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Hydrocarbon Generation Modelling along the UK North Eastern Atlantic Margin

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Basins along the UK Atlantic margin, including the Faroe-Shetland Basin (FSB) and Rockall Trough, are characterised by a number of rifting and volcanic events. The principal source rock, the Upper Jurassic Kimmeridge Clay Formation, is extremely deep (>8 km) in the kitchen areas within these basins and at such depths of burial the source rocks would normally be expected to generate mainly dry gas, if still capable of generating hydrocarbons. However the drilling results in the FSB showed that oils and condensates are present in the area. Volcanic overprinting on these basins further complicates the relationship between the predicted hydrocarbon type and the burial depth, since the regional heating associated with the volcanism and dynamic support provided by the underlying mantle plume should have produced enhanced maturation over that expected from burial depth alone. The extent of regional heating associated with the volcanic events such as this is controversial, since current interpretation of AFTA data suggests that there is no evidence for elevated heat flows during this period (Green, 1999). Additionally most basin modelling studies also indicates that there has been no hear flow anomaly associated with either the rifting or volcanic events (Dean et al., 1999; Holmes et al., 1999). This hypothesis of no increase in heat flow associated with either rifting or volcanism can be shown to be impossible from the second law of thermodynamics (Carnot Theorem). Given this failure to follow the laws of thermodynamics, the absence of elevated heat flows associated with rifting or volcanism is incorrect.

The Mesozoic burial histories for the Kimmeridge Clay source rock are dominated by extension particularly during the Cretaceous. From wells located in the southern Faroe-Shetland area, a thermal history incorporating elevated heat flows during the individual rifting and volcanic events was derived (Fig.1). Using the standard kinetic approach to geochemical modelling such heat flow histories predict very mature dry gas generation (Fig. 2), which is in conflict with the observed hydrocarbon data from the basin. This conflict can be resolved when the thermodynamic retardation of maturation and hydrocarbon generation by overpressure development is incorporated into the model (Fig.2) (Scotchman and Carr, 2001).

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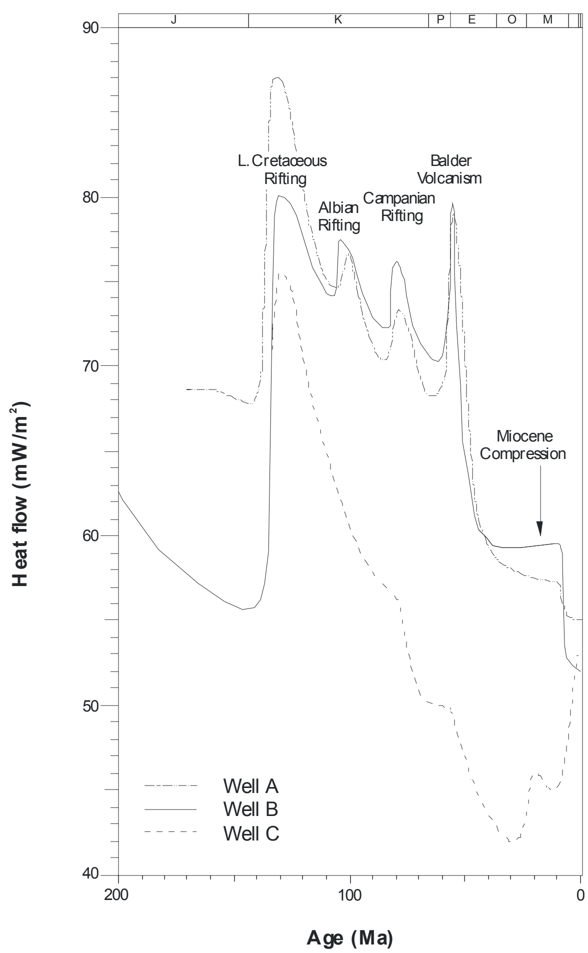

