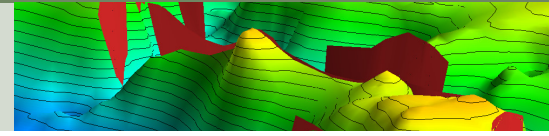


New 3D Model of Capel and Faust basins released

Geological model assists in the assessment of offshore frontier basins

Karen Higgins

Geoscience Australia has recently completed a study of the Capel and Faust basins, remote frontier basins located over the northern Lord Howe Rise, offshore eastern Australia (figure 1). The Lord Howe Rise is a continental fragment that broke away from what is now the Australian continent's east coast during the final break up of eastern Gondwana, commencing in the Cretaceous. The Capel and Faust basins cover an area of 210 000 square kilometres within Australian waters at water depths between 1500 and 3000 metres. The area of



the basins is comparable with a number of Australia's hydrocarbon producing provinces. Previous investigations hinted at deep basins that could be prospective for hydrocarbon resources, but new data was necessary for a more definitive assessment.

There is usually a high degree of uncertainty in the geological interpretation of frontier sedimentary basins because there is usually little pre-existing data or associated analysis. Consequently, Geoscience Australia acquired new data in this area during 2006–2007, including rock samples and high-quality reflection seismic, potential field and bathymetric data (figure 1). 2D analyses of these datasets were found to be inadequate in providing a satisfactory interpretation of the area's geology. This was the result of the combination of:

- a comparatively wide (15 to 40 kilometre) seismic line spacing
- lack of direct evidence (such as a deep drill hole) for the composition and age of basin sediments
- the widespread presence of volcanic and intrusive rocks masking features on seismic data
- the highly compartmentalised basin structure.

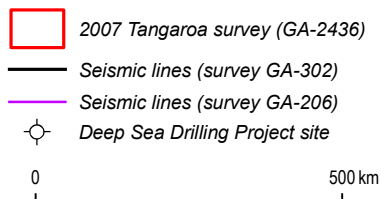
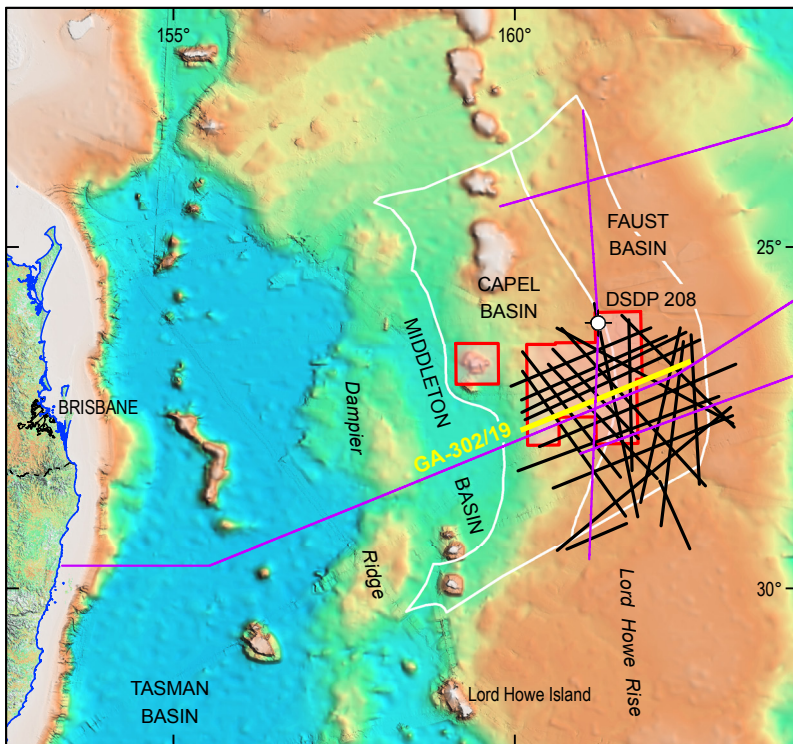


Figure 1. The location of data acquisition by Geoscience Australia in the Capel and Faust basins with Deep Sea Drilling Project holes on a bathymetric image (Colwell et al 2010). Seismic line GA-302/19 is highlighted in yellow.

