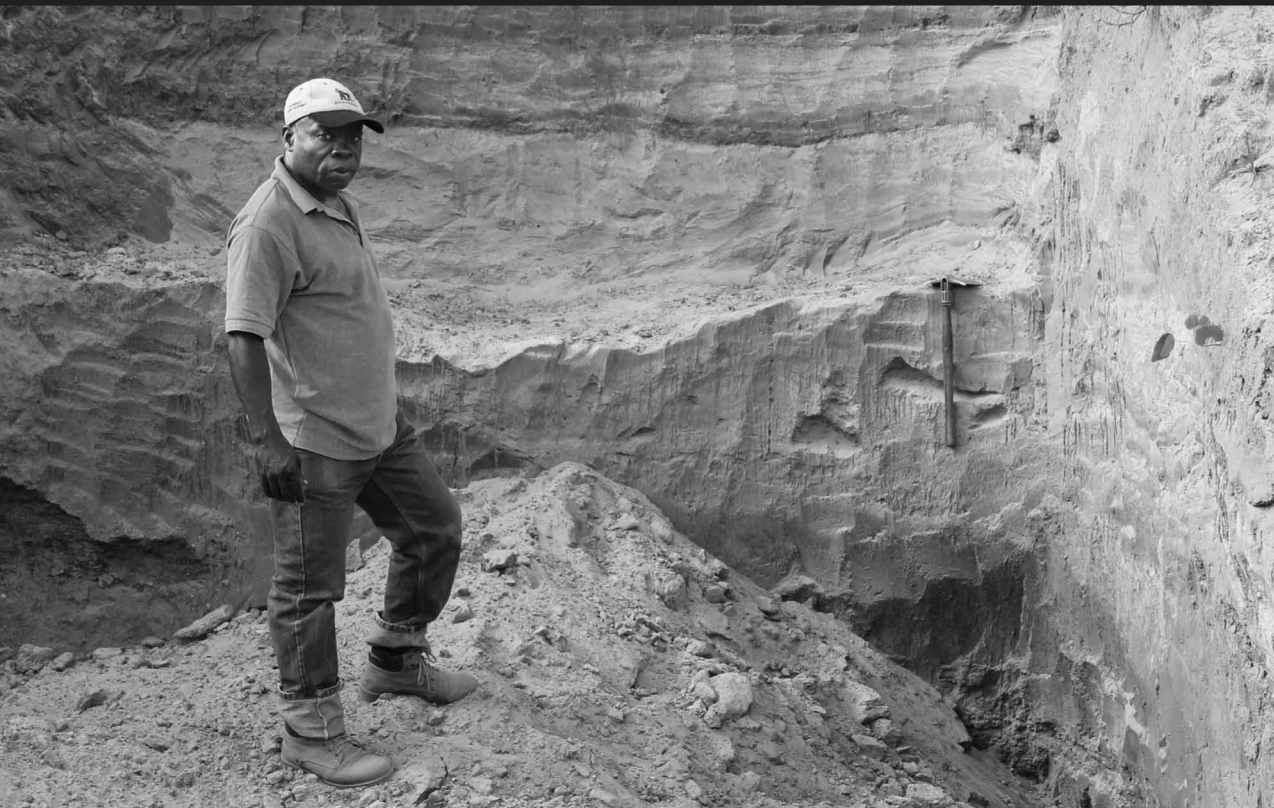




The African Neogene – Climate, Environments and People

Jürgen Runge

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CLIMATE, ENVIRONMENTS AND PEOPLE

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The African Neogene – Climate, Environments and People

Editor

Jürgen Runge

*Centre for Interdisciplinary Research on Africa (CIRA/ZIAF),
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Front cover: Togolese Geographer Tignoati Kolani investigates laminated alluvial sediments of the Keran River, a tributary of the Oti-Volta catchment in West Africa (Photo: J. Runge, April 2016).

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Foreword

The eleven papers presented in the 34th volume of *Palaeoecology of Africa* (PoA) illustrate both the ongoing challenges and problems facing Neogene and Quaternary environmental reconstruction on the African continent. They look at the climate and environments of the past at different temporal and spatial scales as well as the role played by humans in those environments. Methodologically, the contributions cover a wide range of interdisciplinary approaches such as the geomorphological shape of landscapes (macro-scale river basin evolution); interpretation of sedimentary records of deltas, caves and rock-shelters; and the palynological significance of pollen grains from high altitude floating bogs. Interpretation of these findings to correctly reconstruct ancient landscapes' ecosystem processes is always complex and a challenge for the authors.

