

## Methanotrophic bacteria drive seasonal anoxia and the formation of a benthic nepheloid layer in a deep alpine lake

J. BLEES<sup>1</sup>, H. NIEMANN<sup>1</sup>, C. B. WENK<sup>1</sup>, J. ZOPFI<sup>1</sup>,  
M. VERONESI<sup>2</sup>, C. J. SCHUBERT<sup>3</sup> AND M.F. LEHMANN<sup>1</sup>

<sup>1</sup>Department of Environmental Sciences, University of Basel, Basel Switzerland; moritz.lehmann@unibas.ch

<sup>2</sup>Institute of Earth Sciences, University of Applied Sciences of Southern Switzerland, Canobbio-Lugano, Switzerland

<sup>3</sup>Swiss Federal Institute of Aquatic Science and Technology (EAWAG), Kastanienbaum, Switzerland

We investigated the composition and formation mechanisms of a seasonal benthic nepheloid layer (BNL), a layer of high suspended particle concentration, in the monomictic southern basin of Lake Lugano. During stratified water column conditions, lasting from early summer until winter mixing in January/February, the BNL developed from the sediment-water interface and expanded 20–30 m into the water column, in tandem with the rising redox transition zone. Methanotroph-derived fatty acids (C<sub>16:1 $\omega$ 5-8</sub>), with  $\delta^{13}\text{C}$  values as low as -90‰, dominated the fatty acid pool within the BNL. Based on C-isotope data, we calculated that up to 98% of the lipid carbon is methane-derived, suggesting that the BNL is primarily composed of aerobic methane oxidising bacteria. The lipid composition indicates that the methanotrophic community in the BNL in Lake Lugano is dominated by Type I methanotrophic bacteria. Total cell numbers ranged between 0.9 and 3.6 × 10<sup>6</sup> cells mL<sup>-1</sup> during full development of the BNL. In incubation experiments we determined CH<sub>4</sub> turnover rate coefficients that translate into potential CH<sub>4</sub> oxidation rates as high as 20 μM d<sup>-1</sup>. The corresponding cell-specific rates were up to 49 × 10<sup>-5</sup> pmol cell<sup>-1</sup> h<sup>-1</sup>, which is reasonable for Type I methanotrophic bacteria. CH<sub>4</sub> oxidation in the BNL was limited by the diffusive supply of O<sub>2</sub> from the upper hypolimnion, implying that CH<sub>4</sub> oxidation is the primary driver of the seasonal expansion of the anoxic bottom water volume, and explaining the vertical migration of the BNL in response to its own O<sub>2</sub> consumption. Our study demonstrates that methanotrophic activity at the interface between oxic and anoxic water masses can drive the formation of a BNL. Such a layer of high bacterial density and high CH<sub>4</sub> oxidation potential may thus function as an efficient CH<sub>4</sub> barrier, preventing CH<sub>4</sub> transport into surface waters, and eventually evasion to the atmosphere.

## Niobium Mineralization in a Magnetite-Rich Carbonatite, Elk Creek, Nebraska (USA)

<sup>1</sup>M. BLESSINGTON, <sup>1</sup>R. KETTLER, <sup>2</sup>P. VERPLANCK  
AND <sup>3</sup>G.L. FARMER

<sup>1</sup>Department of Earth and Atmospheric Sciences, University of Nebraska, Lincoln, NE, 68588-0340, USA

<sup>2</sup>U.S. Geological Survey, Central Mineral Resources Science Center, Box 25046, Denver Federal Center, MS-973, Denver, CO 80225-0046, USA

<sup>3</sup>Department of Geological Sciences, University of Colorado, Boulder CO 80309-0399, USA

The Elk Creek carbonatite is a roughly circular 7km\*7km intrusive carbonatite-alkaline syenite complex located in Southeast Nebraska. The complex is overlain by younger marine sediments and quaternary glacial till – No surface exposure exists, but drill cores collected by Molycorp in the 1970s-80s have been made available to the public for research. The carbonatite comprises several geochemically distinct intrusive phases with notable anomalous enrichment in rare earth elements and niobium. These phases include a dolomite-magnetite carbonatite (“magnetite beforite”) phase which consists of two lobes, each approximately 0.1 square kilometer in size and extending downward to the maximum extent of drilling (900 meters). This dolomite-magnetite carbonatite is typically an aphanitic microbreccia including accessory apatite, biotite, and pyrite. Hematite dusting on mineral surfaces is pervasive, and veining is widespread. Fragments of dolomite-magnetite carbonatite are also present in a spatially-associated breccia along with fragments of apatite-dolomite carbonatite.

XRF analysis of a powdered bulk sample of the dolomite-magnetite carbonatite yields data that indicate that the dolomite-magnetite carbonatite differs from other carbonatite phases in that it has much higher Ti, Th, and W compared to the other intrusive phases. It also differs from the other intrusive phases in that Fe > Mg and it is depleted in light REE relative to the other rocks. The magnetite carbonate also contains micron-scale (0.01-0.10mm diameter) accessory niobium pyrochlore, disseminated in dolomite and biotite, in economically-significant concentrations (10,000ppm or higher Nb in bulk sample). The prevalence of pyrochlore across the entire complex is directly related to the presence of this dolomite-magnetite carbonatite.