Karatsolis and others present new elemental records from sediments of drift/contourite deposits in the North Atlantic Ocean, which likely recorded changes in strength of currents composing the lower limb of the Atlantic Meridional Overturning Circulation (AMOC). Therefore, these records have the potential to shed light on deep water formation and AMOC dynamics during warmer-than-today climate states of the Late Miocene to Early Pliocene. Identification of intervals I, II and III seems robust from the presented datasets, however their paleoenvironmental interpretation should be supported by additional data. Below, I present suggestions that could improve paleoceanographic interpretations and the argumentation to support the presented age model, as well as general and minor comments.

We thank the reviewer for the positive comments and for proposing additional analysis that can strengthen the interpretations made.

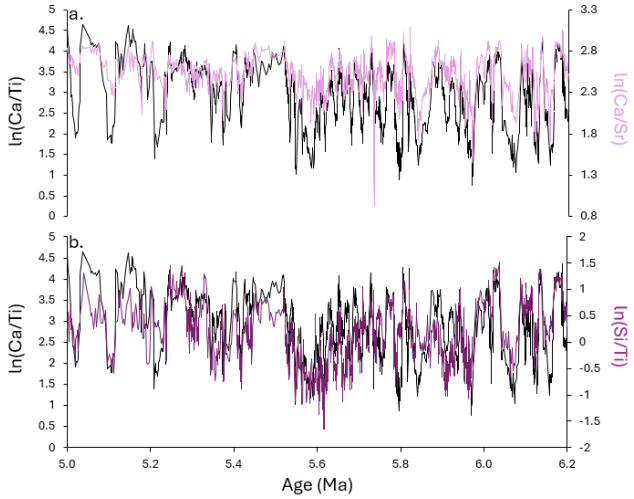
**Interpretation of XRF-derived elemental records:**

- Possible changes in carbonate vs biosiliceous components should be assessed, or at least ruled out, with a version of the ln(Si/Ti) ratio, as previously applied in the eastern Equatorial Pacific Ocean.

This is a useful addition to the records. We have now calculated the ln (Si/Ti) and present time series of this elemental ratio (Figure S4). The record mostly follows the observed patterns of the ln (Ca/Ti) ratio (used to estimate the carbonate content), supporting that this ratio possibly reflects changes in biogenic silica. We now present the ratio and discuss the results in the text:

Material and Methods: "The latter (ln(Si/Ti)) has been previously used to infer changes in biogenic silica production in the eastern equatorial Pacific (e.g., Kochhann et al., 2016; Holbourn et al., 2014)."

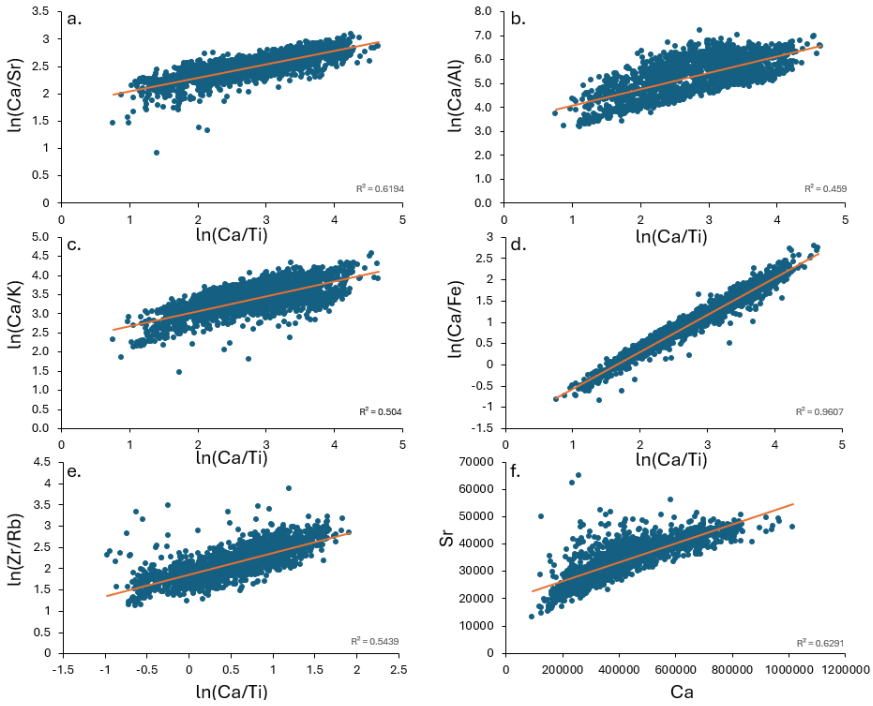
Discussion: "The natural logarithm of Si/Ti follows the main fluctuations observed in the $CaCO_3$ (wt%) content record (Figure S4), suggesting that this ratio reflects biogenic opal sedimentation and is higher when the dilution from detrital input is reduced."




