Coupled 3-D stratigraphic and Fault Seal Modeling to Predict Hydrocarbon Migration and Trapping in the Western Ceduna Sub-Basin, Australia

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ABSTRACT

Top seals and faults represent key risks to migration and preservation of hydrocarbons in the frontier Ceduna Sub-Basin (Australia). To overcome the paucity of well data in the sub-basin, numerical stratigraphic forward modelling was utilised to constrain the stratigraphic distribution (facies, grain size and volume of shale) of prospective Late Cretaceous marine and deltaic sequences (Tiger and Hammerhead sequences) and to investigate the structural control on hydrocarbon migration and trapping. A basin-scale stratigraphic forward model was initially produced over the Ceduna Sub-Basin and neighbouring depocentres (1100 km by 600 km, 20 km horizontal resolution, 1 Ma interval). A nested fine resolution stratigraphic model (80 km by 60 km, 0.5 km horizontal resolution, 200 ka interval) was then produced over the Trim 3D seismic survey in the western part of the sub-basin and four simulations were produced to match a range of estimates of volume of shale derived from the nearby Gnarlyknots-1A well. These stratigraphic data were in turn integrated as properties into a 3D geomodel of the Trim 3D survey to assess hydrocarbons migration and trapping scenarios at prospect scale. Reservoir faults sealing potential was quantified using Shale Gouge Ratio and top seal frameworks was investigated based on silt and shale thicknesses, distribution and extend. Fault and top seal investigation suggests (i) restricted potential for structural trapping near the base of the marine Tiger sequence, (ii) the likely presence of a regional migration pathway associated with transitional sandy lower shoreface deposits, and (iii) the association of intraformational top seals and increasing fault seal potential in the deltaic succession of the Hammerhead sequence potentially resulting in a series of stacked structural traps.