Meridional ocean circulation intensity through MIS 11 from Nd isotopes in South Atlantic cores

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Abstract

The waxing and waning of North Atlantic Deep Water (NADW) in the South Atlantic has been used to monitor changes in meridional overturning circulation. Neodymium (Nd) isotopes are a valuable water mass tracer in this region because the ε_{Nd} value of intermediate and deep waters is dependent on the mixing ratio of southern- and northern-sourced water. A spliced record from deep cores RC11-83 (42.07ºS, 9.717ºE, 4718m) and TNO57-21 (40.6ºS, 7.816ºE, 4918 m) showed higher values (>2ε_{Nd} units) during the LGM compared with today, indicative of a weakening or shoaling of NADW in the South Atlantic during glacial periods[1]. Nearby core TNO57-6 (42.92ºS, 8.88ºE, 3750m) is slightly further south and significantly shallower than RC11-83/TNO57-21 and showed a substantially greater Last Glacial Maximum (LGM) to Holocene offset (>4 ε_{Nd} units)[1,2]. However, further studies have indicated that the methods for obtaining the bottom water ε_{Nd} signal at site TNO57-6 were likely compromised by a contaminating phase within the fine sediment during leaching. We modified our previous procedure, in line with the Cambridge group[3], and are extracting the ε_{Nd} values of dissolved Fe-Mn oxide encrusted, mixed-species, planktonic foraminifera. Confirmation of the results as a bottom water signal is indicated by agreement with the ε_{Nd} values of fish debris from the same depth[3]. The resulting record shows a Holocene ε_{Nd} value around -9.7 with a gradual increase of ~3 ε_{Nd} units to an LGM value around -6.5 ε_{Nd} units. This trend is similar to the TNO57-21/RC11-83 record. We have applied the new procedure down-core, and developed a set of glacial-interglacial pairs for each transition since MIS 11. All interglacial stages show ε_{Nd} values similar to Holocene values (-9.5) and each glacial shows an increase of about 2 ε_{Nd} units, with the exception of MIS 8, which appears to show a smaller increase of ~1 ε_{Nd} unit. We interpret these data as recording changes in the presence of NADW in the South Atlantic between glacials and interglacials, and indicating similar intensities in the export during interglacials through MIS 11, and also in glacials except for MIS 8. The record may also be interpreted as indicating stronger shoaling of the northern component waters during MIS 2, 6 and 10 than during MIS 8, and this will be further investigated. Overall the data indicate similar levels of stability were reached during the warm and cold phases of several glacial-interglacial cycles.

[1] Piotrowski, *et al*. (2004) *Earth Planet. Sci. Lett*. **225**, 205. [2] Rutberg, et al. (2000) *Nature*, **405**, 935. [3] Roberts, *et al*. (2010) *Science*. **327**, 75.

Stable isotope and trace element records in Holocene stalagmites from Java: Paleoarchive of climate change and human activity?

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Speleothems are important archives to trace paleoclimate and paleoenvironmental changes. This has widely been proven in temperate zones, but there is a lack of studies from the tropics. To further close this gap, active stalagmites, formed since the early Holocene, from Bribin cave located in the Gunung Sewu karst, Middle Java, Indonesia have been analysed in high resolution.

The $\delta^{18}O$ values vary between -6 and -8 ‰ with lowest values approximatily 8.5 ka ago indicating a period of high rainfall amount in the early Holocene. This assumption is supported by a continuous concurrent lowering of corresponding Sr/Ca and Mg/Ca ratios with time, displaying a shorter contact time with the limestone in the Karst.

During the early and mid-Holocene, relatively low $\delta^{13}C$ values of 12.2 ± 0.24 ‰ were recorded which is indicative of a predominant contribution of carbon from C3 plants of the overlying tropical rain forest. However, the $\delta^{13}C$ values show a dramatic, but almost continuous increase from -12.0 to -7.8 ‰ over the last ~1.1 ka. This increase may reflect a change in vegetation density (less isotopically light plant material) and/or composition (C4 instead of C3 plants) at the surface.However, during the corresponding period of time, no distinctive trend was detectable for the $\delta^{18}O$ values with oscillations around -6.8 ± 0.25 ‰. Consequently, a possible change in vegetation cannot be explained by considerable climatic changes alone which would have also influenced the $\delta^{18}O$ signal. Mg/Ca and Sr/Ca ratios partially positively correlate with the $\delta^{13}C$ record over the last 1.1 ka indicating that some changes in the water balance still might be of importance resulting in longer or shorter contact time with the karstic limestone. An alternative interpretational approach may relate the marked $\delta^{13}C$ increase of the last millenium to human activities. Pollen and sedimentological studies from the area strongly suggest that extensive and organized forest clearance has been taking place on Java for the last 1.5 or 1.2 ka, respectively [1].

[1] Sémah & Sémah (2012) *Quaternary International* **249**, 120-128.