

**THE PROSPECTS FOR ALTERNATIVE SOURCE ROCKS AND HYDROCARBONS
IN THE SOUTHERN AND EASTERN NORWEGIAN NORTH SEA BASINS**

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The southern and eastern Norwegian North Sea basins considered here comprise the Central Graben, the Norwegian-Danish Basin, the Egersund Basin and Stord Basin. In terms of exploration the region can be considered partly very 'mature', referring to the Central Graben, and partly 'immature' where the basins to the east and north-east of this are concerned. A large number of geochemical studies have been performed in the region, albeit mainly in the Central Graben, including detailed reservoir sourcing / filling studies as well as more conventional regional studies. From studies of the oils and potential source shales and siltstones of the Central Graben, the primary source rock units consist mainly of various Upper to Middle Jurassic, partly time-equivalent formations. These studies however have also revealed the possibility for distinctly different facies within the traditional Upper Jurassic units of the Central Graben which yield oils with distinct geochemical differences. Besides these source rock units, in the basins to the east there have been speculations as to the existence of units of other ages which may have at least co-sourced some of the migrated hydrocarbons which have so far been recorded. With the focussing of exploration interest in the Central Graben to detection of satellite fields, together with an increasing interest in the potential of the more 'marginal' basins towards the east, it has been recognized in more recent times that the possibility for alternative sourcing in the region has become more important.

The principal potential source rocks of the region comprise the U.Jurassic / L.Cretaceous (Kimmeridgian-Ryazanian) Draupne Fm. of the Stord Basin and its time equivalents: the Tau - Sauda Fms. in the Egersund and Norwegian-Danish Basins, and the Mandal - Farsund Fms. in the Central Graben. Within these, certain formations (Draupne, Tau, Mandal) stand out as being better sources, with rich TOC contents and the classic marine Type II-II/III kerogen, and which have effectively become a benchmark for the North Sea, together with their UK equivalent, the Kimmeridge Clay Fm. (KCF). Other units with apparently lesser potential at the outset include the M-U.Jurassic Heather Fm. (and Sandnes/Bryne Fms.), the M.Jurassic Brent Gp., the L.Jurassic Drake Fm., the Triassic Skagerrak Fm., Permian Kupferschiefer and Carboniferous shales/coals.

Based on an extensive geochemical database of oils, shows, submarine seeps from surface geochemical surveys, and of potential source rocks, both the 'norms' and 'outliers' of

migrated hydrocarbons and source rocks in the region have been determined and compared. Although there are local gaps in knowledge due mainly to a lack of wells, particularly in the basins east of the Central Graben, it is clear firstly that, in a significant number of instances, the migrated hydrocarbons recorded have been at least co-sourced by lithologies which are more 'terrigenous' than the normal U.Jurassic shales and siltstones of the region. This is perhaps more apparent in the basins outside of the Central Graben. It is also clear that there are possibilities for facies variations within the U.Jurassic, even within the Central Graben, approaching those seen e.g. in the KCF of the Atlantic margin areas northwest of Scotland. These include extremes of e.g. isotopically heavy / highly anoxic, also oxidized red-bed variants of the Mandal/Draupne Fm. in the Central Graben, the former having an oil equivalent. There is also the possibility for relatively oil-prolific Heather Fm facies as opposed to the usual more gas-prone facies, this being perhaps similar to that for example developed on the eastern flank of the S.Viking Graben as a relatively shallow lagoonal variant. In addition to these the L.Jurassic Drake Fm. and Triassic Skagerrak Fm. shales are shown to have good oil potential locally. The various GC, GC-MS and C isotope parameters used are discussed, including, most importantly, the potentially misleading effects of some organic mud additive components on the geochemical data.

