DINOFLAGELLATE CYST ANALYSIS OF A LATE QUATERNARY MARINE SEDIMENT CORE FROM THE CAMPOS BASIN

Oliver P.R. Bazely[1]; Mauro B. de Toledo[1]; Viviane B. Campos [1]; Monica B. Crud [1], Viviane M. de Oliveira[1], Cintia F. Barreto[1], Alex S. Freitas[1]
obazely@paetro.org
[1]- Grupo de Paleoecologia Tropical, Universidade Federal Fluminense
Universidade Federal Fluminense, Instituto de Geociencias, 4 andar, Av. Gal. Milton Tavares de Souza s/n, Gragoata, Niteroi, RJ 24.210-346, Brazil.

Keywords: dinoflagellate cysts, palaeoclimatology, Rio de Janeiro, microfossils, Late Quaternary

1. INTRODUCTION

The tropics are a major source of latent and sensible heat and therefore form an important component of the global climate system (Wang et al., 2004). Research into the El Niño Southern Oscillation (ENSO) has demonstrated the ability of tropic climate to rapidly and consistently reorganize (Chiang, 2009), while studies of highly-sensitive convective structures have been suggested as the cause of wider regional climate sensitivity (Lindzen & Nigam, 1987). Conversely, evidence suggests that tropical regions do not initiate the abrupt climate changes known to occur in other latitudes (Vellinga & Wood, 2002) and that the region does not exhibit the same inertia as temperate regions, such the North Atlantic (Chiang, 2009).

ENSO is just one of the many climate systems that occur in the tropics, with the Inter Tropical Convergence Zone, tropical monsoon and the interhemispheric thermal gradient all forming recognizable phenomena. Research also suggests that the signature patterns of Dansgaard-Oeschger oscillations and Heinrich events are present in tropical palaeoclimate records (Vellinga & Wood, 2002; Cheng et al. 2007). This provides clear evidence of global climate linkages (teleconnections), and reinforces the need to study tropical palaeoclimate in a global context.

On a regional scale, the subtropical Atlantic coast of Brazil, including Rio de Janeiro state (RJ) is primarily influenced by two atmospheric systems; firstly, the South American Summer Monsoon (SAMS) and; secondly, coastal cyclones associated with a winter extratropical regime. It is suggested that, over the long term, precessional insolation controls precipitation levels, as higher insolation values cause a larger shift in land-ocean temperature contrasts. A further degree of change has been attributed to the North Atlantic, with evidence for the southward displacement of the South Atlantic Convergence Zone (SACZ) during Heinrich events (Cruz et al., 2006)

45 mm

Subtropical coastal Brazil is also influenced by patterns of oceanic circulation, which presently form the Brazil Current, a western boundary current that brings warm saline water southwards along the coast of RJ. There are also many localised features, such as the Cabo Frio upwelling. During the Pleistocene, changes in the North Atlantic are thought to have complementary changes in the South Atlantic. It is feasible that these changes would alter the currents around RJ, further altering local climatic conditions.

This project is part of a study that aims to reconstruct the palaeoenvironment of RJ during the Late Quaternary, based on a multi-proxy analysis of two marine cores from the Campos Basin. Studies of pollen will provide information on terrestrial climates, while studies of dinoflagellate cysts and foraminifers and diatoms will provide information on palaeoceanography. The microfossil data will be placed in an independently-dated chronological framework, which is intended to permit resolution of any abrupt climate events that may have influenced the region. This presentation provides a report of on-going results and preliminary conclusions associated with the dinoflagellate cyst record.

