Controls on fluvial paleodischarge and sediment influx: Current paradigms and potential future scenarios from passive (Gulf of Guinea) and active (Central America) margins

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Abstract

The paradigm of fluvial paleodischarge and sediment influx in the tropics provides valuable information on the controls/drivers on climate evolution, eutrophication and sedimentary organic matter preservation. The seasonal migration of Intertropical Convergence Zone (ITCZ) and variability in monsoonal strength determined by precessional forcing are the main controls on precipitation and fluvial discharge. This study is comparing data from selected cores from the nearshore (40 m) and continental shelves (2,000-4,000 m) of the Gulf of Guinea (e.g., Congo, Niger Delta, Ghana/Ivory Coast margin) and Central America (CA) (e.g., Costa Rica, Panama Gulf) to test these controls during the latest Pliocene to Quaternary. Integrated terrestrial and marine palynological records from the T89-16 Core (Congo) and GCs 1-3 (Niger Delta) in the Gulf of Guinea (GoG) record these drivers at the millennial-centennial time-scale. Paleoenvironmental inferences suggest that "flood pulse events" have influenced sedimentation rates on the Congo Fan and the Niger Delta. The data highlight a sequence of abrupt changes in the two locations registered by influxes of post-depositional pollen and non-pollen data to the GoG (Cyperaceae, Poaceae, *Podocarpus*, charred grass cuticles, *Pediastrum*, Ti/Zi ratios, sedimentation rates). These sporadic influxes provide evidence for enhanced fluvial discharge and river-induced upwelling during which fresh water plume nutrient rich, sedimentary organic matter, and sedimentation rates stimulated primary production, and phytoplankton blooms and preservation (e.g., dinoflagellate cyst productivity and demise). We suggest that this fluvial paleodischarge event from the Last Glacial Maximum (20 ka yr.) and subsequent deglaciation (18 yr.) likely resulted from latitudinal migration of the mean ITCZ across the GoG from its more southerly Last Glacial Maximum, suggesting the extension of monsoonal influences and mild arid conditions over the region.

Positions of ITCZ and Monsoon intensity and study locations

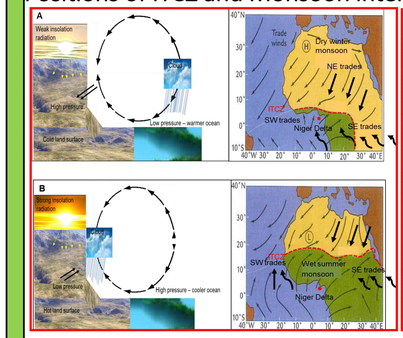


Fig. 1. The ITCZ and Monsoon system:

A. The boreal winter.

B. The boreal summer seasons.

(Modified from Griffiths, 1972 and Leroux, 1993)

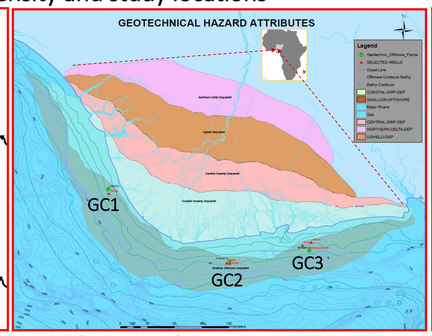


Fig. 2. The Niger Delta in southern Nigeria, Gulf of Guinea (Kulke *et al.*, 1995).

Geotechnical positions of **GC1** = East, **GC2** = Central, **GC3** = West along the shallow offshore; **GC = Gravity Core**.

