Review by Daniel Palchan

Responses in red

Review for: Controls of aeolian and fluvial sediment influx to the northern Red Sea over the last 220 000 years
Werner Ehrmann1, Paul A. Wilson2, Helge W. Arz3, Gerhard Schmiedl4

The manuscript is original and provides detailed information regarding the siliciclastic sediment compositions in core KL23 from the north part of the Red Sea. The data set provided in this manuscript is valuable and continues this group's work from recent years, where they infer paleoclimate trends from the isotopic values and clay minerals compositions. This contribution is important in providing high-resolution mineralogical and geochemical data and should be published for others to use. The discussion uses the available literature and draws broad spatial teleconnections based on various paleoclimate records and models. They provide a strong case for the ties between low latitude northern Red Sea and high latitudes ice caps glacial-interglacial cycle climate variability over the equatorial insolation driven variability seen southward in Red Sea archives.

The authors argue for a reasonable scenario – where during glacial periods and low global sea levels, the Nile River delta was exposed, and its sediments served as a significant source for terrigenous eolian sediments blown southward to the Red Sea. Their argument relies on increased smectite content and Ti counts during glacial periods, both likely originating from volcanic detritus. Another source of eolian sediments suggested by the authors to be significant in the past is the "Tokar Gap" and two other similar mountain gaps in the eastern borders of the Red Sea fringing mountain belt. These interpretations of the results might prove valid, however, other interpretations may well be inferred from the same results, following the discussion raised here:

Line 155 – contrary to the stated argument the DSAF% maps from (Kunkelova et al., 2024) shows relatively high values for the region between Sallum (Egypt) and Benghazi (Libya). Indeed, this region is the source of reconstructed air parcel routes (Palchan and Torfstein, 2019). On the other hand, lower latitude East Sahara is not a probable source of dust to KL23 due to the local wind patterns and their convergence southward from it (e.g., Menezes et al., 2018).

Agreed, we have added the italicised clause to the sentence in question:

High contributions in the past from relatively inactive modern-day sources cannot be ruled out, but present-day DSAF maps (Schepanski et al., 2007; Kunkelova et al., 2022) strongly suggest that, today, *with the exception of a narrow strip of northeastern Cyreneaica (north easternmost Libya),* the northeastern corner of Africa (Egypt and eastern Libya) is a weak source of dust in comparison to other areas in the region such as the lower latitude Eastern Sahara, the Horn of Africa, the Levant, the central Arabian Peninsula, and Mesopotamia (see Kunkelova et al., 2024, their Fig. 9, for the most comprehensive DSAF data set).

Note that we now also include this coastal strip in an expanded discussion of potential unradiogenic dust sources to balance input to KL23 from the exposed Nile delta (lines 318-325).

Line 180 – the treatment of removing marine barite is important but seems not very significant in interpretation of the provided Sr isotopes, as all of the previous terrigenous data from KL23 (Palchan et al., 2013) is higher than the modern seawater composition of 0.709. Hence, as to the authors claim, it should be even more radiogenic than reported. Even so, comparing the Sr values in the current and previous work the difference seems to be negligible.

It is the size (not sign) of the offset in Sr isotope composition between barite (sea water) and the terrigenous fraction that determines the impact of barite contamination, but we agree that contamination is modest at KL23 compared to elsewhere, even within the Red Sea. Thus, we have added the following text to the first paragraph of Section 4.1:

Note that, while marine barite can severely contaminate terrigenous ^{87}Sr / ^{86}Sr, even where barite accumulation rates are modest (Jewell et al., 2022), that is not the case at KL23. This is because, here, the offset in Sr isotope composition between the terrigenous sediments supplied to the site (~0.7095 to ~0.7140) and barite (modern seawater) is modest in comparison to sites located elsewhere, for example, in the central Red Sea, the Mediterranean Sea and North Atlantic Ocean.

Line 258 – using the term "substantial" is a bit of a stretch as core KL23 smectite base levels are around 40% of the clay composition, thus, the rise during glacial periods is only additional 10%. This increase is proportional to the content of other clays as the analysis was done only on the <2um fraction. Thus, the rise could reflect decrease in other clays rather than more input from a specific source.

