

# Sedimentation in the African Rifts

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# Sedimentation in the African Rifts

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# Contents

List of contributors . . . . .	vii
Preface . . . . .	ix
Obituary . . . . .	xiii

## Continental Rift Basins

READING, H.G. African Rift tectonics and sedimentation: an introduction . . . . .	3
GROVE, A.T. Geomorphology of the African Rift System . . . . .	9

## African Rift Basin Development

FAIRHEAD, J.D. Geophysical controls on sedimentation within the African Rift Systems . . .	19
ROSENDAHL, B.R., REYNOLDS, D.J., LORBER, P.M., BURGESS, C.F., MCGILL, J., SCOTT, D., LAMBIASE, J.J. & DERKSEN, S.J. Structural expressions of rifting: lessons from Lake Tanganyika, Africa . . . . .	29
BAKER, B.H. Tectonics and volcanism of the southern Kenya Rift Valley and its influence on rift sedimentation . . . . .	45
WILLIAMS, L.A.J. & CHAPMAN, G.R. Relationships between major structures, salic volcanism and sedimentation in the Kenya Rift from the equator northwards to Lake Turkana . . . .	59
SWAIN, C.J., SKINNER, N.J. & KHAN, M.A. Depth to metamorphic basement in the Koobi Fora region from seismic and gravity data. . . . .	75
WATKINS, R.T. Volcano-tectonic control on sedimentation in the Koobi Fora sedimentary basin, Lake Turkana . . . . .	85

## Siliciclastic, Chemical, Pedogenic and Organic Sediments in Contemporary Rift Environments

REID, I. & FROSTICK, L.E. Slope processes, sediment derivation and landform evolution in a rift valley basin, northern Kenya . . . . .	99
FROSTICK, L.E. & REID, I. Evolution and sedimentary character of lake deltas fed by ephemeral rivers in the Turkana basin, northern Kenya . . . . .	113
COHEN, A.S., FERGUSON, D.S., GRAM, P.M., HUBLER, S.L. & SIMS, K.W. The distribution of coarse-grained sediments in modern Lake Turkana, Kenya: implications for clastic sedimen- tation models of rift lakes . . . . .	127
YURETICH, R.F. Controls on the composition of modern sediments, Lake Turkana, Kenya .	141
ABELL, P.I. & MCCLORY, J.P. Sedimentary carbonates as isotopic marker horizons at Lake Turkana, Kenya . . . . .	153
RENAUT, R.W., TIERCELIN, J.J. & OWEN, R.B. Mineral precipitation and diagenesis in the sediments of the Lake Bogoria basin, Kenya Rift Valley . . . . .	159
EUGSTER, H.P. Lake Magadi, Kenya: a model for rift valley hydrochemistry and sedimentation?	177
CROSSLEY, R. Sedimentation by termites in the Malawi Rift Valley. . . . .	191
CASANOVA, J. East African Rift stromatolites . . . . .	201
HAMILTON, A. & TAYLOR, D. Mire sediments in East Africa . . . . .	211

## Sedimentary History of African Rift Basins

TIERCELIN, J.J. The Pliocene Hadar Formation, Afar depression of Ethiopia . . . . .	221
WILLIAMS, M.A.J., GETANEH ASSEFA & ADAMSON, D.A. Depositional context of Plio-Pleistocene hominid-bearing formations in the Middle Awash valley, southern Afar Rift, Ethiopia . . .	241

