A marine record of dust deposition off the Cape Verde Islands, Africa on interglacial-glacial time scales

Hayley R. Flanagan[1], Larry C. Peterson[1], Arash Sharifi[1,2], Ali Pourmand[1]

[1]Rosenstiel School of Marine, Atmospheric, and Earth Science, University of Miami, Miami, FL 33149, USA. [2]Isobar Science, Miami, FL 33155

UNIVERSITY OF MIAMI
ROSENSTIEL SCHOOL of MARINE, ATMOSPHERIC & EARTH SCIENCE

NEPTUNE ISOTOPE LABORATORY
ROSENSTIEL SCHOOL OF MARINE AND ATMOSPHERIC SCIENCE

Introduction

- The Sahara Desert is the world's largest mineral dust source, contributing up to 70% of all global emissions (van der Does et al., 2018) (Figure 1).
- Dust is hypothesized to be an important climate driver through both direct and indirect interactions with radiation and ocean biogeochemistry (Figure 2).
- It is important to identify the source areas of dust since sources control the magnitude, mineralogy, and solubility of nutrients for primary productivity (Barkley et al., 2022).
- This study focuses on the dust record in GS7205-60, a deep-sea sediment core from off the coast of West Africa.

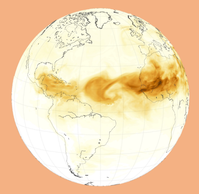


Figure 1. Dust export from the Sahara Desert.

Figure 2. Impact of dust on climate (Mahowald, 2010).

Figure 3. Location of piston core GS7205-60 and nearby Ocean Drilling Program Site 659.

Objective: To examine variability in dust input to the eastern Atlantic and test whether the dust that is deposited offshore can be traced to a specific region in Africa, and how potential dust sources may have changed in response to glacial-interglacial climate cycles.

Methods

1.) Stable Oxygen and Carbon Isotope Analysis ($\delta^{18}O$ and $\delta^{13}C$)

- *Cibicides wuellerstorfi* were picked from samples taken every 5 cm of the core (Figure 4).
- 3-4 individuals were analyzed on a Thermo-Finnigan Delta Plus with Kiel Device in the Stable Isotope Lab.

2.) Radiogenic Sr-Nd-Hf-Pb Isotope Analysis

Figure 4. The benthic foraminifera *Cibicides wuellerstorfi*.

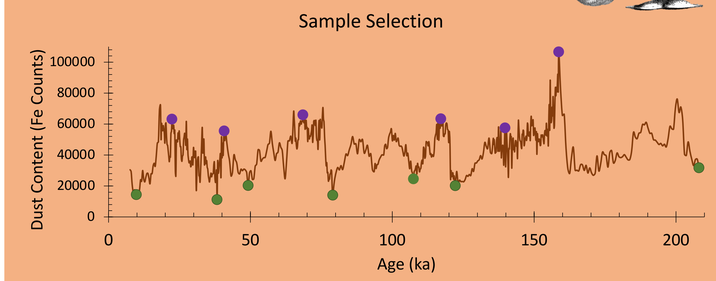
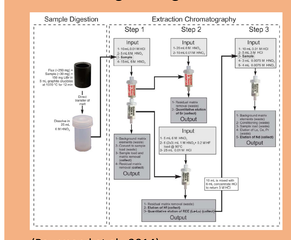


Figure 5. 13 samples were selected for radiogenic isotope analysis based on significant iron (Fe) variability, which is a proxy for dust. The Fe data were previously available from high-resolution XRF scanning. The age control comes from the benthic $\delta^{18}O$ record shown in Figure 8.



(Pourmand et al., 2014)

Figure 6. The organic content, biogenic carbonate, Fe and Mn oxyhydroxides, and biogenic silica were removed from each of the samples in a three-stage chromatographic extraction scheme (Pourmand et al., 2014) to separate the Sr, Nd, Hf, and Pb.

Figure 7. Measurements of $^{87}Sr/^{86}Sr$,$^{147}Nd/^{143}Nd$,$^{176}Hf/^{177}Hf$, $^{208,207,206}Pb/^{204}Pb$, and $^{207,208}Pb/^{206}Pb$ ratios were made on a ThermoFisher Scientific Neptune Plus High-performance Multi-collector Inductively Coupled Plasma Mass Spectrometer at the Neptune Isotope Lab .

The source of paleodust to marine sediments off the coast of West Africa has changed over the last glacial-interglacial cycle.