In this volume, a strong regional focus is set on Nigeria in order to reflect the basic research carried out by growing number of African scientists, which is often linked to applied research supporting the oil and gas industry in the Niger Delta. Besides near-coast Nigerian case studies, regional research in this book covers the margins of the wider Congo Basin, for example, Loango Bay (R. Congo), the eastern Kivu Rift Valley (D.R. Congo), and the Mumba Rock Shelter (Tanzania). One applied contribution from West Africa looks at the growing importance of Developing Minerals and GIS techniques in the urban areas of Accra (Ghana). The role of previous research carried out in the Tibesti Mountains in Central Sahara is recalled by a paper, which also highlights future research potential that will contribute to the not-yet-answered questions of the African palaeoenvironment.

Two obituaries pay tribute to longstanding members of the PoA Editorial Board: the late colleagues Karl W. Butzer (1934–2016) and Françoise Gasse (1942–2014).

The peer review process was thankfully supported by numerous anonymous reviewers. Two student assistants, Tobias Buchwald and Nishtha Prakash, from the University of Frankfurt Physical Geography Working Group and the Centre for Interdisciplinary Research on Africa (ZIAF) helped streamline the editing process. Dr. Joachim Eisenberg reliably formatted the manuscripts for PoA layout and style. He also revised many figures and carried out additional and complex cartographic art work for this book.

Finally, I take this opportunity to place on record my gratitude to Senior Publisher Janjaap Blom and his team from Routledge/Taylor & Francis/CRC Press in Leiden (The Netherlands) for the continuous support to PoA.

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Contributors

Olabisi Adekeye

Department of Geology and Mineral Science, University of Ilorin, Nigeria

Onema Adojoh

School of Environmental Sciences, University of Liverpool, L69 7ZT, United Kingdom; Geosciences and Geological and Petroleum Engineering, University of Missouri Science and Technology, Rolla, MO 65409-0410, USA,
Email: adojoho@mst.edu

Mike I. Akaegbobi†

Department of Geology, University of Ibadan, Nigeria

Samuel Akande

Department of Geology and Mineral Science, University of Ilorin, Nigeria

Akintunde Akintola

Geology Department, Olabisi Onabanjo University, Ago-Iwoye, Nigeria

Samson Bankole

Department of Geosciences, University of Lagos, Nigeria,
Email: sbankole@unilag.edu.ng

Olugbenga A. Boboye

Department of Geology, University of Ibadan, Ibadan, Nigeria,
Email: boboyebenga@yahoo.com

Florent Boudzoumou

Département de Géologie, Université Marien Ngouabi, Brazzaville, Congo

Pastory G.M. Bushozi

Department of Archaeology and Heritage University of Dar es Salaam, Tanzania, Email: pbushozi@gmail.com

Jacinta N. Chukwuma-Orji

Department of Geology, Federal University of Technology, Minna, Nigeria,
Email: jacinta@futminna.edu.ng

Woody (Fenton) P.D. Cotterill

Geocodynamics Research Hub, c/o Department of Earth Sciences, University of Stellenbosch, Matieland, 7602, South Africa, Email: fenton.cotterill@uct.ac.za

Olusola Dublin-Green

Department of Geosciences, University of Lagos, Nigeria

Robert Duller

School of Environmental Sciences, University of Liverpool, L69 7ZT,
United Kingdom

Frank D. Eckardt

Department of Environmental and Geographical Science, University of
Cape Town, Rondebosch, 7701, South Africa, Email: frank.eckardt@uct.ac.za

Dupe Egbeola

Department of Geology, University of Ibadan, Ibadan, Nigeria

Bernd-D. Erdtmann

Institut für Angewandte Geowissenschaften, Technische Universität
Berlin, Sekr. EB 10, Ernst-Reuter-Platz 1, D-10587, Berlin, Germany

Tyrel J. Flügel

Department of Environmental and Geographical Science, University of Cape
Town, Rondebosch, 7701, South Africa; Department of Environmental and
Geographical Science, University of Cape Town, Rondebosch, 7701, South Africa,
Email: tyrel.flugel@gmail.com

Baldur Gabriel

Gertraudenstraße 13, 16225 Eberswalde, Germany, Email: Baldur.Gabriel@web.de

Pierre Giresse

Centre de Formation et de Recherches sur les Environnements Méditerranéens,
Université de Perpignan, Perpignan, France, Email: giresse@univ-perp.fr

Isah A. Goro

Department of Geology, Federal University of Technology, Minna, Nigeria

Chantal Kabonyi Nzabandora

Faculty of Sciences, University of Bukavu, D.R. Congo,
Email: chantalkabonyi@gmail.com

Luis Leque

Natural Museum, Madrid, Spain

Audax Mabulla

National Museums of Tanzania, Tanzania

Dieudonné Malounguila-Nganga

Département de Géologie, Université Marien Ngouabi, Brazzaville, Congo,
Email: malounguila@hotmail.fr

Fabienne Marret

School of Environmental Sciences, University of Liverpool, L69 7ZT,
United Kingdom, Email: F.Marret@liverpool.ac.uk

