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Geoscience Australia

THE BREMER SUB-BASIN

–a new deepwater petroleum opportunity

The recent completion of Geoscience Australia's Bremer Sub-basin Study heralded the first frontier exploration opportunity under the Australian Government's Big New Oil Program.

Barry Bradshaw and Southern Australian Frontiers Project staff

In 2003, the Australian Government announced the injection of an additional $25 million into Geoscience Australia's petroleum program for new data acquisition and for data preservation and archiving. This boost was followed by the introduction in the 2004 federal budget of tax incentives for exploration in frontier areas.

Geoscience Australia developed a portfolio of potential projects based on integrated programs of seismic acquisition, geological sampling and oil seep detection. Deepwater frontier basins were considered among the most promising candidates and the Bremer Sub-basin was identified as a key frontier area in 2003 (*see AusGeo News* 77). A study commenced in 2004 to determine if it was formed under geological conditions suitable for generating and trapping large volumes of hydrocarbons.

The petroleum potential of this deepwater (100 to 4000 metres) section of the Bight Basin off the southern coast of Western Australia (figure 1) has yet to be tested by exploratory drilling. Previous studies suggested that a series of Middle Jurassic – Early Cretaceous sediment depocentres may contain prospective structures for trapping hydrocarbons (Stagg & Willcox 1991, Bradshaw et al 2003). However, a lack of subsurface geological data, along with the deepwater setting, discouraged exploration for over 30 years.

New datasets

Acquisition of new datasets began in February–March 2004, when Geoscience Australia's Marine Survey 265 collected several hundred subsurface geological samples by dredging a series of submarine canyons that incise up to two kilometres into the sub-basin (figure 1; see Blevin 2005). Samples were analysed to determine age, organic geochemistry and petrographic properties.

A further 1300 kilometres of new seismic data within the sub-basin came from the Southwest Frontiers Survey (S280) of October–November 2004.

Final results of the Bremer Sub-basin Study, incorporating analytical results from dredge sample analyses with seismic interpretations, have recently been released (Bradshaw 2005).

