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Biogeosciences Discussions
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Interactive comment on "Unusual biogenic calcite structures in two shallow lakes, James Ross Island, Antarctica" *by* J. Elster et al.

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Dear editor, We have very much appreciated the overall effort of both reviewers as well as their fair criticism and thorough reading of our manuscript. We have revised the text, accepted most reviewers' comments and added new figures as suggested. At the same time, two figures were moved to supplementary information (former Figures 4 and 5, now as S1 and S2). Below, we are responding stepwise to comments made by the reviewers. In the revised text we highlighted (by tracking changes in the reviewing mode) all the changes to our manuscript and kept major deletions to enable easy comparison with the original text.

Reviewer #1: First, the microbial mats should be described more thoroughly. I don't see the microbial mats in Fig. 8. These micrographs (recorded under cross polars,

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which is not mentioned) only show the minerals, and it is impossible to see the claimed microbial mats – dark zones may simply represent pure epoxy resin. At least plane polarized photomicrographs of the same zones should be added to show, e.g. green-pigmented mats. It would be better to use fluorescence techniques (e.g. Gérard et al. ISMEJ 2013,: : :) to clearly shown the microorganisms.

Figure 8 shows thin sections of dry samples from the black zone visible on Figure 2a. That is why the biofilm is represented only by a very thin black layer. We are sorry for this unclear situation and we modified the accordingly the figure legend as well as the text itself. The use of cross polars method was also added. Moreover the fluorescence technique was used to demonstrate the presence of living mats on the rock surface (added as new Fig. 6).

Also, I'm not convinced with the rock pictures that the dark surface of the rocks is dark because of the presence of cyanobacteria, since the basaltic rocks would also be darks: could the cyanobacteria be very thin and transparent? Or do they have very dark pigments? Microscopy pictures of the cyano and algae are lacking in the paper.

The black colour of the rock surface shown of Fig. 6 (as Fig. 5 in the new version) is definitely caused by the presence of cyanobacteria. The dominant species Calothrix elsteri contains high amount of the dark pigment scytonemin (data not shown here). The black colour of this species is demonstrated on the micrphoto added as new Fig. 4 (together with photo of the co-dominating filamentous alga as requested above).

In Fig.7b, arrows should be used to better distinguish mucilage and filaments.

Arrows were added to the Fig. 7b to make the picture clearer.

It is claimed that "The regular leather biofilm structure with distinct cyanobacterial-microalgal composition and incorporated mineral grains is a modern analogue of some of the oldest well-described 10 Archean stromatolites (sensu Allwood et al., 2006)." – this is wrong, there is no similarity at all. Paleoarchean stromatolites do not show

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trapping and binding, they only show alternance of carbonaceous laminae and silica/carbonate laminae, which is not observed in your modern samples as you apparently only have a single mat layer with scarce carbonate precipitation.

This statement was deleted from the text.

Second, the finding of the carbonates spicules is very interesting and well documented and should be discussed in more depth. Many references are cited on carbonates precipitated from evaporation: do any of those resemble the spicules (I guess not, which could be a biogenicity argument)?

As far as we know, structures similar to the spicules observed in our study have not been documented, yet. We tried to reflect this in the title of the paper as well as in the discussion, where a sentence was added to stress more this biogenicity argument.

Moreover, a tubular hollow is shown in Fig. 8d in a carbonate spicule and claimed as a cyanobacterial filaments: abiotic carbonates may form hollow mineral tubes without requiring the presence of a filament of cells (Fan & Wang, Advanced Materials, 2005).

The possibility of abiogenic formation of these hollows was added to the discussion.

More importantly, the surface textures of the spicules, interpreted as "worn" etching figures can also be interpreted as primary structures: in Fig. 9 I see a new type of mesostructured carbonate crystal formed through highly oriented growth of micro/nanocrystals: see the references below showing and discussing in vitro and biotic growth of mesocrystalline structures. In general, mesostructured crystals strongly suggest growth in presence of organic matter, such as mucilage.

The possibility of primary origin of the surface textures of spicule presented on Fig. 9a-b was added to the text together with some of the suggested references.

Minor comments: "lake water was mostly formed by detached benthic species; no substantial phytoplankton developed in the lakes." – is that published elsewhere (please cite) or not (maybe show pictures of floating microorganisms)

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The characteristics of phytoplankton in the lakes was not published. The low biomass in the open water was formed by detached filaments or tiny filament clumps, and no floating mats were observed. This part of the text was amended to describe better the situation.

