Fluids: migration, overpressure and diagenesis

Introduction and review

A. J. FLEET[1] and W. G. CORDEY[2]

[1] *BP Exploration, Sunbury Research Centre, Chertsey Road, Sunbury-on-Thames, Middlesex TW16 7LN, UK*
[2] *Shell UK Exploration and Production, Shell-Mex House, Strand, London WC2R 0DX, UK*

Petroleum and water are at the very heart of success or failure for exploration and production but, being fluids, are not easy to observe or predict in the geological environment. The 'Fluids' Sessions, therefore, dealt with many issues which are both at the forefront of technical developments and commercially topical. A consequence of this was that the number of contributions was fewer than had been hoped, particularly on the subject of overpressure. Some studies, because they are very much in their infancy, could only provide a cursory treatment of the topic.

Fluid formation and movement in basins ultimately govern when and where petroleum accumulations occur, reservoir quality in most instances, and the development of overpressure. The composition of petroleum leaving a source rock is very much a function of source-rock type and the subsequent thermal history. The presence of overpressure can dictate the expulsion direction and thus the overall composition of the hydrocarbons entering a migration pathway from one or more source rocks. Phase changes along the migration pathway, or in the reservoir during uplift or burial, determine the phase(s) of the hydrocarbons retained over geological time and must be evaluated together with, or in the context of, tectonism and faulting.

The importance of understanding overpressured regimes cannot be overemphasized, both from the purely exploration aspect and the issues involving safety and the environment. The papers of **Leonard** and **Garenstroom *et al.*** address the problem. **Leonard** reviews sub-surface pressure in the Norwegian Central Graben and emphasizes the need to build up a three-dimensional understanding of pressure and its relevance to field distribution, generation and migration, reservoir quality and drilling procedures. He argues that all possible causes of overpressure need consideration in evaluating a basin. **Garenstroom *et al.*** discuss the relationship between overpressure and minimum effective stress and relate the areal distribution of overpressures to the structural framework.

Since the problems associated with predicting petroleum charge to a trap and with interpreting the significance of hydrocarbon seeps in terms of prospects, fairways or dry belts are concepts well entrenched in exploration thinking (e.g. England and Fleet 1991), they receive little explicit attention in this section. **Burrus *et al.*** and **Høvland** are the exceptions. The former use whole basins, including the Paris Basin, as experimental testbeds to deduce that different expulsion styles occur in different basins and to help in determining whether oil or gas is available from a given source rock. Their work illustrates the strength of using basin-scale 2D fluid flow modelling carefully calibrated against observations. **Høvland** contributes a further dimension to his work on seabed features which indicate evidence for seepage. Not only are these features widespread offshore NW Europe but they take on a broad variety of forms from 'freak' high-amplitude sandwaves to cold-water corals.

Other contributions to the section can be described as innovative or, indeed, in some instances, speculative. The most innovative, at least in bringing new science to bear on petroleum occurrence, is presented by **Ballentine and O'Nions**. They use rare gases (helium, neon and argon) to begin to understand the processes and relative proportions of fluid movement in sedimentary basins. Two of their initial studies, in the Pannonian and Vienna basins, point towards movement of much larger volumes of water than had previously been envisaged and large-scale petroleum gas–water interaction. The fluids discussed by **Warren and Smalley** are less exotic; they turn the spotlight on water and outline its variation in composition. Attention is drawn to the relevance of this variability with respect to reservoir quality, reserves estimates and scale prediction. Their paper is very much a curtain raiser to an atlas of North Sea formation waters due for publication in 1993.

The final three papers of the section focus on the part water plays in diagenesis. **Burley**, in a paper which he confesses to be 'speculative and likely to be highly provocative', suggests that much diagenesis in Jurassic reservoirs in the Northern North Sea can be attributed to hot fluid circulation during the Tertiary. He advances a detailed model which takes into account structural position, fault control on fluid migration and trap. **McAulay *et al.*** consider in detail the diagenetic development of Brent group reservoir sands in the Hutton and NW Hutton fields. **Gluyas *et al.***, in contrast, stand back from the detail and discuss the close inter-relationships through time of reservoir charge and cementation. Both processes can take about 10 Ma and in some reservoirs compete in a 'race for space'. They believe both may be triggered by major changes in basin dynamics such as phases of rapid subsidence and accompanying tectonism.

Overall the papers reflect the wide range of 'Fluid' topics and issues which relate to petroleum geology and more specifically to NW Europe. However, in many instances, they are only able just to scratch the surface or fly inventive kites. The next conference, it is hoped, should see the substantial development of many of the ideas presented here, and hopefully, the use 'in anger' of some of these to make exploration predictions and solve development and production problems.

Reference

ENGLAND, W. A. AND FLEET, A. J. 1991. *Petroleum Migration*. Geological Society, London, Special Publication, **59**.

From *Petroleum Geology of Northwest Europe: Proceedings of the 4th Conference* (edited by J. R. Parker).