

Petroleum Geology:  
From Mature Basins to New Frontiers—  
Proceedings of the 7th Petroleum Geology Conference

Volume 1



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Proceedings of the 7th Petroleum Geology Conference

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Volume 1

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# DVD Contents

The two 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
- 8 movies of virtual fieldtrips
- 18 posters as pdf files

The book PDF is fully searchable with hierarchical bookmarks for easy navigation. The Virtual Fieldtrips have textual links from the book PDF. Separate navigation windows allow the Posters and Fieldtrips to be selected from a separate contents listing.

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*J. Thurmond*

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*M. Tomasso, R. Bouroullec and D. Pyles*

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## Preface

The Seventh Petroleum Geology Conference (PGC VII) was the latest in a prestigious series dating back to 1974. Over the years, this conference series and the associated proceedings volumes, commonly known as the 'Barbicans', have provided an important reference to NW Europe exploration and production, from its early life as an emerging world class petroleum province, through to its current mature stage. The previous conference opened the door to embracing selected other areas of the world, while still maintaining the tradition of the former five preceding conferences. The seventh conference, entitled: 'Petroleum Geology: from Mature Basins to New Frontiers', while also staying true to its roots, was a truly international conference, with sessions encompassing many of the petroleum provinces of the world, that is: Europe; Russia, the Former Soviet Union (FSU) and the circum Arctic; North Africa and the Middle East; and Passive Margins worldwide. As the world seeks new energy sources, it was most appropriate to have a session dedicated entirely to unconventional hydrocarbon resources. Regular features such as a core workshop were present. In addition, innovative new features, such as the geocontroversies debates and virtual field trips, both of which are described below, enhanced what was already a well established conference format.

The conference series has been distinguished by its high scientific quality; PGC VII is no exception. We are confident that these proceedings volumes will continue to be the standard reference for successive generations of petroleum geoscientists. The proceedings, in general, will follow the thematic format of the conference itself, and the majority of the papers presented in the conference appear as scientific contributions in the proceedings volumes. This preface attempts to provide an insight into the unifying themes of the conference.

The scene was set by a plenary address on 'Global Petroleum Systems' to place the various geographic-based sessions into their mega-regional plate perspective.

The geocontroversies debates, mentioned above, were designed to address certain broader challenges facing society and the petroleum industry today, in contrast to the highly scientific nature of the presentations in the other sessions. The format of the geocontroversies debates was one whereby two expert protagonists presented their case: one for and one against a motion. The three motions, one of which was presented on each of the three days of the conference, were entitled: 'This House believes that the North Sea is finished'; 'This House believes that National Oil Companies (NOCs) are the future of the petroleum industry'; and 'This House believes "Peak Oil" is no longer a concern'. Each debate was concluded with a poll in which the audience raised a yellow or red card to indicate their support or opposition to the motion. The results were, respectively, that the North Sea is not finished; NOCs are the future of the petroleum industry; and that 'Peak Oil' is indeed with us! The debates were a great success, enjoyed by all, and set a benchmark for the future.

The virtual field trips transcended all aspects of petroleum geoscience, using a medium whereby delegates could 'return to the rocks' and go on a field trip to various exotic parts of the world, but without leaving London. Significant advances over recent years in geoscience data acquisition, visualization and analysis now permit the construction of detailed digital outcrop models. In a visualization environment, these outcrop models can be viewed sequentially in 3D to simulate a geological field trip. While it is recognized that virtual field trips will not surpass the benefits of undertaking actual field work, they clearly have their place in the petroleum geoscientists' tool-kit. For example, digital outcrop mapping techniques, showing lateral and vertical facies associations and the distribution of fracture networks, can be transformed into a static geocellular model, the forerunner for reservoir simulation. Eight case studies are provided as video-clips on the accompanying DVD. The various localities visited include Ireland, France, Norway, Egypt, Greece and the USA. More widespread use of these technologies, and associated new developments, are undoubtedly a future trend in petroleum geoscience, as the keen interest in this session demonstrated.

The core workshop has been a successful regular feature of recent 'Barbican' conferences, enabling petroleum geoscientists to 'get their hands on the rocks'. This has, in large part, been due to the enthusiasm and dedication of Dr Colin Oakman. Colin sadly passed away at the time of preparing for PGC VII. It is most appropriate that this core workshop bears his name. Colin would have been duly proud. The core workshop focussed on reservoir sedimentology of the North Sea Basin and featured presentations by PhD students, academics and consultants that placed the reservoirs, as shown by the cores, into context. The cores illustrated a diverse range of 'classic' North Sea reservoirs. Cores were presented from the alluvial and fluvial clastics and carbonate turbidites of the Carboniferous of the southern North Sea. The central North Sea was represented by cores from Triassic aeolian and fluvial clastics, Jurassic (Fulmar Formation) shoreface sandstones and Cretaceous deepwater fan deposits. The northern North Sea was represented by cores from the deltaic sequences of the Jurassic (Brent group). In summary, the core workshop provided an impressive display of reservoirs of various ages, facies and geography across the North Sea Basin to complement the papers and posters of the Europe session.

