AFQUA
THE AFRICAN QUATERNARY
ENVIRONMENTS, ECOLOGY AND HUMANS

Inaugural Conference
and Workshops

30 JAN - 7 FEB 2015

University of Cape Town
Cape Town, South Africa

afqua2015.com
Conference and Workshop Venues

Main Conference Venue:  
Baxter Theatre Centre  
Main Road Rondebosch, Cape Town  
GPS Coordinates:  
33° 57.422’S, 18° 28.231’E

Venue for Saturday 31 January:  
ZOO LT2 - Lecture Theatre Two, John Day Zoology Building  
Upper Campus University of Cape Town  
GPS Coordinates:  
33° 57.375’S, 18° 27.662’E

Workshops and meetings venues:  
EGS - Environmental and Geographical Science Building  
South Lane Upper Campus, University of Cape Town  
GPS Coordinates:  
33° 57.429’S, 18° 27.595’E

Directions

To reach UCT from the airport, proceed on the N2 towards Cape Town and take the Muizenberg (M3) off-ramp. Continue until you reach and turn off at the Woolsack Drive/University of Cape Town off-ramp. From here:

Baxter Theatre

Turn left at the Woolsack intersection, continue down Woolsack Drive until you see the UCT turn-off to your left, turn right onto the bridge over Woolsack Drive.

Lecture Theatre Two, John Day Zoology Building and Environmental and Geographical Science (EGS) Building

Turn right at the Woolsack intersection, go under the bridge and around a hairpin bend to reach the northern entrance to Upper Campus. The John Day Zoology Building is situated on University Avenue North road. The EGS Building is situated on South Lane, just below the Jammie Shuttle bus West Stop station.
We would like to acknowledge the generous support of our donors:

Professor Anton le Roux, Dean of the Faculty of Science, UCT
Department of Environmental & Geographical, UCT
University Research Committee, UCT

Many thanks to the following for donating their time and skills

Dr Graham Avery
Dr Greg Botha
Dr David Braun
Professor John Compton
Dr Fenton Cotterill
Mr Gavin Fleming and Mr Admire Nyakudya
Dr Eric Grimm
Professor Steve Juggins
Professor Michael Meadows
Mr Philip le Roux
Ms Emma Loftus and Ms Amy Jeffrey
Dr Marie-France Loutre
Professor Michael Meadows
Professor John Parkington
Professor Judith Sealy
For some time now we have realised that there is a large gap between the four-yearly INQUA International Congresses and the local conferences of INQUA Members that potentially underplays continent-wide consideration of matters Quaternary. We therefore have great pleasure in announcing the first continent-wide conference on the African Quaternary (AfQUA). We are delighted to welcome you to Cape Town where we hope you will be able to share your ideas and concerns, learn new things and develop projects from local to continental scales, and meet colleagues from across Africa and the world. The conference includes invited plenary talks on topics of particular importance, as well as scientific sessions with oral and poster presentations. Furthermore, the AfQUA meeting recognises and specifically addresses the difficulties in communication when working in Africa. While these impediments can make things difficult for established researchers, they are even more problematic for young scientists who are trying to learn their discipline and develop their careers. To help lessen these problems, a series of training workshops follows the conference. These will cover a range of topics, some practical and some academic, but all addressing skills that Quaternary scientists need to advance and express their science.

We hope that these inter-Congress AfQUA meetings will become a regular feature of the Quaternary calendar and look forward to your participation.
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conference and Workshop Venues</td>
<td>I</td>
</tr>
<tr>
<td>Contents</td>
<td>III</td>
</tr>
<tr>
<td>Programme</td>
<td>IV</td>
</tr>
<tr>
<td>Plenary Talks</td>
<td>V</td>
</tr>
<tr>
<td>Northern Africa</td>
<td></td>
</tr>
<tr>
<td>FS1: African landscape evolution in the Late Quaternary: linking data to environment</td>
<td>34</td>
</tr>
<tr>
<td>FS2: Dating and correlation of African archives of environmental change and archaeology</td>
<td>44</td>
</tr>
<tr>
<td>Recent Past, Future Perspectives</td>
<td>50</td>
</tr>
<tr>
<td>Central-West Africa</td>
<td></td>
</tr>
<tr>
<td>FS5: African climates and environments of the last 2,000 years</td>
<td>70</td>
</tr>
<tr>
<td>FS3: Quaternary human-environment interactions in Africa: archaeological, ecological, and evolutionary perspectives</td>
<td>76</td>
</tr>
<tr>
<td>FS4: Molecular-isotopic studies of modern ecosystems and palaeoclimatic changes in Africa</td>
<td>87</td>
</tr>
<tr>
<td>FS6: Climate Change in the Africa: intra- and inter-hemispheric patterns and linkages</td>
<td>92</td>
</tr>
<tr>
<td>Notes</td>
<td>97</td>
</tr>
<tr>
<td>Committee &amp; Organisers</td>
<td>102</td>
</tr>
</tbody>
</table>
**Programme**

**FRI 30 JAN 2015**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 - 9:45</td>
<td>Registration Opens</td>
</tr>
<tr>
<td>9:45 - 10:20</td>
<td>Assembly</td>
</tr>
</tbody>
</table>

**ORAL SESSION 1: Northern Africa** (Chair: R Cheddadi, I Bouimetarhan)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 - 10:45</td>
<td>I M Akaegbobi: Palaeoclimatic studies of Lake Chad Basin and its implication on lake level fluctuation using isotope geochemistry</td>
</tr>
<tr>
<td>10:45 - 11:00</td>
<td>A Jeffrey, E Stoetzel, S Parfitt, N Barton, R Nespoulet, M A El Hajraoui, A Bouzougar, C Denys and J A Lee-Thorp: Oxygen and carbon isotopes in Gerbillinae (gerbil) teeth provide palaeoaridity records in two Late Pleistocene Moroccan sites</td>
</tr>
<tr>
<td>11:15 - 11:30</td>
<td>A Benkaddour, L Vidal, R Adallal, Ch V Coulomb, M Noulrbait, A Rhoujji, C Sonzogni and R Cheddadi: New lacustrine records from the Moroccan Middle Atlas</td>
</tr>
<tr>
<td>11:30 - 11:45</td>
<td>R Cheddadi: Holocene climate change in the Middle Atlas mountains, Morocco</td>
</tr>
<tr>
<td>11:45 - 12:00</td>
<td>Open Discussion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Lunch</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 - 13:15</td>
<td></td>
</tr>
</tbody>
</table>

**PLENARY: M E Meadows:** A century of Quaternary studies in southern Africa: an historical perspective

<table>
<thead>
<tr>
<th>Time</th>
<th>Session/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00 - 15:00</td>
<td>POSTER SESSION 1: Northern and Southern Africa</td>
</tr>
</tbody>
</table>

**ORAL SESSION 2: Southern Africa** (Chair: B Chase, L Quick)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:15 - 15:30</td>
<td>C Henshilwood and K van Niekerk: New archaeological excavations of Later and Middle Stone Age deposits at the Klipdrift Complex, southern Cape, South Africa: 2010-2013</td>
</tr>
<tr>
<td>15:30 - 15:45</td>
<td>G Hall, S Woodborne and L Wadley: Proxy palaeoenvironmental data from stable carbon isotopic analysis of archaeological charcoal: Middle Stone Age evidence from Sibudu, KwaZulu-Natal</td>
</tr>
<tr>
<td>15:45 - 16:00</td>
<td>N Naidoo, J Sealy and S Brunton: Nelson Bay Cave: A palaeoenvironmental reconstruction of the last 22 ka using stable carbon and oxygen isotopes from bovid tooth enamel</td>
</tr>
<tr>
<td>16:00 - 16:45</td>
<td>J Fitchett, S Grab, M Bamford and A Mackay: Toward an improved Holocene palaeoenvironmental and palaeoclimatic reconstruction for eastern Lesotho</td>
</tr>
<tr>
<td>16:15 - 16:30</td>
<td>J MacPherson, L Gilson and M T Hoffman: Biome distributions and dynamics at ecotones in the Greater Cape Floristic Region</td>
</tr>
<tr>
<td>16:30 - 17:00</td>
<td>Open Discussion</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Session/Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>18:00 - 20:00</td>
<td>Welcome Reception</td>
</tr>
</tbody>
</table>

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**V**

**AFQUA - THE AFRICAN QUATERNARY - ENVIRONMENTS, ECOLOGY AND HUMANS | Inaugural Conference and Workshops 2015**
### ORAL SESSION 3: African landscape evolution in the Late Quaternary: linking data to environment (Chair: D S G Thomas)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30</td>
<td>D S G Thomas and R M Bailey</td>
<td>Accumulation Rate Variability analysis of southern African Late Quaternary desert dune chronologies</td>
</tr>
<tr>
<td>8:45</td>
<td>F E Eckardt, T Flügel, F Cotterill, C Rowe and M McFarlane</td>
<td>Kalahari tectonic landforms and processes beyond the Okavango Graben</td>
</tr>
<tr>
<td>9:00</td>
<td>A Rowell, D S G Thomas and R M Bailey</td>
<td>Exploring the use of sand ramps as novel archives of Late Quaternary environmental change in Southern Africa</td>
</tr>
<tr>
<td>9:15</td>
<td>M A G Andreoli, C Clarke, M Cloete, M Evans, C Harris, A Logue, O Majodina, T McCarthy, F Netterberg, I Stengel, L van Rooy and S Woodborne</td>
<td>8m deep palaeosols exposed at Vaalputs, Namaqualand, South Africa: unique windows to Late Cenozoic palaeoclimates and pedogenic processes.</td>
</tr>
<tr>
<td>9:30</td>
<td>M Evans, M A G Andreoli and P Mathebula</td>
<td>Constraining the timing of sedimentary in-fills at the Vaalputs radioactive waste disposal facility, Namaqualand, South Africa</td>
</tr>
<tr>
<td>9:45</td>
<td>H Cawthra, J Compton, E Fisher and C Marean</td>
<td>Former land surfaces and palaeoshorelines on the Mossel Bay continental shelf, South Africa</td>
</tr>
<tr>
<td>10:10</td>
<td>Open Discussion</td>
<td></td>
</tr>
<tr>
<td>10:40</td>
<td>Break</td>
<td></td>
</tr>
</tbody>
</table>

### ORAL SESSION 4: Dating and correlation of African archives of environmental change and archaeology (Chairs: C Lane, S Armitage, A Stone)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:40</td>
<td>L Farr and S Jones</td>
<td>Spatial and temporal variation in North African palaeoenvironmental and archaeological records during Marine Isotope Stage 4</td>
</tr>
<tr>
<td>10:55</td>
<td>C Martin-Jones, C S Lane, H F Lamb, N J G Pearce and V C Smith</td>
<td>Developing a Holocene tephr stratigraphy for African archaeological sites</td>
</tr>
<tr>
<td>11:25</td>
<td>S Burrough, R M Bailey and D S G Thomas</td>
<td>Dating the desert: A decade in the dark with Kalahari quartz</td>
</tr>
<tr>
<td>11:40</td>
<td>S Armitage, C S Henshilwood and K L van Niekerk</td>
<td>Single-grain OSL dating of the Howiesons Poort layers at Klipdrift Shelter, Southern Cape, South Africa</td>
</tr>
<tr>
<td>12:00</td>
<td>Lunch</td>
<td></td>
</tr>
</tbody>
</table>

### ORAL SESSION 5: Recent Past, Future Perspectives (Chair: Lindsey Gillson)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:15</td>
<td>L Gillson</td>
<td>Palaeoecology and ecosystem management in the Anthropocene – where are we now?</td>
</tr>
<tr>
<td>13:30</td>
<td>C Tolo, E A Majule and J B Leju</td>
<td>Indigenous knowledge of subsistence farmers in promoting resilience and agricultural productivity in a changing climate, Lake Victoria Basin: Case study of Rakai and Isingiro Districts, Uganda</td>
</tr>
<tr>
<td>13:45</td>
<td>M Virah-Sawmy and L Gillson</td>
<td>Using palaeoecology and social anthropological surveys to design better climate smart adaptation strategies: case of Southwest Madagascar</td>
</tr>
<tr>
<td>Time</td>
<td>Session</td>
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</tr>
<tr>
<td>14:00 - 14:15</td>
<td>O A Ediang and A A Ediang: West African coastal region: investigating the role of integrating global and indigenous knowledge systems in West Africa</td>
<td></td>
</tr>
<tr>
<td>14:15 - 14:30</td>
<td>C Twesigye: The impact of human-environmental interactions on the evolution of fisheries in Africa and its sustainability</td>
<td></td>
</tr>
<tr>
<td>14:30 - 14:45</td>
<td>J Runge, J Eisenberg, M Sangen, M Neumer and E Becker: Late Quaternary valley and slope deposits and their palaeoenvironmental significance in the Upper Congo Basin, Central Africa</td>
<td></td>
</tr>
<tr>
<td>14:45 - 15:00</td>
<td>I M Akaegbobi and G O Ogungbesan: Pliocene – Holocene Vegetation and Paleoenvironmental History of the Coastal Lagoon Areas of Lagos, Southwestern Nigeria using Pollens</td>
<td></td>
</tr>
<tr>
<td>15:00 - 15:15</td>
<td>C N Nwoji and C V Nnamani: Paleoenvironmental interpretation and age determination of the onshore Niger Delta Basin using microfloral assemblages</td>
<td></td>
</tr>
<tr>
<td>15:30 - 15:45</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>15:45 - 16:00</td>
<td>F P D Cotterill, B Nagy, B Watters and D Bellstedt: Tracking Quaternary and Neogene Landscape Evolution through the geocodynamics of fishes: unique proxy of tenures and mode of Africa’s dambos and depocentres</td>
<td></td>
</tr>
<tr>
<td>16:00 - 16:15</td>
<td>T Matthews and G J Measey: Palaeoenvironmental and evolutionary implications of fossil frog assemblages from the South African west and south coasts</td>
<td></td>
</tr>
<tr>
<td>16:15 - 16:30</td>
<td>E Singels, K J Esler, R M Cowling, A J Potts and J de Vynck: The role of geophytes in stone-age hunter-gatherer diets</td>
<td></td>
</tr>
<tr>
<td>16:30 - 16:45</td>
<td>P Bushozi and L Leque and A Skinner: New evidence for the technological development and substance economy during the Middle Stone Age (MSA) from Mumba in northern Tanzania</td>
<td></td>
</tr>
<tr>
<td>16:45 - 17:00</td>
<td>E Kyazike: Later Stone Age and Iron Age Cultures at Kansyore Island in Western Uganda</td>
<td></td>
</tr>
<tr>
<td>17:00 - 17:15</td>
<td>A Kay and J O Kaplan: A classification of subsistence lifestyles and land use in prehistoric Africa</td>
<td></td>
</tr>
<tr>
<td>17:15 - 17:30</td>
<td>D L Roberts, A S Carr, T Matthews and M D Bateman: Early modern human fossils: A tale of earthquakes and cannibalism</td>
<td></td>
</tr>
</tbody>
</table>

**SUN 1 FEB 2015**

**Fieldtrips**
### ORAL SESSION 8: East Africa (Chair: C Ogola)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 - 8:45</td>
<td>F Schäbitz, Bernd Wagner, F Viehberg, V Wennrich, J Rethemeyer, J Just, N Klasen, A Asrat, H Lamb, V Förster, M Trauth, A Junginger, A Cohen and the HSPDP science team</td>
<td>First results from the deep drilling at Chew Bahir (S-Ethiopia)</td>
</tr>
<tr>
<td>8:45 - 9:00</td>
<td>E Ndiema, P Kiura, R Kinyanjui and P Powell</td>
<td>Recent archaeological excavations in high altitude caves from Mt. Elgon, in Western Kenya: Preliminary findings</td>
</tr>
<tr>
<td>9:00 - 9:15</td>
<td>I Bouimetarhan, L Dupont, H Kuhlmann, J Pätzold, M Prange, E Schefuß and K Zonneveld</td>
<td>Northern Hemisphere control of deglacial vegetation changes in the Rufiji uplands (Tanzania)</td>
</tr>
<tr>
<td>9:15 - 9:30</td>
<td>G van der Plas, R Marchant and D Verschure</td>
<td>Developing a regional network of high-resolution pollen data and historical records to constrain the spreading of maize through East Africa</td>
</tr>
<tr>
<td>9:45 - 10:10</td>
<td>Open Discussion</td>
<td></td>
</tr>
<tr>
<td>10:10 - 10:40</td>
<td>Break</td>
<td></td>
</tr>
</tbody>
</table>

### ORAL SESSION 9: Southern Africa (Chair: C Ogola)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:40 - 10:55</td>
<td>T Haberzettli, M Wündsch, H Cawthra, G Daut, P Frenzel, T Kasper, S Meschner, M Zabel, J Baade, K L Kirsten, L J Quick, M E Meadows and R Mäusbacher</td>
<td>The RAIN project and first results from Eilandvlei and Verlorenvlei</td>
</tr>
<tr>
<td>10:55 - 11:10</td>
<td>L J Quick, T Haberzettli, M Wündsch, K L Kirsten, T Kasper, J Baade, G Daut, R Mäusbacher, M E Meadows and M Zabel</td>
<td>A Holocene vegetation history from the southern Cape coast of South Africa: palynological and microcharcoal evidence from Eilandvlei</td>
</tr>
<tr>
<td>11:10 - 11:25</td>
<td>K L Kirsten, T Haberzettli, M Wündsch, L J Quick, T Kasper, J Baade, G Daut, R Mäusbacher, M E Meadows and M Zabel</td>
<td>Hydrological development of the Eilandvlei system, southern Cape coast, South Africa during the Holocene</td>
</tr>
<tr>
<td>11:40 - 11:55</td>
<td>E Loftus, J Lee-Thorp and J Sealy</td>
<td>A record of Holocene sea surface temperatures from archaeological shell middens along the southern coast of Africa</td>
</tr>
</tbody>
</table>

| Time          | Lunch                                                                      |                                                                      |
|---------------|                                                                            |                                                                      |
| 12:00 - 13:15 | Lunch                                                                      |                                                                      |

| Time          | PLENARY: S Nicholson: Rainfall over the African continent since 1800       |                                                                      |
|---------------|                                                                            |                                                                      |
| 13:15 - 14:00 |                                                                            |                                                                      |

| Time          | POSTER SESSION 2: East Africa, Central-West Africa, FS5 African climates and environments of the last 2,000 years |                                                                      |
|---------------|                                                                            |                                                                      |
## ORAL SESSION 11: Quaternary human-environment interactions in Africa: archaeological, ecological, and evolutionary perspectives (Chairs: G Barker, T J Faith, C Hunt, H Lamb, T Reynolds, C Steininger, C A Tryon)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 - 8:45</td>
<td><strong>J Compton</strong>: Did we speciate on the Southern Coastal Plain of South Africa?</td>
</tr>
<tr>
<td>8:45 - 9:00</td>
<td><strong>J Wilkins, K S Brown, S Oestmo, T Pereira, K L Ranhorn, B J Schoville and C W Marean</strong>: Human-environment interaction through the Late Pleistocene on the South Coast, South Africa: Generating a high-resolution record of lithic technological change for integration with the SACP4 Paleoscape model</td>
</tr>
<tr>
<td>9:00 - 9:15</td>
<td><strong>S Brunton, J Sealy, D Styned, and J T Faith</strong>: Reinvestigating the paleoenvironment at Klasies River during MIS 4-5 (125-60 kya) using a multi-proxy approach</td>
</tr>
<tr>
<td>9:15 - 9:30</td>
<td><strong>M Will and N J Conard</strong>: What drives cultural change in the Middle Stone Age of Sibudu, KwaZulu-Natal?</td>
</tr>
<tr>
<td>9:30 - 9:45</td>
<td><strong>D Braun, N E Levin, D Styned, R Pickering, F Forrest, D L Roberts, T Matthews, S B Lehmann, D B Patterson, A I H Herries, K Fitzsimmons, L C Bishop and W Archer</strong>: The context of hominin behaviour at Elandsfontein in the Mid-Pleistocene</td>
</tr>
<tr>
<td>9:45 - 10:00</td>
<td><strong>A Nhundu</strong>: Climate change and cultural dynamics from the late Holocene period to the abandonment of the Mapungubwe capital on the greater Mapungubwe landscape</td>
</tr>
<tr>
<td>10:00 - 10:10</td>
<td>Open Discussion</td>
</tr>
<tr>
<td>10:10 - 10:40</td>
<td>Break</td>
</tr>
</tbody>
</table>
## ORAL SESSION 12: Southern Africa (Chairs: J Sealy, C Henshilwood)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:40 - 10:55</td>
<td>J De Vynck, K Hill, R Anderson, R M Cowling and C W Marean</td>
<td>Return rate estimates for inter-tidal foraging from experiments on the south coast of South Africa: implications for debates over the significance of early marine resource use</td>
</tr>
<tr>
<td>10:55 - 11:10</td>
<td>K Kyriacou, D M Blackhurst, J E Parkington and A D Marais</td>
<td>Coastal foraging and marine foods as a source of brain-specific nutrients for Middle Stone Age hunter-gatherers along the Atlantic west coast</td>
</tr>
<tr>
<td>11:10 - 11:25</td>
<td>M-J Stowe, J Sealy and S Brunton</td>
<td>Palaeoenvironmental reconstruction based on carbon and oxygen stable isotope analysis of bovid tooth enamel from Elands Bay Cave, South Africa</td>
</tr>
<tr>
<td>11:25 - 11:40</td>
<td>M Will, A W Kandel, K Kyriacou and N J Conard</td>
<td>Modeling coastal adaptations in the MSA of southern Africa</td>
</tr>
<tr>
<td>11:40 - 11:55</td>
<td>N Bicho, J Haws, M Raja, O Madime, C Gonçalves, J Cascalheira, V Aldeias, M Benedetti and T Pereira</td>
<td>Middle and Late Stone Age of the Niassa Region, Northern Mozambique. Preliminary results</td>
</tr>
</tbody>
</table>

### Lunch (12:00 - 13:15)

**PLENARY:** T C Johnson, J P Werne, E T Brown, A Abbott, M Berke, J Halbur, S Contreras-Quintana, S Grossheusch, S Schouten, J Sinninghe Damsté, R Lyons, C A Scholz, A Cohen, J King: A progressively wetter climate in Southern East Africa over the past million years

### POSTER SESSION 3: African landscape evolution in the Late Quaternary: linking data to environment, Molecular-isotopic studies of modern ecosystems and palaeoclimatic changes in Africa, Dating and correlation of African archives of environmental change and archaeology, General

### ORAL SESSION 13: Molecular-isotopic studies of modern ecosystems and palaeoclimatic changes in Africa (Chair: A Boom)

<table>
<thead>
<tr>
<th>Time</th>
<th>Presenters</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:15 - 15:30</td>
<td>J Luyt and J Sealy</td>
<td>Isotopic biogeochemistry of contemporary mammals from C3 environments: implications for palaeo-datasets</td>
</tr>
<tr>
<td>15:30 - 15:45</td>
<td>A Baker, J Routh, N Pedentchouk and A N Roychoudhury</td>
<td>Leaf wax and bulk stable carbon isotope records of plant type assemblages and palaeoenvironment changes in Mfabeni Peatland (South Africa), since the late Pleistocene</td>
</tr>
<tr>
<td>15:45 - 16:00</td>
<td>E Niedermeyer, B M Chase, G Gleixner and A Mulch</td>
<td>Southwestern African climate change during Heinrich Stadial 1 inferred from plant wax δ¹³C and δD from rock hyrax middens</td>
</tr>
<tr>
<td>16:00 - 16:45</td>
<td>R Granger, M E Meadows, E Schefuß, J Compton and A Hahn</td>
<td>Late Holocene variations in Benguela SST, vegetation and hydrology in southwest Africa</td>
</tr>
<tr>
<td>16:15 - 16:30</td>
<td>M Simon, C Purcell, R Hall, M Ziegler, S Barker, G Knorr, M T J van der Meer, S Kasper and S Schouten</td>
<td>Land-ocean connectivity in southernmost East Africa over the past 270,000 years: A combined multiproxy and modelling approach</td>
</tr>
<tr>
<td>16:30 - 17:00</td>
<td></td>
<td>Open Discussion</td>
</tr>
</tbody>
</table>
## ORAL SESSION 14: Quaternary human-environment interactions in Africa: archaeological, ecological, and evolutionary perspectives (Chairs: G Barker, T J Faith, C Hunt, H Lamb, T Reynolds, C Steininger, C A Tryon)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speakers</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 - 8:45</td>
<td>A Cohen, C Campisano, R Arrowsmith, A Asrat, A Deino, C Feibel, A Hill, J Kingston, H F Lamb, T Lowenstein, D Olago, R B Owen, R Renaut, F Schabitz, J J Tiercelin and J Wynn</td>
<td>The Hominin Sites and Palaeolakes Drilling Project (HSPDP): Collecting palaeolake drill cores from the East African Rift Valley to document the environmental context of human origins</td>
</tr>
<tr>
<td>9:00 - 9:15</td>
<td>R N Kinyanjui, R Potts, A K Behrensmeyer and M Bamford</td>
<td>Comparing the Quaternary palaeoenvironments of two major Hominin sites: the Olorgesailie and Koobi Fora Basins, Kenya</td>
</tr>
<tr>
<td>9:15 - 9:30</td>
<td>S Meyer, O Bödeker, R Vogelsang, M Kehl, S A Brandt, E Fisher and O Bubenzer</td>
<td>Late Pleistocene rockshelter stratigraphies and palaeoenvironments in Northeastern Africa – Case study Mochena Borago (Ethiopia)</td>
</tr>
<tr>
<td>9:30 - 9:45</td>
<td>F Henselowsky, K Kindermann, M Kehl and O Bubenzer</td>
<td>What influences the sediment composition of a rockshelter in a hyperarid environment? Insights from sedimentological and micromorphological analyses at the archaeological site Sodmein Cave, Egypt</td>
</tr>
<tr>
<td>9:45 - 10:00</td>
<td>C Ogola, O Mwebi and O Isaya</td>
<td>Archaeological fauna from Thimlich Ohinga Cultural Landscape, South Western Kenya</td>
</tr>
<tr>
<td>10:00 - 10:10</td>
<td>Open Discussion</td>
<td></td>
</tr>
<tr>
<td>10:10 - 10:40</td>
<td>Break</td>
<td></td>
</tr>
</tbody>
</table>

## ORAL SESSION 15: Southern Africa (Chairs: B Chase, M Meadows)

<table>
<thead>
<tr>
<th>Time</th>
<th>Speakers</th>
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<tbody>
<tr>
<td>10:40 - 10:55</td>
<td>X Zhao, L Dupont, E Schefuß, M E Meadows, A Hahn and G Wefer</td>
<td>Holocene vegetation and climate variability between winter and summer rainfall zones of South Africa</td>
</tr>
<tr>
<td>10:55 - 11:10</td>
<td>M Bamford</td>
<td>Early Holocene charcoals from Stratum 4d of Wonderwerk Cave, Northern Cape</td>
</tr>
<tr>
<td>11:10 - 11:25</td>
<td>L Scott, G Gil-Romera, E Marais and G A Brook</td>
<td>Evidence of vegetation change in Late Quaternary deposits of the Namib Desert and boundary region</td>
</tr>
<tr>
<td>11:25 - 11:40</td>
<td>S Lim, M Chevalier and B Chase</td>
<td>50,000 years of climate and vegetation change in the southern Namib Desert</td>
</tr>
<tr>
<td>11:40 - 11:55</td>
<td>I Schmidt, G Ossendorf, A Bolten and O Bubenzer</td>
<td>Human occupation in southern Namibia during the Late Pleistocene – a geoarchaeological approach</td>
</tr>
<tr>
<td>12:00 - 13:15</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>13:15 - 14:00</td>
<td>PLENARY: M Claußen</td>
<td>Abrupt African Quaternary Climate and Vegetation Change: concepts, modelling, and data</td>
</tr>
<tr>
<td>Time</td>
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<tr>
<td>14:00 - 15:00</td>
<td><strong>POSTER SESSION 4:</strong> Quaternary human-environment interactions in Africa: archaeological, ecological, and evolutionary perspectives, Climate Change in the Africa: intra- and inter-hemispheric patterns and linkages</td>
<td></td>
</tr>
<tr>
<td>15:00 - 19:00</td>
<td><strong>ORAL SESSION 16:</strong> Climate Change in the Africa: intra- and inter-hemispheric patterns and linkages (M Meadows)</td>
<td></td>
</tr>
<tr>
<td>15:15 - 15:30</td>
<td>S P Harrison, D Kelley, G Li, J S Singarayer and I C Prentice: Climate, vegetation, fire and the carbon cycle: Africa during the last 21,000 years</td>
<td></td>
</tr>
<tr>
<td>15:30 - 15:45</td>
<td>J Singarayer and S L Burrough: Interhemispheric symmetry in the African rain belt during the late Quaternary</td>
<td></td>
</tr>
<tr>
<td>15:45 - 16:00</td>
<td>M Chevalier and B M Chase: Pollen-based quantitative temperature and precipitation reconstructions in southeast Africa</td>
<td></td>
</tr>
<tr>
<td>16:00 - 16:45</td>
<td>B M Chase, A Boom, A S Carr, M Chevalier, S Lim, M E Meadows and P J Reimer: Drivers and responses of late Quaternary southern African palaeoenvironments</td>
<td></td>
</tr>
<tr>
<td>16:15 - 16:30</td>
<td>J A Collins T Caley, B Beckmann and E Schefuß: The evolution of precipitation in northern Central Africa over the last 25,000 years: insights from leaf-wax δD</td>
<td></td>
</tr>
<tr>
<td>16:30 - 17:00</td>
<td>Close of Conference</td>
<td></td>
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<tr>
<td>19:00</td>
<td><strong>CONFERENCE DINNER</strong></td>
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</table>
### POSTER SESSION 1

**FRI 30 JAN 2015**

#### NORTHERN AFRICA

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Novello, A-E Lebatard, A Moussa, D Barboni, F Sylvestre, D L Boulès, C Paillès, G Buchet, A Decarreau, P Duringer, J-F Ghienne, J-C Mazur, C Roquin, M Schuster and P Vignaud</td>
<td>Phytolith records from a 10Be/9Be dated lacustrine succession in the Lake Chad basin: insight on the Pliocene palaeoenvironmental changes in Central Africa</td>
</tr>
<tr>
<td>B Wagner, A Kolvenbach, F Schäbitz, Viehberg, A Junginger, V Wennrich, J Rethemeyer, T Endale, H Lamb and A Asrat</td>
<td>Late Glacial and Holocene environmental history of the Ethiopian Highlands inferred from a 12 m long sediment record from Dendi crater lakes</td>
</tr>
</tbody>
</table>

#### SOUTHERN AFRICA

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>L Bodmann, T R Hill, J M Finch, M Warburton and J van der Merwe</td>
<td>High-resolution pollen and charcoal records from three montane wetlands in the Cathedral Peak area, KwaZulu-Natal Drakensberg</td>
</tr>
<tr>
<td>J Brink</td>
<td>Comparing the large mammal fossil record and the archaeological record during the mid to late Quaternary in southern Africa</td>
</tr>
<tr>
<td>S Burrough and D S G Thomas</td>
<td>An OSL chronology for Stone Age archaeological sites in the upper Zambesi valley</td>
</tr>
<tr>
<td>J C L de Jager and L Joubert</td>
<td>The evolutional pressure of glacial aridification and the use of pollen-ovule ratio as a predictive proxy of pollen transfer efficiency (PTE) in Periplocoideae (Apocynaceae)</td>
</tr>
<tr>
<td>G Dewar, P Reimer, J Sealy and S Woodborne</td>
<td>Holocene marine radiocarbon reservoir correction delta R for the west coast of South Africa</td>
</tr>
<tr>
<td>N Du Plessis, M E Meadows, L J Quick and K L Kirsten</td>
<td>A new late Holocene pollen record from Eilandvlei, South Africa</td>
</tr>
<tr>
<td>T J Duthie, T R Hill and M J Bunting</td>
<td>Relevant source area of pollen spectra in Cathedral Peak, KwaZulu-Natal Drakensberg, South Africa</td>
</tr>
<tr>
<td>J Fell, K L Kirsten, P Frenzel, S Meschner, M Zabel and M E Meadows</td>
<td>Spatial patterns of modern diatom distribution in the Eilandvlei Catchment, Wilderness, South Africa</td>
</tr>
<tr>
<td>M Gomes, M Humphries, K L Kirsten and D Drake</td>
<td>Diatom-based reconstruction of salinity in Lake St. Lucia, South Africa: A Holocene climate history</td>
</tr>
<tr>
<td>M M Haaland, R F Rifkin and C S Henshilwood</td>
<td>Late Pleistocene figurative art mobilier From Apollo II Cave, southern Namibia</td>
</tr>
<tr>
<td>L la Grange, D D Stynzer and J C Sealy</td>
<td>Using stable isotopes and dental microwear to investigate the utility of rock hyraxes as palaeoenvironmental proxies</td>
</tr>
<tr>
<td>S Moyo, D Mphuti, E Cukrowska, C Henshilwood, K van Niekerk and L Chimuka</td>
<td>Mineralogical and geochemical investigation of Middle Stone Age soils at the Blombos Cave in South Africa</td>
</tr>
<tr>
<td>T Sheik, J M Finch and M Humphries</td>
<td>A Holocene sedimentary charcoal record from Lake St Lucia, KwaZulu-Natal, South Africa</td>
</tr>
<tr>
<td>C Sievers and J Wintjes</td>
<td>&quot;An enchanted garden&quot;; the flora of Great Zimbabwe</td>
</tr>
<tr>
<td>K Smith and D Stynzer</td>
<td>Changing distribution of the elephant genera Loxodonta and Elephas throughout the African Pleistocene: implications for palaeoenvironmental variability</td>
</tr>
<tr>
<td>K L Strachan, J M Finch, T R Hill, R L Barnett and P Frenzel</td>
<td>Environmental controls on surface foraminifera from Keiskamma and Knysna estuaries, South Africa</td>
</tr>
<tr>
<td>A C van Aardt, L Scott and P J du Preez</td>
<td>Towards addressing the disjunction between palaeo- and modern ecology in the western Free State</td>
</tr>
<tr>
<td>K van Niekerk and C S Henshilwood</td>
<td>The engraved ostrich eggshell from the Howiesons Poort layers from Klipdrift Shelter, southern Cape, South Africa</td>
</tr>
<tr>
<td>P Zisadza-Gandiwa, J M Finch, S Woodborne and G Hall</td>
<td>Variability of stable-carbon isotopic pattern of baobab (Adansonia digitata L.): A natural palaeoclimatic proxy for the Mapungubwe Cultural Landscape, Limpopo Province, South Africa</td>
</tr>
</tbody>
</table>
### POSTER SESSION 2

**MON 2 FEB 2015**

**EAST AFRICA**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>K Dollman and C Steininger</td>
<td>An analysis of the diet of microvertebrate fauna within the Laetoli site</td>
</tr>
<tr>
<td>M Kasangala Junior and N Mugeruza</td>
<td>Climate disturbance in the eastern Democratic Republic of Congo</td>
</tr>
<tr>
<td>J Nakintu and J B Leju</td>
<td>A 10000 ¹³C yr diatom record from Napoleon Gulf and Sango Bay, Lake Victoria</td>
</tr>
</tbody>
</table>

**SOUTHERN AFRICA**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>P Adeonipekun, T A Adeniya and A E Agbalaya</td>
<td>Palynological study of a 30 m borehole in a coastal environment in Nigeria</td>
</tr>
<tr>
<td>O Adojoh, F Marret, R Duller and P Osterloff</td>
<td>Mangrove vegetation and geochemical proxies: A key unravelling high resolution record of sea level, climate and palaeoenvironmental change along the Niger Delta margin, Gulf of Guinea, Nigeria</td>
</tr>
<tr>
<td>R Lem, F Marret and J Marshall</td>
<td>Towards an understanding of the millennial variability of the West African Monsoon system: a combined palynological and geochemical approach</td>
</tr>
<tr>
<td>I Yabi, I T Imorou4 and S Zakari</td>
<td>Mutations socio-environnementales récentes et perspectives de développement durable dans le bassin du fleuve Niger au Bénin</td>
</tr>
</tbody>
</table>