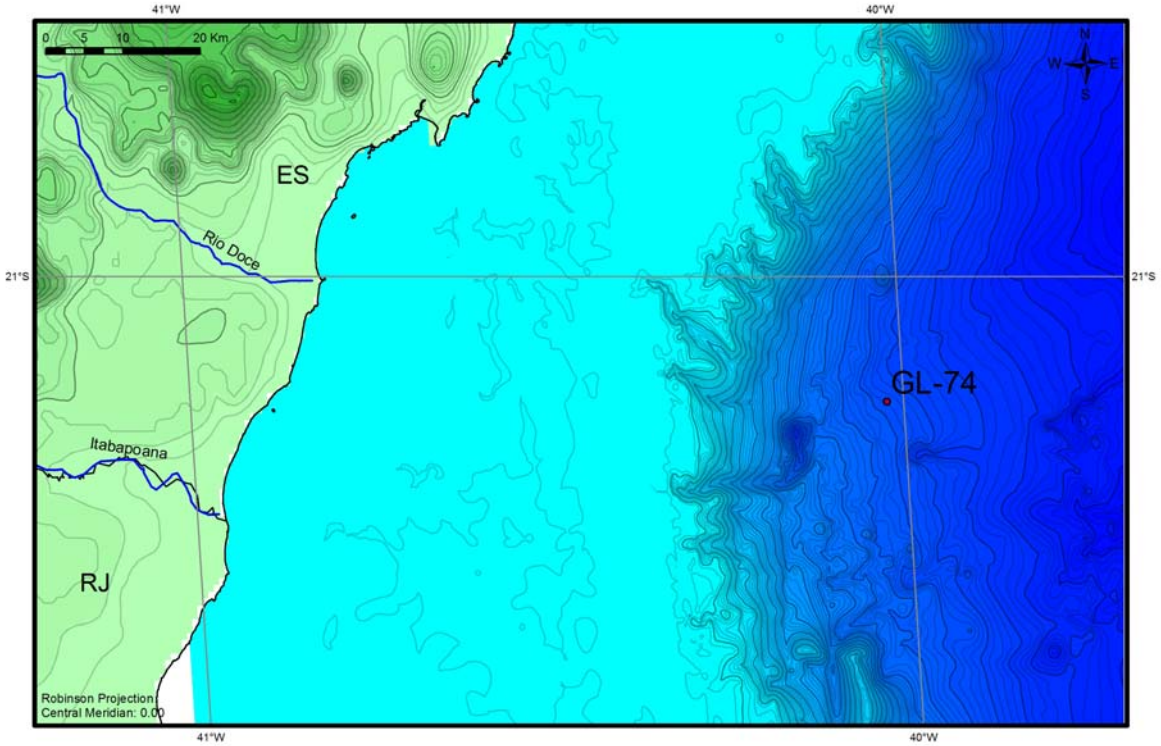
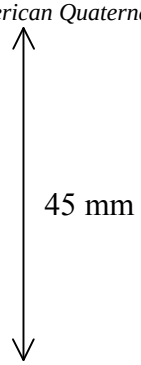


Figure 1. Map showing core sites, with bathymetry and topography. Contours are 100m (bold) and 25m (normal).



1. Materials and Methods

GL-74 is a 19.75m long core, recovered from the base of the continental slope of the Campos Basin (-40.02362,-21.15225), at a depth of 1279 m. The sedimentary regime appears to have been stable, as no core disturbances are observable. The core is primarily composed of grey/brown lutite, with occasional carbonate deposits. The core is located near several sub-marine canyons and palaeofluvial channels.

The core has been quantitatively analysed for dinoflagellate cyst abundance. Samples were first treated with HCl, to remove carbonates. Clays were then disaggregated with sodium pyrophosphate, prior to silica dissolution in HF. Samples were then sieved at 10qm to remove any remaining fine particles. When necessary, samples were further cleaned using <10 seconds of ultrasound. Residues were mounted using glycerol, to enable cyst rotation. Dinoflagellate cysts were identified to species level, and genus level where further taxonomic classification was impossible (Fensome, 2004; Marret & Zonneveld, 2003). Approximately 35 taxa have been identified, with 20 taxa commonly present.

