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Characterising Top Seal in the Vulcan Sub-Basin, North West Shelf, Australia

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Abstract

The occurrence of palaeo-oil columns in Late Jurassic and Cretaceous reservoirs in the Vulcan sub-basin indicates that hydrocarbon accumulations have leaked. It is unclear whether accumulations have leaked through breach of top seal or fault seal. This study evaluates the top seal potential for hydrocarbon accumulations in the Vulcan Sub-basin. For this purpose a top seal potential assessment methodology was developed.

Seal potential (SP) combines seal capacity (the hydrocarbon column height that can physically be held back by seal), seal geometry (the areal extent and thickness of the seal) and seal integrity (rock mechanical properties of the seal). Seal capacities are measured using mercury injection capillary pressure calculations. Areal extent is evaluated using sedimentological and sequence stratigraphic principles. Thickness is determined empirically from well logs and seismic data. Seal integrity is derived from a brittleness index. In addition, a component relating to data quality and quantity is included in seal potential evaluation.

The main sample set for this study is composed of drill cuttings. For this reason a comparison of seal capacity results measured from cuttings and cores has verified that cuttings samples provide accurate seal capacity measurements.

Lower Vulcan Formation SP ranges from low to high due to variations in seal capacity and thickness risks as well as data quality and quantity. High SP occurs in the main depocentres and low SP occurs on the palaeo-highs and basin margins. Upper Vulcan Formations SP ranges from low to moderate due to variations in seal capacity. Moderate SP occurs in the depocentres and low SP on the basin margins. In the Echuca Shoals Formations seal capacity,

seal extent and integrity as well as data quality and quantity are good. However seal thickness is inconsistent, resulting in SP variations from good to poor as a function of thickness. Jamieson Formation has high seal capacities, is thick and areally extensive, however the seal potential is locally moderate (for example on the Ashmore Platform) due to seal integrity risk. SP for the Jamieson Formation is controlled by the thickness and the amount of calcite present in the rock, which affects the brittleness of the formation and hence the seal integrity. The Woolaston, Gibson and Fenelon (WGF) Formations are grouped together as a regional seal and in this group SP varies from low to high. The WGF rocks generally have high seal capacities, are areally extensive and thick with good data quality and quantity sample set wise. Where the WGF is predominantly marl and calcilutite some of the highest brittleness index values were recorded and hence the WGF has a low SP in these areas.

Based on the overall seal potential analysis, almost all seals in the area are capable of holding back hydrocarbon columns greater then present or palaeocolums recorded. This suggests that hydrocarbon leakage in the Vulcan Sub-Basin did not occur as a result of top seal capillary failure.