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Interactive comment on "Rates and pathways of CH_4 oxidation in ferruginous Lake Matano, Indonesia" *by* A. Sturm et al.

Anonymous Referee #3

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The article of Sturm et al. describes the investigation of methane oxidation pathways in Lake Matano, Indonesia. This unique ecosystem is considered to represent conditions like they existed in Precambrian oceans, and thus understanding of methane fluxes in such an ecosystem would provide valuable information of Earth' early methane cycle. The authors performed incubation experiments with radiolabeled methane and obtained methane oxidation/methane assimilation rates for various depths ranging from oxic to fully anoxic.

General comments: The authors state that methane oxidation in the anoxic water column is supported by oxidized metals or nitrogen oxides, however, the evidence provided to make this conclusions is not sufficient to make these statements. Conclusions are based on theoretical ΔG calculations based on in-situ concentrations of above mentioned potential electron acceptors including sulfate. In my opinion, these cal-

culations can only remotely reflect the actual situation since the fluxes are not considered here. Sulfate concentrations were discussed to be insufficient to explain the observed rates, which led to the conclusion of its minor contribution to AOM. Lake Matano ecosystem has been described as rich in iron and manganese oxides, which could fuel a cryptic sulfur cycle in this lake. Thus, sulfate produced via such a process could potentially still fuel the sulfate dependent AOM without a measurable sulfate accumulation. Incubation experiments of lake water amended with the discussed potential electron acceptors would possibly add more information about their stimulation of methane oxidation rates. Another very valuable addition to unravelling the methane oxidation pathways in different depth intervals would be the investigation of microbial community including 16S rRNA phylogeny and known functional genes. The authors speculate of the involvement of nitrogen oxides in AOM and since the functional genes are known for both nitrite- and nitrate dependent AOM, it would be interesting to see whether at least the so far known organisms are involved. Moreover, the authors show that the substantial amount of methane must be assimilated into biomass. I wonder what part of the microbial community id responsible for the calculated methane uptake.

In general, the authors should either weaken their conclusions about the involvement of alternative electron acceptors in observed methane oxidation or provide additional evidence to support the current statements.

Specific comments to introduction: Lines 20-23: M. oxyfera enrichment cultures were shown to perform nitrite-dependent anaerobic methane oxidation. Please correct the text. The enrichment culture of archaea performing nitrate-dependent methane oxidation was described to produce nitrite (not ammonium) as the main end product which provided substrate for anammox bacteria (Haroon et al., 2013). Please correct the text.

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