

## Review comments

Lenz et al. looks at how expanding hypoxia may influence Mn burial in the Baltic Sea. They present a detailed data set of porewater and sediment geochemistry for sites that range from fully oxic to euxinic which, even on its own, represents a significant contribution to the field. The authors, suggest that recent inflow events of oxic waters to the Gotland deep basin of the Baltic are no longer being recorded in the Mn-carbonate record. They proposed a mechanism for this change, whereby recent eutrophication of the Baltic has stimulated sulfide production in the sediments, and this sulfide production prevents Mn-carbonates from forming. The authors proposed mechanism is speculative, however they do present a diagenetic model that demonstrates, at least in theory, that this mechanism is possible. As is evident by the reviews of this manuscript, this interpretation is contentious, however due to the importance of this issue with regards to using Mn-carbonates as a proxy for redox state, I think this is a debate that would be best settled in the literature, where they and others can test and eventually verify or disprove this hypothesis. For this reason I recommend publication, provided that the following comments are addressed.

## Major Comments

- 1) The addition of the diagenetic model is an improvement to the manuscript, as it provides a demonstration that the hypothesized Mn dynamics at the Gotland Deep site are possible, and makes their argument for this mechanism much more convincing. However I think they could do a better job of explaining the model results. For example I found figure 6C very confusing. It is strange to plot each form of magnesium ( $Mn^{2+}$ , Mn-oxides Mn-carbonates) at a different time in the simulation, and on a first read I had no idea what this figure was trying to show. It would be better to show a time series of how each Mn species changed throughout the simulation. For example plots of the depth integrated  $Mn^{2+}$ , Mn-oxides, Mn-carbonates over time would be far more intuitive for readers and, I think, demonstrate their point far more clearly. At the very least the time points where the depth profiles are taken from must be more clearly labeled on the figure. In the figure caption they say "Depth profiles of Mn oxide (after 4 months),  $Mn^{2+}$  at the start of the anoxic phase" does this mean the  $Mn^{2+}$  profile are at the same point in time as the Mn oxide profile, if not at what timepoint in the simulation is it taken from? "...at the start of the anoxic phase.." is vague.
- 2) The  $Mn^{2+}$  depth profile in Figure 6C has magnesium concentrations well above anything observed in Figure 2 (and an order of magnitude above what is observed in Gotland Deep). Also is a concentration of 16000  $\mu\text{mol/g}$  of Mn oxide reasonable, by my calculation this would work out to a Mn[%wt] of 86%  $[(0.016 \text{ mole} * 54\text{g/mole})/1 \text{ g sed} * 100 = 86\%]$ . I think the model results would be more believable if their parameter choices produced concentrations that were at least the same order of magnitude as what they observe.
- 3) I think the model is under utilized in the manuscript. By looking at the Damkohler numbers for each transport process and rate constant, I think it is likely that the authors could do a better job of characterizing the tipping point between Mn-carbonate preservation and preservation, these would help make their conclusions more quantitative.
- 4) I am concerned by the fact that the model does not treat Mn-carbonate formation as a precipitation/dissolution reaction that accounts for thermodynamic equilibrium. This despite the fact that as Figure 3 shows sediment conditions transition with depth from under to over saturation at most sites. I am wondering if the lack of Mn-carbonate preservation in Gotland Deep could not also be explained simply by changes in saturation state between oxic and anoxic conditions.

## Minor comments

- 1) The authors should say what the initial conditions for their model simulations were.
- 2) Page 18-line 6 ( $> 1 \mu\text{M}$  verses  $<0.26 \text{ mM Mn}^{2+}$ ) should be ( $> 1 \text{ mM}$  verses  $<0.26 \text{ mM Mn}^{2+}$ )