**FS5 African climates and environments of the last 2,000 years posters**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Andama, J B. Leju and C U Tolo</td>
<td>Late Holocene trends of sediment based heavy metal concentrations in Lake Victoria: Ecological impact assessment</td>
</tr>
<tr>
<td>J Fitchett and S Grab</td>
<td>Changes in south-east African tropical cyclone landfall frequency over the past 161 years</td>
</tr>
<tr>
<td>S Grab, D J Nash, P Morake and S Mills</td>
<td>“But what silence! No more gazelles…”: Historical and contemporary occurrence of mammals in Lesotho, southern Africa</td>
</tr>
<tr>
<td>F Klein, H Goosse, D Verschuren, and N E Graham</td>
<td>Comparing East African climate model results with lake records over the last 1000 years</td>
</tr>
<tr>
<td>Q Zhang, K Holmgren and H Sundqvist</td>
<td>Multi-decadal rainfall dipole oscillation over southern Africa modulated by variation of austral summer land-sea contrast</td>
</tr>
</tbody>
</table>

### POSTER SESSION 3

**TUES 3 FEB 2015**

**African landscape evolution in the Late Quaternary: linking data to environment**

<table>
<thead>
<tr>
<th>Authors</th>
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</tr>
</thead>
<tbody>
<tr>
<td>J Baade, C Glotzbach, K Rowntree, B Reinwarth, A Paape, J Miller and J Le Roux</td>
<td>Contemporary and long-term erosion and sediment yield in South Africa. Implications for and benefits from palaeo-ecological sedimentary records</td>
</tr>
<tr>
<td>H Cawthra, J Compton, A Hahn and M Zabel</td>
<td>Stratigraphy of incised channels on the Mossel Bay continental shelf, South Africa</td>
</tr>
<tr>
<td>H Cawthra, M Bateman, A Carr, J Compton and P Holmes</td>
<td>Understanding Late Quaternary changes at the land-ocean interface: The evolution of the Wilderness coastline, South Africa</td>
</tr>
<tr>
<td>S Egger and M Claussen</td>
<td>Dynamics of Holocene Saharan dust sources and transport</td>
</tr>
<tr>
<td>M Evans, Z Jinnah and S Mhlongo</td>
<td>Palaeo-environmental reconstruction of the Dieprift Gullies</td>
</tr>
<tr>
<td>T Flügel, F Eckardt and F P D Cotterill</td>
<td>The development of the present day drainage patterns of south-central Africa</td>
</tr>
<tr>
<td>D S G Thomas and J A Durcan</td>
<td>Age and significance of Holocene valley fills in the Skeleton Coast, Namibia</td>
</tr>
</tbody>
</table>
### Programme

#### Molecular-isotopic studies of modern ecosystems and palaeoclimatic changes in Africa


#### Dating and correlation of African archives of environmental change and archaeology

A Deino, R Potts, R Dommain and A K Behrensmeyer: The Olorgesailie Drilling Project (ODP): Understanding the last 1 Ma of palaeoclimate and human evolution in East Africa

E Githumbi, C C Mustaphi and R Marchant: Holocene ecosystem, social and landscape dynamics in East Africa

C S Lane, C M Martin-Jones, T C Johnson, H F Lamb, N J P Garrett, C A Scholz, V C Smith and D Verschuren: Toward a late Quaternary tephrastatigraphic framework for connecting East African palaeoenvironmental archives

S Mavuso and M Bamford: Yellow Marker Tuff, Laetoli: A geological study

A Stone, M D Bateman and D S G Thomas: Rapid assessment of Namib Sand Sea sediment chronologies? Testing a portable luminescence reader against full OSL dating

#### General


V Gröner, M Claussen and C Reick: Palaeobiodiversity in subtropical Africa - ecological assessment of a conceptual model approach

#### POSTER SESSION 4

### WED 4 FEB 2015

#### Quaternary human-environment interactions in Africa: archaeological, ecological, and evolutionary perspectives

O Bubenzer, K Kindermann, S Kröpelin, M Melles, J Richter, F Schäbitz, B Tezkan, R Vogelsang, B Wagner and G-C Weniger: From Africa to Europe in the Late Quaternary – ways of dispersal, bridges and barriers

M H Simon, M Ziegler, I R Hall, S Barker and C Stringer: Southeast African climate variability and early human evolution pulses


#### Climate Change in the Africa: intra- and inter-hemispheric patterns and linkages

M Chevalier and B M Chase: CREST – Climate Reconstruction Software

A Hahn, H Cawthra, J Compton, N Herrmann, K L Kirsten, M E Meadows and M Zabel: Holocene palaeoclimatic variations as recorded offshore south-western South Africa
## WORKSHOPS

### THURS 5 FEB 2015

<table>
<thead>
<tr>
<th>Time</th>
<th>Name</th>
<th>Topic</th>
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<tbody>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Juggins</strong></td>
<td>Analysing palaeoecological data with R (EGS - Studio 5)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Nyakudya</strong></td>
<td>Quantum GIS (EGS - computer lab)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Grimm</strong></td>
<td>Tilia/Neotoma/Bacon-Clam (EGS - Studio 3)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Loutre</strong></td>
<td>Frequency analysis (EGS - Room 2.27)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Chase, Nash &amp; Nicholson</strong></td>
<td>Africa 2K (EGS - Seminar Room 1)</td>
</tr>
</tbody>
</table>

### FRI 6 FEB 2015

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
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</tr>
<tr>
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<td><strong>Grimm</strong></td>
<td>Tilia/Neotoma/Bacon-Clam (EGS - Studio 3)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Loftus &amp; Jeffrey</strong></td>
<td>Stable isotopes for non-experts (Archaeology)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Chase &amp; Meadows</strong></td>
<td>SHAPE (EGS - Seminar Room 1)</td>
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### SAT 7 FEB 2015

<table>
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<tr>
<td>9:00 - 17:00</td>
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<td>Analysing palaeoecological data with R (EGS - Studio 5)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Nyakudya</strong></td>
<td>Quantum GIS (EGS - computer lab)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Grimm</strong></td>
<td>Tilia/Neotoma/Bacon-Clam (EGS - Studio 3)</td>
</tr>
<tr>
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<td><strong>Loftus &amp; Jeffrey</strong></td>
<td>Stable isotopes for non-experts (Archaeology)</td>
</tr>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Cotterill</strong></td>
<td>Geoecodynamics – Landscape Evolution (EGS - Seminar Room 1)</td>
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### SUN 8 FEB 2015

<table>
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<tr>
<th>Time</th>
<th>Name</th>
<th>Topic</th>
</tr>
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<tbody>
<tr>
<td>9:00 - 17:00</td>
<td><strong>Juggins</strong></td>
<td>Analysing palaeoecological data with R (EGS - Studio 5)</td>
</tr>
</tbody>
</table>
A century of Quaternary studies in southern Africa: a historical perspective

M E Meadows
Department of Environmental & Geographical Science, University of Cape Town, South Africa
mmeadows@mweb.co.za

Most of the technological developments that characterised the development of the discipline of Quaternary Science emerged historically in the temperate northern hemisphere. Preservation of palaeoecological proxies, in particular pollen, is favoured in these environments and, together with an obvious interest in glacial sediments and associated erosional features, the ancestral home of modern Quaternary Science is doubtless to be found in the Universities of Europe and North America. Nevertheless, studies in palaeoanthropology, palaeontology and archaeology have a long and distinguished history in Africa in general and in southern Africa in particular. It is arguably this concern with the history of humankind that ultimately led – albeit somewhat later than in the northern hemisphere – to a growing interest in Quaternary environments here too. Quaternary geological studies were largely suppressed by the intense focus on economic geology and the vast mineral reserves of the sub-continent, in particular gold and diamonds. Increased numbers of archaeological and palaeoanthropological studies, however, led to the recognition that palaeoenvironmental reconstructions were essential to a better understanding of the evolution of ancestral and modern humans and of changing climates. This, together with the advent of radiocarbon dating, led ultimately to the establishment of a recognisable Quaternary science discipline in South Africa. EM van Zinderen Bakker (ZB) joined the Department of Plant Sciences in what is now known of the University of the State in the 1950s and, together with his first PhD student, JA (Joey) Coetzee this added significant impetus to the emerging science. The initial basis of ZB’s work was pollen analysis and the laboratory quickly developed a substantial pollen reference collection to support research. The relatively limited occurrence of suitable wetland deposits in the region led to the group exploring opportunities for what were, at least in the 1970s and 1980s regarded as less ‘conventional’ deposits, including pan sediments, cave sediments and even coprolites. There were some true Quaternary pioneers in the region. John Vogel established a laboratory in 1967 at the CSIR in Pretoria that, among other measurements, was able to provide radiocarbon ages, in particular for many important archaeological deposits and subsequently on other kinds of sediments. Tim Partridge’s work on southern African landscape evolution arguably, in the words of Philip Tobias ‘…revolutionsed conventional wisdom on the geomorphic history of a large part of this continent’. There was, at the University of the Witwatersrand, a strong palaeontological research thrust associated with the Bernard Price Institute, which fostered the development of related studies there and a Quaternary palaeoecological research centre was established at the University of Cape Town in 1986. While typically associated with only small numbers of Masters and PhD students, initiatives at all of these centres ultimately led to the establishment of laboratories in other Universities, paralleled by growth in the number and geographical range of studies as well as an increase in the diversity of types of evidence brought to bear on the problems of reconstructing environments of the past. Visiting scientists too have played their part. Further technological developments and improvements in temporal resolution facilitated by advances in dating and other technologies and funding have facilitated an improving understanding the Quaternary history of southern Africa. Many questions remain unanswered but the science is flourishing in an era when a deeper understanding of the sensitivity of environments to perturbations, both anthropogenic and otherwise, is increasingly vital.

Keywords: History of Quaternary science; environmental reconstruction; van Zinderen Bakker, Vogel, Partridge, radiocarbon dating
Rainfall over the African continent since 1800

S Nicholson
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A newly created semi-quantitative data set commencing in 1800 allows us to examine the spatio-temporal variability of African rainfall on an annual time scale during over two centuries. The data consist of a moisture index ranging from -3 to +3 for 90 regions with coherent rainfall variability. The continent as a whole has exhibited marked fluctuations of rainfall on scales from decades to millennia. A small number of patterns are dominant and are remarkably stable over time. That is, the spatial patterns and their degree of dominance are markedly similar during the nineteenth and twentieth centuries. The robustness of these patterns has implications for the interpretation of palaeoclimate data. As for temporal variability, the most important result is a period of near continent-wide aridity in much of the first half of the nineteenth century. It was particularly severe in the 1820s and 1830s. This was marked by severe and persistent droughts and the drying trends in numerous lakes.

Keywords: rainfall, 19 century, spatial teleconnections, drought, interannual variability

A progressively wetter climate in Southern East Africa over the past million years

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Hominin evolution underwent important change in the last 1.3 million years, including the extinction of Paranthropus and several other African mammal species at about 1.2 Ma, leaving Homo as the sole remaining hominin genus in East Africa (1). Our genus experienced a major increase in cranial capacity at about 500 ka, and our species, H. sapiens, first appeared at ~200 ka. There was a major turnover in mammal species in East Africa around 400 – 500 ka, favoring descendants of smaller size and less specialized diet (2, 3). What drove evolution in this direction? Climate certainly played a role, for it is the major factor that influences the distribution of vegetation and habitability on the landscape.

A major climate shift, the Mid Pleistocene Transition (MPT), occurred between 1250 and 700 thousand years ago (ka) when the global glacial – interglacial cycles shifted their dominant resonant response to astronomical forcing from 40,000 to 100,000 years. Here, we present a 1.3 million year climate record from the Lake Malawi basin (East Africa) that is based primarily on measurements of TEX86 for temperature and of δ13C of leaf wax for hydroclimate. The record displays strong 100 ky (eccentricity) cycles of temperature and
rainfall after the MPT. Climate in this sector of East Africa evolved through the MPT from a highly variable and predominantly arid environment to conditions that were often wetter, and interspersed with progressively colder ice age temperatures. This trend towards a wetter environment runs counter to the climate history of North Africa, and reflects a spatial heterogeneity in the evolution of African climate, at least for the last million years, that undoubtedly affected the dispersal of our human ancestors.

*Keywords: Quaternary climate, Lake Malawi, Human evolution*

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**Abrupt African Quaternary Climate and Vegetation Change: concepts, modelling, and data**

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Pronounced changes in African climate, specifically during the transitions between glacial and interglacials, have been found in palaeo climatic archives. Some geological records suggest abrupt climate shifts others, more gradual transitions. Here, we present an overview of theory and numerical climate system simulations aiming at understanding these changes. African climate and vegetation shifts were likely induced by large changes in ice masses, ocean circulation and monsoon dynamics which, in turn, were triggered by variations in the Earth orbit around the sun and subsequent alteration of meridional insolation gradients. It is shown that abrupt change, or ‘tipping, could result from a strong feedback between vegetation and climate at different times at different locations. Moreover, strong feedback in one region can lead to ‘induced tipping’ in other, seemingly stable regions. However, the diversity of plants can affect the strength of biogeophysical feedback. Regions rich in plant diversity may stabilize the system leading to more gradual transitions. As alternative hypothesis, abrupt changes may also emerge from intrinsic threshold behaviour of hydrological systems and ecosystems. Consequently, testing any hypotheses on and models of African Quaternary climate and vegetation dynamics, specifically regarding the nature of abrupt change, requires an ensemble of independent and detailed palaeo climatic and palaeo botanic records.

*Keywords: modelling African Quaternary climate change, abrupt African climate change, African vegetation change*
Oxygen and carbon isotopes in Gerbillinae (gerbil) teeth provide palaeoaridity records in two Late Pleistocene Moroccan sites

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Available evidence indicates that climate in North Africa has varied strongly since the Last Interglacial between periods of humidity and aridity. Here we sought to develop an independent proxy for past humidity shifts in Mediterranean NW Africa over the last 125 ka using stable oxygen and carbon isotopes from Gerbillinae (gerbil) teeth. A modern study of gerbil teeth from mesic, semi-arid and arid bioclimate zones across NW Africa established that their δ18O composition is sensitive to moisture availability and relative humidity, because of their strong reliance on plant water. Unsurprisingly the δ13C composition of the teeth reflects the vegetation consumed by the animal in its highly localized microhabitat. We analysed gerbil teeth from two archaeological cave sequences, El Harhoura 2 and Taforalt, located on the Atlantic and Mediterranean coasts of Morocco respectively. Although the two sequences do not overlap perfectly in time, the δ18O and δ13C composition of gerbil teeth in both sequences indicates that both the Atlantic and Mediterranean coasts of NW Africa experienced humid to arid climate shifts during MIS 5 and MIS 3/2. The climate data is interpreted in relation to other environmental, and cultural, shifts in the archaeological record in the two sites.

Keywords: Gerbillinae, isotope, palaeoaridity, oxygen, carbon
Termination of the African Humid Period: Insights from Wadi Shati, Libya

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Uncertainty remains as to whether the termination of the African Humid Period (AHP) was a sudden or gradual event. Work examining this notion has been undertaken in the Sahara, but is in its infancy in comparison to more established records from Eastern and Western Africa; no records currently exist for the central Sahara. The Fezzan region of Libya forms a large closed basin that contains a wealth of ancient palaeolake and riverine sediments indicative of past humidity in the central Sahara. Examination of a mid-Holocene sediment core extracted from palaeolake Wadi Shati, the largest lake found in the region (660 km2 during the Holocene), affords an insight into the local and regional response of the Fezzan basin during the AHP. Core sediments were dated using OSL and analysed using XRF, Ion Chromatography and Laser Granulometry and extractions were made for palaeobiological analyses. Phytolith analysis was employed to examine the palaeovegetation record of the region in the absence of pollen within the sediment sequence. The presence of grass and tree phytoliths illustrates the response of the regional vegetation to changes in precipitation and outlines a shift from a wooded savannah to a grassland environment. Gypsum horizons of both groundwater and evaporitic origin were identified in conjunction with notable sand-rich layers and were used to determine high and low lake stands. The results do not support the hypothesis of a sudden acidification of the Sahara at 4.9 ka, but instead suggest that aridification had begun in the Fezzan region by 7.6 ka, the climate oscillated after 6.2 ka, and lake desiccation was complete by 5.3 ka. These results show that there is evidence of the climate becoming drier over a 1500 year period, during which the Sahara desert became established. The data additionally indicates that this drying was not just a gradual process, as there is much evidence for climatic variability throughout the record.

Keywords: African Humid Period, Sahara, Phytoliths, Gypsum

New lacustrine records from the Moroccan Middle Atlas

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In order to better predict potential future climate changes, it is necessary to investigate those, modern and past changes, particularly in the most sensitive areas such as the Mediterranean. The Moroccan Middle Atlas Mountains, considered as Moroccan water tower, has more than 30 small natural lakes. These water bodies are, in general, well preserved. They are characterized by different sedimentological, hydrological and hydrochemical behaviors. Their sedimentary archives allow to reconstructing the natural changes of their hydrology, lake levels and geochemistry but also the impacts of the human activities on their watershed. Two lacustrine sites are concerned in here: Azigza lake (32°58’N, 5°26’W, 1470 m asl) and Dayet Hachlaf (33°32’N 5°00’W, 1760 m asl).

The first part of this study is dedicated to understand modern behavior of Azigza Lake and the second part is an attempt to reconstruct hydroclimatic changes during the last 6 kyr in Dayet Hachlaf.
Holocene climate change in the Middle Atlas mountains, Morocco

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Several fossil records covering the Holocene period were recently collected from the Middle Atlas, Morocco. We have dated them and studied their pollen content. An earlier climate reconstruction from a record collected in Lake Tigalmamine suggested that the annual precipitation during the period between 10 and 6ka (uncalibrated) was rather lower than today which is not coherent with available data from other sites in the Mediterranean or the European temperate latitudes. In North Africa (say between 16°N and 24°N), fossil data show also that the early Holocene was more humid than today due to a northward shift of the summer monsoon. The Middle Atlas records that show an opposite trend are all located at a higher latitude than 24°N and high altitude as well.

In this presentation I will show data from several sites which tend to confirm, coherently, that climate was very probably drier during the early Holocene (11 to 7 cal kBP) than today in the Middle Atlas area. Indeed, there was a well-developed steppe with a rather reduced tree cover which clearly indicates that the amount of available moisture in the Middle Atlas was rather lower than today. As is often the case, there must be several causes that may explain the regional low moisture over the Middle Atlas during the early Holocene. For instance, the northward shift of the summer monsoon has probably (if not certainly) not reached the Mediterranean basin during the Early Holocene and/or the NE-SW trade winds were weaker than today and/or the Atlantic moisture source was weakened through an enhanced upwelling.

Keywords: Holocene, Middle Atlas, Pollen, Climate, Morocco

In Azigza, both surface and underground waters are alkaline (pH about 8.5) with low salinity (from 360 to 730 μS/cm according to the season). Modern sedimentation is dominated by carbonate (up to 75%) with high sedimentation rate, about 5mm/y during the last two centuries. Isotopic data ($\delta^2$H, $\delta^{13}$C and $\delta^{18}$O) on both water and ostracods carbonate shows a short water residence time and reveal that the isotopic signal in ostracod is close function of the water isotopic composition and local climatic conditions. These results assess the potential of Lake Azigza sediment sequences to provide reliable information of past hydrological changes.

Past hydrologic and climatic conditions are inferred from a 250 cm core obtained from Dayet Hachlaf. This, 14C dated, core spans the last 6000 years. Geochemical (grain size, Total Organic Carbon, Organic matter C/N ratio) and isotopic ($\delta^{13}$C) contents show that the period between 5.5 and 5 ka was cold with a low primary productivity, a decreasing carbonates precipitation and a decline of the pine populations. After 5 ka, when the lake level was lower, authigenic carbonates became more abundant in place of the silty and silty clay sedimentation. At the same time the forest vegetation composed of pines and oaks expanded. Human impact in the middle Atlas is not recorded until late Holocene (~2.6 ka). It is characterized by soil deterioration and land-derived sediment especially clay and silt.

These climatic changes (present dry period) and human impact (deforestation and soil deterioration since about 2 ka) affecting the Middle Atlas may have a dramatic consequence on hydrological resources and human activities in the nearest future.

Keywords: Moroccan Middle Atlas Mountains, palaeohydrology, palaeoclimate, geochemistry

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Keywords: Moroccan Middle Atlas Mountains, palaeohydrology, palaeoclimate, geochemistry
Phytolith records from a $^{10}$Be/$^{9}$Be dated lacustrine succession in the Lake Chad basin: insight on the Pliocene palaeoenvironmental changes in Central Africa

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Marine records off the African coasts indicate high climate variability in tropical Africa during the Pliocene, revealed by a succession of humid and arid phases tuned with precessional cyclicity of the Earth’s orbit. To date, few data provided information on Pliocene climate features and variability in Central Africa. This region, however, is known to have experienced significant environmental changes during the Holocene, including the expansion of what we currently know as the Lake Chad in a Megalake of 340,000 km². A borehole drilled in the Bol Archipelago (Lake Chad basin, 13°28’N, 14°44’E) in the 1970’s offered us the possibility to better document palaeoenvironmental changes in Central Africa during the Pliocene. We focused on 25 fossil samples which we dated and analyzed for their micro-biological content (phytolith, diatom, and pollen). To interpret fossil phytolith assemblages, we made a new modern phytolith reference collection from both plant (mainly grasses) and modern soils/sediments from Chad (including samples from the marsh areas of current Lake Chad). We also built a new phytolith index, called “Aquatic grass phytolith index”, which aims at discriminating the signal of aquatic grasses that locally grow in association with lacustrine bodies. Phytolith assemblages indicate the dominance of humid grassy vegetation between ~5.5 and 2.4 Ma, in agreement with the expansion of the savanna biome simulated by models. Also, variations of the Aquatic grass phytolith index support alternating lacustrine and peri-lacustrine conditions at Bol during the Pliocene. Between ~3.6 Ma and 2.7 Ma, the increase of silicified bulliform cell phytoliths in the phytolith assemblages, concomitantly with a significant decrease of sediment diatom concentration, suggest high aridity in the basin that is consistent with the aridification recorded in northern Chad (oxygen isotope on fish teeth) and elsewhere in North and West Africa (pollen, dust records) during the mid-Pliocene.

Keywords: tropical Africa, Pliocene, phytolith, palaeoenvironment
Late Glacial and Holocene environmental history of the Ethiopian Highlands inferred from a 12 m long sediment record from Dendi crater lakes

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A 12 m long composite sediment sequence from Dendi crater lakes, located on the central Ethiopian Plateau, was recovered during a field campaign in March and April 2012. The sediment sequence was analysed with sedimentological and geochemical methods including XRF scanning, grain size measurements, and the determination of total organic carbon (TOC), total inorganic carbon (TIC), total nitrogen (TN) and total sulphur (TS). Bulk organic carbon samples from 23 horizons throughout the sequence were used for AMS radiocarbon dating and provide the basis for the establishment of a robust age-depth model. The sediment sequence covers almost continuously the last 12.5 ka and indicates high Ca and TIC at the base, which infer relatively high carbonate content and most likely a relatively low lake level. The most prominent sedimentary horizon in the entire sequence is formed by an almost 2 m thick tephra, which was deposited between 11.0 and 10.5 ka BP and probably originates from the Wonchi crater 15 km to the southwest of the Dendi lakes. The sedimentological data indicate that the input of clastic terrigenous matter was highly variable during the African Humid Period (AHP) and was relatively stable during the mid Holocene. Higher variability over the last ca. 4 ka is probably related to increasing human activity in the area or to a changing climate regime. The climate in the area is mainly controlled by variations in solar isolation and atmospheric circulation patterns, which are influenced by the position of the ITCZ and the Congo Air Boundary (CAB). Compared with other sediment records from Ethiopia the influence of the AHP on sedimentation patterns seems to be less pronounced at Dendi crater lakes, which is probably due to their location in the Ethiopian highlands and a more humid climate throughout the Holocene.

Keywords: Ethiopia, Dendi lakes, Holocene, palaeoclimate, tephra
New archaeological excavations of Later and Middle Stone Age deposits at the Klipdrift Complex, southern Cape, South Africa: 2010-2013

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From 1998 – 2009 intermittent archaeological site surveys along 60 km of coastline located in the De Hoop Nature Reserve, southern Cape, South Africa resulted in the detailed mapping of more than 160 archaeological sites. In 2010 and 2011 two of the sites in the reserve that comprise the Klipdrift Complex, Klipdrift Shelter (KDS) and Klipdrift Cave (KDC), were selected for test excavations. The excavations form a part of the Tracsymbols project, funded by a European Research Council FP7 grant (2010-2015) and an NRF Research Chair at Wits University (http://tracsymbols.eu). The selection of the Klipdrift sites was based on their visible, in situ Later Stone Age (LSA) and Middle Stone Age (MSA) deposits, the preserved fauna and their relative accessibility. Excavations in 2010 at KDC (c. 14 - 10 ka) indicated late Pleistocene deposits. In 2011 test excavations commenced at KDS revealing c. 1.6 m deep, well preserved, horizontal MSA deposits with Howiesons Poort technology. The clear separation of stratigraphic levels at both sites enabled the accurate recovery of materials from discrete depositional levels.

Here we report on the preliminary excavations from these sites. The research emanating from these sites has the potential of contributing to current debates about the origins of modern human behaviour with a specific focus on the Homo sapiens that inhabited the southern Cape during the MSA. Excavations at the Complex will continue in the future.

Keywords: Middle Stone Age, archaeology, Homo sapiens, early human behaviour

Proxy palaeoenvironmental data from stable carbon isotopic analysis of archaeological charcoal: Middle Stone Age evidence from Sibudu, KwaZulu-Natal

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Stable carbon isotopic analysis of archaeological charcoal can provide a meaningful source of palaeoenvironmental information. Through a series of experiments on modern tree stem, branch and charcoal samples, it was demonstrated that δ13C values from these materials preserve an environmental signal. Additional experimentation indicates that the environmental isotope signature is preserved through the charcoalification process. These experimental results indicated the potential to derive environmental evidence from archaeological charcoal. The Middle Stone Age (MSA) sequence from Sibudu has yielded well preserved palaeoecological proxy evidence, including abundant charcoal. The δ13C ratios of Podocarpus and Celtis charcoal from Howiesons Poort (65-62ka); post-Howiesons Poort (~58ka) and late MSA (~48ka) levels indicate shifting local vegetation communities in response to changing climatic conditions. During the Howiesons Poort, the local environment was more humid and moist than present, dominated by evergreen forest. The vegetation changed to open savannah grassland or woodland in response to drier and colder conditions during the post-Howiesons Poort and into the late MSA occupations. The charcoal isotopic evidence is supported by diverse proxy evidence from macro and micro-faunal remains, macro-botanical remains, mineralogical, sedimentological, magnetic susceptibility and pollen analyses from Sibudu.

Keywords: stable carbon isotopes, charcoal, Sibudu, environmental proxies, Middle Stone Age
Nelson Bay Cave: A palaeoenvironmental reconstruction of the last 22 ka using stable carbon and oxygen isotopes from bovid tooth enamel

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Quaternary palaeoclimatic and palaeoenvironmental records of south-western Africa are important in understanding global climate and oceanic patterns, Cape floristic diversity and human evolution. Yet, at the present time the climatic records for the region are quite sparse. In order to better understand the OIS 2-1 time frame, we have analysed δ¹³C and δ¹⁸O in 227 bovid teeth spanning the last 22 ka from Nelson Bay Cave (NBC). This is an important time period as it encompasses the Last Glacial Maximum (LGM), the Pleistocene-Holocene transition and the Holocene Altithermal (HA). NBC is an archaeological site located on the south coast of South Africa, near the town of Plettenberg Bay. The archaeological deposits encompass most of the last 20 ka; there are also deeper underlying stratigraphic levels likely to date to ca 70 ka. Layers dating from OIS 2-1 have produced a wealth of archaeological material, including stone and bone artefacts, ornaments and beads, a variety of faunal bones and human remains. Currently, NBC is located within the year round rainfall zone (YRZ) at the transition between temperate and tropical rainfall systems. This constant supply of precipitation supports both C3 and C4 vegetation. Changes in seasonality and amount of rainfall in the area have been linked to the positions of both these systems and the expansion and contraction of Antarctic sea ice through time. It has been hypothesized that the winter rainfall zone (WRZ) extended further eastwards in the late Quaternary. This study investigates the extent of the WRZ during the LGM through stable isotopic studies of bovid tooth enamel. Grazers have been used in this study as they best reflect the proportions of C3 to C4 grasses found within an ecosystem. Species used in the study include Syncerus caffer, Damaliscus dorcas and Hippotragus. Carbon isotope measurements from these grazers are indicative of mixed rainfall with a strong summer component throughout the period since the LGM. Interestingly there are substantial differences in the carbon isotope values between these species. Hippotragines are more enriched than Syncerus caffer, which in turn is more enriched than Damaliscus dorcas. This is likely to be the result of different feeding preferences within different species.

Keywords: palaeoclimatic and palaeoenvironmental reconstruction, stable light oxygen and carbon isotopes, south west coast

Toward an improved Holocene palaeoenvironmental and palaeoclimatic reconstruction for eastern Lesotho

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The high altitude eastern Lesotho Highland observes climate patterns distinct from those of surrounding lower altitude regions, representing a niche environment with a unique biodiversity, leading to well adapted but restricted biomes. With a heavy reliance on subsistence agriculture, Lesotho faces the threat of considerable economic loss and sustained threat to livelihoods, should current rates of climate change persist or intensify. Furthermore, eastern Lesotho serves as southern Africa’s primary water catchment, and one of the few catchments in the broader region in which precipitation exceeds evaporation. Any changes in the climate and hydrological systems, as are likely under climate change scenarios, would have an effect on the natural biomes, livelihoods, and water security both locally and regionally. Climate change research in eastern Lesotho, and it potential to inform adaptation, is thus of particular value.

The high levels of endemism in the eastern Lesotho region limits the accuracy of climate responses inferred...
from lower altitude sites. Understanding natural and human impact on these ecosystems necessitates a multiproxy approach from well-dated, highly resolved archives sampled from the local region, followed by an integration of data with other lower altitude records to understand more fully the sensitivity of these highland regions. Whilst palaeoenvironments for large parts of southern Africa are now relatively well reconstructed through the Holocene, the Lesotho highlands region represents a notable gap of such knowledge.

This paper presents the preliminary results of a Holocene palaeoenvironmental reconstruction for eastern Lesotho, based on pollen, diatom and sediment analysis, and supported by a high temporal resolution AMS dating chronology. Sediment cores were extracted from two peat bogs at Sani Top (ca 2800 m a.s.l.) and Mafadi (ca 3390 m a.s.l.), and from an exposed gully-sidewall profile approximately 1km south of the Sani Valley (ca 2950 m a.s.l.). Past patterns in vegetation and biodiversity will be constructed using pollen, whilst changes in precipitation patterns will be inferred from diatom and sediment analysis. With a well constrained age model, this will facilitate a more complete understanding of temperature and rainfall fluctuations in eastern Lesotho during the Holocene.

Keywords: Eastern Lesotho, palaeoenvironmental reconstruction, diatoms, pollen

Biome distributions and dynamics at ecotones in the Greater Cape Floristic Region

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The distributions of biomes within with the Greater Cape Floristic Region (GCFR) of South Africa have been stable relative to those expressed more commonly globally in the Late Quaternary. In fact, they often appear so stable in the fossil record that it is difficult to infer the long-term ecological processes determining biome distributions and dynamics. Understanding how relevant environmental parameters - such as climate, fire, herbivory and land-use - interact with plant ecosystems is particularly important with respect to protecting and managing the Cape flora's outstanding biodiversity.

We sought to emphasise changes in biome distribution in relation to environmental parameters by sourcing sediment cores directly from present-day biome ecotones in the GCFR. Pollen, charcoal, and coprophilous fungal spores were analysed from radiocarbon dated cores at fynbos-succulent karoo and fynbos-Afrotemperate forest biome ecotones. From the mid-Holocene to modern times only subtle changes in biome distribution are evidenced. This is despite strong evidence for change in fire (charcoal) herbivory (coprophilous fungal spores), as well as the regional palaeoenvironmental record. Overturning among taxa of the fynbos biome is more pronounced, and relates more closely to changes disturbance as well as published records of environmental change.

We emphasise the importance of interactions among topography, climate, and land-use at both regional and local scales in promoting resilience at the inter-biome scale. Plant functional type and functional diversity are also interpreted as key factors in explaining both inter- and intra-biome distributions and dynamics. Finally, we comment on the results in terms of the individualistic and organismic concepts in community ecology.

Keywords: fynbos, Cape flora, refugia, ecology, theory
The RAIN project and first results from Eilandvlei and Verlorenvlei

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As part of the SPACES programme, funded by the German Federal Ministry of Education and Research (BMBF), the RAIN (Regional Archives for Integrated Investigations) project focuses on closely integrated investigations of both terrestrial and marine environmental archives in South Africa in order to assess past climate and ecosystem change. RAIN aims to enhance the knowledge of land-ocean interactions following transport pathways from source to sink. Previous studies have shown that combined multi-proxy analyses from different environmental systems can contribute significantly to an improved understanding of climate dynamics in southern Africa. Thus, RAIN integrates palaeo-information obtained from paired terrestrial and marine archives in climatically contrasting areas, i.e., the three major rainfall zones of South Africa. A great potential for decoding climate dynamics in southern Africa lies in the connection and comparison of data from its western and eastern boundaries. The RAIN project follows this approach by selecting sites along a W-E transect and applying identical, state-of-the-art methods to all archives.

For this contribution we focus on lacustrine sediments from the year-round rainfall zone (YRZ) and winter rainfall zone (WRZ), where field campaigns were carried out in each zone to recover sediment cores for analysis.

The first campaign, in October 2013, targeted several coastal lakes in the Wilderness Embayment, situated on the southern cape Coast within the YRZ. The second campaign took place up the west coast in May 2014 and focussed on Verlorenvlei, a lake in the WRZ close to the coast of the Atlantic Ocean.

At Wilderness a 30.5 m long sediment core from Eilandvlei was recovered. Radiocarbon dating reveals a basal age of about 10,300 cal BP indicating an average sedimentation rate of about 3 mm.a⁻¹. Up to now, this ultra-high-resolution record of environmental change during the Holocene represents a unique discovery for southern Africa. Using initial Ca and Sr XRF-scanning data from this core, different phases of deposition can be reconstructed. While high Ca and Sr values can be linked to phases of enhanced deposition of marine sediments, low Ca and Sr values are indicative for periods of reduced marine but dominant terrestrial sediment input. This is supported by initial ostracod and foraminifera investigations on core catcher samples. Further hydro-acoustic investigations reveal a sediment thickness of ~100 m which would markedly extend the record further back in time.

At Verlorenvlei, in the WRZ, paired parallel sediment cores (16 and 10 m) were recovered from two different locations within the lake. The lowermost 2 m of each core consists of sand, possibly a fossil beach. An initial radiocarbon result from a piece of wood at 13.5 m sediment depth in the longer core reveals an age of 8,890 ±50/−140 cal BP indicating that, similar to Eilandvlei, this record encompasses almost the entire Holocene. This closes a gap which remained from previous studies in this area and extends the existing data from wetland investigations around the lake by more than 2000 years. 102.4 ± 0.3 pMC measured in a recent water plant and 101.8 ± 0.3 pMC in a sediment surface sample shows the absence of a modern reservoir effect.

Keywords: RAIN, rainfall zones, Eilandvlei, Verlorenvlei, palaeoenvironmental reconstruction
A 4.2 ka palaeosalinity record derived from lacustrine sediments from Groenvlei, Wilderness Embayment, South Africa

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Within the framework of the RAIN project (Regional Archives for Integrated iNvestigations) which deals with interdisciplinary investigations of climate evolution in southern Africa, the coastal lake Groenvlei was investigated. The lake is located on the southern Cape coast within the year-round rainfall zone and is separated from the Indian Ocean by a 1.6 km wide dune cordon. Groenvlei is mainly fed by rainfall, runoff, and ground water and at present has no aboveground connection to the sea.