2. Age Model

The palaeoclimatological information for GL-74 is placed in a chronological framework, based on several radiocarbon dates obtained from bulk planktonic foraminifers. Raw ages were calibrated using the Marine09 calibration curve, including a local ΔR reservoir correction of ±17 yr (Reimer et al., 2009; Angulo et al., 2005). Dates were integrated using BCal (Buck et al., 1999), a program that exploits Bayesian statistical methods. For the section of the core beyond the radiocarbon age range, biostratigraphic marker horizons are used, although, due to the lack of certainty associated with these features, the age model for this section remains tentative (Vicalvi, 1997)

3. Results

Presently, 45 samples have been analysed for dinoflagellate cyst content. Results indicate that hydrographic conditions were different during the MISS 5e interglacial, in comparison to the Holocene. This may be indicative of a wider non-analogous climate configuration in the region during MISS 5e. The dinoflagellate cysts with saline affinities, tropical affinities and oligotrophic tolerances are more abundant, which may indicate higher temperature and increased stratification in comparison to the present interglacial.

The results also suggest that there was a progressive decrease in water temperature at around 65 ka BP, which corresponded with a reduction in salinity, potentially indicating a reduction in evaporation. The resolution of the study is not yet high enough to resolve the abrupt climate events that occurred during the last glacial period, so the synchrony with northern hemisphere events remains unknown.

45 mm

The Last Glacial Maximum (LGM) is characterized by a slight increase in species with a tropical temperature affinity, and those with a saline affinity. The climatic implications of these changes remain ambiguous, as species with a tropical temperature affinity may have different controlling factors, and the temperature characteristic may be due to co-variance, as opposed to correlation.

4. Future Work

More samples will be counted from this core in the coming months. This will enhance the resolution of the palaeoclimatic reconstructions. The environmental categorization of the individual cyst species will also be further refined, eliminating some of the ambiguities evident in the present record.

