Thermal models of the central Scotian Slope and the effects of salt on heat flow

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A global push towards deeper water exploration has resulted in the drilling of six exploration boreholes on the deepwater Scotian Slope between 2002 and 2004 bringing the total Scotian Slope well count to twelve. Unfortunately, exploration to date on the Scotian Slope has yielded only minor hydrocarbon shows with limited, low quality, reservoir sands and has yet to demonstrate the same hydrocarbon prosperity as the shallow water Scotian Shelf. The shales of the Scotian Slope's Verrill Canyon Formation have been inferred as prominent source rocks feeding the interior Scotian Basin's reservoirs. However, as few wells exist on the slope, little core is available for vitrinite reflectance analysis in order to determine the maturation history of organic material on the deep water slope (Kidston et al. 2007). In the summer of 2008, we acquired nearly 50 seafloor heat flow measurements from the central Scotian Slope. The data show significant lateral variations in seafloor heat flow corresponding to the presence of high thermal conductivity salt diapirs across the slope, as well as a general increase in heat flow in the seawards direction. Two phases of 2D thermal and petroleum systems models were produced (Louden et al. 2009) in order to predict the maturation potential and depth of the maturation window across the central Scotian Slope. The first phase of modelling was constrained by limited vitrinite reflectance (%Ro) and temperature data from available Scotian Slope wells, while the second phase was constrained by the recently acquired seafloor heat flow data. Calibrating the models to the heat flow data has resulted in a lower basement heat flux, lower temperatures at depth and thus a deeper hydrocarbon maturation window than previously expected. This suggests that the earlier models may have over-predicted the maturation of all source rock intervals and that the basin may be more oil prone than previously thought. As expected, both phases of models predicted significantly higher seafloor heat flow values above salt diapirs than in surrounding regions. However, the ratio of increase relative to the surrounding background values in the models did not match the increases recorded by the measured seafloor heat flow data. Variations between modelled and measured values are likely the result of convective fluid flow or variations in 3D, out of plane, salt geometries not accounted for in the 2D models. In order to test the effects of 3D variations in salt geometries on seafloor heat flow 3D thermal and petroleum systems models have been developed as constrained by available vitrinite reflectance, temperature and seafloor heat flow data, with basement heat flux defined from simple crustal rifting models after McKenzie (1978) and Royden and Keen (1980).

References

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