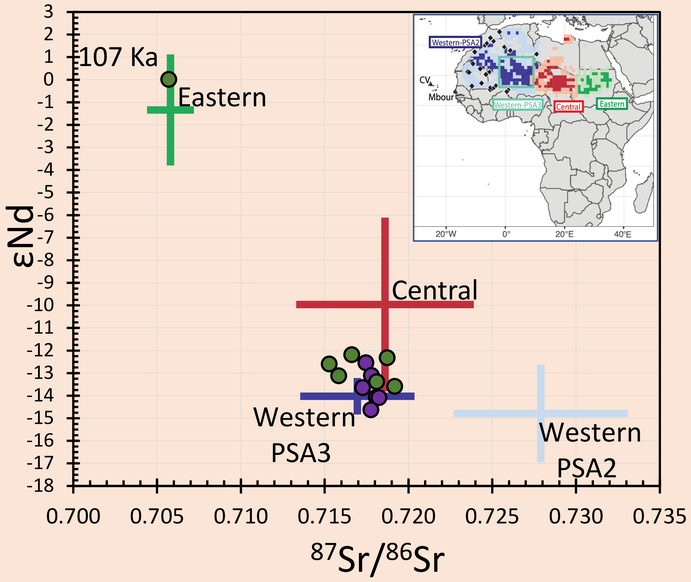


Figure 10. The $^{87}Sr/^{86}Sr$ and εNd ranges are known for several potential dust source areas in the Sahara Desert (add Reference) and are shown here in comparison to the $^{87}Sr/^{86}Sr$ and εNd values of the 13 samples measured for this study. Our data suggest that most dust that reached the location of GS7205-60 originated from a region between Western PSA3 and Central source areas, except for one sample (107 ka) which has isotopic values more characteristic of dust derived from the Eastern region.

Acknowledgments & References

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Results

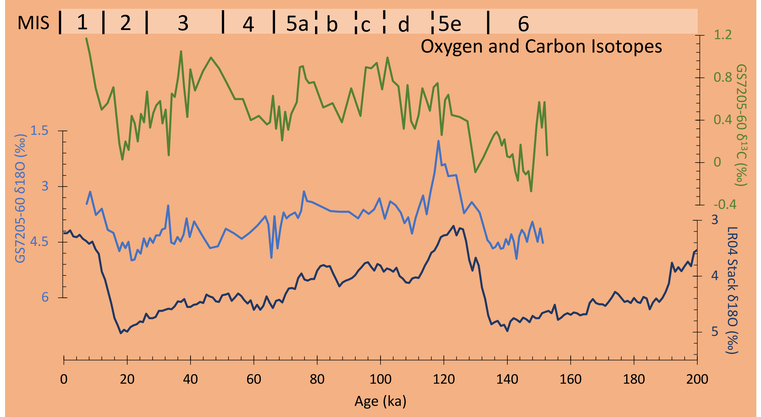

Figure 8. $\delta^{13}C$ and $\delta^{18}O$ (‰) of the first 5.5 meters of GS7205-60. $\delta^{18}O$ of GS7205-60 samples were correlated to the LR04 stack (Lisiecki and Raymo, 2005) to generate an age model for the core. The standard marine isotope stages (MIS) are shown across the top.

Sr-Nd-Hf-Pb isotope profiles over the last 200 ka

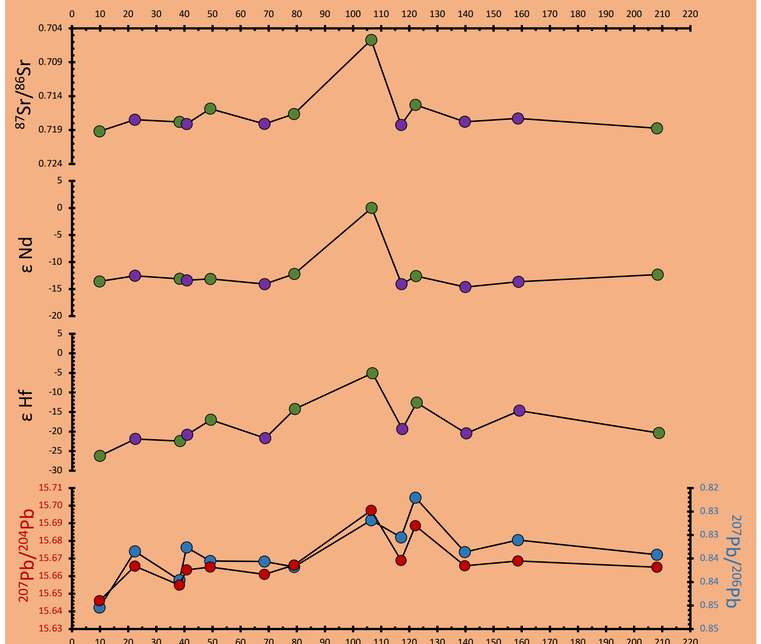

Figure 9. Sr and Nd isotopic profiles of the samples record a similar range of values regardless of the dust concentration, except for the low dust episode that corresponds to Marine Isotope Stage 5d (~107 ka). Published studies (Castañeda et al., 2009; Osborne et al., 2008) support this being a generally wet interval in Africa that has been linked to human migration patterns.

Summary

This project was undertaken as a pilot study to determine whether changes in the provenance of Saharan dust could be detected using a suite of modern radiogenic isotope tools. The Sr-Nd-Hf isotope values measured in our set of 13 samples maintain a similar range throughout episodes of low and high dust export to this site during the last full glacial-interglacial cycle; a significant deviation from these values, however, is observed in Sr-Nd-Hf isotope values during the low dust episode that corresponds to MIS 5d within the longer Eemian interglacial period. If this finding is confirmed (or rejected) through future study and higher resolution sampling, the observed variability may help improve our understanding of how glacial-interglacial forcing mechanisms impact the flux and source of mineral dust from North Africa's shifting provenance source areas through time.