Contents

VOLUME 1
DVD Contents xii
The Technical and Editorial Committee xv
Foreword xviii

The Global Resource Context
Estimating undiscovered resources and reserve growth: contrasting approaches 3
R. R. Charpentier
The meaning of oil depletion and its consequences 11
C. J. Campbell

Exploration Histories and Future Potential
Exploration histories and future potential: overview 23
B. A. Vining, J. W. Munn, S. J. Stoker and D. Erratt
The discovery patterns of the resources of the rift and gas provinces of the North Sea compared with some analogous provinces worldwide 25
A. Spencer, K. Chew and G. Leckie
UK North Sea exploration: a future? 35
B. A. Vining, J. E. Mabillard and P. Van Rijssen
The remaining hydrocarbon potential of the UK Continental Shelf 41
Assessment of undiscovered resources on the Norwegian Continental Shelf 55
O. J. Østvedt, P. Blystad and C. Magnus
Exploration history on the Norwegian Continental Shelf, 1990–2002: expectations and results 63
P. Blystad and E. Søndenå
The life cycle of the Netherlands’ natural gas exploration: 40 years after Groningen, where are we now? 69
J. Breunese, H. Mijnlieff and J. Lutgardt
Predicting gas production from future gas discoveries in the Netherlands: quantity, location, timing, quality 77
J. Lutgardt, H. Mijnlieff and J. Breunese
The hydrocarbon potential of the Danish Continental Shelf 85
M. Hemmet
Jotun Field reservoir geology and development strategy: pioneering play knowledge, multidisciplinary teams and partner co-operation – key to discovery and successful development 99
D. Bergslien, G. Kyllingstad, A. Solberg, I. J. Ferguson and C. F. Pepper
Tullich Field 111
J. M. Rodriguez, H. Scholey and K. P. Flanagan
Characterization of the Heimdal Sandstones within Alveim, Quads 24 and 25, Norwegian North Sea 123
R. Fitzsimmons, D. Veiberg and T. Kråkenes
Sand injecties: an emerging global play in deep-water clastic environments 133
A. Hurst, J. A. Cartwright, D. Duranti, M. Hause and M. Nelson
Tilted oil–water contacts: modelling the effects of aquifer heterogeneity 145
H. Dennis, P. Bergmo and T. Holt
The North Sea Chalk: an underexplored and underdeveloped play
J. Megson and T. Tygesen

Reserve growth in chalk fields of the North Sea
D. L. Gautier and T. R. Klett

The Valdemar Field, Danish Central Graben: field compartmentalization and regional prospectivity of the Lower Cretaceous chalk play
F. Jakobsen, J. R. Ineson, L. Kristensen, H. P. Nytoft and L. Stemmerik

The Lower Cretaceous plays of the Central and Northern North Sea: Atlantean drainage models and enhanced hydrocarbon potential
C. D. Oakman

The discovery of Goldeneye: Kopervik prospect and play mapping in the South Halibut Basin of the Moray Firth
J. Wilson, G. Wall, H. J. Kloosterman, D. Coney, G. Cayley, J. Walker and C. Linskaill

The technical challenges to exploration and development of the Kopervik fairway, Outer Moray Firth, UK
J. Argent, R. Blight, P. Cox, R. Hardy, A. Law, J. R. Smallwood and D. Walter

Lower Cretaceous: the next target for oil exploration in the Barents Sea?
J. Seldal

The Buzzard Field
G. Doré and J. Robbins

Exploration history of the high-pressure, high-temperature plays: UK Central North Sea

Jade Field: an innovative approach to high-pressure, high-temperature field development

Depositional and structural controls on Triassic reservoir performance in the Heron Cluster, ETAP, Central North Sea
T. McKie and P. Audretsch

Production from Muschelkalk carbonates (Triassic, NE Netherlands): unique play or overlooked opportunity?
M. Pöppelreiter, R. Borkhataria, T. Aigner and K. PIPPING

The Caister–Murdoch System (CMS) III Carboniferous cluster development, UK Southern North Sea
M. M. Cooper, S. D. W. Easton, J. J. Lynch and I. M. Fozdar