In order to reconstruct palaeoenvironmental changes around Groenvlei, a short sediment core (121 cm length) was recovered from the central part of the lake and investigated using geochemical (ICP-OES, XRF), mineralogical (XRD) and granulometric analyses. Moreover, micropalaeontological investigations, i.e., on distribution of ostracod and diatom associations were carried out.

The sediments consist mainly of carbonates and to a lesser degree of allochthonous dune material, especially quartz sand. Several sediment layers are characterized by the deposition of calcareous Chara fragments. Radiocarbon dating has revealed an age of 4,200 cal BP for the entire record with no age reversals, indicating a continuous sediment accumulation with an average rate of 0.3 mm.yr⁻¹. A semi-quantitative evaluation of the XRD measurements shows a marked change in the mineralogical composition. Prior to 2,000 cal BP sediments are dominated by aragonite and additionally by the presence of dolomite. Sediments deposited thereafter mainly consist of Mg-calcites. This is supported by similar shifts in the chemical composition shown by the Mg and Sr data. The ability of Sr to be incorporated in the crystal lattice is much higher for aragonite than for calcite. The high Mg concentrations in the lower core section are related to the diageneric formation of dolomite. Aragonite is the main calcium carbonate phase which is precipitated at high Mg concentrations and thus, high water salinity. In contrast, lower salinity probably led to the precipitation of calcite. Hence, the Groenvlei record enables the reconstruction of palaeosalinity and provides evidence for a distinct change from high to low lake water salinity at 2,000 cal BP.

Several possible causes of this change are apparent. Due to the lack of foraminifera in the entire record, an aboveground connection to the Indian Ocean via the nearby Swartvlei estuary during the covered time period seems unlikely. A lowering in the mean sea level and thus reduced subterranean saltwater intrusion is a possible explanation. Changes in climatic conditions might also be responsible for the shift in salinity. Prior to 2,000 cal BP drier conditions and hence, lower lake-levels would have resulted in increased lake water salinity. A rather rapid shift to moister conditions thereafter, also indicated by enhanced minerogenic input into the lake, could then have resulted in dilution of the high saline water. Since previous studies indicate a climatic change at 2,000 cal BP, the latter interpretation seems to be the most parsimonious.

Keywords: palaeolimnology, lake sediments, geochemistry, salinity reconstruction, southern Cape coast
Hydrological development of the Eilandvlei system, southern Cape coast, South Africa during the Holocene

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The Wilderness embayment on the southern Cape coast of South Africa lies in the year-round rainfall zone and experiences climatic phenomena associated with the polar westerlies and the tropical easterlies. Bounded by the Outeniqua Mountains in the north and the Indian Ocean in the south, the embayment contains several coastal lakes lying in an east-west orientation. Eilandvlei, the most westerly lake in the complex, currently receives freshwater from the Duiwe River as well as groundwater throughflow, local surface runoff, and direct precipitation, while backflow along the Serpentine Channel brings in brackish and marine waters. The retrieval of sediment cores along a northwest-southeast transect has provided long, continuous records for a high-resolution study into the development of the system during the Holocene epoch. The combination of the records presents a complimentary account of environmental conditions and climatic fluctuations over the last ca. 10 000 cal yrs BP. Preliminary results of diatom analysis suggest the primary controlling mechanism for the system is salinity with strong and rapid biological responses to changes in source waters, revealing periods of marine inundation and dynamic water level fluctuations. However, anthropogenic forcing during the last few centuries has resulted in considerable modifications of the natural functioning of the lake system, altering dynamics and nutrient influx. The Wilderness lakes show great potential as natural geochronaries for Holocene environmental changes, and ongoing multi-proxy analyses on Eilandvlei, Swartvlei, Groenvlei, Rondevlei and Bo-Langvlei are expected to reveal further insights into the relative influences of climate variability, sea-level change and human impact.

Keywords: Holocene, diatoms, palaeolimnology, southern Cape, South Africa

A Holocene vegetation history from the southern Cape coast of South Africa: palynological and microcharcoal evidence from Eilandvlei

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The southern Cape falls within the Fynbos Biome, a global biodiversity hotspot, and encompasses rare Afrotropical forest patches and is therefore of great botanical importance. As this area includes the transition from southern Africa’s winter rainfall zone to the year-round rainfall zone, it is also important from a climatic perspective. The Wilderness embayment, located on the southern Cape coast, represents one of the key focus areas within the RAIN (Regional Archives for Integrated iNvestigations) project. RAIN aims to integrate palaeoenvironmental data from both terrestrial and marine archives in South Africa in order to assess past climate and ecosystem change. The field campaign in October 2013 yielded several sediment cores from the Wilderness lakes. Surpassing all expectations, the core that was recovered from Eilandvlei was 30.5 m in length. With a basal age of 10 300 cal yr BP, this core represents a uniquely high-resolution Holocene sequence for southern Africa.

Preliminary palynological and microcharcoal data from the Eilandvlei sediment core have been generated and are used to investigate vegetation dynamics including the different responses of particular vegetation types to Holocene environmental changes. Distinct shifts in the relative dominance of key fynbos, coastal thicket and Afrotropical forest indicator taxa are evident within the Eilandvlei record. These are likely a result of changing temperatures, rainfall amounts and seasonality, whereas the changes in the aquatic and riparian pollen percentages are linked to localised changes in the Eilandvlei system. The combination of microcharcoal and pollen analyses can reveal important insights into the relationship between fire regimes, vegetation changes...
and climate. Within the Eilandvlei record, significant peaks in microcharcoal concentrations, signifying increased fire frequencies and intensities, appear to be associated with reductions in forest and thicket percentages.

These data combined with ongoing multi-proxy analyses, provide important insights into the palaeoecology of lowland fynbos and the nature of Holocene environmental change on the southern Cape coast.

**Keywords:** pollen, microcharcoal, Holocene, southern Cape, palaeoenvironments

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A record of Holocene sea surface temperatures from archaeological shell middens along the southern coast of Africa

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Seasonality plays a critical role for shaping environments in southern Africa. Particularly, seasonal rainfall regimes are key in determining ecosystem patterning across the subcontinent. Unfortunately, the region has few highly resolved intra-annual records useful for investigating seasonality. Archaeological shell middens along the southern coast of Africa have enormous potential as archives of intra-annual sea surface temperature (SST) from the late Holocene to the Last Interglacial.

A central motivation for this study is to investigate the role of the wind belts in regional precipitation patterning. The south coast is affected by localised upwelling cells driven by easterly winds that occur predominantly in summer in association with the South Atlantic anticyclone. Cohen and Tyson (1995) proposed that, because the incidence of upwelling at key locations along the coast reflects these prevailing seasonal wind directions, upwelling frequency (reflected in intra-annual SST variation) is a proxy for the average position of the westerly wind belt. Models proposed to explain the influence of the Southern Hemisphere westerly wind belt for southern African climate suggest that their position is a key factor in long-term precipitation variation in the region. Thus seasonal SST variations may correspond with wet-dry conditions along the southern coast and in the southern African interior. A seasonal SST record, interbedded with the human cultural material, can also provide details of ancient human lifeways. Given that shellfish resource exploitation among hunter-gatherers may have had a seasonal dimension shaped by overarching systems of settlement and social organisation, it is valuable to know at which times of the year populations lived at the coast.

This paper reports the preliminary results of oxygen isotope analyses of micromilled opercula from Holocene aged sites along the south coast, including Nelson Bay Cave and Byneskranskop 1. We assess the comparable Holocene SST record of Cohen and Tyson, and discuss the implications of our findings for interpretations of atmospheric dynamics during the Holocene, and hence the relationship with southern African climate. We also consider this seasonal climate record in the light of regional and local technological changes observed in the archaeological sites across this period.

**Keywords:** SST, isotope palaeothermometry, Turbo sarmaticus, Holocene, south coast

**References**
Return rate estimates for inter-tidal foraging from experiments on the south coast of South Africa: implications for debates over the significance of early marine resource use

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The origins and significance of coastal foraging has gained increasing interest in discussions of modern human origins research. The south coast of South Africa has the oldest and best studied evidence for early use of coastal resources, and various researchers have argued that coastal resource use was significant for cognition (Broadhurst et al., 2002), social complexity, and the maintenance of population refugia (Marean, 2010). To date there has been little consensus, and even less empirical evidence, on the foraging returns for inter-tidal resources in this coastal environment. Here we present the first net return rate estimates for inter-tidal foraging in the varied south coast of South Africa. Foraging experiments were conducted with Khoe-San descendants in the area and hourly caloric net return rates were recorded over 30 low tides and through the seasons. Net return rates varied as a function of gender, tidal range, marine habitat types and condition of surf. The mean net return rate (kcal/hour) in some instances equals or exceeds that recorded for hunting of large mammals, and shows that under the right conditions the south coast provides an extraordinarily rich protein resource. Our results show that strategic coastal foraging along the south coast could have been a highly productive foraging strategy for emerging modern humans. We relate these results to recent analyses and discussions of Middle Stone Age coastal foraging.

Keywords: Coastal foraging, return rates, MSA

References:

Coastal foraging and marine foods as a source of brain-specific nutrients for Middle Stone Age hunter-gatherers along the Atlantic west coast

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Shellfish residues and other marine faunal remains recovered from Middle Stone Age (MSA) sites along the Atlantic west coast attest to the systematic exploitation of coastal foods in this region from at least the Last Interglacial (120 ka). Fragmentary fossil remains classified as anatomically modern, and material cultural remains consistent with complex social behaviour and cognition, have been recovered from the same archaeological contexts. The apparent link between the routine consumption of marine foods and emergence of modern Homo sapiens in southern Africa is tantalising, and warrants further investigation. Specifically, quantitative information on the nutrient content of marine and terrestrial foods available to prehistoric hunter-gatherers in the southwestern Cape is needed in order to better assess the importance and role of coastal foods in human evolution. The nutrient content of 123 samples from a range of marine and terrestrial animals and plants...
known or presumed to have been eaten by Middle Stone Age people in this region was measured by means of spectrophotometry and gas chromatography. As a result, several generalizations can be made about the distributions of essential nutrients in marine and terrestrial foods. Protein, as well as essential micronutrients including iron, copper and zinc, are abundant and widely available in the tissues of marine and terrestrial animals. Iridaceous plants represent the only significant source of energy in the form of carbohydrates available to prehistoric hunter-gatherers in the southwestern Cape. Lipid or fat and polyunsaturated fatty acids (PUFAs) are unevenly distributed in marine and terrestrial foods. In terrestrial vertebrate animals, longer-chain omega-3 eicosapentaeanoic and docosahexaenoic acid (EPA and DHA) are restricted to certain edible components, namely the livers and brains. These PUFAs are abundant in the edible tissues of marine mammals and birds, fish livers, and intertidal shellfish. The distribution of essential nutrients in marine and terrestrial foods would have had important implications for MSA hunter-gatherers in the southwestern Cape. When integrated into the existing ecological, anthropological and archaeological framework of this region, the results of this research provide a quantitative framework within which competing scenarios for settlement and subsistence strategies can be evaluated, and nutritional constraints identified. The simplest marine resources, namely intertidal mussels and limpets, are rich in brain-specific nutrients including iron, copper and zinc, and arachidonic, eicosapentaeanoic and docosahexaenoic acid; they also contain moderate amounts of protein, fat and energy. Episodic visits to the coast would have allowed MSA hunter-gatherers to exploit these abundant, predictable, accessible and reliable small nutrient packages, which would have been available all year round. Women, particularly when pregnant or lactating, and very young children, who have the highest requirement for brain-specific nutrients, would have benefited the most from the consumption of even small amounts of shellfish. The integration of marine resources into the diets of MSA people in the southwestern Cape represents a distinct nutritional advantage likely to have played an important role in the emergence of large-brained, anatomically modern humans.

Keywords: intertidal mussels and limpets, small nutrient packages, long-chain polyunsaturated fatty acids, anatomically modern humans

Palaeoenvironmental reconstruction based on carbon and oxygen stable isotope analysis of bovid tooth enamel from Elands Bay Cave, South Africa

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Stable carbon and oxygen isotopes of biogenic apatite from fossil fauna have become an important tool in palaeoenvironmental research. In the case of large herbivores, the δ13C values from enamel apatite reflect the proportions of C3 and C4 plants consumed. C3 plants include shrubs and trees as well as grasses suited to winter rainfall regimes, C4 plants are mainly grasses adapted to summer rainfall. Here we present δ13C and δ18O values of 98 samples of tooth enamel from both grazing and browsing bovids from the terminal Pleistocene and Holocene layers of Elands Bay Cave. The assemblage is dominated by steenbok (Raphicerus campestris) and grysbok (Raphicerus melanotis), which are known to feed on browse if available. However, the assemblage also includes large grazers. This study aims to determine whether the grasses they were eating were purely C3 or included a C4 component. The results suggest that during the terminal Pleistocene and early Holocene, vegetation communities were largely C3, implying that the rainfall regime was strongly dominated by winter rain. From the mid-Holocene onwards, grazers show more enriched δ13C indicating that C4 grasses became more common, likely as a result of a somewhat increased component of summer rainfall. The results presented here provide insight into vegetation history and climatic change along the West Coast of South Africa. The δ18O values from enamel carbonate reflect a complex combination of meteoric drinking water, diet and physiological processes, and vary quite widely within and between species. There is, however, a significant difference between δ18O values of grazers and browsers, with browsers having more positive δ18O. This pattern has been reported previously, although it is not universal. Browsers probably consumed leaves enriched in 18O as a result of evapotranspiration.

Keywords: stable isotopes, palaeoenvironmental reconstruction, biogenic apatite
Modelling coastal adaptations in the MSA of southern Africa

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The Middle Stone Age (MSA) of southern Africa provides the longest record of marine resource exploitation and coastal settlement by modern humans. These adaptations to coastal landscapes feature prominently in current studies of the biological and behavioural evolution of Homo sapiens. In particular, researchers have emphasized the role that the consumption of marine foods might have had on brain evolution and demography as well as the potential of coastal landscapes to promote dispersal of Homo sapiens out of Africa. Here we present results on coastal settlement systems from our excavations at the site of Hoedjiespunt 1 (HDP1), South Africa, and review recent advances in research on coastal adaptations. The aim of this contribution is to assess the nature and importance of these adaptations by systematically evaluating the current evidence from southern Africa. In this process, we intend to build the foundation for formal evolutionary models that are so far lacking. HDP1 dates to the last interglacial (MIS 5e) and consists of three phases of occupation. Our excavations demonstrate the simultaneous occurrence of flexible raw material use, anticipated long-distance transport of tool stone, systematic gathering of shellfish and use of ground ochre. The inhabitants executed scheduled movements to the coastline for exploiting shellfish during these brief, but repeated, settlements. The horizons at HDP1 reflect a consistent pattern of technology, shellfish collection and land-use that suggests stable adaptations of modern humans to coastal landscapes as early as MIS 5e. The findings from HDP1 complement other recent research on coastal sites in the MSA of South Africa. The archaeological record provides evidence for coastal adaptations on the southern Cape of Africa as far back as the late Middle Pleistocene (MIS 6). Studies from the western and southern coasts of South Africa demonstrate that coastlines provided important resources for occupations between MIS 6 and 4. These coastlines, however, represent diverse geographic, oceanographic and environmental settings. While these dissimilarities explain some of the observed differences, the available data suggest that early modern humans exploited marine resources in a comparable manner. Mobile hunters and gatherers frequently integrated variable coastal landscapes and their resources into their settlement strategies during the MSA across more than 100 ka.

The long-lasting and consistent nature of these behaviours is a crucial part of models that see coastal adaptations influencing the bio-cultural evolution of modern humans. The lack of comparable adaptations before MIS 6 is consistent with such a scenario. While marked increases in brain size occurred earlier in human evolution, the incorporation of coastal resources in the diet provided new, easily accessible and often non-seasonal food resources with particularly high amounts of brain-specific nutrients, sustaining large brains and high cognitive functions. Although the quantities in the diet were low during the MSA, marine foods could have buffered against shortages in terrestrial resources and thus reduced mortality in populations. Our results and theoretical insights can serve as a point of reference to formulate better models of coastal adaptations and their evolutionary impact.

Keywords: Middle Stone Age, coastal adaptations, marine resources, human evolution, settlement dynamics
Middle and Late Stone Age of the Niassa Region, Northern Mozambique. Preliminary results

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Located between modern-day South Africa and Tanzania, both of which have well-known and extensive Stone Age records, Mozambique and its Stone Age sequence remain largely unknown in the broader context of African Pleistocene prehistory. This is in spite of the country’s critical position linking southern and eastern Africa, and of its clear potential to inform various models about recent human evolution. Specifically, the geography of Mozambique makes its sea coast a natural area of interest to evaluate recent scenarios about the importance of coastal adaptations to the success and diffusion of Homo sapiens outside of southern Africa. Here, we present the results of field survey in the Niassa lake region. Two main contexts were surveyed: river valleys running to the Niassa (Malawi) lake and limestone bedrock exposure where Middle and Late Stone Age sites and deposits were found during 2014, including dozens of surface sites as well as a few in situ localities in rockshelters with both lithic artefacts and well preserved faunal remains.

Keywords: Mozambique, Middle Stone Age, Late Stone Age

Holocene vegetation and climate variability between winter and summer rainfall zones of South Africa

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To better understand Holocene vegetation and hydrological changes of South Africa, we analyzed pollen and microcharcoal of marine sediment core GeoB8331-4 from the inner continental-shelf south of the Orange River mouth covering the last 9800 years. Most pollen is from the Orange River catchment area, which lies largely in the summer rainfall zone (SRZ). Pollen from the Cape region in the winter rainfall zone (WRZ) is continuously delivered by the southeast trade winds. During the early Holocene (prior to 8900 cal. yr BP), the presence of Renosterbos vegetation indicates a relatively northward extension of the WRZ. Pollen from the Cape region in the winter rainfall zone (WRZ) is continuously delivered by the southeast trade winds. During the early Holocene (prior to 8900 cal. yr BP), the presence of Renosterbos vegetation indicates a relatively northward extension of the WRZ. A percentage minimum of grass pollen suggests low summer rainfall in the SRZ. Towards the mid-Holocene (8900-3100 cal. yr BP), Renosterbos vegetation decreases indicating a southward retraction of the WRZ. At the same time, a rather moist savanna rich in grasses implies increased summer rainfall in the SRZ, suggesting a southward shift of the SRZ. Effects of human activities such as overgrazing are apparent during approximately the last 300 years. Based on the different pollen sources from the SRZ and WRZ respectively, contrasting climate developments are evident in the SRZ and WRZ during the last 9800 years. For the SRZ, the records suggest relatively arid conditions during the early Holocene. The climate in the SRZ gradually became more humid towards the mid-Holocene resulting from increased austral summer insolation. The opposite trend was found in the WRZ. The early Holocene humid conditions in the WRZ may be attributed to an equatorward shift of the southern westerlies.

Keywords: pollen, vegetation change, climate variability, Holocene, South Africa
Early Holocene charcoals from Stratum 4d of Wonderwerk Cave, Northern Cape

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Wonderwerk Cave in the Northern Cape Province of South Africa has a record of occupation spanning some 2 million years comprising flora, fauna and cultural artefacts, and therefore has the most complete macrobotanical record associated with hominin/human activities in southern Africa. Here the charcoals from Stratum 4d of excavation 1, (dated about 12 200 – 8 600 years ago) are identified and a preliminary vegetation reconstruction has been done. As there are thousands of pieces of charcoal a selection of them has been taken and studied. Some pieces were not identifiable. Although the number of pieces assigned to each taxon cannot be taken as a direct measure of abundance because charcoal fragment distribution can assist in interpreting abundance. Some of the taxa identified are Searsia lancea (Anacardiaceae); Commiphora cf. schimperi. (Burseraceae); Strychnos sp. (Loganiaceae) and Dombeya rotundifolia (Sterculioideae, Malvaceae). Assuming that the firewood was of local origin, the climate during the latest Pleistocene would have been slightly more mesic than today’s arid to semi-arid climate.

Keywords: charcoal, Holocene

Evidence of vegetation change in Late Quaternary deposits of the Namib Desert and boundary region

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A review of palynological sequences from various deposits provides evidence for plant cover and patterns of past vegetation change in Namibia for the late Quaternary despite the scarcity of suitable deposits, complexity of environmental factors, diverse settings and spatially and temporally scattered nature of data. In this dry region fossil hyrax dung deposits had the most potential. The oldest pollen from the Brandberg (Damaraland) of between 49-39 ka, suggests relatively warm dry conditions with a tree-rich pollen assemblage of Rhus, Dombeya, Combretaceae, Euclea in a grassy vegetation that included succulent Aizoaceae. A marked difference is seen in pollen composition at ca. 43 ka and ca. 21 ka with prominent Asteraceae pollen of the Pentzia, Stoebe and Artemisia types, and Passerera, grass and Olea pollen, suggesting cool conditions with available moisture probably coming in winter from the west coast. At Mirabib (central Namibia, almost 200 km south of Brandberg), increased Stoebe type also occurred ca. 43 ka but the assemblage differs by a stronger presence of grass pollen indicating relatively wet conditions in this part of the desert. The transition from OIS 2-1 is not recorded in Namibia but the period between ca. 10 and 8 ka at Blasskranz and Mirabib (central Namib) had high proportions of grass pollen suggesting relatively moist conditions with some Stoebe type and occasional tree pollen, showing a slight offset with spring and bat guano data from Windhoek (ca. 8-7.6 ka). Generally lower grass pollen ratios at Blasskranz ca. 7.4-7.2 ka, less than at Mirabib, indicates dryness. To the north along the Huab River (Damaraland) at ca. 7 ka, prominent Commiphora occurred corresponding with a similar development at Blasskranz but not at Mirabib.
Between about 7 and 6.5 ka different Asteraceae and Acanthaceae types alternated at Blasskranz with less grass pollen suggesting dry conditions. By 6.4 -5.2 ka grassy conditions occurred here with increasing arboreal pollen of Salvadora, Mimosoideae and Searsia, and later Combretaceae, representing a major change in the Blasskranz sequence after 5.5 ka to an environment of summer-rain seasonality and C4 photosynthesis. This was followed by a short decline in grass pollen indicating a relatively dry phase (ca. 5-4.3 ka). Grass pollen numbers recovered during the subsequent phase but Combretaceae declined gradually in favour of Grewia, Commiphora and Capparaceae ca. 2 ka. At Blasskranz, microscopic charcoal peak at times when savanna is prominent. Burning seems to be controlled by interplay between fuel cover, seasonality and moisture availability. To the north ca. 6-1 ka, at Huab River and further to Orupembe in Kaokoland, grassy vegetation occurred corresponding in part with the Otjikoto Lake and Blasskranz records to the east and south respectively. Different patterns at Blasskranz and the nearby Kuiseb River over the last 2 ka may be related to the proximity of the latter to the coast. After 1 ka mopane woodland developed at the northern sites with a parallel dry fluctuation without mopane at Blasskranz and the Kuiseb River.

Keywords: hyrax dung, pollen, Namibia, seasonality, grassland
Aridity during the mid- to late Holocene and the Last Glacial Maximum, when austral summer insolation was at its maximum. These results are, however, consistent with a range of proxies for Benguela upwelling, and the hypothesis that increased upwelling will reduce tropical moisture flow into the region, and result in drier conditions. With other terrestrial records from the region, these results confirm the importance of the Benguela system as a driver of southwest African climate change, and underline the need to consider the potential impact of taphonomic issues such as changes in source area and the secondary deposition of sediment when interpreting marine records.

**Keywords:** pollen fossil, microcharcoal, hyrax midden, Namib Desert, vegetation history

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**Human occupation in southern Namibia during the Late Pleistocene – a geoarchaeological approach**

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Southern Namibia holds a rich Late Pleistocene archaeological record, known from research along the escarpment as well as within the coastal mining sperrgebiet. The area, situated between the Orange River and Namib Sand Sea, between the Atlantic coast and the Huib Plateau, comprises a diverse set of geological and geomorphological features. Although little is known about the impact of Pleistocene global climatic developments on this region, it probably provided an arid, but relatively stable environment for Pleistocene occupants. Recent archaeological investigations at the archaeological site of Apollo 11, however, indicate that the local settlement history took place in a discontinuous manner during the Late Pleistocene. Given the still scarce data on regional palaeo-climate/environment as well as almost absence of geoarchaeological on-site investigations, the observations allow for the formulation three (not necessarily mutually exclusive) hypotheses for the discontinuous occupation pattern: a) the pattern reflects demographic changes related to environmental changes; b) it is caused by geogenic site formation processes; c) it is related to culturally/socially embedded changes in land-use systems.

A project recently funded at the University of Cologne intends to investigate these preliminary observations on a regional scale. The project focuses on the interdisciplinary study of a Late Pleistocene archaeological sequence in the vicinity of Apollo 11. By gaining information on site-formation processes, the environmental context as well as chrono-cultural developments, results will contribute to test the above mentioned hypotheses. Here, we present the first general results of our interdisciplinary geoarchaeological study of the southern Namibian Pleistocene landscape, using geostatistical methods to explore and investigate available spatiotemporal data. Incentives are planned to better understand and identify cultural/behavioural and environmental variables leading to the success or failure of Late Pleistocene populations in this region.

**Keywords:** Namibia, Late Pleistocene, geoarchaeology, landscape, human settlement
High-resolution pollen and charcoal records from three montane wetlands in the Cathedral Peak area, KwaZulu-Natal Drakensberg

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The uKhahlamba Drakensberg Mountains in KwaZulu-Natal are internationally recognised as an area of outstanding natural and cultural heritage value, in addition to providing important ecosystem services. The Cathedral Peak area has been the focus of historical catchment monitoring and burning trials since the early 1920s. The area is also host to a number of undisturbed high-altitude wetlands which show potential for palaeoecological analysis. The Cathedral Peak through its historical monitoring over the past century is an ideal site for environmental change research due to the potential for comparison of historical and palaeoecological data. Short sediment cores were extracted from three wetland sites at altitudes of 1500 m (Elands Vlei), 1700 m (Brotherton) and 1900 m (Catchment VI). High-resolution pollen and charcoal analysis were combined with Accelerator Mass Spectrometry (AMS) dating for chronological control. This provides a vegetation and fire history reconstruction for the Cathedral Peak area. AMS ages indicate basal ages of Elands Vlei at 240 ± 30 cal yr BP, Brotherton at 2710 ± 30 cal yr BP and Catchment VI at 760 ± 30 cal yr BP was determined for each at 27cm except Elands Vlei at 25cm, thus covering relatively recent past. This research can effectively contribute to improving our understanding of vegetation and fire management in this important catchment area.

Keywords: Afromontane, pollen, charcoal, vegetation, fire

Comparing the large mammal fossil record and the archaeological record during the mid to late Quaternary in southern Africa

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The mammalian fossil record in southern Africa reflects a long-term trend towards drier climates. It is a trend that is generally shared with East Africa and is reflected in the number of arid and semi-arid adapted taxa shared between the two subregions, both in the past and in the present. However, this biogeographic connection appears to have become diminished to some extent towards the end-Early Pleistocene, when in the south the appearance of wetlands on a sub-regional scale contributes to a distinctive faunal character. In faunal terms this time is known as the Florisian Land Mammal Age and it spans between c. 0.6 Ma and the beginning of the Holocene. The trend towards wetter conditions on a sub-regional scale is a deviation from the longer-term trend towards aridity. The wetland faunal signal extended across modern biome boundaries and intersected the open habitat of the central interior and surrounding savannah areas, but excluded the Cape montane and coastal areas. In this contribution the coincidence of major changes in the large mammal fossil record and the archaeological record in southern Africa is explored.

Keywords: large mammal evolution, southern endemism, wetlands, archaeological record

References


An OSL chronology for Stone Age archaeological sites in the upper Zambezi valley

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Theories concerning the distribution of early people in the landscape place great importance on the temporal dynamics of water availability, and may be particularly relevant in the Kalahari basin where water resources are highly variable during the late Quaternary. That this basin was, at times, a key resource for Stone Age populations is evident from the extensive occurrence of stone tools, most notably in association with the fluvial networks and lake sumps of the Zambezi-Okavango system. Today, these riparian corridors link the semi-arid desert region to the southern sub-tropics and, in the past, drove environmental change in the Kalahari, potentially impacting the occupation and dispersal of hominins within the interior southern African basin. Here we report new ages on previously undated Stone Age archaeological assemblages along the upper Zambezi valley and examine the broader relevance of these sites within the context of palaeoenvironmental change.

Keywords: Stone-age archaeology, Zambezi, Holocene, Kalahari basin

The evolutionary pressure of glacial aridification and the use of pollen-ovule ratio as a predictive proxy of pollen transfer efficiency (PTE) in Periplocoideae (Apocynaceae)

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The influence of climate change on the evolution of pollination mechanisms and floral morphology is poorly understood, even though angiosperm pollination and reproductive success is strongly influenced by extrinsic factors such as climate, habitat integrity and pollinator activity. In southern Africa the Periplocoideae (Apocynaceae) is represented by seven genera namely; Cryptolepis R.Br, Ectadium E.Mey, Mondia Skeels, Petopentia Bullock, Raphionacme Harv., Stomatostemma N.E.Br. and Tacazzea Decne. Periplocoideae are characterized by pollen aggregated in tetrads which are shed onto sticky spoon-shaped translators at anthesis. Pollen aggregation in the Apocynaceae has been shown to cause elevated pollen transfer efficiency (PTE) and as a result, reduced pollen production and low pollen-ovule ratios. It is therefore postulated that low pollen-ovule ratio is associated with pollen aggregation and can be used as a measure to test the relationship between PTE and pollen aggregation. Livshultz et al. (2011) propose that the various degrees of pollen aggregation in the Apocynaceae developed in reaction to aridification during glacial periods of the Tertiary, which resulted in a pronounced pollinator allee effect. This suggests that all Periplocoideae genera, which have the same degree of pollen aggregation, should have similar PTE’s and consequently similar pollen-ovule ratios. We determined the pollen-ovule ratios of representatives of all seven southern African Periplocoideae genera and mapped these onto the Periplocoideae phylogeny modified from Ionta & Judd (2007) and Joubert et al. (in prep). We show that there is much variation in pollen-ovule ratio among the seven Periplocoideae genera and therefore postulate significant differences in the PTE of the seven genera. We investigate differences in floral structure and habitat of the seven genera as possible causes of this variation in PTE. Understanding how pollen-ovule ratios changed during the evolution of Periplocoideae, in reaction to changing environments, provide a basis for predicting plant evolutionary trends in reaction to anthropogenic climatic change.

Keywords: Apocynaceae, Periplocoideae, pollen-ovule ratio, pollen transfer efficiency (PTE), pollen aggregation

References


Holocene marine radiocarbon reservoir correction delta R for the west coast of South Africa

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In order to calibrate radiocarbon ages based on samples with a marine carbon component it is important to know the marine carbon reservoir correction or ΔR value. This study measured the ΔR on both known-age pre bomb marine shells and paired marine and terrestrial samples from two regions on the west coast of South Africa: the southwestern Cape and Namaqualand. Pooling the data by region produces ΔR values that are similar enough to use a west coast weighted mean ΔR of 146 ± 85 14C years to correctly calibrate marine shell or mixed marine and terrestrial 14C ages. There are however temporal differences in ΔR throughout the Holocene, which we compare with proxy data for upwelling and sea surface temperatures.

Keywords: marine reservoir effect, radiocarbon dates, southern Africa, west coast

A new late Holocene pollen record from Eilandvlei, South Africa

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It is a well-known fact that the South African palaeoenvironmental record is fairly limited, mainly due to the fact that environmental conditions do not favour the preservation of proxy data sources. This being said, new evidence is emerging from the Wilderness Embayment along the Southern Cape coast of South Africa. This area is of particular interest from a palaeoclimatic perspective due to its location within the year round rainfall zone of South Africa, while the presence of both Fynbos and Afrotemperate forest within this region further highlights the importance of studies in the area. This study presents a new late Holocene pollen and charcoal record from Eilandvlei, extending from ca. 3 800 cal yr BP to the present. The sequence is dominated by fynbos, most notably Ericaceae and Restionaceae, with the single largest contributor to the assemblage being the succulent/drought resistant element ChenoAm-type. Significantly increased levels of ChenoAm-type is evident for the period ca. 3200 cal yr BP to ca. 2600 cal yr BP indicating a major marine event in the area. The record further encompasses the arrival of European colonists in the region ca. 1800 AD, marked by the appearance of Pinus, with subsequent notable fluctuations in other taxa, e.g. Podocarpus and Stoebe-type, possibly the expression of the anthropogenic effect on the landscape. This high resolution record thus highlights significant, albeit short term, fluctuations in climate and vegetation patterns along the southern coast of South Africa and adds to the inadequate records available for the region thus far.

Keywords: late Holocene, palynology, Southern Cape, Wilderness
Relevant source area of pollen spectra in Cathedral Peak, KwaZulu-Natal Drakensberg, South Africa

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The KwaZulu-Natal Drakensberg is internationally recognised as a region of universal significance because of its superlative natural beauty, cultural history, and aesthetic value, its wealth of biological diversity, its diverse arrangement of natural wetlands and other sensitive ecosystems, and its exceptional quality of preservation of palaeoecological material. Specifically, the Cathedral Peak area of the Drakensberg has remarkably diverse topography and steep altitudinal gradients that exists over a relatively short spatial area, which have consequently resulted in a topographically complex and ecologically diverse and unique landscape. The Drakensberg therefore serves as an incredibly rich palaeoecological data source. Consequently, Cathedral Peak is a region conducive to palaeo-related studies, and where much palynological enquiry has been conducted. In any given site containing pollen rich sediments, it is important to consider the sources of that pollen, and the means by which it arrived at the site of its preservation. Only by doing this, can one better interpret the pollen assemblage in terms of past vegetation. Simple models of pollen dispersal and deposition have been developed and shown to capture the broad patterns of pollen deposition in relation to vegetation by validation against empirical data from modern pollen studies. Yet, almost no work has been done in South Africa on the subject of pollen dispersal and deposition. Models of pollen dispersal and deposition therefore have great potential for palaeoecological application in a South African context, where we can use them to improve and develop our understanding of contemporary pollen-vegetation relationships with the aim of establishing a robust foundation for improving our interpretation of long-term palaeoecological records. Understanding the characteristics of pollen dispersal and deposition of different taxa is crucial to accurately reconstructing past landscapes using fossil pollen data, with the intention of better improving our ability to project and understand future environmental change.

Keywords: Drakensberg, palynology, modelling, vegetation

Spatial patterns of modern diatom distribution in the Eilandvlei Catchment, Wilderness, South Africa

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Diatom species compositions are often distributed along environmental gradients and are influenced by a number of environmental parameters. The spatial patterns of modern diatoms can be combined with palaeolimnology to provide a powerful means to assess ecological change in coastal lake systems on multiple time scales. The modern distribution of diatom assemblages in surficial sediments in the Eilandvlei catchment was studied in order to ascertain spatial patterns and explore the main environmental parameters responsible for community structure. Canonical correspondence analysis revealed that among four measured environmental variables; salinity and conductivity accounted for most of the variance in the diatom data. The species composition of the catchment was found to be dominated by brackish species. In general, the brackish species’ Cocconeis placentula, Amphora coffeaeformis and Planothidium delicatulum were prevalent among all sites in the catchment, indicating the brackish nature of the system. Geographic Information System techniques were used in the analysis of the distribution of diatom species. Diatoms were classed by salinity preferences into brackish, fresh and marine taxa and their spatial distribution was analysed relative to water temperature and salinity distributions. The community pattern gave an accurate representation of ecological conditions of the sampling sites, displaying salinity and temperature gradients through the catchment. Brackish species were most abundant through the estuary while marine species were concentrated through sections of Eilandvlei and Rondevlei. Freshwater species were found at low
abundances through the system. The distribution of the three classes of diatoms suggests that this assemblage is structured by salinity. This distribution of modern diatoms can provide useful analogues to interpret palaeoenvironmental reconstructions in the region in the future.

