An Indian Ocean record of the evolution of the South Asian Monsoon circulation

*Christian Betzler[1], Gregor P Eberli[2], Dick Kroon[3], James D. Wright[4], Peter K Swart[2], Bejugam N Nath[5], John J Reijmer[6], Carlos A Alvarez-Zarikian[7], IODP Exp. 359 Scientists[7]

1. University of Hamburg, 2. University of Miami, 3. University of Edinburgh, 4. Rutgers University, 5. CSIR-National Institute of Oceanography, 6. King Fadh University of Petroleum & Minerals, 7. International Ocean Discovery Program

The South Asian Monson (SAM) is one of the most extreme features in Earth’ s climate system, yet its initiation and variations are not well established. The SAM is a seasonal reversal of winds accompanied by changes in precipitation with heavy rain during the summer monsoon. It is one of the most intense annually recurring climatic elements and of immense importance in supplying moisture to the Indian subcontinent thus affecting human population and vegetation, as well as marine biota in the surrounding seas. The seasonal precipitation change is one of the SAM elements most noticed on land, whereas the reversal of the wind regime is the dominating driver of circulation in the central and northern Indian Ocean realm. International Ocean Discovery Program Expedition 359 aimed to resolve the evolution of the South Asian Monsoon by tracing back in time its sedimentary signatures and by resolving changes in the ocean circulation system in the archipelago of the Maldives.
Data from the Maldives Inner Sea provide an archive that reveals an abrupt onset of the SAM-linked ocean circulation pattern and its relationship to the long term Neogene climate cooling. In particular it registers ocean current fluctuations and changes of intermediate water mass properties for the last 25 myrs that are directly related to the monsoon. Dating the deposits of SAM wind-driven currents yields an age of 12.9 Ma indicating an abrupt SAM onset, over a short period of 300 kyrs. This coincided with the Indian Ocean Oxygen Minimum Zone expansion as revealed by geochemical tracers and the onset of upwelling reflected by the sediment's content of sedimentary organic matter. The sedimentary signature of the dust influx to the Maldives, the seismic stratigraphy of the carbonate platform, and the sediments recovered indicate that there was a winter monsoon between 12.9 and 25 Ma, but that ocean currents were weaker. Abrupt SAM initiation favors a strong influence of climate in addition to the tectonic control, and we propose that the post Miocene Climate Optimum cooling, together with increased continentalization and establishment of the bipolar ocean circulation, i.e. the beginning of the modern world, shifted the monsoon over a threshold towards the modern system.

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