PALAEOECOLOGY OF AFRICA
International Yearbook of Landscape Evolution and Palaeoenvironments
30

African Palaeoenvironments and Geomorphic Landscape Evolution

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AFRICAN PALAEOENVIRONMENTS AND GEOMORPHIC LANDSCAPE EVOLUTION

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Volume 30

Foreword

I take pleasure in presenting the "jubilee" edition "30" of the new Palaeoecology of Africa. This meanwhile historic series started some 44 years ago in 1966 under the auspices of Eduard van Zinderen Bakker (1907–2002). In these early days research on former climates, ecosystem changes and landscape dynamics (palaeoecology) was still a new topic in South Africa. This was also true for other African regions in lower latitudes where less was known on the palaeoenvironmental conditions especially during the northern hemisphere glaciations. Professor van Zinderen Bakker started by introducing Palynology as a scientific tool for studying vegetation and climate evolution. However, it was soon realized that the study of fossil pollen and spores is so strongly connected to other scientific disciplines that it would be useful to include biogeography, archaeology, geology, geomorphology, pedology and related fields which have a bearing on the study of the past and present environment. In the course of the time the area covered by numerous articles has been extended from South Africa to the whole of the continent, its surrounding islands and Antarctica. Since then Palaeoecolgy of Africa has become an independent international medium for palaeoenvironmental studies in Africa, and one of the first multi- and interdisciplinary oriented journals. The growing awareness of potential threats by "Global Change" during recent years has emphasized once more the importance of palaeoecological research and knowledge. Aside from the past and present history of landscapes, predictions on future climate developments will be only possible when we know what had happened already once during earth history. With this in mind the past can be considered as to be the key to understand the nearby future.

The "jubilee" edition of the series offers the occasion to include on the one hand several longer review articles that illustrate the growing knowledge on African palaeoenvironments (and will give an orientation on the extensive literature), on the other hand it contains a broad variety of different interdisciplinary case studies from all over Africa. It is now already the third volume of Palaeoecology of Africa since 2007 when the series was undertaken large scale modernization. Formatting of the papers to the PoA layout was reliably done by Erik Hock to whom I am most grateful. Ursula Olbrich revised numerous figures and assisted by carrying out cartographic work on the book. The Taylor & Francis team in Leiden with senior editor Janjaap Bloom supported the editorial work. The Frankfurt Centre for Interdisciplinary Research (CIRA) assisted by financial support to print this volume. Many thanks go to all colleagues for submitting their papers to Palaeoecology of Africa.

The volume also serves to the memory of Professor Timothy Cooper Partridge who suddenly died on 8th December 2009. He is honored within the series by an obituary of Professor Phillip V. Tobias. Regarded as the leading South African geomorphologist the international scientific community has lost a distinguished scholar and leader in palaeoenvironmental research. This book is devoted to Tim.

Jürgen Runge
Bangui and Frankfurt
May 2010

OBITUARY

In Memoriam Timothy Cooper Partridge[1] 7th December 1942–8th December 2009

Phillip V. Tobias

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The untimely and sudden death of Professor Timothy Cooper Partridge (Figures 1 and 2) on 8th December 2009 has robbed the community of geomorphologists, geographers, palaeoclimatologists, palaeontologists and archaeologists of a distinguished scholar and leader in his fields.

Timothy Cooper Partridge was born in Pretoria, South Africa, on 7th December 1942. In 1959, Tim Partridge matriculated from Parktown Boys' High School, Johannesburg, with four distinctions.

Figure 1. Professor Timothy Cooper Partridge (1942–2009).

[1] Published in the South African Geographical Journal 2010 (slightly modified version).

After his initial graduation from the University of the Witwatersrand, he pursued graduate studies at the University of Natal under geomorphologist Professor Lester King. Among King's well-known works, he had studied the geomorphology of the South African *Australopithecus*-bearing dolomitic limestone caves. This must have played a part in determining at least one of Partridge's research directions, for he spent some forty years of his life elucidating the geology, stratigraphy and geomorphology of these cave deposits.

