

Interactive comment on “The calcareous nannofossil *Prinsiosphaera* achieved rock-forming abundances in the latest Triassic of western Tethys: consequences for the $\delta^{13}\text{C}$ of bulk carbonate.” by N. Preto et al.

N. Preto et al.

nereo.preto@unipd.it

Received and published: 16 July 2013

Referee #2 suggests that the interpretation of the carbon isotopic curve as recording primary productivity variations should be preferred. His comments are insightful and give us the opportunity to explain our interpretation of stable carbon isotopes more clearly. We in fact proposed primary productivity as a possible factor modifying the $\delta^{13}\text{C}$ of bulk carbonate indirectly, however, we still believe additional data are required to support this interpretation. For a complete understanding of the primary productivity in the Rhaetian of western Tethys, and to compare it with the volume proportion of

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nannofossils in the rock and carbon isotope curve, we would need to know at least the flux of nannofossils to the sea floor and the amount of other primary producers in Rhaetian surface waters, apart from those producing nannofossils. The second point is critical: *Prinsiosphaera* is a fossil which taxonomical affinity is unknown, and was part of a pelagic ecosystem that should not be compared to the Recent. We have no clue on whether the abundance of *Prinsiosphaera* is a reasonable proxy for primary productivity in the Rhaetian, or other primary producers, which were however not calcifying and may have thus not preserved, should be considered instead. In such a situation, which is hardly comparable to the Recent, a strictly geochemical proxy (as, e.g., rock TOC) should probably be preferred. Below, the comments of referee #2 are addressed with more detail.

ANONYMOUS REFEREE #2: "The authors concluded "As the proportion of nannofossil tests increased, the contribution of microspar with low $\delta^{13}\text{C}$ diminished, determining the isotopic trend." This statement might be misleading, because it implies that the rocks are just composed of (a) nannofossils and (b) microspar which is interpreted as a cement. But even a rock that is composed almost completely of microspar today must have consisted originally of sedimentary particles (plus porosity). What was the original composition of such rocks? It might be possible that they were originally aragonitic and therefore the components are not visible anymore."

ANSWER: The rock, as it is now, is indeed (almost) only made of nannofossils and microspar. The original components that are now not visible anymore were aragonite (presumably aragonite mud) from adjacent platforms. Since the substitution of aragonite with calcite is a dissolution-precipitation process, microspar is in fact interpreted here as a cement (following Melim et al., 2001; Munnecke et al., 1997; Wesphal, 2006 and references therein). This is already stated clearly in the manuscript (Pag. 15, line 5).

ANONYMOUS REFEREE #2: "The authors cite Melim's papers as argument that the diagenetically altered, primarily aragonitic deposits of the Bahamas still retain more or

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less the original isotopic sea-water composition (which is probably due to the fact that by far most of the cement carbonate derived from dissolution of aragonite rather than by the decay of organic material). The values are not shifted towards lighter values although according to Melim they contain a lot of microspar"

ANSWER: In Melim et al. (2001), limestones made of microspar retain the isotopic signature of shallow water aragonite, ca. 3‰ at Bahamas, which is ca. 1.8‰ heavier than that of calcite precipitated in equilibrium from a supersaturated solution (Rubinson and Clayton, 1969, *Geochimica et Cosmochimica Acta* 33:997-1002). This is because, as the referee correctly points out, all aragonite sediment was converted in microspar in a semi-closed diagenetic environment (i.e., all carbonate from dissolved aragonite precipitated locally as calcite microspar). If this was the case of our Late Triassic sections, we should observe heavier carbon isotopes in rocks mostly made of microspar, because of the different fractionation of carbon entering aragonite with respect to the calcite of nannofossils. However, as periplatform sediments of the Great Bahama Bank reach the marine burial diagenetic environment, organic matter is completely consumed already. Late Triassic rocks of the studied sections, and in particular those of the Lagonegro Basin, still contain organic matter. This implies that carbon, other than that from the dissolution of aragonite, was available at time of microspar formation. Carbon from organic matter must have been supplied at times of precipitation of microspar for the rock to reach a carbon isotopic composition lower than that of nannofossil-dominated rocks, and lower than the carbon isotope composition of sea-water estimated by Korte et al. (2005).

ANONYMOUS REFEREE #2: "Another important point is the amount of mechanical compaction of the original sediment because this determines the amount of calcium carbonate required to cement the sediment. A reduction in nannofossil abundance does not necessarily imply an increase in cement carbonate. So why should a reduction of calcareous nannofossils shift the carbon isotope values towards lighter values? It is the pre-cementation porosity that determines the amount of cement, not

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the amount of nannofossils. I am not sure if it is possible at the current state of the manuscript, but information on the amount of compaction might be of interest in this respect."

ANSWER: This is a very important point that referee #2 is making, which deals with the substantial difference between the rock and the sediment. Of course, the original sediment must have been characterized by a significant porosity. This porosity is then lost by mechanical compaction and cementation. mechanical compaction may concentrate nannofossils with respect to the other sediment components. However, it is the isotopic signature of the rock - not of the sediment - that we are measuring, and the rock is eventually only made up of nannofossils and microspar, the latter occupying the porosity that was left after mechanical compaction, and substituting aragonite components of the sediment. Almost all microspar (except the carbon from organic matter) derives from the dissolution of aragonite sediment after (initial) mechanical compaction. In this two-component rock, although it is not the amount of nannoplankton to determine (cause) the amount of cement, the proportion of the two components is strictly correlated and the bulk isotopic composition is the weighted mean of the isotopic compositions of nannofossils and microspar. Certainly, an estimate of compaction would be of interest, especially if sediment fluxes are to be estimated, but it is hard to obtain at the moment and beyond our scopes (we don't attempt to, and we couldn't, estimate fluxes).

ANONYMOUS REFEREE #2: "Why not interpreting the carbon isotope curve as a result of changes in primary productivity? An increase in productivity would (as the authors wrote) probably increase the export of isotopically light organic matter to the sea floor, but on the other hand the surface water, where the calcareous nannoplankton lived and calcified, would be enriched in ^{13}C . High primary productivity would therefore result in a high number of isotopically heavy calcareous nannoplankton. Couldn't this explain the correlation seen in figure 8?"

ANSWER: The discussion on the interpretation of carbon isotopes will be reshaped,

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substantially excluding the discussion of other Late Triassic sections. The interpretation of carbon isotopic trends, and in particular of the Late Rhaetian positive trend, as caused by rising surface productivity will be discussed. It should be noted however that we don't know whether higher productivity would imply a higher flux of *Prinsiosphaera* to the sea floor, and that there is no clue on whether the *incertae sedis* *Prinsiosphaera* is a good proxy for surface primary production. Further data should be produced before such hypothesis could be accepted, as TOC, but a discussion of this hypothesis is already possible and will be expanded in the discussion. Rise of the $\delta^{13}\text{C}$ because of higher productivity, however, cannot explain the carbon isotopic composition of bulk carbonate lower than that of Late Triassic (Rhaetian) seawater that is observed at Pignola-Abriola.

ANONYMOUS REFEREE #2: "Two minor points: - I recommend changing the term "microfacies" to "ultrafacies" throughout the MS. - Figure caption of figure 5: change 'Silicization' to 'Silification'"

ANSWER: We will modify the revised text as suggested.

Interactive comment on Biogeosciences Discuss., 10, 7989, 2013.