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

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We thank Anonymous Referee #1 for the careful reading and exhaustive comments on our manuscript. Below, we extracted the referee's comments and provide a point-by-point answer.

Anonymous referee #1 raises three main issues: (1) about the methodology, which is not considered to provide a volumetric estimate; (2) about correlation of Rhaetian carbon isotope records; (3) about the timing of the onset of Ridgwell's "Mid Mesozoic

Revolution". Several points are then discussed within these three main topics.

(1) Adequacy of the method.

ANONYMOUS REFEREE #1: "The methodology used by Preto & co-authors to evaluate Prinsiosphaera's proportion, IS NOT a volumetric estimate."

"It does not provide a volume (cc)"

"The authors expressed their results in percentages obtained analysing a surface not a volume of rock."

"The point counting method [...] gives a fairly accurate estimate of the nannofossil proportion in a rock but not in terms of volume"

ANSWER: Despite being not commonly used by specialists in nannoplankton, point-counting is the standard technique for the volumetric estimation of rock components (Chayes, 1951: Petrographic modal analysis. Wiley, London, 113 pp.; Van der Plas and Tobi, 1965; Tucker, 1988, 1991; Flügel, 2004, to mention just a few) and provides an unbiased estimation of the volume of rock components (Chayes, 1951; Chayes, 1954: The theory of thin-section analysis. Journal of Geology, 62:92-101). Point counting measures volume proportions of components that can be transformed to volumes for any given rock volume. Our methodological approach thus do provide a volumetric estimate of Prinsiosphaera in Late Triassic rocks. It is probably worth to mention that this is only true under some assumptions, which are however commonly met: (a) point-counting is performed on a surface; (b) the sampling step is wider than the largest rock component (Van der Plas and Tobi, 1965). Note that rock anisotropy does not bias the estimate (Chayes, 1954), while rock inhomogeneity may affect the precision, but would not bias, the results (Van der Plas and Tobi, 1965). These assumptions were left untold in the manuscript because they are met in most rocks, but can be specified in the revised manuscript.

ANONYMOUS REFEREE #1: "[The methodology used by Preto & co-authors] does

not provide a flux of nannofossil produced calcium carbonate"

ANSWER: This is correct, however, it is beyond the scopes of this work to estimate fluxes. Furthermore, a flux estimate is impossible without independent absolute time measurement, because the geochronology of the Rhaetian is still debated, with proposed durations for this age ranging from 3 to 8 millions of years (Gradstein et al., 2012: The Geologic Time Scale 2012, Elsevier).

ANONYMOUS REFEREE #1: "Size and volume of nannofossil carbonate particles should be calculated using the formulas currently employed by nannofossil specialists to quantify the amount of biogenic carbonate (see for example Bornemman et al 2003, Palaeo3 and references therein...)." "Preto & co-authors should evaluate and discuss these quantitative approaches in detail if they think that they are unsuitable to estimate total volume of nannofossils"

ANSWER: Methods as those depicted in Bornemann et al. (2003) are, of course, perfectly suitable for the volume estimation of nannofossils, but are designed to transform counts of individuals in a given area or volume to carbonate volumes, hence the necessity to reconstruct volumetric information throughout morphometric analysis of nannofossil species. Counts of individuals are convenient especially when different taxa must be evaluated separatedly, however, in our study we dealt with consolidated limestone bearing a single nannofossil taxon. Volume estimation by point-counting is the standard approach in these conditions (Flügel 2004, and references therein) and one that allows error estimation (Van der Plas and Toby, 1965). We plan to add the main point of this answer in the revised version of the manuscript for further clarity: "Methods for volume or flux estimation based on counts of individuals in a given area or volume (Young and Ziveri, 2000) are perfectly suitable for the volume estimation of nannofossils, especially if munerous taxa are to be distinguished, but modal analysis is the most adequate method for unbiased volume estimation of a single component in a consolidated rock (Chayes, 1951; 1954)".

ANONYMOUS REFEREE #1: "The authors should also be more convincing about the reliability and reproducibility of their data giving a critical estimate of magnitude errors"

ANSWER: Estimation of errors can be easily added in the revised manuscript: "Point counting was planned in order to maintain two-sigma errors within less than 5%, implying that > 400 points per frame must be counted (Van der Plas and Toby, 1965). In a few cases, variability between frames of the same sample exceeds the error bounds (e.g., in sample at m 39.75 of Pizzo Mondello section). This was attributed to sample inhomogeneity (e.g., because of discontinuous biorturbation or preserved lamination)."

(2) Correlation of Rhaetian carbon isotope excursions.

ANONYMOUS REFEREE #1: "The paragraph on d13C interpretation is long, unclear, full of repetitions and useless for the manuscript final conclusions. The carbon isotope interpretation and comparison made by Preto & al suffers from inconsistent stratigraphic correlations."

ANSWER: Discussion about correlations can in fact be reduced drastically, without affecting our conclusions. In particular, the whole part of this chapter discussing correlation of a (putative) negative carbon isotope excursion at the Norian/Rhaetian boundary will be removed. This should make this chapter shorter and concise.