He served on the lecturing staff of the Department of Geography at the Witwatersrand University from 1965. For several years he was a research officer in geotechnics with the South African Council for Scientific and Industrial Research. He was Chief Engineering Geologist to Loxton, Hunting and Associates, before setting up his own consultancy, T.C. Partridge and Associates. He headed this consultancy for more than a quarter of a century and it produced over five hundred professional reports in engineering geology, pedology, hydrogeology and photogeology. The specialist activities included the geotechnical classification of land for housing and industrial development, the exploitation of groundwater resources for rural development and site evaluation for large dams. He was a photogeologist of international repute. Using aerial photographs, and other remote sensing imagery, he mapped and analysed some 600.000 square kilometres in Western Australia and the Australian Northern Territory. Nearer home, he made similar surveys covering some 100.000 square kilometres in South Africa, as well as substantial areas of Botswana and Angola.

In his deep interest in the processes that gave rise to the unique landforms of Africa, with its elevated interior plateaux, lengthy marginal escarpments and the eastern Rift Valley, Partridge followed in the footsteps of two eminent geomorphologists of the 1940s and 1950s, Sir Frank Dixey and Lester King, but there was a difference. Whereas the findings of these early pioneers were largely limited to the recognition of flights of planation surfaces and the inferences from them of successive tectonic uplifts, Partridge systematically mapped the distribution of these erosional remnants and assessed the deformations which they had experienced since their creation, as well as the timing of both warping and uplift events. This was achieved through wide-ranging field-work, as well as through his interpretation of remote sensing imagery, in which he was highly skilled. Partridge paid especial attention to the timing and magnitude of tectonic movements in the East African Rift System. A major motivation for this focus was the fundamental importance which these movements have had in providing the ecological backdrop and environmental stimuli that materially influenced the evolutionary pathways along which the genus, *Homo*, evolved from early hominid progenitors. He claimed that much of the vertical uplift of up to 2.000 metres, that had given rise to the elevated plateaux of eastern and southern Africa, was relatively recent, namely post-Miocene. This claim placed Partridge at loggerheads with a cohort of international colleagues, who repeatedly denied the possibility of geologically recent continental uplifts in passive marginal settings. However, in his Alex du Toit Memorial Lecture of 1997, Partridge gathered together and consolidated the evidence delimiting the timing of these movements.

In defending over more than ten years, in the face of widespread international opposition, his assertion that large-scale uplift of major areas in Africa had occurred during the Neogene, and through his subsequent vindication, on the basis of his own and of independent evidence, Partridge belonged in a small coterie of scientists who were responsible for what has been called "premature discoveries". The validity of their hypotheses and paradigms was, in each case, acknowledged by the scientific world only much later. As examples, Raymond Dart's claim in 1925 that the Taung child represented a creature transitional to humankind was accepted only 25 years

later; the pivotal rôle played by *Homo habilis*, that L.S.B. Leakey and his colleagues proclaimed in 1964, took close on twenty years to gain wide acceptance; whilst Alex du Toit's evidence encapsulated in *Our Wandering Continents* (1937), following the work of Taylor (1910), and Wegener (1912), was resuscitated and supported not before the 1960s when the scientific basis of plate tectonics was established.

Partridge tenaciously maintained his position on the importance of neotectonics, until opposition crumbled in the face of overwhelming evidence. His scientific input seems to have revolutionised conventional wisdom on the geomorphic history of a large part of this continent.

The hominid-bearing cave and tufa deposits of South Africa have, since 1924, produced more early hominid specimens than any other area of the world. However, despite their large number and undeniable importance for an understanding of human origins, these finds have, until recently, been somewhat eclipsed by those from the Rift Valley of East Africa. This was owing in part to the impact of the academic boycott on South African science and scientists, and in part to the fact that, with few exceptions, the Rift Valley deposits were securely dated, in contradistinction with the dolomitic cave deposits of South Africa.

In the 1970s he was appointed Honorary Research Associate attached to the author's Palaeo-anthropological Research Unit at the University of the Witwatersrand, and he occupied a similar position in the Sterkfontein Research Unit since its inception. These two research organisations recovered more than six hundred specimens of early hominid fossils since 1966. Partridge was early confronted by the difficulties of dating the South African cave-sites. Yet he knew that it was crucial to place these hominid fossils, and the contemporaneous fauna, in the correct stratigraphic and chronological sequence.

