Session: Europe
Europe overview

G. GOFFEY

PA Resources UK Limited, 4th Floor Waterfront, Winslow Road, Hammersmith, London, UK (e-mail: ggoffey@paresources.uk.com)

Abstract: Over 35 years, the Petroleum Geology Conference series has been the leading UK conference dedicated to making public the scientific advances and findings of some four decades of NW European hydrocarbon exploration and production. Leading edge issues in the NW European province after four decades include small pool and high pressure high temperature (HPHT) exploration, late-stage field exploitation and field redevelopment. The rich subsurface datasets and pioneering of emerging technologies provide a stream of valuable models, lessons, techniques and ideas which have both local and international applicability. Papers grouped under the exploration theme contain regional, local and detailed studies which illustrate the nature of current exploration activity for small, deep and complex structural and stratigraphic prospects. Closer and more comprehensive integration of seismic-derived understanding of structural evolution and seismic, well and analogue-derived depositional and sequence stratigraphic constraints are probably the most fruitful approaches and are shown by a number of papers. Papers on field development and production themes describe the industry's response to challenges such as low permeability and reservoir prediction through the use of multiple 3D and 4D seismic datasets and the exploitation of advances in drilling, well logging and completion technologies to drain progressively smaller per well reserves. Again, integration is the watchword, here between interpretations and analyses of subsurface data with well planning and construction. Finally, a number of papers describe current techniques in petrophysics, 3D and 4D seismic applications and remote sensing approaches.

History of the Petroleum Geology Conference series from 1974 to date: from NW Europe to international

The first conference in 1974 was described in the foreword to the proceedings as ‘the most important and significant geological conference ever presented in the European area, and possibly in the world, in view of the great importance of the North Sea development in the total world energy picture’. The conference was seen as unique because most of the presentations were previously unpublished findings of the oil industry, rather than from academia. Publication of the proceedings of the conference (Woodland 1975) initiated a series that have become essential reference works for geoscientists working the NW European hydrocarbon basins.

The second conference was held in 1980 (Illing & Hobson 1981) and more than 1000 delegates from 12 countries listened to papers describing the emergence of the North Sea as a major oil province. The Right Honourable David Howells, then UK Secretary of State for Energy, commented on how the discovery of new oil reserves would depend on new ideas and a fresh approach. His talk anticipated the licensing of previously unexplored deepwater areas west of the UK and highlighted the need for new discoveries to sustain UK hydrocarbon self-sufficiency into the 1990s.

The third conference (Brooks & Glennie 1987) took place in 1986 in arguably the first major downturn experienced by the modern petroleum industry. In his opening address, the Right Honourable Alick Buchanan-Smith, UK Minister of State for Energy, presciently observed the cost in human terms of the industry downturn, with the great loss of skilled personnel from the industry.

The fourth conference was held in 1992 (Parker 1993) and attracted 1230 delegates including 350 from 15 overseas countries. This was the first event to feature a Core Workshop displaying some 600 m of cored rocks. Conference Chairman Jim Brooks observed in his introduction that whilst the major companies had dominated in the early days of North Sea exploration, independents were increasingly involved in the exploration, development and production of offshore fields.

Held in 1997, the fifth conference (Fleet & Boldy 1999) was the last to be focused exclusively on NW Europe. Highlights of this conference were the increasing integration of disciplines within the geosciences and of geosciences with other disciplines, the development of reservoir modelling and 3D/4D seismic techniques, and the ongoing refinement of sequence stratigraphic approaches.

The sixth conference in 2003 (Doré & Vining 2005) was the first to explicitly broaden its perspective to encompass international activities. Entitled North West Europe and Global Perspectives, the conference aimed to both import ideas and concepts from the international arena as well as exporting to other parts of the world ideas and concepts developed in the North Sea ‘laboratory’. New themes for the NW Europe industry were infrastructure-led exploration, tail-end production and field rejuvenation. The emergence of gas as a fuel for the future was marked by a section dedicated entirely to gas.

The Right Honourable John Smith, then UK Under-Secretary of State for Energy, commented in his opening address to the First Conference in 1974 that ‘the successful exploitation of North Sea hydrocarbon resources with the new data and technological innovation it will produce, will lead . . . to worldwide development of offshore petroleum in waters that have until now seemed impossible to work’. In 2009, the seventh conference was inspired by Smith’s prescient observations to build upon the NW European roots of the series to develop into a truly international conference, sharing insights, techniques and success stories on a global basis ‘from mature basins to new frontiers’.

