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Biogeosciences Discussions

Interactive comment on "^{210}Pb-^{226}Ra chronology reveals rapid growth rate of *Madrepora oculata* and *Lophelia pertusa* on world's largest cold-water coral reef" *by* P. Sabatier et al.

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210Pb-226Ra chronology reveals rapid growth rate of Madrepora oculata and Lophelia pertusa on world's largest cold-water coral reef

Response to the Anonymous Referee #1

We thank the Anonymous Referee#1 for his/her review and very interesting comments on our manuscript. We have taken into account those in order to improve our paper. Please find our answers to the review below.

Major comments

In general, the English grammar should be improved The language was check by Jason Hall-Spencer, native English speaker and corrected in the new version of the manuscript.

The results concerning the Lophelia pertusa specimen should be interpreted in a more conservative way. 12263/1: Give uncertainty for the calculated growth rates (see also further below). Is it really valid to use a two point fit for section B3? 12263/5: "Both growth rate estimates are in good agreement" To my opinion, this is completely accidental. We are partly agree with the reviewer, this growth rate estimation based on 3 and 2 samples respectively on branches 1 and 3 are not very confident, with a high uncertainties. The high Mn content on this specimen not allows to precise our estimation. But this estimation is similar between the two branches, even if the estimation based on two points, for the branches 3 was highly criticism, as underlined by the accidental theory of the reviewer. Moreover, this estimation 8 mm/yr, is in the previously published growth rate range, between 2 and 26 mm/yr (for the most extreme values). Knowing that this is one of the first results of growth rate estimation on this in situ Lophelia specimen based on short-lived radionucleides, in our opinion it is interesting to publish this data in a high conservative way as suggest by the reviewer. Thus in the new version of the manuscript we take more caution about Lophelia growth rate.

All suggested English corrections were done.

Minor comments

12250/20: "Moreover, ocean warming may induce further yet unknown threats." This is completely speculative. We delete this sentence.

12252/21-25: Show a hydrographic/bathymetric map of the area including the reef and sampling location. This map was already published in Fossa et al., 2005. But to illustrate the sampling procedure we add a new figure 1 (see below) with two ROV pictures. Figure Caption : Submersible dives on Røst reef in June 2007, a) image taken looking down a steep wall with large L. pertusa buttresses extending 3-4 m out

from the substratum; dead skeletons are encrusted in brown metal oxides, living parts are white (67ËŽ30′30" N 9ËŽ25′30"E, 340 m depth). b) coral collection from reef crest formed by orange and white M. oculata and L. pertusa colonies. Krill and copepods were abundant during sample collection (67ËŽ30′20" N 9ËŽ24′45"E, 300 m depth).

12253/25: Samples Mb, Mt and Lb, Lt are not indicated in Figure 1 and 2. We have not the exact location of these samples; they are sampled on other branches at the top and the base of these two specimens.

12255: Explain ICP-MS, AMS, and AMS-LMC14 ICP-MS : Inductively Coupled Plasma Mass Spectrometry AMS-LMC14 : Accelerator Mass Spectrometry - Laboratoire de mesure du Carbon 14 We precise in the manuscript these terms

12255/7: Give reference for JCp-1. We added the reference in the manuscript: Japan Coral Porites sp. (JCp-1) standard. Okai, T., Suzuki, A., Kawahata, H., Terashima, S. and Imai, N. (2002) Preparation of a new geological survey of Japan geochemical reference material: coral JCp-1. Geostandards Newsletter 26, 95–99.

12257/17: Figure 3 and Tables 1 and 2 show 210Pb activities not excess 210 Yes and the 210Pb excess activities are calculated by the equation 2, defined in the manuscript.

12257/25: 5% uncertainty – is this one sigma? This is 2 sigma, as described in part 3 Analytical methods

12258/18: the fact that “All (210Pb/226Ra) activity ratios along the coral specimen are once more clearly above secular equilibrium” does not allow the conclusion that the resulting age model is accurate (line 21). This is true, this sentence allow to “try” to establish an accurate age model for this deep sea coral. We make this change in the new version of the manuscript.

12260/5 it is not exactly clear what you mean by “the first phase” We add at the end of this sentence in brackets “before the depth of the polyp” to precise what we mean by is the first phase.

