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Glacial-interglacial subsurface dynamics of the Northern Indian Ocean revealed from individual foraminiferal stable carbon and oxygen isotope compositions

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Stable isotopic compositions ($\delta^{13}C$ and $\delta^{18}O$) of individual planktonic foraminiferal tests provide valuable insights into seasonal changes and inter-annual climate variability, including El Niño-Southern Oscillation events. These isotopic records help in tracking changes in ocean conditions such as seawater temperature, mixed-layer depth, and ocean primary productivity [1]. However, interpreting isotopic variability is species-specific, as each foraminiferal species exhibits distinct depth preferences and fractionation characteristics. In this study, we have analyzed $\delta^{13}C$ and $\delta^{18}O$ in *Globigerina bulloides* and *Globorotalia menardii* from relatively large size fractions to investigate the factors affecting the surface to sub-surface ocean dynamics, mixed layer variability, and productivity. *G. bulloides* is primarily a surface-dwelling species that migrates downward during maturation, whereas *G. menardii* inhabits the thermocline and ascends as it matures. The downward migration of *G. bulloides* to the base of the mixed layer and the upward movement of *G. menardii* into the upper thermocline offer a complementary perspective on the subsurface ocean dynamics. Here, we compare the $\delta^{13}C$ and $\delta^{18}O$ variations in both the species in sediment cores from the Bay of Bengal and Arabian, covering the last glacial maximum (LGM) and the Holocene. These two ocean basins are influenced by distinct upper ocean processes. $\delta^{18}O$ values reflect a combination of temperature and salinity, with potential vertical migrations validated using the TraCE-21K model data [2]. In contrast, $\delta^{13}C$ values indicate changes in the productivity and/or upwelling, deviating from modelled $\delta^{13}C$ signatures of dissolved inorganic carbon. Our findings highlight that a comparative analysis of $\delta^{13}C$ and $\delta^{18}O$ values of *G. bulloides* and *G. menardii* offers valuable insights into the temporal evolution of productivity and variations in the mixed layer-thermocline boundary, both of which are key factors in past climate changes.

Ref.

[1] Thirumalai et al. (2013), Paleoceanography, 28, 401-412.
[2] He and Clark (2022), *Nat. Clim. Ch.,* 12, 449-454.