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# Integrated geodynamic and basin models of the Vøring Margin

Tom Pedersen[1], Torbjørn Throndsen[2] and Finn Tony Lysell[3]

[1] Institute for Energy Technoloy, P. O. Box 40, N-2007 Kjeller
[2] Querqus AS, P. O. Box 76, N-2007 Kjeller
[3] Globex Norway AS, P. O. Box 46, N-3167 Åsgårdstrand

Volcanic rifted passive margins can only be successfully explored by the petroleum industry if it can develop integrated concepts and models of these geologically very complex structures. More than in non-volcanic settings the architecture and evolution of the entire crust must be taken into account. Of particular importance is the timing and volumes of magmatic rocks emplaced not only within the sediments, but also at greater depths as magmatic underplating. A good understanding of these factors is mandatory for realistic estimates of heat flow histories and thus the maturation of organic matter to form hydrocarbons.

We have developed dedicated models aimed at simulation of volcanic margin formation and evolution including heat flow anomalies caused by magmatic underplating. The VOLCMARG program solves the heat equation on a deforming numerical grid taking into consideration lithosphere deformation, magmatic underplating by over- or under accretion as well as partial fusion (or anatexis) of the continental crust due to influx of hot magmas. The heat flow histories calculated by VOLCMARG are used as input to the basin simulator BAS developed by Institute for energy technology. BAS computes the temperature within the sediments including the effects of sills intrusions, as well as formation and expulsion of hydrocarbons. Input data to our models are depth converted seismic sections where the lower crust including magmatic elements is defined from deep seismic sounding and refraction data. Wells provide information on lithologies and their properties as well as present day temperatures and maturities

Our simulations indicate that traditional Upper Jurassic oil prone source rocks, which probably exist at great depths, became mature and largely overmature already in Early Cretaceous, i.e. before reservoir deposition in Late Cretaceous and Early Tertiary and subsequent trap formation. Cretaceous source rocks with voluminous oil potential remain to be confirmed in the area. Therefore, hydrocarbon charge to prospective levels appears to depend largely on the contribution from the remaining potential of the overmature Jurassic source rocks as well as from any poor Cretaceous source rocks. These factors strongly enhance gas relative to oil.

The emplacement of volcanic elements about 55 Ma led to rapid realisation of the remaining hydrocarbon potential in the affected areas, and this was mainly gas. Subsequent cooling of the sedimentary column after the volcanic activity decayed led to massive water-phase exsolution and migration of gas towards the traps. This further enhanced the gas prone character of the area.

Relative early accumulation and thus long residence times for gas in the traps imply a risk for significant diffusional losses through the cap cock.

In summary, the possibilities for significant volumes of oil in the area depend either on the presence of Cretaceous oil prone source rocks, or relatively shallow positions of the Jurassic source rocks combined favourably with the thermal effects of the volcanic elements. The latter aspect requires relative precise understanding and integration of these elements into a petroleum system analysis of the margin.