In addition, he determined which materials within the deposits retained an unambiguous palaeomagnetic signal and helped to derive magnetostratigraphies for the important Sterkfontein and Makapansgat sites. Most recently, he headed the team that provided the first absolute dates for major new finds at Sterkfontein, using cosmogenic nuclides.

Tim Partridge made seminal contributions by systematically placing these uniquely important finds within stratigraphic, palaeo-environmental and geochronological frameworks. In this virtually lifelong endeavour, the successive breakthroughs that Partridge achieved or catalysed made a fundamental contribution to the placement of the early South African hominids in time, and thus to the establishment of phylogenies linking them to their East African counterparts. Equally important was his work on the depositional environments and sedimentologies of these deposits, which, together with evidence gleaned from the species composition of the faunas, plant remains and the stable light isotopes present in tooth enamel, permitted the reconstruction of palaeo-environmental conditions at the times when the deposits were formed. To this evidence Partridge added that derived from the reconstruction of uplift histories for the interior plateaux of South and East Africa. As he observed in several publications, these uplifts were of sufficient amplitude to have had major impacts on African environments during some intervals when species turnover was rapid among animals including hominids. These findings were important, too, for an understanding of the circumstances underlying significant changes in hominid demography.

Partridge's seminal research encompassed most of the important South African sites, including Sterkfontein, Makapansgat, Kromdraai and Taung (Figure 2). He was instrumental in providing a date (based on magnetostratigraphy) for what is arguably the most important hominid specimen yet discovered in South Africa, the 3,3 million year old virtually complete skeleton from Sterkfontein, Stw 573, which is presently

being exhumed by R.J. Clarke and co-workers. The recently announced $^{26}Al/^{10}Be$ dates, confirming the age of this specimen and of other early hominid remains from Sterkfontein, owe much to Partridge's input, particularly the three-dimensional stratigraphy that he established for this site, which permitted sampling in parallel sections.

Since the mid-1980s Tim Partridge has been deeply immersed in research on Quaternary palaeoclimates. The rapidly increasing importance of his contributions in this field was acknowledged when he was appointed to the Scientific Steering Committee of the PAGES (Past Global Changes) Core Project of the International Geosphere-Biosphere Programme in 1989. Partridge's contributions to the deliberations of this influential committee over six years were significant, especially in decisions on the scientific strategy for the analysis of the PAGES third Pole-Equator-Pole transect through Europe and Africa. A book synthesising the results of this work, entitled *Past Climate Variability through Europe and Africa*, included an important review of southern Africa by Partridge and co-workers.

Arguably the single most important palaeoclimate project initiated by Partridge has been an investigation of the long terrestrial record contained within the

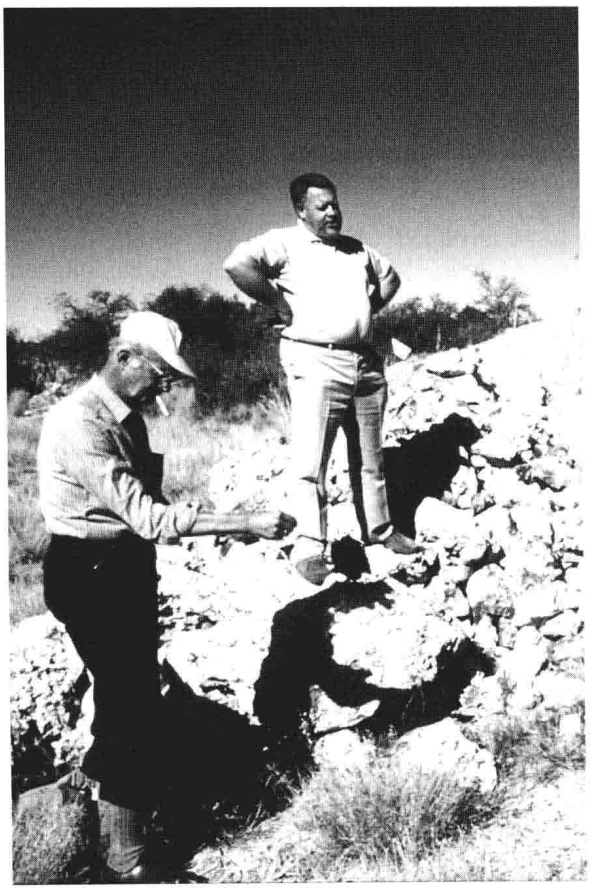

Figure 2. Professor Tim Partridge in 1990 on an excursion of the South African Association of Geomorphologists (SAAG) explaining the geomorphic evolution of the Vaal River's terraces. In the foreground left Professor Jürgen Hövermann (Photo: J. Runge).

