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The chemistry and uranium isotopic composition of a coupled timeseries of sequentially leached aeolian and sinking marine particles

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Deep sea sediments record the history of the oceans and of the atmosphere through the accumulation of the sinking particle flux on the seafloor. Nevertheless, the accumulating sediments might experience significant compositional shifts during their journey from source to sink, including weathering of atmospheric dust or fluvial material, scavenging or reverse-scavenging of chemical elements in seawater, and the formation of authigenic phases on or within sinking particles. The composition of sinking particles is a combined result of their sources contribution, weathering history, and marine biogeochemical processes.

Here, we investigate the source to sink signal transfer in the Gulf of Aqaba, northern Red Sea, by studying two overlapping time series of atmospheric dust, collected between 2009-2019, and sinking particulate matter collected using a sediment trap deep mooring between 2015-2018. The samples were sequentially leached such that five (dust) or four (marine particles) mineralogic fractions in each sample were separated, and the uranium isotopic composition ($^{234}U/^{238}U$) and inorganic elemental abundances were determined.

Each mineralogic fraction of the samples is characterized and the results are used to determine the chemical and isotopic end members of silicate and carbonate particles (e.g, Saharan and Arabian dust, local soils, sand, and rock) and compare them with known compositions in potential source areas. The water-labile, Fe-Mn oxides and dolomite fractions record the interplay between the particulate matter and seawater and allow to evaluate the dynamics of water column processes such as aeolian deposition, bottom sediment resuspension, and scavenging and reverse-scavenging, authigenic mineral precipitation, and contents and compositions of seasalts.

In addition, the uranium isotopic composition is used to estimate comminution ages of 0-40,000 years for aeolian input and 20,000-350,000 years for fluvial and local soil.

In summary, coupling the two coeval time series of sequentially leached dust and sediment trap material yields a unique understanding of the dynamics of the geological source to sink process, and together with the quantification of the timeframe of the silicate particle travel times (i.e., their comminution age), we provide a quantitative description of the transportation of particulate matter across the Sahara-Arabia Desert belt.