

Pliocene Panamanian Gateway tectonics and climate change at 3.3 Ma: palynological and Mg/Ca analysis of MIS M2 at Caribbean ODP Site 999

Van Renterghem Cédéric and Stephen Louwye

Research Unit Palaeontology, Department of Geology and Soil Science, Ghent University, Krijgslaan 281 S8/WE13, 9000 Ghent, Belgium

E-mail: cederic.vanrenterghem@gmail.com, stephen.louwye@ugent.be

The Late Pliocene (3.60 to 2.59 million years ago) climate was characterised by a prolonged global warmth and a vigorous thermohaline circulation, while atmospheric carbon dioxide concentrations were slightly higher than modern day values. It has therefore been intensively studied as an analogue for future climate conditions (Dowsett *et al.*, 2009). Nevertheless, a short lived, but severe, glaciation event corresponding to Marine Isotope Stage M2 (MIS M2, 3.30 million years ago) interrupted this episode of global warming (Lisiecki and Raymo, 2005). The benthic oxygen isotope stack of Lisiecki and Raymo (2005) shows a significant shift towards higher $\delta^{18}\text{O}$ values, and this corresponds to an extreme sea level lowstand of approximately -65m. MIS M2 occurred just before the mid-Pliocene Warm Period and is considered as a failed attempt to reach the Northern Hemisphere Glaciation, which is often associated with changes in Panamanian Gateway tectonics (De Schepper *et al.*, 2009).

The MSc research aimed to understand what exactly caused this global cooling event. In order to reconstruct oceanic changes near the Central American Seaway before, during and after MIS M2, a high resolution record from Caribbean Ocean Drilling Program Site 999 was analysed for dinoflagellates and Mg/Ca ratios on surface and thermocline dwelling foraminifera. These proxies were used to reconstruct changes in overall water mass characteristics and sea surface temperatures (SST), respectively. The advantage of this combined approach is that changes in water mass properties can eventually be linked to independent temperature variations, leading to a Central American palaeoceanographical reconstruction before, during and after MIS M2.

The results indicate that there was an open and free connection between the Caribbean Sea and the Pacific Ocean prior to MIS M2. The inflow of relatively fresh and cold Pacific waters caused a gradual decrease in Caribbean SSTs, which led to an important decline in North Atlantic Current strength. A slowdown in the thermohaline circulation was hence a necessary prerequisite to create a global and extensive cooling event such as MIS M2. Meanwhile, upwelling along the equator attracted high amounts of heterotrophic dinoflagellates, inducing high productivity waters near the study site. The subsequent expansion of the Greenland Ice Sheet and the sharp drop in sea level controlled in return the throughflow across the Central American Seaway, eventually leading to the emergence of the land bridge. The restriction of surface water exchange and the installation of the West Atlantic Warm Pool enhanced the thermohaline circulation intensively. This is reflected by peak Caribbean SSTs during and after MIS M2, while the dinoflagellate cyst assemblages are now characterised by both high temperature and high salinity supporting inner neritic species. A more vigorous northward heat transport hence caused a high latitude warming and the waning of previously formed ice sheets. This final key event eventually prevented the climate system to enter a full glacial mode. On the contrary, it even bounced back into the warm mid-Pliocene interval.

My MSc research study once more emphasised the importance of oceanic gateways in global climate change.

References

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