What do you mean by “soft mineral”? “

By “soft mineral” we mean the mixture of dry or semi-dry cells, sheets and mucilage of cyanobacteria and algae biofilm infilled with crystals of feldspathoids (tectosilicate minerals) and mineral grains (semi-rounded quartz grains). In the text, we changed it to “soft mineral matter”.

Studies based on field or laboratory experiments have shown that some cyanobacteria and algae are able to tolerate prolonged periods of desiccation.” – please cite these studies

The references Tashyreva and Elster (2015) and Pichrtová et al. (2014) were added to demonstrate the ability of both cyanobateria and algae to tolerate dessication.

The segregation of Ca2+ and HCOôĂĂĂ3 between ice and the residual solution depend on the freezing rate and hydrogen – oxygen isotope fractionation” – I don’t understand this sentence. Do you mean that H/O isotope fractionations can distinguish biotic and freezing-related precipitations?

The sentence above was deleted in the revised text. Based on our measurements, we cannot clearly decide if the winter abiotic calcite precipitation accompanies microbial lithogenic processes.

Reviewer #2: General comments: The present paper describes characteristics of unique organosediment structured from shallow Antarctic endorheic lakes. The paper is comprehensive and well written and I have only few comments. The thermal regime section (3.2) is too descriptive and unnecessary, given that majority of the information can be gathered by looking at Figures 3, 4 and 5. Having three figures (Fig. 3-5)

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showing seasonal changes in air and water temperatures is also unnecessary as well. I would recommend using only one figure and moving the others into supplementary materials.

The section 3.2 was significantly shortened, and the former Figures 4 and 5 were moved to Supplementary materials as suggested.

The biological characteristics of the organosediment structures (section 3.3) could be better described and better presented and would benefit from including light microscopy photographs of the different cyanobacterial and algal species.

The microphotos of the dominant species were added as new Figure 4.

The discussion should be tightened up and some sections could be either entirely omitted or moved to the Results, particularly the descriptions of the environmental properties (section 4.1.).

The section 4.1 was shortened. However, we believe that the discussion of environmental properties (chemistry and thermal regime) is crucial for the understanding of benthic community characteristics and functioning and also for the explanation of possible origins of the calcite structures.

The discussion would benefit from adding a section discussing the possible origins of the structures as well as clearly describing the process of their formation.

The section discussing possible origin of calcite spicules was amended and new aspects based on available literature were added to the text Unfortunately, process of formation of the spicules could not be assessed in detail based on available data.

There are too many figures in the manuscript and some of them are not very informative and thus could be moved to supplementary materials.

The original figures 4 and 5 were moved to supplementary materials.

Specific comments: Page 13594, Line 26: Remove “on a range of spatial scales”

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Removed.

Page 13595, Line 3: Preclude the development of larger organisms Corrected.

Page 13595, Line 4: Organosedimentary structures instead of Organisedimentary The sentence is not entirely clear Corrected.

Page 13595, Line 14: related “to” rather than related “with” Sentence starting with Calcite is too complex and should be divided into several sentences Preposition corrected and the sentence was divided.

Page 13596, Line 6: Pleistocene and Holocene Corrected.

Page 13596, Line 16: Missing “)” after Nedbalova Corrected.

Page 13597, Line 12: Catchment areas would be more meaningful in km2 than in m2 Catchment area units changed to km2.

Page 13597, Line 15: How dramatically? A sentence was added to clarify the extent of water level fluctuations.

Page 13604, Line 17: FSD instead of FDS Corrected

Page 13608, Line 24: Please add reference for the trapping of the mineral grains The reference Riding (2011) was added.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/12/C7023/2015/bgd-12-C7023-2015-supplement.pdf

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Interactive comment on Biogeosciences Discuss., 12, 13593, 2015.

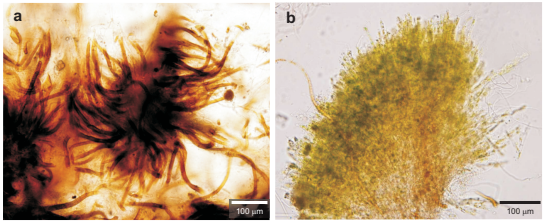

Fig. 1. Fig. 4 Dominant species in the photoautotrophic mats.