Timothée Miyouna

Département de Géologie, Université Marien Ngouabi, Brazzaville, Congo,
Email: miyounatim@yahoo.fr

Rosemary Okla

Ghana Geological Survey Authority, Accra, Ghana,
Email: rosemaryokla@gmail.com

Edward A. Okosun

Department of Geology, Federal University of Technology, Minna, Nigeria

Samuel Olobaniyi

Department of Geosciences, University of Lagos, Nigeria

Peter Osterloff

Shell UK Limited, Aberdeen, AB12 3FY, United Kingdom,
Email: Peter.Osterloff@shell.com

Emile Roche

Palaeontology, University of Liège, Belgium,
Email: rocheemile@yahoo.fr

Jürgen Runge

Centre for Interdisciplinary Research on Africa (ZIAF) and Institute of Physical
Geography, Johann Wolfgang Goethe University, Altenhöferallee 1, 60438
Frankfurt am Main, Germany, Email: j.runge@em.uni-frankfurt.de

Eckert Schrank

Institut für Angewandte Geowissenschaften, Technische Universität
Berlin, Sekr. EB 10, Ernst-Reuter-Platz 1, D-10587, Berlin, Germany

Florence Sylvestre

CEREGE, Technopole Environnement Arbois-Méditerranée,
Aix-en-Provence, France, Email: sylvestre@cerege.fr

Salome H. Waziri

Department of Geology, Federal University of Technology, Minna, Nigeria



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CHAPTER 1

Obituaries: Karl W. Butzer (1934–2016) Françoise Gasse (1942–2014)

Jürgen Runge

*Centre for Interdisciplinary Research on Africa (CIRA/ZIAF),
Johann Wolfgang Goethe University, Frankfurt am Main, Germany*

Florence Sylvestre

*CEREGE, Technopole Environnement Arbois-Méditerranée,
Aix-en-Provence, France*

It is with deep regret to report that ‘Palaeoecology of Africa (PoA)’ lost two of its long-time editorial board members: the German-born, US-American geographer, palaeoecologist and archaeologist, Karl W. Butzer in 2016; and the French palaeobiologist (diatom specialist), palaeoclimatologist and palaeohydrologist, Françoise Gasse in 2014. Both supported and accompanied over many years the long-term success story of PoA. Founded in 1966 by Professor Eduard M. van Zinderen Bakker (1907–2002) and assisted by Professor Joey Coetzee (1921–2007, see *Palaeoecology of Africa*, Vol. 29, 2009) the PoA series has consistently published interdisciplinary scientific papers on landscape evolution and on former environments of the African continent as well as papers on changes in climate and in vegetation cover interconnected to environmental dynamics from the Cainozoic up to the present. Recently, the PoA also broadened its horizons to the steadily growing influence of humans on many of the field sites studied that has shaped the scientific profile of the series.

1.1 KARL W. BUTZER

Karl W. Butzer ([Figure 1](#)) was born on August 19, 1934 in Mühlheim an der Ruhr (Rhineland, Germany). The rise of Nazi Germany coincided with his childhood, and in 1937, his Catholic family decided to escape from Germany. Karl and his older brother Paul were smuggled under the seat of a school bus to England, where they later reunited with their parents. Finally, during World War II in 1941, the Butzers emigrated to Montreal, Canada (Doolittle, 2016; Turner II, 2017). “The trauma of migration, family separation, persecution, [...] incidents of prejudice in Canada, and an uncertain fate of family members left behind, are all experiences that have influenced [Karl Butzer’s] outlook on life” (Offen, 2003, p. 125).

Subsequently he studied at McGill University (Montreal) where he received two degrees—the B.Sc. (Honours) in Mathematics (1954), and the M.Sc. in Meteorology and Geography (1955). With the assistance of an exchange fellowship, he returned to Germany and studied under Carl Troll (1899–1975), the initiator of the concept