12260/20: The assumption that 210Pb(0) was constant is crucial for the age model. Do you have evidence for this assumption? 12261/20-22: What is “Andrews et al. (2009)“ good for in this context? The above argumentation seems circular to me: 210Pb input is assumed to be constant; results indicate a “well constrained slope” providing evidence that the input was constant; consequently the coral must have grown continuously We illustrated in the following figure 2 (see below) different possibility of coral growth and/or variable initial 210Pbex. A) The 210Pbex initial was not constant and vary in time > growth cannot be calculated. B) The 210Pbex initial was constant as the growth rate also > 210Pbex defined a well constrained slope that allows to calculate this growth rate. C) The 210Pbex initial was constant as the growth rate, but there is a growth interruption (dotted line) > 210Pbex defined two well constrained models with the same slopes that allows to calculate a unique growth rate (constant). D) The 210Pbex initial was constant but growth rate changes in time > 210Pbex defined two well constrained slopes that allow to calculate these two growth rate. E) The 210Pbex initial was constant but growth rate was variable in time > we can not calculate the different growth rate.

In our study the data display in figure 6 of the manuscript allow to propose that both the initial 210Pbex and the growth rate were constant (case B). If the initial 210Pbex vary in time and/or if the growth rate was not constant (or more than one variation case D), we can not calculate the age of the coral. It is also possible to have an initial 210Pbex constant but a variable growth rate (case E), in this case the age of the coral can not be calculated. Thus, this is not a circular argumentation and yes the assumption that 210Pbex(0) was constant is crucial and without that not growth rate calculation can be made. Andrews et al., (2009) already discuss this possibility and the possibility to have a growth rate interruption (case E).

12261/_15-20: Please indicate first which equation you use, and then present the results. This sub-section appeares confusing to me. We added the reference to the equation used for age estimation and we point out our paragraph in the new version of

the manuscript see below: The exponential slope for 210Pbex corresponds to a linear growth rate of 2.58 $\pm$ 0.19 polyp.yr-1 or 14.4 $\pm$ 1.1 mm.yr-1, using the equation 8. This growth rate estimate yields an basal age of 31 $\pm$ 3 years (1sigma) for this 45cm-long specimen of M. oculata. To test the simplification of constant flux of (226Ra) on growth rate estimation, we used the Equation 6 instead of 8 to determine the age of the coral (using variable flux of (226Ra), see table 1) and we get the same results within uncertainties. Thus the used of constant flux of (226Ra) do not influence growth rate estimation.

12262/11: "At 2 sigma uncertainty levels both bomb-14C and 210Pb-226Ra age estimates are almost identical" Give uncertainties for the 14C-derived growth rates, and then compare them. Either the values agree on a 2-sigma level or not! The 14C age uncertainties are give in the above sentence "40$\pm$3 yr" in the manuscript and are illustrate in the figure 7. 210Pb age estimation is given at the beginning of this paragraph.

12262/28: Which samples (exactly) were excluded? We added in the news version of the manuscript "grey points in figure 8"

12264/16-17: "This type of correction can not be applied on the L. pertusa specimen in relation to the very high Mn content of the two last branch (B2 and B3)." Why is this so? If the Mn correction model works for one coral but not for an adjacent one, is it a good model then? The first problem to apply this Mn correction was the too high Mn contents for the Lophelia specimen in regard to the Madrepora one. Higher was the Mn content higher were the uncertainties on the Mn correction in regard to the r^2 of the relation between Mn and 210Pbex. The age of the Lophelia specimen was a second problem for applied this correction (around 100 years based on the estimation over the first not contaminated branch). Knowing that there is 210Pb coating (210Pboxide) with Mn, this 210Pboxide increase with the age of the coral. On the other hand, the 210Pbex, integrated to the lattice during its formation (used for age determination), decrease in relation to its half-live (22,3 years), thus the ratio between 210Pboxide and 210Pbex was too high for an accurate correction. This is why the Mn correction can

not be applied on the Lophelia specimen.

Tables and Figures: Include Mn data in Table 1 and 2 We added in the news version of the manuscript the Mn data for Lophelia and Madrepora sample in table 1 and 2.

