Sedimentation in the African Rifts

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Sedimentation in the African Rifts

EDITED BY

L.E. FROSTICK
Department of Geology
Royal Holloway and
Bedford New College
University of London

R.W. RENAUT
Department of
Geological Sciences
University of Saskatchewan
Saskatoon

I. REID
Department of Geography
Birkbeck College
University of London

J.J. TIERCELIN
GIS Océanologie et Géodynamique
Université de Bretagne Occidentale
Brest

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List of contributors

P.I. Abell *Dept of Chemistry, University of Rhode Island, Kingston, Rhode Island 02881, USA*

D.A. Adamson *School of Biological Sciences & Quaternary Research Unit, Macquarie University, North Ryde, New South Wales 2113, Australia*

Getaneh Assefa *Faculty of Sciences, Addis Ababa University, PO Box 1176, Addis Ababa, Ethiopia*

B.H. Baker *Center for Volcanology, University of Oregon, Eugene, Oregon 97403, USA*

R. Bonnefille *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

C.F. Burgess *Dept of Geology, Duke University, Durham, North Carolina 27706, USA*

J. Casanova *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

G.R. Chapman *British Geological Survey, 154 Clerkenwell Road, London EC1R 5DU, UK*

J. Chorowicz *Dept de Géotectonique, Université de P. et M. Curie, 4 place Jussieu, 75252 Paris, Cedex 05, France*

A.S. Cohen *Dept of Geology, The Colorado College, Colorado Springs, Colorado 80903, USA*

R. Crossley *Dept of Geography & Earth Science, Chancellor College, University of Malawi, PO Box 280, Zomba, Malawi*

G. Curtis *Dept of Geology & Geophysics, University of California, Berkeley, California 94720, USA*

G. Delibrias *Centre Faibles Radioactivités—CNRS, 91/90 Gif-sur-Yvette, France*

C. Denys *Laboratoire de Paléontologie des Vertébrés et de Paléontologie Humaine, Université de P. et M. Curie, 4 place Jussieu, 75252 Paris, Cedex 05, France*

S.J. Derksen *Marathon Oil Co., PO Box 269, Littleton, Colorado 80160, USA*

R. Drake *Dept of Geology & Geophysics, University of California, Berkeley, California 94720, USA*

C. Elenga, *Ecole Normale Supérieure, 5 rue Boucicaut, 92260 Fontenay-aux-Roses, France*

H.P. Eugster *Dept of Earth & Planetary Sciences, Johns Hopkins University, Baltimore, Maryland 21218, USA*

J.D. Fairhead *Dept of Earth Sciences, The University, Leeds LS2 9JT, UK*

D.S. Ferguson *Dept of Geology, The Colorado College, Colorado Springs, Colorado 80903, USA*

L.E. Frostick *Dept of Geology, Royal Holloway & Bedford New College, Egham Hill, Egham, Surrey TW20 0EX, UK*

P.M. Gram *Dept of Geology, The Colorado College, Colorado Springs, Colorado 80903, USA*

A.T. Grove *Dept of Geography, The University, Cambridge CB2 3EN, UK*

A. Hamilton *Dept of Environmental Sciences, University of Ulster, Coleraine, Co. Londonderry, Northern Ireland*

R.L. Hay *Dept of Geology, 245 Natural History Building, 1301 W. Green Street, University of Illinois, Urbana, Illinois 61801, USA*

J.P. Herbin *Institut Français du Pétrole, BP18, 92502 Rueil Malmaison, Cedex, France*

A. Hill *Dept of Anthropology, Yale University, New Haven, Connecticut 06520, USA*

S.L. Hubler *Dept of Geology, The Colorado College, Colorado Springs, Colorado 80903, USA*

M.A. Khan *Dept of Geology, University of Leicester, Leicester LE1 7RH, UK*

J.J. Lambiase *Marathon Oil Co., PO Box 269, Littleton, Colorado 80160, USA*

A.M. Lezine *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

P.M. Lorber *Dept of Geology, Duke University, Durham, North Carolina 27706, USA*

J.P. McClory *Dept of Chemistry, University of Rhode Island, Kingston, Rhode Island 02881, USA*

J. McGill *Dept of Geology, Duke University, Durham, North Carolina 27706, USA*

C.K. Nyamweru *Dept of Geography, Kenyatta University, PO Box 43844, Nairobi, Kenya*

R.B. Owen *Dept of Geography & Earth Science, Chancellor College, University of Malawi, PO Box 280, Zomba, Malawi*

G. Perinet *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

M. Pickford *Institut de Paléontologie, 8 rue Buffon, 75005 Paris, France*

H.G. Reading *Dept of Earth Sciences, The University, Parks Road, Oxford OX1 3PR, UK*

I. Reid *Dept of Geography, Birkbeck College, London WC1E 7HX, UK*

R.W. Renaut *Dept of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan S7N OWO, Canada*

D.J. Reynolds *Dept of Geology, Duke University, Durham, North Carolina 27706, USA*

C. Robert *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

B.R. Rosendahl *Dept of Geology, Duke University, Durham, North Carolina 27706, USA*

R.J.G. Savage *Dept of Geology, University of Bristol, Bristol BS8 1SS, UK*

D. Scott *Dept of Geology, Duke University, Durham, North Carolina 27706, USA*

K.W. Sims *Dept of Geology, The Colorado College, Colorado Springs, Colorado 80903, USA*