sedimentary infilling of the Tswaing impact crater (previously the Pretoria Saltpan). Drilling of the crater began under Partridge's direction in 1988, and by 1989 a lacustrine sequence 90 metres thick had been cored and the impact origin of the crater confirmed. Further analysis showed the sediments to span the past 200.000 years. Apart from important chemical, mineralogical and biological evidence preserved in this sequence, the sediments themselves have yielded one of the best proxy rainfall records from anywhere within the world's mid-latitudes. The transfer function that gave rise to this record was based on granulometry, with calibration from soils sampled along a transect spanning the full range of present Southern African climates. This unique contribution is widely accepted as an important aid in palaeoclimatic reconstruction.

From this record Partridge was able to show that, when insolational forcing due to precessional changes in the earth's orbit was strong, rainfall fluctuations occurred at precessional frequency (23.000 years). When the insolational signal weakened, changes associated with variations in the intensity of the oceanic thermohaline circulation around Southern Africa, and in the extent of the circum-Antarctic atmospheric vortex, became dominant. This highly significant finding is contributing materially to an understanding of the global climate system in the tropics and sub-tropics.

Even more arresting in its vision and implications was Partridge's proposition, announced during a conference in Aix-en-Provence in August 2001. This was based on careful analysis of significant leads and lags in the onset of climatic changes during the Last Glacial Period, observed in Antarctica, in the Kalahari (where they were signalled by the beginning of periods of dune mobility, defined by series of luminescence dates), and in oceanic records from the North Atlantic. He interpreted these substantial and consistent discrepancies as indicating that major climatic events during the Last Glacial were forced from the high latitudes of the southern hemisphere. In particular, he argued that Heinrich Events, associated with massive discharges of icebergs from the ice-sheets fringing the North Atlantic, which repeatedly stalled the oceanic circulation that drives the Gulf Stream, were initiated by an increase in the range and intensity of moisture-bearing winds blowing northwards across the equator. These large-scale changes in atmospheric circulation, in his view, caused the rapid enlargement and ultimate collapse of extensive segments of the northern ice-sheets.

This highly original interpretation is not without its critics, but if correct, as growing evidence appears to indicate, it needs to be taken into account by analysts concerned with scenarios of future climate change in a greenhouse world. Natural changes triggered from the southern hemisphere, particularly those causing variations in oceanic heat transfer, may critically and unexpectedly alter the course of events predicted from modelling experiments based on current paradigms of global atmospheric circulation and the progressive build-up of greenhouse gases. Partridge's proposition that the Antarctic plays a more important role in climatic change than has been acknowledged hitherto is being echoed by others and may yet help to promote a switch of regional focus in the study of global climate change.

Tim Partridge was an earth scientist whose extensive research output over 38 years bore testimony to a broad range of skills. His principal focus was on the recent geological past and his area of interest was Africa, particularly the region south of the equator. His reputation among earth scientists with research interests in this area is unrivalled. But his standing as a scientist of exceptional originality extended far beyond Africa's shores and stemmed from major inputs to several fields of geology. His contributions to an understanding of the geological setting within which our earliest ancestors evolved are admired worldwide—indeed such is his reputation in this field that he was invited to present the opening public address at a conference

of the Royal Swedish Academy of Sciences on *The Origin of Humankind and the Environment* in May 2000. The placement of the world's most important assemblage of early hominid fossils—that from South Africa—within an increasingly precise chronological framework is largely the result of his efforts, and culminated in his announcement early in the new millennium, of the first absolute dates for specimens from Sterkfontein.

Partridge's contributions to an understanding of the mechanisms underlying the evolution of passive continental margins, and of palaeoclimatic processes that have impacted the African continent, and, in some cases, sent ripples across the globe, are well known within the relevant international communities and were acknowledged by his election to high office within international and national scientific bodies.