Keywords: benthic diatoms, modern distribution, South Africa, salinity gradient

Diatom-based reconstruction of salinity in Lake St. Lucia, South Africa: A Holocene climate history

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Coastal water bodies on the east coast of South Africa contain sedimentary deposits that provide potential archives of long-term, high-resolution climate change. Lake St. Lucia, on the north coast of KwaZulu-Natal, is the largest coastal lagoon system in South Africa and has international recognition as a UNESCO World Heritage Site. The St. Lucia system evolved from fluvial origins and today is underlain by an intricate network of buried river channels that reflect almost continual deposition since the start of the Holocene. Recorded data for the last 50 years show that St. Lucia has been subject to extreme salinity fluctuations driven by drought and flood events. Hence, the environmental sensitivity of St. Lucia to climate-driven water balances makes it an ideal site to investigate changes in salinity associated with palaeoclimate variability. Two 15.9 m cores have been extracted from the Lake St. Lucia in order to provide a detailed account of the hydrological cycle during the Holocene. One core was obtained from False Bay and the other from North Lake and provided a basal age of ca. 8300 cal yrs BP and ca. 7000 cal yrs BP respectively. The main focus of this study is to present a high-resolution reconstruction of the salinity history of Lake St. Lucia using diatoms, in order to understand the hydrological evolution of this system. Findings from this research will contribute to a larger multiproxy study that aims to provide a more detailed understanding of the characteristics and timing of palaeoenvironmental change in the summer rainfall zone of South Africa.

Keywords: Lake St. Lucia, palaeoclimate, Holocene, summer rainfall region

Late Pleistocene figurative art mobilier From Apollo II Cave, southern Namibia

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Southern Africa has long featured as a significant source of information concerning the cultural, technological and cognitive evolution of Homo sapiens. Of the indications of cognitive complexity that become prevalent during the Middle Stone Age, abstract and figurative art present explicit evidence for modern and symbolic human behavioural capacity. The only examples of figurative art securely dated to the African Late Pleistocene comprise seven stone plaques from Apollo II Cave in southern Namibia. These were recovered by W. Erich Wendt in 1969 and 1972 from levels dated by 14C and OSL methods to c. 30 000 years. Photographs of the plaques were originally published in full colour in 1974 and subsequently in greyscale in 1976. Given the cultural and evolutionary significance of these artefacts, we provide insight into the imagery on the plaques by way of high resolution colour photography and digital 3D modelling.

Keywords: Middle Stone Age; Namibia; Apollo II; Art mobilier; Digital photography
Using stable isotopes and dental microwear to investigate the utility of rock hyraxes as palaeoenvironmental proxies

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Rock hyraxes (Procavia capensis) are a common component of faunal assemblages at South African archaeological sites. Previous studies of their remains have focused on elucidating aspects of diet, settlement, and mobility in prehistoric human populations. In recent years, hyraxes have also been recognized as valuable palaeoenvironmental indicators due to the fact that their stratified communal middens record pollen profiles and isotopic shifts which reflect environmental conditions at the time of deposition.

This study focuses on the degree to which carbon and nitrogen isotopes and dental microwear reflect the environment and diet of rock hyraxes. Carbon isotope ratios can reflect the relative contribution of C3 and C4 taxa in diet. There is a lack of consensus as to whether hyraxes are preferential grazers or browsers, and this research aims to resolve this discord by quantifying the carbon isotopic ratios in rock hyrax bone collagen collected across vegetation biomes of South Africa to reconstruct diet directly. Grazing and browsing leave different short-term microscopic wear patterns on teeth. Grass consumption causes scratches on the enamel surface, whereas eating shrubs, trees, and bushes leads to pitting. Here dental microwear is used to distinguish grazers from browsers in C3 regions, where both grasses and shrubs yield depleted δ13C values. It is believed that rock hyraxes may graze more at certain times of the year, and variability in the wear patterns may lend credence to this hypothesis. It has been found that nitrogen in mammals can indicate the relative aridity of environments as they recycle urea in their gut during water stress, resulting in low urine output and therefore enriched δ15N values of body tissues. Hyraxes, being especially adapted to arid environments, show unusually enriched δ15N values compared to other species. The sample analysed in this study includes individuals from a range of rainfall gradients, allowing the relative importance of environmental and metabolic determinants of δ15N to be observed.

Preliminary carbon isotope results support preferential browsing in rock hyraxes, with mean δ13Ccollagen values of -20.3 +/- 1.8‰, indicating a C3 contribution of ~70 ± 12.9% (n=214). A pilot study of rock hyrax dental microwear indicates the presence of both scratches and pits on the enamel surface, suggesting that they consume both graze and browse. However, the life-time average obtained from δ13C values shows that grazing is likely periodic. Preferential browsing introduces limitations to the degree to which one can use rock hyrax remains to interpret past shifts in the winter, summer, and year-round rainfall zones. Thus far, δ15Ncollagen results indicate that despite broad variation between individuals from relatively wetter and drier environments, these values are not controlled by moisture availability alone. The lack of any significant relationship between δ15Ncollagen values and rainfall suggests that further investigation into the primary determinants of δ15N values is required before firm conclusions can be made.

Keywords: rock hyraxes, stable isotopes, dental microwear, palaeoenvironments, nitrogen metabolism

Mineralogical and geochemical investigation of Middle Stone Age soils at the Blombos Cave in South Africa

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Archaeological soils play a pivotal role in the location of sites and identification of activity areas. However, visual observation provides minimum information regarding the processes involved in the formation of the soil
features, thus limiting site interpretation. In this paper, the results from the multielement, physicochemical and mineralogical analyses of selected archaeological soils from the Middle Stone Age (MSA) layers of the Blombos Cave are presented. The soils were investigated using Inductively Coupled Optical Emission Spectrometry/Mass Spectrometry (ICP-OES/MS) and Fourier Transform Infra Red Spectroscopy. The physicochemical characterisation of the soils was achieved by measuring total organic carbon (TOC), pH, and electrical conductivity. Mineralogical analyses of the soils using FTIR reveal the occurrence of calcite and aragonite minerals. The calcite can be classified in terms of origin as geogenic and pyrogenic/anthropogenic. Aragonite was attributed to the shellfish material. Multielement analysis revealed elevated levels of Fe, K, S, Mg and P, Mg, Ba and Zn in some soils. This provides a possible indication of ochre use and processing, burning of plant and animal material.

**Keywords:** soil features, multi-element, mineralogy, archaeology

**Water accessibility in historically low income areas of Zambia**

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Zambia has a good climate and favourable rainfall pattern; this provides sufficient recharge for the surface and ground water resources. In spite of the sufficient surface and ground water resources, accessibility to water at household level is problematic both in quantity and quality.

The study examined water accessibility as well as water quality at the household level. The research looked at water sources for households and considered the complications of accessibility to water and the available opportunities therein. The investigation involved 50 households and the data were collected by the use of questionnaires (to assess accessibility) and laboratory tests (for ascertaining water quality). In addition to this, government departments such as the health, agriculture, forestry and education as well as the municipal council were interviewed on the topic under study. The study was descriptive in nature where clustered sampling procedures using simple random methods were utilised to select the households which were to participate in the study.

The key findings were that; accessibility to water household levels is still a challenge in the settlement as most of the point sources (shallow wells, the stream and the river) were found to be contaminated. In addition to this, it was found that there was no direct relationship between the economic performance of a household and accessibility to water. The study also observed that there were opportunities among the people in the settlement as they were increasingly entering the education system and adult literacy was being encouraged in the settlement. Furthermore, the settlement has groundwater resources which indicate that there can be sufficient water provision for the residents.

**Keywords:** accessibility, household, water

**A Holocene sedimentary charcoal record from Lake St Lucia, KwaZulu-Natal, South Africa**

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Lake St Lucia is an estuarine lake located on the Maputaland Coastal Plain within the extensive Maputaland-Pondoland-Albany biodiversity hotspot. This region is recognised for its diverse flora and flora, including two endemic vegetation types, Maputaland Sand Forest and Maputaland Woody Grassland. An overall biome shift, from open savannah to closed thicket is suggested for the region and thought to be the result of increased atmospheric CO2. This interpretation is, however, limited by short time series. Sedimentary sequences from Lake St Lucia have the capacity to increase the timescale over which environmental changes can be examined through the analysis of fossil charcoal and pollen records. A 15.6 m sediment core from North Lake, St Lucia was extracted using a piston corer. Accelerator Mass Spectrometry (AMS) dating suggests a basal age of 7631 ± 47 cal BP and continuous sedimentation rates throughout the
mid to late Holocene. Grain size and loss-on-ignition (LOI) were performed to characterize core sediments. Sedimentary charcoal was analysed to reconstruct a regional signal of fire frequency and intensity. CHAR (particles/cm/yr) peaks at c. 6 kyr which may suggest higher fire activity during the warm, moist Holocene Altithermal, perhaps related to increased availability of fuel load. CHAR remains fairly consistent over the past c. 5 kyr suggesting little disturbance to fire regimes during this time. Increased CHAR over the past c. 2 kyr may be linked to the Iron Age human colonisation of the region. Increasingly active fire management in the recent past may curb the savannah-thicket transition in the region. Integration of the long time series provided by this study is therefore essential to guide conservation initiatives in the region and to provide baseline understanding of long-term fire regimes.

Keywords: sedimentary charcoal, Maputaland, Holocene, fire-vegetation dynamics

“An enchanted garden”; the flora of Great Zimbabwe

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In 1891, Mrs Theodore Bent described Great Zimbabwe as “an enchanted garden”. She and her husband, and many subsequent visitors, recorded their impressions of the site in words and photographs. Within these recordings of the impressive stone-walled site, aspects of the surrounding vegetation are included. Through a close visual analysis of these documents, we track the changing face of vegetation at Great Zimbabwe, from its lush overgrown late nineteenth-century state to a more sparsely vegetated contemporary setting. We examine aerial and satellite imagery and photographs taken by various explorers, researchers and tourists, including the extensive legacy of the Frobenius expedition between 1928 and 1930. Through a method known as repeat photography, widely used in geography, but to our knowledge, not yet applied to archaeology in southern Africa, we also recreate particular views to reveal how the vegetation has changed. Building on previous studies that establish the importance of trees for ritual and other purposes and the effects of vegetation growth on the preservation of the walling at Great Zimbabwe, we examine the vegetation as an integral part of the landscape, visually and culturally. For example, the two large Mimusops zeyheri (Red Milkwood/Mucheche) trees on either side of the conical tower took on new symbolic meaning in 1987 when their boughs linked above the conical tower; this joining together is said to symbolise the unity between the Zimbabwean political parties ZANU and ZAPU. Through our work we have also created a geo-referenced digital archive of photographs of Great Zimbabwe.

Keywords: Great Zimbabwe, vegetation, repeat photography

Changing distribution of the elephant genera Loxodonta and Elephas throughout the African Pleistocene: implications for palaeoenvironmental variability

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Three elephantid genera inhabited Africa at the onset of the Pleistocene: Loxodonta, Elephas and Mammutthus. Mammutthus went extinct by the end of the early Pleistocene; however Loxodonta and Elephas persisted, with the latter eventually going extinct by the end of the Pleistocene. The traditional view with regards to the distribution of Loxodonta and Elephas is that they rarely co-occurred in the same region of Africa during the Pleistocene, despite being contemporaneous for much of their evolutionary histories. This view is based on assumed differences in habitat preference, with Pleistocene Loxodonta regarded as closed-country adapted and Pleistocene Elephas as open-country
adapted. After the extinction of Elephas in Africa, it is thought that modern Loxodonta expanded its range into that previously occupied by Elephas. While intriguing, the geographical and temporal distributions of these two genera have never been systematically evaluated. We begin to address this issue by plotting known fossil occurrences of Loxodonta and Elephas on a map of Africa. Three maps were produced: one of early, one of middle, and one of late Pleistocene. These maps show that the traditional view of non-coexistence of Elephas and Loxodonta is overstated, as fossil remains of both genera can be found at the same localities in eastern Africa throughout the Pleistocene. This notwithstanding, occasional co-occurrences in the north and south of the continent at various times during the Pleistocene, apparently bears out the idea of habitat separation between the two genera. In these regions, Elephas appears to have been more common than Loxodonta at times when open habitats prevailed, while Loxodonta was more common than Elephas when closed habitats predominated. When both genera were present in similar abundance, such as in East Africa, open habitats seemed to have prevailed.

*Keywords:* Pleistocene, elephants, biogeography, palaeoenvironments

Environmental controls on surface foraminifera from Keiskamma and Knysna estuaries, South Africa

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Foraminifera have been widely used to reconstruct Holocene sea-level changes, based on their vertical distribution relative to the tidal frame. The accuracy of foraminifera as sea-level indicators depends on a robust understanding of their environmental controls. Surface samples were collected from salt marshes associated with the Keiskamma (86 samples) and Knysna (68 samples) estuaries, located, respectively, on the east and southern coastlines of South Africa. Corresponding environmental datasets for elevation, pH, salinity and temperature were collected, in addition to extensive vegetation surveys. Canonical correspondence analysis of foraminiferal assemblages yielded two distinct subdivisions. Agglutinated assemblages were restricted to the vegetated high and middle marsh zones while the calcareous assemblages occupied the mudflats of the intertidal zone. The dominating agglutinated assemblages for both sites were Trochammina inflata and Miliammina fusca. The calcareous assemblage was predominantly comprised of Ammonia sp. and Elphidium sp. Canonical correspondence analysis was used to investigate the relative importance of each environmental variable across the surveyed gradients. Three foraminiferal zones were identified, with a clear vertical distribution of species within the high and low marsh. However, elevation may have less of a control over the distribution of foraminiferal assemblages in the middle marsh zone. This modern foraminiferal training set will contribute to predictive transfer functions for reconstructing high-resolution records of relative sea-level change along the southern African coastline.

*Keywords:* foraminifera, sea-level change, vertical zonation, salt marshes, salinity, elevation

Towards addressing the disjunction between palaeo- and modern ecology in the western Free State

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An investigation of the modern vegetation in the western Free State raised questions about the origin and history of the Grassland Biome in this area, where intriguing landforms exist that must have been accompanied by considerable palaeo-ecological changes. However, information about the development of the modern biome in the area during the late Cainozoic is mostly lacking due to a scarcity of organic deposits in this dry region. To address this question as part of an ongoing project, we conducted vegetation surveys and looked for clues in the published geology. From east to west, the modern
vegetation survey shows complexity in C4 grassland and savanna. It is adapted to dry conditions and ephemeral pans. The woody component of the savanna is open and mostly on aeolian sand. Rocky dolerite outcrops (sills and dykes) in the area are dominated by shrub vegetation adapted to boulders and shallow gravel-rich soils. Pan vegetation varies from dwarf shrubs in soil with high salt content, to grass-covered pans in soil with lower salt content, to perennial pans with floating and anchored aquatic plants. Water saturated wetlands in the western Free State are limited to perennial springs. The geology of the region is dominated by the Beaufort and Ecca Groups (Karoo Supergroup), with a large number of depessions (deflation pans). We investigate a previous suggestion for two putative palaeo-tributaries of the Vaal River, the Kimberley River and the Modder River, in the valleys of which we now find pans but due to long term erosion, no sedimentary evidence. These palaeo-rivers were presumably cut off during the Late Cenozoic by tectonic and geomorphologic changes. Palaeo-lakes like Alexandersfontein that formed in pan basins suggest that the region underwent considerable environmental change that must have influenced the past vegetation. With the exception of a rare fossil fauna of late Pliocene age from a railway cutting near Virginia, no nearby evidence of Neogene biota exists to provide clues of vegetation cover in this or adjacent areas. For the more recent Pleistocene and Holocene periods in proximity of the study area, marked vegetation and moisture fluctuation cycles were reported from a few palynological and faunal sites (Florisbad, Erfkroon, Alexanderfontein and Baden-Baden). The only indications about the Last Glacial Maximum Period are reported in recent pollen studies at Baden-Baden (pollen) and Erfkroon (phytoliths, isotopes, fauna). When comparing our modern vegetation survey with the available palynological data, striking differences are observed. The presence of fynbos elements suggests marked migration of community types currently several hundred kilometres outside the study area. To identify vegetation relics from the much earlier history of the area during the Neogene, when the palaeo-rivers presumably existed, can therefore only be highly speculative with the nearest evidence for those times coming from as far away as the South Western Cape. For future palaeoecological research, palynology of rare available sites like Florisbad and Baden Baden is essential and they should be optimised to reveal more information about the palaeo-climate and its associated vegetation of the region.

Keywords: palaeoecology, modern vegetation, palaeo-rivers, pans, climate change

The engraved ostrich eggshell from the Howiesons Poort layers from Klipdrift Shelter, southern Cape, South Africa

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Until recently, the occurrence of engraved ostrich eggshell fragments (EOES) were only known from two Middle Stone Age sites, Diepkloof Rock Shelter (n=409) in the Western Cape of South Africa and Apollo 11 (n=2) in Namibia. At both sites the EOES are associated with the Howiesons Poort technocomplex. It has been suggested that the limited range of this cultural tradition might indicate regional traditions, and may be a useful tool for defining cultural spheres. The engraved designs could also relate to expressions of group identity (Texier et al 2013).

Excavations at a new Howiesons Poort site in the southern Cape of South Africa, Klipdrift Shelter (KDS), since 2011, have produced over 110 fragments of EOES from layers spanning the period 65.5±4.8 ka to 59.4±4.6 ka. This discovery extends the known range of this engraving tradition, but still limits its geographic extent. This could be a function of preservation rather than regional traditions.

The designs entail variations of cross-hatched or subparallel line themes, and most are similar to those reported from Diepkloof. As at Diepkloof, some changes in the motifs are apparent through time. These changes in design coincide with shifts in the lithic and faunal assemblages at KDS.

Keywords: Klipdrift, engraved ostrich eggshell, Howiesons Poort

References

Variability of stable-carbon isotopic pattern of baobab (Adansonia digitata L.): A natural palaeoclimatic proxy for the Mapungubwe Cultural Landscape, Limpopo Province, South Africa

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Quaternary palaeoecology has evolved into ‘applied palaeoecology’ through methodological advancements in reconstructions of past environment and has great potential in increasing our understanding of vegetation dynamics under climate change on time scales relevant to society. Despite having a well-documented archeological history, the Mapungubwe Cultural Landscape’s (MCL) palaeoenvironment has been neglected. Establishing whether landuse of the site was to some extent climatically driven requires investigating the validity of causality theories relating to agro-pastoral expansion and decline of the Mapungubwe kingdom which remains a gap in the absence of detailed palaeoecological analysis. Stable isotope dendroclimatology theory can provide useful insights and this method needs to be tested since the basis of such an application lies in a spatially explicit and consistent seasonal pattern of variation of an environmental parameter which directly or inversely affects the carbon isotopic composition laid down in the xylem tissue. In this paper, we examine palaeoclimatological records of three baobabs (Adansonia digitata L.) sampled on two sites in MCL using a combination of methods ranging from α-cellulose extraction, Accelerated Mass Spectrometry (AMS) and Radio Carbon dating. We hypothesise that climate change played a major role in landuse and vegetation dynamics in MCL. The isotopic series for each baobab were plotted and interpreted in relation to potential feedbacks between climate, landuse and anthropogenic disturbance that could have influenced vegetation dynamics and landuse in the area. The Southern Hemisphere Bomb Radiocarbon curve and a Calibrated Age Model suggest the sampled baobabs were producing 2 rings per annum and have a growth hiatus for the period covering the Little Ice Age. This study provides insights into two contrasting but complementary approaches to understanding past environments from a quantitative perspective, i.e., a geological approach that aims to reconstruct past environments and an ecological approach that attempts to test ecological hypotheses in time rather than space. We fail to reject the hypothesis that climate change played a major role in early human history in this ecologically important and historically significant protected area, the MCL and World Heritage Site. Findings of this study suggest that human occupation of the area can be linked to the climatic conditions that were favourable (AD800-900) and attracted people to the site, and the isotopic evidence indicates that the fall of the Mapungubwe kingdom (AD1200-1300) coincides with the period that had increased aridity. Our study show that high resolution information about past climates may be obtained by analysing the C isotope values from baobab samples, however, this approach needs further testing in different localities to demonstrate that the baobab is a reliable palaeoclimatic proxy. Moreover, this demonstrates that palaeoecology and vegetation science are multivariate subjects requiring a multi-proxy approach for holistic reconstructions of past environments.

Keywords: palaeoclimate, baobab, proxy, vegetation, Mapungubwe
Accumulation Rate Variability analysis of southern African Late Quaternary desert dune chronologies

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Aeolian dune systems are iconic and extensive southern African landscape components that have long been recognised as evidence of Quaternary environmental change, especially but not exclusively within the Kalahari basin. Luminescence dating was thought to be the panacea for enhancing dune record utility by providing a chronometric basis for interpretation, but problems have remained with regard to age and environmental interpretations. Several strands of research are attempting to enhance the utility of desert dune records in Quaternary research; here we consider how to assimilate and interpret dunefield records more effectively.

Recent studies suggest that accumulation rate may be a better means of assessing past dune system reactions to climate and environmental change than raw ages alone (Leighton et al., 2014). A new data treatment method (Bailey and Thomas, 2014), termed Accumulation Rate Variability (ARV), provides a quantitative model through which factors affecting dune sediment accumulation can be better analysed in terms of their effects on dune ages and in turn on the interpretation of dune records as a proxy for past environmental conditions. Here we apply ARV to all available southern African dunefield age data, as represented in the literature and the INQUA dune atlas database (Thomas and Burrough 2014), comparing resultant Late Quaternary AVR data for individual dunefields with previously published dune system and other palaeoproxy records of climate change.

Keywords: dunes, luminescence dating, Accumulation Rate Variability

References


Kalahari tectonic landforms and processes beyond the Okavango Graben

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The southern African Kalahari basin is generally regarded as a stable shield area which is subject to neotectonic modification along western branches of the East African Rift System (EARS) with much focus having been given to the Okavango Graben and its associated geomorphology. In this study, we look for surface expressions that are indicative of recent to on-going tectonic modification beyond the Okavango region. A number of landforms can be highlighted. These include drainage lines in north eastern Namibia which are aligned along a “horsetail” fracture system, interpreted as the response to an apparent incipient rifting extending west of the Okavango Graben and Gumare fault line. The second region of interest, in north eastern Botswana, is known to house a second lesser graben, centred along the Ntwetwe panhandle but with a wider surface manifestation than previously noted. We can demonstrate that the area north of the Makgadikgadi has been modified by “piano key” type fault blocks. And thirdly, structural modifications to linear dune ridges of the southern central Kalahari manifest faulting, shearing and rotation. These
Exploring the use of sand ramps as novel archives of Late Quaternary environmental change in Southern Africa

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Sand ramps are extremely common but under-investigated landforms in many drylands. They are accumulations of aeolian sand, interspersed with varying proportions of talus, colluvium, debris flow, rock fall and/or fluvial deposits, anchored against a topographic barrier. As they are stabilised by the adjacent hillslope, and it is inferred that different units require different environmental conditions to form, sand ramps have the potential to preserve long term records of environmental change that can be independently dated by OSL. In areas such as southern Africa where poor preservation restricts the use of ecological proxies and traditional geoproxies (e.g. dunes) are often difficult to interpret, the sand ramp record may be instrumental in understanding Late Quaternary environmental change. However, while there is some literature on the formation of individual sand ramps, a systematic, subcontinent-wide study of geomorphic drivers and palaeoenvironmental utility is yet to be undertaken. Here we present early results from a systematic study of 12 sand ramps from the Namib, Karoo and Kalahari regions of southern Africa.

Preliminary results indicate that the palaeoenvironmental record from these sand ramps covers at least the last 130,000 years and suggests a close relationship with local sediment availability.

Keywords: sand ramps, luminescence dating, geomorphology, Namibia

8 m deep palaeosols exposed at Vaalputs, Namaqualand, South Africa: unique windows to Late Cenozoic palaeoclimates and pedogenic processes

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The Koeberg nuclear power station near Cape Town has been a reliable producer of electricity since 1984. Whereas the spent fuel is currently stored at the utility, the low level radioactive waste is trucked north for over 600 km to the Vaalputs facility in Namaqualand. At this site, in a sub-arid and sparsely populated area, drums of radioactive waste are buried in carefully managed trenches up to 8 m deep. As part of the operational requirements and institutional obligations, Vaalputs has been the focus of detailed geological and environmental investigations over a period of more than 30 years (see Evans et al., this Conference).

In outline, the geology of the area consists of a thin, ± 15 m sequence of Late Mesozoic to Cenozoic continental clastic sediments of the informally termed Koa Plateau Group (KPG) overlying a Mesoproterozoic granitic basement, more local sub outcrops of Dwyka Group (Karoo) diamictite and a few ±67 Ma old volcanic pipes. Sedimentation of the KPG occurred under changing climatic conditions in shallow basins ahead of the
Constraining the timing of sedimentary in-fills at the Vaalputs radioactive waste disposal facility, Namaqualand, South Africa

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Vaalputs is a low level radioactive waste disposal facility located in a semi-arid part of the Northern Cape about 100 km SE of Springbok at between 30°05’ and 30°10’S, and 18°30’ and 18°37’E at an altitude of ±1000 m. It is the only facility of its kind in Africa and is operated by the Nuclear Energy Corporation of South Africa (NECSA). The radioactive waste is disposed of in large, ~8 m deep trenches which exposed only the upper portions of the Vaalputs sedimentary sequences described by Brandt and co-workers (Brandt, 1998; Brandt et al., 2003, 2005). The sequence, now referred to the Koa Plateau Group (see Andreoli et al., this Conference) consists of unconsolidated red sand (attributed to the Quaternary Gordonia Formation) and Mesozoic to Cenozoic beds interpreted as fluvial deposits. The red sand is the major interest in this study, being located at various positions in the stratigraphy; it occurs either as a surficial veneer or as infillings of cavities possibly related to bioturbation. In particular, we have identified a number of red sand “tongues” filling potholes-like structures whose origin and position in the stratigraphic sequence are not properly understood. The structural, compositional and textural characteristics of the red sands suggest that these tongue-like features developed under climatic conditions very different from those of today. A study of the textural-geochemical characteristics and ages of the sediment in-fills by optically stimulated luminescence (OSL) is expected to offer clues to the geomorphologic, including fluvial activity, and palaeoclimatic episodes that led to their development. Initial results on samples collected at various depths across a well-developed soil tongue and the adjacent wind-reworked surficial veneer indicate that these specimens are not very sensitive to dating, with low signal brightness and a large amount of scatter in the data, suggesting incomplete bleaching of the signal in the quartz grains.

Keywords: Vaalputs, palaeoclimate, soil, OSL dating

receding Great Escarpment. The KPG comprises the Cretaceous Dasdap Formation (kaolinitized sandstone, conglomerate), the Cenozoic Lower and Upper Vaalputs Formations (siltstone and greywacke respectively) and a veneer of Red Sand correlated to the Quaternary Gordonia Formation in the Kalahari basin. With the exception of the Gordonia Formation, all other terms are informal.

In soil classification terminology the Red Sand (thickness 0.3-2 m) includes the A and B1 horizons. The B2 horizon consists of calcrtized dorbank (duricrust) and ranges in depth from 0.3-1.5 m. The B2 horizon represents a truncated palaeosol with a complex morphology and texture relating to the fluvial parent material and its complex pedogenic history. A much generalized stratigraphy of the “B2” horizon comprises a lower zone of chemical precipitates (changing upward from calcrite to sepiocrete) overlain by an upper layer of very hard, silicified duricrust. The “C” horizon consists of variably weathered (i.e. shattered, calcified/oxidized; thickness: 2-3 m) greywacke at the top of the Upper Vaalputs Formation. Laterally extensive, shallow-dipping slickensided shear fractures are a distinctive feature of the “C” horizon and extend upward to dissect the whole of the overlying “B2 horizon”. Texturally complex veins enriched in Ca, Si, Ba, Sr and REE “wrap around” large peds of dorbank. Whereas the contact between the C and B2 horizons tends to be gradual, that between the B1 and B2 horizon is abrupt with a stoneline and indicates a lithological discontinuity. This suggests that the Red Sand Formation was deposited over a very irregular, often rough land surface characterized by duricrust blocks structurally dislocated by the abovementioned shear fractures) and numerous potholes/sinkholes whose depth may exceed 8 m (see Evans et al., this Conference). Although far from complete, our data and observations provide evidence of the profound physical and chemical effects that the alternating climates of the Pleistocene had on the Namaqualand environment, as we recovered Acheulian hand axes up to 1.9 kg in weight from dorbank just a few km east of Vaalputs.

Keywords: Vaalputs, Quaternary, palaeosols, dorbank, calcrite

Vaalputs is a low level radioactive waste disposal facility located in a semi-arid part of the Northern Cape about 100 km SE of Springbok at between 30°05’ and 30°10’S, and 18°30’ and 18°37’E at an altitude of ±1000 m. It is the only facility of its kind in Africa and is operated by the Nuclear Energy Corporation of South Africa (NECSA). The radioactive waste is disposed of in large, ~8 m deep trenches which exposed only the upper portions of the Vaalputs sedimentary sequences described by Brandt and co-workers (Brandt, 1998; Brandt et al., 2003, 2005). The sequence, now referred to the Koa Plateau Group (see Andreoli et al., this Conference) consists of unconsolidated red sand (attributed to the Quaternary Gordonia Formation) and Mesozoic to Cenozoic beds interpreted as fluvial deposits. The Cenozoic sediments are clay-rich and were probably deposited in semi-arid conditions as unchannelized floodouts. The red sand is the major interest in this study, being located at various positions in the stratigraphy; it occurs either as a surficial veneer or as infillings of cavities possibly related to bioturbation. In particular, we have identified a number of red sand “tongues” filling potholes-like structures whose origin and position in the stratigraphic sequence are not properly understood. The structural, compositional and textural characteristics of the red sands suggest that these tongue-like features developed under climatic conditions very different from those of today. A study of the textural-geochemical characteristics and ages of the sediment in-fills by optically stimulated luminescence (OSL) is expected to offer clues to the geomorphologic, including fluvial activity, and palaeoclimatic episodes that led to their development. Initial results on samples collected at various depths across a well-developed soil tongue and the adjacent wind-reworked surficial veneer indicate that these specimens are not very sensitive to dating, with low signal brightness and a large amount of scatter in the data, suggesting incomplete bleaching of the signal in the quartz grains.

Keywords: Vaalputs, palaeoclimate, soil, OSL dating
References


Former land surfaces and palaeoshorelines on the Mossel Bay continental shelf, South Africa

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Two marine geophysical surveys and scuba diving surveys were used to examine evidence of past sea-level fluctuations and interpret seafloor geological deposits offshore of Mossel Bay. A terrestrial landscape, now submerged by high sea levels, has been described. The most prominent beach and dune deposits currently exposed on the seafloor date from the Marine Isotopic Stage (MIS) 6 glacial to MIS 5 interglacial periods and include incised lowstand river channels and regressive aeolianites. Sedimentological analyses suggest that the palaeo-beach depositional environment was comparable to that seen today and consisted of a relatively gently sloping beach on a wave-dominated coastline.

Although overall relatively flat, local topography on the Agulhas Bank reflecting relict dune deposits promoted a lowstand landscape rich in wetlands, meandering river courses and water bodies focussed in back barrier settings similar to modern day Wilderness. In the vicinity of Vlees Bay, Table Mountain Group sandstone outcrops as flat exposures. The low angle gradient of the South Coast mid- to outer shelf resulted in a significant lateral migration of the shoreline with relatively minor changes in sea level. The palaeoscape model of Fisher et al. (2010) generated estimates of the distance and placement of the coastline at 1.5 kyr increments through the last 420 kyr. This model showed that the shoreline was as far away as 96 km from Pinnacle Point during glacial maxima. In addition to the gradient of the shelf, periods associated with high sediment supply as defined by this work (MIS 6, MIS 5, MIS 4, MIS 2), likely experienced significant progradation on both highstand and lowstand sea-level cycles. Palaeoshorelines in Mossel Bay become linear on the outer shelf beyond the extent of the present-day log-spiral embayment. Sea level was up to 130 m lower than today during the MIS 6 glacial and the seismic and geological record presented in this study reveal a vastly different coastal environment to that of today. Wetlands and floodplains were far more extensive and broad, shallowly incised rivers carved the broad, flat, coastal plain. As sea level rapidly transgressed towards the Last Interglacial, coastal barrier systems shifted in a landward direction and were rapidly cemented by subaerial carbonate diagenesis. The geological record of shelf evolution between the MIS 4 (71 – 57 ka) and MIS 2 (29 – 14 ka) glacial stages suggests that laterally extensive floodplains were infilled, and overspilled, with sediment into the channels carved during the MIS 6 glacial. Extensive dunefields, extending up to 10 km inland from their associated palaeoshorelines, covered much of the emergent shelf. The seismic stratigraphic record, as well as the diagenetic features, indicates that the water table was close to the surface. The sedimentary bedforms may have obstructed or slowed drainage as suggested by leached palaeosols and carbonate mixing observed in thin section.

Keywords: submerged landscape, Quaternary sea level fluctuations

References:

Contemporary and long-term erosion and sediment yield in South Africa. Implications for and benefits from palaeo-ecological sedimentary records

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Erosion is a major source for the allochtonous minerogenic and organic material in sedimentary records. Thus, sedimentary records have the potential to provide data on the temporal variation of average erosion from the source area of the deposits. For lithologically heterogenous source areas sediment fingerprinting might provide further information on the spatial variation of erosion in time. However, erosion (i.e. the mobilization), the transport and the deposition of material, is governed by a complex pattern of basic conditions (e.g. climate, vegetation, soils, geomorphology, human impact) and processes (e.g. deposition and erosion along transport path and in the sedimentary environment).

This contribution will provide a review on the current state of the art concerning contemporary spatial variation of erosion and sediment yield in South Africa. It further summarizes the current data available on long-term erosion rates primarily derived from cosmogenic nuclide analyses. Based on a currently ongoing bi-national collaborative research project funded by the German Research Foundation (DFG) the presentation elaborates on the differences between contemporary and long-term erosion rates for the Kruger National Park (KNP) in the Lowveld Savanna. The KNP represents one of the few savanna regions in South Africa where arable farming has never impacted the soils. This provides the opportunity to distinguish the relative contribution of either methodological differences or human impact and climate when comparing contemporary and long-term erosion rates and guidelines for interpreting sedimentary records.

Keywords: erosion, palaeoecology, South Africa

Poster Presentations

Stratigraphy of incised channels on the Mossel Bay continental shelf, South Africa

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Nine discrete seismic sequences are interpreted for the area from Still Bay in the west to Buffels Bay in the east and to a maximum water depth of 110 m. Seismic stratigraphy revealed 17 seismic units in the region (A – Q). The 17 discrete seismic units are bounded by 2 unconformities (U/C 1 and 2), 3 regional sequence boundaries (SB 1, 2 and 3) and 1 wave ravinement surface (WRS). Unit A represents bedrock and is dominated in this region by the Silurian Table Mountain Group Skurweberg Formation arenaceous sandstones. Units B, C and D are associated with the Pletmos Basin stratigraphy, expressed onshore as the Cretaceous Uitenhage Group. Sequences 1 and 2 represent Synrift successions I and II, respectively. Unit E (Sequence 3) is interpreted as drift deposits, now exposed by extensive planation since the Neogene and forming the Agulhas Bank. SB 1 is interpreted to be a planation surface formed by extensive erosion since the middle Miocene. With the onset of major mid Pleistocene glacial – interglacial cycles, reactivation of existing surfaces formed deposits visible in the seismic record. Shelf sedimentation since at least MIS 7 and evolution of shifting shorelines dominate the offshore and littoral zone record of the South Coast and stratigraphically form part of the Bredasdorp Group sedimentary record. Sequence 7 preserves systems tracts providing insight into the depositional and erosional processes from MIS 7 to the Last Interglacial (MIS 5e). Sequence 8, the most complete sequence documented in this study, commenced with the retreat of sea-level from MIS 5e and extends to the Holocene highstand (MIS 1). Within Sequence 8, the response of sedimentation to MIS 5 stages 5e-a, MIS 4, MIS 3 and MIS 2 is documented. Sequence 9 commences with the fall of sea level since the Holocene highstand.
Active incision of rivers, forming channels on the shelf, is represented as bathymetric lows carved into strata where SB 1 dips and forms depressions. The incision shows shallow, broad, relatively flat fluvial systems with associated floodplains. Seismic stratigraphy revealed four fill units within South Coast incised channels, based on seismic character of deposits, bounding horizons and observed geometries. The seismic architecture suggests that the infill sequences represent mixed fluvial and estuarine deposits, floodplain deposits and lastly, infilling by the most recent episode of marine sedimentation.

