10th Inkaba yeAfrica Scientific Conference

BIOMARKER RECORDS OF ENVIRONMENTAL CHANGES AND THEIR CLIMATIC INFERENCES IN THE MFABENI PEATLAND (SOUTH AFRICA) SINCE THE LATE PLEISTOCENE

ANDREA BAKER[1], JOYANTO ROUTH[2], ALAKENDRA N. ROYCHOUDHURY[1]

[1]DEPARTMENT OF EARTH SCIENCES, STELLENBOSCH UNIVERSITY, STELLENBOSCH, SOUTH AFRICA

[2]DEPARTMENT OF WATER AND ENVIRONMENTAL STUDIES, LINKÖPING UNIVERSITY, LINKÖPING, SWEDEN

Introduction

Southern Africa is situated at a dynamic junction between tropical, subtropical and temperate climate systems, which are subject to seasonal excursions in the Inter Tropical Convergence Zone and sea-surface temperature (SST) gradients between two regional oceans. As a consequence of the regional topography and semi-arid climate (1), there is a lack of continuous terrestrial climate archives in Southern Africa (2, 3), and uncertainty prevails over how terrestrial ecosystem responded to past climate fluctuations and their dominant forcing mechanisms.

Aim

Employ biomarker proxies to explore the late Pleistocene & Holocene environment and reconstruct the climatic controls governing peat accumulation in Mfabeni peatland, St Lucia, KwaZulu-Natal, South Africa.

