

# **Scientific results from the deepened Lopra-1 borehole, Faroe Islands**

*Edited by*

James A. Chalmers and Regin Waagstein

## Geological Survey of Denmark and Greenland Bulletin 9

### Keywords

Faroe Islands, Palaeogene basalts, Lopra-1/1A borehole.

### Cover

Maersk Rig 81 on the location of the Lopra-1/1A wells at Suđuroy, Faroe Islands, in August 1996 shortly after the start of drilling. Photo: Regin Waagstein.

### Frontispiece: facing page

Maersk Rig 81 on the location of the Lopra-1/1A wells at Suđuroy, Faroe Islands, in August 1996 shortly after the start of drilling. Photo: Regin Waagstein.

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*Digital photographic work:* Benny M. Scharck

*Graphic production:* Knud Gr@phic Consult, Odense, Denmark

*Printers:* Schultz Grafisk, Albertslund, Denmark

*Receipt/acceptance dates of manuscripts:* see end of individual articles

*Printed:* 31 May 2006

ISSN 1604-8156

ISBN 87-7871-179-7

## 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.* 9, 156 pp.

### Available from

Geological Survey of Denmark and Greenland (GEUS)

Øster Voldgade 10, DK-1350 Copenhagen K, Denmark

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# Introduction

Martin V. Heinesen, Arne Rosenkrands Larsen and Kai Sørensen

Systematic preparation of the legal framework to govern full-scale hydrocarbon exploration in the Faroe Islands was initiated in 1992, after the Danish government and the Faroese Home Rule government had agreed on the future administrative regime with respect to minerals, including hydrocarbons, in the subsurface of the Faroese area. At about the same time, significant hydrocarbon discoveries were made in the UK offshore area west of the Shetland Islands and close to the UK–Faroese border that led to production starting from the Foinaven and Schiehallion fields later in the decade. For these reasons the petroleum exploration community became interested in the Faroese area.

The stratigraphic section exposed in the islands consists predominantly of a 3000 m thick series of mainly tholeiitic basaltic lavas of late Paleocene age, divided informally into a lower, a middle and an upper series. Until the early 1990s, the only deep wells that had been drilled in the Faroese area were the Vestmanna-1 well, drilled in 1980 in the town of Vestmanna on Streymoy, and the Lopra-1 well drilled on the southernmost part of Suðuroy in 1981, both scientific wells funded mainly by the Faroese government with a contributing grant from the Carlsberg Foundation of Copenhagen (Organising Committee 1984). Vestmanna-1 was a 660 m deep, fully cored, slim well that penetrated the lowermost part of the middle series and the uppermost part of the lower series. Lopra-1 was located near where the stratigraphically lowest basalts are exposed. It was originally drilled to a depth of 2178 m and penetrated approximately 2 km of formerly unknown strata, all of which proved to be a continuation of the subaerially exposed lower basalt series. The well was left open, plugged only by a 10" gate valve. The uppermost part of the well was cased with a 16 m conductor pipe with a diameter of 14" and a 9<sup>5</sup>/<sub>8</sub>" casing down to 190 m, whereas the 8½" diameter main part of the well remained uncased down to terminal depth (TD).

Although the Lopra-1 well did not reach the base of the volcanic pile beneath the Faroe Islands, it revealed some information of significance to the hydrocarbon exploration potential of the area. No strong evidence was seen of any sedimentary section nor hydrocarbon generation in the well, but analysis of tiny amounts of methane-rich

gases and oil isolated from the water in the well indicated an origin from marine organic matter beneath the basalt (Jacobsen & Laier 1984). Subsequent seismic experiments, including different vertical seismic profiling (VSP) experiments, indicated a lithological change only *c.* two hundred metres beneath the TD of the well (Kiørboe & Petersen 1995).

After consultation with a number of oil companies, in 1995 the Faroese Petroleum Administration made an arrangement with the Danish state oil company (DONG) to act as operator and coordinator of a joint industry project to deepen the Lopra-1 well. The 19 oil companies that participated in the project are listed in Table 1. The Petroleum Administration was assisted by the Faroese Geological Survey and the Geological Survey of Denmark and Greenland (GEUS). Dansk Operatørselskab i-s (Danop) acted as consultant to DONG with respect to the drilling operation and the Mærsk Rig 81 drilling rig was used. GEUS and the Faroese Geological Survey were responsible for the well site geology and the subsequent geological evaluation of the drilling results.

The primary objective of the deepened well was to ob-

Table 1. The nineteen oil companies that participated in the project

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Amerada Hess Ltd.
Amoco DK Exploration Co.
ARCO British Ltd.
BHP Petroleum Inc.
BP Exploration Operation Co. Ltd.
British Gas Exploration & Production Ltd.
Chevron Europe Ltd.
Dansk Olie- og Gasproduktion A/S (DONG)
Deminex UK Oil & Gas Ltd.
Enterprise Oil Exploration Ltd.
Esso Exploration. & Production UK Ltd.
FINA Research S.A.
LASMO (ULX) Ltd.
Mobil North Sea Ltd.
Norsk Hydro A.S.
Phillips Petroleum Co. UK Ltd.
Saga Petroleum International A.S.
Shell Exploration B.V.
Statoil Efterforskning og Produktion A.S.

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tain lithological and stratigraphic information about the deepest parts of the Faroe plateau basalt series and their substratum and to acquire information in relation to the hydrocarbon prospectivity of the area. Secondary objectives included: (a) determination of the age and depth to the base of the basalt series, (b) characterisation of the pre-basaltic lithologies, (c) characterisation of the physical properties of the basalt series and their substratum to improve interpretation of regional seismic, gravity and magnetic data and (d) thermal maturity determination of inter-basaltic and pre-basaltic organic matter, as well as determination of possible sources for oil and gas shows in the well.

Deepening of the well started on 13 July 1996. It reached its total depth of 3565 m on 3 November 1996. After final wireline logging, it was plugged and abandoned and the rig was released on 13 November 1996. The well penetrated 213 m of subaerially extruded basalt flows of the lower basalt series, a series of pillow lavas 45 m thick and a series of pillow lava debris 41 m thick. Below that was a thick series of volcanic tuffs with some intra-volcanic sandstone and claystone stringers. The only conventional core cut in the well was a 1.5 m (recovered) core from the lowermost basalt flow. Drilling through the base of the volcanics was not achieved.

This book presents a number of research studies carried out in the years following completion of the well. Although no direct information was obtained about pre-volcanic rocks, the deepening of the Lopra-1 well has documented the presence on and under the Faroe Islands of the thickest known composite section through the North Atlantic Palaeogene basalt plateau.

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