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Electron acceptor-based regulation of microbial greenhouse gas production from thawing permafrost

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Permafrost contains about 35% of the global soil organic carbon (0-3 m depth). As a consequence of global warming, the active layer thickness is steadily increasing and its organic carbon is becoming available for degradation, causing a concomitant release of CO_2 and CH4. The climate forcing feedbacks of permafrost thaw are determined by the rate of organic carbon degradation and to which degree it is released as CO_2 or CH4. Methane is produced under anoxic conditions, but the factors that regulate its production are poorly constrained. In this study, we investigate how CH4 production is influenced by the presence of competing anaerobic processes with focus on the role of iron and sulfate reduction. We have collected permafrost cores to 2.2 meters depth from three different lowland sites in Adventdalen on Svalbard. From these cores, we have prepared anoxic batch incubation for each 25 cm depth interval and followed the production of CO_2 and CH4 as well as the iron and sulfate reduction. This approach allows us to monitor the rate of the CO_2 and CH4 production as well as to investigate the correlation between CH4 production and competing anaerobic respiration processes in the active layer as well in the permafrost. These investigations are accompanied by characterization of the carbon, iron and sulfate content in the soil and will be followed by characterization of the microbial community structure. The aim of this study is to get a better understanding of how the availability of sulfate and iron and the microbial community structure regulate the production of CO_2 and CH4 in thawing permafrost, and to elucidate how the rate of the organic carbon degradation changes with depth in permafrost-affected soils. This study improves our understanding of climate feedback mechanisms operating during permafrost thaw.