Two ferruginous Midwestern lakes exhibit vastly different fluxes of methane

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Introduction

Freshwater lakes represent 2-3% of Earth's land surface [1] and are estimated to release up to 103 Tg CH_4 yr^{-1} [2]. Therefore, freshwater lakes are a significant source to the global CH_4 budget.

Brownie Lake in Minneapolis, MN and Canyon Lake in the Upper Peninsula, MI are two freshwater lakes that have been newly characterized as Archean-Proterozoic ferruginous ocean analogs. Both lakes are permanently stratified; Brownie Lake experiences anthropogenically-induced meromixis and Canyon Lake meromixis is naturally occurring. Both lakes are highly ferruginous; dissolved iron concentrations below the chemocline can reach 1.6 mM.

Discussion of Results

According to Bastviken *et al.* [3], lake area can predict the contribution of different CH_4 flux pathways. At Brownie, 65% of CH_4 produced is predicted to be released by ebullition. Similarily, 60% is expected at Canyon. In addition, both lakes harbor similar concentrations of CH_4 in the unmixed, bottom water (~1.55 mM). This CH_4 concentration maximum is similar in other well-studied ferruginous lakes such as Lake Matano (1.4 mM) and Lake La Cruz (2.2 mM). However, the flux of CH_4 from Brownie and Canyon Lakes is greatly different. In 2017, the average flux of CH_4 emitted from Brownie Lake was ~125x higher than Canyon Lake. The controls on these fluxes are beginning to be investigated. Organic matter input, microbial community, nutrient limitation, and oxygen penetration within each water column are significant variables being considered.

[1] Downing *et al.* (2006) *Limnology and Oceanography* **51,** 2388-2397. [2] Bastviken *et al.* (2011) *Science* **331,** 50. [3] Bastviken *et al*. (2004) *Global Biogeochemical Cycles* **18,** 1-12.