Overview of the Europe proceedings

The NW European province continues to mature and break new ground, particularly in small pool exploration, development
and exploitation. The extensive subsurface datasets prevalent in NW Europe and the response of the industry to the challenges it faces provide a rich stream of valuable models, lessons, techniques and ideas which have both local and international applicability. Equally, the importance of new ideas and a fresh approach as noted in 1980 are as important as ever and the industry needs to look to the international arena as a source of such ideas and approaches.

The Europe session at the 7th Petroleum Geology Conference was the most extensive session at the conference and, in addition, the core workshop contained core exclusively from reservoirs of the North Sea and adjacent petrolierous basins. Given the history of the conference series as a NW Europe conference, this emphasis on Europe was to be expected. Papers and posters contained within this proceedings volume have been grouped into three sub-themes: exploration; field development and production; and techniques in exploration and production.

Exploration

A number of authors contributed regional-level papers on European petroleum provinces, represented here by papers from Erratt, Milton-Worsell et al., Petersen, Knutz and Bertello. Erratt draws attention to the interplay between tectonics and sedimentation in hydrocarbon play development. Whilst Milton-Worsell uses an extensive regional dataset of well and in particular long-offset seismic data to draw attention to a potential Palaeozoic basin in an underexplored area of the Central North Sea flanks, Knutz examines the development of Mio-Pliocene ‘channel’ features in the main body of the rift and their linkage to deeper structure, hydrocarbon leakage and potential contourite depositional processes. Further south, a poster by Petersen examines the controlling influence on exploration outcomes of source rock quality in the NW Danish Central Graben. Finally Bertello provides an overview of hydrocarbon occurrence in fold belt to foreland settings in Italy – by a considerable degree the most important hydrocarbon province in southern Europe and not widely appreciated by northern European geoscientists.

The depositional, sedimentological and sequence stratigraphic setting of Middle and Upper Jurassic reservoirs is explored in papers and posters by Johannesen et al., Kieff and Sansom. Johannesen et al. draw together a revised palaeogeographic understanding of Late Jurassic deposition in the Danish Central Graben utilizing recent exploration results, whilst the poster of Johannesen et al. develops a Recent analogue for the depositional architecture of a deep Upper Jurassic barrier and shoreface sandstone reservoir in the Danish offshore. A poster from Kieff explores the use of an extensive core database to understand reservoir development within an overall transgressive interval of marine and marginal marine sandstones of the Middle Jurassic Hugin Formation in the Norwegian South Viking Graben. Finally Sansom constructs a detailed understanding of the shallow marine, Late Jurassic Fulmar reservoir and highlights the previously unrecognized controlling role of intra-Volgan tectonic reconfigurations on basin morphology and reservoir distribution and preservation. Taken together, these papers illustrate the insights possible in the data-rich North Sea setting when reservoir models are built or critically challenged through analysis at various levels from detailed regional reviews, through to core-based studies and the use of recent analogues.

Several papers look at recent discoveries and soon to be drilled prospects. Hollywood and Olsen examine the Paleocene and Upper Jurassic Fulmar discoveries at Huntington in the UK Central North Sea, where the oil columns discovered exceeded the pre-drill predictions due to stratigraphic trapping elements. Similarly, Ward et al. review the HPHT Jasmine discovery, also in the UK Central North Sea, and where again the discovered hydrocarbon column exceeded pre-drill predictions, in this case by some 1100 feet, for reasons not yet fully understood but assumed to relate to fault seal. Rodriguez described the extensive de-risking of what was at the time an undrilled seismic anomaly/stratigraphic prospect West of Shetlands.

These papers and several unpublished oral presentations at the Conference illustrate the nature of exploration activity after four decades of North Sea exploration. Structural traps tend to be small and larger finds tend to occur in stratigraphic traps and complex or deep structural traps. The rich North Sea database lends itself to reworking and to the generation of new insights from comprehensive regional evaluation and the development of models which better integrate seismic-derived understanding of structural evolution and seismic, well and analogue-derived depositional and sequence stratigraphic constraints. It is not clear that such work is undertaken with the frequency, perspicacity and creativity that are justified.

Field development and production

Several papers typified the techniques which have been evolved to understand and tackle the reservoir complexities which pose challenges in the appraisal and development of North Sea fields in the fourth decade of activity in the basin. Challenges include low permeability, reservoir development and prediction, and modelling and understanding of the dynamic behaviour of the reservoir to permit continued commercial development.