Europe, in particular the North Sea, has been the cornerstone of the 'Barbican' conferences over the past 35 years, as summarized in the Europe section of these proceedings volumes. This conference confirmed that a high interest in Europe continues, manifesting itself as the most extensive session of the conference. This is depicted in the proceedings by the themes of exploration, field development and production, and new techniques in exploration and exploitation. The key issues addressed include small pool and high-pressure, high-temperature exploration, late-stage field exploitation, and field redevelopment. In addition, the North Sea has, for many years, provided copious high-quality, multidisciplinary subsurface datasets that permit tracking of plays and fields from discovery through to late life and, in some cases, rehabilitation; it is truly a world class 'laboratory' for future exploration and production activities around the world. This aspect is complemented by the pioneering of emerging technologies that also have applicability around the world.

The exploration theme has papers, regional, local and of a detailed case-study nature, that describe current exploration activity for small, deep pool, and complex structural and stratigraphic prospects in mature and frontier plays. The detailed integration of seismic, well and analogue-derived technologies to better understand structural evolution and sequence stratigraphic-based depositional systems are illustrated by case examples. The field development and production theme contains papers that describe the petroleum industry's responses to the challenges of low-permeability reservoirs and reservoir prediction. Finally, the theme on new techniques in exploration and exploitation contains papers that emphasize the need for integration across the spectrum of geoscience and petroleum engineering disciplines. Papers pertaining to recent advances in petrophysics, 3D and 4D seismic applications, and the targeting of drilling and completion technologies within integrated reservoir models complete this most rewarding section in the proceedings. For those readers searching for Atlantic margin papers in this section, these are placed more appropriately in the Passive Margins section. In this regard, we would encourage readers to look throughout the proceedings, as their particular subject of interest may be in a different section.

The Russia, FSU and circum-Arctic session covered vast, diverse regions, with some complex petroleum systems, ranging in age from the Neoproterozoic to the Cenozoic. These regions have attracted considerable interest from the petroleum industry over the past 20 years. The offshore Arctic, in particular, is perceived as a possible future world-class petroleum province with the likelihood of some new giant fields. It has, however, significant technological challenges in addition to important environmental considerations and its remoteness from markets. The series of regional papers addresses the geology of the Arctic basins, including their tectonic origin, and proposes models for their genetic evolution. It is truly a circum-Arctic regional section, with papers from Russia, Norway, Greenland, USA and Canada. In contrast, at a field scale, this section hosts two field development papers from the north Caspian Basin: the giant Karachaganak and Kashagan fields.

The North Africa and Middle East session is also strongly represented by papers addressing the regional geology. However, in this region, the emphasis was on the search for new older and deeper plays in known areas, and conventional plays in the frontiers. The North Africa petroleum systems of the Ghadames and Kufra basins are featured, including discussion of the glacio-eustatic controls on facies patterns. The impact of recent advances in seismic technology, in providing a step-change improvement in our understanding of basins, and their possible deeper potential, was demonstrated by papers from the comparatively well known Gulf of Suez and northern Red Sea areas. Moving to a field scale, a case study of the appraisal of the Taq Taq field in northeast Iraq provides insights into the technological approaches used to model fracture systems.

The session on Passive Margins was highly popular with delegates. Passive Margins have been the mainstay of global exploration success and fast-track field development over the past 25 years. Deepwater production now exists from Passive Margins as diverse as Angola, Nigeria, Brazil, US Gulf of Mexico, Egypt and India. A generation of petroleum geoscientists have now spent a significant part of their careers exploring Passive Margins using methodologies mostly based on direct hydrocarbon indicators.

