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Title: Cenozoic climate evolution in the Northern Indian Ocean: Evidences from microfossils
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<Abstract>

The Cenozoic era is one of the important times in the geological past where different intense climatic changes occurred from greenhouse to icehouse conditions. In recent times, the Miocene-Pliocene epoch has gained lots of attention due to the potential for understanding the climate sensitivity to CO_2 forcing and projected near future temperature rise. During this period, northern Indian Ocean also experienced several climatic events. Amongst the Cenozoic era, Neogene period represents one of the most crucial intervals in the geologic history of our planet. Specifically, in this part of the world, other than the crustal evolution, formation of the Himalayan Mountain, origin of Asian monsoonal system and evolution of Indian Ocean including the formation of Bengal fan are some of the major events that occurred during this period. Among the various Neogene sequences in India, Andaman-Nicobar is most important for representing the marine deep-water facies and few shallow water sequences. The rocks of deep-water origin in the offshore region have large inputs of biogenic sediments in the form of microorganisms. These sediments contain a number of microfossils like foraminifera, nannofossils, radiolarians, diatoms, calcareous algae etc. The Neogene marine deep water and more rarely shallow water sediments exposed on Andaman and Nicobar group of islands in the northeast Indian Ocean and the northern Indian Ocean sediment cores endows an excellent opportunity to reconstruct paleoenvironments based on qualitative and quantitative analysis of the marine biogenic components and in turn to document changing climate and its influence on the evolution of marine biota. For the reconstruction of past climatic/environmental changes, retrieval of proxy biotic records from the marine realms is a unique tool. The sediments have abundant biogenic components in the form of microfossils those can be used as proxies for marine temperature, nutrient levels and other environmental parameters.

The calcareous and siliceous microfossils from the outcrops on Andaman and Nicobar group of islands and the recovered offshore cores shows a diverse assemblage with tropical low latitude marker forms. Dominance of warm water microfossils during the early to middle Miocene is also co-relatable with the Miocene Climate Optimum (MCO). The nannofossil assemblages of this age also reflect strong preference for warm tropical climate and nutricline condition i.e., depth dependent high variation of nutrient content.

The presence of relatively unusual assemblage compositions, especially the presence of abundant sphenoliths and small reticulofenestrids, in conjunction with rare discoasters and alongside common diatoms, are indicative of high-productivity surface waters and probably upwelling conditions in the late Miocene. In the Tortonian (upper Miocene), low abundance of discoasters and high abundance of small reticulofenestrids (<3 μm) indicate eutrophic condition. The high-productivity surface-water environments can be linked with the intensification of the Indian Summer Monsoon.

Siliceous microfossils from the early Pliocene sediments shows that there was decrease and cessation of BSi (Biogenic Silica) in the region that may be due to nutrient depletion as an impact of Indonesian Through Flow (ITF) constriction. Well-preserved calcareous nannofossils have been also been recovered from the Zanclean (lower Pliocene). During the Zanclean, warm water condition prevailed and from marginal to deep water setting i.e., transgressive event was recognised in the northern Indian Ocean.