

## ***Interactive comment on “Influence of intense scavenging on Pa-Th fractionation in the wake of Kerguelen Island (Southern Ocean)” by C. Venchiarutti et al.***

**Anonymous Referee #1**

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### General comments

This paper discusses the scavenging of Pa and the fractionation between Th and Pa around Kerguelen Island. The paper is a follow-up of the paper published 2008 on Thorium isotopes from the same expedition and samples. In that paper the strong scavenging of Th over the Kerguelen Plateau and along the eastern slope had been described. The new data show that in both areas Pa is scavenged as strongly as Th, ie there is little or no fractionation, a behavior that the authors explain by the high opal content of the particles. This is an important study of the interaction of the ACC, where we can expect a full oceanic depth distribution of the radionuclides, with a scavenging

C1488

regime caused by the natural fertilization and interaction with sediments caused by the Kerguelen Plateau. It is interesting to see that in this regime, as in the 1983 study of Anderson et al., the Pa/Th ratio of boundary scavenging is not controlled by total stripping of a high-Pa/Th water column but by a low Th/Pa fractionation factor. The study is certainly worth publishing and the discussion of scavenging can be published with little change. But some aspects in the results section and first part of the discussion should be improved before the paper can be accepted for publication.

### specific comments

A major problem of the paper results from a methodological issue. The Pa analyses could not be run before decay of the yield tracer added on board. Most stations were analysed later after the addition of a new  $^{233}\text{Pa}$  spike, allowing the determination of the chemical yield after the initial coprecipitation (which was shown at one station to be efficient). But the samples of three stations had been worked up shortly after the expedition and therefore without adding the new spike. The technical problems that prevented the Pa fractions from being analysed by mass spectrometry before the decay of the yield tracer thus prevented the determination of the chemical yield of the filter leaching and ion exchange separation for these three stations. This is clearly stated, but it does not become clear what chemical yield was used to calculate these concentrations and what error was used for that assumed chemical yield. In the discussion of the results, the special status of these three stations could be made clearer, eg by using different colors or symbols. It would be worth while to investigate to what extent the conclusions can be maintained even when these three stations are disregarded altogether.

The discussion from 4.2 ff is quite good. It becomes clear that - both Th and Pa are strongly scavenged from advected water masses: - the deep water is depleted along the eastern flank - the shallow water is depleted while flowing over the plateau. - these depletions occur not by total depletion with high  $F$ , but by strong but partial depletion with  $F \sim 1$

C1489

Is there any data of sediments to confirm the findings? If not, where would it be most valuable to collect and analyse sediment samples?

technical issues

page 4874 line 1 “along” use “throughout the water column”

page 4874 line 13 “mainly” use “not only”

Page 4877 lines 7-9. PF Trough, Northwest-Southeast Trough are not indicated on map

Page 4877 line 17 “then” delete

Page 4878 line 8 “full” delete

Page 4878 line 25. “6 out of 9 stations”. Be consistent with tables and figures. I count 4 ISP stations out of 6.

Page 4879 line 22 “achieved” use “performed”/executed

Page 4880 line 12 “bar” delete

Page 4880 line 13 “yielded” use “require”

Page 4880 lines 14-22. please clarify the procedure. Mention here that Th analyses were reported in the 2008 paper. Were yield tracers added after leaching the filters? Was the 80/20% separation made of the filter or of the leach? Why were Th and Pa not analysed on the same filter leach? Especially line 21 is confusing. Is the Th/Pa separation described here also used to purify the Th fraction of the 80% aliquot? Then are the results consistent with those of the 20% aliquots?

Page 4882 line 4 “samples” use “Pa fractions”

Page 4882 line 13. What is the  $^{232}\text{Th}$  content of the  $^{233}\text{Pa}$  spikes added? (not given in Table 2)

C1490

Page 4883. Make line 4 consistent with line 14

Page 4883 line 25. What chemical yield and what error were used for the Pa calculations of the stations analysed without Pa yield tracer?

Page 4886 lines 21-24 redundant formulation

Page 4887 line 9-14 rather speculative, would fit better in discussion part.

Page 4887 line 23 “to” delete

Page 4887 24-25 reformulate, e.g.: “only in the upper 100m of the water column the particulate part of  $^{231}\text{Pa}$  dominates”

Page 4887 line 27. There is a clear depth dependence in Fig. 4 (as mentioned below)

Page 4887 line 28 “except for a few maxima”

Page 4888 line 1 use fewer digits

Page 4888 line 14-18 gives a qualitative and hard to judge comparison between Pa/Th ratios and BSi, asking for a more rigorous property property plot. Such a plot is presented later as figure, which should be moved up here.

Page 4888 line 22 “surface values” add: (0 and 50m) This paragraph is very weak and better deleted. Tell precisely at what depth you find Si release and Pa/Th fractionation. Normally Si is taken up in surface waters with corresponding isotope effects. It is highly unlikely that opal dissolution at the base of the mixed layer would give an opal dissolution signal in the surface water above that would (more than) cancel the opposite Si uptake signal there.

Page 4890 line 1. “excellent” avoid this word to qualify the correlation of a so clearly non-normal distribution.

Page 4890 line 8-10. The reference refers to a depth range of 1000m and would be appropriate here if over that depth range the falling particles would come across a

C1491

different water mass.

Page 4891 “irreversible” why should this be irreversible?

Page 4891 “Nd concentration” is Nd also scavenged or is there merely isotope exchange?

Page 4892 line 11 “dpm m-2” use “dpm m-4”

Page 4893 line 4,8 reduce # digits

Page 4894 “until now” but apparently not since Chever 2010

Page 4895 line7 “conspicuous” clear?

Page 4895 line 21 “in future reversible-scavenging models” delete.

Page 4903 note “ there are no” use “we did not determine”

Page 4904 to which line belongs “insignificant contribution”?

Page 4906 pis 002 2000m Are these results and their error estimates realistic, realizing that there is significant particulate  $^{230}\text{Th}$  at this depth?

Page 4908 Figure 1. Delete stations that were not sampled or highlight stations that were sampled for Pa/Th

Page 4912 Figure 5. Is this representation as function of density really used in the text?

Page 4913 Figure 6. I am not sure this figure is required here. Most important is a proper analysis of the relationship between fractionation and BSi, especially if this could be given as percentage of the particulate fraction.

Page 4915 Figure 8. It would be more logical to exchange the axes to put KPa as the dependent variable. “the error bar at 100m” is not a useful description here

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