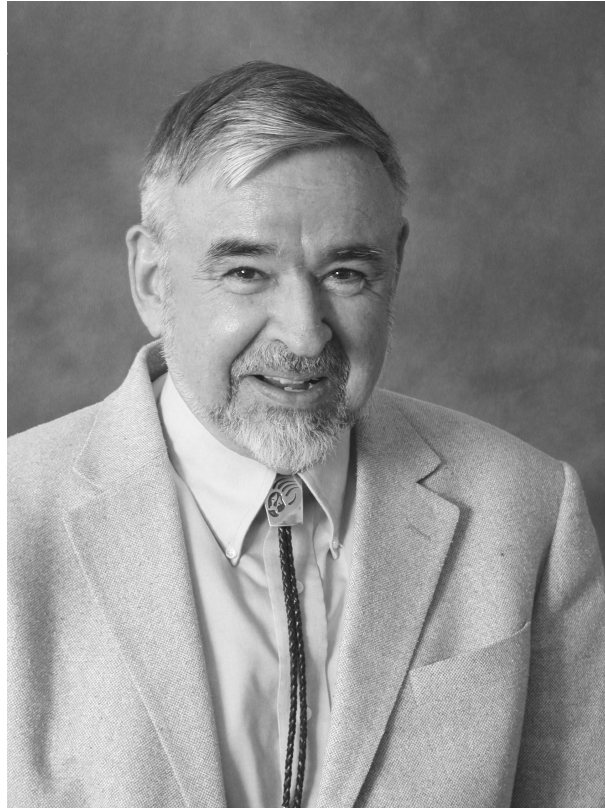


Figure 1. Karl W. Butzer in 2005 (Source: Sounny Wikimedia commons licence).

of “landscape ecology”, at the University of Bonn. In 1957, shortly before his 23rd birthday, he received the doctorate in natural science (Dr. rer. nat.) in the disciplines of Physical Geography and Ancient History. By graduation, Butzer already had published seven scientific articles!

In Bonn, Karl Butzer met Elisabeth Schlösser who became his wife and collaborator for 56 years. “The two honeymooned on Mallorca, where they started a not-so-romantic project on palaeosols and fossil beaches” (Doolittle, 2016). Subsequently the couple worked jointly together in Egypt, Ethiopia, and South Africa. “On their numerous projects in Spain and Mexico, Karl excavated and mapped, while Elisabeth (‘Lis’) scoured archives and translated documents” (Doolittle, 2016).

His outstanding performance at an early stage of his career allowed him to work for two years as a research associate at the German Academy of Sciences and Literature in Mainz, Germany (Turner II, 2017). He was then Assistant, and later Associate Professor at the University of Wisconsin-Madison (1959–1966).

In 1966, he accepted an offer as Professor of Anthropology and Geography at the University of Chicago where he was named the “Henry Schultz Professor of Environmental Archaeology” in 1980. He was elected to various sub-departments, namely the Committee on African Studies, Committee on Evolutionary Biology, Committee on Archaeological Studies (Humanities), and as Professor in the Oriental Institute (University of Texas, 2016).

“Pleistocene geology is primarily concerned with stratigraphy and chronology. A more comprehensive study of past environments is needed, a Pleistocene Geography concerned with the natural environment and focused on the same themes of “man and nature” that are the concern of historical and contemporary geographies. This is a field to which both the natural scientists and the archaeologist should contribute—more directly and with greater enthusiasm” (Butzer, 1964, p. 7)

The University of Chicago provided up to the year 1984 the ideal intellectual home for Karl Butzer (Doolittle, 2016). He viewed Chicago as a great place to live and to raise four children. Butzer’s geoarchaeological research was much appreciated by his colleagues, with whom he not only collaborated, but also considered them as lifelong friends. During the Chicago years, he wrote landmark books such as ‘Desert and River in Nubia: Geomorphology and Prehistoric Environments at the Aswan Reservoir (1968)’ (with C. L. Hansen), ‘Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology (1976)’, ‘Geomorphology from the Earth (1976)’, and ‘Archaeology as Human Ecology (1982): Method and Theory for a Contextual Approach’ (Turner II, 2017). It was obvious that Butzer’s thematic approach and scientific research was, at an early stage, already focused on ‘inter- and transdisciplinary’ perspectives, and therefore, he expanded his efforts on the social dimensions of human-environment relationships.

In 1981, Butzer was visiting Chair and Professor of Human Geography at the Swiss Federal Institute of Technology (ETH) in Zurich for one year. In Zurich, he advanced a full-fledged human-environment science of the past in Archaeology as Human Ecology. Butzer amplified his challenge to palaeoenvironmental and archaeological researchers to appreciate the complexity of human-environment interactions and to allow the exploration of a full range of evidence. Subsequently, from 1982 until 1987, Karl Butzer and his wife carried out comprehensive studies in eastern Spain, combining archaeological excavation, archival documentation as well as settlement and land use studies (Turner II, 2017).

In 1984, Butzer took his final position as the Raymond C. Dickson Professor of Liberal Arts at the Departments of Geography and Anthropology, University of Texas at Austin. In driving proximity to Mexico, Karl Butzer and his wife undertook extensive excursions and field work in the Bajío of north-central Mexico, addressing the environmental impacts of Hispanic land uses. They mainly focused on archival documentation (Lis) and on sediments (Karl) (Turner II, 2017). This research challenged claims about the environmentally degrading land uses of the Colonial period, noting that numerous indicators of pre-Hispanic land degradation were prevalent in the Bajío, some of which improved under Hispanic dominion. As Butzer was always insisting on an evidence-based interpretation of land changes in Mexico, he challenged the popular and common position accompanying the Columbus quincentenary that the Spanish introduction of herd animals and the plough were the fundamental elements for land degradation within colonial Mexico (Turner II, 2017). For his comprehensive contributions to the geography of Latin America, in 2002 he received the Preston E. James Eminent Latin Americanist Career Award (Offen, 2003).