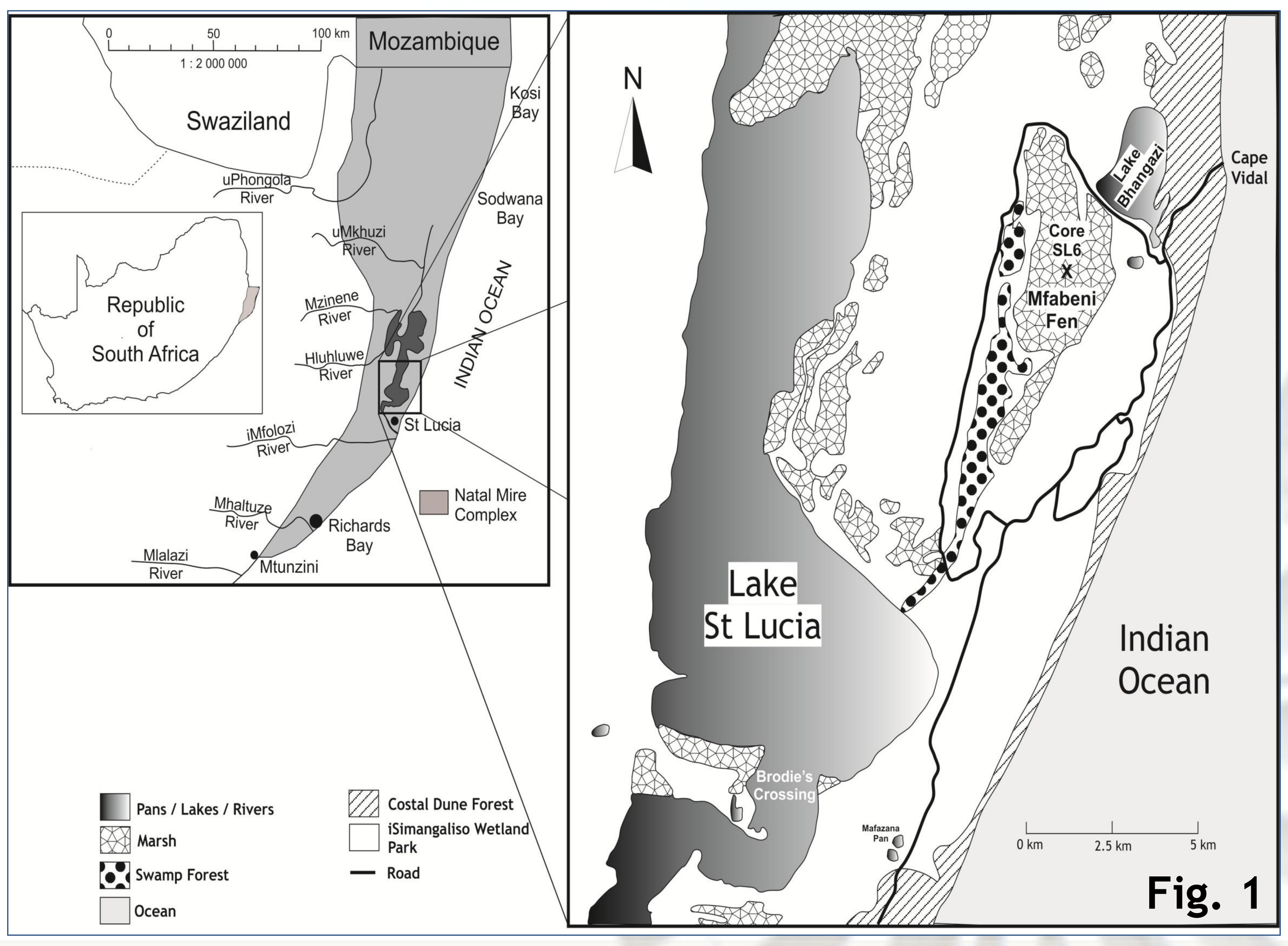

Fig. 1

Study Area

The Mfabeni peatland forms part of the greater Natal Mire Complex (Fig. 1) that extends from southern Mozambique to the south of Richards Bay, South Africa. The peatland is located on the eastern shores of Lake St. Lucia, which falls within the UNESCO world Heritage iSimangaliso Wetland Park. Peat started accumulating by valley infilling within the KwaMbonanbi formation coastal dune depression (4), most probably as a consequence of blockage of the Nkazana palaeo-channel and sustained groundwater input from the Maputaland aquifer (5). The base of the peatland has been dated c. 47.0 kcal yr BP (805 cm), positioning it as one of the oldest continuous coastal peatland records globally (5,6).

