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Dissolved oxygen and sedimentation control on phosphorus transformation in northern Indian Ocean

C. PRAKASH BABU[1], B. NAGENDER NATH[1] and V. RAMASWAMY[1]
[1]*Geological Oceanography Division, National Institute of Oceanography*

Five step phosphorus sequential leaching experiments were carried out on surficial sediments from the northern Indian Ocean in regions with the presence of a mid-depth a) intense oxygen minimum zone (OMZ, dissolved oxygen < 0.5 ml/l; 122-1100 m) in eastern Arabian Sea and b) a weaker OMZ (91-582 m) in western Bay of Bengal, to understand the nature and degree of P-transformation to varying levels of dissolved oxygen. The spatial distribution of P transformation in eastern Arabian Sea sediments show north-south variation and is in accordance with varying intensity of OMZ. Under high surface production, high sedimentation and less intense OMZ in SE Arabian Sea, the fraction of P associated with organic and biogenics (Porg and Pbio) is high, molar Corg/Porg ratios (322-447) are relatively low and Corg/Preactive ratios are close to Redfield ratios. However, in NE Arabian Sea sediments impinged by intense OMZ, low fractions of Porg and Pbio (less than deep sea sediments) with relatively high molar Corg/Porg ratios (341-508) on one hand with Corg/Preactive ratios less than Redfield ratios on the other are observed. This indicates higher degree of regeneration and diagenetic transformation of labile forms of P to other phases in the sediments impinged by OMZ. High P authigenic fraction (Paut ~50%) in NE Arabian Sea sediments when compared to low Paut (10-39%) in SE Arabian Sea suggest significant P sink switch in northern region. Authigenic P fraction is high by a factor of 2-8 in sediments from OMZ compared to deep sea sediments overlain by well oxygenated water column emphasizing the importance of OMZ in P-sink switch. In western Bay of Bengal significant P sink switch is noticed only in Krishna-Godavari (KG) river basin sediments. In contrast to eastern Arabian Sea high Paut fraction (17-37%) is observed in KG basin sediments from OMZ as well as from deeper depths. High organic matter settling flux, high sedimentation rates, fine grain-size, high smectite content and low porosity restrict the exchange of sea water constituents with pore waters causing the development of reducing conditions either in pore waters and/or close to the interface resulting in P sink switch in KG basin sediments. Molar Corg/Porg and Corg/Preactive ratios (despite an observation of Porg release from organic matter), are surprisingly lower than Redfield ratios suggesting that these ratios do not provide information regarding P release in regions receiving high terrigenous influx. Regions with high sedimentation rate and experiencing oxygen depleted waters form important sites for gaining knowledge on P transformations. Even though the areas covered by high sedimentation and OMZ are small compared to open ocean, these areas form important sites for P burial and need to be considered for global P budget calculations.