3D modelling and petroleum exploration

Because of these challenges, effective data integration and analysis methods were essential. By using the 3D visualisation and modelling environment provided by GOCAD™, the diverse datasets were captured, processed and interpreted to create an integrated 3D geological model. This model enabled key geological and petroleum prospectivity questions to be answered. 3D geological analysis of offshore Australian areas at a basin-wide scale is a relatively new field of study. Usually petroleum exploration companies analyse basins at the scale of exploration prospects when undertaking detailed 3D mapping of hydrocarbon accumulations and modelling of fluid flow.

Geoscience Australia previously used basin-scale 3D geological modelling in a study of the Bremer Basin, located on the southern margin of Australia (Bradshaw 2005). However for this study

the model was produced at the end of the project to allow 3D visualisation of key interpretations and datasets. In the Capel and Faust basins study, the 3D visualisation environment was proactively used during the analytical workflow, as a workspace for data integration and testing of geological interpretations. This integrated 3D methodology is increasingly being used for petroleum prospectivity assessment at a basin scale.

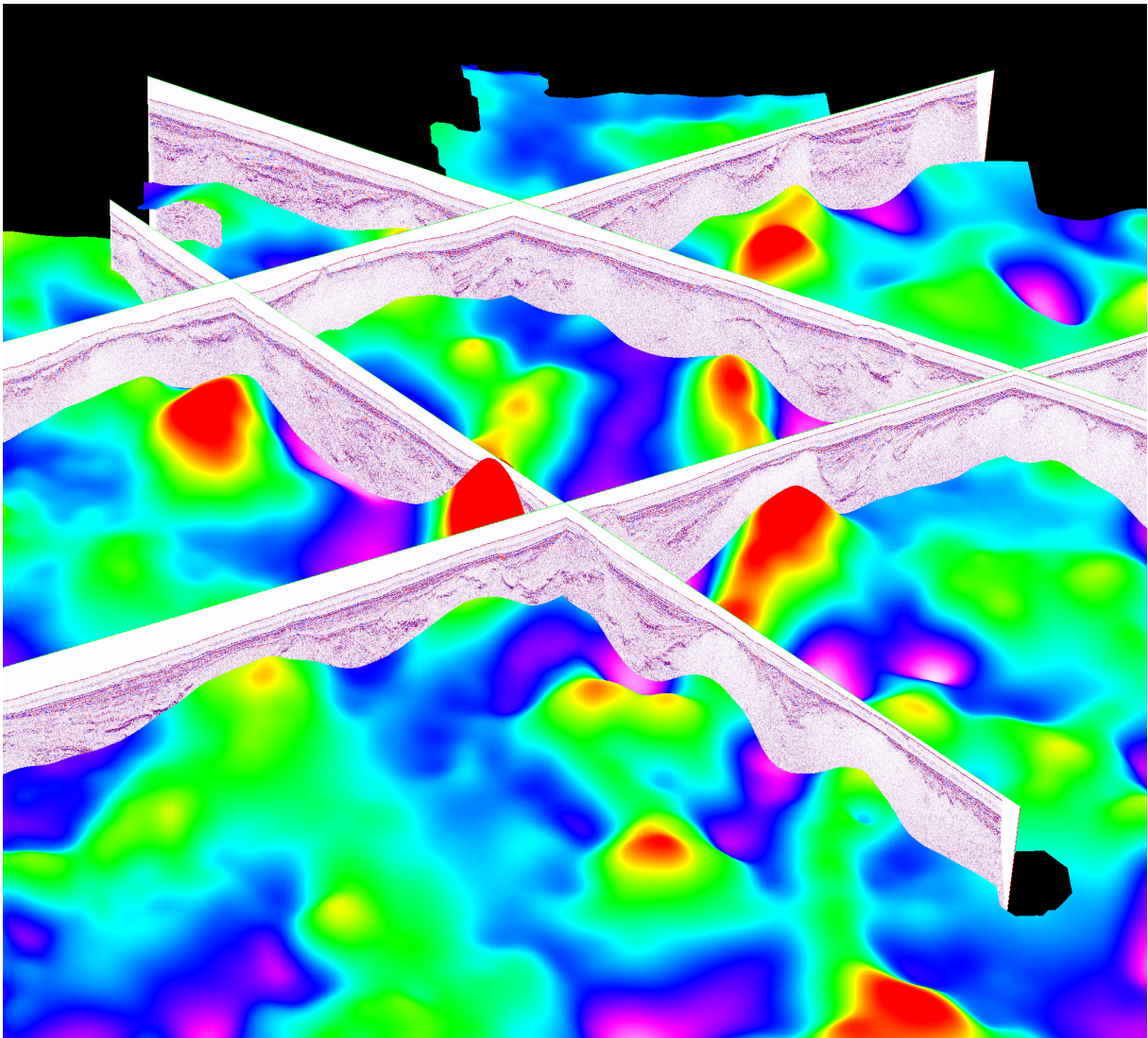


Figure 2. 3D visualisation of selected GA-302 seismic lines and grid of marine gravity data. The strong correlation between basement topography (revealed by seismic data) and gravity anomalies allowed gravity data to be used to interpolate structures between seismic lines.

