Basin Modeling of the Porcupine Basin, Ireland

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ABSTRACT

The Porcupine Basin (PB) is part of a chain of hyperextended basins extending along the north-western Atlantic margin. Key questions remain regarding its geological and thermal evolution, especially in undrilled areas in the south of the basin, which is the focus of current exploration interest. Research on the PB has direct relevance to understanding the driving mechanisms for the formation and evolution of hyperextended margins. A significant amount of information exists on the lithostratigraphy and depositional systems, the tectonics and timing of key geological events in the northern part of the PB. The extent of Jurassic crustal thinning linked to hyperextension appears to increase southward, yet the tectonic drivers remain uncertain. Mantle exhumation and serpentinisation have been suggested, while the products of Cenozoic igneous activity appear widespread. We evaluate a range of geological scenarios using numerical basin modelling tools in the PB. A robust stratigraphic and tectonic framework has been defined using abundant seismic data available across the entire basin and several structure maps have been generated, serving as inputs for basin modelling. Preliminary 1D modelling work on wells drilled in the north of the basin have constrained the burial history, maturity and present-day geothermal gradient, but also highlighted a range of solutions largely depending on the heat-flow history and extent of Late Jurassic hyperextension. Published 2D basin modelling work suggested a link between hydrocarbon leakage and carbonate mound formation through hydrocarbon migration from a mature source rock kitchen. However, most modelling work to date was based on a pure-shear setting following adapted versions of the McKenzie rift model. Recent results of 2D modelling of mantle serpentinisation (simple shear scenario) in the Norwegian Atlantic Margin demonstrated that this process was possible during the Jurassic rift phase, and could partly account for crustal high velocity zones, together with Cenozoic plume-related igneous activity. This situation has similarities to the PB, and preliminary basin modelling results will be presented using a range of basin modelling platforms (Genesis; TecMod; PetroMod). This, coupled with enhanced details on crustal structure and paleo-thermal history, will yield a better understanding of petroleum systems in the Porcupine Basin.