Fault trap analysis of the Permian Rotliegend gas play, Lauwerszee Trough, NE Netherlands
F. V. Corona

Role of Cenozoic fault reactivation in controlling pre-rift plays, and the recognition of Zechstein Group evaporite-carbonate lateral facies transitions in the East Orkney and Dutch Bank basins, East Shetland Platform, UK North Sea
N. J. Richardson, M. R. Allen and J. R. Underhill

Hydrogen exploration: a review of global hydrogen accumulations and implications for prospective areas in NW Europe
N. J. P. Smith, T. J. Shepherd, M. T. Styles and G. M. Williams

Better Recovery Through Better Reservoir Characterization

Better recovery through better reservoir characterization: overview
J. G. Glayas and S. W. Garrett

Ardmore Field: rebirth of the first offshore oil field, UKCS
J. G. Glayas, B. Mair, P. Schofield, P. Arkley and D. McRae

A significant satellite: the Nevis South Field in Block 9/13
G. W. Farquharson and J. P. C. Gibson

Extending the life of the Varg Field, a tail-end production opportunity
J. E. Battìé, E. I. H. Siggerud and O. G. Tveiten
From spit system to tide-dominated delta: integrated reservoir model of the Upper Jurassic Sognefjord Formation on the Troll West Field 423
T. Dreyer, M. Whitaker, J. Dexter, H. Flesche and E. Larsen

Turbidite reservoirs of the Selje Formation, Central North Sea: geological challenges for improving production 449
M. Hempton, J. Marshall, S. Sadler, N. Hogg, R. Charles and C. Harvey

The Mittelplate oil field 461
M. Doehler

The Magnus Field: extending field life through good reservoir management and enhanced oil recovery 469
A. G. MacGregor, P. Trussell, S. Lauver, M. Bedrock, J. Bryce and T. Moulds

Designer wells to maximize recovery for Otter Field development, Northern North Sea 477

A late life opportunity: using a multidisciplinary approach to unlock reserves in the Rannoch Formation, Ninian Field 495

Managing reservoir uncertainty after five years of field life: Britannia Field 511

4D Ocean Bottom Seismic technology: an innovative tool for improved hydrocarbon recovery at Gullfaks 527
M. Thompson and P. Digranes

Geologically based estimation of k_h/k_0 ratios: an example from the Garn Formation, Tyrihans Field, Mid-Norway 537
C. Elfenbein, Ø. Husbey and P. Ringrose

Estimation of shape factors in fractured reservoirs 545
F. If and P. Frykman

In situ stresses in the North Sea and their applications: petroleum geomechanics from exploration to development 551
R. R. Hills and E. J. Nelson

Gas Renaissance

The global gas renaissance: opportunities for innovative exploration plays and new technologies in existing fields and unconventional gas resources in the liberalized gas market place: overview 567
S. D. Barley and D. Ireson

The world according to gas 571
A. Odedra, S. D. Barley, A. Lewis, M. Hardman and P. Haynes

Challenges of developing Carboniferous gas fields in the UK Southern North Sea 587
S. Corbin, S. Gorringe and D. Torr

Exploration potential of the mature Southern North Sea basin margins: some unconventional plays based on alluvial and fluvial fan sedimentation models 595
A. Moscariello

Key challenges to realizing full potential in an emerging giant gas province: Nile Delta/Mediterranean offshore, deep water, Egypt 607
J. C. Dolson, P. J. Boucher, J. Siok and P. D. Heppard

On the dynamics of capillary gas trapping: implications for the charging and leakage of gas reservoirs 625
Ø. Sylta

Biodegradation, gas destruction and methane generation in deep subsurface petroleum reservoirs: an overview 633
S. R. Larter, I. M. Head, H. Huang, B. Bennett, M. Jones, A. C. Aplin, A. Murray, M. Erdmann, A. Wilhelms and R. di Primio

Surface geophysical monitoring of gas fields: some experiences 641
O. Eiken, T. Tollesen, F. Aanvik and T. Alsos

