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Research Article

Centennial-millennial scale global climate-linked monsoonal and non-monsoonal changes in the eastern Arabian Sea during the last 42,800 years

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ABSTRACT

The Arabian Sea significantly impacts the global climate due to its hosting of one of the largest sedimentary bodies in the Modern Ocean basin and thickest oxygen minimum zone. It makes the study of fine-scale evolutionary changes in the Arabian Sea imperative to address the ongoing challenges in developing a strong and cohesive model for predicting rapid climate change in the future. Therefore, this study carried out environmental magnetic, grain size, stable isotope, total organic carbon (TOC), trace elements (TE), and rare earth elements (REE) investigations on a well-dated 2.68 m long sediment core from the eastern Arabian Sea to understand the fluctuation in monsoon and non-monsoon-driven sediment supply and associated primary productivity changes during the late Quaternary. The careful observations of chronological changes in the investigated parameters concerning coeval major global events enabled us to successfully identify the response of major global climatic events that occurred around 42.8–28 ka, 17 ka, 14.5 ka, 11.7 ka, 9.7 ka, 8.2 ka, 4.6–3.9, and 2–0.6 ka. These global events also played a crucial role in co-regulating the water column oxygen conditions in the Arabian Sea. Comparing our record with a sedimentary record from off Chennai, Bay of Bengal, suggests that opposite variations (anti-phasing) between southwest (SW) monsoon and northeast (NE) monsoon is a post-25 ka phenomenon. Pre-25 ka SW and NE monsoon showed similar variations (same phase), and we speculate that this anti-phasing between the SW and NE monsoon was cyclically driven by the earth's axial precession cycle.

1. Introduction

The Arabian Sea hosts one of the most prominent sedimentary bodies in the modern Ocean basin (Clift et al., 2002). It provides the largest source of moisture to the Indian monsoon and the most dynamic interactions between the atmosphere, oceans, and continents on Earth (Chen et al., 2022; Clemens et al., 1991; Ghosh et al., 1978; Levine and Turner, 2012; Sengupta and Sarkar, 2006). Also, by influencing oceanic productivity and hosting the world's thickest oxygen minimum zone in its water column, the Arabian Sea exerts a significant impact on the global climate and biogeochemical cycling (Altabet et al., 2002; Bange et al., 2005; Cai et al., 2022; Cai et al., 2019; Kumar et al., 2020a; Naqvi et al., 2000). It makes the study of the finer evolutionary changes in the Arabian Sea, in tandem with Indian monsoon variability and cyclic global climatic events, imperative to address the challenges in developing a strong and cohesive model for predicting rapid climate change in the future.

Various sources contribute lithogenic material to the Arabian Sea, including both fluvial and aeolian sources (Burdanowitz et al., 2019; Clift et al., 2002, 2014; Kumar et al., 2020b; Ramaswamy et al., 1991;

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