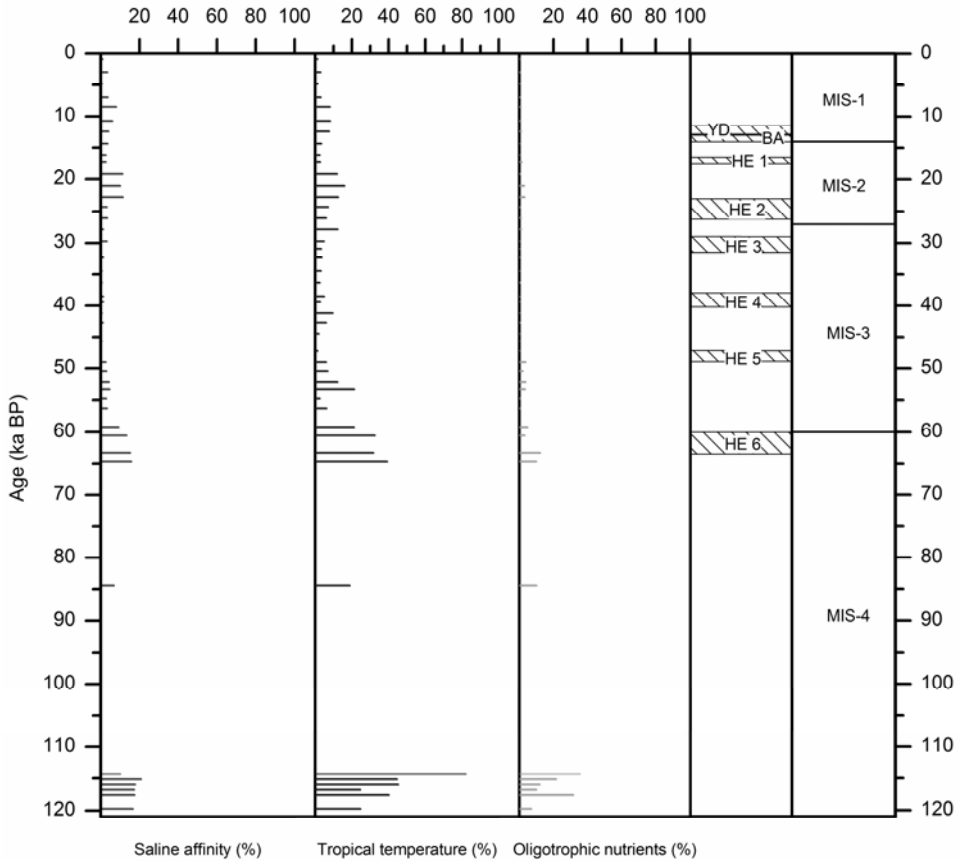


Figure 2 – A summary of the present climate reconstruction, based on known dinoflagellate cyst affinities. Heinrich event dates are taken from Fletcher (2008). The results clearly show non-analagous environmental conditions during the last (Eemain) interglacial. Percentage scales are not exclusive, so the same species may be present in the same category.

REFERENCES

Angulo, R.J., de Souza, M.C., Reimer, P.J., and Sasaoka, S.K., 2005, Reservoir effect of the southern and southeastern Brazilian coast: *Radiocarbon*, v. 47, p. 67-73

Buck, C.E., Christen, J.A., and James, G.N., 1999, BCal: an on-line Bayesian radiocarbon calibration tool: *Internet Archaeology*, v. 7.

Cheng W, Bitz CM, Chiang JCH. 2007. Adjustment of the global climate to an abrupt slowdown of the Atlantic meridional overturning circulation. In *Past and Future Changes of the Ocean's Meridional Overturning Circulation: Mechanisms and Impacts*, ed. A Schmittner, JCH Chiang, S Hemming, pp. 295–313. Washington, DC: Am. Geophys. Union

Chiang, J.C.H., 2009, The Tropics in Paleoclimate: *Annual Review of Earth and Planetary Sciences*, v. 37, p. 263-297.

Cruz, J.F.W., Burns, S.J., Karmann, I., Sharp, W.D., and Vuille, M., 2006, Reconstruction of regional atmospheric circulation features during the late Pleistocene in subtropical Brazil from oxygen isotope composition of speleothems: *Earth and Planetary Science Letters*, v. 248, p. 495-507.

Fensome, R.A., and Williams, G.L., 2004, The Lentin and Williams index of fossil dinoflagellates., *American Association of Stratigraphic Palynologists*, 909 p.

Fletcher, W.J., and Sánchez-Goñi, M.F., 2008, Orbital- and sub-orbital-scale climate impacts on vegetation of the western Mediterranean basin over the last 48,000 yr: *Quaternary Research*, v. 70, p. 451-464.

Lindzen, R.S., and Nigam, S., 1987, On the role of sea-surface temperature-gradients in forcing low level winds and convergence in the tropics: *Journal of the Atmospheric Sciences*, v. 44, p. 2418-2436.

Marret, F., and Zonneveld, K.A.F., 2003, Atlas of modern organic-walled dinoflagellate cyst distribution: *Review of Palaeobotany and Palynology*, v. 125, p. 1-200.

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Ramsey, C.B., Buck, C.E., Burr, G.S., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning, S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., van der Plicht, J., and Weyhenmeye, C.E., 2009, INCAL09 and Marine09 Radiocarbon age calibration curves, 0-50,000 years cal BP: *Radiocarbon*, v. 51, p. 1111-1150.

Vellinga, M., and Wood, R.A., 2002, Global climatic impacts of a collapse of the Atlantic thermohaline circulation: *Climatic Change*, v. 54, p. 251-267.

Vicalvi, M.A., 1997, Biostratigraphic and paleoclimatic zoning of upper Quaternary sediments from the Campos basin slope: *Petrobras Bulletin of Geosciences*, v. 11, p. 132-165.

Wang, X.F., Auler, A.S., Edwards, R.L., Cheng, H., Cristalli, P.S., Smart, P.L., Richards, D.A., and Shen, C.C., 2004, Wet periods in northeastern Brazil over the past 210 kyr linked to distant climate anomalies: *Nature*, v. 432, p. 740-743.