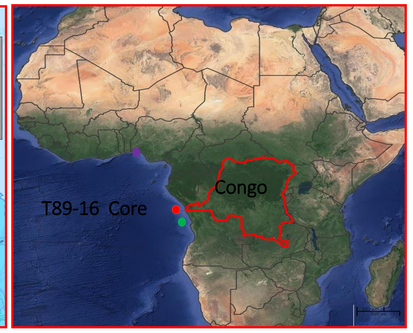


Fig. 3. Location of T89-16 core and other cores in the Gulf of Guinea noted in Fig. 5:

Core C237 (green) (Giresse *et al.*, 1982)

Core KW31 (Purple) (Pastouret *et al.*, 1978)

Objectives

- To determine the ***timing and role of the ITCZ in climate variation*** based on the palynomorph data (vegetation, dinoflagellate cysts, non –pollen palynomorphs), sediment supply, and geochemical components during the Late Quaternary in the Gulf of Guinea.
- To evaluate and compare the future impacts of climate and monsoon intensity on marine dinoflagellate communities, biogenic productivity, and terrestrial vegetation in the passive Atlantic and active Pacific margins (Figs. 1, 2, 3 & 6).

Methodology

- This research involves a multi-proxy study based upon three gravity cores of just under 3 m length each and one piston core ~ 75 m long (Figs. 4 & 5).
- Nannofossils (dating GCs), AMS date (T89-16), sedimentology and palynomorph and geochemistry techniques were applied (Figs. 4 & 5).

A. Original Gravity Core | B. Core sampling at 2 cm | C. Slabbed Core | D. Collected core samples in bags

Results

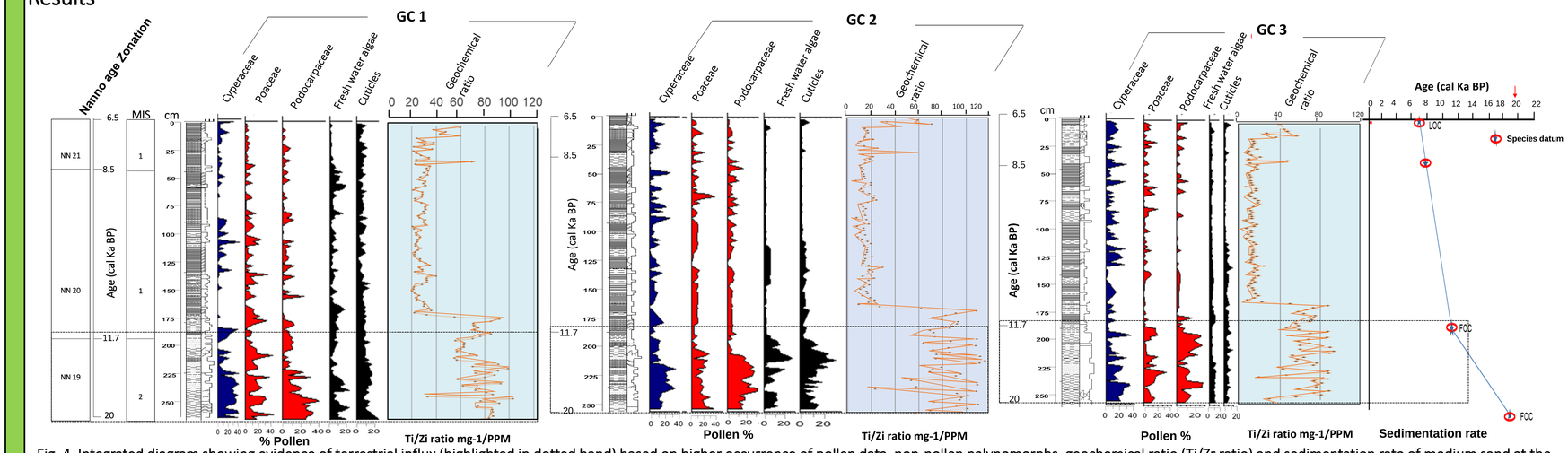


Fig. 4. Integrated diagram showing evidence of terrestrial influx (highlighted in dotted band) based on higher occurrence of pollen data, non-pollen palynomorphs, geochemical ratio (Ti/Zr ratio) and sedimentation rate of medium sand at the base of the gravity cores (GCs) at ~ 272-202 cm (Niger Delta).