Population cycles and civilizational collapse, including articles on institutional structures, demography, climatic forcing, and environmental degradation appeared in 1980–1982, 1990, 1994, and 1997. Butzer organized a symposium on ‘Collapse, Environment and Society’ in 2010, and a review presentation appeared in the Proceedings of the National Academy of Sciences, in conjunction with a set of specialist papers, co-edited with Georgina Endfield in 2012 (University of Texas, 2016).

Other themes of Karl Butzer addressed in terms of geoscience included studies on coastal geomorphology (Egypt, Spain, South Africa, and Atlantic Canada, between 1960 and 2002), and tufa waterfalls, playa lakes, or periglacial phenomena in South Africa and Spain (between 1964 and 1979). Biographical themes bring

published recollections on emigration, ethnic prejudice, and academic freedom in the authoritarian state (2001–2004) (University of Texas, 2016).

His last paper in 2016 on ‘Dry lakes or *Pans* of the Western Free State, South Africa: Environmental history of Deelpan and possible early human impacts’ was published in honour of Professor Louis Scott, Bloemfontein, South Africa, in the series *Palaeoecology of Africa* (Volume 33).

Karl Butzer served as editor from 1978–2009 for the *Journal of Archaeological Science*, and as series editor of *Prehistoric Archaeology and Ecology* for the University of Chicago Press (1973–1988). He also held positions as member of the editorial boards of many distinguished journals such as *Advances in Archaeological Method and Theory*, *Catena*, *Geographical Review*, *Geomorphology*, *Physical Geography*, *Progress in Human Geography*, *Palaeoecology of Africa*, *Paleorient*, *Stratigraphic Newletters*, and *Quaternaria*.

“Following the traditions of natural history, Karl Butzer believed that both inductive and deductive approaches, always informed by empirical evidence, were required to arrive at robust interpretations. He was suspicious of purely theoretically driven research applied to past and present human-environment interactions, commonly responding by demonstrating instances in which the evidence ran counter to theory or, at least, required a much more nuanced understanding of the processes in question. This understanding was not fully gained by the mechanistic explications of the natural sciences, but required an appreciation of what historical, ethnographic, and cultural evidence had to offer” (Turner II, 2017, p. 5).

Karl Butzer loved field research, presenting his results to the scientific community, teaching and mentoring, especially at the graduate level. He received the Graduate Teaching Award from the University of Texas at Austin in 2005 (University of Texas, 2016). His research output was remarkable. He published 14 books and monographs, 275 refereed articles, book chapters, and encyclopaedia entries written in English, German, and Spanish; some having been translated into six other languages. He was most at home in the field, and his field of research was extensive! (Turner II, 2017). This is appropriately underlined by the following quote: “... his students in geography, archaeology, geology, and Latin American, African, and Middle Eastern Studies attest, you could learn more in one day in the field with Professor Butzer than you could in a semester-long course with any other professor...” (Doolittle, 2016).

On May 4, 2016, at the age of 81 Karl W. Butzer passed away in Austin, Texas after a short illness (Knapp 2016). “Karl is survived by Lis, two daughters, Helga and Kieke, and two sons, Carl and Hans, seven grandchildren, and his older brother, Paul” (Turner II, 2017, p. 7). He will be greatly missed.

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- University of Texas, 2016, In Memoriam Dr. Karl W. Butzer, 3 p., <http://sites.utexas.edu/butzer>.

1.2 FRANÇOISE GASSE

Françoise Gasse was born on June 22, 1942 in Bergerac (Département Dordogne) in the south-western region of France (Figure 2). Her early childhood was impacted by political uncertainty due to World War II (German occupation) and to post-war experiences of her family and relatives.



Figure 2. Françoise Gasse at work in the laboratories at CEREGE (Gasse 2014, p. 140).

Until much later, she left her home in the French countryside for higher education and went to the greater Paris area. As she was always interested in nature, she oriented herself towards natural sciences and received in 1967 her first university diploma (*Agrégation de Sciences Naturelles*). For almost 20 years, from 1967–1986, she worked as tutor and lecturer in Botany at the traditional higher vocational school for teacher training (*Ecole Normale Supérieure*) in Fontenay-aux-Roses, a suburb south of Paris.

