GEOLOGICAL SURVEY OF DENMARK AND GREENLAND BULLETIN 1 • 2003

The Jurassic of Denmark and Greenland

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GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF THE ENVIRONMENT

Geological Survey of Denmark and Greenland Bulletin 1

Keywords
Northwest Europe, Denmark, Greenland, Sweden, the Netherlands, Jurassic, chronostratigraphy, biostratigraphy, lithostratigraphy, sequence stratigraphy, structural history, basin evolution, sedimentology, palynostratigraphy, geochemistry, coal petrography/palynology

Cover
Palaeogeography of the Mesozoic rift system in the North Atlantic region in the Middle Jurassic (*c*. 160–180 Ma), viewed towards the north. Reconstruction by Stefan Sølberg, based on the palaeogeographic maps of Ziegler (1990) and Doré (1992). For references, see Surlyk (2003, this volume).

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Lay-out and graphic production: Carsten E. Thuesen
Printers: Schultz Grafisk, Albertslund, Denmark
Manuscripts submission/acceptance dates: see individual articles
Printed: 28th October 2003

ISBN 87-7871-116-9

Geological Survey of Denmark and Greenland Bulletin
The series *Geological Survey of Denmark and Greenland Bulletin* replaces *Geology of Denmark Survey Bulletin* and *Geology of Greenland Survey Bulletin*.

Citation of the name of this series
It is recommended that the name of this series is cited in full, viz. *Geological Survey of Denmark and Greenland Bulletin*.
If abbreviation of this volume is necessary the following form is suggested: *Geol. Surv. Den. Green. Bull.* 1, 948 pp.

Available from
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Øster Voldgade 10, DK-1350 Copenhagen K, Denmark
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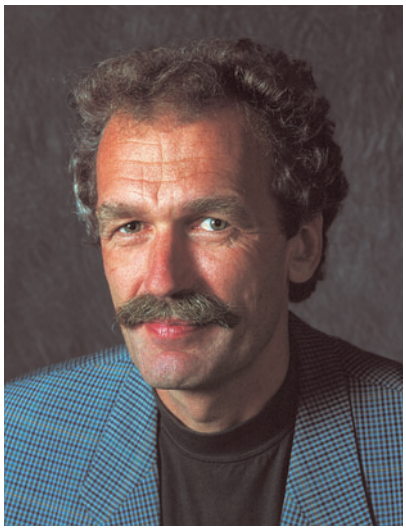

This book is dedicated to the memory of **Ole Winther Christensen** (1951–1998), Director of the Geological Survey of Denmark (DGU) from 1990 to 1995 and the Geological Survey of Denmark and Greenland (GEUS) from 1995 to 1998.

From its conception in the early 1990s, the 'Jurassic book' has benefited from the progressive integration of Danish geological institutions. This began in 1995 with the amalgamation of DGU with the Geological Survey of Greenland (GGU) to form GEUS and culminated in 2002 with the opening of the Geocenter Copenhagen, a conglomeration of GEUS, the Danish Lithosphere Centre (DLC), the Geological Museum and the Geological and Geographical Institutes of the University of Copenhagen. Ole Winther Christensen played a key role in both these positive developments in Danish geology. Sadly, he was not to experience the full realisation of the Geocenter Copenhagen concept due to his untimely death in 1998.

Referees

The editors are indebted to the following referees, whose conscientious and incisive reviews have been invaluable in the production of this book – your efforts are greatly appreciated.

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Preface

The Jurassic sedimentary successions of Denmark and East Greenland accumulated on opposite sides of a complex rifted seaway between present-day Greenland and Northwest Europe. The Mesozoic–Cenozoic sedimentary basins created along this seaway are of major importance both scientifically, as they preserve a record of the early evolution of the North Atlantic region, and economically as one of the rift arms contains the North Sea petroleum province. The Jurassic System, in particular, has been the focus of intensive study in Northwest Europe and Greenland. Not only has this system, since the days of William Smith, been at the forefront of stratigraphic research but it also forms a critical component of the North Sea hydrocarbon province, yielding both the most important source rocks and a wide range of sandstone reservoirs.

Although the stratigraphic development of the Jurassic in Denmark and East Greenland can be compared at a number of levels, the nature of the occurrences in the two regions is very different. The Jurassic of East Greenland is one of the world's best-exposed ancient rift basins and is widely regarded as a classic 'field laboratory'. The Jurassic strata are exposed in spectacular cliff sections that provide unique opportunities for detailed research into process sedimentology, genetic stratigraphy and 3D sedimentary architecture. The Danish Jurassic strata, in contrast, have limited outcrop but are well known from the subsurface, both on land and beneath the waters of the North Sea. The papers collected in this volume reflect this contrast – the stratigraphic evolution of East Greenland has been deciphered primarily on the basis of detailed outcrop geological studies whereas the corresponding stratigraphic analyses of the Danish Basin and the Danish sector of the Central Graben are largely dependent on 'remote' subsurface data. Jurassic stratigraphic research in Denmark over the last two decades has benefited immensely from the interaction between these two contrasting yet complementary approaches.

