

Anomalous uptake of CH₄ in volcanic soils indicative of a novel sink mechanism for atmospheric CH₄

PETER J. MAXFIELD^{1*}, EDWARD R.C. HORNIBROOK²,
RICHARD P. EVERSLED³

¹Centre for Research in Biosciences, Department of Applied Sciences, University of the West of England, Bristol, UK. BS16 1QY (*correspondence: pete.maxfield@uwe.ac.uk)

²Department of Earth and Environmental Sciences, University of British Columbia – Okanagan, Kelowna, BC, Canada.

³Organic Geochemistry Unit, School of Chemistry, University of Bristol, UK, BS8 1TS.

There is a great diversity of natural and anthropogenic sources of atmospheric methane (CH₄) but only three known sinks: oxidation by hydroxyl radicals in the troposphere, stratospheric loss, and oxidation by soil bacteria. To date, no physical processes have been reported that sequester atmospheric CH₄, however, sorption of CH₄ to mineral surfaces in marine sediment is common [1] and CH₄ adsorption onto selected nanoporous zeolites has been modelled [2].

We conducted a ¹³CH₄ stable isotope switching (SIS) [3] study on Hawaiian soils to investigate the effects of soil weathering and development on atmospheric CH₄ uptake. Results indicated an anomalous sink mechanism for atmospheric CH₄ that appears to be most likely linked with long term abiotic adsorption of atmospheric CH₄ under Earth surface conditions (temperature and pressure). Capture and sequestration of CH₄ was reversible, and adsorbed CH₄ bio-available; demonstrated by subsequent CH₄ oxidation by high affinity methanotrophic bacteria in younger soils (<150 ka).

We suggest the composition of the colloidal fraction (<2 μm) of a soil impacts CH₄ sink capacity beyond the direct influence that physical structure has on soil gas diffusion. The type, activity, and surface area of soil minerals appears to exert a direct control on CH₄ uptake, storage and supply, prior to CH₄ access by soil methanotrophs. This additional uptake mechanism increases the potential microbial CH₄ sink and explains elevated CH₄ uptake capacities reported from minearologically similar andisols in Tenerife [4].

[1] Ertefai *et al.* (2010) *Geochim. Cosmochim. Acta.* **74**, 6033–6048, [2] Kim *et al.* (2013) *Nat. Commun.* **4**, 1694, [3] Maxfield *et al.* (2012) *Rapid Commun. Mass.* **26**, 997-1004, [4] Maxfield *et al.* (2008) *Environ. Microbiol. Rep.* **1**, 450-456.