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Tectono-stratigraphic evolution of the Centaur 3D survey, Exmouth Plateau, North West Shelf, Australia

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This project illustrates the tectono-stratigraphic evolution of the Exmouth Plateau, a deep-water sub-basin within the Northern Carnarvon Basin. The project was completed by fully interpreting the Centaur survey, a recently acquired 3D seismic dataset located in the northwestern part of the plateau. The investigation involved detailed qualitative and quantitative seismic analysis of structural and stratigraphic elements that were then assessed on their impact to the hydrocarbon potential of the area.

The Centaur provided spectacular imaging of NNE- and NE-trending, highly-segmented rift-border faults that make up the main graben-forming boundaries formed between the Late Triassic and Early Cretaceous, as a consequence of rifting of Greater India from Australia. The rifted fault blocks were affected by subsequent tectonic uplift associated with ridge push, then degradation, creating rounded eroded footwall crests and re-deposited hangingwall strata up to 50 m thick. Continued extension and displacement of the rift-border faults created long, obliquely trending intra-graben faults that intersected the rift-border fault hangingwalls. Extensional fault-propagation folding helped create 1-3 km wide, asymmetric depocentre synclines in the hangingwall of the rift-border faults, while uplifting and rotating footwall strata eastwards. Since the beginning of passive margin phase in the Late Cretaceous, the plateau has been subjected to minor episodic fault reactivation, subsidence and slumping, including Neogene inversion producing a localized anticlinal structure within the southern margin of the survey. The timing of formation is supported by mass-transport flows away from the uplifted area and onlapping of sediments onto the structural high.

Seismic facies analysis of the Triassic strata has shown a multitude of stratigraphic elements including deltaic channel systems, sheeted sand bodies, igneous intrusions and hydrothermal vent complexes. Amplitude extractions have identified potential structural traps in tilted Triassic fault blocks as well as potential stratigraphic traps in intra-Triassic channels, in sandbodies and potentially in igneous intrusions.
Several lines of evidence suggest that the overall structural evolution of the rift-border faults was influenced by the reactivation of pre-existing Early Triassic structures, these include, 1) existence of fault-propagation folding of Triassic rift-border faults, 2) along strike variations in geometry and orientation of rift faults and 3) the appearance of faults propagating upwards obliquely through Lower Triassic strata. Unlike the traditional orthogonal extension models of rifting that creates long, linear rift patterns, the structural geometry is comparable to analogue models of offset or oblique rifting, where the rift-border faults are short, highly-segmented and curved, containing long intra-graben faults formed perpendicular to the direction of extension to create numerous asymmetric hangingwall depocentres.

The results of the project suggest various structural and stratigraphic elements that provide varying levels of risk and reward in the Triassic prospective play targets for petroleum exploration. While the Triassic strata provide potential hydrocarbon targets, fault reactivation since the Early Cretaceous, mass-transport complexes Cretaceous and Tertiary and fluid escape features of the Top Triassic pose a threat to the seal quality of trapped hydrocarbons and slope stability for drilling infrastructure.