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RECONSTRUCTING PAST DEEP-WATER CIRCULATIONS OF INDIAN OCEAN

Relevant for: Geography | Topic: Important Geophysical Phenomenon - Tides, Oceanic Circulation and Ocean Bottom Relief

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The global conveyor belt, shown in part here, circulates cool subsurface water and warm surface water throughout the world. The Atlantic Meridional Overturning Circulation is part of this complex system of global ocean currents. Photo: oceanservice.noaa.gov

Global overturning circulation — the equatorward transport of cold, deep waters and the poleward transport of warm, near-surface waters — controls ocean heat distribution and atmospheric carbon dioxide levels, thus playing a critical role in global climate.

Studies have indicated that tectonically driven changes in the ocean gateways such as the closure of the Central American Seaway, a body of water that once separated North America from South America, since the late Miocene period, had a dramatic impact on the circulation.

It is thought that tectonic changes might have led to the formation of two separate water bodies — northern component water in the North Atlantic and Antarctic Bottom Water (AABW) in the Southern Ocean. Consequently, it is also hypothesised that there would have been large-scale changes in the Deep Water Circulation (DWC) in the oceans across the world, thus impacting global climate through ocean-atmosphere carbon dioxide and heat exchanges.

But these formulations have remained untested due to lack of adequate data. Some records that are available are from near the deep-water formation regions mostly from the Pacific and the Atlantic Oceans. Hence, they might not necessarily reflect the impact and change in deep water circulation.

Now, the Indian Ocean does not have any major deep-water formations of its own. It acts only as a host for NCW and AABW. Further, the northern parts of the Indian Ocean are located at one of the terminal ends of the GOC, far away from the deep-water formation regions and oceanic seaways. These specific features could make the northern Indian Ocean an ideal basin to do this.

Few studies have been carried out in the Indian Ocean to reconstruct past deep water circulations based on iron-manganese crust records and authigenic neodymium isotope composition of sediment cores. But iron-manganese crusts are situated at deeper depths and are bathed only by AABW, making it suitable only for the reconstruction of the history of AABW,

and authigenic neodymium isotope records are available only from the Bay of Bengal region. But they too cannot help as the Himalayan rivers that empty into the Bay also bring in substantial amounts of Neodymium particulates.

A new study (*Nature Communications*) by a team of researchers from the Goa-based National Centre for Polar and Ocean Research and the School of Earth, Ocean and Atmospheric Sciences in Goa University has now sorted out the issue.

The scientists have generated an authigenic neodymium isotope record from the Arabian Sea and reconstructed the DWC record of the Indian Ocean for the period from 11.3 million years ago (Miocene era) to 1.98 million years ago (Pleistocene era).

“The record shows a clear shift from the Pacific water dominated deep circulation system before about nine million years ago, to the onset of a modern-like deep water circulation system in the Indian Ocean comprising of Antarctic bottom water and northern component water during the Miocene-Pliocene transition (about six million years ago). Our finding suggests a widespread impact of the late Miocene Central American Seaway closure on the evolution of ocean deep water circulation and validates the so-called Panama Closure Hypothesis,” says Dr. Waliur Rahaman from the National Centre for Polar and Ocean Research (NCPOR) and one of the corresponding authors.

The two months long expedition was carried out on-board drilling vessel R/V JOIDES Resolution from March 31 to May 31, 2015.

Commenting on the findings, Dr. Sambuddha Misra, Associate Professor, Centre for Earth Sciences, Indian Institute of Science, who was not part of the research work, says the study is highly significant since it provides unequivocal evidence in support of the theory that the closing of the gap between North and South America had led to the evolution of the modern form of GOC. The work is also commendable as it involved extremely difficult measurements, he adds.

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