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Biogeosciences Discussions

Interactive comment on "Groundwater and porewater as a major source of alkalinity to a fringing coral reef lagoon (Muri Lagoon, Cook Islands)" *by* T. Cyronak et al.

Anonymous Referee #1

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Summary

This article looks at two sources of total alkalinity – discharge of fresh groundwater and advective circulation of water through permeable sediments – in Muri Lagoon on the island of Rarotonga. Radon is used as a tracer of fresh groundwater discharge while chambers are used to measure porewater exchange. The groundwater endmember is characterized using a single piezometer, which is sampled at two depths. The study period is 28.5 hours (1 diel cycle or 2 tidal cycles) on March 17, 2012. The authors found significant inputs of TA from both groundwater sources. Fresh groundwater discharge was always a TA source, while porewater exchange varied between being a

source and a sink. Fresh groundwater discharge seemed to be driven by the tides and was greatest at low tide, while porewater exchange was affected more by diel biological cycles of photosynthesis, respiration and coral calcification.

Review

In general, I found this article to be interesting and well-written, with no major problems, and I would recommend it for publication. Minor comments, which I feel could improve the quality of the manuscript, are listed below.

1. p. 15504, line 3: Please explain how calcification rates are determined based on changes in water column TA using the equation provided. One sentence summarizing the idea behind this method would be sufficient.
2. p. 15504, line 19: You say that "Porewater advection can occur on various temporal and spatial scales resulting in numerous exchange rates over variable time scales". However, in this paper you quantify this advection at only one location in the lagoon, over a very short time scale (28.5 hours). Please comment somewhere in the paper about how much spatial and longer-term temporal variability might occur, and how this variability could be addressed in future work.
3. p. 15505, line 8. The authors state that few studies have looked at SGD on coral reefs. I know that more studies have been done than the ones they cite – at least studies that look at SGD in areas that have coral reefs, even if they don't quantify fluxes of SGD directly onto the reefs. Some examples of additional articles the authors could cite are: Knee et al. 2008, 2010; Street et al. 2008; Blanco et al. 2011; Kim et al. 2011 (listed at the end of the review).
4. p. 15507, line 1. Can you comment on how similar or different the water-column monitoring site and the porewater chamber site were, and how this could have affected the results? Also, was there any particular rationale for where you decided to locate these two sampling sites?

5. p. 15507, line 6: Change “MuriLagoon” to “Muri Lagoon”.

6. p. 15507, line 22: Please explain why you used three different spinning rates for the chambers. Was it one of the study goals to compare them? Is it standard to use three rates?

7. p. 15507, line 28: Typo: change “dusing” to “using”.

8. p. 15508, line 11: When you say “a moving average period of 3” what does that mean? Three measurements? Please clarify.

9. p. 15508, line 26: Did you make sure that the use of the peristaltic pump did not result in any loss of Rn? I ask because I tried to use a peristaltic pump to collect samples for Rn analysis from a piezometer, and when I compared it to a submersible pump (Whale, 12V) the Rn concentrations from the peristaltic pump were always lower. If you did anything to control or account for Rn loss, please note it, or if you have a reason for thinking this would not be a problem, please explain. Otherwise, there’s not that much that can be done at this point, but it might be something to think about for the future.

10. p. 15509, line 4: Would you expect a significant amount of ^{226}Ra decay to occur on the time scale of this study (28.5 hours)? It seems to me that it would be negligible since the half-life of ^{226}Rn is about 1200 years.

11. p. 15509, line 24. Please explain at this point in the paper or earlier the purpose of looking at δ^{13}C DIC.

12. p. 15511, line 9. “TA had a complex dynamics that was related to both diel and tidal cycles”. Is your time series actually long enough to support this assertion?

13. p. 15512, line 7: “which would alter the chemistry of porewaters in the permeable sediments thereby affecting both flux rates. . .”. Can you be more specific about

how the chemistry would be altered and how the flux rates would be affected? The current statement is quite vague.

14. p. 15512, line 16. Looking at Fig. 2, it seems like you see almost the exact same patterns regardless of the chamber (diffusive, 40 RPM or 60 RPM). Based on that figure, I would never conclude that the 40 RPM chamber data would give you a large positive flux, and the other two would give you a negative flux – they basically look the same. Yet in the text and in Table 2 you say that the difference is large and significant. Can you reconcile these apparently conflicting views of the data?

15. p. 15514: I think you need to recognize the possibility that the groundwater endmember could be variable and/or different from the estimate you got based on very limited piezometer sampling. The large difference between the two depths sampled seems to open the possibility that if you sampled more depths or more locations on the beach, you would see a wider range of Rn activities, and the average could also be different.

16. p. 15516, line 1: Can you calculate the net flux of TA for the one-day study period from 1) Rn-derived SGD and 2) porewater exchange and present it in the text? Fig. 12 gets at this a bit, but I think it would be better to actually present it in the text as well.

17. Please comment somewhere in the text about how representative the tidal cycle you sampled was for the area in general. Did you sample during a spring or neap tide?

18. p. 15517, line 26. Typo: Change “coralcover” to “coral cover”.

19. p. 15518, line 12: Please state clearly whether porewater exchange is a net source, net sink, or neither for TA according to your results.

20. Figs 2 and 3: I found Fig. 3 somewhat difficult to interpret and I thought it might be better to eliminate Fig. 3 and instead add a dashed line to each panel on Fig. 2, showing the PAR. You could eliminate the gray bar because the variation in PAR would indicate whether it was day or night. That way it would be really easy to see how trends in TA_C flux, DO flux, DIC flux and H^+ flux match up in time with variation in PAR.

21. Fig. 11. It was unclear to me by the SGD TA flux was represented as columns while all other fluxes were represented as points with error bars and/or lines.

Additional References:

Knee, K.L., et al. . 2010. Nutrient inputs to the coastal ocean from submarine groundwater discharge in a groundwater-dominated system: Relation to land use (Kona Coast, Hawai'i, USA). Limnology and Oceanography.

Knee, K.L., et al. 2008. Sources of nutrients and fecal indicator bacteria to nearshore waters on the north shore of Kaua'i (Hawai'i, USA). Estuaries and Coasts.

Street, J.H., et al. 2008. Submarine groundwater discharge and nutrient addition to the coastal zone and coral reefs of leeward Hawai'i. Marine Chemistry.

Kim, G. et al. 2011. Submarine groundwater discharge from oceanic islands standing in oligotrophic oceans: Implications for global biological production and organic carbon fluxes. Limnology and Oceanography.

Blanco, A.C., et al. 2011. Estimation of nearshore groundwater discharge and its potential effects on a fringing coral reef. Marine Pollution Bulletin.

Interactive comment on Biogeosciences Discuss., 9, 15501, 2012.