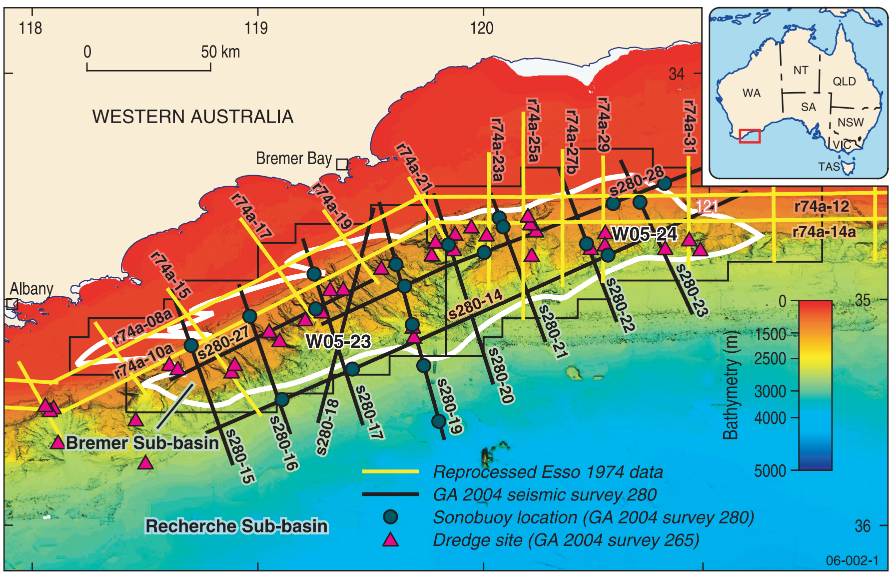
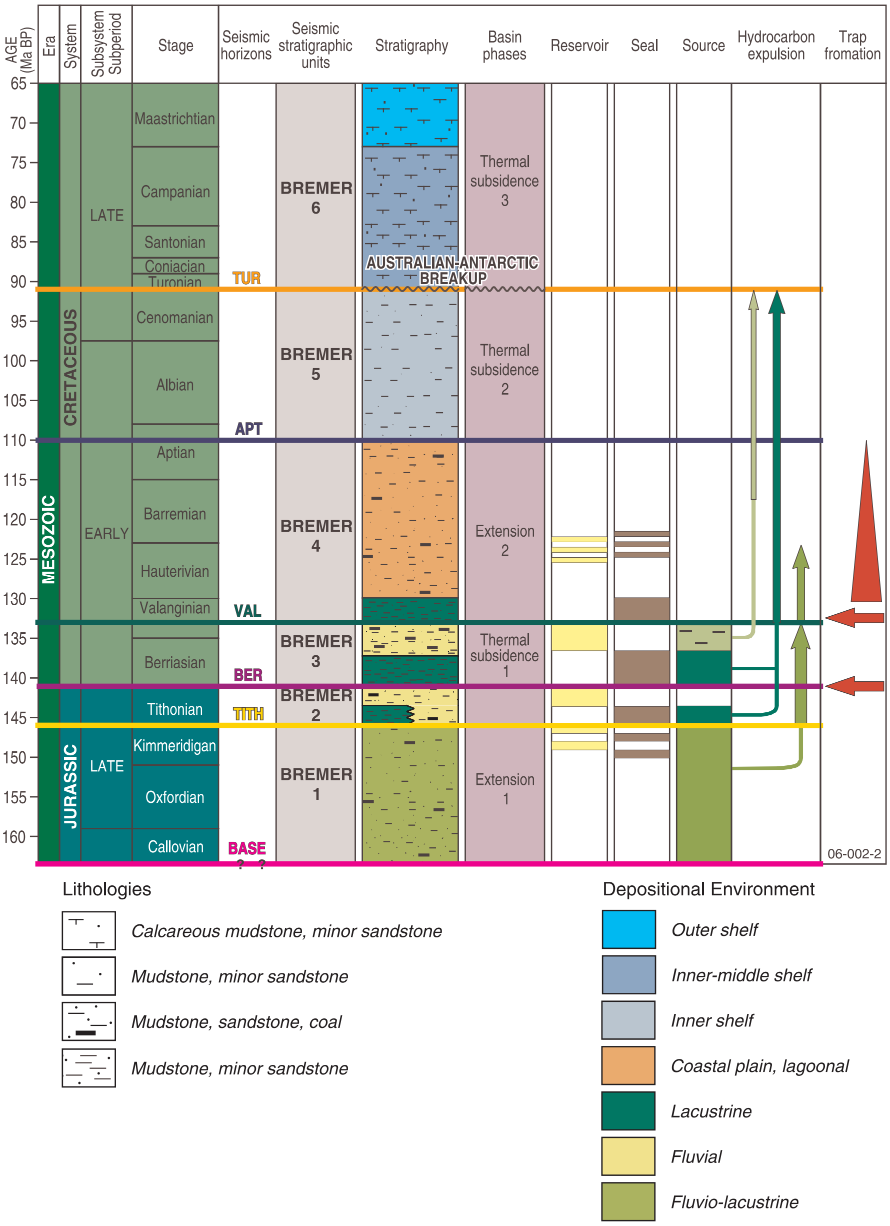


Figure 1. Datasets used in Geoscience Australia's Bremer Sub-basin Study superimposed over a bathymetry image. Also shown are 2005 acreage release areas (closing date 20 April 2006) and the sub-basin's extent.