Judy Field: rejuvenation through a second phase of drilling 651
T. Keller, R. Bayes, H. Auld and M. Lines

Shearwater (UK Block 22/30b): managing changing uncertainties through field life 665
R. Gilham, C. Hercus, A. Evans and W. de Haas
Evidence for a major sediment input point into the Faroe–Shetland Basin from the Kangerlussuaq region of southern East Greenland 913
M. Larsen and A. G. Whitham

At the edge of a new ocean: post-volcanic evolution of the Palaeogene Kap Dalton Group, East Greenland 923
M. Larsen, C. Heilmann-Clausen, S. Piasecki and L. Stemmerik

Controls on the structure and evolution of the NE Atlantic margin revealed by regional potential field imaging and 3D modelling 933
G. S. Kimbell, J. D. Ritchie, H. Johnson and R. W. Gatilff

Structure of the Hatton Basin and adjacent continental margin 947
L. K. Smith, R. S. White, N. J. Kusznir and iSIMM Team

Sedimentary evolution of the Lower Clair Group, Devonian, West of Shetland: climate and sediment supply controls on fluvial, aeolian and lacustrine deposition 957
G. J. Nichols

Volcanogenic impact on phytogeography and sediment dispersal patterns in the NE Atlantic 969
D. W. Jolley, A. Morton and I. Prince

Paleocene exploration in the Faroe–Shetland Channel: disappointments and discoveries 977
J. R. Smallwood and W. J. Kirk

Aspects of the Cenozoic deformational history of the Northeast Faroe–Shetland Basin, Wyville–Thomson Ridge and Hatton Bank areas 993
H. Johnson, J. D. Ritchie, K. Hitchen, D. B. McIntoy and G. S. Kimbell

The structural framework of the Irish Atlantic Margin 1009
D. Naylor and P. M. Shannon

The crustal structure and regional development of the Irish Atlantic margin region 1023

The Corrib gas field, offshore west of Ireland 1035

The deep structure of the Porcupine Basin, offshore Ireland, from gravity and magnetic studies 1047
P. W. Readman, B. M. O’Reilly, P. M. Shannon and D. Naylor

Neogene evolution of the Atlantic continental margin of NW Europe (Lofoten Islands to SW Ireland): anything but passive 1057
M. S. Stoker, D. Praeg, P. M. Shannon, B. O. Hjelstuen, J. S. Laberg, T. Nielsen, T. C. E. van Weering, H. P. Sejrup and D. Evans

First results from shallow stratigraphic boreholes on the eastern flank of the Rockall Basin, offshore western Ireland 1077
P. Haughton, D. Praeg, P. M. Shannon, G. Harrington, K. Higgs, L. Amy, S. Tyrrell and T. Morrissey

Reconstructing the Mesozoic–Cenozoic exhumation history of the Irish Sea basin system using apatite fission track analysis and vitrinite reflectance data 1095
S. P. Holford, J. P. Turner and P. F. Green

Deep-water Plays and Reservoirs

Deep-water clastic reservoirs: a leading global play in terms of reserve replacement and technological challenges 1111
A. Hurst, A. J. Fraser, S. I. Fraser and F. Hadler-Jacobsen

Submarine fan morphology and lithology distribution: a predictable function of sediment delivery, gross shelf-to-basin relief, slope gradient and basin topography 1121

Cretaceous and Palaeogene turbidite systems in the North Sea and Norwegian Sea Basins: source, staging area and basin physiography controls on reservoir development 1147
O. J. Martinsen, T. Lien and C. Jackson

The reservoir development of the Late Maastrichtian–Early Palaeocene Ormen Lange gas field, Møre Basin, Mid-Norwegian Shelf 1165
J. Gjelberg, O. J. Martinsen, M. Charnock, N. Möller and P. Antonsen
Paleocene deep-marine sandstone plays in the Siri Canyon, offshore Denmark–southern Norway 1185
L. Hamberg, G. Dam, C. Wilkinson and T. G. Ottesen