Among the honours that have been accorded to Tim Partridge are fellowships of the South African Geographical Society (1980), the S.A. Institute of Engineering Geologists (1994) and the Royal Society of South Africa (1995). His achievements have further been recognised through the award in 2001 of the Fellowship of the Geological Society of South Africa, and the award of the Geological Society's Jubilee Medal in 1989, which he shared with Dr. Rodney R. Maud, for an article entitled *Geomorphic Evolution of Southern Africa since the Mesozoic.*

Tim Partridge's greatest gift lay in his ability to grasp the broad picture without compromising attention to detail or the application of conceptual models of the highest sophistication. He was always mindful of the importance of good field evidence and was quickly able, through his highly developed skills, to comprehend its implications in the regional or even global context. This stamped him as a world leader in geology, remarkable for the depth and breadth of his vision in an age of increasingly narrow specialisation (Figure 2).

Tim Partridge at various times held many national and international positions. These included chairmanship of the Cainozoic Task Group of the S.A. Committee on Stratigraphy and of the S.A. National Committee for INQUA. He was President of the Institute for the Study of Mankind in Africa and of the Southern African Society for Quaternary Research (SASQUA). He was leader of the Palaeoclimates of the Southern Hemisphere Project of INQUA, and co-leader of the Pilot Project on Climates of the Past of UNESCO and the International Union of Geological Sciences. As part of the INQUA Commission on Stratigraphy, he chaired the Working Group on the Plio-Pleistocene Boundary. Seriously topical today, he led the project on Long-term Climatic Change of the Foundation for Research Development Special Programme on Southern African Climatic Change. Likewise he led the FRD Special Programme on Palaeoclimates of Southern Africa during the Quaternary. He was a member of the Board of Control of the Bernard Price Institute for Palaeontological Research of the Witwatersrand University.

It would be quite wrong to leave readers with the impression that Tim Partridge was purely a scientist's scientist. He loved life, sparkled at dinner parties—or around a camp-fire—could expound knowledgably and often passionately on music, history, art and photography, people, wine and food. He loved travel and he loved people. His gentle and kindly manner, his human skills, made it a joy to work with him, to savour his breadth of experience, his originality of mind and his love of literature and language, and to enjoy his friendship.

He married Marilyn Phillips, a medical practitioner and specialist anaesthetist, in 1973 and they spent 31 years happily and creatively complementing each other's careers. Tim was predeceased by Marilyn and by their son, Astley. Tim Partridge was married to Susan Jordan on 26th September 2009. Less than three months later, they were putting the finishing touches to a book, *Caves of the Ape-men*. He turned 67

on Monday, 7th December 2009: a day later, while working on the book with his long-time devoted assistant, Mrs Pat Moon, he was smitten with a severe heart attack and died within minutes. So the last of his books will perforce appear posthumously. This book and his other 150 published works (see selected publications) will help to keep Tim Partridge's memory green.

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Preface and Introduction

With the presentation of volume 30 of Palaeoecology of Africa (PoA) the series celebrates its 44th anniversary since starting in 1966. The jubilee edition of the yearbook looks back and forward, showing the history of the series, and former as well as recent trends and developments in palaeoenvironmental research. The 13 papers gathered together in this volume are covering numerous aspects, ideas and regions on former climates, vegetation cover, ecosystems and landscape dynamics all over Africa applying a huge variety of scientific methods (Figure 1). The reader will find complex reviews and new assessments as well as recent manuscripts on the former dynamics of ecosystems. Aside from natural changes in climate the human impact on landscapes and ecosystems is highlighted by some contributions. The concern and growing public awareness of recent and future Global Climate Change has underlined the importance and necessity of a better knowledge on past climate conditions to gain a better understanding of future processes that will probably change earth's environments within a relatively short time span. The past is the key to the future!