N.J. Skinner *Dept of Physics, University of Botswana, Private Bag 0022, Gaborone, Botswana*

C.J. Swain *Dept of Physics, University of Zimbabwe, PO Box MP 167, Harare, Zimbabwe*

M. Taieb *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

D. Taylor *Dept of Environmental Sciences, University of Ulster, Coleraine, Co. Londonderry, Northern Ireland*

N. Thouveny *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

J.J. Tiercelin *GIS Océanologie et Géodynamique, Université de Bretagne Occidentale, 29287 Brest, Cedex, France*

A. Vincens *Laboratoire de Géologie du Quaternaire, CNRS—Case 907 Luminy, 13288 Marseille, Cedex 9, France*

R.T. Watkins *Dept of Geology, University of Cape Town, Rondebosch, Cape Town, South Africa*

L.A.J. Williams *Dept of Environmental Sciences & Museum of Comparative Zoology, University of Lancaster, Lancaster LA1 4YQ, UK*

M.A.J. Williams *Dept of Geography, Monash University, Clayton, Victoria 3168, Australia*

P.G. Williamson *Dept of Geological Sciences & Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA*

R.F. Yuretich *Dept of Geology & Geography, University of Massachusetts, Massachusetts 01003, USA*

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 (Yuretich; 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

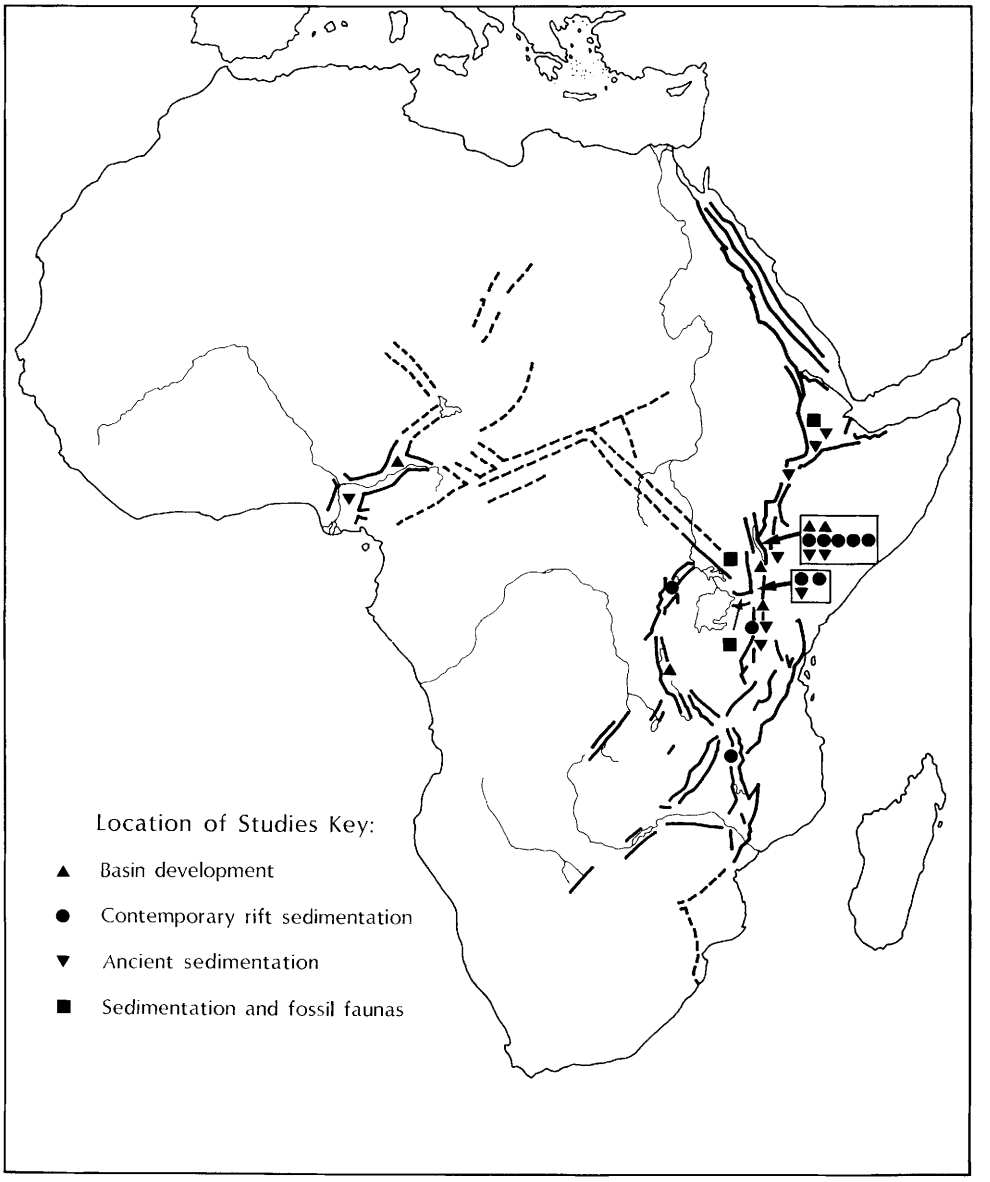

FIG. 1. Location of studies.

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

L.E. Frostick
R.W. Renaut
I. Reid
J.J. Tiercelin

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.