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Mapping Geological Structures In The Onshore Canning Basin, Western Australia, From Gravity Gradiometry Data

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ABSTRACT

A study was undertaken to test whether it is possible to map the basement configuration and sedimentary horizons from gravity gradiometry (AGG) data, within the EP431 Buru Energy permit on the Mowla Terrace in the onshore Canning Basin, Western Australia. Gravity data integrated with seismic and well data assists in petroleum exploration especially in this area where seismic is limited or thick carbonate sequences makes the interpretation of seismic data difficult and challenging.The use of gravity gradiometry data allows the density contrasts between basement and overlying sediments to be mapped, and also the mapping of multiple intra-sedimentary density interfaces, including the top of carbonates.

The airborne gravity gradiometry (AGG) survey data was acquired in 2015 over Buru Energy's EP431 permit. The survey was flown on 1km spaced north-south traverses with east-west tie lines spaced 10km apart. The data was gridded using a special two-step gridding procedure using two different gridding algorithms with the final grid mesh, 50m by 50m. The two-step gridding procedure was applied to all six tensor components, as well as the Bouguer gravity data.

Horizon Mapping Technique (ESA-MWT) was applied to map density interfaces using AGG data. The test study was conducted on a narrow 8km long swath along the 2D seismic traverse, HCG-300 with three wells: Pictor-1, Pictor-2 and Pictor East-1 close to the traverse and three additional wells: Antares-1, Mowla-1 and Edgar Range-1 located nearby. Lithological and stratigraphic information from these petroleum exploration wells was used to correlate the detected density contrasts with the geology.

ESA-MWT, which is based on energy spectral analysis, was applied to gridded Bouguer and specially transformed tensor components to attenuate or enhance different frequencies of the gravity field generated by several inter-sedimentary formations as well as the underlying basement. The ESA-MWT procedure was conducted at stations 1km apart along the seismic line. At each station, multiple spectra were computed over incrementally increasing windows. For each spectrum, the depth was interpreted and plotted versus window size, and from these graphs, multiple Depth-Plateaus were detected at each station. These Depth-Plateaus which correspond to density contrasts within the sediments and the underlying basement, were laterally merged with those from adjacent stations forming density interfaces.

These results were then validated with seismic and the litho-stratigraphy from well data showing a good correlation with the tops of several sedimentary formations and intra-formational lithological boundaries. Ten density interfaces were mapped: Top Precambrian Basement, Top Nambeet Formation, Intra-Willara Interface, Top Acacia Sandstone, Top Willara Formation, Intra-Goldwyer Interface, Top Goldwyer Formation, Top Nita Formation, Intra-Tandalgoo Group Interface and Intra-Tandalgoo Group Interface.

The density interfaces derived from the AGG data were mapped in metres and converted to TWT to validate the results versus seismic interpretation. The results show very good correspondence with basement and sedimentary horizons derived from seismic.

Comparison with the Pictor-1 gamma ray and bulk density, well log data, shows that some of the horizons mapped from AGG data, correspond to the top of the formations or intra-formational lithological boundaries. There is a good correlation between the interpreted density interfaces and the corresponding sedimentological boundaries intersected in the well, in particular with the lithological changes indicated on the geophysical logs such as the abrupt changes in gamma ray counts.

The geological model built along the Test Profile from interpretation of the AGG data shows good correlation with the wells and seismic data.