Review of « Application of clustering techniques to study environmental characteristics of microbialite-bearing aquatic systems » submitted by Dalinina et al. to Biogesciences

General comments

This manuscript presents a statistical analysis of some chemical parameters determined from modern natural water masses (lakes, rivers, ocean, hypersaline ponds) where carbonate microbialites are present. Carbonate microbialites are geobiologically important structures that are present in the geological record of the last 3.5 billion years and are considered amongst the oldest evidence for life on our planet. The processes that lead to the formation of microbilaites are partially known and include at least the trapping and binding activity of microbial mats and the change in the carbonate chemistry of microbial mat microenvironments induced by microbial metabolic processes. It is clear that the chemical composition of the ambient water provides an important boundary condition that likely affects both chemical and biological processes within the microbial mats. Thus, I agree with the authors that ambient water chemistry has to be considered as a factor.

The statistical analysis comes to the conclusion that none of the parameters considered can explain the occurrence of microbialites in the observed settings, or the absence of microbialites in seawater ("Results from this work suggest that microbialites are broadly distributed across the environments with a wide spectrum of geochemical characteristics. None of the variables studied here are readily responsible for the formation of microbialites". In this last respect, I do not understand why seawater in considered an environment not conductive to microbialite formation when, as the authors point out, microbialites form in seawater (Bahamans) and slightly modified seawater (Shark Bay). Clearly, microbialite formation is possible in seawater and factors other than water chemistry may be responsible for the rarity of microbialites in the modern ocean.

Microbialites are present in freshwater, seawater and hypersaline environments and the key factors that may control their development or their absence from a given environment may be physical and biological. As for the chemical parameters, I suggest to look more into how ambient water chemistry modulates the effect of photosynthesis on the chemical microenvironment of microbial mats (Arp et al., 2011; Aloisi, 2008). This might help in guiding the treatment of ambient water chemistry. For example, rather than considering dissolved Si or Ba as a parameter, I would rather devise ways of using the pH-alkalinity-Ca triplet statistically, because these three parameters define the saturation state of fluids with respect to carbonate minerals, as well as pH-alkalinity defining the buffer capacity of fluids.

For the above reasons, I think this manuscript – although presenting an interesting and alternative approach to existing microbial mat studies – is not mature enough to be published in Biogeosciences.

I encourage the authors to extend their statistical approach to other sites and other parameters – including biological and physical parameters - to understand if this statistical approach will provide new insight on the factors controlling microbialite formation. Their section 4.3 nicely explains which additional parameters could be considered in the statistical analysis; this section can be used as a basis for improving this work.

References

Arp et al. (2001) Photosynthesis-induced biofilm calcification and calcium concentrations in Phanerozoic oceans, Science, 292, 1597–1784, 2001.

Aloisi, G. (2008) The calcium carbonate saturation state in cyanobacterial mats throughout Earth's history, Geochimica et Cosmochimica Acta, 72, 6037-6060.