In 1970, while still lecturing at Fontenay-aux-Roses, Françoise Gasse started to work on a dissertation in the Laboratory of Quaternary Geology (Professor Henriette Alimen). The PhD was completed in 1975 when receiving the *Docteur-ès-Sciences, Sciences de la Terre* at the *Université Pierre et Marie Curie* in Paris. Her dissertation on Lake Abhé near the Ethiopia-Djibouti border (Afar) was the first continuously dated African Plio-Pleistocene diatom record. In her dissertation, Gasse showed, through an innovative methodology, that Lake Abhé—today a small, shallow, hyper-alkaline waterbody—was a 160 metre deep freshwater lake that extended over 5000 km² during the early to Mid-Holocene (see publication in *Nature*, Gasse, 1977).

Since 1986, she was permanently employed at the National Centre for Scientific Research (CNRS, *Centre National de la Recherche Scientifique*) in Orsay, Paris, a public organization under the responsibility of the French Ministry of Education and Research, where she was Research Director and was responsible for the bioindicator, climate and environmental modelling team at the hydrological isotope lab. Shortly after the turn of the millennium, Françoise Gasse moved from Orsay to the CEREGE (*Centre Européen de Recherche et d'Enseignement en Géosciences de l'Environnement*) in Aix-en-Provence. She was always very active, both at national and international level, for example as a member of PAGES/IGBP/PEP and the International Continental Scientific Drilling Program (ICDP).

Her involvement in the PAGES (Past Global Changes) programme with regional- to continent-wide landscape transects (Pole-Equator-Pole) through Europe and Africa (PEP3, 1991–2001) sharpened Gasse's interest and understanding for inter-hemispheric teleconnections, ocean-land relationships, climate model reliability, and model-data comparison that were subsequently used to validate models. An important objective of the PEP3 project was to provide quantitative parameters and compare them to simulations derived from climate models. One way to translate palaeolimnological data (lake level, salinity, and isotopic composition) in terms of quantified controlling factors is by hydrological modelling of individual lakes. This approach helps elucidate lake functioning, can yield estimates of past conditions in a lake basin, and can be used to predict lake status under specific future scenarios (Gasse, 2014).

Gasse as a specialist of diatoms initiated pioneer research to reconstruct Quaternary climates and environments in the Sahara and the Sahel, East Africa (Ethiopia), Madagascar, in western and south Asia (Caspian Sea, Tibet), and in the Middle East (Lebanon). Her research commonly integrated diatom and isotopic data. It was characterized both by her sophisticated understanding of the importance of basin hydrogeomorphology in palaeoclimatic interpretation, and the rigour of her taxonomic identification of diatoms.

Therefore, the present knowledge of palaeoclimatology within arid zones is mainly based on her studies on sedimentary archives from lakes and palaeolakes. One of her key contribution has been to develop the use of diatom assemblages to quantify how lake physico-chemistry parameters (salinity, pH) have evolved over time.

Most of her numerous and well-cited articles (>200) deal with the late Quaternary environment, including the late glacial and the last climatic transition. But Gasse's focus was also on the more recent period, the Holocene and the last millennia, with important contributions showing the existence of rapid events—as seen from the hydrological cycle—during those periods that were previously thought to be stable, with major dry spells around 8000 and 4000 years ago.

She was an engaged editorial board member of internationally recognized scientific journals such as *Earth and Planetary Letters*, *Geology*, *Nature*, *Palaeoecology of Africa*, *Science*, *Science Reviews*, *Quaternary Science Reviews*, and many others. She supervised 25 doctoral theses closely linked to her interdisciplinary, multi-proxy data studies.

In 2005, Françoise Gasse was the first woman to receive the Vega Medal in Gold awarded by the Swedish Society for Anthropology and Geography. In 2010, she was awarded the Hans Oeschger Medal of the European Geosciences Union (EGU) for her contribution to the reconstruction of climate variability during the Holocene. Her last contribution to the journal *Palaeolimnology* in January 2014 was an ultimate tribute to the deserts, “Reminiscences and acknowledgments from a lover of deserts near the end of her professional life” (Gasse, 2014).

“I appreciate having friends throughout the world. I confess, however, that my best ‘souvenirs’ are and will remain the fantastic memories of travels to remote countries, seeing landscapes and colours that I could not have imagined and having the opportunities to interact with fascinating cultures and observe so many different ways of life” (Gasse, 2014, p. 143).

Francoise Gasse passed away on April 22, 2014. She was a scientific pioneer on many fronts. Her impact is ongoing and the quality of her career is exemplary. Her friendly and discrete authority, her radiant smile, and her cleverness will remain in our memories.

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CHAPTER 2

Exploration of the Tibesti Mountains— Re-appraisal after 50 years?