Angola Block 18: a deep-water exploration success story 1199
A. J. Fraser, D. Hikewich, R. Sym, J. Penge, A. Raposo and G. Simon

Deep-water plays of the Mauritanian continental margin 1217
A. Vear

**Understanding Petroleum Systems**

Understanding petroleum systems: an overview 1235
G. Fries, P. H. Nadeau and I. C. Scotchman

Modelling the Central North Sea pressure history 1237
R. E. Swarbrick, B. Seldon and A. J. Mallon

Modelling the effects of transient overpressure on the petroleum systems of the UK North East Atlantic Margin and northern North Sea areas: implications for the deep water South Atlantic and Gulf of Mexico 1247
I. C. Scotchman and A. D. Carr

Petroleum system analysis: impact of shale diagenesis on reservoir fluid pressure, hydrocarbon migration, and biodegradation risks 1267
P. H. Nadeau, P. A. Bjørkum and O. Walderhaug

Dynamic fault seal analysis and flow pathway modelling in three-dimensional basin models 1275
S. M. Clarke, S. D. Burley and G. D. Williams

How wrong can it be? Understanding uncertainty in petroleum systems modelling 1289
J. Wendebourg and K. Trabelsi

Plumbing the depths of the Central Graben: towards an integrated pressure, fluid and charge model for the Central North Sea HPHT play 1301
P. Winefield, R. Gilham and R. Elsenger

Quantitative hydrocarbon potential mapping and organofacies study in the Greater Balder Area, Norwegian North Sea 1317
H. Justwan and B. Dahl

The history of hydrocarbon filling of Danish chalk fields 1331
O. V. Veijbæk, P. Frykman, N. Bech and C. M. Nielsen

Late Cenozoic depositional history of the Danish North Sea Basin: implications for the petroleum systems in the Kraka, Halfdan, Siri and Nini fields 1347
E. S. Rasmussen, O. V. Veijbæk, T. Bidstrup, S. Piasecki and K. Dybkjær

Understanding the diagenetic evolution of potential reservoirs in fold/thrust belts: an example from eastern Venezuela 1359
F. J. S. Schneider

**Unlocking the Future with Innovative Geophysics**

Recent advances in geophysical technology: introduction and review 1369
P. A. F. Christie and E. Robein

Using multicomponent seismic data to better characterize and manage reservoirs 1377
P. Kristiansen and J. Waggoner

4D seismic quantification of a growing CO₂ plume at Sleipner, North Sea 1385
R. A. Chadwick, R. Arts and O. Eiken

Modelling seismic response from North Sea chalk reservoirs resulting from changes in burial depth and fluid saturation 1401
O. V. Veijbæk, R. Rasmussen, P. Japsen, A. Bruun, J. M. Pedersen, G. Marsden and I. L. Fabricius

The drive for better bandwidth and resolution 1415
M. S. Egan
3D Visions

A vision for 3D seismic technology and visualization 1483
R. J. Davies, R. Gras and X. Payre

Three-dimensional visualization for well placement and geosteering: Njord Field, offshore mid-Norway 1487
C. Dart, J. M. Denichou, T. Bridger, R. Haugen, J. Sjøholm, Å. Halvorsen, V. Øye and M. Seim

Applications of visualization in the Britannia Field, UK North Sea 1507

The MacCulloch Field: improving reservoir characterization through time-lapse analysis 1517
J. Scorer, N. Fuller, J. Malcolm and J. Bruner

Using spectral decomposition as a hydrocarbon indicator tool in the Norwegian Sea 1533
R. H. Leadholm, T. J. F. Austin and P. F. Ostendorf

4D analogue models of extensional fault systems in asymmetric rifts: 3D visualizations and comparisons with natural examples 1543

Automated interpretation of geological fault surfaces imaged in 3D seismic data 1557
D. Gibson, J. Turner, M. Spann and T. Wright

Application of 3D seismic visualization techniques for seismic stratigraphy, seismic geomorphology and depositional systems analysis: examples from fluvial to deep-marine depositional environments 1565
H. W. Posamentier