Building an integrated 3D model

The Capel and Faust 3D geological model is composed of two fundamental components: horizon surfaces and fault surfaces. A number of horizon surfaces, based on 2D seismic interpretation, define key depositional and erosional events in the evolution of the basins (Colwell et al 2010). These surfaces bound major sedimentary units, which may source, host or trap petroleum accumulations. Seven key horizon surfaces were selected for the 3D geological model. Ages were assigned to most of the horizons by inference from major regional tectonic events (Colwell et al 2010). Fault surfaces represent fractures formed largely through tectonic movements that cut through

the basin sediments or form basin margins. Faults may also facilitate the trapping, migration and leakage of hydrocarbons potentially generated within the basin (figure 3). Two fault types were interpreted in the seismic datasets: major basin-bounding or basement offsetting faults, and minor intra-basin faults.

The seismic data was the primary dataset used for model

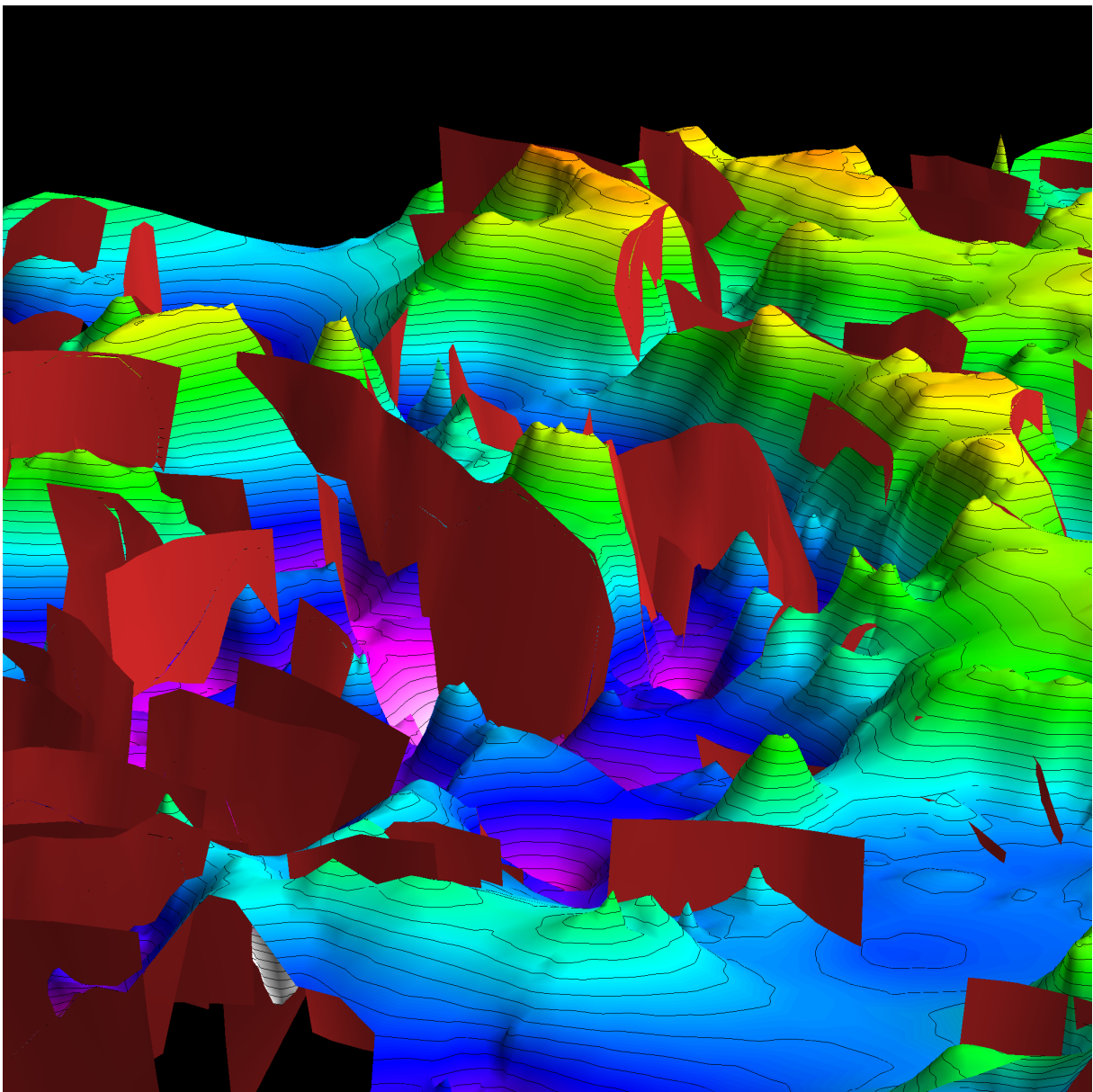


Figure 3. 3D basement architecture and faults (in red) of the Capel and Faust basins study area. The purple and blue colours delineate the base of the depocentres which have been filled with sediments. The green, yellow and orange colours represent the basement highs which border the depocentres.

building, but the comparatively wide spacing of the seismic lines required integration of other datasets to enable 3D surfaces to be generated (figure 1). Interpreted trends in gravity, magnetics and bathymetry datasets, which have a three kilometre line spacing in some areas, assisted in filling in the gaps in seismic coverage. The bathymetry data indicated many of the basin edges, particularly where fault movement is ongoing and has influenced the seafloor morphology. The gravity and magnetic data highlighted the location of basins and how they trend between seismic lines (figure 2). Areas of steep gradients in the gravity and magnetic data (Hackney 2010, Petkovic 2010, Petkovic et al 2011) were extracted as ‘worms’ and by upward continuation to highlight significant subsurface structures, their continuity and the regional structural trends. Maximising information extracted from the available datasets in this way, and their integration in 3D, allowed a robust geological model to be built.

Assessing petroleum prospectivity

The 3D horizon and fault surfaces were iteratively tested and modified as geologic interpretations evolved during the project lifecycle. The final horizon and fault surfaces were then seamlessly integrated to produce a complete 3D geological model (figure 3). This produced a series of horizon surfaces cut by fault surfaces, facilitating the display of the magnitude and sense of fault movement. The geometry of fault surfaces also revealed how the faults evolved over time; for example, faults exhibiting alternating segments of large and small displacement probably formed through the joining of multiple, but initially separate, short faults.