Baldur Gabriel

Berlin, Germany

ABSTRACT: The Tibesti Massif is the highest and largest mountain area in the Sahara. With more than 3400 m a.s.l., it must have reached into different climatic zones during cold periods of the Quaternary. Hence, for the whole of Northern Africa, it acted as an ecological niche and as a refuge during the arid phases; while during the humid “pluvials”, it operated as a centre for propagation. The former investigations into palaeoclimate, landscape, and cultural history, carried out mostly by French scientists and by the German Research Station at Bardai (established by the Free University of Berlin), came to an end after 1970 due to political problems. Only recently, researchers from the University of Cologne have resumed geoscientific research in this large, to date little-known area. This paper explains some of the previous activities and results and highlights important gaps in present knowledge. The history of climate and landscape evolution can better and more precisely be understood, in particular, by additional investigations into fluvial terraces (which document successions of erosion and accumulation) as well as into processes of weathering (fossil soils and their stratigraphic interference and intercalation by volcanic activities), and into the analysis of fossil-bearing sediments of ancient lakes, especially in high-altitude volcanic craters. In respect to cultural history the study of archaeological remains can help to solve hitherto unsettled questions: Where did people, animals, and plants, which populated the Sahara after the beginning of the Holocene humidification, come from? Where was the centre of the early African ceramic production? Where can we localize the origin of the wide-spread African cattle-herders? – There have long-since been serious suppositions and theories that the Tibesti was the main source of the beginning and further evolution of the Neolithic in Northern Africa. By this it must have fundamentally influenced the civilizations and state societies of the Old World that later evolved.

2.1 INTRODUCTION

German research in the North African dry belt has quite a long tradition. Already by the end of the 18th century Friedrich Hornemann crossed the Sahara, travelling from Cairo via Siwa and Murzuk up to the Niger River (Hornemann, 1802), followed during the 19th century by lengthy voyages of Heinrich Barth (Barth, 1857–58), Gustav Nachtigal (Nachtigal, 1879–89), and Gerhard Rohlfs (Rohlfs, 1868, 1881). Between World War I and World War II especially Leo Frobenius (Frobenius, 1963), together with Hans Rhotert (Rhotert, 1952), brought interesting results from their long expeditions. After World War II, in 1954–55, it was Wolfgang Meckelein from the Berlin Geographical Society, who managed an extended journey to the central Sahara, also

to Wau en-Namus, and nearly up to the northern edge of the Tibesti Mountains (Meckelein, 1959) (Figure 1).

At that time, the Tibesti was rather inaccessible and accordingly rather disregarded by scientists, though it was with 3415 m a.s.l. the highest and with 150,000 km² the largest mountain range in the centre of the Sahara (Gabriel, 1991). Since 1899, it was part of the French colonial administrative authority. In fact it was not occupied before 1914, but gradually this was followed by its exploration (Gabriel, 1973). In 1921 already, Jean Tilho, a geographer from the French military service, published a detailed topographic map of the massif (Tilho, 1921). The geology, in general, was investigated first by Marius Dalloni (Dalloni, 1934–35) and later on – predominantly the volcanic phases – by Pierre Vincent (Vincent, 1963) and others. Extensive botanical research activities were undertaken by Pierre Quézel (Quézel, 1958). Charles LeCoeur explored the language, the habits, and the ethnographical situation of the people (LeCoeur, 1950, 1956; cf. Chapelle, 1957). However, the evolution of climate, landscape, and civilizations during the Quaternary was just mentioned as side-issues in marginal notes or – mainly various prehistoric data and discussions – communicated by enthusiastic members of the military staff like Paul Huard (Beck and Huard, 1969; Huard, 1978).

