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Biogeosciences Discussions

Interactive comment on "Phosphorus burial in the ocean over glacial-interglacial time scales" *by* F. Tamburini and K. B. Föllmi

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Referee comment on Tamburini & Föllmi (2008): Phosphorus burial in the ocean over glacial-interglacial time scales.

Tamburini & Föllmi (2008) address the largely unresolved question: Does the total inventory of dissolved phosphate in the global ocean vary on glacial/interglacial timescales? To this end the authors present valuable new data on the burial of reactive phosphorus in marine sediments. The data indicate that the burial flux was reduced under glacial conditions in deep ocean settings. Moreover, a compilation of previously published shelf data is presented showing a glacial decrease in the burial of reactive P also in shallow water environments. Overall, the data seem to imply a diminished burial of reactive P under glacial conditions. It should, however, be noted that the data

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set may not be representative for the global ocean. It also shows a high degree of spatial variability and the authors acknowledge that more data are certainly needed to evaluate the global patterns of reactive P burial in modern and glacial oceans.

Previous studies showed that the burial of reactive P is largely controlled by the oxygen level in ambient bottom wasters. The burial of P in iron and manganese hydroxides and oxides is favored under high dissolved O2 concentrations while low O2 values promote the benthic mobilization of dissolved phosphate from hydroxides and oxides and P-bearing organic phases. Most proxies and ocean circulation models suggest a more sluggish ventilation of deep water masses under glacial conditions. It is thus likely that glacial deep-sea sediments were exposed to low-oxygen bottom waters promoting the release of dissolved phosphate. The independent data presented by Tamburini & Föllmi indeed show a decrease in reactive P burial at the deep-sea floor under glacial conditions. This is probably the most important new result of their study and it may be valid on a global scale since it is consistent with our current understanding of ocean circulation and phosphorus geochemistry.

Interestingly, the Tamburini & Föllmi data show an increase in glacial P burial at the continental slope and rise. This increase did not compensate for the decrease in P burial in deep-sea and shelf sediments. It is probably caused by the erosion and down-slope transport of continental shelf sediments during glacial regressions. However, the enhanced burial at the continental rise may also be related to changes in ocean circulation. Models and proxies suggest that many intermediate water masses were better ventilated under glacial conditions. The burial of reactive P in slope sediments may have been promoted by an increase in bottom water O2 values.

Subsequently, the authors use a simple mass balance approach to constrain the dissolved phosphate inventory of the glacial ocean. To make a long story short, the inventory increases if the input exceeds the output. Marine reactive P is derived from continental weathering and erosion and is removed from the oceans by burial at the seafloor. The authors argue that the input of reactive P from the continents was not

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significantly reduced under glacial conditions. Based on this assumption and the new burial data, the mass balance implies that the dissolved phosphate inventory of the glacial ocean was significantly higher than today. The authors propose that the glacial inventory was enhanced by 7 – 47 % with respect to the modern inventory. This conclusion is consistent with previous model results but it should be noted that glacial to interglacial changes in P input and output fluxes are poorly constrained.

Marine productivity is often limited by dissolved phosphate. The expansion of the phosphate inventory could, thus, trigger an increase in export production, a decrease in atmospheric pCO2 values and the spread of low oxygen conditions in deep waters. The authors suggest that the glacial draw-down of atmospheric pCO2 may be partly due to the expansion of the dissolved phosphate inventory. The new data presented by the authors thus support a very old hypothesis that has been advanced more than 30 years ago.

The authors do not present a rigorous statistical evaluation of their data set. This is the major shortcoming of their contribution. Even though the new data presented by the authors are not very conclusive they are adding valuable new information on the global patterns of phosphorus burial on glacial/interglacial timescales.

Additional approaches are probably needed to better constrain the dissolved phosphate concentrations in the glacial ocean. The P-contents of corals, authigenic iron and manganese precipitates and other geological archives need to be evaluated systematically to reconstruct the glacial phosphate level. Until these independent data have been generated the proposed expansion of the glacial dissolved phosphate concentration and its contribution to the glacial draw-down of atmospheric pCO2 remain largely unconstrained.

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