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Investigating the potential for anaerobic oxidation of methane in organic soils using ^{13}C-labelled methane

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Anaerobic methane oxidation, an important biogeochemical process limiting the flux of methane from marine sediments to the atmosphere, has recently also been demonstrated in terrestrial environments. This poses a challenge to the generally accepted model that methane is produced in anaerobic soils and that methane oxidation only occurs under well-aerated conditions. In contrast to aerobic methane oxidation, which is performed by methanotrophic bacteria, the anaerobic oxidation of methane is performed by ANME archaea, close relatives of methanogens.

This project aims to investigate the potential for anaerobic methane oxidation in organic soils, and ultimately to model the process to predict its overall significance. In northern latitudes, organic soils are a major source of methane to the atmosphere and thus contribute to global warming. However, the role of methane oxidation in such soils is poorly understood.

Preliminary work has focussed on developing effective methods for identifying methane oxidation in anoxic soils. Given that anoxic soils are predominantly methanogenic, a key challenge is to separate methane production from methane consumption. In the method developed here, sealed headspaces above anoxic soil slurries are labelled with $^{13}C\text{-}CH_4$, and gas samples are taken for subsequent analysis of overall methane concentration and ^{12}C / ^{13}C-methane isotope ratios. The underlying concept is that any $^{13}C\text{-}CH_4$ that disappears from the headspace can be attributed to methane oxidation, even where there is a positive overall methane flux from the soil. Methane oxidation should also result in associated increases in headspace $^{13}C\text{-}CO_2$. Preliminary results relating measured methane and carbon dioxide concentration changes and isotope ratios to inferred microbial activity are presented for different

anoxic organic soils. Maintaining anoxic conditions is the soil slurries is essential if true anaerobic methane oxidation is to be detected, as is shown by experimental work demonstrating that the slurries of the same soil readily switch from net production to net consumption of methane if air is not excluded from the system.

Future work will test the sensitivity of the ^{13}C-CH_4 enriched headspace technique using anoxic marine sediments in which anaerobic methane oxidation might be expected. Also, prompted by recent reports of anaerobic methane oxidation in nitrate-rich and sulphate-rich terrestrial environments, the impact of amending the soil slurries with sulphate and nitrate will also be investigated.