Abiotic N_2O production enhanced by Fe precipitates in anoxic seawater

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There is evidence emerging that suggests atmospheric nitrous oxide (N_2O) played an important role for climate and an early biosphere on the Archaean Earth. Based on a model of the atmospheric chemistry induced by solar energetic particles, abiotic nitrogen fixation was a viable and steady source of NO_x and N_2O (1). Further support of an N_2O-rich ancient environment comes from metagenomic analysis of soil microbial communities (2). N_2O respiration seems to have evolved prior to the separation of the domains *Bacteria* and *Archaea (3)*. We hypothesize that substantial N_2O in the Archaean can be triggered by enhanced flux to the atmosphere. This stimulation is based on the catalytic effect of Fe precipitates on NO_x reduction to N_2O.

Here, we investigate abiotic N_2O production from an anoxic, Fe^{2+}-rich artificial seawater, analogous to the composition inferred for the Archaean ocean. Our results indicate a pH-dependent process (Fig. 1), that is greatly enhanced in the presence of distinct Fe precipitates. We used nitrite as substrate for N_2O production with an initial concentration ratio nitrite:Fe^{2+} of 1:2.

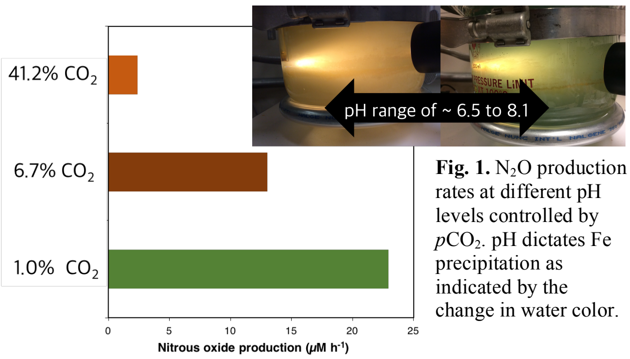

Fig. 1. N_2O production rates at different pH levels controlled by pCO_2. pH dictates Fe precipitation as indicated by the change in water color.

The data shown is based on 24 hour runs of an anoxic reactor and linear regression of the N_2O headspace determined by IR spectroscopy. We will further present results from experiments with magnetite derived from *Magnetospirillum* cultures as well as FeOOH precipitates produced by photooxidation. Our work can help to better understand the significance of N_2O in the anoxic Archaean, and complement reaction rates derived from microbial denitrification.

[1] V. S. Airapetian, A. Glocer, G. Gronoff, E. Hébrard, W. Danchi, *Nature Geoscience* **9** (2016). **[2]** C. M. Jones, A. Spor, F. P. Brennan, M. -C. Breuil, *et al.*, *Nature Climate Change* **4**, 801-5 (2014). **[3]** W. G. Zumft, P. M. Kroneck, *Advances in Microbial Physiology* **52**, 107-227 (2007).