Biogeosciences Discussions

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Comment on bg-2021-244

Anonymous Referee #1

Referee comment on "Dissolution of a submarine carbonate platform by a submerged lake of acidic seawater" by Matthew P. Humphreys et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-244-RC1, 2021

Humphreys et al., characterize biogeochemical (dissolved) properties in sink holes, recently discovered in the Caribbean. The data is high quality and they make use of it to infer local processes, how sink holes may have evolved and for what purposes their study may be useful in the future. Their study is novel, interesting, and well written. I enjoyed reviewing this paper and have only few comments (mostly related to readability and clarifications).

General comment:

- I got confused quite often with when data referred to the sinkhole and when did it refer to the acid lake. For example, T_Si seems to refer to the acid lake but it is introduced in the methods to refer to the sinkhole. If possible, this should be carefully assessed in the revised version and cleaned up.

Comments along the text:

Introduction:

The introduction was well written and referenced, and was informative for a person who has no specific knowledge on sinkholes like me.

Methods:

The calculation of AOU should be described at least briefly.

Where was the optical O2 sensor mounted? Outside the vessel at the surface? Or on the CTD? This was confusing and also did not become obvious from Fig. 1c. Please clarify.

I would abbreviate dissolved inorganic carbon as DIC as it seems most widely used. Or otherwise C_t, following Dickson et al. (2007). But I don't have strong feelings about this.

Since the constants by Sulpis et al. are relatively new, it would be useful to provide a

comment why Humphreys et al. use those the most for their calculations.

I did not fully understand how the authors calculated the preformed values. When I look into the supplement then the S or sigma values in the sinkhole are a range. But for P_pref, I believe they need a distinct value. So what value would that be within the range? Is it the corresponding S or sigma value at the surface of the sinkhole? Please clarify and perhaps amend supplementary figures accordingly.

The description of the delta T_C components is not sufficient to understand what happened here (at least not for me). What is R_N, R_P, etc.? I assume R_N is the molar C/N ratio? This needs to be clarified. Also, for R_P there is only one number which is understandable if it is C/P but I would add the 1 anyways to avoid confusion.

Related to this but more generally: I wonder how much sense it makes to use average Anderson and Sarmiento stoichiometry for this when we know that stoichiometry systematically varies across latitudes (or with nutrient concentration), according to Martiny et al., 2013/2014. It would perhaps be helpful to accommodate for this discussion. Shouldn't make much of a difference because T_C(OM) is low but it may raise some eye-brows.

Line 164: This is unclear. Do you mean that delta TC(R) was delta TC-(deltaTC(OM)+deltaTC(CO3)) ? Perhaps just make a new equation to avoid confusion.

Line 165: what is the "stoichiometric coefficient for OM-associated silicate remineralisation (RSi)"?? Please try to be less cryptic and more descriptive. You lost me here until line 170. Please explain why you did, what you did here and wat the goal was before you provide

how you did it.

Line 194: Perhaps remind the reader what the connection depth was.

Line 195: I am not sure about this statement. Do the authors mean that denser waters from deeper ocean regions cannot reach to the top of the platform because the surface of the platform is too shallow? If so, can the authors exclude that water may be pushed upwards somehow (e.g. upwelling) and then overflow into the sinkholes? I would agree that something like this seems unlikely but not sure if they can exclude this.

Line 197: check the unit for O2.

Line 198: I don't understand this sentence. Please explain why each physical tracer corresponded to a "significantly different" off-platform water depth.

Line 205: I assume the authors have also considered that the corrosive conditions in the acid lake may have increased dissolution/chemical weathering which may have increased salinity? Can this thought be easily dismissed or is it worth mentioning it? The +0.45 in S cannot come from CaCO3 dissolution, I guess, but could it be something else? Do you have data on major ion composition? (I am not sure if this is at all relevant but your data made me wonder so it may be worth throwing a sentence at this).

Line 215: It is interesting that TA is comparatively little increased relative to DIC. Does this mean that the water inside the acid lake has a short residence time because it gets enriched with CO_2 but doesn't have enough time to stay in there to dissolve $CaCO_3$ to its full potential?

Line 220: This should be moved to the methods, as I was wondering where the 1/3 of each was justified in equation 3. Or at least say that the reason for this will be given in secion XXX.

Fig. 2e. Why is delta T_si (R) only shown for sinkhole N, which has the acid lake (or is it?). The data representation is a bit confusing.

Line 286: I agree that the sinkholes could be useful natural analogues but I don't think the authors have provided particularly useful examples. The analogy to Precambrian conditions does not really make sense because that would mean that the acid lake is isolated for very, very long. But this does not seem to be the case as the authors state themselves. Thus, I don't think it has value as an analogue for that. The acid lake certainly has value for Ocean Acidification but care must be taken due to low O_2, which may restrict its value. I think the acid lake constitutes an excellent natural analogue for the deliberate sequestration of CO_2 into the ocean, either linked to "Direct Air Capture with carbon capture & storage (DACCS)", "Bio-energy with carbon capture & storage (BECCS)", or electrochemical splitting of H_2O into NaOH and HCl (the "SEA MATE" approach from Eisaman et al), where the HCl could be sequestered in the deep ocean. I believe that the sinkholes have more values for this than what the authors mentioned so far. It may be worth considering this, potentially even in the abstract where they mention this also.

Line 299: "Likely"? Or is "may have" more appropriate?

The Figures are generally really nice.

Fig. 1. Why are is one sinkhole (e.g. sinkhole S) at different locations? This is confusing.

Fig. 2. Subplot b: Fig. 1 shows multiple sinkhole locations for sinkhole S, so what do the blue triangles in the case of sinkhole S refer to? (Same question for sinkhole N and E).

Table 1: Why are DIC and TA in mmol/kg when they are usually reported in µmol/kg? Not really important but distracted me a bit while reading.