Furthermore, the concentration of the clay fraction in the samples drops significantly from ±12% to ±4% during the respective interval of increased smectite (Fig. 3B & Fig. 6C).
However, the use of εNd reflects sources without this issue and its low values "(typically ~ –8 to –6 εNd)" points to that if there is indeed a Deltaic source, it is surely not "substantial" as it resembles more granitoid detritus compared with the Deltaic higher εNd values.

Agreed, the term "substantial" is excessive and we replace it in the revised version with "distinct".

As a result of the closed sum effect, a reduction in the concentration of one clay mineral may be caused by an increase in the concentrations of other clay minerals. Smectite as the dominant clay mineral shows the largest amplitude in its concentration pattern. We consider it unlikely that the documented changes in smectite content were driven by dilution, because this explanation would require that the other four less abundant clay minerals would need to fluctuate together with one another. Thus, we infer that smectite variability is the primary pacemaker of change in the clay mineral assemblage.

We added a paragraph to the revised results section.

Methods remarks:

Section 2.3 – the leaching method is not specified. This is important and needs clarification and detail. Similarly, there is no detail on the analysis method (i.e., TIMS? Multi-collector?). Even if this is described in a previous paper, it is important to include minimal information regarding the method and analysis (indeed, this is discussed later in section 4.1). For example, what standard was used during the analysis, and what value was assumed for it?

We now include the following text in a more detailed methods in the supplements of the revised manuscript:

We treated our samples to remove all authigenic marine contaminants from the isotope fingerprint of the terrigenous fraction (carbonate, authigenic Fe-Mn oxyhydroxide coatings, organic carbon and marine barite) using the method of Jewell et al. (2022). That study demonstrated that small quantities of marine barite can have a large contaminating effect on the isotopic composition of the terrigenous fraction, especially for Sr. To remove marine barite, samples were leached with 0.2 M diethylene triamine pentaacetic acid (DTPA) in 2.5 M NaOH and left in a water bath set to 80 °C for 30 minutes. Following the recommended treatment protocol in Jewell et al. (2022), we repeated this step four times on three test samples to determine how many treatments were optimal for complete barite removal at this site. Marine sediments were considered free of marine barite when there was no appreciable decrease in Sr or Ba concentration, and no further change in measured ^{87}Sr / ^{86}Sr of the silicate fraction with additional DTPA-NaOH treatment. Based on our test samples, we employed one DTPA-NaOH treatment (following the removal of all other marine phases). Analyses were performed by MC-ICPMS at the University of Southampton's Waterfront Campus.

Figure remarks:

Fig. 2a the window lacks a crucial potential source area depicted as increased DSAF% in northern Sahara around 20°N (Kunkelova et al., 2024). This region is a prominent source of air parcel reconstruction (Palchan and Torfstein, 2019).

We think the reviewer intended to say 30°N, but this is a good suggestion. We have expanded the window in Fig 2a as suggested. Furthermore, we modified the manuscript text in the first paragraph of Section 4 ("Discussion") and in Section 4.2 ("Sea-level controlled aeolian sediment influx from the Nile delta") to include the possibility of a dust contribution from the small coastal strip of Cyrenaica. We also now cite Palchan and Torfstein, (2019) on their air parcel analysis.

In summary, this is a fascinating paper with substantial data contribution on the clay mineralogical compositions in the northern Red Sea – a region largely overlooked. The conclusions drawn based on the results are partly debatable; the paleoclimate community will surely benefit from the discussion.

Thank you for the constructive comments on our contribution.

Daniel Palchan

References

Kunkelova T., Crocker A. J., Wilson P. A. and Schepanski K. (2024) Dust Source Activation Frequency in the Horn of Africa. *J. Geophys. Res. Atmospheres* **129**, e2023JD039694.

Menezes V. V., Farrar J. T. and Bower A. S. (2018) Westward mountain-gap wind jets of the northern Red Sea as seen by QuikSCAT. *Remote Sens. Environ.* **209**, 677–699.

Palchan D., Stein M., Almogi-Labin A., Erel Y. and Goldstein S. L. (2013) Dust transport and synoptic conditions over the Sahara–Arabia deserts during the MIS6/5 and 2/1 transitions from grain-size, chemical and isotopic properties of Red Sea cores. *Earth Planet. Sci. Lett.* **382**, 125–139.

Palchan D. and Torfstein A. (2019) A drop in Sahara dust fluxes records the northern limits of the African Humid Period. *Nat. Commun.* **10**.