Results and Discussion

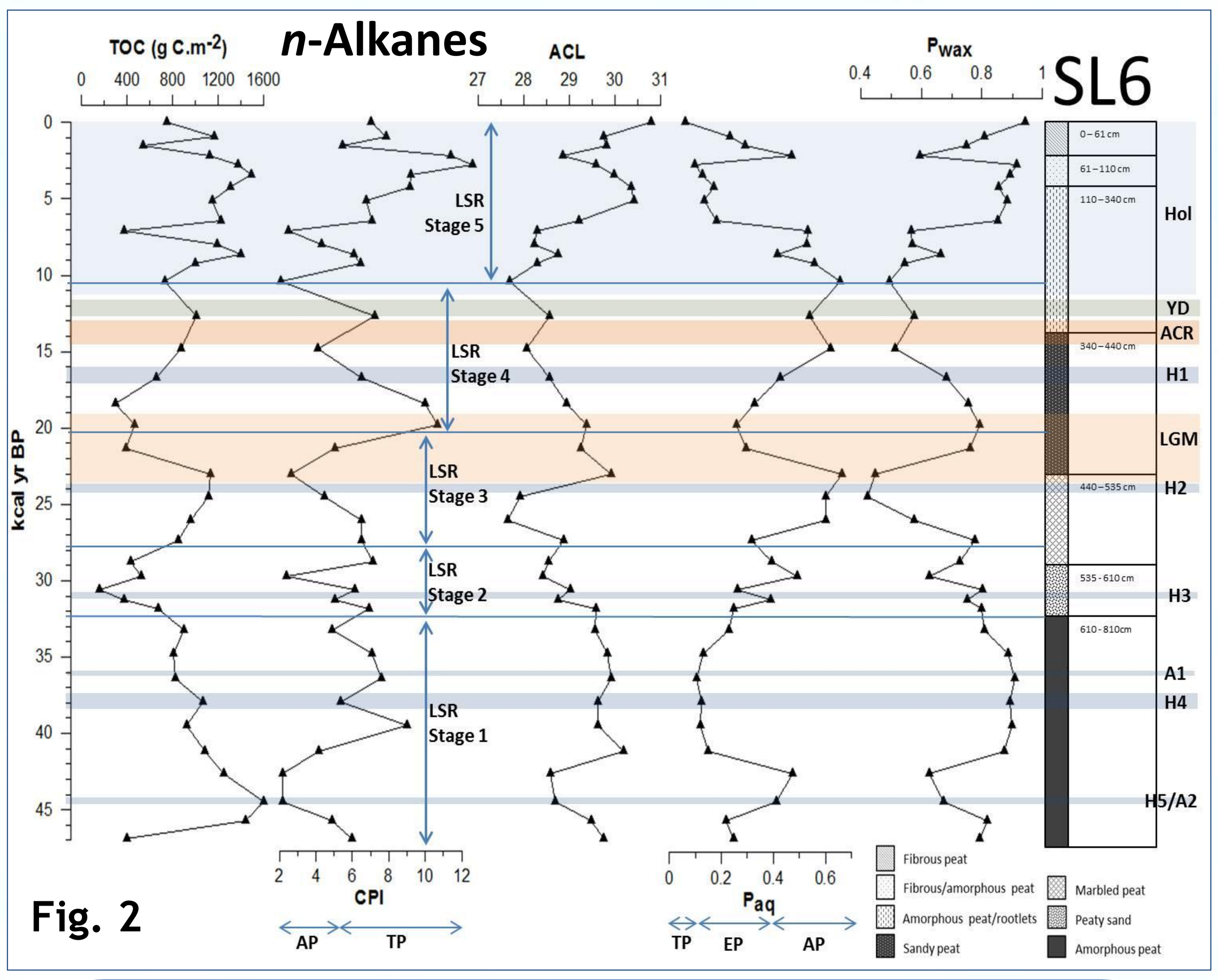

Fig. 2

n-Alkane ratios (Fig.2)

- CPI_{alk}, ACL_{alk} and P_{wax} values suggest predominant terrestrial plant (TP) OM input, concordant with *n*-alkane molecular homologue distributions (Fig. 4).
- P_{aq} values fall generally within emergent plant (EP) ranges, except btw 44.5—42.6, 29.7, 26.1—23.1, 16.7—7.1 and 2.2 kcal yr BP signalling dominant aquatic plant (AP) input.
- P_{aq} exhibits a significant negative correlation with ACL_{alk} and CPI_{alk} ($r=-0.83/-0.51$; $P=0.01$; $df = 37$), indicating a link between peatland hydrology and plant wax chain lengths & OM maturity.
- CPI_{alk} exhibits opposite trend to TOC during Pleistocene and similarly trend during the Holocene inferring a switch from bio reactivity to depositional OM preservation dynamics.

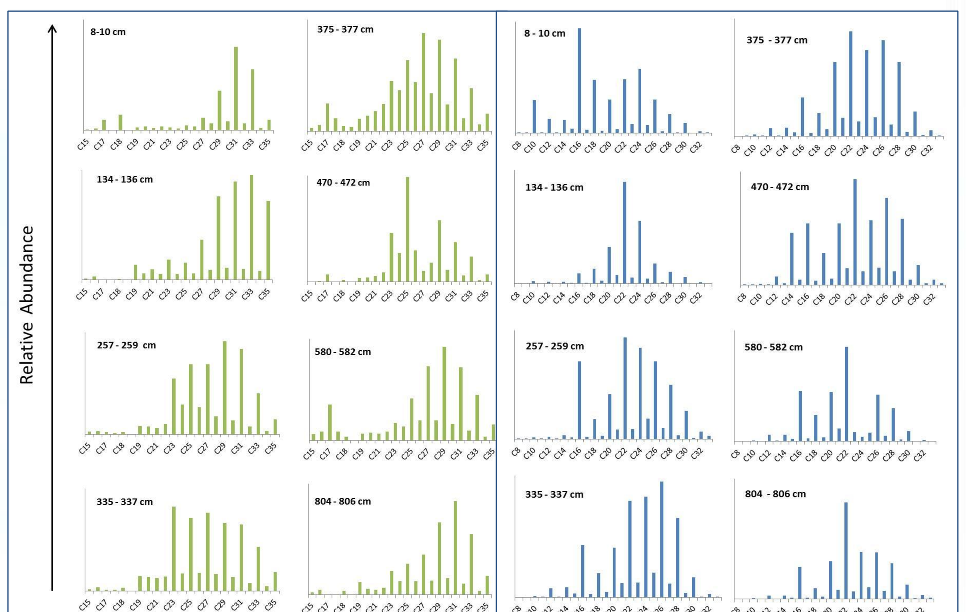

Fig. 4

n-Alkanoic acid ratios (Fig. 3)

- CPI_{FA} displayed a significant positive correlation with Holocene TOC ($r=0.65$; $P=0.01$; $df=12$) reinforcing the depositional OM preservation dynamics during this period.
- CPI_{FA} showed a significant negative correlation ($r=-0.38$; $P=0.01$; $df=37$) with *n*-alkane P_{aq} suggesting increased input of less recalcitrant mid-chain n-alkanes prevalent in AP.
- $C16_{FA}$ and $C18_{FA}$ unsat/sat ratios drop to near zero within 3 and 5 kyrs after burial, respectively.
- Negligible temperature perturbations at the site during the LGM could be reason for $CPI_{alk/FA}$ and ACL_{alk} exhibiting more dominant moisture, as opposed to temperature effects.