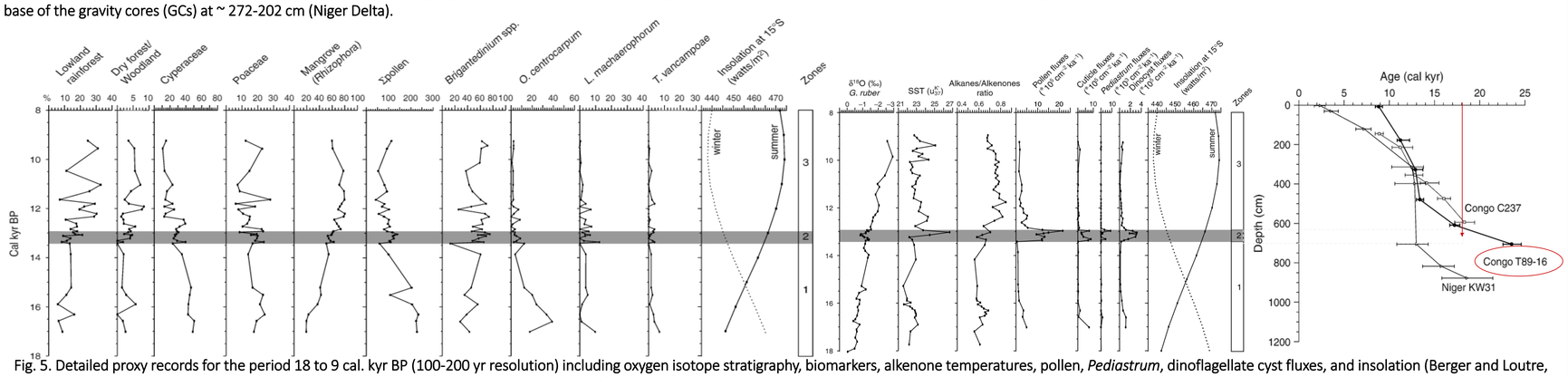
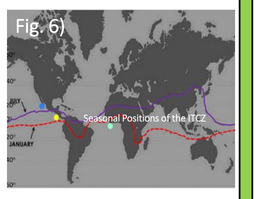


Fig. 5. Detailed proxy records for the period 18 to 9 cal. kyr BP (100-200 yr resolution) including oxygen isotope stratigraphy, biomarkers, alkenone temperatures, pollen, *Pediastrum*, dinoflagellate cyst fluxes, and insolation (Berger and Loutre, 1991). Oxygen isotope stratigraphy (S. Mulitza, unpublished data) is based on the planktonic foraminifer *Globigerinoides ruber* (Congo) (After Marret *et al.*, 2001).

Implications, Conclusions and Future work

- During the last glacial interval, the Niger Delta (20-11.7 Cal. Ka BP) records significant Cyperaceae, Poaceae, *Podocarpus*, charred cuticles, *Pediastrum*, Ti/Zi ratio, mixed sediment, and rapid sedimentation rate (Fig 4).
- Congo fan (13.5-12.94 Cal. Kyr) also records higher peaks of Cyperaceae and Poaceae, a distinct negative spike in $\delta^{18}O$ associated with maxima in pollen assemblages and fluxes in cuticles, dinoflagellate cysts and *Pediastrum*, abrupt sedimentation rate, and higher alkane/alkenone ratio. (Fig. 5).
- These ***combined oceanic and terrestrial data*** provide coherent records of Congo river and Niger Delta fluvial paleodischarge that we interpret as a reflector of continental-scale precipitation signal, driven by arid climate & southern migration of the mean annual position of the ITCZ (Figs. 4 & 5).
- Thus, these studies, provide relevant insights to the current debate on the significance of the tropics in driving global climate change.
- ***In the future***, we planned to investigate cores from Costa Rica (blue), Panama (yellow), and the Ghana/Ivory Coast (sky blue) to test the effect of ITCZ and monsoonal forcing, and compare results (Niger Delta & Congo) for regional and global understanding of the controls within the passive Atlantic and active Pacific margins (Fig. 6)



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