New Figure S4

- Since Ti counts can be influenced by provenance changes (i.e., basaltic grains from Iceland), authors should provide in the supplement evidence that the ln(Ca/Ti) ratio shows trends comparable to those of ratios using Ca over other terrigenous elements (e.g., Fe, K, Al).

We now provide a cross plot showing the correlation between Ca/Ti and Ca against the other terrigenous elements mentioned by the reviewer (Figure S2). The correlation ranges from moderate to very strong, showing the potential to use these elements to infer variations in terrigenous input, but also demonstrates that different elements might be reflecting different terrestrial sources and provenance. The correlation between ln(Ca/Ti) and ln(Ca/K) has the lowest $R^2$(0.5), hinting to some differentiation between the source of Ti and K in drift detrital-related detrital sediments, as has been suggested by the use of this ratio in previous studies (see references in methods and discussion).




New Figure S2

- Authors should perform an overall assessment (it does not have to be a detailed micropaleontological assessment) of discrete samples for signs of dissolution of calcareous microfossils, and proportions of high productivity taxa (e.g., infaunal benthic foraminifera). This would allow to disentangle whether shifts in carbonate content were driven by preservation or productivity changes. The paleoenvironmental interpretation of interval II strongly depends on the assessment of micropaleontological samples to disentangle dilution-dissolution-productivity.

A low resolution micropaleontological assessment was performed for every core catcher sample on the ship. We have revisited these samples and enriched the observations and now provide a summary table in the supplement (Table S1). This includes estimates for the abundance and preservation of planktonic foraminifera and calcareous nannofossils. The preservation patterns do not show a clear signal, but fragmentation of planktonic foraminifera (potential indicator of dissolution) increases after 5.67 Ma and remains higher in samples within Intervals II and III. Benthic foraminifera experts were not part of this study. Further detailed and higher resolution work (including benthic foraminifera assemblages) should shed light on micropaleontological evidence for changes across the presented intervals.

Material and Methods

"To further constrain the possible effect of $CaCO_3$ dissolution, micropaleontological observations from 11 core catcher samples across the study interval were compiled based on the available shipboard descriptions (Parnell-Turner et al., 2025b; Table S1). These include qualitative estimates of calcareous nannofossil and planktonic foraminifera abundance and preservation. Additional observations from the foraminifera residues were added after the expedition, including an estimate of fragmentation of foraminifera shells."

Results

"The micropaleontological analysis showed that calcareous nannofossils and planktonic foraminifera were abundant and mostly well-preserved from the base of our study interval until (~5.72 Ma). After that, their preservation and abundance varied significantly, without a clear consistent change through time. Samples at the end of Interval I and within Interval II (~5.67, ~5.6 and ~5.3 Ma) have rare planktonic foraminifera and moderate preservation (Table S1), falling possibly within intervals of higher detrital input. Relative fragmentation (%) of planktonic foraminifera shells (Table S1) shows a more consistent pattern, with a general stepwise increase at ~5.67 Ma, and higher numbers during Intervals II and III. An interval with increased relative abundance of *Discoaster* species and coccospheres is observed at ~5.67 and ~5.6, at the end of Interval I.

Discussion

"Towards the end of Interval I, an increase in species of the genus *Discoaster* is observed in shipboard data (Table S1). Discoasters are mostly linked to (sub)tropical latitudes and oligotrophic waters (e.g., Chepstow-Lusty et al., 1989, and references therein) and they could reflect the influence of southerly sourced water masses, or an overall increase in SST, although more detailed assemblage data is required to confirm this."...

"The overall higher foraminifera fragmentation in samples right before and at the end of Interval III (~5.6 and ~5 Ma; Table S1) is consistent with increased dissolution."

