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Trace metal geochemistry reveal paleo-productivity fluctuations in the Indian Ocean from middle to late Miocene

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Primary productivity in ocean surface waters is crucial for the marine food web, climate regulation, oxygen production, carbon dioxide sequestration and marine biodiversity. In the modern global warming scenario, the rising sea-surface temperatures can negatively impact the primary productivity by inhibiting vertical mixing in the upwelling zones, thereby disturbing the marine ecosystem. Understanding productivity changes during past climatic conditions similar to those of today is crucial for predicting future trends. Trace metal analysis, using Q-ICP-MS, was carried out on marine sediment samples retrieved through International Ocean Discovery Program, Expedition – 359, from sites U1467 and U1468 in the Maldives Inner Sea, with the aim of deducing paleo-productivity changes in the tropical Indian Ocean from middle to late Miocene. The accumulation of metallic micronutrients in the sediments carry productivity signals, therefore, we use a suite of elements - Cadmium (Cd), Copper (Cu) and Nickel (Ni), normalised with Calcium (Ca) - as productivity proxies for this study. Interestingly, the elements show positive correlations and similar trends. The results obtained reveal a decreasing trend from ~14 Ma to ~9.7 Ma, indicating lowered primary productivity in the region. A notable sharp increase at ~9.7 Ma aligns with the high-productivity event in the Indian Ocean (10–8 Ma), majorly attributed to monsoon wind strengthening linked to Himalayan uplift and/or global cooling and Antarctic ice sheet expansion. Higher values persist post-~9.7 Ma, with notable exceptions at ~7.4 Ma and ~6 Ma.