ANONYMOUS REFEREE #1: "There are convincing evidences however, that the negative excursion documented by Sephton et al (2002) rather approximates the end Rhaetian event (please, check Hall & Pitaru, 2003; Geology) than the Norian-Rhaetian boundary."

ANSWER: We thank the referee to have brought this important reference (and related papers) to our attention. We agree that the carbon isotope excursion of Sephton et al. (2002) should not be considered, because it probably dates close to the Triassic/Jurassic boundary. Reference to Black Bear Ridge section will be deleted from the revised manuscript.

ANONYMOUS REFEREE #1: "the carbon isotope data by Mette et al (2012) from the Eiberg section (Austria) can not document the rise in d13C that follows the negative shift at the Norian Rhaetian boundary because only sediments belonging to the end Rhaetian Marshi zone outcrop at Eiberg (Krystyn, 2005).

ANSWER: The Eiberg section of Mette et al. (2012) encompasses the three main subdivisions of the Rhaetian stage, that correspond to three ammonoid biozones (P. suessi, V. stuerzenbaumi and C. marshi) (Mette et al., 2012, fig. 3, pag. 64). Their biostratigraphic framework is based on Golebiowski, 1989, 1991 and Krystyn, 2008. We couldn't identify the reference suggested by the referee. Mette et al. refer to Krystyn et al., 2005 (Krystyn, L., Böhm, F., Kürschner, W., Delegat, S., 2005. The Triassic–Jurassic Boundary in the Northern Calcareous Alps. In: Palfy, J., Ozsvart, P. (Eds.), Programm, Abstracts and Field Guide. 5th Workshop of IGCP 458 (Tata and Hallein 2005), pp. A1–A14). If this was the suggested reference, we infer it was considered by Mette et al. (2012) when they laid down their biostratigraphic framework for the Eiberg section. However, in the absence of a documented negative carbon isotope excursion, it is adequate to drop also the part of discussion about the correlation with Eiberg in the revised manuscript.

ANONYMOUS REFEREE #1: "it is not completely true that no negative excursion is recorded at the N-R boundary by Krystyn et al (2007) at Steinbergkogel. A negative trend is discernible in the d13C curve of figure 3 (Krystyn et al 2007)"

ANSWER: It is correct that an excursion of less than 0.5 ‰ could be possibly identified at Steinbergkogel, close to the Norian/Rhaetian boundary. However, it is common practice in stable isotope stratigraphy not to consider isotopic excursions of such a small magnitude as valid, especially when dealing with measurements on bulk carbonate. More specifically, the isotopic record of Steinbergkogel was discussed in literature and no isotopic excursion was highlighted so far. Krystin et al. (2007, page 194), points out that "The values remain more or less constant all along the measured interval, varying between 2.4‰ to 2.9‰" and "there are no significant carbon isotope variations around

the two boundary options and the observed fluctuations are of too small amplitude for long-distance correlation". Krystyn et al. (Albertiana 36:164-172, 2007) also state that "The δ13 Ccarb curve shows no significant variations across all three boundary options" and Richoz et al. (Berichte der Geologischen Bundesanstalt 76:17-19, 2008), referring (also) to the Steinbergkogel section, state that "the isotopic values [...] show no shift across the newly proposed Norian/Rhaetian boundary". It would be incorrect to discuss a < 0.5‰ presumed isotopic excursion whereas the literature is clearly uniform in excluding that such excursion should not be correlated, and most probably do not exist. We suggest that no further effort should be spent to discuss a putative carbon isotope excursion at Steinbergkogel than that of the original manuscript, as we wish to simplify this part of the text.

ANONYMOUS REFEREE #1: "the scale of figure 3 of Krystyn et al (2007) has been squeezed"

ANSWER: In our figure 8, the scale of the 4.4-meters-long Steinbergkogel A section was not squeezed, but rather expanded (by a factor of ca. 5X) with respect to Pizzo Mondello and Pignola-Abriola, in order to allow comparison.

(3) Onset of the Mid Mesozoic Revolution.

ANONYMOUS REFEREE #1: "The third point to be fixed is related to the start-up of the 'Mid-Mesozoic revolution' (Ridgwell 2005) that the authors date back to the late Triassic."

ANSWER: With our contribution, we document the time at which nannofossils reach rock-forming abundances. In this sense, we provide an age for the onset of the mechanism that eventually led to the "Mid Mesozoic Revolution" of Ridgwell. The referee, however, is correct in pointing out that this does not imply that the Rhaetian ocean was in Cretan mode already. Sentences in the discussion and conclusions can be modified as follows: Discussions (Page 13 line 10) The sentence "This crucial event of the global carbon cycle, known as the "Mid Mesozoic Revolution" (Ridgwell, 2005),

may thus date back to the end of the Late Triassic." is deleted. Conclusions (Page 17 line 10) "The latest Triassic was thus the first time in Earth history when calcareous plankton reached rock forming abundances, a condition that started up the so-called “Mid-Mesozoic Revolution” of Ridgwell (2005), i.e., the permanent stabilization of the long term carbon cycle in the oceans by the initiation of a pelagic carbonate factory". Expressed in this way, those sentences should avoid the impression that we set a precise and definitive age for the Mid-Mesozoic Revolution.

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