Figure 1. Derived heat flow model for Faroe-Shetland Basin study wells

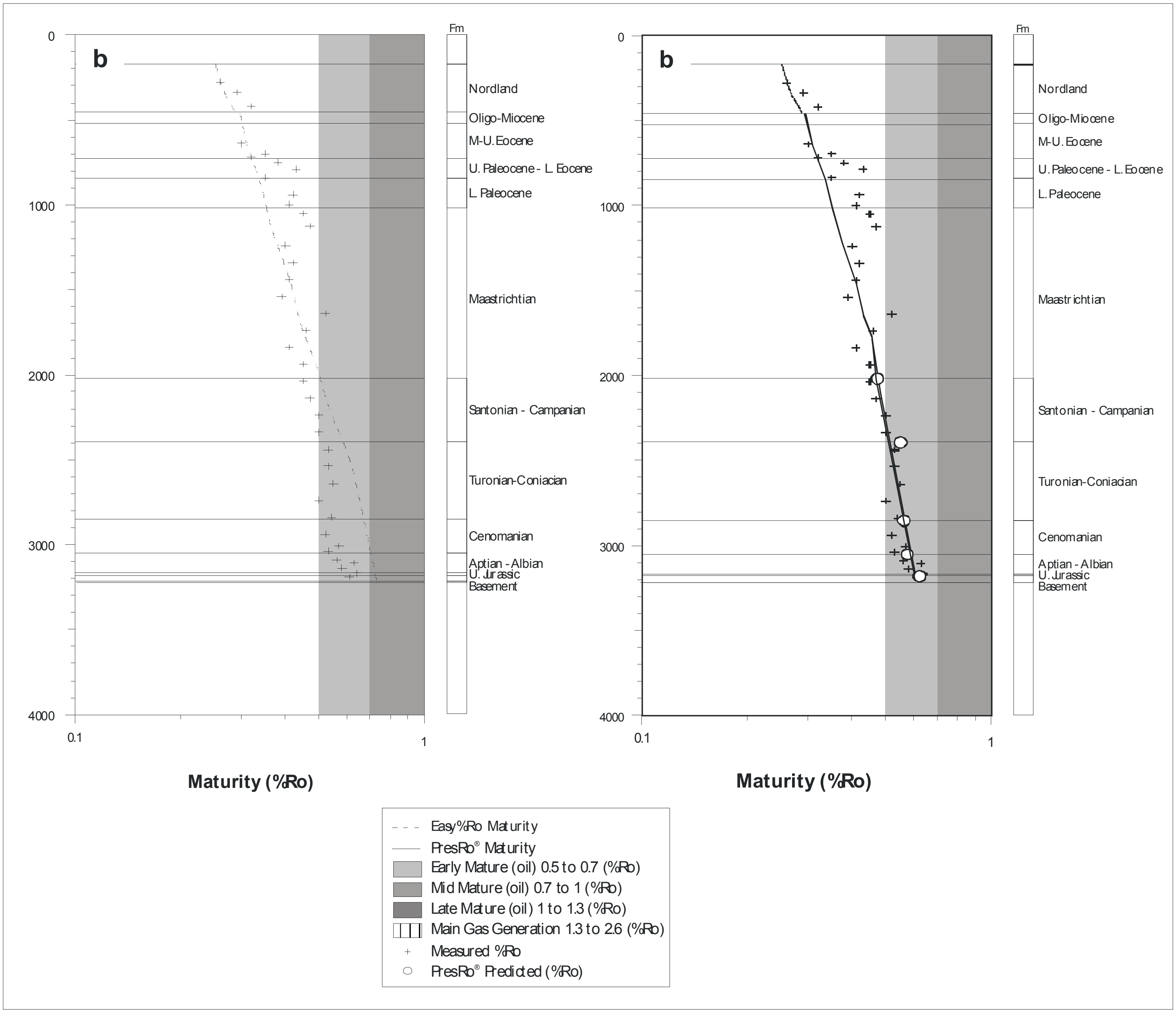

Figure 2: Comparison of maturation models for Well B using kinetic model (Easy%Ro) and pressure model (PresRo).