Kilometre-scale sandstone intrusions in the Eocene of the Outer Moray Firth (UK North Sea): migration paths, reservoirs and potential drilling hazards 1577
M. Huse, J. A. Cartwright, R. Gras and A. Hurst

Automated mapping of carbonate build-ups and palaeokarst from the Norwegian Barents Sea using 3D seismic texture attributes 1595
A. Carrillat, D. Hunt, T. Randen, L. Sonneland and G. Elvebakk

3D visualization of a rock sample, Rotliegend sandstone, Southern Permian Basin: applications for core analysis and petrophysics 1613

Extrusive and intrusive magmatism in the North Rockall Trough 1621
K. Thomson

Salt tectonics above complex basement extensional fault systems: results from analogue modelling 1631
T. Dooley, K. R. McClay, M. Hempton and D. J. Smit
DVD Contents

These proceedings volumes also include an interactive DVD. The DVD is both Mac and PC compatible and includes three main elements:

- The PDF file of the entire proceedings volumes
- 28 QuickTime movies
- 35 Core Displays — comprising 211 plates and 22 posters

The book PDF is fully searchable with hierarchical bookmarks for easy navigation. Both Core Displays and Movies have textual links from the book PDF allowing the user to simultaneously view the relevant electronic material. Separate navigation windows also allow the Core Displays and Movies to be selected from a separate contents listing. Full text narratives are available for both Cores and Movies.

Movies

Movie 1: 3D visualization movie of the Armada and Seymour Fields
A. Samuel, C. Taylor, S. Richards, I. Warburton and P. Highton

Movie 2: Movie of the Silverpit meteorite impact crater
R. J. Davies, R. Gras and X. Payre

Movies 3–17: 3D visualizations of seismic interpretations and borehole images from the Njord Field
C. Dart, J. M. Denichou, T. Bridger, R. Haugen, J. Sjøholm, A. Halvorsen, V. Øye and M. Seim

Movies 18–20: Applications of visualization in the Britannia Field

Movie 21: 3D visualization of sandstone intrusions in the Lower Eocene of the Outer Moray Firth
M. Huuse, J. A. Cartwright, R. Gras and A. Hurst

Movie 22: 3D visualization of a rock sample and its application for core analysis

Movies 23–28: 3D movies of igneous features from the North Rockall Trough
K. Thomson

Core Displays†

A1. Plates A–L: Faults and fractures in the Southern North Sea Rotliegendes*
D. Barr

A2. Plates A–P: Clay content and fault activity controlling localized seal potential of core-scale damage zones in the Witch Ground Graben, UKCS*
E. Edwards, G. Jones, G. Phillips, R. Kniipe and M. Bamford

A3. Plates A–G: Admore Field: rebirth of the UK’s first offshore oil field*
J. G. Gluyas, P. Arkley, P. Schofield and B. Mair

B1. Plates A–L: Sedimentary evolution of the Lower Clair Group, Devonian, west of Shetland: climate and sediment supply controls on fluvial, aeolian and lacustrine deposition*
G. Nichols and S. James

B2. Plates A–G: CMS III: Carboniferous Westphalian channel sand development in the Southern North Sea*

B3. Plates A–F: Modelling fine-scale sedimentological heterogeneity for optimal production from the Neptune Field, aeolian gas reservoir UKCS*
R. Garden, S. Henderson, M. Mentiply, R. Cook and J. Smart

B4. Plates A–B: Production from Muschelkalk carbonates (Triassic, NE Netherlands): unique play or overlooked opportunity?*
M. Pöppelreiter, R. Borkhataria, T. Aigner and K. Pipping
T. King, M. Wannell and T. Alqassar

B6. Plates A–B: Triassic reservoir performance in the Heron cluster, ETAP, Central North Sea*
T. McKie, P. Audretsch and L. Bater

C1. Plates A–K: Judy Field: rejuvenation through a second phase of drilling*
T. Keller, H. Auld, M. Lines and R. Bayes

C2. Plates A–C: Upper Brent reservoir variations, Otter Field, Northern North Sea*