Interactive comment on Biogeosciences Discuss., 8, 12247, 2011.

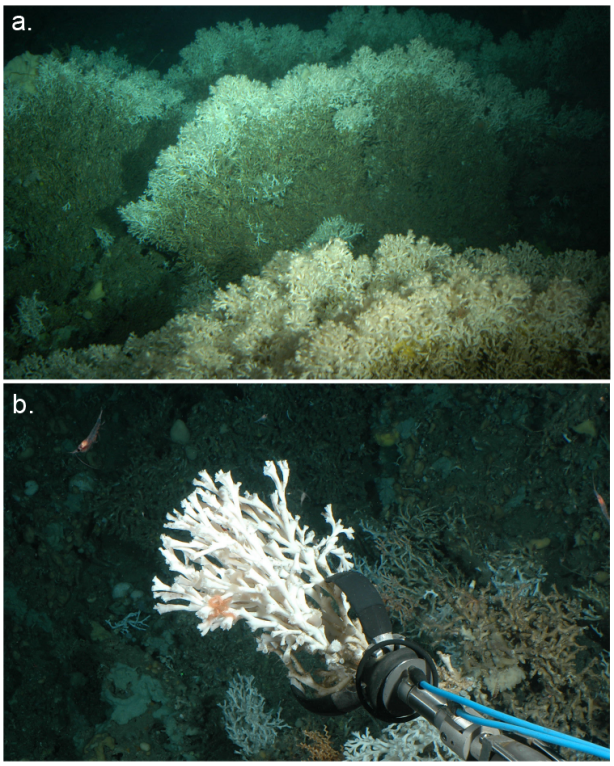

Fig. 1. Submersible dives on Røst reef in June 2007 (caption too long see in the text of the reponse to the R1)

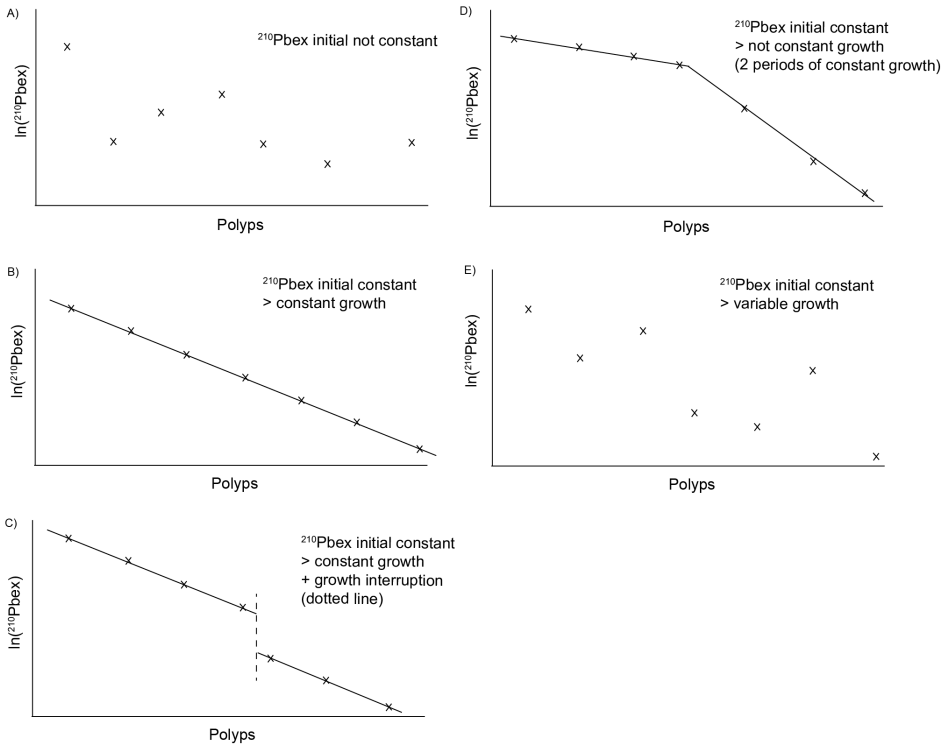

Fig. 2. Different possibility of coral growth and/or variable initial 210Pbex (for more details see in the text of the reponse to the R1)