The subtle shelf depressions expressed as bathymetric lows, mapped at depths between 30 and 110 m below mean sea level, are filled with fine grained silty material interpreted to represent back-barrier and interdune sediment (Seismic Units L and M). These likely represent wave-dominated barrier environments with dunes intersected by narrow entrance channels connecting the low-energy, back-barrier lagoons to the open coast. Here, we describe the infill successions since 22 ka based on analysis of sediment cores obtained.

Keywords: shelf seismic stratigraphy, bathymetric depressions

Understanding Late Quaternary changes at the land-ocean interface: The evolution of the Wilderness coastline, South Africa

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Coastal barriers have been widely used to understand the responses of coastal margins to fluctuating Pleistocene sea-levels. What has become apparent, particularly with the development of robust chronological frameworks, is that gaps in terrestrial barrier sedimentary records are not uncommon and that they most likely reflect phases of barrier construction on the now submerged continental shelf. Thus, understanding the land-ocean interface through time is critical so as to fully appreciate the Quaternary archives contained within the barriers and their associated back-barrier deposits. This study uses offshore and lakefloor (back-barrier) seismic profiling from the South African south coast at Wilderness to link sub-aerially exposed barrier stratigraphy to the presently ‘drowned’ geological and sedimentological record. During sea-level regressions, both the incision of fluvial channels and the deposition of back-barrier systems occurred across the continental shelf. During late low stand/early transgression periods, landward shoreface migration occurred, pre-existing channel incisions were infilled and pre-existing barriers were truncated. Rapid transgression, however, allowed the preservation of some back-barrier deposits, possibly aided by protection from antecedent topography. As sea-level neared the present elevation, erosion of the mid shelf sediments resulted in the development of a Holocene sediment wedge. This sand, presently preserved in the back-barrier lakes, reflects sea-level inundation during the Holocene High stand while overlying terrestrial muds reflect subsequently reduced marine influence as sea-levels assumed their approximate present elevation in the middle to late Holocene. The combination of on and offshore data has facilitated this reconstruction and, based on the stratigraphic relationships in the sequence, the approximate ages of several palaeo-river systems to be identified. Their history is intimately tied to the evolution of the aeolian facies within the embayment. As previously assumed, aeolian sedimentation tracked the shoreline onto the continental shelf during the Late Pleistocene. Here we have been able to provide more detail for this process and we identify 8 separate now sub-marine aeolian units, extending down to 130 m below modern sea-level. Their approximate ages are constrained with reference to the eustatic sea-level record and the deepest units are consistent with the estimated magnitude of sea-level lowering during last glacial maximum shoreline on the South Africa coastline. Our work clearly demonstrates that within transgressive-regressive sea-level cycles, accommodation space for barriers is controlled by antecedent drainage pathways and gradient of the adjacent inner continental shelf.

Keywords: aeolianite, dunes, barriers, palaeochannels, seismic profiling
Dynamics of Holocene Saharan dust sources and transport

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The transition from the “green” Sahara of the early Holocene to today’s hyper-arid conditions was triggered by a shift in orbital forcing and a consequentially changing climate. Marine sediment records reveal an abrupt increase in dust flux from the Sahara into the North Atlantic about 5500 years ago (de Menocal et al., 2000). This abrupt change may be related to a sudden change in vegetational cover noted by Brovkin et al., 1998 and Claussen et al., 1999. In contrast, palaeo-climate and ecosystem data derived from the sediment record from Lake Yoa (Ounianga Kebir, North-East Tchad, Kroepelin et al., 2008) indicate a more gradual change in vegetation coverage and precipitation. Therefore, we explore the hypothesis that the dynamics of dust fluxes is related to changes in hydrological quantities such as lake area and soil moisture rather than vegetation cover.

Investigations are guided by the following questions: Which relevance and weighting do changes in vegetation coverage, lake coverage and large-scale soil moisture have in affecting the dynamics of Holocene Saharan dust transport? Does Saharan dust transport in interaction with changing climate develop multiple equilibria and bifurcations?

The dust source model by Stanelle et al. (submitted) is applied to set up stationary state simulations for the Holocene and today’s conditions. Holocene surface characteristics, including vegetation cover and hydrological quantities such as lake area and soil moisture, are derived from proxy data and the dynamical wetlands hydrology scheme by Stacke (2012). Modelling results of the amount of emitted and deposited dust for present climate and Holocene climate are evaluated and compared with measured data.

Keywords: Holocene, Saharan dust dynamics, abrupt climate change

References


Palaeo-environmental reconstruction of the Diepdrift Gullies

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The Diepdrift erosional site is located about 5 km north of Bela Bela in Limpopo Province, South Africa. It is an interesting geological feature as it is the only locally situated gully of its size in the Bela Bela area. No surrounding areas show a large degree of gulling as is depicted by the Diepdrift site. It is located in the heart of the Bushveld Complex surrounded by granites of the Rooiberg Suite as well as forming the drainage
and catchment basin of the Waterberg Group. It lies unconformably above these characteristic red granites, and is situated between two large granite domes that flank the site to the east and the west. These domes form a radial drainage pattern, which converges in the Diepdrift site, slightly upstream and along the length of the gully. A river meanders through the gully itself, and is fed by smaller streams flowing towards the centre of the feature. The banks of the river channel seem to incise into the walls of the gully causing a basal undercutting appearance. The river flows down slope towards the south and collects in a dam further downstream in the adjacent farm. The sediments consists of various horizons of brownish-orange to grey, fine to coarse grained sandstones and palaeosols with a vertical piping / gullying pattern forming on the exposed faces of these stratigraphic units. The faces are exposed over varying depths. In some locations the exposed face is as small as 0.5 m, while in other areas, predominantly downstream, the faces are exposed up to 6 m in height. The gully seems to weather down to the previously mentioned granite in some locations. This granite forms the basal bedrock underlying the sediments.

The aim of this research project is to produce a palaeoenvironmental reconstruction for the Diepdrift gullies and to derive an understanding of gullying in the area and the factors which contributed to its formation. Through optically stimulated luminescence dating a high resolution geochronology will be derived which will allow for the correlation of the stratigraphy to recognised climatic events that were recorded for the Quaternary. Initial results suggest that the Diepdrift structure is as a result of an alluvial fan collecting material from the underlying granite bedrock in an around the area and from other sediments further upstream. The fairly regular, continuous layering and lack of prominent channel deposits places the gully in the distal sections of the fan. Possible colluvial action is likely to influence the initial sediments from the granite domes on either side of the deposit. However, this does not directly affect the deposit itself. Due to the sodic nature of the soils the gullying in the site can be attributed to cation exchange causing degradation of the soils in an arid to semi-arid climatic environment.

**Keywords:** gullies, optically stimulated luminescence dating, Quaternary environmental reconstruction

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**The development of the present day drainage patterns of south-central Africa**

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One of Africa’s most distinctive morphological characteristics is the occurrence of the low lying Congo Basin (mean elevation of 400 m.a.s.l) adjacent to the elevated Kalahari Plateau (mean elevation of 1100 m.a.s.l). The transition zone between low and elevated Africa also demarcates the watersheds between the Congo and Okavango-Zambezi drainage systems. This south-central African watershed, here termed the Congo-Kalahari watershed, is dominated by a smooth, seasonally wet tableland, flanked by the Angola highlands in the west and the Western branch of the East African Rift System (EARS) in the east. Thus the Congo-Kalahari incorporates three types of landforms: old, macro-landforms of the Kalahari Plateau and Congo Basin; newer, meso-landforms of EARS, horst and graben structures; and newer, process landforms as evidenced by headwater capture features and channel adjustments along the watershed. Therefore a better understanding of the Congo-Kalahari watershed may provide insights into the development of the mega-geomorphology of central and southern Africa.

The Congo-Kalahari watershed separates the northerly flowing tributaries of the Congo River from the southerly flowing tributaries the Zambezi and Okavango Rivers. The present day drainage patterns of these river systems were investigated using remote sensing and a geospatial information system. The observed juxtaposition of river drainage patterns suggests a multi-stage evolution of these drainage systems with several controls acting on the development of these river systems. While much of south-central Africa’s drainage has been impacted on by events of the Neogene, significant changes have occurred during the Quaternary. It is during the Quaternary that the Congo and Okavango-Zambezi drainage systems attain their...
modern forms, although these systems have and continue to be modified throughout the Quaternary. By combining geomorphic and geologic evidence with published data from several fields, including phylogeography, an overview of drainage system evolution may be discerned.

Keywords: south-central Africa, Congo, Kalahari, GIS

Variability of submerged shorelines in a subtropical setting: Preliminary findings

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This study presents the initial results of an ultra-high resolution seismic survey of a submerged shoreline offshore Durban, South Africa. This is the first step in a larger project examining the detailed seismic and geomorphic anatomy of submerged shorelines from different geomorphic regimes along the east coast of South Africa. These data reveal seven distinct seismic units within the sub-surface. Unit 1 is incised by numerous Holocene aged valleys and has been interpreted by Green and Garlick (2011) to represent Early Santonian (Cretaceous) siltstone. The Cretaceous incisions are filled with two distinct sediment packages which make up unit 2. Unit 2 is capped by a very high amplitude erosional reflector. This surface is interpreted as a regionally developed erosional surface interpreted as the Holocene wave ravinement surface. Unit 3 is present as several ridge and pinnacle-like outcrops which are welded onto the lower-most resolved unit (unit 1). These too are truncated in places by the wave ravinement surface. The ridges occur at water depths between 70-40 m and mark the position of several submerged shorelines. Unit 4 lies landward of selective unit 3 outcrops and drapes over unit 2. Core GeoB18302 intersected this unit at 5m depth from the seafloor and confirmed this material to be stiff lagoonal clay. C14 dating of this clay yields an age of 35 395 ±592 years. Unconsolidated Holocene sediments form a seaward thinning wedge ~16 m thick and make up unit 5. Core GeoB18302 penetrated approximately five metres of disaggregated calcareous sandstone rubble and rests on a wave ravinement surface. Unit 6 similarly rests directly over the wave ravinement surface. As this rests directly on an erosional surface and has limited thickness, it is interpreted as coarse erosional lag. The youngest sedimentary package, Unit 7, comprises seaward dipping parallel reflectors and is best developed to landward. This unit consists of moderate to high amplitude reflectors similar to those of unit 5, suggesting that this unit is made up of further reworked calcareous sandstone. The morpho-stratigraphic characteristics of these facies are attributed to palaeo coastal and near-shore processes acting on the palaeo-shoreline, and are comparable with current coastal and near-shore processes.

Keywords: palaeo-shoreline, submerged, shoreline, Holocene

References


Age and significance of Holocene valley fills in the Skeleton Coast, Namibia

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East-west orientated valleys with extremely ephemeral modern channel flow are a significant landscape feature of northwest Namibia. Today these valleys are important sources of aeolian dust, as each year plumes during Berg wind events fertilise Atlantic waters off the Skeleton Coast.

Here we provide an OSL chronology for silts from the Huab valley, demonstrating a temporarily complex Holocene sequence of valley-wide infilling (with early phases associated with the African humid period?) and subsequent late Holocene entrenchment during confined channel flows. Age data affirm fluvial histories from
the Hoanib system (Eitel et al 2006), but additionally provide an association with modern aeolian dynamics and dust-sourcing that points to the vital role of wet – accumulation as sourcing the aeolian systems of today’s hyper-arid regime.

**Keywords**: Holocene, valley fills, luminescence dating, aeolian dust

**References**


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**Sinkholes collapse mapping in Doukkala, Morocco**

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A significant proportion of the Doukkala (Meseta of Morocco) is composed of limestone. This rock is susceptible to rapid evolution to karst in some particular environment and a collapse may occur in such karstic feature.

This study aims to develop a methodology using geographical information systems (GIS) and 3D geological model to map the risk prone areas at the Doukkala. This document could be an useful tool for decision makers.

The data was integrated into a geographical information system (GIS). Combining the lithology, the hydrogeology and the geomorphology enables us to delineate areas of low, moderate, high, and very high risk.

**Keywords**: karstification, collapse, 3D geological model, risk map, GIS, Doukkala
Spatial and temporal variation in North African palaeoenvironmental and archaeological records during Marine Isotope Stage 4

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Marine Isotope Stage 4 (MIS4) covers the timeframe of c. 74-59 ka and is generally regarded as a period of sudden and rapid climatic deterioration in North Africa. MIS4 is argued to coincide with regional decreases in population size and density in North Africa, possibly concomitant with retraction into refugia in certain locales. Sitting awkwardly against this picture is recent mtDNA evidence from living human populations which suggests that, approximately c. 60 ka, Homo sapiens groups exited Africa in a successful migration that resulted in colonisation of Asia, Australia and Europe. These dispersals of Homo sapiens are usually attributed to humid climatic phases in MIS5 and MIS3, when hydrological networks are argued to have been reactivated in response to pluvial events, resulting in the wetting of normally arid regions such as the Sahara.

This paper reviews palaeoenvironmental and archaeological data from marine and terrestrial archives in the North African region, which are dated to the MIS4 timeframe. We evaluate spatial and temporal variation in the datasets in relation to global climate records and investigate their reliability to inform us of millennial and sub-millennial environmental change, and demographic processes in North Africa. In particular, we look at the chronometric dating of palaeoenvironmental and archaeological datasets and investigate issues regarding chronological precision, spatial resolution and geoarchaeological context. We present geoarchaeological and lithic data from part of the Haua Fteah cave sequence (Libya) which has associated MIS4 dates, and discuss how these findings fit into a wider picture of regional environment change and human population dynamics.

Keywords: MIS4, North Africa, dating, environment, geoarchaeology

Developing a Holocene tephrostratigraphy of Ethiopia

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Ethiopia experiences a highly variable climatic regime, subject to the seasonal migration of the Inter-Tropical Convergence Zone (ITCZ) and monsoon variability. These climatic changes are recorded in Holocene lake sediments throughout the Ethiopian Rift Valley. Synchronizing widespread regional palaeoclimate archives requires accurate and precise chronological control.

Explosive volcanic eruptions generate large volumes of volcanic ash (tephra) which may be transported over continental scales and deposited in sedimentary sequences rapidly. A tephra layer represents a time-parallel marker which can be used to link sedimentary archives. Tephra from the same eruption is traced between different sites on the basis of its unique geochemical ‘fingerprint’. Ultra-distal ‘non-visible’ cryptotephra layers are increasingly used to extend the geographical range over which palaeoenvironmental archives can be correlated.

Many caldera forming eruptions occurred from East African Rift volcanoes during the early Holocene to late Pleistocene. The tephras deposited provide chronological control on Pleistocene Ethiopian palaeoanthropological sites. However, Holocene tephra deposits remain largely un-documented in Ethiopia.

Lacustrine cores were collected from Ethiopian Rift lakes (Ashenge, Hayk, Dendi, Hora, Tilo, Awassa and Chamo) covering 50 cm thick tephras in Lakes Tilo and Awassa during ~ 700 – 9,800 cal yr BP. These tephras have a similar major element composition to those in Lake Hora sediments (250 km NE of Lake Tilo). Distal rhyolitic tephra, possibly originating from the Afar, were deposited in Lakes Ashenge and Hayk between ~ 5,400 – 14,500 cal yr BP. Further work is now required in order to test potential correlations between these lacustrine archives.
The resulting tephr stratigraphy will provide a dossier of regional Holocene volcanism and allow temporal and spatial climatic changes in this region to be investigated.

Keywords: tephrochronology, correlation, palaeoclimate, Ethiopia, geochemistry

U-Th burial dating of ostrich eggshell: A new geochronometer for African archaeological sites

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Obtaining precise and accurate dates can be challenging at African archaeological sites, especially those that lie beyond the range of radiocarbon dating. We report herein a promising new approach to U-series dating of ostrich eggshell (OES) fragments and beads that occur widely in African archaeological contexts.

U-Th dating has about ten times the range of radiocarbon dating (~500 ka rather than 50 ka) and ancient OES are generally geochemically suitable for the U-Th technique. U in OES is acquired after burial but the burial age may be estimated from measured apparent ages if U uptake takes place by diffusion. Using OES from three Pleistocene-Holocene east African sites, we have: (1) measured U concentration profiles of OES normal to their exterior surface (by laser ablation ICP-MS), (2) determined apparent U-Th ages on outer and inner layers of eggshells (by solution ICP-MS), and (3) calculated U-Th burial ages using a simple model for diffusive uptake of uranium.

We have assessed our method by comparing the U-Th burial ages with radiocarbon dates for OES calcite from the same shells and find good agreement in 9 out of 11 cases. Moreover, two corrupt U-Th dates reveal themselves via anomalous patterns of apparent ages, providing reliability criteria innate to the U-Th data. The oldest OES we have tried yielded apparently reliable U-Th burial ages of ~140 ka, indicating that this approach may be applicable throughout the Late Pleistocene.

Keywords: U-Th dating, ostrich eggshell, late Pleistocene, geochronology, Middle Stone Age

Dating the desert: A decade in the dark with Kalahari quartz

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The sand mantled interior of southern Africa preserves in its landscape an intriguing and important record of past environmental change. The highly aerobic and oxidative sediment conditions of the Kalahari basin are however not favourable to organic preservation: understanding the nature and timescale of environmental change using conventional (and unconventional) proxies has therefore proved challenging. Luminescence dating has, for 20 years, provided an alternative, landscape dynamics perspective, directly dating the deposition of sedimentary quartz in the shorelines of huge, now-dry, lacustrine systems and enabling us to place a timeframe on past periods of activity of dune fields that today remain stable and inactive.

More than 700 OSL dates later, however, a number of issues arise that challenge the ability to develop a clear record of Late Quaternary landscape dynamics in the Kalahari. The lack of coherence from optically dated geoproxy records emerging from the Kalahari basin has been variously attributed to evolving techniques and the existence of poor quality data; sampling frequency, termites, tectonics and an incomplete understanding of the relationship between landscape activity and climatic conditions. Using new data from the Northern Kalahari, this paper outlines the limits of luminescence dating in the southern African interior and reports current progress on developing a reliable and robust optical chronology for Kalahari basin landforms and, importantly, a clear understanding of what exactly that chronology can and can’t tell us about environmental change.

Keywords: Kalahari, landscape dynamics, OSL, dunes
Single-grain OSL dating of the Howiesons Poort layers at Klipdrift Shelter, Southern Cape, South Africa

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Klipdrift Shelter in the De Hoop Nature Reserve, southern Cape, South Africa is part of a cave complex containing Later Stone Age and Middle Stone Age deposits. Excavations at Klipdrift Shelter yielded a lithic component consistent with the Howiesons Poort technological complex. The preliminary results from Klipdrift Shelter provide new insights into the Howiesons Poort and contribute further to ongoing knowledge about the complex behaviours of early Homo sapiens in southern Africa. However, the significance of the Klipdrift Shelter finds are dependent upon the temporal relationships between this and other Middle Stone Age sites in southern Africa.

Single-grain OSL dating was applied to a suite of eight samples, spanning the Howiesons Poort layers at Klipdrift Shelter. Initial analysis indicated indicate inter-sample variability in the optimal preheating regime, a phenomenon also observed at Diepkloof Rock Shelter (Tribolo et al., 2013). In addition, some samples yielded complex equivalent dose distributions, consistent with either incomplete resetting of the OSL signal prior to burial, or the post-depositional incorporation of younger grains from overlying sediments. Having optimised measurement conditions and data analysis techniques to circumvent these problems, the Howiesons Poort layers yield ages consistent with the 64.8-59.5 ka chronology published by Jacobs et al. (2008). The implications of these findings for the ongoing debate concerning the age and duration of the Howiesons Poort technological complex (e.g. Jacobs et al., 2008, Tribolo et al., 2013, Guérin et al., 2013) will be discussed.

Keywords: chronology, OSL, MSA, Howiesons Poort

References


Poster Presentations

The Olorgesailie Drilling Project (ODP): Understanding the last 1 Ma of palaeoclimate and human evolution in East Africa

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The Olorgesailie Drilling Project (ODP) is an effort to directly link the outcrop geology of the famous and well-studied palaeoanthropological site of Olorgesailie, southern Kenya Rift, with a penecontemporaneous core removed from a nearby accumulation basin. The project is an international, multi-disciplinary consortium of geoscientists led by Dr. Rick Potts of the Smithsonian Institution. Olorgesailie has been investigated for many years, with a detailed outcrop record that covers the last 1.2 Ma, but parts of the section are missing due to erosion, non-deposition, and channelized deposition in the past ~500 ka. The Koora Plain, ~10–20 km south of Olorgesailie, was targeted for drilling for its potential to record a more continuous palaeoenvironmental record contemporaneous with deposition of latter half of the Olorgesailie sequence.
In October, 2012, two cores reaching depths of 166 and 110 m, spaced ~1.5 km apart, were recovered from the Koora Plain. These cores have been characterized lithologically and sampled for a wide variety of palaeoenvironmental indicators (pollen, phytoliths, fungal spores, diatoms, ostracodes, isotope chemistry, plant biomarkers, charcoal, clay chemistry) as well as geochronological and geological studies (40Ar/39Ar dating, tephra geochemistry, palaeomagnetism, petrology).

Microscopic analysis of 242 smear slide samples extracted from the longer core revealed a complex depositional sequence of deep lake phases rich in diatoms, volcanic ash layers, pure diatomites, shallow near shore phases, sandy fluvial deposits, pedogenically modified zones, and interspersed carbonate layers. Variable charcoal frequency indicates several periods of higher fire activity.

Approximately 140 samples of tephra and trachytic basement lavas were sampled from the two cores. Initial 40Ar/39Ar dating results indicate, in the longest core, that the sequence extends from ~70 ka at the top, to ~1.07 Ma at basement lava floor underlying the sedimentary sequence. Age constraints derived from the more than 20 ArAr dates obtained so far will help construct a reliable age model for the cores.

Poster Presentations

**Holocene ecosystem, social and landscape dynamics in East Africa**

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Despite evidence for significant climatic variability throughout the Holocene, and having strong ecological gradients and complex societal-ecosystem changes, East Africa still has relatively few multi-proxy records of environmental change. This research is part of a Marie Curie ITN project titled ‘Resilience in East African Landscapes’ with an overall focus on spatiotemporal dynamics of human-landscape interactions in East Africa over the last millennium. The research will analyse sediment cores as part of a multi-proxy study combining palaeoenvironmental, historical and archaeological records to characterise past landscape and ecosystem change and to disentangle natural and anthropogenic drivers. This will be achieved using swamp sediments that accumulate through time and that archive past climatological, environmental and biological conditions of the catchment surrounding the depositional setting. Pollen data will provide evidence on ecosystem dynamics, charcoal data will provide evidence on fire histories, and x-ray fluorescence and magnetic susceptibility data will help to understand the depositional environment and characterise the geochemical variability. These data will be combined with land cover interpretations from historical maps, air photographs and satellite imagery to understand recent rates and character of ecosystem change.

The study sites are located on the Mau Escarpment and Amboseli regions of central and southern Kenya, respectively. These two areas cover a wide range of ecological zones, representing a mixed topography between the Rift Valley and adjacent uplands. A core consideration of the project will be on how societies, landscapes and ecosystems have responded to climate change both currently and in the past under different conditions, so as to better understand how they may respond to future climate change. The use of this data together with modern pollen and historical archives will provide a representation of landscape change which when combined will provide biophysical and social information on the human environment interactions over time that will be useful for land use management decisions and used to inform socio-economic policies and land management decisions.

**Keywords:** palaeoecology, East Africa, pollen, charcoal, environmental history
Toward a late Quaternary tephrostratigraphic framework for connecting East African palaeoenvironmental archives

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Understanding the spatial and temporal variability of climate forcing and palaeoenvironmental response across a continent as climatically diverse as Africa relies upon comparison of data from widespread palaeoenvironmental archives. Accurate, precise and independent chronologies for such records are essential; however, this remains a challenge in many environments and often prevents the valid comparison of detailed palaeo-proxy records. Many studies have now shown that volcanic ash (tephra) can be detected in terrestrial and marine sediments thousands of kilometres from their source, often as microscopic or “cryptic” layers. As well as offering opportunities for direct dating of the sediment sequence (e.g. by 40Ar/39Ar methods), tephra layers can provide stratigraphic tie-lines between archives, facilitating precise correlations at single moments in time. Furthermore, where two or more tephra layers are co-located in multiple records, rates of change can be compared within a period of equivalent duration, even in the absence of absolute age estimates.

Investigations into the presence of visible and non-visible (crypto-) tephra layers within lacustrine palaeoenvironmental records of the last ~150 ka BP from across East Africa are revealing the potential for this approach to (i) correlate palaeoclimate archives from across and beyond tropical Africa within a regional tephrostratigraphic framework; (ii) provide age constraints for individual core chronologies, in particular beyond the limits of radiocarbon dating; and (iii) increase our knowledge of the history of Late Quaternary explosive volcanism in East Africa.

Keywords: tephrostratigraphy, lakes, chronology, palaeoenvironment, cryptotephra

Yellow Marker Tuff, Laetoli: A geological study

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Laetoli in northern Tanzania is renowned for being one of Africa’s most important palaeontological and palaeo-anthropological sites. This location is home to very significant findings; second largest assemblage of Australopithecus afarensis finds, the discovery of Paranthropus aethiopicus and the famous Laetoli footprints. Furthermore, the diverse faunas from the Upper Laetolil Beds (3.63–3.85 Ma) and Upper Ndolanya Beds (2.66 Ma) are from time periods that are generally poorly-represented at other East African palaeontological sites in. At these stratigraphic units, the fossils provide important windows into the faunal and floral diversity during the Pliocene, and they serve as reliably dated reference faunas for comparison with other Plio-Pleistocene sites in Africa. This locality has been particularly well dated and the stratigraphy is well documented due to remarkable outcrop as well as containing volcanic ash. This project will be concerned with the upper stratigraphic unit, which consists of a series of aeolian and fall-out tuffs. The top of the unit is enclosed by the Yellow Marker Tuff (YMT) (8 m thick), with other tuffs throughout the sequence designated as marker tuffs. The Yellow Marker tuff does not follow any stratigraphic uniformity and the coloration has not been well explained. This non-consistent stratigraphy is attributed to multiple eruption events. The tuff is also considered to be geochemically inconsistent in all localities, with local contaminations from reworking being the cause. As there are good exposures of the YMT in Laetoli, this project aims to understand the genesis of this stratigraphic layer. This work will be geologically based; focusing on geological mapping of the tuff in localities as well as high resolution sampling for geochemical fingerprinting. The project will also adopt facies analysis to environmentally place the YMT and to better understand the timing and depositional history that led to the currently observed distribution of the tuff.

Keywords: YMT, Laetoli, geochemical, facies analysis, fingerprinting
Rapid assessment of Namib Sand Sea sediment chronologies? Testing a portable luminescence reader against full OSL dating

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There is currently very little chronological control for the sediments of the Namib Sand Sea, which cover 34,000 km², with just 45 OSL ages from four sites. Further coverage is greatly needed to refine our understanding of sand sea age and dynamics. Bubenzer et al. (2007) suggest emplacement of the main large complex, or compound, linear dunes occurred before and up to the LGM, under SE trade winds and then reshaping in the Holocene by westerly winds. The influence of westerlies in the Holocene is also suggested by Bristow et al. (2007) where a powerful combination of ground penetrating radar (GPR) and OSL dating reveal a wholesale lateral migration of Visitors Dune from west to east over the last 6 ka. In contract, dune flank material of last-interglacial age is found at Narabeb, 30 km to the south of Visitors Dune (Stone et al., 2010).

OSL dating is a time consuming and involved process, particularly for the top half of the age equation (equivalent dose, De) using established protocols (SAR) (chemical pre-treatment and analytical measurements). Over the past decade a portable OSL reader has been developed and this can be applied to bulk sediment (as collected in the field) in order to make rapid assessment of sample luminescence characteristics (e.g. Munoz-Salinas et al., 2011). Although portable reader signals are not directly comparable and transferrable to standard laboratory assessment of De, it may be possible to convert this information to rough ‘range-finder’ ages. We use samples from two sites with very different depositional ages to test whether this difference is detected in simple portable reader signals. We also produce a linear regression between portable reader signals (on bulk field material) and full laboratory protocol De estimates (on clean, extracted quartz) as a tool for producing ‘range-finder’ ages in the field.

Keywords: Namib Sand Sea, geochronology, luminescence dating, portable OSL reader, rapid range finder age

References
Bubenzer, O. Bödeker, Besler, H., 2007. A transcontinental comparison between the southern Namib Erg (Namibia) and the southern Great Sand Sea (Egypt), Zentralblatt fur Geologie und Palaontologie Teil I, 7–23.
Palaeoecology and ecosystem management in the Anthropocene – where are we now?

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Ecosystems today are dynamic and complex, leaving ecosystem managers faced with the paradox of conserving moving targets. New approaches to conservation in the Anthropocene are developing that aim to conserve ecological function and process, rather than attempt to protect static snapshots of biodiversity. To do this effectively, long-term information on ecosystem variability and resilience is needed. While there is a wealth of such information in palaeoecology, archaeology, and historical ecology, it remains an underused resource by conservation ecologists and natural resource managers; the relevance of such studies to present-day conservation and management dilemmas is not always made explicit, and the jargon often makes such publications incomprehensible to those outside the field.

This review summarizes recent progress in the application of palaeoecology and other long-term data to conservation and ecosystem management. Key areas include re-wilding, fire management, climate change adaptation, management of ecosystem services and landscape resilience and sustainability. Interdisciplinary frameworks that in include natural science, social science, the humanities and traditional indigenous knowledge are presented.

Keywords: Anthropocene, climate change, sustainability, ecosystem services, traditional indigenous knowledge.

Indigenous knowledge of subsistence farmers in promoting resilience and agricultural productivity in a changing climate, Lake Victoria Basin: Case study of Rakai and Isingiro Districts, Uganda

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Developing countries are vulnerable to negative impacts of climate change due to over reliance on climate-sensitive sectors, mainly agriculture. Limited adaptive capacity makes them vulnerable to climate-induced hazards. However, indigenous communities the world over, have well-developed indigenous knowledge systems (IKS) for managing issues affecting their livelihoods in a cost-effective, and sustainable manner since time immemorial, and IKS application in ensuring sustainable agricultural productivity is no exception. This paper presents findings of a cross-sectional survey on the use of indigenous knowledge (IK) by subsistence farmers in the Lake Victoria basin to increase resilience in changing climate. Results showed overall, significantly high community awareness levels with the majority, implicating climate change as main challenge facing agriculture. Nevertheless, as adaptation and mitigation measures, local communities use a myriad of IK and IKS in subsistence farming. The use is multifaceted, aimed at increasing productivity in terms of quantity and quality. IK is used in soil conservation/moisture retention, water-harvesting/storage, climate/weather forecasting for timely planting, selecting suitable planting and storage/preservation of seeds in changing climate. Besides, communities have convincing rationale/reasons for each IK use. No doubt, some IKS documented have positive aspects that can augment scientific knowledge in promoting climate change adaptation and mitigation among vulnerable communities dependent on climate-sensitive resources.

Keywords: changing climate, Indigenous Knowledge Systems, subsistence farming, Lake Victoria Basin, Uganda
Using palaeoecology and social anthropological surveys to design better climate smart adaptation strategies: case of Southwest Madagascar

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We describe how inter and intra annual variability is recognised and responded to on the ground by farmers in arid Southwest Madagascar through village and household surveys. A range of specific coping and adaptation strategies are employed by farmers to respond to climate shifts, some generic across regions and some facilitated by specific local factors. We discuss how “smart” global climate change smart strategies are for this context, taking into account the household surveys, future predictions and past climate and ecosystem changes from the palaeo record from the region. Overall, the study has begun to understand the complexity of coping and adaptation, and the factors that influence the decisions that are taken. We argue how house-hold surveys, together with complementary data on future prediction and past impacts, can really support more tailor made and smarter climate change adaptation.

Keywords: adaptation, agro-pastoral, arid system, climate change, forest conservation

Climate Change Adaptation and Mitigation through Agro forestry systems: Case study Wolayta Zone of Southern Ethiopia.

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Agro forestry systems not only provide a great opportunity for sequestering carbon, and hence helping to mitigate climate change, but they also enhance the adaptive capacity of agricultural systems in tropical and subtropical regions. Climate change is one of the most serious threats the world faces. It will affect all of us, but will have a disproportionate impact on millions of poor rural people. For development work to be effective, we must not only help poor rural people emerge from poverty, we must also enable them to cope with and mitigate the impact of climate change. Afforestation and reforestation, better land-management practices such as agro forestry, rehabilitation of degraded crop and pasture land and better farming practices can all contribute significantly to reducing greenhouse gas emissions. This paper presents data that examine the mitigation and adaptation potential of different agro forestry systems as well as their significance for income generation for rural populations. We then present the scientific evidence that leads to the expectation that agro forestry also has an important role in climate change adaptation, particularly for small holder farmers. We conclude with priority research questions that need to be answered concerning the role of agro forestry in both mitigation and adaptation to climate change. New areas of research are proposed and a better use of existing agricultural management knowledge is called for.

Keywords: climate change, Agro forestry systems, adaptation, mitigation
West African coastal region: investigating the role of integrating global and indigenous knowledge systems in West Africa

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The Niger-Benue drainage system, which has, over the long geological period of 55 million years, supplied sediments from the Nigerian hinterland for the construction of the petroleum-rich Niger Delta on the coast, has demonstrated the long-term impact of unifying geological processes in a nation with divergent human interests.

The United Nations has enacted the right of the indigenous people. Indigenous people’s participation in climate change issues is almost nonexistent. Incorporating indigenous knowledge can add value to the development of sustainable climate change strategies that are compatible with local needs. This can only be achieved when people participate in joint analysis, which leads to action plans that strengthen existing ones.

This paper contributes to the wealth of knowledge already existing on the major role indigenous people play in preserving their ecosystem. This has resulted in the recent calls for the integration of indigenous knowledge systems into global knowledge system strategies. Until now, integrating local knowledge systems into climate change concerns is not a completely new idea.

A comprehensive review of literature using electronic and non-electronic databases formed the methodology. The study confirmed that management of barriers to information sharing is not a legal problem, but a systemic problem that requires comprehensive and coordinated approaches. Such information is unique and fundamental to the sustainable development of a nation’s earth resources and the protection of her citizenry from a wide variety of natural hazards.

The study also revealed that barriers to successful information sharing must be managed to allow the delivery of accurate and timely information to those able to use it for greatest protection of those both in coastal in Nigeria and West Africa regions.

The paper concludes by drawing attention to the fact that promoting indigenous people’s participation in climate change issues is an important initiative towards adaptation and sustainable development in Africa and around the world. It is increasingly realized that the global knowledge system has dominated research, policies and programmes that address current climate change’s challenges, mitigation and adaptation strategies.