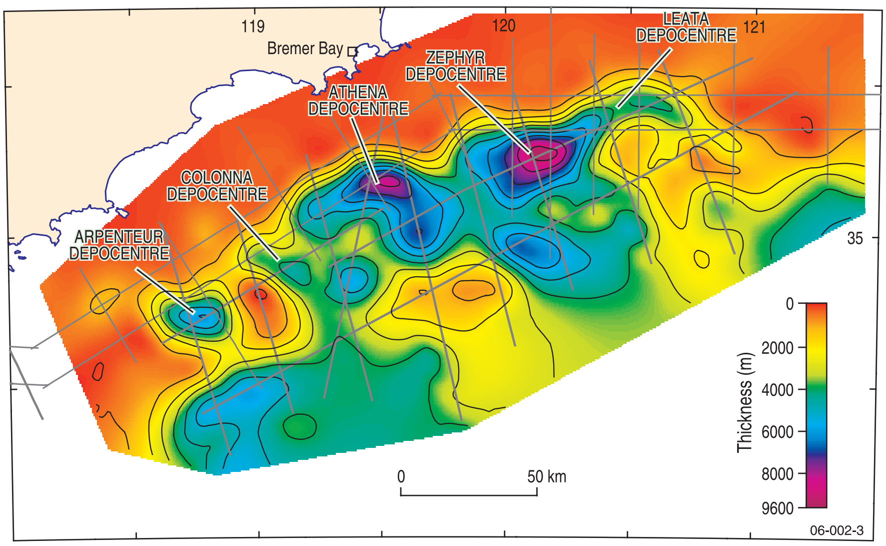
Stratigraphy

The first detailed stratigraphic framework for the sub-basin has been compiled by integrating biostratigraphic and lithofacies data from dredge samples with seismic interpretations. Six seismic stratigraphic units (Bremer 1–6) have been interpreted (figure 2). Most of the basin succession consists of Middle Jurassic – Early Cretaceous sedimentary rocks from the Bremer 1, 2, 3 and 4 units, deposited in ancient rivers and lakes during rifting between Australia and Antarctica. Middle–Late Cretaceous and Cainozoic marine sedimentary rocks are also present, but form only a relatively thin (generally less than one kilometre) stratigraphic section.

Particularly important for petroleum exploration is a series of three major cycles of lacustrine and fluvial sedimentation in the Bremer 2, 3 and 4 units. These cycles provide key petroleum system elements: organic-rich source rocks to generate hydrocarbons, and sandstones overlain by thick mudstones that could reservoir them (figure 2).



▲ **Figure 2**. Stratigraphy and petroleum system elements of the Bremer Sub-basin.



▲ **Figure 3.** Total sediment thickness map highlighting the main sediment depocentres in the Bremer Sub-basin.

Petroleum systems

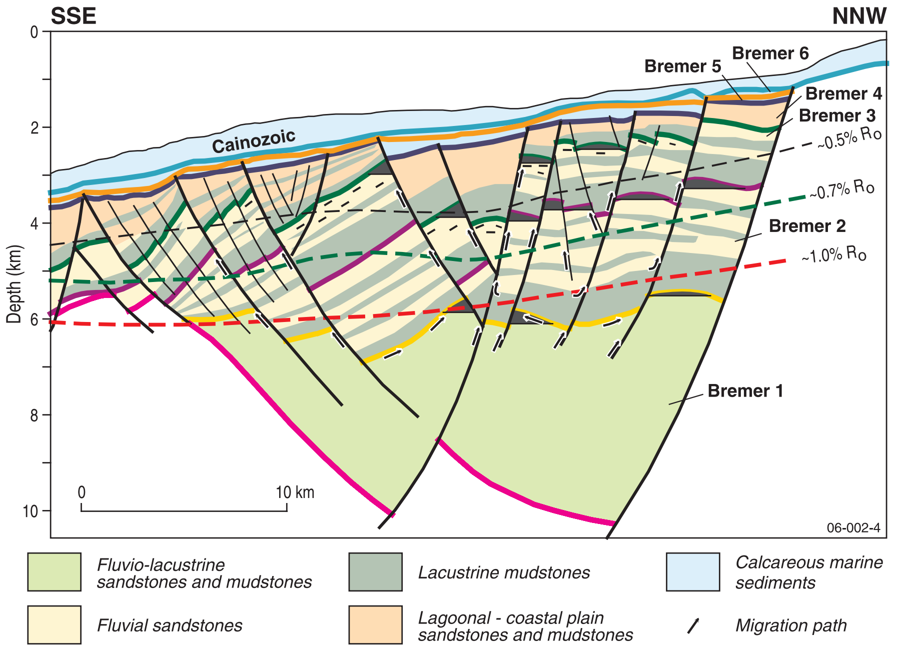
One-dimensional burial history modelling (using pseudo-wells located in the main sediment depocentres) indicates that four source rock intervals have the potential to generate and expel hydrocarbons (figure 2). Fluvial–lacustrine mudstones from the Middle–Late Jurassic Bremer 1 unit are generally gas prone, with their main phase of hydrocarbon expulsion modelled to occur during the Tithonian–Berriasian, before most structures formed in the sub-basin. Lacustrine mudstones at the base of the Bremer 2 and Bremer 3 units have good potential to generate oil and gas, with their main phase of hydrocarbon expulsion modelled to occur during the Valanginian–Cenomanian, about the same time that most traps formed.

