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Comparative geochemistry of Indian margin (Arabian Sea) sediments: Estuary to continental slope.

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Factors controlling the distribution of organic matter in the Arabian Sea have been the subject of much research and debate ever since organic-rich slope deposits were associated with the mid-water oxygen minimum zone (OMZ) However, the debate remains open, and numerous interacting factors have been invoked as important controls. A limitation of most previous studies is that they have been restricted to limited portions of the margin, and have not included molecular-level tracers that allow distinction of organic matter (OM) source and degradation state as factors in OM distribution.

We report results from sites across the Indian margin of the Arabian Sea, which were analysed for carbon and nitrogen compositions (elemental and isotopic), grain size and indices of OM source and degradation state. Site locations ranged from the Mandovi/Zuari estuaries to depths of ∼2000m on the continental slope, thus spanning both the semi-permanent OMZ on the upper slope (∼200-1300m) and the seasonal hypoxic zone that impinges on the shelf.

Source indices showed mixed marine and terrigenous OM within the estuaries, but overwhelming predominance (80%+) of marine OM on the shelf and slope, even in nearshore deposits. Thus, riverine OM is heavily diluted or efficiently remineralised within or immediately offshore of the estuaries. Any terrigenous OM that is exported appears to be retained in nearshore muds; lignin phenols indicate that the small terrigenous OM content of slope sediments is of different origin, potentially from rivers to the north.

Organic C contents of surface shelf and slope sediments varied from <0.5 wt% in relict shelf sands to a maximum of >7 wt% at upper slope sites within the OMZ, then decreasing to ≤1wt% at 2000m. However, major variability (∼5 wt%) occured within the OMZ at sites with near-identical depths and bottom-water oxygen. A strong relationship between organic C and grain size was seen for OMZ sediments, but lower C loadings were found for sites on the shelf and below the OMZ. Diagenetic indices confirmed that lower C content below the OMZ is associated with greater extent of OM degradation, but that C-poor shelf sediments are not consistently more degraded than those within the OMZ.

Together, results indicate that OM enrichment on the upper slope, where it occurs, can be explained by winnowing or other physical processes on the shelf combined with progressive OM degradation with increasing oxygen exposure below the OMZ. Reduced oxygen exposure may contribute to observed OM enrichment with the OMZ, but hydrodynamic processes are the overriding control on sediment OM distribution, even within the OMZ.