C3. Plates A–J: A significant satellite: the Nevis South Field, 9/13a
G. W. Farquharson and J. P. C. Gibson

D1. Plates A–D: Shearwater Field: managing changing uncertainties through field life
R. Gilham, K. Hardacre, J. J. van der Velde, C. Nicolai, W. de Haas, C. Hercus and K. Sardar

D2. Plates A–I: The Mittelplate oil field*
M. Doehler

D3. Plates A–H: Reservoir heterogeneity within an Oxfordian braid-delta complex, Ross Sandstone, Captain Field*
C. J. Denney, J. F. Wham and M. Guy

D4. Plates A–F: Core from the Buzzard Field: wells 20/6-3, 20/6-4 and 20/6-5
G. Doré and C. Forster

D5. Plates A–H: Enhanced oil production of the Varg Field, through revising the geological understanding area PL038, Central North Sea
E. I. H. Siggerud, J. E. Batté and O. G. Tveiten

D6. Plates A–B: The Magnus Field: extending field life through good reservoir management and enhanced oil recovery*
A. G. MacGregor, P. Trussell, S. Lawer, M. Bedrock, J. Bryce and T. Moulds

E1. Plates A–C: From spit system to tide-dominated delta: integrated reservoir model of the Upper Jurassic Sognefjord Formation on the Troll West Field*
T. Dreyer, M. Whitaker, H. Flesche, J. Dexter and E. Larsen

E2. Plates A–D: Cores from the Atlantic Field, Kopervik Fairway, Outer Moray Firth, UK*
R. Blight, B. Philips and A. Law

E3. Plates A–C: The discovery of Goldeneye: Kopervik prospect and play mapping in the South Halibut Basin of the Moray Firth*

E4. Plates A–E: Managing reservoir uncertainty after five years of field life: Britannia Field

E5. Plates A–D: The Seven Heads Field: revisiting an old discovery
A. M. C. Holland, G. Sykes, T. Tabby and I. Phillips

F1. Plates A–C: Water flooding effects in chalk
J. Pedersen and K. Clausen

F3. Plates A–B: Helland Hansen well 6505/10-1 NOCS: enigmatic deep-water sandstone facies, Upper Cretaceous Lysing Formation*
D. Boyd, J. Berry, E. Birkeland, R. Ravnås and D. Wall

G1. Plates A–K: First results from shallow stratigraphic boreholes on the eastern flank of the Rockall Basin, offshore western Ireland
P. Haughton, D. Praeg, P. M. Shannon, S. Tyrell, T. Morrissey and L. Amy

G2. Plates A–C: Sub-basalt imaging: new insight from investigations of petrophysical and seismic properties of Faroes basalts (SeiFaBa project)

G3. Plates A–H: Characterization of the Heimdal sandstones within the PL203 area, Norwegian North Sea
R. Fitzsimmons, D. Veiberg and T. Krøkenes
G4. Plates A–E: Jotun Field reservoir facies  
D. Bergslien, G. Kyllingstad, A. Solberg, I. J. Ferguson and C. F. Pepper

G5. Plates A–F: MacCulloch Field: improving reservoir characterization through time lapse analysis*  
N. Fuller, J. Scorer, J. Malcolm and J. Bruner

H1. Plates A–G: Turbidite reservoirs of the Sele Formation, Central North Sea  
M. Hempton, J. Marshall, S. Sadler, D. Jones and S. Skinner

H2. Plates A–C: Tullich Field (9/23a-29U)*  
J. M. Rodriguez, H. Scholey and K. P. Flanagan

H3. Plates A–C: Use of Karoo outcrop analogues in reservoir characterization and 3D modelling of the Glitne Field, Norwegian North Sea*  

H4. Plates A–C: The Alba Field  
S. Groves, C. Bell and P. Nevill

H5. Plates A–H: Mid Eocene deep-marine clastic systems, Ainsa Basin, Spanish Pyrenees: Importance of mass transport complexes (MTCs) and synsedimentary tectonics*  
K. T. Pickering

*Includes poster.
†Core Display F2 was withdrawn.