BONNEFILLE, R., ROBERT, C., DELIBRIAS, G., ELENGA, C., HERBIN, J.P., LEZINE, A.M., PERINET, G. & TIERCELIN, J.J. Palaeoenvironment of Lake Abijata, Ethiopia, during the past 2000 years.	253
WILLIAMSON, P.G. & SAVAGE, R.J.G. Early rift sedimentation in the Turkana basin, northern Kenya . . . . .	267
HILL, A., CURTIS, G. & DRAKE, R. Sedimentary stratigraphy of the Tugen Hills, Baringo, Kenya	285
NYAMWERU, C.K. Quaternary environments of the Chalbi basin, Kenya: sedimentary and geomorphological evidence . . . . .	297
OWEN, R.B. & RENAUT, R.W. Sedimentology, stratigraphy and palaeoenvironments of the Holocene Galana Boi Formation, NE Lake Turkana, Kenya . . . . .	311
VINCENS, A., CASANOVA, J. & TIERCELIN, J.J. Palaeolimnology of Lake Bogoria (Kenya) during the 4500 BP high lacustrine phase. . . . .	323
THOUVENY, N. & TAIEB, M. Preliminary magnetostratigraphic record of Pleistocene deposits, Lake Natron basin, Tanzania . . . . .	331

### **Sedimentation and the Preservation of Fossil Faunas**

HAY, R.L. Role of tephra in the preservation of fossils in Cenozoic deposits of East Africa . . . . .	339
PICKFORD, M. Sedimentation and fossil preservation in the Nyanza Rift System, Kenya . . . . .	345
DENYS, C., CHOROWICZ, J. & TIERCELIN, J.J. Tectonic and environmental control on rodent diversity in the Plio-Pleistocene sediments of the African Rift System . . . . .	363
Index . . . . .	373

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## Preface

This book arises out of an international meeting held at the apartments of the Geological Society of London in September 1984. The meeting attracted considerable interest from academics working on both African Rift geology in particular, and fault-controlled sedimentation in general. In addition, a large group of oil company representatives attended, reflecting the general increase in exploration interest in non-marine basins and the recent recognition of the importance of non-marine sediments as sources of oil and gas.

The main aim of the meeting and of this book is to provide an opportunity for the presentation of recent results and ideas that have been produced by many individuals working on various aspects of African Rift sedimentation. The research has been carried out in universities and other establishments in more than ten countries spread throughout four different continents. Fieldwork associated with this research has been conducted in eight different African countries—Chad, Ethiopia, Kenya, Malawi, Nigeria, Sudan, Tanzania and Uganda. Geographical representation is very wide, but it is not comprehensive. This is partly explained by the difficulties of access that have arisen because of political unrest. Some sectors of the rift have been effectively closed to research in recent years. There has been a concentration of effort in the Kenyan, Ethiopian and Tanzanian sectors of the African Rift in the last two decades. This has arisen as geologists have adopted the role of camp followers to the exciting fossil hominid discoveries of Louis, Mary and Richard Leakey, and of Don Johanson and others.

However, in the last few years there have been both southward and westward trends in interest and more research has been conducted in the Lake Tanganyika and Lake Malawi sectors of East Africa and in the Benue trough and its extensions (see Fig. 1).

Another aim of both the meeting and this volume is to provide a clearer picture of the interrelationship of structure and patterns of sedimentation during the early and middle phases of continental rift development. The models developed here for the African Rift will undoubtedly find application in the interpretation of ancient rift sediments worldwide. This is not only of academic importance. There are significant economic implications attached to the current interpretation of non-marine petroleum source and reservoir rocks.

In rifts, as in all sedimentary basins, the nature

and quality of clastic reservoirs are largely controlled by the rate and nature of tectonic adjustment. Fault movements govern the size, location and subsidence of sedimentary basins, as well as the pathways of sediment transport and the thickness, orientation and interdigitation of the facies belts. Saline lakes are a common feature of rift basins and are often sites of high organic productivity. Much of the kerogen that evolves is sapropelic. This, combined with rapid burial and high thermal gradients, favours rapid maturation of hydrocarbons which can then migrate into flanking coarse clastic alluvial fan and deltaic deposits. In closed lake basins the rapid fluctuation of water level results in an interdigitation of coarse and fine lithofacies near the shoreline, and this provides the excellent stratigraphic traps for oil and gas.

