

Redox chemistry of shallow permafrost porewaters in western Spitsbergen

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The western coast of Spitsbergen, located in the zone of continuous permafrost, is kept relatively warm for its latitude by the north Atlantic current. This sensitivity to oceanic and atmospheric warming provides an early warning system for the response of permafrost to climate change. This response includes the release of stored organic carbon and nutrients, which can lead to increased greenhouse gas (GHG) emissions from Arctic wetlands. The aims of this study are to i) develop a methodology to investigate *in-situ* processes contributing to GHG emissions in shallow permafrost, and ii) correlate the geochemical properties of these permafrost sediments with their potential to support GHG emission.

The focus of this project is on three locations within 10 kilometres of Longyearbyen, Western Spitsbergen, Svalbard. All locations were covered by warm-based ice during the Last Glacial Maximum, and so it was only after the deglaciation around 10,000 years ago that permafrost aggraded. After deglaciation, the following depositional environments typical of Svalbard formed and were the subject of this study: i) a sequence of raised beaches, formed due to isostatic rebound, and ii) a prograding delta overlain by aeolian sediments. Ice-wedge polygons and wetlands developed at all study sites.

Each location was drilled to a depth of 2 metres. The extracted sediment cores were transported frozen and stored at -18°C . Cores were subdivided at 2 centimetre depth resolution and the samples were equilibrated anaerobically with deionised, degassed water in sealed vials. Concentrations of methane and carbon dioxide in the vial headspace, the chemistry of the supernatant, and the initial moisture content of the sediments were determined.

Results show a zonation of redox chemistry with depth. Low redox chemistries, indicating anoxia, appear only below 60 cm depth. A correlation of ferrous iron and sulphate is also clear, indicative of the process of sulphide oxidation via reduction of ferrous to ferric iron (below 60 cm). Concentrations of dissolved methane in the porewaters are low ($<20 \mu\text{mol l}^{-1}$) and concentrations of dissolved carbon dioxide are higher ($<4000 \mu\text{mol l}^{-1}$). Nitrate concentrations are high throughout ($\sim 0.25 \text{ mmol l}^{-1}$). These results point to relatively high redox environments, in which the production of carbon dioxide dominates over the production of methane. This indicates that methanogenesis is limited in these environments by competing anaerobic respiration processes and/or counteracted by anaerobic oxidation of methane, which need to be accounted for in predictions of the future permafrost carbon feedback.