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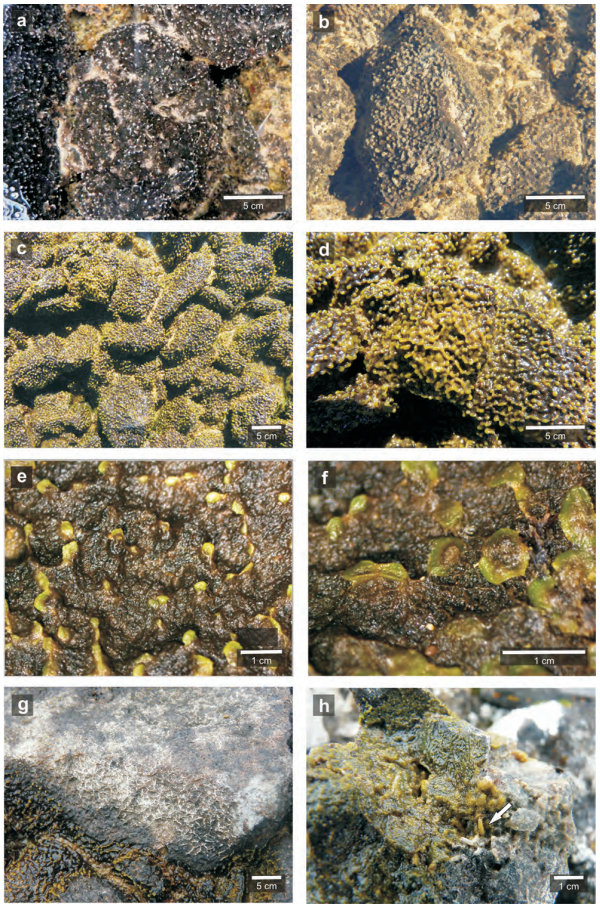

Fig. 2. Fig. 5 Photoautotrophic mats in lakes 1 and 2.

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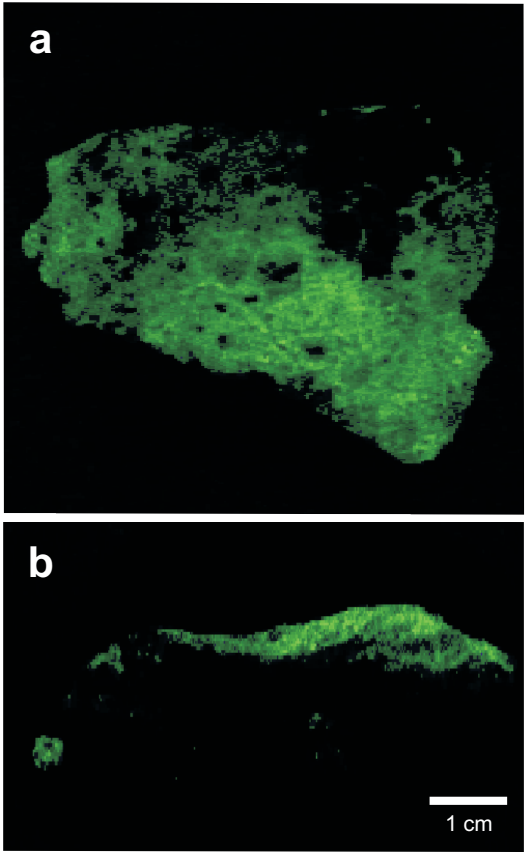

Fig. 3. Fig. 6 Photoautotrophic mat covering a stone visualized using imaging fluorometry.

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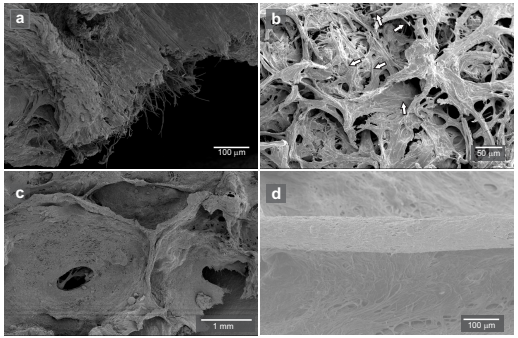

Fig. 4. Fig. 7 SEM macrographs showing the structure of the dried mat in the lakes.

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