Vieira (2,3), and Warwick F. Vincent (3)

(1) Centro de Quimica Estrutural, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, Lisboa, Portugal, (2) IGOT, Centro de Estudos Geográficos, Universidade de Lisboa, Lisboa, Portugal, (3) Centre d'études nordiques & Dépt de biologie, Laval University, Québec City, Québec, Canada

Rising temperatures are contributing to the rapid degradation of Arctic permafrost soils.
Several studies have been using some biogeochemical tracers as indicators of the organic matter degradation although fewer attention has been given to sulphur. In fact, the chemistry of this element is of environmental importance because it plays a key role in the degradation of natural organic matter and influences the partitioning, speciation and fate of other trace elements.
To better understand the role of sulphur in biogeochemical processes in permafrost soils several campaigns were undertaken in the Canadian subarctic region of Kuujjuarapik-Whapmagoostui and Umiujaq (QC) as a part of the Canadian ADAPT and the Portuguese PERMACHEM projects. In four sites along those regions soil samples were collected and pore water were extracted. Dissolved sulphur compounds (sulphide and sulphate) were determined in water samples while in soils particulate sulphides, pyrite and elemental sulphur were quantified by voltammetry. Organic sulphur compounds were identified using 33SssNMR and X-ray diffraction both in powder and single crystal analysis were used to identify crystalline sulphides. Finally, subsamples of soils and water samples were analysed for total particulate and dissolved organic carbon.
The results showed that sulphur composition depends largely on the origin of permafrost soils. In soils originated from organic-rich palsas, the proportion of organic sulphur (% of the total) is higher than 50%, while in mineral lithalsa soils the opposite was found. In both cases the origin of sulphur was mainly from plant organic matter degradation. The combined structural and chemical analysis allowed the identified different stages of soil degradation by determined the ratio between inorganic and organic sulphur species and by following the different NMR and XRD spectra.
These preliminary results pointed to the importance of the sulphur biogeochemistry in permafrost soils and provide a good toll in permafrost degradation biogeochemical studies.