Interpreting 2D Seismic with the Assistance of FALCON® Airborne Gravity Gradiometer Data in the Canning Basin*

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Abstract

In recent years, airborne gravity gradiometry has gained popularity as a useful tool for all stages of oil and gas exploration. It is able to be acquired rapidly, cost effectively and provide complete coverage of exploration blocks. When combined with seismic, magnetic, well and other geological data, significant advances in the understanding of the geology of a project area can be made. In a variety of geological environments, gravity anomalies resulting from density contrasts contain useful information about the distribution of rocks in the subsurface. Lithologies with atypical densities include carbonate, salt and volcanic rocks. These lithologies are good targets for gravity gradiometry but are often difficult to resolve with seismic meaning gravity gradiometry can complement and add value to new or existing seismic surveys. Transfer faults oblique to seismic lines are often difficult to identify on seismic lines but are obvious on gravity gradient data. Gravity gradiometer surveys are often used to interpolate structures between widely spaced ‘vintage’ 2D seismic lines and assist in more effective planning of new seismic surveys.

References Cited


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Gradiometer data in the Canning Basin

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Background
Hydrocarbon exploration in under-explored frontier basins is often challenging due to the sparse coverage of ‘vintage’ seismic data. The Canning Basin is such an under-explored frontier basin. Partly due to the limited hydrocarbon exploration history, this basin has made little progress for many years. For example, the deep structure of the Fitzroy Trough and its margins was largely unknown. This example from the Canning Basin illustrates how FALCON® Airborne Gravity Gradiometer (AGG) data greatly enhances the 2D seismic interpretation, making it a valuable tool in exploring frontier basins.

Introduction
Buru Energy acquired a large FALCON® Airborne Gravity Gradiometer (AGG) survey (28,000 km²) over the south-western margins of the Fitzroy Trough and Gregory Sub-basin, and parts of the Jurgarra Terrane, the Mowla Terrane, Broome Platform and Crossland Platform (Figure 1). Figure 2 shows the lithostratigraphy of this part of the Canning Basin. Figure 3a. Integrated structural interpretation of the AGG data in the vicinity of the traverse (Figure 3b). AGG data were used to map structure between the seismic lines and in areas where seismic data was of low quality. Time-to-depth conversion of the interpreted traverses was completed using CGG’s proprietary software LCT. Using velocity data available on 2D seismic data was interpreted iteratively with AGG and airborne magnetic data, well, Landsat Geocover and SRTM (Shuttle Radar Topography Mission) data, along with published geological maps and literature.

Method
The integrated interpretation and modelling method involves the following stages:

1. Integration of AGG and seismic data with all available datasets, structural interpretation maps of the intra-sedimentary fault structure (Figure 3a) and basement fault structure were produced. Intra-sedimentary features, including faults, were mapped at intermediate and shallow levels, and the distribution of various gravity sources was mapped at an intermediate structural level (Figure 3b). AGG data were used to map structure between the seismic lines and in areas where seismic data was of low quality.

2. Werner (Werner, 1953) and Euler (Bled et al., 1996) methods in Inverse magnetic data were used to produce a depth to magnetic basement map.

3. Before the potential field data interpretation project started, a seismic interpretation was performed by Buru Energy. Figure 4 illustrates limitations of some of the ‘vintage’ seismic data along one of the modelled traverses. It shows that the interpretation of some of the seismic lines is limited by data quality and further interpretation was only possible through integration with other data.

4. Seismic traverses crosscutting the survey area were reinterpreted using the integrated structural interpretation as a constraint (Figure 4). All selected traverses are NE-SW (Figure 3a), each of them consisting of up to three seismic lines, occasionally with gaps in the seismic coverage (Figure 3b) and basement fault structure were produced. The structural interpretation maps were used together with the seismic data to constrain fault locations and depths as well as the thickness distributions of geological units. Gradually an improved understanding of the tectono-sedimentary evolution of the basin was obtained, allowing for a better understanding of the deep structure.

5. Time-to-depth conversion of the interpreted traverses was completed using CGG’s proprietary software LCT. Using velocity data scattered from well data, the digitised interpreted seismic traverses were converted from the time domain to the depth domain.

6. The interpretation of the seismic traverses was then validated by 2.5D gravity modelling. To account for excess or absent mass, modifications were made to the interpretation. In some cases multiple models were tested to assess the plausibility of alternative geological assumptions. Figure 5 shows an end result of the gravity modelling of the seismic traverse (Figure 6).

7. Knowledge gained from the 2.5D gravity modelling was fed back into the structural interpretation maps to update the conceptual model. Using this workflow, significantly improved interpretation of ‘vintage’ seismic data can be achieved. A comparison of the initial seismic interpretation (Figure 4) to the final validated interpretation (Figure 5) clearly shows the value of integrating AGG and other datasets to produce an integrated interpretation that honours all data. Figure 7 shows the result of 6 modelled sections in the northern part of the survey in 3D view.

Result
The result of this interpretation and modelling is an improved understanding of the 3D structure, stratigraphy and tectono-sedimentary evolution of the basin. The seismic data that was used to constrain the modelling could be interpreted with increased confidence to deeper levels, as the cross sections were validated by 2.5D gravity modelling. The detail of the interpretation, construction and modelling allowed the identification of potentially prospective stratigraphic units, structural trends, and prospective structures. The selection of areas for future exploration and seismic acquisition has been facilitated.

Conclusions
In underexplored frontier basins, like the Canning Basin, integrated interpretation of ‘vintage’ quality seismic data in-conjunction with AGG data and the value of 2.5D gravity modelling of geological cross sections along seismic lines has proven to be valuable. Although there could be multiple solutions the guided interpretation of the vintage seismic data provides key geological insights to constrain the final inversions of the gravity data. By gravity modeling multiple seismic traverses the 3D understanding of the structure, stratigraphy and tectono-sedimentary evolution of the basin can be better understood. This ultimately leads to more informed exploration decisions, such as targeted seismic surveys and drilling locations.

REFERENCES