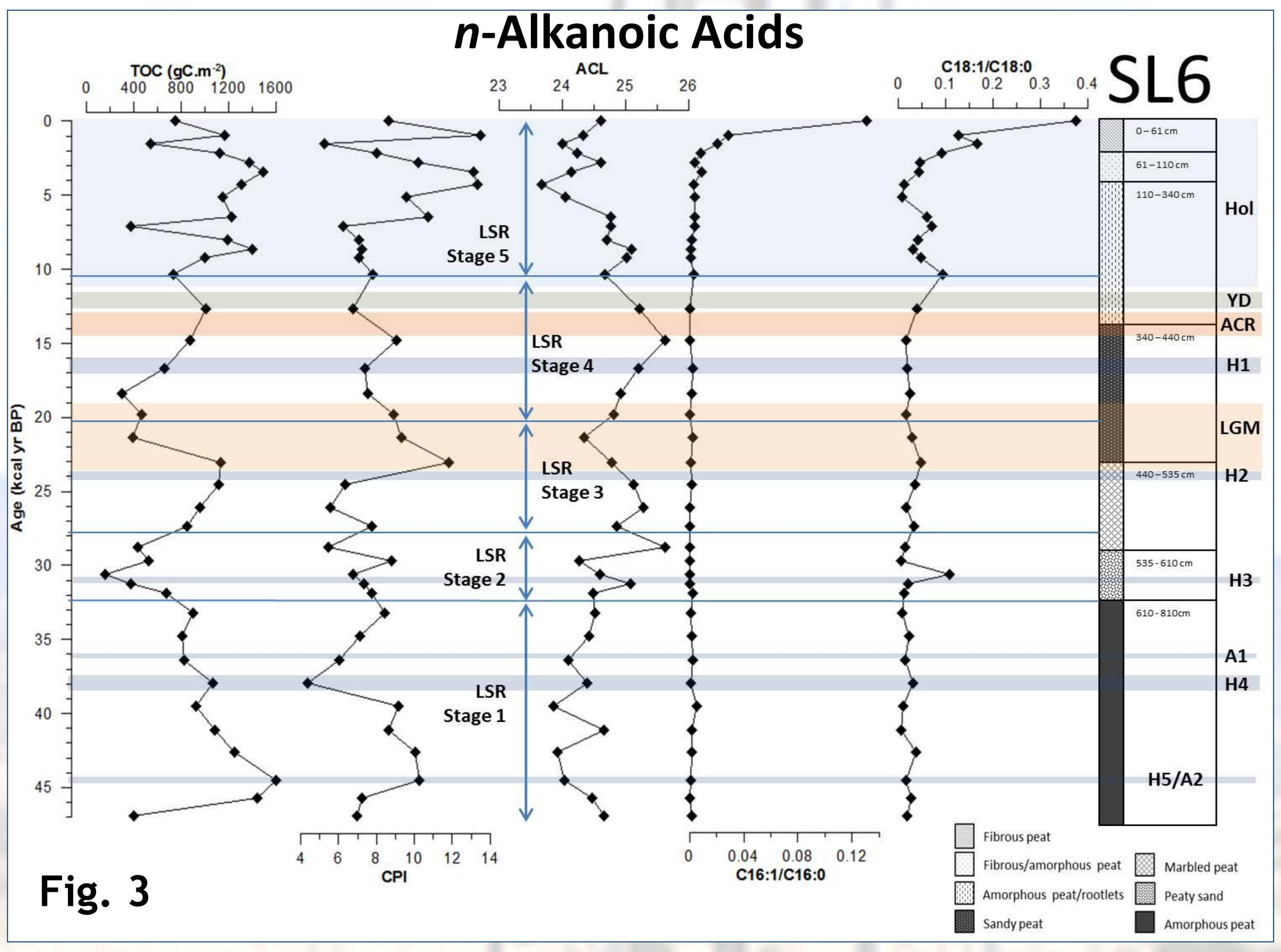

Fig. 3

Conclusions:

- Mfabeni peat sequence is dominated by higher TP and EP input, with the exception of dominant AP input during periods of shallow lake conditions in the peatland, concordant with increased Indian Ocean SST (7) and continental rainfall output (8).
- Both *n*-alkane and *n*-alkanoic acid CPI, and *n*-alkane ACL proxies suggest a stronger moisture influence than temperature on the local plant assemblages, arguably due to moderate glacial cooling experienced in low latitude coastal regions.
- The local climate was dominated by fluctuations in the adjacent Indian Ocean SST and displays an anti-phase interhemispheric trend with the better documented climatic events in the northern hemisphere.

