Methane geochemistry's 'stealth' process: Microbial oxidation

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For the purposes of this presentation, I consider a 'stealth' process as one that cannot be directly measured. Microbial methane oxidation, aerobic and anaerobic, are examples. Most of the fluxes used to assemble the global methane budget are net fluxes, the difference between production and consumption, so direct measurements of production and consumption require tracer measurements. Several recent high-profile climate modeling papers have fallen into the 'stealth process' trap by failing to explicitly consider microbial oxidation.

This talk reviews recent developments in quantifying methane oxidation in the oxic ocean and estimates the global importance of both aerobic and anaerobic oxidation in a range of environments as controls on global change induced production. New methods sre discussed and remaining challenges are enumerated.

Phase separation, degassing and anomalous methane at the Menez Gwen hydrothermal field

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The Menez Gwen neovolcanic dome, lying at ~800m depth, hosts one of the shallowest basalt-hosted hydrothermal systems on the Mid-Atlantic Ridge and vent fluids there have unusually high CH_4/H_2 ratios relative to ultramafic- and other basalt-hosted systems [1]. To further constrain the origin of this CH_4, fluids were sampled in 2010 from vents on the dome's eastern flank, and from a newly discovered vent field, Bubbylon, 5km to the south of the Menez Gwen dome.

Maximum vent temperatures (270–298°C) in the eastern Hot Sands and AzorAna areas are near the 2-phase boundary and near-seafloor subcritical phase seperation (boiling) is pervasive. Endmember CH_4 (0.37–3.6mmol/kg) and CO_2 (11–78mmol/kg) concentrations are high, but H_2 (0.06–0.57mmol/kg) is low, and only a narrow Cl range (202–368mmol/kg) is evident. Two volatile-rich diffuse fluids (91–117°C) sampled appear to have formed by subsurface mixing of near zero salinity vapor phases with entrained seawater, with apparent CH_4 and CO_2 end-member concentrations of ~30 and ~600mmol/kg, respectively. Such extreme volatile enrichments due to boiling are likely responsible for the ubiquitous gas bubble exsolution evident at the seafloor, releasing substantial CO_2 and CH_4 to the water column. Despite boiling-related variability, endmember CH_4/H_2 ratios (2.5–18) remain anomalously high in 2010. Trace NH_4^+ concentrations (<5μmol/kg) and $\delta^{13}C_{CH4}$ values (-16.6‰ to -19.9‰) within the typical range of unsedimented systems preclude any subsurface sedimentary source of thermogenic CH_4 [2]. Thermodynamic considerations also exclude abiotic CO_2 reduction to CH_4 at the conditions encountered by fluids. This suggests a deeper source of CH_4, such as the volatile-rich fluid inclusions found in oceanic crust Layer 3 [3]. CH_4 radiocarbon and C_{2+} hydrocarbon analyses are ongoing.

[1] Charlou *et al.* (2000) *Chem. Geol.* **171**, 49–75. [2] Lilley *et al.* (1993) *Nature* **364**, 45–47. [3] Kelley & Früh-Green (1999) *J. Geophys. Res.* **104**, 10439–10460.