

Rifts and Passive Margins
Structural Architecture, Thermal Regimes, and
Petroleum Systems

Rifts and passive margins are extremely important for the petroleum industry, as they are areas of high sedimentation and can contain significant oil and gas resources. This book provides a comprehensive understanding of rifts and passive margins as a whole. It synthesizes in one volume the existing information devoted to specific aspects of these vitally important hydrocarbon habitats. This collection of state-of-the-art information on the topic facilitates the better use of this knowledge to assess the risks of exploring and operating in these settings and the development of systematic and predictive hydrocarbon screening tools. This book will be invaluable for a broad range of readers, from advanced geology students and researchers to exploration geoscientists to exploration managers exploring for and developing hydrocarbon resources in analogous settings.

MICHAL NEMČOK is a research professor at the Energy & Geoscience Institute at the University of Utah and a visiting professor at the Energy and Geoscience Institute Laboratory at the Geological Institute SAV, Bratislava, Slovak Republic. He has performed structural and hydrocarbon evaluations in numerous rift settings, such as the Pannonian Basin system in the Czech Republic and Slovakia; the Basin and Range province of the western United States; the Bristol Channel Basin in the United Kingdom; the Central Basin in the Democratic Republic of Congo; and the Salton Sea region in California. He has also worked in many passive margin settings, such as West Australia, West India, East India, the eastern United States and Canada, the African margins of the Central Atlantic, the Equatorial Atlantic, the Gulf of Mexico, the Guyana-Suriname Basin, Gabon and Cameroon, the Black Sea region, and southeastern Brazil. The results of most of these studies have been presented in thirty-seven articles published in refereed scientific journals and in three edited books. He is the coauthor of *Thrustbelts: Structural Architecture, Thermal Regimes and Petroleum Systems* (2005, Cambridge University Press).

Rifts and Passive Margins

*Structural Architecture,
Thermal Regimes, and
Petroleum Systems*

MICHAL NEMČOK

**ENERGY & GEOSCIENCE
INSTITUTE**

*University of Utah
and*

*Energy and Geoscience Institute Laboratory at
the Geological Institute SAV*



CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning, and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9781107025837

© Michal Nemčok 2016

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2016

Reprinted 2017

Printed in the United Kingdom by Print on Demand World Wide

A catalog record for this publication is available from the British Library.

Library of Congress Cataloging in Publication Data

Nemčok, Michal.

Rifts and passive margins : structural architecture, thermal regimes, and petroleum systems / Michal Nemčok, University of Utah.

Includes bibliographical references and index.

ISBN 978-1-107-02583-7 (hardback)

QE606.N44 2016

551.8'72--dc23 2015023014

ISBN 978-1-107-02583-7 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party Internet Web sites referred to in this publication and does not guarantee that any content on such Web sites is, or will remain, accurate or appropriate.

To Ján, Eva, and Bruce

Contents

<i>Acknowledgments</i>	page ix	12	The role of deformation in thermal regimes of rifts and passive margins	294
Introduction	1	13	The role of fluid flow in thermal regimes of rifts and passive margins	312
1 Basic description of structural styles in rift and passive margin settings, including extension directions and key structural elements	3	14	Introduction to hydrocarbons in rift and passive margin settings	334
2 Mechanics of rifting and transition to drift phases	31	15	Models of source rock distribution, maturation, and expulsion in rift and passive margin settings	347
3 Determination of unstretched continental, thinned continental, proto-oceanic, and oceanic crustal boundaries	76	16	Models of reservoir quality distribution	376
4 Determination of timing of rift and continental breakup events	97	17	Sealing characteristics	414
5 The role of lithospheric composition and compositional variations in evolving rift margin architectural development and in breakup locations	122	18	Models of hydrocarbon migration	442
6 The role of preexisting anisotropy in structural styles of rifts and passive margins	146	19	Trapping styles	473
7 The role of syn-extensional deposition and erosion in evolving structural styles of rifts and passive margins and the effects of tectonics on deposition and erosional patterns	170	20	Hydrocarbon preservation	505
8 Fluid flow systems associated with oceanic hot spots, oceanic transforms, continental transforms, and rifts	209		<i>References</i>	507
9 The role of pre-rift heat flow in thermal regimes of rifts and passive margins	245		<i>Index</i>	595
10 The role of structural and stratigraphic architecture in thermal regimes of rifts and passive margins	256			
11 The role of syn-rift deposition and erosion in thermal regimes of rifts and passive margins	273			

Acknowledgments

I wish to thank all those who contributed to the progress of this book, including the work on the earlier report (Energy and Geoscience Institute Report No. 01-00059-5000-50501401). The project called “Hydrocarbon exploration models in deep-water rift and passive margin settings,” which took place during 2006–2008, was funded by Gaz de France, Nexen, Reliance, and RWE, which are gratefully acknowledged. Ivana Nemčoková, Marína Matejová, Štefánia Sliacka, and Ray Levey helped with organizing the subsequent work on the book. Detailed discussions with Bruce R. Rosendahl, Andreas Henk, Sudipta T. Sinha, Mainak Choudhuri, Clay Jones, Charles J. Stuart, Joseph N. Moore, Tom Powell, and Mitch Stark improved parts of the book focused on rift-drift transition, finite-element modeling, continental break-up, hot spot effects, fluid flow models, depositional systems at passive margins, and geothermal reservoirs and their controlling factors, respectively. Júlia Kotulová, Paul Sikora, Mauricio Parra, and Ján Král’ provided friendly reviews of Chapter 15 and Vitrinite reflectance and Rock-Eval

pyrolysis text in Chapter 4, Chronostratigraphy text in Chapter 4, Low-temperature thermochronology text in Chapter 4, and Low-temperature thermochronology text in Chapter 4, respectively. Ivana Nemčoková made the language editing and figure formatting for the entire manuscript. Štefánia Sliacka assisted with permissions and book production processes. Doug Jensen kindly helped with book cover design prior to manuscript submission. Gabi Lach kindly provided a cover photograph. Geological photographs and figures were provided by Robert S. Tye, Gary J. Hampson, Gianreto Manatschal, Sudipta T. Sinha, Achyuta Ayan Misra, Mainak Choudhuri, and Atul Patidar. Ivana Nemčoková, Marína Matejová, Štefánia Sliacka, Matej Molčan, Samuel Rybár, Lucia Ledvényiová, Michal Jánošík, Ondrej Pelech, Patrícia Ekkertová, Andrea Bartošová, Tomáš Klučiar, Ján Nemčok, Jakub Bobrovský, Soňa Tomaškovičová, Marián Bošanský, Viera Šimonová, Eva Komanická, Ivana Perichtová, Jakub Múčka, and Martin Mal’a helped with figure drafting. Marína Matejová and Štefánia Sliacka assisted with references.