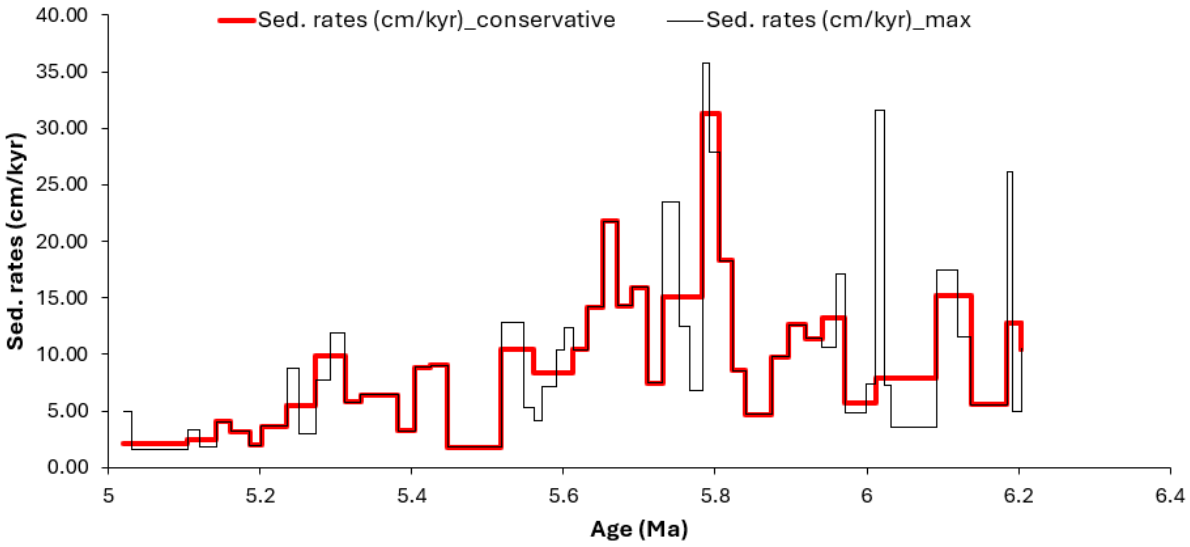
**Age model:**

- Can high energy depositional processes of contourite/drift deposits affect the identification of magnetochrons? This possibility should be discussed and ruled out for Site U1564.
- The revised age model for Site U1564 is based on a maximal tuning approach, with a high number of tie points. Authors should provide a comparison with a minimal tuned version of the age model (as supplementary material) to ensure that the maximal tuning is not adding artificial features to the record in the time domain.
- Rapidly accumulating drift bodies in the North Atlantic are interesting and often preferred for P-mag studies, since they are characterized by high-sedimentation rates and can therefore provide higher temporal resolution of records (e.g., Di Chiara et al. 2025, Chanell 1999). That being said, we agree that high-energy depositional processes related to these deposits can potentially affect magnetostratigraphic records, but they do not necessarily prevent reliable magnetostratigraphic interpretation. In the case of U1564, the sedimentological observations do not indicate major depositional discontinuities that would compromise the continuity of the magnetostratigraphic record. Furthermore, the identified magnetic polarities are supported by independent biostratigraphic constraints (Parnell-Turner et al., 2025). A relevant sentence has been now added to the manuscript.

- Sedimentation rates based on a minimal tuning strategy (one tie point per cycle) are now presented in the supplement (Figure S5). Indeed, some of the high peaks that we mentioned (lines 285-289 of initially submitted manuscript) are now reduced in amplitude (e.g., at 6.02), while the density of tuning points is also influenced differentially across the record due to the changes in sedimentation rates (intervals with higher sedimentation rates lead to more "spaced-out" points). Despite that, the overall variability and patterns remain, and there are no indications that the main breakpoints of the intervals should be placed elsewhere. Related to that, we now acknowledge a general age estimate uncertainty of 10-25 kyr and provide a range of time for the transitions between intervals.

A relevant sentence has been added accordingly:

"More importantly, even if a conservative astronomical tuning strategy with reduced tie points is followed, the main sedimentation rate features and interpreted interval transitions remain unchanged (Figure S5)."




Nes Figure S5

**General comments:**

- The introduction focuses excessively on basic information on sedimentary archives, and fails to explore in depth the role of the AMOC in the Earth system. For instance, the role of AMOC in heat exchange between the two hemispheres, and the resulting impacts of hydroclimate changes, is not even mentioned. Therefore, I strongly suggest to rewrite this section, streamlining the importance of deep time reconstructions of deep-water dynamics in the North Atlantic to better understand late Cenozoic climate change.

We have now restructured the introduction accordingly and have added few more sentences explaining the role of the AMOC in the Earth system and the significance of past climatic records in reconstructing its changes.

Introduction: "The Atlantic Meridional Overturning Circulation (AMOC) is a major feature of the modern thermohaline circulation, the strength of which plays a key role on surface ocean heat

distribution, and impacts, among others, the position of the Intertropical convergence zone rain belt, as well as the intensity of the African monsoon (e.g., Lenton et al., 2025 and references therein; Schneider et al., 2014). For this reason, AMOC reconstructions in deep time have been a central goal of paleoceanography and scientific ocean drilling, especially during warmer-than-present time intervals (e.g., Liu et al., 2024; Dausmann et al., 2017). AMOC consists of two main limbs, a northward flowing set of currents and a southward return flow. In the high latitude North Atlantic, the North Atlantic current (NAC) moves saline surface waters from tropical regions northward, which subsequently cool in the Nordic and Labrador seas, sink, and form the main component of North Atlantic deep water (NADW; Fig. 2)…"

- There is no statement in the Conclusions on whether overturning intensity was reduced during interval II.

Based on the comments from other reviewers, we avoid making bold claims on the total overturning based on our records. We have added a nuanced comment describing an overall weakening of the influence of ISOW related currents at Site U1564 during Intervals II and III.

"Interval II (5.55–5.23 Ma) was characterized by a reduced influence of ISOW-related bottom currents, evidenced by muted amplitude of XRF elemental ratios and lower sedimentation rates, as well as higher carbonate content."

**Minor comments:**

- What does (high/low) mean in Table 1? Is it the phase relationship between record and target? Please clearly state it.

It is the relative value of the record it describes. A clarification has now been added.

- Please revise throughout the text the use of before/after (should only be used in the time domain) and above/below (should only be used in the depth domain).

This has now been implemented.

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