Keywords: West African coastal region, invest integrating global, indigenous knowledge systems, West Africa

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The impact of human-environmental interactions on the evolution of fisheries in Africa and its sustainability

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The impact of human-environmental interactions on the evolution of fisheries in Africa was assessed in three sites within the Lake Victoria Basin using remote sensing technologies and standard water quality analysis techniques. The three selected sites were: (i) Nzoia River Basin (Kenya), (ii) Nakivubo Wetland (Uganda) and (iii) Simiyu drainage basin (Tanzania). A detailed review of the archives of Uganda Fisheries Research Institute and the Uganda Forestry Authority dating from the beginning of the 20th Century and ending with the first decade of the 21st century was also conducted. Lake Victoria is the second largest fresh water lake in the world and Africa’s single most important source of inland fishery production. The present and past connections between the Lake Victoria basin, Congo basin and the Nile basin are reviewed as they impact on the evolution of African fishery examined. After the Lake Victoria fishery was initially fished down in the first half of the 20th century, Lake Victoria became home to a series of introduced food fishes, culminating in the eventual demographic dominance of the Nile perch, Lates niloticus. Simultaneously, with the changes in fish stocks, Lake Victoria experienced dramatic changes in its ecology. The lake fishery during most of the 20th century was a multispecies fishery depending on a diverse lake ecosystem, in which native food fish were targeted. The lake ended the century with a much more productive fishery, but one in which the introduced species made up the majority of the catch. Reviews on many fish stocks in Lake Victoria indicate declines before the expansion of the Nile perch population. Two decades after the rise of Nile perch in Lake Victoria, this species has showed signs of being overfished, and some of the native species that were in retreat or even thought extinct, are now reemerging. Data on the resurgence of the indigenous species suggest that heavy fishing of Nile perch may enhance biodiversity. This development has resulted in renewed interest in management options that promote both fishery sustainability and biodiversity conservation. The quality of the effluent generated by industries found within the study sites and their effects on downstream discharge was also determined. The physical and chemical analysis of water quality revealed high levels of phosphates and nitrates along the agricultural zones of River Nzoia Basin. The satellite images revealed that in all the three study sites land vegetation cover has continuously reduced in size. The extent of environmental degradation caused by agricultural, domestic, and industrial waste, and climatic fluctuations, and how these affect biodiversity and fishery sustainability in Africa is discussed.

Keywords: African fishery, biodiversity conservation, evolution, climate, human-environmental interactions, sustainability
Central-West Africa

Oral Session 6

Late Quaternary valley and slope deposits and their palaeoenvironmental significance in the Upper Congo Basin, Central Africa

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A great deal of palaeoenvironmental research on tropical alluvia and slope sediments was based on the erroneous assumption of the long term persistence of a relatively stable climate and associated vegetation in low latitudes during the Quaternary. Recent geomorphological and ecosystem history research in Cameroon, the Central African Republic and in the eastern Congo basin (Democratic Republic of Congo) has provided evidence of the frequent occurrence of multi-layered alluvia and fans in river valleys as well as stratified slope deposits (hillwash, stone-lines, pedisediments) that reflect former modifications of the environment. Numerous radiocarbon dates indicate that tropical ecosystems are highly sensitive to climate change through modification of surfaces and run-off dynamics. A well-documented stratigraphic record characterised by variable sediment layers of 2.0–5.5 metres thick spans the Holocene and the Pleistocene back to 50 kyrs BP. Buried stone-lines indicate once drier, more open landscapes under alternating wet and dry climates in currently humid and semi-humid regions. A conceptual morphodynamic model is presented to summarize process response to former environmental modifications.

Keywords: alluvia, slope sediments, stone-lines, rainforest-savanna border, Central Africa

Pliocene – Holocene Vegetation and Paleoenvironmental History of the Coastal Lagoon Areas of Lagos, Southwestern Nigeria using Pollens

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Vegetation history and distribution pattern of the coastal lagoons around Lagos were reconstructed by means of pollen contained in sediments from a drilled hole penetrating an average depth of 65 m. The recovered palynomorphs enabled delineation of 4 zones ranging from Pliocene to Holocene age. The occurrence of Zonocostites ramonae (Rhizophora spp.) appears cyclic with its decline indicating period of mangrove replacement by fresh-water swamp and lowland forest corresponding to low sea level times.

This study reveals the prevalent plant associations in the area at early Pliocene comprised abundant lowland rainforest and fresh water swamp with low abundant of mangrove forest indicating lesser marine influence at the area. This period is followed by abundant mangrove forest for the rest of Pliocene period with a sharp decline at the end of Pliocene marking a sharp Plio-Pleistocene boundary. The early Pleistocene witnessed a gradual increase in mangrove species with a maximum towards the mid Pleistocene. The pollen record analysis suggest that changes in the coastal ecosystem could be directly related to local sedimentary processes, which can be linked to relative sea level fluctuations and/or climatic variations.

Keywords: palynomorph, sea level, palaeoenvironment, provenance, assemblages
Palaeoenvironmental interpretation and age determination of the onshore Niger Delta Basin using microfloral assemblages

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Keywords: palynomorphs, agedating, palaeoenvironmental interpretation, onshore, palyno-ecological, Niger Delta

Palynological analyses were carried out on 81 samples from a well drilled for hydrocarbon production in the onshore basin of Niger Delta. The samples were composited at 18 m intervals between 2440 - 3900 m and processed for palynomorphs occurrence. The samples were prepared using conventional acid maceration, alkali treatment, wet sieving and density separation. A total of 50 types of palynomorph were identified and the index forms were used for zonation, relative age dating and palaeoenvironmental interpretation. Some of the diagnostic palynomorphs recovered include: Monoporites annulatus, Psilastephanocolporites sp., Pachydermites diederixi, Concentricystes circulus, Zonocostites ramonae, Psilatricolporites crassus, Matonisporites equiexinus, Polyadopollenites aff. Microreticulatus, Crototricolpites densus, Gemmatriletes clavatus, Magnatriaties howardi, Multiaeolites formosus, Retibrevitricolporites obodoensis, Verrutricolporites rtundiporus, and Retitricolporites irregularis. Two zones were interpreted for the analysis, they are P820 and P780. These zones belong to Echitricolporites spinosus Pantropical zone of Germeraad, Hopping and Muller (1968). The zones were defined based on occurrence of some marker palynomorphs and dated to Middle Miocene to Late Miocene ages. The palaeoenvironmental interpretations for the analysed well were based on the consideration of the percentage occurrences of the environmentally significant palynomorphs represented within the different ‘palyno-ecological communities’ recognised in the sediments. These ‘palyno-ecological communities’ include the percentage occurrence of Marine (Organic Walled Microplanktons), fresh water swamp/forest elements and savanna species. Based on the above criteria, upper shoreface, lower shoreface and proximal offshore depositional environments were interpreted for the analysis.

Palaeoenvironment and fluvial dynamics in Southern Cameroon during the Last Glacial Maximum – a multi-methodological approach

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Keywords: palynology, palaeoecology, fluvial dynamics, Southern Cameroon, Last Glacial Maximum

How dynamically do river systems react to climatic fluctuations? Or are they mainly characterized by an internal fluvial variability? With a multi-methodological approach the behavior of two river systems during the LGM was analyzed in southern Cameroon.

The search for climatic signals in late Quaternary alluvial sequences remains a challenge in southern Cameroon. Significant grain-size changes in the stratigraphies and sedimentological data indicate major modifications of fluvial dynamics. However, the main triggers for these modifications remain to be specified. Since vegetation cover has a strong influence on hydrology, fluvial dynamics and floodplain, the climatic signal can be better interpreted with additional information on the palaeovegetation. Pollen and macro-remains are good indicators of the former plant cover, but their presence is restricted to specific preservation conditions in waterlogged (clayey) sediments.

Most palaeochannel sequences, especially those dating around the LGM, comprise sandy sediments with very low potential for pollen preservation. On the other hand, these sediments often contain abundant phytoliths and freshwater sponge spicules. Phytoliths offer a diagnostic tool for palaeovegetation research. They are used to reconstruct ancient vegetation from terrestrial and lake sediments, palaeosoils, and deep-sea cores, with a time-depth of up to 20 Ma. Sponge spicules are siliceous support structures of freshwater sponges that are conserved after the death of the sponge. For Africa, 58 species have been described. Although sponge spicules always originate from wet environments, they can be eventually deposited in secondary locations through eolian or fluvial transport. Spicules transported from distant places usually exhibit a higher degree of deterioration in the form of broken or pitted spicules, while complete and well-preserved spicules point to in situ deposition.
Meandering and anabranching to anastomosing river sections were investigated with remote sensing of LANDSAT-ETM+ and ASTER data to identify suitable stillwater locations, like oxbows, abandoned and seasonal branches and backswamps for sediment sampling. Sediments were sampled every 20 cm with an Eijkelkamp Edelman corer and at some locations a thin percussion probe (3 cm diameter, 50 cm length) enabled the sampling of waterlogged sediment and stratigraphy studies of laminated clayey sediments. Phytolith and freshwater sponge spicule samples were taken from six Late Pleistocene alluvial sequences with chronostratigraphic data. From each sample, 15–20 g of dried sediment was processed.

**Keywords:** LGM, fluvial dynamics, remote sensing, Alluvial alluvial sequences, sSponge spicules

**Poster Presentations**

**Palynological study of a 30 m borehole in a coastal environment in Nigeria**

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Most information about the late Quaternary of Nigeria has come from the Niger Delta area, mainly as a result of oil exploration activities which made sub-surface samples more easily available. There is a need to search for information from other areas to re-evaluate the present knowledge of the Nigerian Quaternary. In an effort to do this, sediments from a 30 m bore-hole in the coastal environment of Nigeria were palynologically and sedimentologically studied. Bore-hole samples were collected at 2 m intervals and subjected to standard palynological and sedimentological treatments and analyses. The salinity of the sediments was also investigated to augment deductions. Phyto-ecological groups were generated from the abundantly recovered pollen and spores. Variations in the proportion of palynomorph assemblages were related to the sedimentology and salinity values. Four lithofacies units were delineated while five palaeoclimatic zones were recognized based on the relationship trends of phyto-ecological groupings. The salinity trend correlates positively with palynomorph abundance. Dolomitic intervals lack palynomorphs. Open vegetation pollen became more abundant in the uppermost intervals, while mangroves that were previously dominant became markedly reduced most likely indicating anthropogenic activities.

**Keywords:** Lagos, palynomorphs, sedimentology, salinity, phyto-ecological groups, late Quaternary

**Mangrove vegetation and geochemical proxies: A key unravelling high resolution record of sea level, climate and palaeoenvironmental change along the Niger Delta margin, Gulf of Guinea, Nigeria**

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The concept of using palynodebris (palynomacerals) associated with pollen data offers additional information in the interpretation of climate, eustasy and palaeoenvironmental analysis during the last deglaciation period across the Niger Delta margin. Non-palynologists usually utilise the term “junk” owing to their lack of awareness of the usefulness in reconstructing palaeoenvironmental change in areas where non-biostratigraphic tools (fauna, seismic, wireline logs) are biased. This research involves a multi-proxy study based upon three gravity cores of just under 3 metres length each. These materials (late Pleistocene to mid-Holocene in age) have been collected from the sea bed (approx. 40 mbsf) from offshore locations of the Niger Delta, and have been sampled at every 2 cm implying a high-resolution study.
Central-West Africa

Poster Presentations

The palynological and lithofacies component results suggest that assemblages of palynodebris (translucent phytoclasts, opaque phytoclasts and amorphous organic matter) associated with the 5-15 micron sieved fraction, were deposited under different environmental conditions. The littoral vegetation and associated palynodebris distributions dominate over the hinterland vegetation as a result of turbidity flow, oxidation and mangrove sediment trapping mechanism restricted to the proximal settings of Niger Delta. Evaluation of palynodebris integrated with palaeovegetation, lithofacies and trace elements components have led to the recognition of palaeoenvironmental change from deltaic marginal marine through to continental shelf settings. Mudstones with dominant mangrove pollen were deposited in the anoxic palaeoenvironments during a humid climate period suggested to be associated with an abundance of translucent phytoclasts characteristic of estuary / tidal flats settings. Conversely, hinterland pollen and very fine sand and siltstones have been deposited during dry climate periods, in association with an abundance of opaque phytoclasts and Amorphous Organic Matter (AOM) indicating delta plain and lagoonal palaeoenvironmental settings. Palynodebris, integrated with the aforementioned proxies allowed the interpretation of depositional settings especially in this case of limited deltaic floral diversity.

Keywords: Niger Delta, palynodebris, phytoclasts, eustasy, palaeoenvironments, climate, mangroves

Towards an understanding of the millennial variability of the West African Monsoon system: a combined palynological and geochemical approach

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The last decades have seen catastrophic droughts in the Sahel, strongly affecting millions of people. It has been discovered that the reduction in precipitation was linked to changes in the adjacent oceanic temperatures, but what remains unclear is whether this pattern of recent weak precipitation is part of a natural cycle or is linked to climatic warming. In order to understand the natural variability of the African monsoon it is necessary to look back in time. The long-term history of the West African Monsoon variability has mainly been deduced from a few sites from Western Africa, but these often contain gaps. Coupled ocean-atmosphere general circulation models have been developed to simulate past environmental conditions and help to better understand forcing mechanisms (lower sea-surface temperatures for example), but palaeodata from climate proxies remain essential to validate and calibrate the models.

Inspection of a 34 m marine sediment record collected off the Ogooué River mouth, Gabon, allows for the identification and timing of terrestrial and marine environmental changes across western equatorial Africa over the past 140 000 years. Palynological analysis documents vegetation change throughout the core sequence and through the combination of elemental geochemistry, magnetic susceptibility, and foraminiferal identification, a thorough and innovative multiproxy record is established. It is envisaged that the study will play a pioneering role in the advancement of palaeoclimatic change research, and more specifically enhanced understanding of the movement of the West African Monsoon system across western equatorial Africa, during the mid to late Quaternary period.

Keywords: palynology, West African Monsoon, multi-proxy approach
Mutations socio-environnementales récentes et perspectives de développement durable dans le bassin du fleuve Niger au Bénin

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Avec une étendue d’environ 48 000 km² (presque 42 % de la superficie nationale), le bassin béninois du fleuve Niger est un des quatre grands ensembles hydrographiques du Bénin. La présente étude s’intéresse aux dynamiques environnementales qui affectent ce bassin et envisage des solutions de gestion intégrée et durable de ses ressources à valeurs écologique et socioéconomique.

Les données utilisées concernent les paramètres hydro-climatiques (pluie, température, débits), les unités pédologiques, les unités d’occupations du sol de même que les données et informations issues d’enquêtes effectuées sur le terrain. Ces données et informations ont été obtenues par la documentation complétée par les investigations de terrain. Des outils d’analyses et de traitements statistiques et cartographiques (cartes d’occupation du sol de 1995 et 2013) ont été mis à contribution pour mettre évidence les différentes mutations qui affectent les principales composantes environnementales du milieu d’étude.

Le bassin est caractérisé par une instabilité pluviométrique doublée d’une tendance à la hausse des températures minimales notamment. Les irrégularités pluviométriques affectent les ressources en eau (diminution des débits en cas de sécheresse et inondations qui accompagnent les excès pluviométriques). En outre, le milieu est le siège des activités agropastorales menées par une population en pleine croissance avec des pratiques et techniques peu respectueuses des composantes environnementales. À cela s’ajoute l’exploitation forestière qui a pris de l’ampleur souvent au mépris des normes réglementaires. Il s’ensuit alors une dégradation du couvert végétal (y compris celui des aires protégées) qui entraîne le dénudement des berges et accentue l’érosion des sols. Des politiques alternatives de gestion intégrée et rationnelle méritent donc d’être mises en œuvre pour assurer une durabilité des ressources naturelles de ce milieu.

**Keywords:** Bénin, bassin du Niger, mutations hydro-climatiques, pressions anthropiques, politiques alternatives
Tracking Quaternary and Neogene Landscape Evolution through the geoecodynamics of fishes: unique proxy of tenures and mode of Africa’s dambos and depocentres

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In the framework of Earth System Science, landscapes are the templates structuring the biosphere; these ‘membranes’ interfacing between exosphere and geosphere preserve remarkably rich evolutionary records that are nonetheless challenging to read. As the focus of persistent hydrological processes, wetlands especially hold a pivotal role as research archives. This presentation highlights exciting developments in geobiology, exploiting the genetics of freshwater fishes as an evolutionary record to resolve wetland evolution across Late Cenozoic Africa. This ‘Geoecodynamics Approach’ exploits the genomic record of extant species to decipher dynamics of biota, landforms and earth surface regimes down to local spatio-temporal scales [S Afr J Geol 2011 114:489-514 https://sites.google.com/site/fpdcotterill/research/landscape-evolution-and-african-geology/].

Hitherto challenging problems in palaeoenvironments can be quantified by focal studies of species studied as biotic indicators of landscape evolution. Thus, using fishes, molecular clocks can date the tempo and mode of speciation to quantify where and when formative events etched, eroded, buried, warped and crumpled the earth’s surface. Here we focus on a recently completed study of the evolutionary history of Cyprinodontiform fishes. The remarkable life history evolution of these small fishes – especially annualism – has maintained their high fidelity to seasonally desiccated floodplains in tropical savannas over evolutionary timescales. Deciphering speciation patterns of the numerous local endemics obtains up hitherto unobtainable fine-scaled spatio-temporal resolution into wetland dynamics. Molecular genetics opens up the finer details of their genomic record shaped by the evolutionary history of these fishes. Refined molecular clock calibrations on Bayesian phylogenetic reconstructions recover ancestral-area relationships on a dated “time-tree”. The biotic evolutionary patterns it reveals provide a proxy of the tenures and turnovers of individual landforms – specifically dambos and floodplains - over the past 10 Ma. The focus of this narrative on evolving wetlands opens up a new window into the Late Cenozoic evolution of Africa’s tropical savannah landscapes. It reconstructs when “landscape-shaping” events alternatively linked and isolated the substantive wetlands that arguably constituted hominin source-habitat. These analyses confer powerful insights into the relationship between palaeoecological dynamics, and external forcing agents, pertinently climate and tectonics. Focusing on East Africa and the Zambezian Region, this presentation evaluates this emerging narrative of African wetland evolution in the framework of the Delta Hypothesis, linking hominins to tropical wetlands.

Keywords: geoecodynamics, molecular clocks, phylogenetic reconstructions

Palaeoenvironmental and evolutionary implications of fossil frog assemblages from the South African west and south coasts

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Fossil frogs are useful palaeoenvironmental indicators due to the fact that they are particularly sensitive to climate change, especially to fluctuations in warming and moisture levels. This is due to their permeable skin, unshelled eggs, biphasic ontogeny, and the fact that the
timing of breeding is driven by environmental cues such as temperature and moisture. Fossil frog assemblages may therefore be used to trace palaeoenvironmental change over time. An advantage of these assemblages is that they reflect the local environment as frogs have small home ranges and may potentially provide information on the types of water bodies available, and also on the terrestrial environment. Frog bones have been recovered from a number of South African west and south coast archaeological and palaeontological sites dating to the early Pliocene, Pleistocene and Holocene. Analysis of the assemblages incorporates taxonomy and taphonomy, and in some cases osteohistology which was used to examine growth and demographic patterns. The Cape amphibian fauna is recognised as being globally significant, but the origin and evolution of the high degree of endemism of south-western Cape frogs is currently unknown. Results have contributed new information on past distribution patterns of South African frog taxa and indicates that climate change may profoundly alter a local frog community.

Keywords: Anura, fossil, Pleistocene, palaeoclimate

The role of geophytes in stone-age hunter-gatherer diets

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Underground storage organs (USOs) serve as a staple source of carbohydrates for many hunter-gatherer societies and they feature prominently in discussions of diets of early modern humans. While the way of life of hunter-gatherers in South Africa’s Cape is no longer in existence, there is extensive historical and archaeological evidence of hunter-gatherers’ use of such plants as foodstuffs. This is to be expected, given that the Cape supports the largest concentration of plants with USOs globally. The southern Cape is the location of several Middle Stone Age sites that are highly significant to research on the origins of behaviourally modern humans, and this provided the context for our research. Here we evaluate the foraging potential of USOs by identifying how abundant edible biomass is in a coastal setting of the southern Cape, how easily it is gathered, and how nutritious it is. We staged a range of foraging events to provide an indication of the potential return rates for selected USOs when a forager is likely to be naïve about foraging for them. Nearly all of the sites sampled (83%) contained at least one edible USO species, and the edible biomass can be highly concentrated in space. The edible USO biomass fell within the range of biomass observed in areas supporting extant hunter-gatherer communities. The six USO species we assessed for nutritional content contained between 40-228 calories/100 g. They also grow near the soil surface and were gathered with minimal effort. Some 50% of the foraging events conducted yielded enough calories to meet the daily requirements of a hunter-gatherer of small stature within 2 hours. Thus, we demonstrate that USOs are a readily available food resource in the southern Cape landscape and that they more than likely played a critical role in providing food for early humans.

Keywords: hunter-gatherer, USOs, biomass, Middle Stone Age, return rates

New evidence for the technological development and substance economy during the Middle Stone Age (MSA) from Mumba in northern Tanzania

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Recent palaeoenvironmental and geo-chronological evidence suggests that during the glaciation period in northern hemisphere, tropical Africa experienced prolonged series of arid-dry climatic conditions with short burst rainy seasons. Such unfavourable environmental
conditions that dominated most of Pleistocene, influenced the rate of of speciation, extinction, replacements and is said to be one of the leading factors for hominin dispersal from their ancestral land in tropical Africa to new geographical niches in Eurasia. Genetic, human fossils and archaeological records suggest that a second wave of human dispersal to Eurasia occurred somewhere around 100,000 to 50,000 years ago, whereby early African modern humans dispersed from their motherland in Africa. Ultimately, they colonized new continents and replaced other archaic humans globally, with some degree of interbreeding. They managed to continue existing in new environments probably because of advanced technological and behavioral capabilities. This interpretation can be clarified and widely supported by human fossil and archaeological evidence in Africa where modern humans evolved for the first time. However, the subject matter related to technologies, subsistence and behavioral shifts is a hotly debated topic in archaeology. This paper contributes to the ongoing discussion by providing new technological evidence from recent archaeological excavation at Mumba rock-shelter in northern Tanzania.

Keywords: MSA Technological, subsistence, behavioural shifts

Later Stone Age and Iron Age Cultures at Kansyore Island in Western Uganda

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This presentation is part of an ongoing project. The coexistence and overlap of Kansyore (LSA) and Urewe pottery (IA) in time and space has been reported at several East African sites and at Kansyore Island in particular. However, why and how this occurred is not clear due to the assumption of accidental mixture. The study intends to reconstruct the cultural history of these two sister cultures (Late Stone Age and Iron Age) believed to have accidental admixtures despite their separate geographical locations and archaeological constructs. Emphasis is placed more on the role of historical and environmental factors for the migration, contact and social organization of these cultures using pottery resemblances and other artefacts as archaeological props. These will be supplemented by ethnographic methodology such as in-depth interviews, key informants, archival records and folk tales. The theory of cultural resemblances whether in material or ideational culture has a lot to borrow from history and evidence. Some fragmented evidence exists from accumulated research efforts in the areas of study. What is lacking is the historical foundation of the contact period and pre-contact periods if any, or the possibility of independent invention of early stone tools by the late stone culture. Which culture existed first, who were the migrants or did they exist independently of one another at their different aboriginal bases? The presentation aims at examining the cultural characteristics of the LSA/IA interaction at Kansyore Island. The objectives are to examine the cultural behaviour of the Later Stone Age and Iron Age people. In so doing, the research will examine models of hunter-gatherer and food production interaction, settlement and mobility patterns that characterized the LSA/IA transition period.

Keywords: Later Stone Age, Iron Age, interaction, co-existence, environment

A classification of subsistence lifestyles and land use in prehistoric Africa

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The Iron Age in sub-Saharan Africa is characterized by not only the appearance of metallurgy, but in many areas, also the first widespread establishment of agricultural societies. The shift from foraging to farming and metallurgy in Africa fundamentally altered the relationship between humans and their environment, and may have had widespread consequences for regional climate and hydrology, which in turn could have had feedback effects on human populations. During the period from approximately 1000 BCE to 1500 CE, the Iron Age spread episodically from West Africa east and south, with periods of rapid spread interspersed with stagnation and even abandonment of agricultural lifestyles. Theories for this sporadic transition range from
exogenous environmental factors and mass migrations, to animal disease distributions and endogenous niche construction in response to growing populations. The Quantifying the economic and environmental transformation of Africa during the Iron Age (ACACIA) project seeks to explore this problem through the use of integrated human-environment models. As a first step towards developing these models, this paper presents a societal-subsistence based classification of land use in sub-Saharan Africa during the Iron Age. Each category in the classification considers environmental, geographic, temporal, and technological attributes, but also allows for some variation within each category. The classification is based on a broad synthesis of published archaeological, archaeobotanical, and ethnographic observations, and illustrates the various degrees of land use intensity employed by different groups at different times, e.g. wild-forage, herding, vegetable or cereal crops, and the firing of pottery or iron metallurgy. Our classification scheme will inform the development of models that will be used to quantify the impact of Iron Age Africans on their local and regional environments, and test hypotheses about the importance of human agency for the development of African environments over the late Holocene.

Keywords: archaeology, land use, Iron Age, environment, modelling

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Early modern human fossils: A tale of earthquakes and cannibalism

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The thirteen South African coastal caves with Middle Stone Age (MSA) occupation have greatly illuminated our understanding of early modern human origins, but significant numbers of human fossils occur in only two. Die Kelders Cave 1 (DKC1) yielded 27 fossils (minimum 10 individuals) and Klasies River Mouth (KRM) ~52 fossils, but representing only a few individuals. At KRM cannibalism is strongly implicated in fossil accumulation, but at DKC1 the reason has remained unclear. We show that DKC1 is located adjacent to a major geological fault, which was the source of powerful earthquakes during MSA times. Resulting massive rock falls in the uppermost two MSA horizons correlate strongly with concentrations of human remains, pointing to seismicity as the cause of mortality and fossil accumulation. Seismicity may also explain the overwhelming dominance of juvenile remains at DKC1 (only adults at KRM), probably most exposed to death by this agency.

Keywords: human fossils, Die Kelders, earthquakes
Towards a multidisciplinary approach to long-term ecology of climate-plant-fire interactions across the Mediterranean Biome

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Mediterranean biomes occupy only 5% of global terrestrial ecosystems, but contain some 20% of all plant species (Cowling et al., 1996). Conserving this biodiversity necessitates a more complete understanding of the role of fire in Mediterranean climate environments, since fire is known to be one of the key influencing factors. Current research on fire ecology is increasingly focused on the evolutionary and ecological role that fire has on shaping plant functional types and community assembly. A longer temporal perspective is required in order to assess the relative importance of different drivers, such as climate, fire, herbivory and their thresholds.

Despite the existence of several long, well-dated, high resolution records of vegetation change and fire regimes at centennial to millennial time, few address questions related to the long-term role of fire in the Mediterranean biome as a disturbance factor and how it interacts with plant species or potentially determines the presence of fire-trait adaptations or exaptations.

Our aim in this study is to explore how Mediterranean Biome (MB) plant species that express clear fire-adaptation traits have responded to changing fire regimes over longer-term timescales.

The objective is to analyze late Quaternary sediment cores from the world’s five MB regions: the Mediterranean Basin, the South African Cape, southwestern Australia, central Chile and southern California. In each, different proxies for vegetation - namely fossil pollen, macrofossils and non-pollen palynomorphs - and for fire occurrence - i.e. different sizes of charcoal particles - will be used to reconstruct vegetation and fire dynamics. Vegetation proxies will be grouped under fire-trait and plant functional types in order to compare plant community changes across each biome. Independent climate change proxies are available in some regions, while in others past climate models for particular time-windows can be used to shed light on long term climate variability.

In addition, we will test the ability of an ecosystem to recover after disturbance to a previous status (resilience) at different selected time intervals with an agent-based model wherein fire ignition is simulated in an area and vegetation response is inferred from the actual fossil data. The expected recovery time of plants will be validated through analysis of their rates of change as observed in the fossil sequence. This study represents a first step in systematically exploring vegetation-fire dynamics at the biome level, and will lead to the development of a reliable quantitative model of the effect of fire in Mediterranean vegetation communities.

Keywords: fire plant traits, fire ecology, Mediterranean, simulation

References
Palaeobiodiversity in subtropical Africa - ecological assessment of a conceptual model approach

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The timing and abruptness of the mid-Holocene vegetation decline in subtropical Africa has been investigated during the past two decades using a wide range of model and palaeoproxy reconstruction approaches. While some studies indicate an abrupt collapse of vegetation at the ending of the African Humid Period (AHP), others propose a gradual decline. Claussen et al. (2013) used a conceptual model considering the effect of plant diversity in terms of moisture requirements on vegetation-precipitation feedback and on the abruptness of vegetation cover decline. They suggest that the strength of vegetation-precipitation feedback depends on the plant composition. High plant diversity could stabilize an ecosystem, whereas a reduction in plant diversity might allow for an abrupt regime shift. Based on new data the role of biodiversity for subtropical ecosystem stability is assessed here. We investigate how the four main phytogeographical plant types reconstructed by Hély et al. (2014) were distributed, structured and organized from species to landscape level and how they might have responded to changes in mean annual precipitation. In the light of these findings, the conceptual model by Claussen et al. (2013) is re-tuned and critically assessed. The original model captures the buffering effect of biodiversity and the potential role of individual functional plant types on ecosystem stability for simple cases. The application to AHP conditions requires a more complex approach. Tropical taxa cannot be simulated because these species grow in gallery forests where they are only indirectly linked to local precipitation. Niche occupation, concurrence and co-existence of different plant types cannot be properly simulated. In a new set up, the representation of the ecological niche and precipitation threshold values are adapted to reconstructed vegetation. First results indicate a more realistic behavior of subtropical plants interacting together with precipitation under changing climate conditions. For a deeper insight into AHP community dynamics and climate-vegetation feedback, further aspects need to be improved such as individual feedback coefficients, the calculation of mean vegetation and the relation of growth and water availability.

Keywords: African Humid Period, palaeobiodiversity, ecosystem stability, climate-vegetation feedback

References


First results from the deep drilling at Chew Bahir (S-Ethiopia)

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Chew Bahir is one of the five sites drilled during 2013-14 in the framework of the Hominin Sites and Palaeolakes Drilling Project (HSPDP), in order to understand the climate and environmental history during the evolution of hominins in East Africa. The Chew Bahir record will concentrate on the younger part of that history and is further supported by collaborating projects, including the Cologne Collaborative Research Centre (CRC-806), the German and the British International Continental Drilling Project (ICDP). The site is located in the southern part of the Main Ethiopian Rift (MER) at about 500 m asl and lies close to the famous excavation of anatomically modern humans at Omo Kibish. Following a transect from west to east, 6 short cores (max. depth 11m) already delivered the basic understanding of sedimentation processes from the border to the centre of that former lake, mainly by using XRF scanning data. The age-models for these cores are based on 32 AMS radiocarbon dates, which roughly place the base of the centremost core at about 45ka BP. The K-record is one of the most promising proxies in all these cores allowing a climatic interpretation of wet and dry cycles (dry LGM, wet African Humid Period, dry Younger Dryas, wet early Holocene and dry Holocene since 5 ka BP) mostly triggered by solar radiation as well as changes in the position of the ITCZ and the Congo Air Boundary (CAB). In March 2014, a 41.5m deep core was taken from the centre of that basin. As with the short cores, the K counts measured by XRF scanning show fluctuations, which reflect climate change. 14C and OSL dating as well as palaeomagnetic measurements on this core are still in progress, but will be available by the time of the meeting. Preliminary stratigraphic indications suggest that this record may reach back to MIS5-MIS6. In Nov-Dec 2014 the HSPDP deep drilling down to the target depth of 400m will take place and probably allows a palaeoenvironmental reconstruction back in time to nearly the origin of our ancestors.

Keywords: Chew Bahir, palaeoecology, Hominins, Ethiopia

Recent archaeological excavations in high altitude caves from Mt. Elgon, in Western Kenya: Preliminary findings

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In this paper, we present the results of recent archaeological investigation at Chepnyalil and Kiptogot rock shelters in Mount Elgon, Western Kenya. The eastern flank of Mt. Elgon is penetrated by lava tube caves of early Miocene age and many of these caves have been settled by humans in the past. Recent excavation unearthed lithic tool assemblages, which resemble both Middle Stone Age (MSA) and Late Stone Age (LSA) technologies (e.g. levallois and discoid core reduction methods) and typologies (retouched points,
bladelets, geometrics). Although the archaeological record from the greater Mt Elgon area still suffers from major gaps especially in chronometric analyses, Optically Stimulated Luminescence (OSL) chronologies are currently underway and, if confirmed, the MSA and LSA typological classification, and by association the implied occupation of the caves, provides the first evidence of MSA occupation in this topographically elevated region of East Africa. Furthermore, as environmental proxies indicate that the late Pleistocene to early Holocene was marked by increased aridity, it suggests an important link between the environment and human adaptations in higher elevation ecosystems.

Keywords: Mt Elgon, Chepnyalil, high elevation human adaptation

Northern Hemisphere control of deglacial vegetation changes in the Rufiji uplands (Tanzania)

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In tropical Eastern Africa, vegetation distribution is largely controlled by regional hydrology which has varied over the past 20,000 years. Therefore, accurate reconstructions of past vegetation and hydrological changes are crucial to better understand climate variability in the tropical Eastern African region. Through high-resolution pollen records from a marine sediment core recovered from offshore of the Rufiji River, our data show significant shifts in pollen assemblages during the last deglaciation identifying, through respective changes in both upland and lowland vegetation, specific responses of plant communities to atmospheric (precipitation) and coastal (coastal dynamics/sea level changes) alterations. Specifically, an interval of maximum pollen representation of dry and open vegetation occurred during the Northern Hemisphere cold Heinrich event 1 (H1) suggesting the expansion of drier upland vegetation under arid conditions. This dry spell is followed by an interval in which forest and humid woodland expanded, indicating a hydrologic shift towards more humid conditions. Droughts during H1 and the return to humid conditions around ~14.8 kyr BP in the uplands are primarily attributed to latitudinal shifts of the Intertropical Convergence Zone (ITCZ) driven by high-latitude Northern Hemisphere climatic fluctuations. Additionally, our results show that the lowland vegetation, consisting of well developed salt marshes and mangroves in a successional pattern typical for vegetation occurring in intertidal habitats, has responded mainly to local coastal dynamics related to marine inundation frequencies and soil salinity in the Rufiji Delta as well as local moisture availability. Lowland vegetation shows a substantial expansion of mangrove trees after ~14.8 kyr BP suggesting an increased moisture availability and river runoff in the coastal area. The results of this study highlight the de-coupled climatic and environmental processes to which vegetation in the uplands and the Rufiji Delta has responded during the last deglaciation.

Keywords: pollen record, upland vegetation, Rufiji, Heinrich event 1, ITCZ

Developing a regional network of high-resolution pollen data and historical records to constrain the spreading of maize through East Africa

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Historical records place the introduction of maize (Zea mays) in East Africa (EA) around the end of the 16th century, but in many inland regions it became a common food crop only in the 20th century. The aim of this study
is to document the introduction and spread of maize through EA with greater temporal and spatial resolution, using high-resolution pollen data from across the region correlated with historical records. To attain this goal, sediment cores from lakes in Kenya, Tanzania and Uganda are studied for fossil pollen content, focusing specifically on the large grass pollen grains uniquely attributed to maize. Lead-210 and/or Cesium-137 dating is required to date the regional first appearance of maize with appropriate precision. Where available, historical agricultural records are used to quantify the time difference between the documented start of maize cultivation and its first appearance in a local pollen record. Preliminary results from Lake Challa (southern Kenya, close to Mt Kilimanjaro) and Lake Simbi (western Kenya, close to Lake Victoria) date the first appearances of maize around AD 1860 and 1940, respectively. Integration of our results from these and other East African lakes with equally well-constrained published data may eventually create a chronological marker horizon for pollen records of East Africa’s recent environmental history.

Keywords: maize, pollen, Kenya, Lake Challa, Lake Simbi

Bush encroachment and long-term savanna dynamics: the Mursi and the Mago National Park in southwestern Ethiopia

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Savannas sustain the livelihoods of many thousands of people in Africa, while environmental policies addressing savanna preservation have been highly controversial (Homewood, 2004). This is especially so in connection with bush encroachment, an important factor reducing available grazing areas for both domestic and wild animals. A lively debate has centred on tree-grass coexistence in savannas and on long-term ecosystem response to disturbance. The less studied rangelands of East Africa, where national park management is often in conflict with local communities, provide a good opportunity to test various hypotheses about savanna dynamics and thus to help the development of new guidelines for the protection of this environment.