The volume opens with an introduction by Reading which places the African Rifts in a global context. Grove follows with a broad view of the present landforms and the relationship between the rift basins. These set the scene for later more local analyses of these important sediment sinks.

As tectonic adjustment is paramount in controlling rift basin sedimentation, the next section of the book focuses on the structural evolution of both the western (Fairhead) and the eastern (Rosendahl *et al.*; Baker; Williams & Chapman; Swain *et al.*; Watkins) branches of the African Rift. Baker, Williams & Chapman, and Watkins concentrate on surface expressions of faulting and volcanism, relating these to basin location and size, as well as to controls on sediment provenance. In contrast, Fairhead and Rosendahl *et al.* use geophysical data to elucidate subsurface rift basin structure and the thickness of sedimentary fills.

The third section is concerned with contemporary patterns of sedimentation. The first three papers (Reid & Frostick; Frostick & Reid; Cohen *et al.*) consider various aspects of clastic sediment sources, transport and deposition in the Turkana basin, following the debris train from source right through to present sink. Then follow papers dealing with chemical processes and diagenesis in modern rift lakes (Yuretech; Renaut *et al.*; Eugster), and Abell & McClory discuss the application of isotopic analyses of sedimentary carbonates to stratigraphic and palaeoenvironmental interpretation. The section closes with a consideration of organic controls of sediment deposition. Crossley examines the effect of a pedogenic subaerial process, Casanova investigates the lacustrine



biosediments, and Hamilton & Taylor review the accumulation of plant material in marginal wetlands.

The modern patterns discussed in the third section are analogues that assist interpretation of older preserved equivalents and are a natural precursor for the fourth section. This consists of a series of case studies of sediments from various

parts of the rift, ranging in age from late Mesozoic to Holocene. These case studies focus attention on the Ethiopian (Tiercelin; Williams *et al.*; Bonnefille *et al.*), the Kenyan (Williamson & Savage; Hill *et al.*; Nyamweru; Owen & Renaut; Vincens *et al.*) and the Tanzanian (Thouveny & Taieb) Rifts. Each paper provides an important insight into the ways in which long-term lake level

