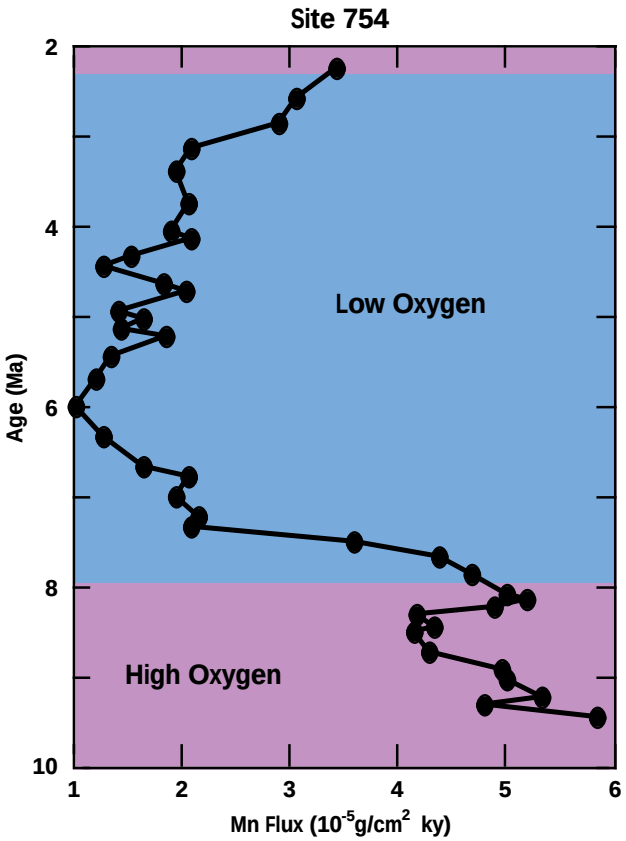
Manganese redirection and expanded oxygen minima in the Neogene Indian Ocean

Robert M. Owen and Gerald R. Dickens, Department of Geological Sciences, University of Michigan



Documentation of changes in the dimensions of oceanic oxygen minimum zones (OMZs) through geologic time is of paleoceanographic significance because the lateral extent of OMZs is primarily determined by the intensity of biological productivity in the overlying surface waters. Recent ODP investigations in the Indian Ocean have shown that temporal variations in these parameters are recorded as changes in the flux of Mn to ridge flanks intersected by the OMZ. Sinking Mn-bearing particulates reach ridge sediment when dissolved O_2 concentrations are > 2.0 mL/L. However, if a pronounced OMZ impinges upon the ridge, it will promote dissolution of the particulate Mn in intermediate waters and advective processes will then transport the dissolved Mn^{+2} to be precipitated in distal, more oxygenated waters. ODP Sites 752, 754 and 757 are located within central Indian Ocean water depths (1090-1650 m) but outside the present lateral dimensions of the Indian Ocean OMZ. High resolution chemical analyses of sediment from these Sites indicate significant reductions in the flux of Mn between 7.5 and 3.0 Ma that are most pronounced between 6.0 and 5.0 Ma [*Dickens and Owen,* 1994]. Because late Miocene-Pliocene paleodepths for these Sites were essentially the same as at present, and because extremely low sedimentation rates most likely precluded sedimentary metal oxide diagenesis, the low Mn fluxes suggest diminished deposition of reducible Mn phases within O_2 deficient waters and that this effect was most pronounced between 6.0 and 5.0 Ma. This interpretation, which is supported by independent studies of changes in benthic foraminiferal assemblages, implies that the late Miocene-early Pliocene Indian Ocean OMZ extended at least 1500 km beyond its present limits and was induced by regionally and/or globally increased biological productivity.

Reference:
Dickens, G.R. and R.M. Owen, Late Miocene-early Pliocene manganese redirection in the central Indian Ocean: Expansion of the intermediate water oxygen minimum zone, *Paleoceanography, 9,* 169-181, 1994.