The origins of this book go back to the early 1990s when the idea was mooted for a book on the 'Jurassic of Denmark and adjacent areas', initially with a view to publication of the main results of Ph.D. studies that were underway at the Geological Survey of Denmark (DGU) at that time. In 1995, with the amalgamation of DGU with the Geological Survey of Greenland (GGU) to form the Geological Survey of Denmark and Greenland (GEUS), the conceptual framework of the book expanded to include the Jurassic of East Greenland, a research area that was under sharp focus both at GGU and at the University of Copenhagen. As the editing of the book entered the final phase, the Geological Survey relocated to the new Geocenter Copenhagen – a centralised amalgam of the Survey (including the Danish Lithosphere Centre) and the Geological and Geographical Institutes and the Geological Museum of the University of Copenhagen. From conception to publication, therefore, the book charts the changing structure of some of the central geological research bodies in Denmark, and its completion coincided with the inception of a new integrated natural science research centre.

The central aim of the book is to present the results of an intense period of research activity in Denmark on the Jurassic System over the last fifteen years – and, where relevant, to present these results at a comprehensive level that is almost impossible in modern scientific journals. Although covering a range of subjects, the common thread that runs through the book is the detailed documentation of the history of the Jurassic rift system as recorded in the sedimentary basins of Greenland and Denmark. Particular areas of focus include: (1) the sedimentary and stratigraphic signatures of syn-rift successions, whether revealed by detailed outcrop study or on the basis of integrated reflection seismic, petrophysical and core data; and (2) testing and application of sequence stratigraphic models and concepts at a variety of scales and in different structural settings.

Although focussing on broad geoscientific topics of general relevance, the book also provides data of specific value to the hydrocarbon industry. The Danish Basin and, in particular, the Danish Central Graben are prospective basins with exploration histories stretching back nearly fifty years. A number of Jurassic fields are under development and production in the Danish Central Graben, and exploration interest remains high. The structural, sedimentological and stratigraphic papers in this volume thus represent a direct source of essential data for the hydrocarbon industry. The onshore East Greenland basins, in contrast, are not prospective *per*

se, yet the detailed sedimentological and stratigraphic analyses included here will be of particular interest to petroleum geologists both as direct stratigraphic analogues of the succession on the conjugate margin (mid-Norway shelf) and as reservoir analogues or case studies applicable particularly to the North Sea region but also valid elsewhere.

Introductory chronostratigraphic reviews of the Lower, Middle and Upper Jurassic were planned from the outset, and contributions were solicited from three international authorities in this field, together with a paper on the Jurassic of southern Sweden. Furthermore, a review of the Jurassic of the Netherlands was invited from the Geological Survey of the Netherlands (RGD) for comparative purposes, building on previous close stratigraphic co-operation between DGU and RGD in the late 1980s.

The aim has been to produce a book that is as balanced and consistent as possible, in terms of content, terminology and appearance. Given the range of subjects covered, however, a certain degree of heterogeneity is inevitable and full consistency in terminology cannot be achieved. The Gradstein *et al.* (1994) time-scale is used in most cases but the Haq *et al.* (1988) and Harland *et al.* (1990) time-scales are employed by some authors; in all cases, the origin of the time-scale used is clearly indicated. Several forms of chronostratigraphic terminology are in common use, all being inherently logical and fully acceptable; particularly prevalent are the 'Standard Zone' nomenclature (Callomon & Donovan 1974) and the 'chronozone' terminology, as laid down in the International Stratigraphic Guide (Salvador 1994). Editorial flexibility has been exercised here, although consistency within individual articles was required. To enhance uniformity, a common graphical style has been imposed wherever possible; detailed sedimentary logs are somewhat variable, however, being dictated by different individual styles and demands.

In an enterprise of this type, undertaken over a number of years, there are clearly many people both in Denmark and abroad who have helped us towards publication. The research projects that formed the initial stimulus behind the book were supported both by state funding – the Danish Energy Agency (Energy Research Program, EFP), the Danish Natural Science Research Council (SNF), the Danish Research Academy and the Norwegian Petroleum Directorate (NPD) – and by the private sector, including Amerada Hess, Amoco, British Petroleum, the Carlsberg Foundation, Conoco, Mærsk Olie og Gas, Norsk Hydro, Saga Petroleum and Statoil. The long-term support of Danish geological research by these funding bodies and companies is gratefully acknowledged. We are also indebted to a long list of international referees; their contribution is acknowledged elsewhere but their importance in upholding the international standard of the papers bears repetition. During the scientific and technical editing phase, we have leaned heavily on three key personnel: Hanne B. Sørensen, who converted editorial hieroglyphics into ordered manuscripts; Birgit Eriksen, who meticulously checked final manuscripts and proof copies; and Stefan Sølberg whose skilled graphical imprint is engraved on almost every illustration in the book. On editorial matters, we have also benefited greatly from close co-operation with Peter R. Dawes and Esben W. Glendal in the editorial office at GEUS. In the latter stages we have been increasingly reliant on the professional layout work by Carsten E. Thuesen.

To all the above, we offer our heartfelt thanks.

Jon R. Ineson *Finn Surlyk*

On behalf of the 'Jurassic book' convening group: Jon R. Ineson, Finn Surlyk, Karen Dybkjær, Lars. H. Nielsen, Niels E. Poulsen.

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