Seismic methods including improved 3D data and the use of AVO techniques during appraisal and in a 4D sense during production have become routine and are substantial value drivers. Similarly, drilling, well logging and completion technologies are allowing new field development and the exploitation of progressively smaller per well reserves. The careful evaluation of all subsurface data and integration with well planning and construction are fundamental in realizing the value offered by these technologies.

The value of seismic methods is shown by Gordon et al. in the evaluation of gas-condensate reservoirs in Laggan and Tormore Fields, West of Shetlands, aided by the use of AVO techniques to reduce uncertainty on reservoir development. Witt et al. report on the start-up of the naturally fractured Clair Field, West of Shetlands, the drainage and completion strategies adopted and the use of permanent ocean bottom cables to assess the 4D response of the reservoir and improve production history matching.

Drilling and completion techniques are fundamental to the papers of Tringham et al. and Purvis et al., who both describe the use of long-reach horizontal wells with multistage hydraulic fracturing to dramatically improve reservoir deliverability in low permeability gas-bearing sandstones in the Southern North Sea. Hampson and Walden provide an update on the two large producing heavy oil fields, Alba and Captain. Here intensive data gathering through multiple 3D surveys, the drilling of pilot holes and logging while drilling (LWD) techniques have allowed long horizontal development wells to be carefully placed to optimize recovery and commercially drain small in-field targets of the order of 1 to 2 × 106 bbl.

Several additional papers examined the continued exploitation of some of the North Sea’s largest fields. Gill and Shepherd describe the geological and reservoir management workflows used to identify field infill drilling targets and optimize field management in Nelson Field, themes continued by Brook et al. in their description of late stage infill drilling in the Scott–Telford field complex. Ray et al. describe the evolved geological understanding of the Buzzard Field sediment gravity flow reservoir and the insights achieved through integration of core, log and dynamic field data.
The challenges of HPHT field appraisal and development are elegantly captured in papers by Kape et al. and Quin et al. The former highlight the importance of careful geological evaluation and modelling given the inevitably under-appraised nature of HPHT fields. This carrying through of risk to the development phase is exemplified by Quin et al.’s paper, which demonstrates how the excellent reservoir encountered in appraisal drilling in Kristin Field on the Halten Terrace, NCS, was found through development and production to be unrepresentative of the appreciably poorer reservoir away from the appraisal wells.

Finally, and in a sense coming full circle, Reekie et al. review the redevelopment of Donan Field and the way that many of the field development techniques which have evolved in the last 20 years have allowed commercial redevelopment of a prematurely abandoned field.

Techniques in exploration and exploitation

This section covers a suite of papers which describe the use of a variety of geological, petrophysical, seismic and remote sensing techniques in exploration and production applications. The role of careful petrophysical evaluation is underlined by papers by Worthington and by Fabricius and Rana. Worthington describes a modus operandi for the recognition of bypassed pay, whilst Fabricius and Rana provide a case history evaluation of the post-fill tilted oil-water contact in the Danish chalk field, Tyra, through analysis of capillary pressure data. Staying with the chalk, Hampton et al. illustrate the development and use of a fully calibrated biostatigraphic zonation with particular intra-field applicability to aid well placement and reservoir management.

O’Connor et al. explore the use of well-derived pressure profiles to predict overpressure distribution and development and infer the development of topseal capacity whilst Purves et al. use 3D seismic data to map fault damage zones as a contribution to the assessment of fault-sealing potential.

With the rich North Sea datasets, seismic techniques continue to be instrumental in field exploitation in particular. A number of papers provide illustrations of current seismic applications. Rushmere et al. analyse the relative impact of acquisition and particularly processing improvements in increasing 4D signal-to-noise ratios, whilst Herwanger et al. examine the application of 4D techniques and their integration into dynamic field models at South Arne Field in Denmark. Abramowitz et al. expand the use of 3D integrated with well data and 2D seismic inversion into a regional study of intra-chalk porosity variations.

Finally, in the remote sensing domain, Hardy and Jones show how deepwater seismic data has unexpectedly revealed temperature and salinity stratification on the water column, whilst Olesen et al. publish results of the Geological Survey of Norway’s aeromagnetic data acquisition and modelling, constrained by some 40,000 measurements of magnetic susceptibility and remnance to increase the utility and insight available through the modelling of magnetic data.

References