Possible novel mechanism of anaerobic methane oxidation in permanently ice-covered Lake Fryxell, Antarctica

VLADIMIR SAMARKIN¹, MICHAEL MADIGAN², MARSHALL BOWLES¹ AND SAMANTHA JOYE¹

¹Department of Marine Sciences, The University of Georgia, Athens, GA

²Department of Microbiology, Southern Illinois University at Carbondale, Carbondale, IL

Perennially ice-covered Antarctic lakes provide a unique opportunity for studying the biogeochemistry of microbial carbon cycling. Anaerobic oxidation of methane (AOM) is an important component of carbon dynamics in lakes. The mechanism of AOM in marine sediments appears to be reverse methanogenesis coupled to sulfate reduction (SR) by a consortia of methanotrophic *Archaea* and sulfate reducing *Bacteria*, with AOM and SR linked in a ratio of 1:1 [1].

We measured rates of AOM and SR in the amictic freshwater Lake Fryxell (McMurdo Dry Valleys) using ${}^{14}CH_4$ and ${}^{35}SO_4{}^{2-}$ as radiotracers. Lake Fryxell contains significant levels of both sulfide and methane, and the latter is completely consumed in its anoxic waters [2]. Experiments to stimulate AOM with sulfate and inhibit it with tungstate were performed to probe for a connection between SR and AOM in anoxic Lake Fryxell near bottom water (Table 1).

Treatment	AOM rate, nM L ⁻¹ day ⁻¹	SR rate, nM L ⁻¹ day ⁻¹
Lake water, 17 m (0.33mM SO^{2-})	28 1+4 3	1.05
SO ₄ ²⁻ , 1.33mM	31.6±6.2	1.72
Tungstate, 10mM	33.9±2.4	0

Table 1: Effect of sulfate and tungstate on AMO and SR.

The data of Table 1 indicate that AOM and SR are uncoupled in Lake Fryxell. Specifically, AOM was neither stimulated by sulfate nor inhibited by tungstate. An alternative mechanism of AOM in Lake Fryxell is thus likely and is under study using molecular and biogeochemical approaches.

[1] Boetius *et al.* (2000) *Nature* **407**, 623–626. [2] Smith *et al.* (1993) *Biogeochemistry* **21**(2), 95–115.

Insights into ancient magma chamber evolution based on Sr and Nd isotopic composition of apatite

S.D. SAMSON* AND T. DASGUPTA

Syracuse University, Syracuse, NY 13244, USA (*correspondence: sdsamson@syr.edu, tdasgupt@syr.edu)

A wealth of information concerning magma chamber complexities has been gathered in recent years based primarily on the observation of chemical and isotopic zonation in phenocrysts from Recent volcanic rocks. There have been considerably fewer reports of isotopic variations in crystals from ancient tephra and from plutonic rocks, although such variations have the potential to provide considerable insights in magma chamber dynamics and evolution. To test the potential for intracrystal isotopic variation in such rocks we determined initial Sr and Nd isotopic compositions of apatite from ~ 300 Ma granitoids and from a 450 Ma K-bentonite all collected in the southeastern USA.

Apatite was chosen because diffusion experiments have shown that Sr and rare earth elements remain virtually closed to diffusion up to $\sim 600^{\circ}$ C. Two approaches were taken to compare compositions of crystal cores and rims. The first method involves the physical abrasion of apatite. This technique destroys crystal rims, but allows for a simple method to analyze cores. The second method involves acid leaching of annealed apatite to dissolve rim material leaving residual cores that can be subsequently analyzed. Results for the apatite in the granitoids can be grouped into two categories: apatite with high 87Sr/86Sr rims and relatively lower ⁸⁷Sr/⁸⁶Sr cores (five plutons) and apatite with the opposite behavior (two plutons). Nd isotopic variations in core and rim are consistent with the Sr isotopic data. Apatite thus appears to be capturing the influx and mingling of both more and less evolved magmatic pulses depending on the granitic system information lost on whole-rock analyses.

Apatite extracted from vertical sampling of a single large K-bentonite have variable ⁸⁷Sr/⁸⁶Sr suggesting crystallization in a very dynamic magma chamber environment. Apatite isotopic composition appears to be an important recorder of petrogenetic processes and provides more information than a whole-rock initial isotopic composition.