

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

Anonymous Referee #2

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Tamburini and Föllmi provide a new and independent set of data that should help to better constrain the marine Phosphorus (P) cycle over glacial-interglacial time scales (isotope stages 1-6). The authors have measured P-phase concentrations following a selective extraction procedure for several sediment cores recovered in various ODP site locations. Changes in the temporal evolution of the reactive-P and detrital-P pools have been considered in the study. Using average P mass accumulation rates for each location, the authors provide global P budgets, consistent with previous models and use a mass balance model to simulate the dissolved-P inventory of the global ocean under glacial conditions.

A previous high-resolution study by Tamburini et al. (Geochim. Cosmochim. Acta, 66, 23, 2002) showed that selective (SEDEX) extraction of P-phases in deep-sea glacial

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sediments during Heinrich events provides consistent information on bottom water dissolved oxygen level (using reactive-P phase concentration measurements) and on continental detritus supply (using mineral bound-P phase concentration measurements). The extent of organic-bound P preservation (one of the reactive-P phases) in Heinrich layers is, however, more complicated and linked both to the nature of organic matter (resistant continental vs. more labile marine sources) and/or to its better preservation during high sedimentation rate periods. Because Heinrich events are characterized by fast changing conditions in deep-sea basins with respect to ambient glacial conditions, i.e. major decrease or breakdown of bottom water circulation (e.g., Broecker, Nature 372, 1994, Rahmsdorf, Nature 419, 2002) and enhanced ice-rafted detritus supply (e.g., Bond et al., Nature 360, 1992), the sensitivity of the method may allow further extrapolations to glacial-interglacial time scales, in particular for dissolved-P (phosphate) release in the water column (concomitant with the depletion in reactive-P phases) and for the extent of erosion and down slope transport (detrital-P mass accumulation in sediments). Reduced circulation strength and enhanced erosion during glacial times should provide, lower and greater storages in deep-sea basins, for reactive-P and detrital-P, respectively. The sea-level decrease should deplete both reactive-P and detrital-P phases along continental shelves in relation with sediment export to deep basins. In contrast, slopes, upwelling and rise sites should rather accumulate reactive-P.

The global MAR estimates (Table 1) are consistent with these assumptions. During glacial times less reactive-P accumulates in basins and on continental shelves whereas more detrital-P is found. When reported as global budgets (Table 3) the results are still consistent. Moreover, detrital-P accumulates on shelves rather than in deep-sea basins as expected for high sea level conditions during interglacial times. Several simulations using estimates of the dissolved-P input and output and the results of P-phase concentration measurements predict an increase in phosphate concentration in the global ocean during a glacial period. Although these simulations are only validated by the modern interglacial inventory and may require some additional refinements, the

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sedimentary P-phases approach of Tamburini and Föllmi provides new and valuable insights.

The method has several advantages with respect to other proxies because P concentrations derive from direct measurements in sediments. But as for any selective extraction procedure, the measured concentrations may not fully reflect the real phosphorus composition (the nature of the phase concentration is linked to the procedure used). However, the results were obtained for all sites using the same method and the procedure has been validated elsewhere (for references see in the text). Therefore, comparisons and budgets may be performed. As mentioned by the authors in the text, the weak point of this study holds in the limited set of sediment cores with respect to potential variability at local scale and representativity for the global ocean. Some major locations for marine P cycling are lacking. Several cores for each sampling site would have certainly provided a more significant pattern on a statistical point of view and thus even more convincing mass balance budgets. But it is far beyond the scope of the study. Although additional core locations would have strengthen the conclusions, I think that the authors made the best use of their available set of data. They provide valuable information that should help to better constrain the marine P cycle and support the need for additional sediment core investigations.

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