It is welcoming now to see a more holistic approach to our understanding of Passive Margins, this being a key feature of the conference and proceedings. New insights are presented and old dogmas questioned. The evolution of Passive Margins is examined using exciting new information on the deeper structure of continental margins. New models are being developed that propose, for example, multiphase rifting events and a better understanding of the role and implications of volcanics. This diverse nature of Passive Margin geodynamics has resulted in different views regarding genetic basin evolution and architecture. This impacts our understanding of thermal history and subsequently the predicted level of maturation of source rocks. Further examples of a more holistic approach include discussion and integration of 'source to sink' concepts that address geomorphology, drainage systems, sediment supply and the influence of palaeoclimate. A principal benefit of these new approaches is a better understanding of the potential of a variety of play types, for example, deltaic depocentres, slope by-pass systems, carbonate platforms and margins, deepwater fold-belts, and pre-rift and syn-rift sections. Technology will continue to play a vital role. Papers were presented that demonstrate that improved seismic imaging techniques are having a profound effect in our understanding of the pre-salt plays offshore Angola. Will the latter mirror the conjugate margin offshore Brazil, the scene of many exciting, world class discoveries in recent years? The comprehensive Atlantic Margin section addresses new results in understanding the sub-volcanic geology of this extensive region. We are confident that further applications of these new approaches will breathe further life into Passive Margins worldwide and unlock new, deeper play potential.

Since the last conference in 2003, there has been a significant increase in interest in unconventional hydrocarbon resources to address, in part, the world's future energy needs. This has been particularly apparent in North America. It therefore appeared appropriate for this conference to address this important topic, and to assign a separate session devoted exclusively to unconventional oil and gas resources. These resources include oil sands, oil shale, shale gas, basin-centred gas, coal bed methane and gas hydrates. Unconventional oil and gas resources are commonly described as continuous or regionally pervasive and, although in-place volume estimates may be large, overall recovery is relatively low. These accumulations certainly challenge the paradigms associated with conventional resources, for example trap delineation is often problematic; reservoirs are developed in rocks formerly considered as sources and seals; and many unconventional oil and gas resources lack hydrocarbon-water contacts.

Pioneering research and technological innovation is underway. Many initiatives are focussed on North America, although other areas of the world are emerging. Aspects of this research are highlighted and complemented by some initial studies in Europe.

A spectrum of different examples from various parts of the world were presented. These include: the Bakken petroleum system, a tight oil play of the Williston Basin in North America; the basin-centred gas plays of the Western Canada Foreland Basin and the Pannonian Basin, Hungary; and the heavy oil deposits of the Athabasca Oil Sands in Canada.

The geological storage of carbon dioxide is rapidly gaining recognition as an important potential method for reducing carbon dioxide greenhouse gas emissions in the near future. These developments are driven by concerns to address climate change. However, these technologies are expected to also have future application to the petroleum industry and other parts of the energy sector. Recent findings from current commercial carbon capture and storage projects in the North Sea and North Africa are presented, and are complemented by major research programmes in North America.

The 'Seventh Petroleum Geology Conference; from Mature Basins to New Frontiers', and these proceedings, owed their success to the efforts of many dedicated individuals over a considerable period of time. We take this opportunity to thank each of them for their contributions, energy and enthusiasm, which have resulted in a complex job well done. We fully recognize that this success has been achieved at the same time as other competing demands for their skills and expertise. The willingness of many companies to release proprietary datasets and concepts, a hallmark of an up-to-date conference and scientific publication, is also gratefully acknowledged. We believe that the highest scientific standards have been attained in line with the tradition of the 'Barbican' conferences and proceedings of the past. In particular, we thank all members of the PGC VII Board, Organizing Committee, and Technical Committee, the latter as convenors for the conference, and subsequently as authors, referees and editors for the proceedings volumes. It has been an honour and a privilege to work with them. We also thank all our sponsor companies and universities for their support, whether this has been through direct funding, or indirectly through the provision of their staffs' valuable time. Finally, we thank the staff of The Geological Society Publishing House for preparation of a publication that will stand the test of time. We hope and trust that you, the reader, will enjoy the proceedings and use them extensively as a scientific standard reference, both as a book on your bookshelf and digitally on your desktop, in the global search for, and exploitation of, future energy resources.

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Volume 2

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# DVD Contents

The two 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
- 8 movies of virtual fieldtrips
- 18 posters as pdf files

The book PDF is fully searchable with hierarchical bookmarks for easy navigation. The Virtual Fieldtrips have textual links from the book PDF. Separate navigation windows allow the Posters and Fieldtrips to be selected from a separate contents listing.

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*J. Thurmond*

Fieldtrip 2: Stratigraphic architecture of an interbasinal deep-water conduit, Grand coyer sub-basin, Eocene–Oligocene Grès d'Annot formation

*M. Tomasso, R. Bouroullec and D. Pyles*

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*D. Hodgetts, P. Wilson, F. Rarity and R. Gawthorpe*

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*J. Howell, S. Buckley, C. Carlsson, H. Enge and T. Knudsen*

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