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Using potential field data to map salt distribution in the Western Officer Basin, Western Australia.

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SUMMARY

The Neoproterozoic western Officer Basin has a total fill of up to 8 km and a depositional history with similarities to other Australian basins, particularly the Amadeus Basin. Exploration has been limited due to the size and remoteness of the basin; therefore potential field data can be a useful and cost-effective tool to assess petroleum prospectivity.

Salt distribution and mobilisation in the Officer Basin has been significantly underestimated due to a lack of quality seismic data. This study uses satellite, digital terrain, magnetic, gravity and seismic data to show the existence of mobilised salt much further west than previously suggested, with significant implications for future exploration in the region.

Key words: Officer Basin, salt, potential fields, magnetics, gravity.

INTRODUCTION

The Neoproterozoic Officer Basin is one of Australia's least explored sedimentary basins. It is bounded to the north by the Musgrave Province, Canning Basin and Paterson Orogen, to the west by the Yilgarn and Pilbara cratons, and to the south by the Cenozoic Eucla Basin. The WA portion of the basin covers about 300,000 km2 and is referred to in this paper as the western Officer Basin. It has a total sedimentary fill of up to 8 km. The Neoproterozoic Browne Formation is the source of mobilised salt in the basin and has played a significant role in its structural evolution; however its distribution is poorly constrained.

Exploration in the western Officer Basin has been hampered not only by its remoteness and lack of access to infrastructure, but also by the perceptions that the basin had limited source rocks and limited potential for hydrocarbon generation due to its age. To date, fewer than 20 petroleum wells have been drilled in the basin and the seismic data coverage is sparse.

Potential hydrocarbon trap styles include structural plays related to salt movement, such as drape folds, overhangs and thrusts. An improved understanding of salt distribution in the Officer Basin is therefore important for successful exploration in the region.

METHOD AND RESULTS

This study uses satellite, digital terrain, magnetic, gravity and seismic data to show the existence of mobilised salt much further west than previously suggested. Surface diapirs were mapped using satellite and SRTM data, and sub-surface salt was mapped using a combination of seismic and magnetic data.

Most of the surface expressions of salt occur in the Gibson area, in the north of the study area, and along the Browne salt wall in the Yowalga area (Fig. 1). The surface expressions of salt structures vary, but in general individual diapirs are semicircular, between 0.5 and 10 km in diameter, and have an elevated rim sometimes visible in the SRTM data. Radial drainage patterns may be present around the edges of the structure.

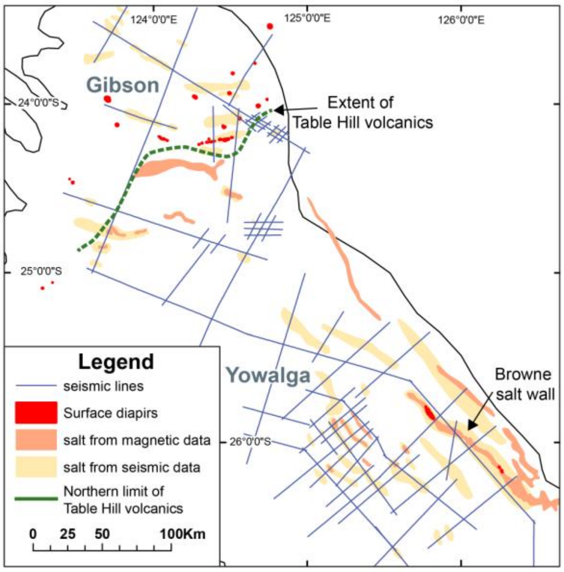

Figure 1. Salt distribution across the study area. Salt diapirs mapped at the surface are shown in red, salt mapped from aeromagnetic data is shown in orange, and salt mapped from seismic data is shown in yellow. The northern limit of the Table Hill Volcanics, mapped from

seismic and magnetic data, is shown in green. Seismic line overlay shows the limits of salt interpretation from seismic data.

In the sub-surface, magnetic data proved to be a useful tool for mapping mobilised salt, due to its effect on the Ordovician Table Hill Volcanics. Disruption of the Table Hill Volcanics provides a magnetic rim on the border of the salt wall (Fig. 2). Previous authors have noted this in the Browne salt wall (Simeonova and Iasky, 2005; Korsch et al, 2013; Goodwin et al, 2013), but several areas in both the northern and central parts of the basin also have similar signatures. The Table Hill Volcanics are absent across most of the Gibson area, but disruption by salt of more magnetic sediments produces a similar signature to those in the Yowalga area.

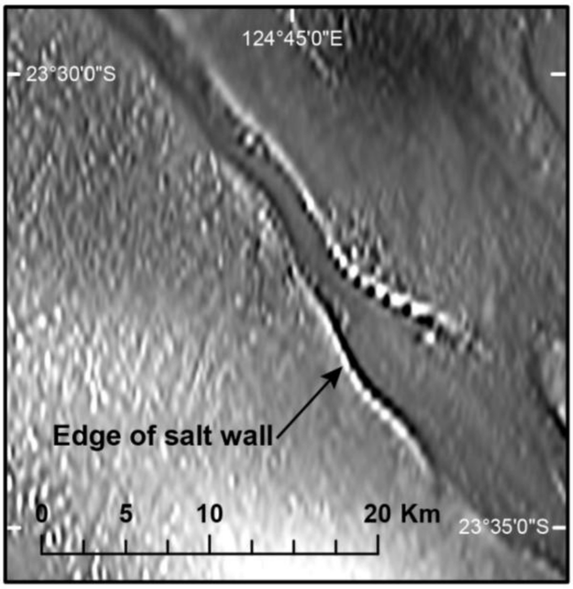

Figure 2. An example of the salt signature in the magnetic data (RTP 1vd) from the Browne salt wall in the Yowalga area.

The distribution of surface salt and salt visible in magnetic data correlates well with salt mapped from seismic data (Fig. 2) but also reveals areas of salt in the southern Gibson Basin where seismic data is sparse. The mapped distribution of salt correlates strongly with the distribution and density of the seismic lines, suggesting that the interpretation of salt is based on and limited by the sparse seismic data.

Analysis of the available gravity data shows a good correlation between gravity lows and the larger areas of mapped salt, but salt is also interpreted in areas with a relatively high gravity signature, making gravity alone unreliable as an indicator of salt. High gravity signatures may show the broad geometry of the basin, rather than details of shallower intra-basin features. Poor resolution and irregular spacing of the gravity data in much of the area (between 700 m and 10 km) also make it difficult to resolve the high-frequency responses expected from a relatively shallow salt body.

To test the hypothesis that higher resolution gravity may better delineate intra-basin features including salt occurrence, a forward modelling profile was constructed to compare with the existing gravity. A geological cross section from seismic data was used to construct the conventional gravity response and the full tensor gradient gravity response, modelled at 120 m sensor height. Both profiles show a good response to the two salt diapirs in the section, with the full tensor gradient gravity providing higher resolution of the salt bodies.

CONCLUSIONS

High-resolution magnetics and gravity data provide a useful tool for mapping salt occurrences in areas of poor or sparse seismic data, and can be used to correlate and improve seismic interpretation. Poor resolution of the existing data, however, is limiting. Forward modelling profiles of gravity data demonstrate that good definition of salt bodies can be achieved with both conventional airborne and full tensor gradient gravity, with the best results from full tensor gradient gravity. Given the difficulties and costs involved with exploration in the Officer Basin, acquisition of higher resolution aeromagnetic and airborne gravity data would be a cost-effective way to improve definition of intra-basin features including salt distribution.

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