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The competition between iron reduction and methanogenesis in an upland soil upon flooding

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Ljubljana marsh is a 16'000-ha fen area in central Slovenia (45˚58´N, 14˚28´E). For centuries it has been drained and reclaimed for agriculture. Becoming recently a part of the *Natura 2000* network, plans are discussed restoring Ljubljana marsh by modifying the drainage system and raising ground water levels. However, a high groundwater table will cause anoxic conditions in the soil eventually leading to production and emission of methane, an important greenhouse gas. A pilot experiment showed the potential for methanotrophy in the upper soil layer (0-30 cm), but only a minor methane production occurring after prolonged anoxic incubation. To predict the effect of changing the water regime, we studied methane and carbon dioxide production, iron reduction, methanogenic substrates, and the respective microbial populations in soil slurries incubated anoxically for 115 days. Below 12˚C, no methane production was observed at all. The lag phase of methanogenesis decreased with increasing temperature approaching a minimum of 7 days at the temperature optimum of methanogenesis at 38˚C. Up to the temperature optimum, the lag phase of methanogenesis was inveresely related to the accumulation of ferrous iron. The Archaea were dominated by Crenarchaeota (16Sr RNA-gene; 46 out of 46 clones). Methanogens as reveiled by the analysis of the mcrA-gene belonged exclusively to *Methanosarcina* (46 clones). In accordance with that, 60 to 100% of methane produced came from acetate. The *Geobacteraceae*-sequences (48 clones) were quite diverse. Iron reducers competed effectively with methanogens for substrates, in particular for acetate. Our results suggest that when the pool of ferric iron can periodically be recharged due to water table fluctuations, production of methane from soil organic carbon will be minor. Methane oxidation may further mitigate methane emissions. However, the effect of plant-mediated processes on methane emission remains still to be studied.