Source Rocks and Hydrocarbon Fluids of the Browse Basin

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ABSTRACT

The Browse Basin is located offshore on Australia's North West Shelf and is a proven hydrocarbon province hosting gas with associated condensate. Oil reserves in the area are small with most in-place oil likely the result of hydrocarbon fluids experiencing pressures less than their saturation pressure resulting in dual phase fluids, coupled with secondary alteration processes and gas leakage. This study reviews the distribution, quality and maturity of source rocks and fluid characteristics in the Browse Basin. All publicly-available Total Organic Carbon (TOC) and Rock-Eval pyrolysis data were compiled and quality checked to determine multiple, viable source rock units. Jurassic and Cretaceous source rock distributions and net thickness were studied using integrated seismic and well log lithofacies mapping, combined with organic geochemistry data. Source rock transformation ratio and generation potential were investigated using a regional pseudo-3D petroleum systems model constructed from new seismic interpretations and calibrated using temperature and maturity data from 34 wells. Monte Carlo simulations were used to test uncertainties around key input parameters including thermal history, source thickness, TOC, Hydrogen Index (HI) and kerogen kinetic composition. Results show that the Jurassic Plover Formation (J10-J20 supersequences) coals and carbonaceous shales are effective, primarily gas-prone source rocks which may have some liquid potential when the generated gas migrates into shallow reservoirs at reduced pressures. Additional sources of hydrocarbons include shales in the Upper Jurassic lower Vulcan Formation (J40 supersequence), Lower Cretaceous upper Vulcan Formation (K10 supersequence) and Echuca Shoals Formation (K20-K30 supersequences). However, these are likely to have only expelled hydrocarbons locally in areas of optimal organic-richness and maturity. Key uncertainties include TOC and HI variability due to lack of well penetration in the depocentres. The molecular composition of the fluids were compiled and quality checked and used to investigate the relationship between the saturation pressure and condensate-gas ratio (CGR). By combining the bulk properties and molecular and isotopic compositions of the fluids with the geochemical compositions of the source rocks in a petroleum systems model, four Mesozoic petroleum systems have been identified and mapped to help understand the source rock potential and fluid characters for the Browse Basin.