Iron oxides stimulate methane emission in rewetted Dutch agricultural soils

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Drained peatlands are net C sources. Rewetting these peatlands may provide potential benefits for carbon emission budgets, but a better understanding of ecosystem functioning following altered biogeochemistry and microbial community composition is essential for optimal mitigation strategies. Therefore the aim of our research was to investigate how the in-situ microbial community of rewetted agricultural soils will respond to the additions of ecosystem-relevant electron acceptors and how the presence of these e acceptors will influence the conversions of CH_4. We collected the top-layer soils from four contrasting Dutch agricultural sites and investigated their potential for methane cycling upon the addition of various electron acceptors. Over the course of 240 days, the methane production and oxidation was followed by GC and GC-MS measurements, and the microbial community was investigated by 16S rRNA amplicon sequencing.

In the presence of iron oxides and in controls without added electron acceptors, soil incubations showed strong CH_4 production. Addition of NO_2^-, NO_3^-, and SO_4^{2-} as electron acceptors resulted in the inhibition of the methane production. No significant anaerobic oxidation of methane was observed within 240 days. Aerobic methanotrophic bacteria were highly active in all 4 soils. The microbial community was mostly determined by the type of the soil. For the Archaea a high relative abundance of Bathyarchaeota and Woesearchaeota was observed in 3 cores. In the incubations were iron oxides were added a high relative abundance of Methanomicrobia was observed. The main Bacterial phyla in all cores were Bacteriodetes and Proteobacteria. This study shows that rewetting of degraded top soil may result in increased greenhouse gas emissions. More research is necessary to better understand methane dynamics in rewetted agricultural soils and to support decision making for best restoration strategies.