Stable isotope probing of the physical and biological controls on the fate and isotopic composition of carbon derived from the terrestrial methane sink

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Methane oxidizing bacteria (methanotrophs) occur in every soil order and are a vital sink for atmospheric CH_4 in well aerated soils. While there is generally good agreement regarding the magnitude of the soil CH_4 sink determined by methane flux determinations and process modeling, significantly, the fate of methane derived C remains largely unknown and unquantified. Poorly characterised aspects of the soil CH_4 sink include the physical and biological controls on the mechanism of CH_4 oxidation; the fate of CH_4, specifically the proportion of C sequestered as organic C *versus* that released as CO_2, the magnitude of kinetic isotope effects (KIEs) associated with high affinity methanotrophy and the influence on the $d^{13}C$ value of atmospheric CH_4. We have used multiple stable isotope approaches to investigate the magnitude, mechanism and pathways of the terrestrial methane sink. $^{13}CH_4$ stable isotope probing (SIP; Evershed *et al.*, 2006) has been used to characterize and quantify methanotrophic populations in a range of different soils (Maxfield *et al.*, 2006). Identification and quantification of methanotrophs is achieved via the analysis of ^{13}C-labelled phospholipid fatty acids, with link being made between population structure and function in relation to the predominant controls on methanotroph populations in a range of soils (Maxfield *et al.*, 2008). SIP has also facilitated taxonomic assignments of methanotrophs with associations being made between CH_4 derived C, methanotrophic bacteria and the downstream processing of their biomass C. The amount of ^{13}C retained within soils was monitored through bulk soil $d^{13}C$ analysis (total sequestered C) and isotopic analysis of soil biomarkers (C flow pathways) revealing that a significant proportion of the CH_4 derived C is retained within soils, rather than being lost as CO_2. SIP studies of *in situ* KIEs associated with uptake of atmospheric CH_4 by high affinity methanotrophic bacteria provide insights into physical and biological factors that influence the mechanism of uptake (Maxfield *et al.*, 2008).

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