We previously studied the role of bush encroachment at centennial to millennial time-scales in the Dara range of the Mago National Park (MNP), an area inhabited by Mursi agro-pastoralists. We showed that bush encroachment is a transient state in savannas, fitting the control hypothesis for alternative stable states (Gil-Romera et al., 2010). Our aim in the present paper is to explore the driving factors of bush encroachment at decennial time-scales; specifically the role of livestock herding - including the impacts of fire and grazing - and other auto-ecological processes such as fast species-specific seedling recruitment and self-thinning.

We surveyed 22 different areas in the Mursi region, within the MNP some of which had been subject to fire and grazing over the past 5 years (8 sites), some over the past 10 years (7 sites) and some which had not been fired or grazed for 25 years or more (7 sites). We recorded coordinates and biometric variables (height, canopy and dbh) for every woody taxon in 50x50 m plots, and then analysed the spatial pattern of the different plots using point-pattern analyses. Specifically, we employed the bivariate O-Ring statistic, tested with a toroidal shift null model, to evaluate spatial association in the establishment and survival of woody plant species, and mark-correlation functions to assess the spatial correlation of biometric variables within and between woody plant species.

The results of this research will help to define the spatio-temporal dynamics of bush encroachment, including the role of fire and grazing, and will provide new data on a crucial environmental process affecting pastoralists and agro-pastoralists in Africa.

Keywords: Africa, savannas, point-pattern analysis, bivariate statistics, woody encroachment, pastoralism

References

Poster Presentations

An analysis of the diet of microvertebrate fauna within the Laetoli site

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Laetoli is a site in Tanzania that is known for its hominin skeletal and trace fossil remains of Australopithecus afarensis, the oldest hominin footprint tracks, and its prolific faunal assemblage. Understanding the evolution of hominins requires an understanding of the habitats that they existed in. Previous research has focused on identifying the diet of macrovertebrate fauna using isotopic analysis. This can be problematic in attempting to interpret the palaeoenvironment within a constrained area, such as Laetoli, because of the expanded home ranges and wide habitat tolerances of some of the larger herbivores. The purpose of this research is to investigate the diet of microvertebrates found within the Laetoli site using isotopic analysis from which a finer resolution of habitat structures within the Laetoli site can be attained.

Keywords: microvertebrate, isotopic analysis, Laetoli

Climate disturbance in the eastern Democratic Republic of Congo

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Democratic Republic of the Congo, specifically in the territories of Uvira, Fizi, Mwenga and Shabunda, the influx of Rwandan and Burundian refugees in the years 1992 and 1994 caused massive logging. Forest trees from reforestation were felled for firewood and construction. This massive timber harvesting in this part of the country, caused climatic disturbances to such an extent that the agricultural calendar was changed. This section has three ecological zones including plain, coastal resources and the highlands. It also has two seasons, the rainy season runs from September to June and the dry season from July to August. The seedlings just practiced from September, so at the beginning of the rainy season, has been postponed to November or even December following the continuation of the dry season, and that in all the ecological zones. This climate disruption had many other consequences. There has been some increase in heat in this part of the country during the night than during the day. The flow of many rivers has declined significantly and many other small rivers have dried. There has been development of plant diseases, especially disease called cassava mosaic while cassava is the main staple food consumed . Both wild and domestic animals were killed. Famine and poverty are widespread. Many people, especially small children, died of diseases caused by the climatic disturbance. Advocated by the government and many organizations development solution that time was: (i) reforestation of denuded areas; (ii) formally prohibited massive timber harvest; (iii) having an authorization for cutting wood. Currently, the proposed solutions are: (i) support the actions of civil society to strengthen the international legal framework for the conservation of protected areas and biological diversity at the national level; (ii) facilitate the exchange and development of techniques for conservation and sustainable use of biodiversity. The Democratic Republic of Congo has signed and ratified several international conventions on the protection of the environment, it would be desirable that the International Union for Conservation of Nature (IUCN) closely monitors the applicability of these conventions in our country.

Keywords: climate disturbance, Democratic Republic of Congo, deforestation
A 10000 14C yr diatom record from Napoleon Gulf and Sango Bay, Lake Victoria

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Diatom assemblages of two cores collected from the Ugandan side of Lake Victoria at the Napoleon gulf and Sango bay provide evidence of long term changes in lake levels and mixing regimes ca. 10,500 years to present. The period from ca. 10500 – 8100 cal yr BP was dominated by high proportions of Aulacoseira granulata and A. ambigua at the expense of A. nyasensis, suggesting a phase of moderate water levels, reduced forest cover in the catchment area and hence strong turbulence. However, from ca. 8100 – 6600 cal. yr. BP planktonic diatoms, A. nyassensis and Nitzschia fonticola increased in abundance, implying an increase in lake level probably due to increased precipitation in the lake basin. This period is also characterized by increased forest vegetation cover as reflected by phytolith assemblages. However, the period from ca 5900 – 1400 cal. yr. BP was characterized by regular fluctuations in lake levels, mixing regimes and vegetation in the catchment areas. An abrupt increase in lake level occurred around 1965 – 1975 AD as indicated by the sudden increase in Aulacoseira species. The lake level however, reduced significantly from ca. 1977 to 2001 AD followed by slight increase recorded from 2001 to 2009 AD. During these phases, there was significant reduction in forest cover at the expense of Poaceae and Cyperaceae in the catchment areas.

Keywords: diatoms, Napoleon Gulf, Sango Bay, Lake Victoria
Palaeoenvironmental evolution of the Afromontane forest in the South Kivu area (Congo D.R.) during the two last millennia

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Pollen analysis of a 2.20 m sedimentary sequence of Musisi-Karashoma mountain marsh records the palaeoenvironmental evolution of the Afromontane forest in the South Kivu area (Congo D.R.) during the two last millennia. Two thousand years ago, the mountainous rain forest developed widely on the Congo ridge of the Kivu country. Around 500 yr A.D., a cold climatic pulse favoured the expansion of Hagenia and at the 9th century A.D. the forest declined a bit probably due to a first human impact of limited importance. The irreversible degradation of the original vegetation occurred during the three last centuries. This fact is detected by the progression in the forest of mesophilous taxa, among others of Hagenia. Comparison with former palynological research gives an idea of the environmental evolution of all the Southern Kivu area. On the lake borders, the first human impact happened between 1800 yr. B.P. and 1500 yr. B.P. During this period, forest gave ground to savannas. These spread in altitude from the 9th till the 12th century because of noticeable anthropogenic influence. Then, forest made up lost ground, probably under a fresh climate consequently of the “Neoglacial period” of Eastern Africa. Likely during the course of the 17th century, with the settlement of new populations in the Interlacustrine area, human impact on the environment became more intensive. A generalized regression of vegetation then took place with a wide progression of open woodlands and savannas in the lowlands and of secondary forest in the highlands.

Keywords: Congo D.R., Southern Kivu, upper Holocene, palynology, palaeoenvironment

Precipitation variability in the Sahel during the last 2000 years revealed by archaeological shell middens in Senegal

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In the second half of the 20th century, a strong multidecadal drought occurred in the Sahel that had catastrophic social and economic consequences. This event made it urgent to better understand the forcing driving precipitation changes in the Sahel and potential impact of anthropogenic global warming. Here, we reconstruct past changes of the precipitation regime in the Saloum Delta, Senegal, from stable isotope analyses in fossil shells of Senilia senilis. The shells were collected in large radiocarbon dated shell middens built by ancient fishermen during the last two millennia. Oxygen isotopic composition in shells is related to salinity conditions in this hypersaline estuary that is very sensitive to changes in precipitation and evaporation. Our dataset shows that salinity is today at its highest level in the past 2000 years. These values were reached abruptly in the 20th century and lie outside the range of natural climatic variability in this site. Monthly resolved isotopic profiles in fossil shells combined with analyses of shell growth lines allowed us to explore the role of rainfall seasonality in the variability of mean conditions.

Keywords: Sahel, monsoon, shell middens, sclerochronology, stable isotopes
Cultural proxies for drought in the Iron Age of South-eastern Africa

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Intensive surveys of the Mapungubwe landscape have yielded some 1150 Iron Age sites, 4% of which include burnt daga (mud) structures. Ethnographic data indicate that the structures were probably purposefully burnt as a ritual of cleansing during times of severe drought. Significantly, the burnings correlate with isotopic data for low rainfall. Simultaneous burnings occur over a wide area of south-east Africa, from KwaZulu-Natal through Zimbabwe to southern Malawi and Zambia. This wide distribution in the summer rainfall region suggests that the droughts are linked to a common cause, such as El Niño events. New baobab data support the correlations and help to date the droughts more specifically.

Keywords: baobab sequence, droughts, isotope data, Mapungubwe landscape, ritual burnings

References


A high resolution proxy rainfall record from isotopic analysis of trees from southern Africa

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There are relatively few high-resolution palaeo-precipitation proxy records from southern Africa that can be used to test the driving forces in the climate system. Instrumental records and historic reconstructions extend to about 200-year time depth, but this does not allow an assessment of responses to the solar minimum during the Little Ice Age. Tree ring chronologies are also limited in both time depth and spatial distribution because few tree species have the desired physiological responses. Stable carbon isotope analysis has yielded promising results but until now has not been systematically applied. The stable isotope chronologies of four baobab trees from the Pafuri area, and five baobabs from the Mapungubwe area provide local rainfall proxies. These records extend the previous tree ring chronology from the region from 201 years up to 1000 years. An additional tree ring record from yellowwood trees provides a similar length isotope chronology from KwaZulu-Natal. These two records provide a vital context for understanding the role of climate in the Iron Age history of southern Africa. In addition, the record can be correlated with oceanic forcing factors such as the El Niño/Southern Oscillation, the Indian Ocean Dipole Moment Index and sea-surface temperatures in the southwestern Indian Ocean. The role of ENSO is less significant that the Indian Ocean forcing. A significant reduction in rainfall from the Medieval Warm Period to the Little Ice Age correlates with changes in the global ocean temperatures, and is argued to be the result of a northward shift in the westerly belt rather than a southerly shift in the ITCZ as has been reported from central eastern Africa.

Keywords: isotope dendroclimatology, baobab trees, yellowwood trees, palaeorainfall, southern Africa, Little Ice Age
Rainfall variability in present-day KwaZulu-Natal, South Africa, during the nineteenth century

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Attempts at document-based historical climate reconstructions for Africa south of the Sahara are hampered by the comparatively recent development of written cultures in many regions. Exceptions are those areas which were either subject to colonial governance or had a history of contact with European colonial powers. Historical climate information for former Natal and Zululand (now KwaZulu-Natal) in eastern South Africa can be derived from published monographs, long-running newspapers such as the Natal Witness, colonial almanacs and Blue Books, and narratives within unpublished diaries, letters and annual reports produced by various groups of British, American, German and Norwegian missionaries. Here we utilise these sources to produce the first chronology of rainfall variability for Natal and Zululand, spanning the period from the earliest documented travel through the region in the 1820s until 1900. Results for years prior to 1860 are annually-resolved, and for 1860-1900 are seasonally-resolved. We compare our results with reconstructions of rainfall variability from other regions of southern Africa, and consider the influence of global climate modes such as the El Niño-Southern Oscillation upon periods of drought and excess rainfall identified from documentary materials.

Keywords: rainfall reconstruction, ENSO, South Africa, 19th century, documentary evidence

Late Holocene trends of sediment based heavy metal concentrations in Lake Victoria: Ecological impact assessment

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This study assessed the trends of sediment based heavy metal (Cu, Cr, Pb, Zn, Ni, As, Hg) concentrations and their ecological impact at the inlet of river Kagera (KAG2) and Napoleon Gulf (LVNG2) sites of Lake Victoria in Uganda during the late Holocene. Total heavy metal concentrations were determined by Energy Dispersive X-ray Fluorescence (EDXRF) spectrometry and radiocarbon ages using the Accelerator Mass Spectrometry method. Sediments were evaluated based on the United States Environmental Protection Agency Sediment Quality Guidelines (USEPA SQGs), Ecological risk factor (Er) and Potential ecological risk index (RI). The results indicate that heavy metals in KAG2 (Hg, Cr, Ni) and LVNG2 (Hg, As) showed increasing concentrations (~0.05) towards the recent years of the late Holocene period. Additionally, Cr, Cu and Ni recorded moderate to heavy pollution in KAG2, ca. 70 cal yrs BP to 2008 AD and no pollution, ca. 250-190 cal yrs BP. These can be attributed to increased anthropogenic activities in recent years. For instance, the concentrations of Hg, As and Cu in LVNG2 after the global industrial period (after 1750 AD to 2008 AD) were higher (~0.05) than concentrations before the industrial period (before 1750 AD). The heavy metals also responded to climatic changes in the past. For instance they recorded decreasing concentrations in LVNG2 during the East Africa drought period (ca. 870-1270 AD) while high concentrations were recorded in LVNG2 and KAG2 between ca. 1270-1850 AD coinciding with the equatorial East Africa wet period. Mercury posed moderate to considerable potential ecological risk in both KAG2 and LVNG2 between ca. 350 cal yrs BP to 2008 AD. Other heavy metals posed no ecological risk. However, there was an overall low ecological risk in the studied heavy metals in both KAG2 and LVNG2 during the late Holocene.

Keywords: Holocene, sediment, metal, Lake Victoria
Changes in south-east African tropical cyclone landfall frequency over the past 161 years

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Little is known about the spatial and temporal trends of tropical cyclone landfalls in the south-west Indian Ocean during recent historical times, specifically the last ca. 100 years. There is a perception, driven primarily by the media, that the frequency of tropical cyclones making landfall on Madagascar and Mozambique is increasing. Through multivariate time series analysis on three storm track records spanning periods of 66 to 161 years, we establish that much of the perceived change in storm numbers can be attributed to improvements in storm detection methods over the past century. Furthermore, we find no statistically significant trends in the frequency of tropical cyclone landfalls over Madagascar and Mozambique over the past six decades, despite the availability of more comprehensive records. There is, however, considerable interannual variability in the number of storms making landfall over the countries investigated; most likely driven by cyclical atmospheric forcing, including ENSO and the Quasi-Biennial Oscillation. Spatially, recent trends indicate an increasing number of tropical cyclones tracking to the south of Madagascar, potentially associated with the southward shift of the 26°C isotherm, combined with a decrease in the steering flow during La Niña years.

Keywords: tropical cyclones, frequency, tracking direction, south-west Indian Ocean, climate change

“But what silence! No more gazelles…”: Historical and contemporary occurrence of mammals in Lesotho, southern Africa

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As human populations and resource demands continue to grow at an ever increasing rate, natural habitats have been in rapid decline and wild fauna decimated at an unprecedented rate. Yet, the dynamics of historical and contemporary mammalian species occurrence and extinctions within given regions are seldom fully understood. Here we investigate the occurrence and status of mammals for the mountain Kingdom of Lesotho, from the late Pleistocene to the present-day. Such work adds valuable knowledge to understanding the historical environmental heritage of the region, which may then be disseminated into national environmental reports, the school environmental curriculum, and at National Parks and Heritage Sites.

We provide historical timelines and records for all reported mammalian taxa (excluding smaller Rodentia) for Lesotho and the surrounding region; based on six published archaeological excavations, faunal images depicted on San rock art sites, several hundred 19th – 20th C historical documentary records (e.g. missionary letters, newspapers), and 59 recent oral history interviews. All known drought, flood, snow and severe cold events are tracked in parallel with the faunal record from ca 1830 onwards. Further information on regional interactions with wildlife (e.g. major hunting events), human conflicts and population expansion are built into the chronology.

We record 58 species of mammals for Lesotho and the surrounding region over the past ca 21 000 yrs, of which only 24 remain today. We document some species occurrences which have not previously been known to the region (e.g. Temminck’s pangolin). Most species were present during the early 19th C, but many regional species extinctions and a major faunal population decline occurred between: 1845-1850, owing mainly to settler
hunting campaigns. Subsequent extinctions have taken place at a wider temporal interval, due to factors including overhunting and human-wildlife conflicts, habitat loss, and some taxa forced into unsuitable mountain refugia where species eventually succumbed to genetic erosion and/or the harsh climate (e.g. the last hartebeest herds died in a snow blizzard). Our results increase current understanding of regional mammalian and environmental changes, such as the timing of historical species occurrences and extinction events and processes in the central-eastern highlands of southern Africa.

Keywords: mammalian change, Holocene, Lesotho

Comparing East African climate model results with lake records over the last 1000 years

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Most of the East Africa’s agriculture depends on the amount and seasonal occurrence of rainfall. This, with other factors such as rapid changes in land use associated with population growth, this region is very sensitive to climate change. However, there is no consensus on future hydroclimatic changes in the region, the drivers responsible for East Africa’s precipitation variability being poorly understood. The general objective of this study is to improve understanding of the mechanisms driving the variability of East Africa’s climate at inter-annual to multi-decadal time scales, using climate-simulation experiments covering the last 1000 years, performed with different global climate models within the framework of the PMIP3/CMIP5 projects. To do so, we first need to assess the reliability of these climate model results by comparing them with proxy-based reconstructions. In East Africa, the only well-dated hydroclimate reconstructions that span the last 1000 years with sufficient time resolution are lake-related records, many of the most useful of them are of lake level. However, the link between simulated precipitation and reconstructed lake level is far from straightforward, hampering direct comparison of the corresponding time series. Consequently, we propose to use a very simple model of lake hydrology that allows translating climate-model output into a simulated lake level record that can then be compared with the reconstruction. To illustrate the potential of this approach, a first test is presented using the 1000-year level-time record of Lake Naivasha in Kenya (Verschuren et al., 2000).

Keywords: model-data comparison, PMIP3, lake level reconstruction

References


Environmental history of Lake Victoria satellite lakes during the last 600 years: Evidence from diatom analysis

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Lakes Kayugi and Kayanja are small satellite lakes situated within the extensive Lwamunda swamp in the western part of Lake Victoria. These lakes were formerly part of Lake Victoria and are believed to have been separated by a 5 km sand bar from the main lake during water level fluctuations about ca. 4000 calendar years ago. This separation caused some endemic cichlid fish species that were formerly found in Lakes Victoria and Nabugabo to take refuge in these small satellite lakes, making them centres of refuge and hence sensitive to environmental change. However, little limnological information is available for these two lakes, as such this study provides the first insights of environmental dynamics of this ecosystem based on diatom assemblages.

Two sediment cores, 22cm and 45 cm long obtained from...
lakes Kayanja and Kayugi respectively, were analyzed for diatom assemblages. The cores were extracted using Renberg gravity corer from near the centre of the lakes. Diatom species assemblages from both lakes were generally few in number with 12 genera recorded in Lake Kayanja and only 8 genera from Lake Kayugi. The diatom assemblages were mainly dominated by Aulacoseira granulata that reflected periods of well-mixed water as a result of low vegetation (forest) cover in the catchment area which exposes the water surface to wind-induced mixing. Presence of benthic species such as Fragilaria, Navicula zonani, Cymbella muelleri, among others were also common, and reflected low lake levels as a result of reduced precipitation and increased temperature that encouraged more evaporation. Generally the diatom records from the two lakes indicate low levels of eutrophication as reflected by low values of Nitzschia: Aulacoseira ratios. This could be attributed to less anthropogenic activities in the catchment area during this period. The analysis also indicated fluctuations in the water levels throughout the period. The period ca. 258-2008 AD indicates fluctuations in the water levels for Lake Kayanja and ca. 600-324 yr. BP for Lake Kayugi, and could adversely affect the ecology of the endemic cichlid species that took refuge in these lakes.

Keywords: diatoms, Lakes Kayugi and Kayanja, Lake Victoria, satellite lakes

Multi-decadal rainfall dipole oscillation over southern Africa modulated by variation of austral summer land-sea contrast

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A rainfall dipole mode characterized by negative correlation between subtropical southern Africa and equatorial eastern Africa has been shown from last millennium palaeo-proxy data, as well as in the most recent 100 years instrumental observation data. The dipole mode exhibits a pronounced multi-decadal to multi-centennial oscillation signal in two datasets. To understand the underlying mechanism, we first evaluated the eight contemporary atmospheric reanalysis data and found that 20CR best represents this dipole character. From the most recent 100 years reanalysis data, we found a pronounced decadal variability of austral summer land temperature over eastern equatorial southern Africa as well as a relatively weak decadal variation in sea surface temperature over the tropical western Indian Ocean. This creates a decadal variation of the land-ocean thermal contrast during the austral summer. Such decadal variability of austral summer land temperature is negatively correlated with the decadal variation of austral summer rainfall over eastern tropical southern Africa. When eastern equatorial southern Africa is in a dry phase, the land-ocean thermal contrast along the eastern coastline tends to strengthen, driving a stronger easterly flow towards the continent. The stronger easterly, via its interaction with the topography, leads to a clockwise circulation anomaly over the inland of the continent, giving rise to a low pressure anomaly and more rainfall in the south. The reverse happens when eastern equatorial Africa is in a wet phase. Therefore, the austral summer land-sea surface temperature contrast variation is the major driver for the rainfall dipole pattern. The variation in land-sea temperature contrast may be remotely influenced by ENSO or PDO.

Keywords: southern African rainfall dipole, multi-decadal oscillation, land-sea contrast
Did we speciate on the Southern Coastal Plain of South Africa?

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Our speciation took place in Africa but when, where and how remain poorly understood. Here, the possibility that anatomically modern humans (AMH) speciated on the Southern Coastal Plain (SCP) of South Africa is explored in terms of palaeolandscapes, palaeoclimates and the archaeological record. AMH appeared sometime around 200 ka (thousand years ago) and by 160 ka were widespread in Africa. Unlike earlier speciation events in our hominin lineage, our speciation does not appear to be associated with new technology leading to increased food extraction. Our speciation appears to instead reflect the first consistent incorporation of marine resources in the diet of our predecessor. Marine resources are diverse and abundant on the SCP and range from beached whales and seals to marine algae and shellfish. Marine resources are far safer and easier to collect from intertidal rocky and sandy shores than foods of equivalent nutrition in terrestrial settings, such as aquatic habitats. Intertidal coastal resources are also impervious to variations in climate, such as drought, that have a large impact on the abundance of terrestrial resources. Rich in calories, protein, fat, omega-3 fatty acids, iodine, iron and zinc, marine resources provide many of the essential nutrients for optimal health and for growing a large brain. Terrestrial aquatic food sources (sedges, fish, amphibians and insects) were being exploited as early as 2 to 1.5 Ma, long before our speciation. In contrast to aquatic foods, marine food resources represent a major new type of food to our lineage. The earliest evidence of a marine diet is from the Pinnacle Point cave site dated to 164 ka. Preserving evidence of a marine diet is unlikely considering past variations in sea level, such that a marine diet was most probably already widespread on the SCP by at least 164 ka. The delay in discovery of such an ideal food source may relate to restricted visits to the coast and conservative dietary behaviours. Habitat and dietary expansion to include the coast and its food types was perhaps forced by the rapid contraction of the SCP during the MIS8 glacial to MIS7 interglacial transition. Populations on the SCP adapting the new behaviour of eating marine resources and who remained isolated for the duration of MIS7 interglacial (20 to 80 kyr or 800 to 3200 25-year generations) may have diverged from other populations in Africa, emerging as AMH who dispersed during the MIS7 interglacial to MIS6 glacial transition. Dispersal away from coastal areas into continental interiors made populations prone to nutrient deficiencies, such as in the case of iodide, with iodide deficiency a persistent problem in many areas today.

Keywords: speciation, human, region of origin, southern coastal plain, South Africa

Human-environment interaction through the Late Pleistocene on the South Coast, South Africa: Generating a high-resolution record of lithic technological change for integration with the SACP Palaeoscape model

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Pinnacle Point 5-6 (PP5-6) on the south coast of South Africa preserves a high-resolution sequence of human occupation spanning 90-51 ka. The lithic assemblage provides a unique opportunity for examining technological change through the Late Pleistocene because it is linked to robust age estimates and multiple proxies for palaeoenvironmental change, including changing coastline positions, speleothem strontium-isotope curves, and phytolith, shellfish and micromammal species abundance data. Using these data, the multidisciplinary South African Coastal Palaeoclimate, Palaeoenvironmental, Palaeoecology, and
Palaeoanthropology (SACP4) project is constructing a palaeoscape model of changing resource availabilities that predicts the relative abundance of different floral and faunal resources available to humans using the Pinnacle Point sites through time. Recent investigations of the PP5-6 lithic assemblage have generated a high-resolution record of lithic technological change that is linked to that rich palaeoenvironmental record. The goal is to identify the environmental conditions during which early Homo sapiens relied on certain aspects of technology, including but not limited to, finer-grained raw materials, heat-treatment of silcrete, and the production of backed pieces, points, and bladelets. The developed methods also serve to standardize analytical procedures across the Pinnacle Point complex of sites, which will extend the record back into the Middle Pleistocene 162 ka, and maximize comparability to other South African Middle Stone Age (MSA) sequences. At PP5-6, major technological shifts occurred at ~90 ka and ~74 ka. At both these times, bladelet production in fine-grained raw materials (e.g., heat-treated silcrete, chalcedony and chert) peaks. At ~74 ka, backed blades first appear and these persist through the sequence to 51 ka. Through this period, however, there are many other aspects of technology that show continuity across what are otherwise periods of pronounced technological change. For example, crested blades were used throughout the sequence for initiating elongated removals along with the same spectrum of raw materials, although in different frequencies. Multiple core reduction strategies were used at PP5-6 with very little temporally-vectored patterning; there was continuity in diversity. Some technological shifts seem to be correlated with palaeoenvironmental change, while others may not. For example, the appearance of backed blades and increased frequency of bladelets on finer-grained raw material at 74 ka correlates with the beginning of MIS 4 when the coast was further away at a distance approaching 30 km, and locally there was an increase in summer rain. Prior to this period however, at 90 ka, there was a comparable increase in the frequency of bladelets on finer-grained raw material, but the sea-levels were within ~10 km and summer rain was weak. Compared to other contemporary MSA sequences, PP5-6 exhibits both similarities and differences, complicating traditional perspectives on MSA technological change through time. A standardized quantitative comparative approach to lithic technology is the best way to move forward with respect to understanding Pleistocene human-environment interaction from a technological perspective on both the temporal and spatial scales. The methodology we developed is already being applied to analyses by our team and others to several African Stone Age sites.

Keywords: Middle Stone Age, coastal South Africa, lithic technology, early modern Homo sapiens

Reinvestigating the palaeoenvironment at Klasies River during MIS 4-5 (125-60 kya) using a multi-proxy approach

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The Klasies River (KRM) site complex is located on the southern Cape coast near the modern town of Humansdorp. A series of five caves have yielded an abundance of archaeological material including stone artefacts, faunal remains, marine shells and human remains. Today, Klasies River is situated in a region that experiences all year round rainfall and has a mixture of C3 and C4 vegetation. In the past, the floral community differed from that of the present day, reflecting shifting glacial/interglacial conditions. Interpretations of the nature and extent of environmental change through the Klasies sequence vary. In this study, we re-assess previous palaeoenvironmental data from KRM, using reconstructed diets of fossil bovids as proxies to investigate shifts in the vegetation communities between ca.125 000-60 000 years ago. Three methodologies were used to reconstruct bovid diets, namely dental microwear texture analysis (DMTA), dental mesowear and stable carbon and oxygen isotope analysis of tooth enamel. Dental mesowear and microwear results suggest that the bovids at KRM ranged between mixed feeding and browsing. δ13C values of several grazing species (Damaliscus dorcas, Hippopotagus leucophaeus, Syncerus antiquus, Syncerus caffer) enable us to track the proportions of C3 and C4 grasses through time. C3 grasses were dominant throughout, although small quantities of C4 grasses were also present. We infer that during OIS 5-4, this area experienced more precipitation in winter than in summer. Isotope results from different types of grazers vary somewhat, according to the dietary preferences of the species. In addition, dental mesowear results support the trends evident in the isotope and microwear data. Ongoing work using these multiple lines of evidence should provide a clearer picture of past environments at...
KRM. Understanding palaeoenvironmental change will inform the discussion on the potential impact of climate shifts on the development and adaptation of early humans in this region.

Keywords: palaeoenvironment, isotopes, DMTA, mesowear, vegetation change, bovid diets

What drives cultural change in the Middle Stone Age of Sibudu, KwaZulu-Natal?

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The archaeological site of Sibudu provides a thick and high-resolution occupation sequence of the Middle Stone Age (MSA) of southern Africa, dating to between 80-40 ka. Due to favorable taphonomic conditions and a strong human presence, high numbers of both anorganic and organic finds have been preserved at the site. Sibudu thus constitutes a good candidate to examine the reasons for cultural and behavioural change of modern humans in the Late Pleistocene of southern Africa.

For this study, we investigate archaeological layers of the recently defined Sibudan, which post-date the Howiesons Poort, as they encompass a large number of successive occupations. These archaeological horizons are in primary condition, yield a high number of finds and date indistinguishably to ~58 ka. The sequence also features abundant changes in lithic technology. On this basis, we examine whether shifts in environment and climate, subsistence, or other social and cultural factors explain the observed technological variability. In order to answer this question, we combine palaeoenvironmental and subsistence data with our observations on changing patterns of lithic technology.

These results show no co-variation between knapping behavior and environmental change. Indicators of climate and vegetation remain constant throughout the period of study while the lithic technology undergoes marked changes. As the inhabitants of Sibudu generally hunted the same range of animals, foraging activities do not appear to be the main driver of different knapping strategies. In contrast, changes in the organization of lithic technology and other socio-cultural factors are better explanations of our data. Variable frequencies of retouch and differences in tool kits throughout the sequence suggest a different use of the site within the settlement system, at least in terms of stone knapping. Furthermore, marked changes in reduction intensities and lithic densities indicate different patterns of site use. These variations either indicate a more economical use of lithic resources in times of scarcer availability of raw materials or higher levels of population. Based on pronounced shifts in the procurement and use of non-local raw materials, differences in mobility and range also appear to play an important role in explaining the observed variation in lithic technology. The inhabitants also manufactured specific tools which are characterized by repetitive patterns of retouch with the goal of producing a particular edge morphology regardless of the reduction stage. The uptake of these techno-functional tool cycles follows an S-shaped cumulative distribution curve throughout the studied sequence. This pattern could reflect local innovations and subsequent increase in popularity by means of biased cultural transmission. Our findings suggest that external factors such as climate and environment should be used more prudently as explanations for cultural change in the MSA. Rather, internal causality such as changes in settlement dynamics, social relations and independent local innovations within populations might play a larger role than previously acknowledged.

Keywords: Middle Stone Age, lithic technology, cultural evolution, modern humans, South Africa
The context of hominin behaviour at Elandsfontein in the Mid-Pleistocene

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Our understanding of human adaptations to the dramatic climatic shifts of the Pleistocene is heavily dominated by data that post-dates the last Interglacial. Despite the incredible record of human occupation of the winter rainfall zone in southern Africa for the last hundred thousand years, remarkably little is known about the context of populations that existed in this region for hundreds of thousands of years prior to the Middle Stone Age. Here we present new findings from a variety of different datasets from the renewed field and laboratory studies of the archaeology, palaeontology and geology of Elandsfontein. We provide initial results from the excavation and geological analysis of the Elandsfontein dunefield and provide new insights into the formation history of the archaeological and palaeontological deposits. This includes an indication of multiple pedogenic intervals and water table fluctuations. This data provides the first real insight into the dynamic environments that existed on West Coast of South Africa during the Mid-Pleistocene. We provide preliminary data on the environments based on multiple proxies (e.g., isotopic composition of fossil teeth, phytoliths) as well as new information on the influence of groundwater fluctuations for landscape heterogeneity. Further, we describe new excavations that provide evidence of the dynamics between carnivores and humans during this time. Finally, we describe new data on the movement of people in this region based on preliminary provenance data on sources of silcrete used by hominins. The combination of geological, palaeontological and archaeological data provides a framework for evaluating how hominins interacted with the unique ecosystems of the Western Cape of South Africa during the Pleistocene.

Keywords: Pleistocene, palaeolithic, palaeoenvironment, Elandsfontein, Acheulean

Climate change and cultural dynamics from the late Holocene period to the abandonment of the Mapungubwe capital on the greater Mapungubwe landscape

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In the Greater Mapungubwe Landscape, which includes eastern Botswana, northern South Africa and southwestern Zimbabwe, important Stone Age cultural change has been recorded for the late Holocene period. Many of these changes are thought to be linked to forager/farmer interactions, however, climate change has not been fully considered as a driving factor behind cultural change in the region. It is hypothesised that during times of environmental stress, when conditions were unfavourable, foragers relied more on farmers and this can be seen between AD 900 and 1300, after which they either abandoned the area, lived in small groups relying on hunting and gathering or assimilated into the farming economy. In order to determine the chronological relationship between climate change and changes in the Later Stone Age sequence and suggest that the changing environment provided a framework within which forager-farmer relations were influenced. Thus, it is suggested that in order to contextualise these interactions, a firm understanding of the local climatic sequence is required.

Keywords: Greater Mapungubwe Landscape, climate change, culture change, isotopic analysis, Later Stone Age
The Hominin Sites and Palaeolakes Drilling Project (HSPDP): Collecting palaeolake drill cores from the East African Rift Valley to document the environmental context of human origins

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HSPDP is an international effort involving over 80 scientists from 10 countries, whose aim is to drill long cores from ancient lake beds adjacent to important Plio-Pleistocene fossil hominin and archaeological sites in Kenya and Ethiopia. High resolution geochemical, sedimentological and palaeoecological records obtained from these cores are being used to improve our understanding of the palaeoclimate and palaeoenvironmental setting of important hominin sites, with an ultimate goal of testing models of hominin evolution and demography. Drilling was focused on lacustrine sedimentary sequences to maximize both the temporal resolution of the records from basin depocenters and to increase the number of proxy and indicator records of environmental change that could be interpreted.

Five study areas have been drilled with 12 boreholes to date by HSPDP with a total of ~1580m of core collected (at an average of 95% recovery). Collectively they span many of the critical intervals of hominin evolution in Africa. The Tugen Hills core, collected in the central Kenya rift, spans from about 3.5-2.5Ma, and encompasses a series of precessionally-driven lake cycles. Three cores from the N. Awash basin (Afar region of northern Ethiopia) record both deep and shallow lakes between ~3.5-2.9Ma. One core from the west side of Lake Turkana (northern Kenya) covers a major deep to regressive lake phase between ~2.0-1.45Ma. Lake Magadi, an extant soda lake of southern Kenya, yielded cores from two sites spanning the last ~800ka. The Chew Bahir basin of southern Ethiopia was drilled with a ~42m pilot hole in early 2014, to be followed by two ~400m holes to be drilled in late 2014, which may span the last ~750ka. In addition to analytical studies of the HSPDP cores, an extensive suite of modeling experiments is also underway to better understand the earth system dynamics underlying our palaeoclimatic findings and the implications of these dynamics for human origins.

Keywords: human origins, East African Rift, scientific drilling, palaeoclimate, lacustrine deposits

Oral Session 14
Lake Victoria is the largest tropical lake in the world, and a defining geographic feature of Equatorial Africa. However, the lake is fairly young (possibly dating to ~400 ka), and both lake size and depth have fluctuated considerably throughout the Pleistocene and Holocene, including periods of complete desiccation, due to climate fluctuations and tectonically induced changes in basin shape and outlet. The lake today serves as an important biogeographic barrier to many lineages of terrestrial vertebrates. Variations in lake size, particularly during desiccation when the lake basin was a topographically smooth C4-dominated grassland, likely played a major role in the range expansion of extant arid-adapted taxa (e.g., oryx and Grevy's zebra) and contain the richest suite of extinct ungulates known from Late Pleistocene eastern Africa, including well-represented species not found elsewhere (e.g., Rusingoryx atopocranion), some clearly targeted by MSA hominins. These intervals may well be correlated with hominin dispersals throughout eastern and central Africa.