Palaeoenvironment reconstruction

- ***LSR stage 1*** (c.47.0—c.32.4 kcal yr BP): Mostly cool & moist with intermittent spikes in temperature & precipitation, coeval with A2 & A1 warming events. EP/TP assemblages prevail, except between c. 44.5 & 42.6 kcal yr BP where AP dominate, coinciding with the TOC core maximum and A2 warming event.
- ***LSR stage 2*** (c. 32.1—27.9 kcal yr BP): Dominant EP/TP assemblages and drier conditions correspond to core TOC minimum. After c. 30.6 k cal yr BP, increase in AP input and shallow lake conditions in response to increased precipitation, thereafter a switch back to EP dominance, due to decreased moisture.
- ***LSR stage 3*** (c. 27.6—c. 20.3 kcal yr BP): Initial period of high precipitation and AP dominance till c. 23 kcal yr BP. Thereafter, sharp decline in TOC with shift to dominant TP assemblages due to cool and dry LGM conditions.
- ***LSR stage 4*** (c.19.8 — c. 10.4 kcal yr BP): Steady increase in AP and TOC after c. 18 kcal yr BP, with increased precipitation and temperature up until the ACR with a return to cooler and drier conditions. Thereafter, warming trend continues.
- ***LSR stage 5*** (c. 10.2 kcal yr BP — present): Overall elevated temperature and precipitation, with interposed cooling events. Early Holocene: cool and wet with predominant local AP input till c. 7.1 kcal yr BP, after which shift to EP/TP assemblages in response to Holocene Optimum conditions. Mid-Holocene: continuation of warm and moderately moist conditions culminating in peak precipitation at c. 2.2 kcal yr BP and sharp increase in AP input, after which a return to predominant EP/TP assemblages similar to the environment found in the peatland today.

References:

(1) Chase, B.M. & Meadows, M.E., 2007. Late Quaternary Dynamics of Southern Africa's Winter Rainfall Zone. Earth-Science Reviews, 84(3-4):103-38. **(2)** Scott, L., Holmgren, K. & Partridge, T.C., 2008. Reconciliation of Vegetation and Climatic Interpretations of Pollen Profiles and Other Regional Records from the Last 60 Thousand Years in the Savanna Biome of Southern Africa. Palaeogeography, Palaeoclimatology, Palaeoecology, 257(1-2):198-206. **(3)** Nash, D.J., Meadows, M.E., 2012. Africa, In: Metcalfe, S.E. and Nash, D.J. (Ed.), Quaternary Environmental Change in the Tropics. John Wiley & Sons, Ltd., UK: 79-150. **(4)** Smuts, W.J., 1992. Peatlands of the Natal Mire Complex: Geomorphology and Characterization. South African Journal of Science, 88(9-10):474-83. **(5)** Grundling, P., Grootjans, A.P., Price, J.S. & Ellery, W.N., 2013. Development and Persistence of an African Mire: How the Oldest South African Fen has Survived in a Marginal Climate. Catena, 110: 176-183. **(6)** Baker, A., Routh, J., Blaauw, M. & Roychoudhury, A.N., 2014. Geochemical Records of Palaeoenvironmental Controls on Peat Forming Processes in the Mfabeni Peatland, KwaZulu Natal, South Africa since the Late Pleistocene. Palaeogeography, Palaeoclimatology, Palaeoecology, 395: 95-106. **(7)** Sonzogni, C., Bard, E. & Rostek, F., 1998. Tropical Sea-Surface Temperatures during the Last Glacial Period: A View Based on Alkenones in Indian Ocean Sediments. Quaternary Science Reviews,17(12):1185-201. **(8)** Schefuß, E., Kuhlmann, H., Mollenhauer, G., Prange, M. & Patzold, J., 2011. Forcing of Wet Phases in Southeast Africa Over the Past 17,000 Years. Nature Geoscience, 480 (7378):509-12.

AEON AFRICA EARTH OBSERVATORY NETWORK
EARTH STEWARDSHIP THROUGH SCIENCE

science & technology
Department: Science and Technology
REPUBLIC OF SOUTH AFRICA

NRF National Research Foundation

iSimangaliso Wetland Park