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Interactive comment on "Dissolved Pb and Pb isotopes in the North Atlantic from the GEOVIDE transect (GEOTRACES GA-01) and their decadal evolution" *by* Cheryl M. Zurbrick et al.

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Reply to reviewers' specific comments (in quotes, their line numbers refer to original manuscript); our response in plain text, line numbers refer to revised version) Reviewer 2:

"Are the authors using the concentration and isotopic ratio of Pb as conservative tracers in a part of discussion (ex. p. 8, the last paragraph)? Is it valid?"

We don't claim anywhere that Pb is a conservative tracer. However, the signatures imparted at the surface are advected into the interior and hence deep water masses

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do reflect their sources to some extent. The Pb isotope ratio is less influenced by scavenging (little change despite Pb removal).

"It is interesting that Pb isotope ratios are relatively homogenous and largely decoupled from Pb concentration. I would like to know more details of the mechanism."

Although Pb sources have varied by an order of magnitude over the past half century, the isotope ratios of the sources have varied less (e.g., Europe always has lower 206Pb/207Pb than North America). To the extent that European and North American emission sources have varied in tandem, the isotope ratios of the ocean don't change very much. This is not strictly true and we acknowledge this in our other papers, e.g. (see reference Kelly et al. 2009: both North American and European Pb sources have evolved over time, and slight differences in the timing of North American and European Pb gas phaseout have altered the proportions seen in the Atlantic Ocean from each source.

"In a previous paper (Wu et al., 2010), the authors proposed the pre-industrial 206Pb/207Pb is 1.210 (based on sediment values) and homogenous in the Pacific deep water. Do you think the Pb isotope ratio in the Atlantic deep water will approach this value because of decrease in anthropogenic effects?"

Wu et al. (2010) were referring to the deep Pacific basin which does not have advected anthropogenic lead, instead transported by sinking particle exchange (in contrast to the advectively dominated Atlantic "bowling alley". But yes, our coral work (Kelly et al., 2009) show that two centuries ago, the Atlantic Pb isotope ratio was similar to typical crustal materials. In time (many decades to a century), the Atlantic could revert to this value if all anthropogenic emission sources were eliminated. But anthropogenic emissions to this basin are still significant despite the elimination of leaded gasoline from automobiles.

"How much is the isotopic fractionation during scavenging and sedimentation? Is it un-detectable? Is it reasonable to assume that the Pb isotope ratio is equal between

dissolved species in seawater and fixed species in sediments?"

First, it is impossible to determine whether Pb undergoes significant isotope fractionation in the environment because there is no non-radiogenic isotope pair to evaluate this (unlike for Nd or Sr). It could be done in the laboratory under controlled situations but I am not aware of any experiments that demonstrate fractionations. Second, it isn't implausible that small isotope fractionations can occur for Pb. After all, they are seen for some other heavy isotope ratios (e.g. Tl, Hg, U). But these fractionations are never more than a few per mil – which is much smaller than the >15% range known from radiogenic signatures. Such small variations are close to our analytical precision and could never be reliably demonstrated.

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