

## ***Interactive comment on “Rates and pathways of CH<sub>4</sub> oxidation in ferruginous Lake Matano, Indonesia” by A. Sturm et al.***

### **Anonymous Referee #1**

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This review is based on files uploaded by Arne Stum (17 oct 2015)

#### General comment

The main subject of this manuscript is methane oxidation in the ferruginous lake Matano. The topic is really interesting, since anaerobic methane oxidation in freshwaters is understudied. The environment is well chosen to study anaerobic methane oxidation coupled with other electron acceptors than sulfate. Just put in evidence such high rates of anaerobic CH<sub>4</sub> oxidation is already very interesting. Also, results of the importance of CH<sub>4</sub> in the foodweb are really interesting.

However, numerous informations are lacking. Results of anerobic methane oxidation, which is the main subject of this manuscript, are poor. Authors only measured sulfate reduction during their incubations, whereas the decrease of nitrate, nitrite, iron and

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manganese concentrations in the incubations would have been really informative. Also, pyrosequencing data are missing. For example, these data would have been really interesting to understand why anaerobic methane oxidation is not coupled with sulfate reduction at 115 and 120m, whereas sulfate concentrations are clearly sufficient. Also, authors talk about CH<sub>4</sub> fluxes in their abstract and conclusion, but no data of fluxes are shown.

General question: Oxidation in the oxic water column: Authors justify low aerobic CH<sub>4</sub> oxidation rates by the inhibition by very high O<sub>2</sub> concentrations above 45 m. However, below 45 m, they say that inhibition due to O<sub>2</sub> would be unlikely. So, how to explain low aerobic CH<sub>4</sub> oxidation rates from 45 to 100 m ? Also, how do the authors explain low CH<sub>4</sub> concentrations in the oxic compartment, since aerobic CH<sub>4</sub> oxidation is low, compared with huge amounts of CH<sub>4</sub> in anoxic water column ? By the water column structure of the lake (not fully described in this manuscript), by the importance of anaerobic CH<sub>4</sub> oxidation ?

#### Specific comments

Abstract Rates are lacking throughout all the abstract. Please correct. Line 4: Authors say here that methane oxidation rates are low, while they show in table 1 and in text that anaerobic methane oxidation rates are high. Please clarify. Line 5: "to preclude strong CH<sub>4</sub> fluxes to the atmosphere" => What proof do you have ? No measurements of CH<sub>4</sub> fluxes were made in this paper. Line 8-9: No direct evidence of which electron acceptors are used. Line 11: Please note the different fractions (fraction of CH<sub>4</sub> assimilated and fraction of CH<sub>4</sub> oxidized to CO<sub>2</sub>). Line 12-13: "...and potentially other ferruginous or low productivity environments" => authors did not study another environment, it is clearly speculative => not in the abstract.

#### Introduction

References are not well sorted. For example, Page 2 Line 17: Kroeger 2011, Cicerone 1988, Conrad 2009; not sorted by year, nor by name. Page 2 Line 17: references are

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not well chosen. Please reference more general papers/reports, such as IPCC. Page 2 Line 22: not only in sediments and soils; methanogenesis can also occur in anoxic water columns Page 3 Lines 8-9: "aerobic CH<sub>4</sub> oxidation is believed to dominate CH<sub>4</sub> consumption in these environments" => reference ? Page 3 Line 12-13: "In the large intervals....where CH<sub>4</sub> occurs": sentence not clear => please clarify Page 3 Line 12-14: Reference ? Page 3 Line 16-17: Reference ? Please better describe water column structure of Lake Matano => Is the structure dependent of season ? Sulfate, nitrate, nitrite... concentrations are the same throughout the year or do they change according to the season ? Etc.

### Material and methods

Page 5 Line 14: (ie. <100 m or > 140m, respectively). Page 5 Lines 13-19: Why did authors use different sampling methods for deep and shallow and intermediate depths ? Page 7 Line 22: "to prevent the introduction of atmosphere" => to prevent the introduction of atmospheric O<sub>2</sub>. Page 8 Lines 1-3: "The syringes....at the end" => sentence not clear. Please clarify the incubations' times. Page 8 Lines 10-11: "Oxygen was below detection...to 130 m" => it is a result; not in the M&M. Page 9 Lines 10-13: "Summaries....215 nmol l<sup>-1</sup> d<sup>-1</sup>." => also a result; not in the M&M. Page 10 Lines 6-8: "Summaries.... 0.11". => not in the M&M.

### Results

Page 12 Lines 3-4: "as previously observed" => put the reference of Crowe's papers here. Page 12 Line 22: it's easier when the text is in the same order as figures => talk about Fe<sup>2+</sup> and NH<sub>4</sub><sup>+</sup> (Fig. 3a) at the same time as O<sub>2</sub> and Mn<sup>2+</sup>. Page 13 Line 9: between 20 m and 39.5 m ranged from 0.2 to 0.43. Page 14 Lines 7-15: references of the figures are missing.

### Discussion

Page 14 Line 20: Table 1 is after table 2 in the text (table 2 appears page 13). Page 15

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Line 18: "comparable freshwater systems" => all the lakes in Table 1 are not comparable to Matano. Temperature highly influences bacterial processes and numerous lakes referenced in this table are boreal or temperate lakes, while Matano is a tropical lake. Page 17 Lines 17-21: sentence not clear => please clarify. Page 18 Lines 9-10: "..., and could ONLY account for up to 7.7, 22.1 and 0.37 %..." => I find that contributing for 1/5 (22.1%) of CH<sub>4</sub> oxidation is not negligible, so the word "only" is misused. Page 18 Lines 12-16: sentence not clear, too long => please clarify. Page 18 Lines 18-20: "This suggests... to 130m" => At 115-120 m, sulfate concentrations are clearly sufficient to explain all the CH<sub>4</sub> oxidation observed, but sulfate reduction rates are very low. Why ? How do you explain that ? Is it due to bacterial communities ? Page 19: Authors admit that a potential contamination by O<sub>2</sub> into syringes lead to uncertainties in the availability of the electron acceptors. I wonder if this method with syringes was well chosen. Why not use glass serum bottles ?

#### Figures and tables

Table 1: Mono Lake nM d-1 => rates are in nmol L-1 d-1 ? Column title: oxidation rate  $\mu\text{mol L}^{-1} \text{d}^{-1}$  => please clarify. Figure 2: This manuscript shows the results of the field campaign 2010. In this figure, 4 other dates are shown, with no reference to another paper in the caption. Please clarify. Figure 3: Please put the legend outside the graph b. Figure 4: The scales of rates are not useful at all. We cannot visualize the rates precisely. Also, please more divide Y scale. Figure 5: caption not clear and no complete. Figure 6: legend not complete => what are dots ? And why show Fe<sup>2+</sup> concentrations in this figure ?

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