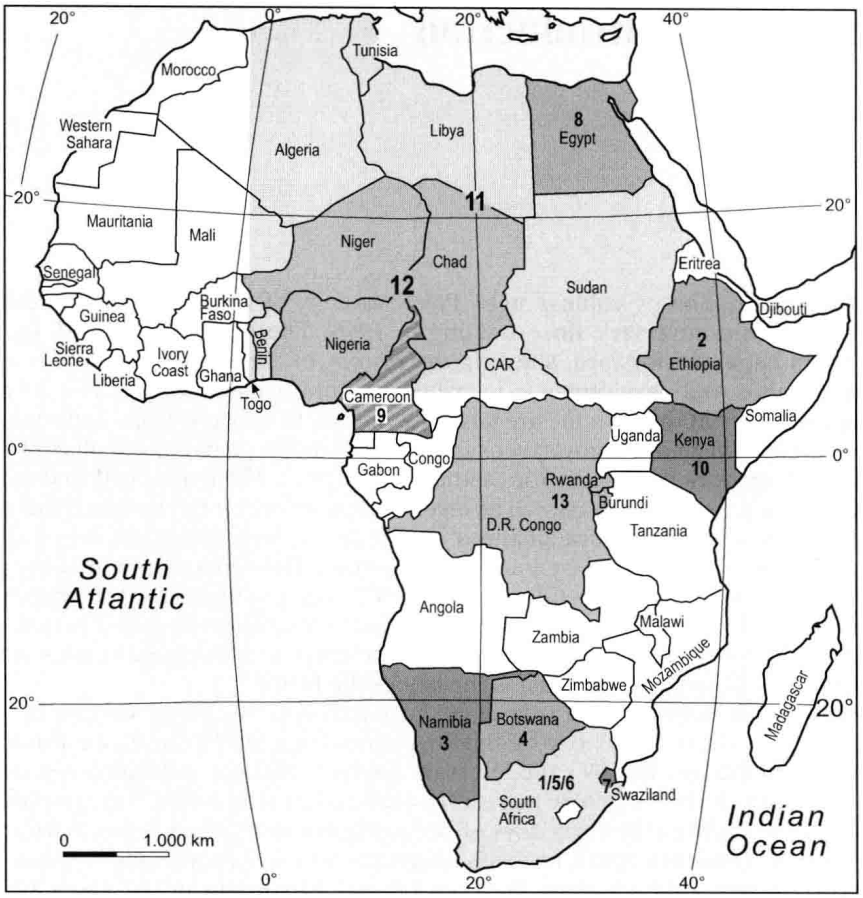
"How it all began" is the title of a short retrospective paper written by Klaus Heine (chapter 1) on the history of the PoA series founded by Professor Eduard M. van Zinderen Bakker. In 1993 the late van Zinderen Bakker published his reminiscences. Some of the introductory pages ("In praise of dust and mud") are re-published in this volume showing the early days of palynological research in South Africa.

A Belgian and Ethiopian research team around Jan Moeyersons is reconstructing environmental changes since the Late Glacial Maximum in the Geba basin of Northern Ethiopia (chapter 2) highlighting the early and today's influence by humans on the environment. Klaus Heine is concerned with climate reconstructions on the basis of fluvial deposits in the Namib desert (chapter 3) doing a critical reappraisal on how proxy data can be gained from complex fluvial sediment facies—often more than only one palaeoecological interpretation is possible.

Terrestrial rockshelter sediments at Tsodilo Hills in the Kalahari Desert of Botswana are analyzed by Andrew Ivester and his team (chapter 4) using optically stimulated luminescence (OSL) dating methods giving a series of soil stratigraphic units evidencing changing conditions over a period of the past 100/120 ka. Aside from the local findings their interpretations are done within a global context.

Grant Hall and Stephan Woodborne (chapter 5) document by other cave sediments from Sibudu, Kwa-Zulu-Natal and OSL datations severe ecosystem changes in South Africa for the oxygene isotope stages 3 and 4 similar to the Last Glacial Maximum. Correlations to archaeological findings for the Middle Stone Age have become possible. For interpretation they look at these terrestrial observations in a regional context focusing on ocean/atmosphere interactions and a weakening of the palaeo Agulhas current.