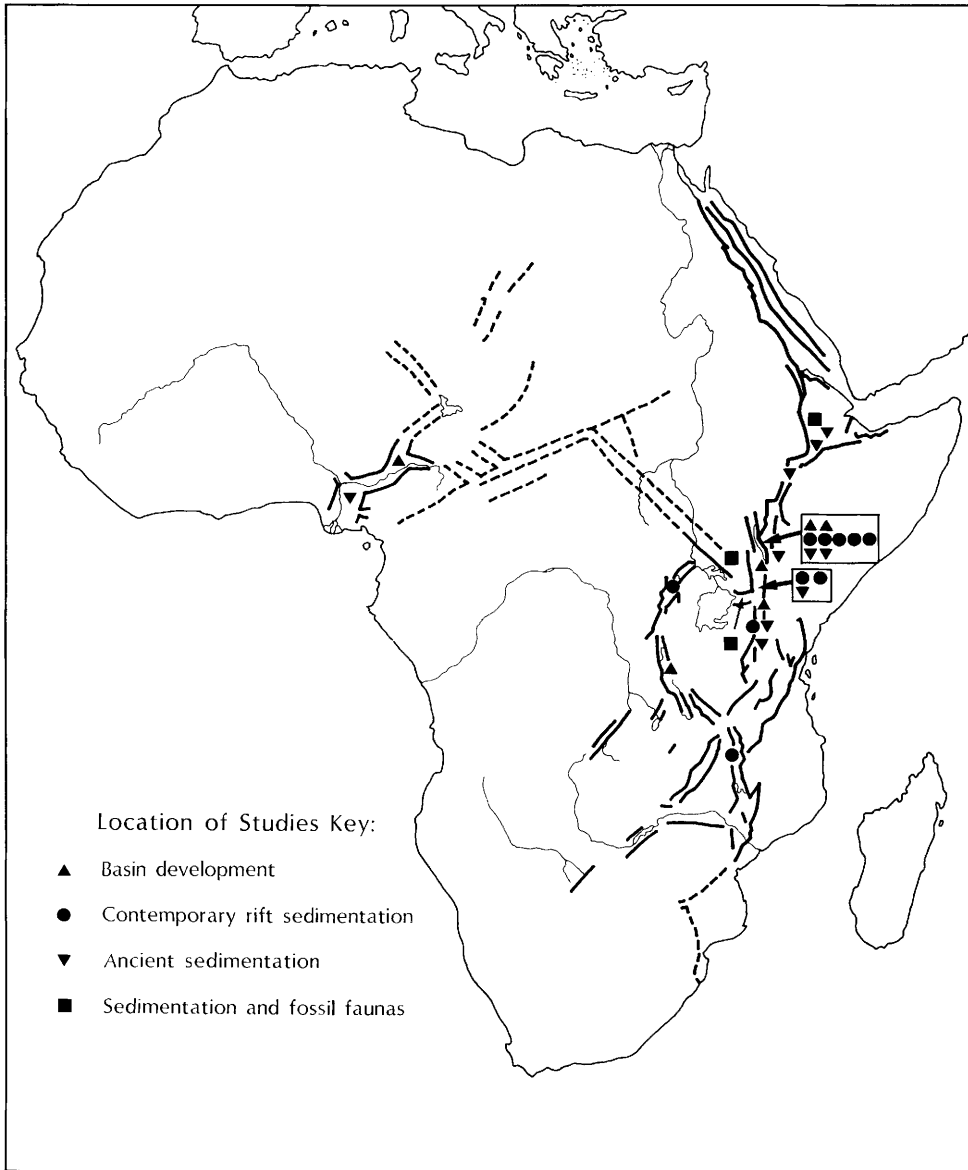


FIG. 1. Location of studies.

fluctuations, responding to tectonic and climatic controls, influence patterns of sedimentation.

One important aspect of the sediments of the African Rifts which has drawn them particularly to world attention, is the prolific and well-preserved vertebrate faunas, especially the early hominid remains. The volume would be incomplete if they were not mentioned. As a result, the final section deals with some of the volcanic and sedimentary factors that lead to good fossil preservation (Hay; Pickford; Denys *et al.*). Rift basins provide sites in which rapid burial and early mineralization preserves a fine record of the evolution of species, including our own. Bill Bishop, late friend and colleague of many of the contributors to this volume, often lectured under a favourite title: 'Rift basins are a good place to die!' This is a good summary of the value of the deposits to palaeontologists in general, but to palaeoanthropologists in particular.

This book provides an overview of sedimentation in a single, extensive continental rift system. However, the wider implications of the work that has been, and continues to be, carried out in Africa are considerable. There are strong similarities in both structure and sediment character between the African Rifts and others which are proven sources of oil and gas (e.g. the North Sea basins, the Ta Chung basin of China, and the Sirte basin of Libya). Models developed for the African Rifts may find wider applications in the exploration of new, as yet untapped, sources of hydrocarbons in little-known rift basins. Besides this, the research in Africa clearly enhances our understanding of already productive basins, and thereby helps industry optimize exploration during further development.

*Saskatoon*  
*August 1985*

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## Obituary

In the period that has elapsed between the meeting at the Geological Society and the final stages in the preparation of this Special Publication three eminent professors of the African Rift System have passed away. A glance through the acknowledgements of the papers that follow will reveal how much we are indebted to the enthusiasm, the insight and the support that each of these men gave to succeeding generations. Basil

King, Emeritus Professor of the University of London died at his retirement home in his beloved Isle of Arran, Scotland. Glynn Isaacs, Professor of Archaeology, University of California, Berkeley, and more recently of Harvard University, was a victim of sudden illness. Brian Baker, Professor of Geology at the University of Oregon, died in Nairobi close by the rift he loved so much. We shall miss all three.