Geophysical Research Abstracts
Vol. 12, EGU2010-8456, 2010
EGU General Assembly 2010

Marine Isotope Stages (MIS) 96-101: Glacial induced closure of the Panamanian Gateway

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We present combined Mg/Ca and δ^{18}O measurements from ODP Site 1241 from the east Pacific and ODP Site 999 from the Caribbean. The studied time interval covers the first major glacial-interglacial cycles (MIS96-101) after intensification of Northern Hemisphere Glaciation. Analyses were performed on the planktic foraminifers *Neogloboquadrina dutertrei* and *Globigerinoides sacculifer*, representing water mass properties in the thermocline and the mixed layer respectively. Data resolution is aimed to be able to resolve millennial scale variations to constrain the changes in water mass conditions during MIS96-101.

Aim of the study is to test the theory that the Panamanian Gateway temporarily closed during glacial MIS 96, 98, and 100 due to a drop in sea level of 50-80 m. This was first suggested in Groeneveld et al., (in prep.) and might have provided the necessary conditions to allow the Great American Biotic Interchange, the large scale migration of mammals from South to North America and vice versa. As this exchange would have required more arid conditions in Central America to allow the fauna, which was mainly adapted to a savannah-like environment, to cross, a glacial period would have provided the right conditions. Reconstruction of sea water temperatures can indicate if and when the gateway closed. With an open Panamanian Gateway relatively cold water flowed from the Pacific into the Caribbean. With the onset of glacial conditions sea surface temperatures (SST) expectedly would show a decrease in the east Pacific (Site 1241). But, SSTs in the Caribbean (Site 999) are expected to rise as no longer relatively cold Pacific water is entering the Caribbean, but rather the warmer waters from the Western Atlantic Warm Pool advanced from the north to the core location. Indeed, reconstructed SSTs from *G. sacculifer* show a decrease of 2.5˚C at Site 1241 and an increase of 3˚C at Site 999 suggesting that the Panamanian Gateway truly was closed during the glacial stage.

Additionally, the Mg/Ca-temperatures of *N. dutertrei*, a thermocline dweller, do not show any change in the east Pacific, but do show a 3˚C cooling in the Caribbean. This suggests that the closing of the gateway only influenced surface water conditions. The decrease in *N. dutertrei* temperatures can be explained in two ways. With the closure the Western Atlantic Warm Pool extended towards the southern Caribbean, increasing sea surface temperatures as indicated by *G. sacculifer*. This resulted in an increase in mixed-layer thickness, pushing the thermocline to a larger water depth. As *N. dutertrei* is often characterized as following the nutrient maximum in the thermocline, it accordingly lived deeper during glacial stages, and, hence, indicates lower temperatures. Alternatively, it was suggested that with the closure of the gateway slight upwelling conditions could have occurred in the Columbia Basin, resulting in colder temperatures in the thermocline and for *N. dutertrei*. Obviously in this case it would mean that upwelling was not very intense as sea surface temperatures meanwhile increased.