Keywords: Lake Victoria, Middle Stone Age, biogeography, non-analogue community, environmental change

Comparing the Quaternary palaeoenvironments of two major Hominin sites: the Olorgesailie and Koobi Fora Basins, Kenya

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East Africa is famous for numerous early hominin sites that have provided quality archives of human evolutionary history that addresses questions regarding the origin of mankind. Among these sites, Koobi Fora and Olorgesailie basins have contributed greatly to scientific data that have filled gaps not only in human evolutionary history but also other life forms and, palaeoenvironmental and palaeoclimatic reconstructions both temporally and
spatially. Both basins are located within the Kenyan rift system; Olorgesailie is in the Southern rift while Koobi Fora is in the northern rift, approximately 900 km apart.

Despite the distance separating both basins, they share some similarities; they are located within arid regions and they are palaeolake basins with lithostatigraphic sequences that span from the Pleistocene and beyond, to Holocene periods. From each basin, the sequences are well correlated spatially across the landscapes.

In addition a common hominin species: Homo erectus and, the associated archaeological artifacts have been well preserved in both basins. In the Olorgesailie basin only this hominin species is found, while in Koobi Fora basin several other Homo species have been found: Australopithecus/ Paranthropus sp. and Homo habilis. We hypothesize that, this disparity exists due to difference in palaeoenvironments between the two basins.

The research therefore intends to investigate the vegetation dynamics that existed in Olorgesailie and Koobi Fora basins during the mid-Pleistocene and Holocene periods and especially investigate the changes between the C3 and C4 plants by analyzing fossil phytoliths as the main proxy for past vegetation reconstruction.

**Keywords:** phytoliths, Olorgesailie, Koob Fora, Quaternary, hominins

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**Late Pleistocene rockshelter stratigraphies and palaeoenvironments in Northeastern Africa – Case study Mochena Borago (Ethiopia)**

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In prehistoric times, the rockshelter Mochena Borago served as a retreat for anatomically modern humans in the southwestern Ethiopian Highlands. During the last decade, archaeological analyses helped in gaining insight into the history of the settlement of the rockshelter in the last 50 ka. Our understanding of the depositional history of Mochena Borago has been increased through element and micromorphological analyses of the shelter sequence and through investigations on potential sediment sources and transport within the site catchment. The sediments include a sequence of palaeo-surfaces and indications of local continuous sedimentation and spontaneous mass movements with roof fall and debris. Furthermore, researchers have found indications of humid periods with high sedimentation rates, in contrast to the low sedimentation rates resulting from climatic and/or morphological changes at the site. Cultural remains of Homo sapiens are especially common in protected areas within the rockshelter, which are associated with sediment accumulation in the northern part of the cave. The southern part shows high-energy erosion through fluvial processes, which is related to the morphological structure of the rockshelter itself and indicated by erosion features within the subsurface. Existing high-energy erosion have probably partly removed sediments with archaeological findings from the cave. This removal has to be taken into account because it means that there might have been an earlier occupation at Mochena Borago. The depositional history is still not fully understood and consequently more investigations are necessary at Mochena Borago; a research site with urgent need for interdisciplinary work on early human history. In the future, the regional connection between different palaeoenvironments in southwestern Ethiopia has to be examined and more climate archives in this region have to be involved.

**Keywords:** rockshelter stratigraphy, palaeoenvironments, micromorphology, geomorphology, human dispersal
What influences the sediment composition of a rockshelter in a hyperarid environment? Insights from sedimentological and micromorphological analyses at the archaeological site Sodmein Cave, Egypt

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Cave sediments in archaeological contexts are often very heterogeneous and adapted analyses should be applied. One focus in hyperarid environments, where geochemical parameters due to the absence of strong chemical weathering are quite rare or missing, is the detailed analyses of grain-size parameters and the micro- and macroscopic sediment composition. Different processes in the cave influences the sediment composition and varying portion of aeolian sand and silt indicate diachronic changes in aeolian input into a cave/rockshelter. With the determination of allochthonous and autochthonous sediments, inferences to climate conditions outside the cave and site formation processes in the cave are detectable.

Sodmein Cave, situated in the Egyptian eastern desert and one of the rare well dated Middle Stone Age living sites in north-eastern Africa, should serve as an example of this special configuration. The stratigraphy contains more than 4 m of sediment with human occupation debris, dating at the base to around 123±15 ka. This site plays an important role in the discussion about “Out of Africa 2” and the migration of anatomically modern humans. For the first time, micromorphological samples and thin sections could be analysed from an archaeological site in hyperarid north-eastern Africa. Due to the high amount of very well preserved plant remains and coprolites, the thin sections not only offer information about sediment accumulation processes and pedofeatures, but also of fauna and flora activity. This study combines the two-dimensional analysis of thin sections with a three-dimensional analysis of sediment samples, using the digital microscope Keyence VHX-2000. Especially the three-dimensional surface analysis of the sand grains can give detailed information about the origin, patina and transport history of the sand particles in context to wadi activity. Additionally, larger organic fragments can also be observed in the strew slides. The combination of both enrich the analyses of the thin sections and strengthen the potential of micromorphology. This information is integrated with grain-size analyses, using laser-particle-analysers and camsizer analyses. Because of the location of the cave in the Thebes-limestone, comparable grain-size analyses with and without carbonate elimination indicates aeolian input of non-carbonate sediments in the silt and sand fraction in single layers.

The methodological mixture of thin-sections, strew-slides, and grain-size analysis is strongly applied in hyperarid environments, where the deposition processes and composition of the sediment is dominating, because pedofeatures and soil genesis are absent. Nevertheless, geochemical investigations are expanding the previous results, but tend to be not sufficient to reconstruct the influence of parameters in such an environment.

For this purpose, Sodmein Cave is an excellent and important site to advance the influencing parameters for this archive and give new insights into sedimentation processes in a Rockshelter, especially in such an extreme hyperarid environment. This study is affiliated to the CRC 806 “Our way to Europe” www.sfb806.de. We thank the German Science Foundation (DFG) for funding this project.

Keywords: rockshelter stratigraphy, micromorphology, Sodmein Cave, MSA
Archaeological fauna from Thimlich Ohinga Cultural Landscape, South Western Kenya

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Thimlich Ohinga Cultural Landscape consists of a group of large dry stone-walled enclosures with one or more entrances and interior features including smaller dry stone-walled enclosures, house depressions and livestock kraals. The dry stone-walled structures were constructed and modified for habitation by a sequence of communities from different linguistic groups migrating into the area from as early as the 16th century. An archaeological study was conducted to determine the nature, contents and functions of the smaller dry stone-walled enclosures found within and in association with the larger dry stone-walled enclosures. The study involved excavations and analysis of recovered archaeological material including animal bones, pottery shards, stone tools, iron implements, beads among others. The study established that the small dry stone-walled enclosures were food processing spaces within the main enclosures with hearths, bones, grinding stones and stone and iron implements. This paper presents the results of analysis of fauna from the excavated features to determine their uses and subsistence strategies of their makers and inhabitants as well as the environmental context in which these structures were built and used. The faunal remains indicate that the inhabitants of the dry stone-walled structures used the smaller enclosures as food processing (cooking and grain grinding) and, exploited wild terrestrial mammals from varied micro-environmental contexts and aquatic food resources besides keeping livestock.

Keywords: archaeology, fauna, subsistence, stone enclosures, environments

From Africa to Europe in the Late Quaternary – Ways of dispersal, bridges and barriers

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The poster presents results of the Collaborative Research Centre “Our Way to Europe: Culture-Environment Interaction and Human Mobility in the Late Quaternary” (www.sfb806.de), which was established in 2009 and is funded by the Deutsche Forschungsgemeinschaft (DFG). The CRC 806 is devoted to the history of mankind and the related natural environment since anatomically modern humans originated. Projects are running in NE-, N-, and NW-Africa on terrestrial, archaeological, and aquatic archives. Interdisciplinary research provide key sites for the investigation of different “Out of Africa hypotheses”.

Keywords: Out of Africa, CRC 806, pathways, barriers

Cultural transition from Later Stone Age to Iron Age cultures: A case study of Nyero rock shelter, Kumi district, eastern Uganda

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Research in Nyero, eastern Uganda was conducted to investigate the cultural transition from Later Stone Age (LSA) to Iron Age (IA). Apart from rock paintings and LSA, little so far is known about the archaeology of Nyero. Primary data was recovered through archaeological survey and excavation. Archaeological materials included; lithics, pottery, charcoal, daub, seeds, and faunal remains. Examination of cultural materials from
excavation presented a clear cultural sequence from LSA through Neolithic to IA. Lower cultural stratigraphic levels yielded pure LSA while upper levels had both LSA and IA cultural materials. Despite conflicting hypotheses, the study revealed that IA technologies did not abruptly replace LSA technologies; the transition was slow and gradual. Results have also showed that LSA people were not displaced by IA people as it was earlier assumed. Further research on LSA Kansyore early settlers, evidence of iron production and conservation studies should be conducted in Nyero.

*Keywords: LSA, Iron Age, cultural transition*

**Southeast African climate variability and early human evolution pulses**

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Climate change and its effects on African ecosystems may have played a key role in human evolution during the Middle Stone Age (MSA). The development of modernity in human populations in Africa has been linked to pulsed phases of technological and behavioural innovation within the MSA of South Africa. The reason for sudden abandonments of occupational sites and reoccupation thousands of years later as well as the short lived flourishing of these technological pulses remain subjects of controversy. Here we present evidence from marine sedimentary archives offshore KwaZulu-Natal (KZN) and Eastern Cape (EC) province, which show that the southeast African climate variability over the last 270,000 years reflects both the long-term effect of regional insolation changes caused by orbital precession and the effects associated with high-latitude Northern Hemisphere Cold Stadial forcing. New evidence is presented that question whether the Marine Isotope Stage (MIS) 6 glacial really resulted in extreme aridity in all areas of southern Africa as proposed by the ‘southern Cape MIS 6 refugium’ scenario. At Florisbad, occupation events are related to wetter phases and one of these occurs in MIS 6 at ~157,000. These findings are supported by indications of human occupation at ~138,000 at Wonderkrater, an inland spring and peat mound site, situated further North of Florisbad. To date it remains unclear whether human settlements occurred because the area served as an oasis in an arid landscape, or was occupied during wet phases. Our results provide strong evidence that innovation pulses of early modern human behaviour and occupation phases in South Africa were, at least in part, climatically influenced.

*Keywords: southeast Africa, climate variability, Middle Stone Age, orbital precession, KwaZulu-Natal province*
There are numerous hypotheses linking climatic trends, events and variability to human origins, evolution and dispersal. Long palaeoenvironmental records from continental sites that may allow tests of these hypotheses are only now becoming available, but most are distant from fossil human sites. The Hominin Sites and Palaeolakes Drilling Project (HSPDP) aims to obtain long continuous sediment cores spanning critical intervals of evolutionary history from lacustrine sites close to globally significant hominin sites in East Africa. Together, the five sites – Northern Awash and Chew Bahir, Ethiopia; West Turkana, Baringo Basin and Lake Magadi, Kenya – will provide multi-proxy records spanning the last 4 million years. This will allow us to correlate and compare environmental changes to the more fragmentary record of evolution, dispersal, extinction and cultural innovation. The project team will evaluate models of climatic and tectonic forcing of environmental processes and landscape resources. We will test hypotheses linking climate variability to physical and cultural evolution. The project is supported by the International Continental Drilling Program (ICDP), NSF (USA), DFG (Germany) and by NERC (UK). Drilling began in June 2013 in Kenya.

NERC funded research focuses on the Chew Bahir site in Ethiopia, where a survey of basin sediments using 2D electrical resistivity tomography was completed in October 2013 and drilling of a 400m core is scheduled for November 2014. A team of UK Quaternary scientists will work with German and Ethiopian colleagues to produce a multi-proxy record which is anticipated will cover the last c. 500,000 years. Detailed analysis will focus on identifying the nature of climate variability during the penultimate glacial-interglacial transition (Termination II: c. 125-135 ka), once an outline chronology has been established. Key proxies are: high-resolution geochemistry; isotopes (δ¹³C, δ¹⁸O carib, δ¹⁸O diatom, δ¹⁸O ostracod); biomarkers (including GDGTs and compound specific leaf wax δ¹³C and δD); pollen; diatoms; ostracods and magnetic properties. The chronological framework will be constructed using radiocarbon, Post-IR IR stimulated luminescence and 40Ar-39Ar dating along with tephrochronology, which will be used to correlate between sites where possible. The record of climatic and ecological change, from Chew Bahir, along with previous data from Lake Tana, will be used as model input to test the hypothesis that periods of high climatic variability correlate with key biological and cultural transitions.

Keywords: Human evolution; East Africa; Ethiopia; Kenya; Termination II
**Isotopic biogeochemistry of contemporary mammals from C3 environments: implications for palaeo-datasets**

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The study explores the effects of environmental and climatic variables on the carbon, nitrogen and oxygen isotopic values of wild African fauna from C3 dominated environments. Most previous studies of isotopic ecology in Africa have been carried out in summer rainfall regions. This study focuses on the winter rainfall zone in the extreme south-western part of Africa, where important archaeological sites record the lifeways of early modern humans. This study of contemporary fauna will provide a baseline for the interpretation of stable isotope analyses of archaeological and fossil animals from this region, a key tool in the reconstruction of palaeoclimates and palaeoenvironments. It will also contribute to a better understanding of isotope systematics in large mammals.

We have analysed δ¹³C and δ¹⁵N in bone collagen and δ¹³C and δ¹⁸O in tooth enamel of 27 species of indigenous wild mammals obtained mostly from game parks and nature reserves in the winter and year-round rainfall zones. The vegetation types covered are Savanna, Succulent Karoo, Nama Karoo, Fynbos, Afromontane Forest, Albany Thicket. Animal species include primates, suids, herbivores and carnivores.

The C3 end point as recorded in tooth enamel of browsers varies according to vegetation type. The most enriched values (mean= -10.2 ±2.6 ‰) occur in the Albany thicket vegetation type and are probably due to browsers feeding on succulents; the most depleted (mean= -14.3 ±1.6 ‰) occur in the Afromontane Forest, due to high rainfall and possibly the canopy effect. Results of multiple regression using the meteorological factors associated with each biome indicate that the best predictor of the δ¹³C apatite results is mean annual precipitation.

When the δ¹³C apatite, δ¹⁸O, δ¹⁵N and δ¹³C collagen isotope results are explored by combining them into components using principal component analysis, the component that explains most of the variation shows significant variation for different biomes. The results of multiple regression show that mean annual temperature, rain days per annum and relative humidity are the controlling factors. The patterns are slightly different in grazers, browsers and omnivores.

This work documents for the first time natural variation in stable C, N and O isotopes in animals from the C3 winter rainfall biome of South Africa. This provides a baseline for the identification of climatic shifts in the past. Isotopic analyses of archaeological fauna will help to elucidate the palaeoenvironmental context for the emergence of modern humans in this region.

**Keywords:** isotopes, winter rainfall zone, δ¹³C, δ¹⁸O, δ¹⁵N

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**Leaf wax and bulk stable carbon isotope records of plant type assemblages and palaeoenvironment changes in Mfabeni Peatland (South Africa), since the late Pleistocene**

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As a consequence of the regional topography and semi-arid climate of southern Africa, there is a general lack of continuous terrestrial palaeoenvironmental archives and, therefore, ambiguity prevails over how terrestrial ecosystems responded to past climate fluctuations in the region. Leaf wax stable carbon isotope (δ¹³Cwax) signatures of peat-forming plants are primarily controlled by the C fixation pathways employed during photosynthesis. Consequently, observed changes in peat δ¹³Cwax trends can best be explained by the changes in relative abundances between C3 and C4 plant inputs at the time of deposition. It is still not clear how the balance between competing southern African tropical woodlands / rainforests (C3) and grasslands (predominantly C4) were affected by changes in temperature, moisture and pCO2 in the past. Regional palynology studies have gone some way to elucidate changes in past plant
assemblages. However, these records do not extend as far back as the last glacial maximum (LGM) and tend to suffer from temporal discontinuities, pollen dispersal range and dating uncertainties. In this study, we employed bulk and compound-specific isotope analyses of terrestrial plant lipids extracted from the Mfabeni Peatland, KwaZulu-Natal, South Africa. The 14C age of the basal peat is c. 47 kcal yr BP, making this setting one of the oldest continuous coastal peatlands on the African continent. This unique archive allowed us to directly reconstruct the changes in local plant type assemblages. We used bulk and compound-specific δ\(^{13}\)C records to explore the changes in proportions of C3 and C4 plant input into the Mfabeni and to compare them with local palynology and peatland chronology records to infer the changes in the palaeoenvironment since the late Pleistocene. Our results suggest shifts between the two dominant competing plant types, in general correlation with the fossil pollen incidence and peat stratigraphy, through C4 plant dominant input being exhibited from c.44.5 to 39.0 kcal yr BP and the late Holocene, while c. 46.9 – 45.7, 38.0, 14.8 kcal yr BP and early Holocene periods demonstrated C3 dominant plant input. These trends advocate that the local Mfabeni plant population responded relatively rapidly to changes in local palaeoenvironment, mainly as a consequence of fluctuations in peatland hydrology. Furthermore, our data showed that there was a poor correlation between the changes in plant type assemblages and known regional and global climate events, which suggests that the local palaeohydrological forcings could have overprinted the regional climate influences on peatland plant communities in the Mfabeni since its inception.

Keywords: Leaf wax C stable isotopes, terrestrial palaeoenvironment, C3 vs C4 plant assemblages, subtropical peatland, late Pleistocene

Southwestern African climate change during Heinrich Stadial 1 inferred from plant wax δ\(^{13}\)C and δD from rock hyrax middens

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Rock hyrax middens represent an emerging, high-potential palaeoclimate archive adding to the otherwise scarce information on the terrestrial palaeoclimate of southern Africa. Plant-derived biomarkers preserved therein provide an excellent tool to infer information about past environmental conditions such as e.g. vegetation type and rainfall. Here, we present stable carbon and stable hydrogen isotope compositions (δ\(^{13}\)C and δD, respectively) of vascular-plant waxes together with chain-length distribution patterns retrieved from a hyrax midden from Spitzkoppe (western central Namibia, southwestern Africa) spanning the past 22,000 years. Our data show significant variability, such as a sharp decrease in δ\(^{13}\)C for the C31 n-alkane at the end of the Last Glacial Maximum (LGM). We interpret this as indicating a shift in dietary source towards a C3-type dominated vegetation consistent with significantly lowered values of the normalized C31 index (n-C31/[n-C29+n-C31]) during that interval. Despite the pronounced δ\(^{13}\)C signal, corresponding δD values show only little change, indicating a less distinct shift in either rain rate or moisture source. Interestingly, isotope records of the C29 and C31 n-alkanes display different patterns throughout the record, with n-C31 showing much larger changes particularly in δ\(^{13}\)C than the n-C29 homologue, indicating plant waxes deriving from different plant functional types. Taken together, our data indicate changes in climate and hyrax diet since the LGM, and highlight the potential of studying a suite of n-alkanes to explore a fuller range of environmental and vegetation dynamics.

Keywords: d13C, dD, plant waxes, rock hyrax middens
Late Holocene variations in Benguela SST, vegetation and hydrology in southwest Africa

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High resolution climate records for the late Holocene are rare in southern Africa, despite the region's recognized importance towards the study of past and present climate variation. This study, which forms part of the project RAIN (Regional Archives for Integrated Investigations) focuses on extracting information on palaeoclimate signals from a marine core located in the west coast mudbelt just offshore of the Olifants River. Terrestrial and marine proxies are combined to form a robust high resolution analysis of the catchment region over the past 2500 years. Alkenones have been used to show fluctuations in SST, whereas compound specific stable carbon and hydrogen isotope analysis demonstrate the variation in higher terrestrial vegetation and hydrology respectively. δ¹³C is used to estimate the changes in the photosynthetic pathway of plants (C3, C4, CAM). δD is used as a recorder of source waters in the region. Grain size analysis at a resolution of 1cm was used to determine the characteristics of the core, which indicated high inputs of coarse material at around 500, 750 and 1500 cal years BP.

Keywords: Benguela SST, organic geochemistry, leaf waxes, southwest Africa, palaeoclimatology

Land-ocean connectivity in southernmost East Africa over the past 270,000 years: A combined multiproxy and modelling approach

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Processes that control the hydrologic balance in southeast Africa during past abrupt climate change remain poorly understood. Here we present a multiproxy data-model integration study combining results from a marine sediment core recovered offshore KwaZulu-Natal province in southeast Africa with model simulations using the fully coupled Community Earth System Model. Simultaneous increases in the accumulation of organic and inorganic terrestrial compounds (e.g. sedimentary terrestrial ratios/concentrations of Iron (Fe) to Potassium (K), and branched glycerol dialkyl glycerol tetraether (GDGT) lipids) in the core suggest that increased precipitation promoted soil erosion processes on land during the last deglaciation and the fluvial transport of this land-derived material to the adjacent marine system. Shifts in the regional hydrological balance towards more humid conditions occurred contemporaneously with Northern Hemisphere Cold Stadials (NHCS) throughout the record. Numerical modelling experiments reveal an apparent Northern Hemisphere control on the subtropical southeast African climate during intervals of abrupt climate change. This interhemispheric teleconnection involves the southward migration of the equatorial and near-equatorial precipitation belts associated with the Inter-Tropical Convergence Zone, a weakening of the Hadley cell in the southern tropics and changes in the surface level pressure systems across the South African continent and Southern Ocean. Furthermore, we use the sedimentary Fe/K ratio as proxy for continental African climate changes and for the first time present a detailed 270,000-year long precipitation record. During the past
270,000 years southeast African climate variability reflects both the long-term effect of regional insolation changes caused by orbital precession and the effects associated with high-latitude NHCSs forcing. These climatic oscillations appear to be coupled and anti-phased with the East Asian Summer Monsoon during the late Pleistocene.

Keywords: southeast Africa climate, KwaZulu-Natal province, land-ocean climate dynamics, Tugela River, Agulhas Current

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Poster Presentations

Hydro-climate variability in the Drakensberg - New proxy-data from Braamhoek wetland, eastern Free State

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A peat sequence from a permanent wetland located near the eastern escarpment in the Drakensberg has been used as a natural archive to detect past shifts in available moisture in the area since c. 16,000 cal yr BP. The study combines vegetation-based proxy-methods (pollen, n-alkane abundance and δ¹³C) with sedimentological methods (mineral magnetic properties). It also improves the sample resolution and dating precision compared to previous palaeoecological and hydrological studies at the site, that were based on pollen, diatom and phytolith analysis (Finné et al. 2010; Norström et al. 2009). Together, the multi-proxy dataset produces a robust record of moisture variability, suggesting three main phases when wetter conditions occurred: 13,800-12,600 cal yr BP; c. 10,200-8500 cal yr BP and c. 2000 cal yr BP to present. Drier conditions are reported after c. 12,600 cal yr BP continuing at least through the Younger Dryas period, until c. 11,300 cal yr BP. The duration of this dry event differs to some extent between proxies; with some inferring dry conditions until c. 10,500 cal
yr BP. Mid-Holocene conditions were dry according to all proxies. A comparison with interior South African records show that the speleothem isotope records from Makapansgat (Holmgren et al., 2003; Lee Thorp et al., 2001) co-varies with the Braamhoek moisture proxies on a multi-millennial time scale. A preliminary leaf wax δD-record from Braamhoek (unpublished data) further shows a positive correlation to the δ18O-record from Makapansgat when considering the long-term trends. This may suggest that the interior and eastern South Africa were under similar climate mechanisms during the studied period. However, when considering records from the southeastern tropical areas, in northern Mozambique, Madagascar and southern Tanzania, an anti-phase relation is recorded to the Braamhoek and Makapansgat hydro-climate indications. This dipolar precipitation pattern is similar to the one identified on inter-annual/decadal time scales related to ENSO variability. Possibly, the dipolar pattern that is evident on multi-millennial time scales (this study), may be related to long-term shifts in ENSO as well as IOD-dynamics during the late Quaternary.

**Keywords:** hydro-climate, pollen, isotopes, n-alkanes, Holocene

**References**


Diepkloof Rock Shelter, located in Western Cape, South Africa has yielded an excellent archaeological record of the African Middle Stone Age. Findings include the earliest observation of Engraved Ostrich Eggshells (Texier et al., 2010) from about 60,000 years ago, indicative of the development of social and cultural behaviour similar to modern humans. We set out to investigate if there is a possible relationship between climate and use of the shelter using the isotopic composition of leaf-wax n-alkanes extracted from sediments excavated from the site. The waxes are derived from grasses and other plants that were brought into the cave for use as bedding or as fuel for fires. The n-alkanes display a long chain distribution, with maxima around the C31 and a strong odd-over-even preference, pointing to a minimal effect of biomass burning (Eckmeier and Wiesenberg, 2009). C31 n-alkane δ13C ranges between about -30‰ and -31.5‰ indicative of a mixture of C3 or CAM vegetation, in line with the vegetation of the region (Carr et al., 2014; Boom et al., 2014). δD values range between about -120‰ and -140‰ and highest values are found within the late Howiesons Poort. This increase likely reflects either increased aridity or increased temperature (Sachse et al., 2012, Rozanski et al., 1993) and might have had some bearing on the appearance of Engraved Ostrich Eggshells at that time.
Climate, vegetation, fire and the carbon cycle: Africa during the last 21,000 years

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Climate-induced changes in vegetation distribution, productivity and fire regimes are important because of their role in the carbon cycle and the potentially strong carbon-cycle feedback to climate. In the absence of comprehensive syntheses of data on the carbon cycle, modelling tools can be used to quantify the likely strength of this feedback. Here we show results from climate-model simulations with Hadley Centre model, HADCM3. We then use the LPX-Mv1 fire-enabled dynamic global vegetation model to examine the impacts of the simulated climate changes on vegetation patterns and fire regimes. We assess the reality of these predictions by comparing model outputs with available records of climate, vegetation and biomass burning across the continent. We show that the simulated changes in vegetation and fire regimes have a significant impact on the carbon cycle during the glacial-interglacial transition, with important feedbacks to climate. We estimate the uncertainties on the magnitude of the carbon-cycle feedback by taking account of the discrepancies between model outputs and available observations using a systematic bias-correction methodology.

Keywords: palaeo-fire regimes, carbon cycle, palaeoclimate simulations, palaeovegetation changes, data-model comparison

Interhemispheric symmetry in the African rain belt during the late Quaternary

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The spatial pattern of precipitation variability in tropical and subtropical Africa over the late Quaternary has long been debated. Prevailing hypotheses variously infer insolation-controlled asymmetry of wet phases between hemispheres, contraction and expansion of the tropical rain belt, and independent control on moisture available in southern Africa via sea surface temperatures in the Indian Ocean. Here we use climate model simulations covering the last glacial cycle (120 kyr) with HadCM3 and the multi-model ensembles from PMIP3 (the Palaeoclimate Model Intercomparison Project 3) to investigate the long-term behaviour of the African rain belt and test these simulations against existing empirical palaeohydrological records.

Keywords: ITCZ, orbital forcing, HCM3, SST, model

Pollen-based quantitative temperature and precipitation reconstructions in southeast Africa

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In terms of our understanding of how southeast African climates have evolved since the last glacial period, a key topic of recent debate has been the extent to which direct precessional insolation forcing (the so-called Orbital Monsoon Hypothesis) (Ruddiman et al. 2000; Kutzbach, 1981) and/or other factors such as Indian Ocean sea surface temperatures (SSTs) (Stager et al., 2011; Chase et al., 2010) have driven regional climate change.
In this paper, we present data derived from fossil pollen sequences in southeast Africa using a new method based on probability density functions (pdfs) calculated from modern plant-climate relationships. This reanalysis allows for the quantified reconstruction of a range of distinct climatic variables from this critical region, and provides significant insight into the nature of long-term climate change. Temperature reconstructions show strong coherency among all sites considered, and parallel southwest Indian Ocean SSTs. Reconstructions of the amount, annual distribution and effectiveness of precipitation since mid-MIS 3 indicate a dichotomy in the precipitation pattern between interior and eastern South African sites. At the millennial timescale, precipitation in eastern sites shows strong similarities with the Indian Ocean SST records as well as with records from the large East African lakes. Interior sites, while clearly being influenced by SSTs, also appear to be sensitive to additional factors, including the position of the southern westerlies, which may interact with tropical systems to create tropical-temperate troughs (Chase, 2010). Our results shed light on the complexity of the mechanisms driving South African rainfall, and clarify several key elements of the current debate, including limitations of models relying on direct insolation forcing to explain long-term climate dynamics.

**Keywords:** climate reconstruction, pollen, rainfall variability, ITCZ, SSTs

**References**


**Drivers and responses of late Quaternary southern African palaeoenvironments**

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Southern Africa occupies a critical transition zone between Southern Hemisphere temperate and tropical moisture-bearing systems. Presently, much of the region’s precipitation falls during the austral summer months, when moist air is transported from the SW Indian Ocean by the tropical easterlies. In contrast, SW Africa receives much of its rainfall during the austral winter months, when expansions of the circumpolar vortex bring the westerly storm track and its associated frontal systems into closer contact with the subcontinent. In the recent geological past, it has been proposed that the relative influence of these systems may have changed substantially, but little reliable evidence regarding regional hydroclimates and rainfall seasonality exists to refine or substantiate the understanding of long-term dynamics. This lack of information can generally be attributed to two primary factors: 1) poor organic preservation in the region’s arid climates limiting the number of long, well-dated records, and 2) ambiguities in the palaeoclimatic significance of many of the available proxies.

In this paper we address these two constraints, presenting 1) new data from fossilised rock hyrax middens, which preserve a diverse array of palaeoenvironmental proxies...
spanning the last 45,000 years, and 2) a new method for obtaining quantified estimates of palaeoclimatic variables from fossil botanical sequences. Combined, this work (supported by the European Research Council Starting Grant “HYRAX”) is providing high resolution records of climate change, insight into changes in rainfall seasonality, and the response of biological systems to abrupt climate change events. Highlighted are records that draw together diverse, independent proxies from a range of archives to provide a more coherent and complete understanding of the mechanisms driving variability in the region’s dominant climate systems, and how the influence of these mechanisms has evolved during the late Quaternary.

Keywords: southern Africa, palaeoclimate, rock hyrax middens, stable isotopes, pollen

The evolution of precipitation in northern Central Africa over the last 25,000 years: insights from leaf-wax δD

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The transition from the arid glacial into the African Humid Period (AHP) in western Africa is relatively well documented (e.g. Gasse et al., 2008, DeMenocal et al., 2000, Schefuß et al., 2005). However, as yet, we do not fully understand the complete spatial and temporal evolution of the West African monsoon over this period. The stable hydrogen isotopic composition of tropical precipitation (δDp) reflects the large-scale intensity of convective precipitation (Sachse et al., 2012; Moerman et al., 2013). We present a record of precipitation δD from Central Africa based on sedimentary leaf-wax n-alkane δD taken from the Gulf of Guinea, off Cameroon. Our data suggest large and abrupt increases in the intensity of precipitation at the onset of the Bølling-Allerød (14.7 ka) and onset of the AHP (11ka) and a small and less abrupt decrease in precipitation at the end of the AHP (5ka). In our presentation, we make comparison of our data with records of salinity from the Gulf of Guinea (Weldeab et al., 2007), with results from the iLOVECLIM climate model (Caley et al., 2013) and also with another leaf-wax δD record from the eastern Sahel (Tierney et al., 2013).

Keywords: leaf-wax δD, West African monsoon, African Humid Period

Poster Presentations

CREST – Climate Reconstruction SoftWare

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Several methods currently exist to quantitatively reconstruct palaeoclimatic variables from fossil botanical data. Of these, methods using probability density functions (pdfs) have proven particularly valuable in certain cases as they can be applied to a wide range of plants assemblages. Most commonly applied to fossil pollen data, their performance, however, can be limited by the taxonomic resolution of the pollen data, as many species may belong to a given pollen-type. Consequently, the climate information associated with different species cannot always be precisely identified, resulting in less accurate reconstructions. This can become particularly problematic in regions of high biodiversity, such as southern Africa.

In this paper, we propose a novel pdf-based method that takes into account the different climatic requirements of
each species constituting the broader pollen-type. Pdfs are fitted in two successive steps, with parametric pdfs fitted first for each species, and then a combination of those individual species pdfs into a broader single pdf to represent the pollen-type as a unit. A climate value for the pollen assemblage is estimated from the likelihood function obtained after the multiplication of the pollen-type pdfs, with each being weighted according to its pollen percentage.

To make this method accessible to the wider community we have developed a point-and-click software package entitled CREST. Written in Python (fast computing), CREST is compatible with all operating systems. Besides facilitating the use of the method, CREST also generates a series of useful graphical and numerical outputs to help understand the results and refine the reconstructions. Finally, we have also included a module dedicated to the study of plant/climate relationships. Statistics can be derived to identify the environmental factors that drive the distribution of a (group of) plant species.

CREST is available from the authors or at www.hyrax.univ-montp2.fr

**Keywords:** pollen, climate reconstruction, probability density functions, software

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**Holocene palaeoclimatic variations as recorded offshore south-western South Africa**

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The BMBF funded project RAIN (Regional Archives for Integrated iNvestigations) attempts to reconstruct the complex climate history of southern Africa at the continental – marine interface. The unique positions of cores GeoB 8331-4 and GeoB18308-1 offshore of the Oranje and Gouritz Rivers facilitate the simultaneous analysis of climate signals from two different climate zones. On the one hand, the sediment influx from these river mouths is driven by precipitation changes in the source region; the east African summer rainfall zone (Compton and Maake 2007) driven by shifts in the ICTZ. On the other hand, variations in local riverine input and marine productivity reflect changes in the coastal oceanic and atmospheric circulation systems such as the Southern Hemispheric Westerlies, the Agulhas and the Benguela currents. We aim to capture the various signals in the sediment and attribute them to source regions and driving factors.

Here we present first insights into variations in the carbonate, organic and clastic sediment components provided by initial XRF and infrared spectrometry analysis. According to lipid biomarker analysis the organic material at the core sites are often of terrestrial origin. Furthermore, diatom analyses reveal that a substantial part of the biogenic silica may be associated to terrestrial diatom species and phytoliths. The organic sediment content reflected by the biogenic silica and total organic carbon concentrations and the Br/Ti ratio, is thus assumed to be a terrestrial signal. In core GeoB8331-4. It shows a decreasing trend throughout the Holocene which may reflect a decrease in vegetation in either the east African Oranje River catchment area or the catchment area of local west coast rivers such as the Holgat River. This
trend is mirrored in the Ti/Rb ratio as the main source of clastic material at the core site is fluvial. A lower fluvial transport capacity during a drier late Holocene would have reduced the terrigenous input to core site. The carbonate sediment content recorded in the Ca/Ti ratio and the total inorganic carbon concentration reveals an opposing, increasing trend since the early Holocene. This may be driven by dilution/dissolution effects from an increased fluvial/organic input during the mid-early Holocene.

In concordance with this study, wetter than present conditions have previously been suggested for the early-mid Holocene (11-6ka) in the eastern South African summer rainfall zone (e.g. Dupont et al. 2011). This may have produced the strong early-mid Holocene terrestrial/fluvial signal at the core site, as the rainfall and vegetation would have been increased in the eastern Orange River catchment. Furthermore, it has been suggested that the Southern Hemispheric Westerlies were shifted to the north in the aftermaths of the last glacial, producing heavier winter rainfalls along the western South African coast (Chase and Meadows, 2007). This could have led to an increased terrestrial input from local rivers to the sediment site in the early-mid Holocene. Core GeoB 18308-1 captures the regional climate signal of the transitional climate zone in the Southern Cape area. Here, increases in terrigenous material as opposed to marine input (Ca/Ti ratio) and predominantly terrestrial organic matter characterize warm/wet periods such as the Medieval Warm Period around AD 1100 to 1200 (Tyson et al. 2000).

**Keywords:** organic and inorganic geochemistry, marine cores, winter and summer rainfall zones

**References**


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