The end product is a 3D geological model that has vastly advanced our knowledge of hitherto poorly understood frontier basins. This model can be used to answer key petroleum prospectivity questions, such as the location of deepest depocentres, the likely location and type of hydrocarbon traps, and the nature of exploration risks. The model and the associated geological interpretations are now available from the Geoscience Australia Sales Centre as Record 2011/01 together with a range of other recently released Records and data products on the Capel and Faust basins (see below).

References

Bradshaw BE (Comp). 2005. Geology and Petroleum Potential of the Bremer Sub-basin, offshore southwestern Australia. Geoscience Australia Record 2005/21. Available at: https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=63730

Colwell JB, Hashimoto T, Rollet N, Higgins K, Bernardel G & McGiveron S. 2010. Interpretation of Seismic Data, Capel and Faust Basins, Australia's Remote Offshore Eastern Frontier. Geoscience Australia Record 2010/06. Available at: <https://www.ga.gov.au/products/servlet/>

controller?event=GEOCAT_DETAILS&catno=69190

Hackney R. 2010. Potential-field data covering the Capel and Faust Basins, Australia's Remote Offshore Eastern Frontier. Geoscience Australia Record 2010/34. Available at: https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70711

Higgins KL, Hashimoto T, Hackney R, Petkovic P & Milligan P. 2011. Building a 3D GOCAD™ Model in offshore frontier basins for prospectivity assessment: Capel/Faust Basins, Lord Howe Rise. Geoscience Australia Record 2011/01. Available at: https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70174

Petkovic P. 2010. Seismic velocity models of the sediment and upper crust of the Capel and Faust Basins, Lord Howe Rise. Geoscience Australia Record 2010/03. Available at: https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=69470

Petkovic P, Lane R & Rollet N. 2011. 3D gravity models of the Capel and Faust Basins, Lord Howe Rise. Geoscience Australia Record 2011/13. Available at: https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=70618

For more information

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Related websites/articles

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www.ga.gov.au/ausgeonews/ausgeonews201009/capel.jsp

AusGeo News 89: Survey of remote eastern frontier basins completed
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