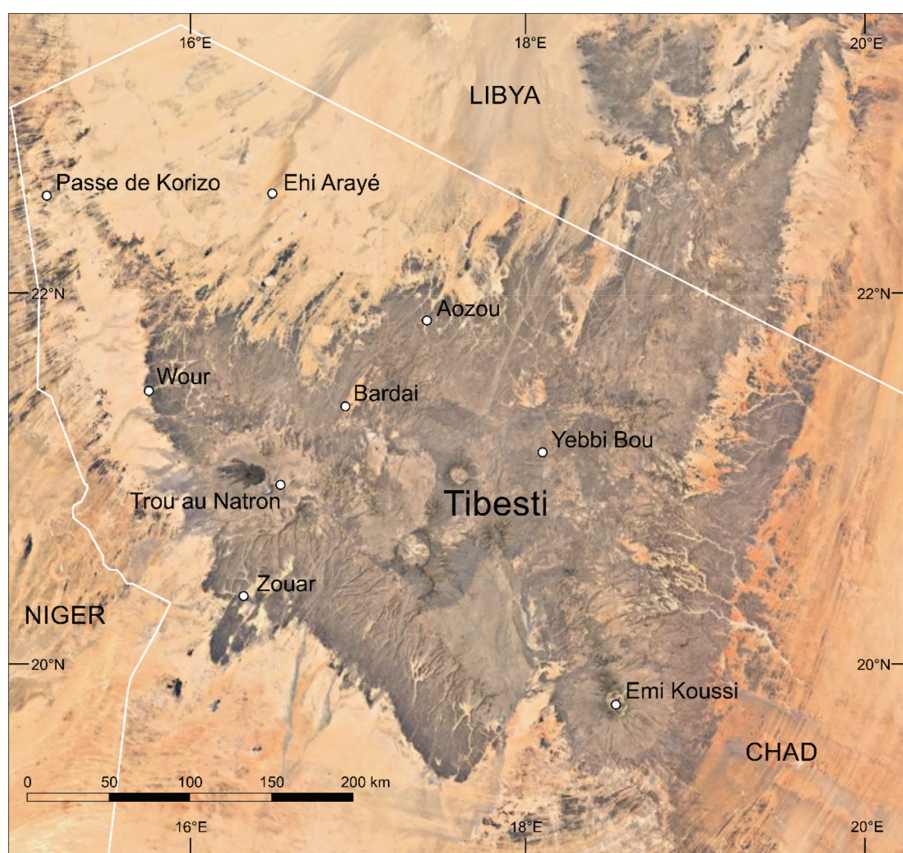


Figure 1. Annotated satellite map of the Tibesti Mountains in Chad – Google Earth; Images © 2017 Landsat/Copernicus.

2.2 THE RESEARCH STATION OF THE FREE UNIVERSITY OF BERLIN IN BARDAI

Therefore, in 1964, the building of a research station by Jürgen Hövermann in Bardai, in the administrative centre of the Tibesti, was quite important and meritorious (Hövermann, 1965). He was professor of geography and the head of the Lab for Geomorphology at the Free University of Berlin. Hövermann had previously investigated the glacial evolution of climate and landscape in central Europe as well as in the high mountains of Ethiopia and he was particularly interested in the effects of the adiabatic gradient: Air temperature depends on the height above sea level, the higher – the cooler (approx. $1^{\circ}\text{C}/100\text{ m}$), and because cold air cannot hold water vapour to the same degree precipitation must increase. Above the freezing point they fall as snow which can aggregate to form snow patches and glaciers and these – gliding downhill – can form trough valleys and nivation hollows like cirques, leaving different kinds of moraine deposits. Additional hints on former climate can be soil patterns from seasonal frozen ground (Gelisol) as in arctic zones or a change of climate can also be ascertained from special distinguishable marks of weathering, erosion, and sedimentation.

As a high mountain area situated in the subtropical dry belt, the Tibesti must have participated in several climatic zones throughout the Quaternary, and climatic changes should be traceable quite easily. Therefore, the massif promised a great variety of palaeoclimatic indicators as well as of ecological niches. Besides it was scarcely explored and it was situated within the reach of central Europe. Such considerations influenced the decision to establish the “Außenstelle des Geomorphologischen

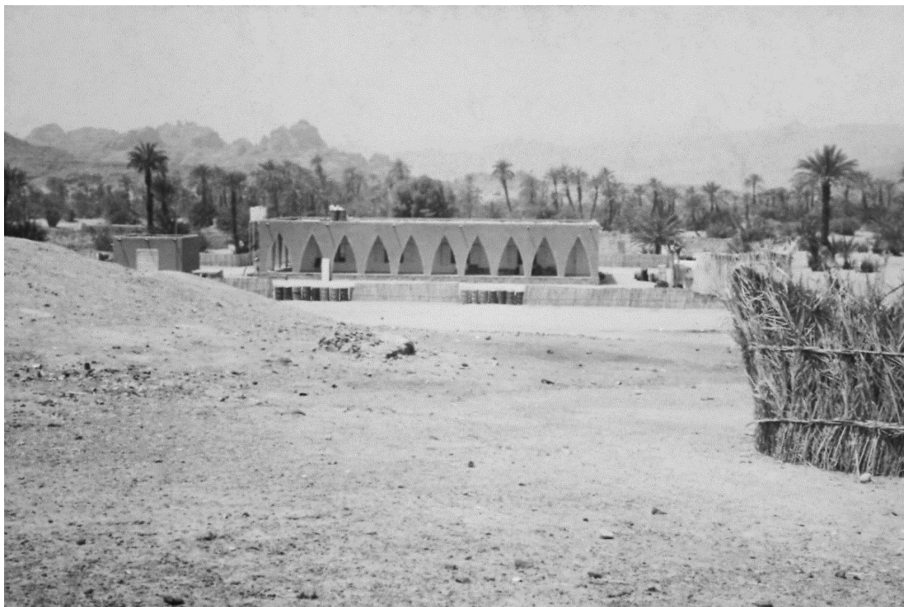


Figure 2. The building of the “Maison allemande” on the southern outskirts of Bardai, surrounded by a fence, seen from the east. The main entrance was from the right, from the centre of the oasis. Over the left corner of the roof, the water reservoir, in white, of the local well is to be seen. The separate small building to the left was the kitchen. – Photo: B. Gabriel, 23.02.1967.