A palaeobotanical approach is applied by Carlos Cordova and Louis Scott (chapter 6) studying the potential of phytoliths from C_3 and C_4 plants (Poaceae, Cyperacea, Restionaceae) in South Africa. They evidence that the dynamics of some climate



1 - Klaus Heine, How it all began—Eduard van Zinderen Bakker and PALAEOECOLOGY OF AFRICA.
2 - Jan Moeyersons *et al.*, Reconstructing environmental changes in Northern Ethiopia.
3 - Klaus Heine, Climate reconstructions in hyper-arid desert environments: the Namib case.
4 - Andrew H. Ivester *et al.*, A sedimentary record of environmental change at Tsodilo Hills White Paintings Rock, Botswana.
5 - Grant Hall & Stephan Woodborne, Ecosystem change during MIS4 and early MIS 3, South Africa.
6 - Carlos E. Cordova & Louis Scott, The palaeoenvironmental potential of phytoliths, South Africa.
7 - Samanta Pelacani & Michael Märker, Gully erosion phenomena, Swaziland.
8 - Ashraf Mohamed *et al.*, Gypsum in desert soils, Egypt.
9 - Mark Sangen *et al.*, Palaeoenvironmental conditions in Southern Cameroon.
10 - Julian A. Ogondo *et al.*, Palaeoclimate of Ondiri Swamp, Kikuyu-Kenya.
11 - Brigitta Schütt *et al.*, A cluster-analysis-based climate classification for NE Africa.
12 - Jean Maley, Climate and palaeoenvironment evolution in north tropical Africa.
13 - Inc Vandecasteele *et al.*, Spatial and temporal distribution of natural hazards in Central Africa.

Figure 1. Location map of study sites and short title according to PoA-chapters.

variables such as total annual precipitation, rainfall seasonality and variability and summer temperatures can be documented by grass phytoliths and that they therefore provide a useful tool for palaeoclimatic reconstructions in this study area.

Geomorphic, pedologic and hydrologic aspects of recent to subrecent donga/gully erosion phenomena (see cover photo of PoA 30) in palaeolandscapes in Swaziland are discussed by Samanta Pelacani and Michael Märker in chapter 7. Spatio-temporal dynamics of gullies and rates of headcut retreat for several forms were calculated by using aerial photograph comparison and setting up high resolution digital terrain models (DTM).

In chapter 8 Ashraf Mohamed, Konrad Rögner and Sixten Bussemer contribute to overall palaeoenvironmental questions by studying the occurrence of gypsum in soils and in crusts emphasizing that the formation of crusts must have had occurred under a more humid climate than the hyper arid climate of today. However, the authors do not give a concrete interpretation neither an ecosystem history hypothesis for these findings from the Western Desert of Egypt.

Chapter 9 summarizes comprehensive palaeoenvironmental findings and proxy data generation from fluvial sediments of several rivers in the rain forest zone of Southern Cameroon by a team around Mark Sangen. These terrestrial records in a humid tropical environment date back to almost 50 ka. Numerous radiocarbon data (^{14}C) and $\delta^{13}C$ figures allowed the reconstruction of former Late Quaternary environments in the western Atlantic part of Central Africa.

Julian A. Ogondo, Daniel Olago and Eric O. Odada summarize in chapter 10 the results on a pollen-diatom and geochemistry study from a near to surface core at Ondiri Swamp in Kenya that evidence historic environmental conditions close to the equator between 1350 to 1810 AD. By comparison with other proxy data from the region (e.g. Lake Naivasha) they confirm shorter climatic fluctuations and subrecent environmental/landscape disturbances. However, this paper also illustrates that it is often a problem to transfer local findings on a wider regional scale, what means that it is also possible that they are more the expression of effects in places.

The region of Northern and Central Africa is covered by the study of Brigitta Schütt, Katharina Ducke and Jan Krause on a cluster-analysis-based climate classification comparing conventional and established climate classifications of Köppen-Geiger, Troll-Paffen and others with their own approach in chapter 11. This paper can have some relevance to the understanding to recent and to short time climate dynamics based on empirical data and is therefore useful to be included in a book on palaeoenvironments.

Chapter 12 is a very comprehensive review paper by the editorial board member of PoA Jean Maley concerning the evolution of climate and palaeoenvironment in the northern hemisphere of Africa from the end of the Tertiary to the Upper Quaternary. Especially the extensive studies on the Lake Chad basin give an excellent overview what has been done so far and what open questions future research is facing.

Finally, chapter 13 by Ine Vandecasteele, Jan Moeyersons and Phillipe Trefois is concerned with climate controlled natural hazards in Central Africa. This paper gives on the one hand an overview of the spatial and temporal distribution of geomorphic and hydrologic hazards by introducing a new data base on these phenomena, on the other hand it shows that research on palaeo-relief and landscape dynamics has a large potential for applied science and for further research.