The Geometry of Normal Faults

Geological Society Special Publications
Series Editor J. BROOKS

GEOLOGICAL SOCIETY SPECIAL PUBLICATION NO 56

The Geometry of Normal Faults

EDITED BY

A.M. ROBERTS, G. YIELDING & B. FREEMAN
Badley Ashton & Associates
Winceby, Lincolnshire
UK

1991

Published by

The Geological Society

London

THE GEOLOGICAL SOCIETY

The Geological Society of London was founded in 1807 for the purposes of 'investigating the mineral structures of the earth'. It received its Royal Charter in 1825. The Society promotes all aspects of geological science by means of meetings, special lectures and courses, discussions, specialist groups, publications and library services.

It is expected that candidates for Fellowship will be graduates in geology or another earth science, or have equivalent qualifications or experience. All Fellows are entitled to receive for their subscription one of the Society's three journals: *The Quarterly Journal of Engineering Geology*, the *Journal of the Geological Society* or *Marine and Petroleum Geology*. On payment of an additional sum on the annual subscription, members may obtain copies of another journal.

Membership of the specialist groups is open to all Fellows without additional charge. Enquiries concerning Fellowship of the Society and membership of the specialist groups should be directed to the Executive Secretary, The Geological Society, Burlington House, Piccadilly, London W1V 0JU.

Published by the Geological Society from:
The Geological Society Publishing House
Unit 7
Brassmill Enterprise Centre
Brassmill Lane
Bath
Avon BA1 3JN
UK
(*Orders:* Tel. 0225 445046)

First published 1991
Reprinted 1992

Distributors
USA
AAPG Bookstore
PO Box 979
Tulsa
Oklahoma 74101–0979
USA
(*Orders*: Tel: (918)584–2555)

Australia
Australian Mineral Foundation
63 Conyngham St
Glenside
South Australia 5065
Australia
(*Orders*: Tel: (08)379–0444)

British Library Cataloguing in Publication Data
The geometry of normal faults.
1. Strata. Faults
I. Roberts, A.M. (Alan Michael) *1959–* II.
Yielding, G. (Graham) *1957–* III. Freeman, B.
(Brett) *1958–* IV. Series 551.87

ISBN 0–903317–59–1

Printed in Great Britain at The Alden Press, Oxford

Contents

Preface

During the 1980s a resurgent interest in extensional tectonics resulted, to a large extent, from the ever-increasing, non-proprietary availability of seismic-reflection data. This interest has generated two previous Geological Society publications: *The Journal of the Geological Society*, **141**, part 4 (1984), and *Continental Extensional Tectonics* (1987). This third publication includes papers presented at the Geometry of Normal Faults Meeting, June 1989 (for a full report, see *Journal of the Geological Society*, **147**, 185–187).

In the early-to-mid 1980s much (although not all) work on extensional fault-systems focussed on the innovative application of thrust-belt-type models to extensional basins. In particular the concepts of section-balancing were introduced to those investigating normal faults.

By the late 1980s it was becoming apparent, however, that the universal application of such models was fraught with difficulty. In particular the evidence of both earthquake seismology and detailed field studies began to indicate that faults involved in crustal extension may be, on all scales, essentially planar structures, not linked in a 'listric', thrust-type array.

It is now clear from the geological record that both planar and listric normal faults exist. The Geometry of Normal Faults Meeting was therefore convened as a forum at which the geological setting and interpretation of these structures could be discussed. An emphasis was placed on the presentation of observational data, from which some ground-rules could be established, rather than simply the discussion of synthetic models. The meeting was jointly sponsored by both the Petroleum Group and Tectonic Studies Group of the Geological Society, in recognition of the fact that both industry and academia have contributed to the advance in knowledge throughout the 1980s.

Recognizing the importance of normal fault geometry to those involved in hydrocarbon exploration, R. Hardman (Chairman of the Petroleum Group) was invited to introduce the meeting and this volume (in collaboration with J. Booth) by reviewing the significance of normal faults in the success of the North Sea hydrocarbon province. Following this introduction the volume is divided into four sections.

Section One, *Seismic and subsurface studies*, deals with the geometry and kinematics of large-scale, crustal-stretching faults. It is faults such as these which typically delimit major hydrocarbon accumulations.

Section Two, *Field-based studies*, presents four separate case studies from disparate geographical areas. These range from the study of small-scale fractures associated with the movement of salt, to the large-scale, intra-plate kinematics of whole fault-arrays.

Section Three, *Fault-displacement studies*, covers a relatively new, but increasingly important discipline, namely the study of detailed displacement-patterns shown by individual faults and small fault-arrays, and the information this can give us about the way in which fault systems evolve.

Section Four, *Analogue-modelling and Section balancing*, presents five different modelling studies of normal fault geometry, and compares the results of these studies with observational data. In this way the geological circumstances in which each model might be applicable can be gauged.

As a volume drawing from largely European participants this Special Publication does not aim to cover all of the aspects and all of the problems of normal fault geometry. In

particular we have avoided the still-contentious issue of normal fault geometry in the Basin and Range Province. We believe, however, that the papers within the volume will help to clarify the circumstances in which the diverse models of normal fault geometry might be applicable, and thus provide a useful source of reference for both the industry interpreter and academic research worker interested in problems of extensional tectonics.

A. M. Roberts, G. Yielding & B. Freeman
Badley Ashton & Associates Limited, Winceby House, Winceby, Horncastle, Lincolnshire, LN9 6PB, UK
May 1990