



## **Sedimentary phosphorus and iron cycling across the Arabian Sea oxygen minimum zone**

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The diagenesis of phosphorus (P) and iron (Fe) is investigated in surface sediments at ten stations along a depth transect from within the oxygen minimum zone (OMZ) to the deep sea in the northern Arabian Sea (Murray Ridge area). Pore-water and solid-phase analyses show that authigenic Ca-P formation is largely restricted to the OMZ, where the input of labile P phases is high. Despite the more efficient sequestration of P as authigenic Ca-P in the OMZ, trends in sedimentary organic C to reactive P ratios indicate that low bottom water oxygen (BWO) generally leads to a more efficient recycling of P from the sediment relative to organic carbon. A reactive transport model (RTM) was applied to quantitatively investigate P and Fe diagenesis at one station at the lower boundary of the OMZ (bottom water O<sub>2</sub>: ~ 14  $\mu$ M). The model results show that Fe redox cycling, which is generally considered insignificant for P sequestration in the Arabian Sea, is crucial for authigenic apatite formation and P burial at this location. When corrected for the contribution of refractory Ca-P in dust, which appears to be a major source of Ca-P minerals in the sediments along the depth transect, the burial efficiency of reactive P deposited at the sediment-water interface at this station is estimated to be 15%, which is markedly lower than previous estimates from similar locations in the Arabian Sea. The model results further suggest that factors other than BWO concentrations, such as the magnitude of depositional fluxes, affect the burial of P and organic C along the depth transect. Sedimentary pyrite contents are, as commonly observed in the Arabian Sea OMZ, low at most stations. Only at one station in the OMZ, pyrite was an important sink for reactive Fe. In general, our results reveal large differences in redox conditions and P and Fe chemistry between stations in the OMZ, indicating dynamic sedimentary conditions under these oxygen-depleted waters. Application of the RTM provided insight into the mechanisms underlying the generally observed low abundance of pyrite in shallow anoxic sediments in the Arabian Sea. The results suggest that pyrite formation is not hampered by previously invoked factors such as limited availability of reactive Fe or low sulfate reduction rates. Instead, it seems that considerable amounts of pore-water sulfide are produced but subsequently lost to another sink, possibly organic matter. Overall, the quantitative model results challenge some of the existing paradigms regarding sedimentary P and Fe cycling in the Arabian Sea.