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The initiation and establishment of the Western Indian Ocean Oxygen Minimum Zone during the Early to Middle Miocene

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Presently, productivity and oxygenation of the Arabian Sea are governed by the upwelling generated along the Oman Margin. Upwelling in this area is strongly related to the modern monsoonal regime and tectonic configuration of the region, which was established during the Early and Middle Miocene (~23.0 to 11.7 Ma). Recent new records from the north Western Indian Ocean (Maldives) and revisitation of older Ocean Drilling Project sites (Omanian Margin, Owen Ridge) have established the upwelling initiation at ~12.8 Ma, concordant with the initiation of the modern-day South Asian Monsoon system. Recently published record from the Maldives reveals initial pulses of decrease in Mn occurred during the Early Miocene, which may indicate initial pulses of upwelling and OMZ expansion at that time. Prior studies have suggested that the early Oxygen Minimum Zone (OMZ) was apparently much larger and more extensive than the modern one. However, several uncertainties persisted regarding initiation of the OMZ, coupling of the OMZ and the upwelling, as well as the evolution of the oxygen state in the OMZ.

In this study, a detailed reexamination of the initiation of the Western Indian Ocean OMZ using records from the Early to Late Miocene from Owen Ridge (15 Ma to 8 Ma). Systemic analysis of sedimentary facies, nannofossil assemblages, as well as trace element and organic geochemical proxies was carried out to ascertain the evolution of the OMZ.

As of the base of the Serravallian a decreasing trend of Mn content is established, reaching minimum values around ~12.8 Ma, coinciding with the initiation of the modern South Asian Monsoon system and concordant with a marked increase in the abundance siliceous fossils has been recorded in the Arabian Sea (ODP site 722). Our study, in light of recently published data, indicates that the formation of the Western Indian Ocean Oxygen Minimum was in fact the culmination of a process that already initiated during the Early Miocene and achieved an apex in the Late Miocene.

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