Biogeosciences Discuss., 9, C3490–C3494, 2012
www.biogeosciences-discuss.net/9/C3490/2012/

Biogeosciences Discussions

Interactive comment on "Imprint of a dissolved cobalt basaltic source on the Kerguelen Plateau" *by* J. Bown et al.

Anonymous Referee #1

Received and published: 22 August 2012

General Comments:

This study presents dissolved cobalt concentration data from the Kerguelen Plateau. High concentrations of dissolved cobalt were observed at many of the stations and the authors attribute this to lithogenic sources from weathering basalts. Evidence from rare earth element distributions, Nd isotopes, and Fe distributions are referenced to make this claim, and the authors estimate the aeolian contribution to be negligible. The authors also use the dissolved cobalt data to propose a lithogenic source constraint to the dissolved iron budget based on the more substantial biological utilization of iron relative to cobalt in these waters and their similar sedimentary source.

This contribution is scientifically relevant, the methods for cobalt analyses are sound, and the dataset appears to be of high quality. Since this area has been studied for other

metals and species, the dataset helps constrain the cycling of cobalt, and strengthens the observations that other species lend to the discussion. Sampling in the Southern Ocean is notoriously difficult, and expanding the geographical coverage presented in this study helps improve our understanding of the global biogeochemical cobalt cycle.

While I recommend that the results be published, I think effort should be made to make the discussion clearer, and to flesh it out a bit more. I also found it difficult to read. Many sentences could benefit from removing qualifying clauses and working toward clearer sentence structure. The discussion could be improved by including a figure or two that utilize ancillary data and/or other referenced data to illustrate their points.

Only two sentences in the methods section are dedicated to describing the dates of the cruise and the primary objective. The Park et al. 2008 reference provides considerable context, but I think a contextual grounding for the study should be present in the manuscript itself and not require outside reading. For example, there is no mention of the Southern Ocean (where the Kerguelen Plateau is located), or the relevance of studying cobalt aside from its potential use as a tracer of lithogenic iron. Some mention of why the cycling of cobalt and iron might be coupled (i.e. they are both affected by redox processes and biological uptake) would also be useful in the introduction, and would connect the first and second paragraphs since the second paragraph focuses solely on iron until the last sentence and the transition between the two is choppy.

I think the authors would benefit from adding in ancillary data that might be available from the cruise (i.e. a transmissometry profile showing low transmittance coincident with high cobalt concentrations or oxygen profile showing low oxygen coincident with high cobalt, or low macronutrients in the presence of high cobalt to highlight the excess of cobalt relative to the biological demand), and potentially plotting some of the published Fe, REE, Nd isotope, or 228Ra data that is referenced with the cobalt data. In many cases, other papers from the same study are referenced, but a figure would help illustrate this even better. There did appear to be CTD data in the Park et al. 2008 reference from the same cruise, so perhaps O2 and transmissometry data are

available?

The authors derive a cobalt budget, but there is no discussion of this budget. What are the implications or importance of their findings? Do the authors envision that cobalt will always be a good tracer of lithogenic input of iron? Is the system around the Kerguelen Plateau similar to any other systems that could drive future research in this area or be a model study for another area?

Specific questions/comments:

In section 3.1, the authors initially describe the range of profile distributions observed. Some of the profiles have 1 data point maxima and I wonder if the complexity of the profiles could be supported by transmissometry data or dissolved oxygen data, especially if the source is attributed to dissolution. As mentioned earlier, a figure showing overlap of similarly strong signals in other species would go far to support the sedimentary source argument.

On pg. 7296, there is reference to an oxygen minimum in Upper Circumpolar Deepwater - how low does it get? The Heggie and Lewis reference later in the manuscript is careful to describe that the mechanism by which cobalt can be dissolved from manganese oxides is dependent upon low O2. While a sedimentary source appears to be a reasonable claim, does the O2 get low enough for reductive dissolution to be a reasonable mechanism?

On page 7296, there is mention of previous works that have suggested sedimentary inputs of cobalt. A recent study by Noble et al. (2012 Limnol. Oceanogr. 57(4) 989-1010) may be a useful reference in support of this shallow shelf sedimentary source of cobalt and iron.

I wonder if biogenic cobalt or iron has been considered. There is a description of basaltic weathering and lithogenic sources, but I wonder if the biogenic particles have been taken into account? Is this included in their estimates? This might be tricky given

the productive region here that is naturally iron fertilized. How much of the production could be coming from recycled iron with resuspension and remineralization of sinking biogenic particles? Could this be an important factor given how shallow some of the waters are along this plateau?

In the plots in Figure 2, while the difference between the open ocean station and the plateau station are referenced as significant (pg 7298 lines 6-9), it is difficult to see this in the profiles. Perhaps the data could be plotted with a break in the x-axis? In its current form, the profiles from C1, A1, and A11 look more or less indistinguishable except for the deepest sample, though A1 and C1 are over the plateau.

On pg 7298, there is a discussion of particulate cobalt, however - only as estimated by making assumptions and using other species. Have the authors tested their estimation of particulate cobalt against the particulate profiles that they had measured to see if the assumptions were sound? It seems to me that lability of the cobalt in the weathering process may be of concern in determining what may or may not be released in dissolved form to the water column. I was also confused as to whether or not remineralization of biogenic material that may have settled would be accounted for. Presumably this would not have the same Nd signature as weathering basalt. I am unclear about what then constitutes a sedimentary source.

On pg 7298, line 8 - what is meant by "whole water"?

On page 7299 line 13, an estimated loss of PCo of 995+/-905 nmolM-2 is reported. I wonder how useful this estimate is.

On page 7299, last paragraph, the authors claim that two stations have "comparable biological activity". Are there references that support this that could be mentioned, like PP rates or chlorophyll?

In section 3.1.2 (lines 5-9), there is discussion of the release of dissolved cobalt from particulate matter due to the reduction of manganese oxides and release of dissolved

metals at the sediment-water interface. As mentioned earlier, the Heggie and Lewis paper is careful to articulate that low oxygen concentrations are crucial in determining whether metals are being deposited/oxidized or reduced and released into the water column. This should be made clear and/or taken into account in the discussion here.

Typographical comments:

pg 7295 line 25: depending on stations location - should be "station"

pg 7297 line 21: DCo inputs are occurring in the intermediate and deep waters that flows along - should be "flow"

pg 7298 line 16: Hence the lateral advection from C01 is the most likely processus explaining - should be "process"

pg 7299 line 4: is possible and consistent to physical observations - "to" should be "with"

pg 7299 line 16: particles aggregation - should be "particle"

pg 7299 line18: between C01 and A03 is supporting the dissolution hypothesis. - reads more clearly as "A03 supports the dissolution"

Interactive comment on Biogeosciences Discuss., 9, 7291, 2012.