Coaly source rocks at the top of Bremer 3 unit—in the thickest basin sections from the central sub-basin—had potential to generate and expel hydrocarbons during the Barremian–Cenomanian, following trap formation. Evidence for hydrocarbon generation in the sub-basin includes several dredge samples with trace oil inclusions identified by fluid inclusion analysis, and fluorescing oil observed in the sedimentary matrix during vitrinite reflectance fluorescence analysis.

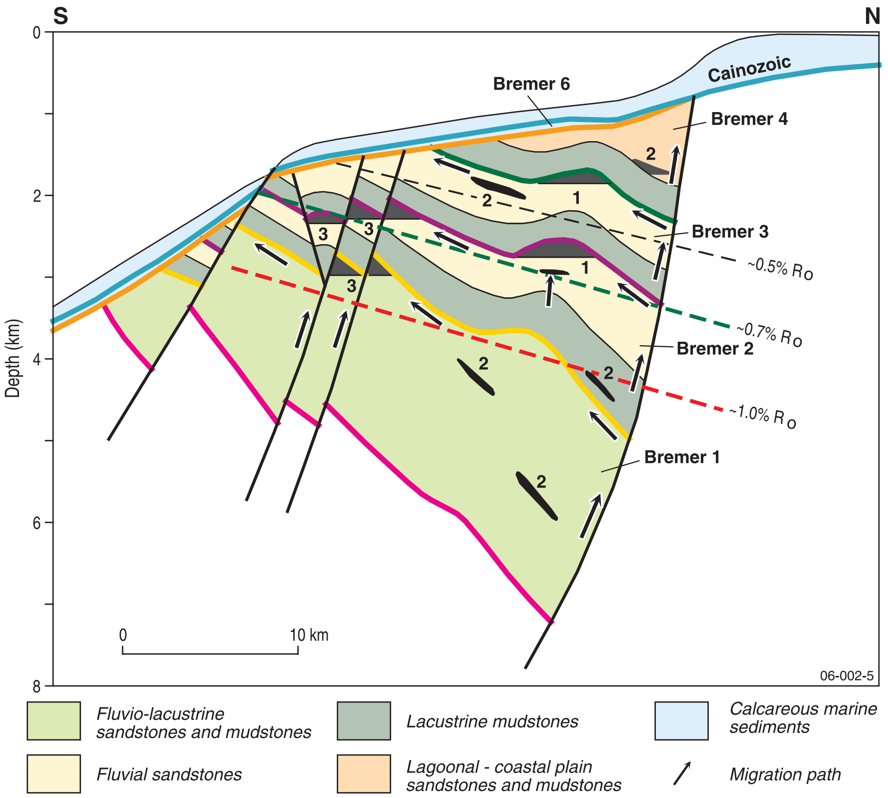
Structures and traps

The Bremer Sub-basin is characterised by a series of five main sediment depocentres that developed during rifting between Australia and Antarctica in the Middle–Late Jurassic. An extensive area over which hydrocarbons could have been generated is located in the Athena and Zephyr depocentres in the central part of the sub-basin, where sediments are 4 to 9.5 kilometres thick (figure 3). Here, the main exploration targets are fault blocks in water depths from 1000 metres to over 2500 metres. The blocks formed during the Valanginian–Aptian, and have the potential to trap around 250 million barrels of oil in place (figure 4). The main risk for exploring these structures is that many faults reactivated during Late Cretaceous break-up, which could have resulted in leakage of hydrocarbons.

Smaller half graben containing four to five kilometres of sediments occur in the Arpenteur, Colonna and Leata depocentres in the western and eastern parts of the sub-basin (figure 3). The main exploration play in these depocentres is large anticlinal structures that formed during the Valanginian–Aptian and have the potential to trap 500 million barrels of oil in place (figure 5). The main risk for exploring these structures, which are in water depths of 500 to 800 metres, is whether enough hydrocarbons were generated from underlying source rocks after the anticlines had formed.



▲ **Figure 4.** Schematic cross-section and play diagram for the Zephyr depocentre, highlighting potential fault block traps.



▲ **Figure 5.** Schematic cross-section and play diagram for the Arpenteur and Leata depocentres (1 = anticlinal traps; 2 = combined structural and stratigraphic traps; 3 = fault block traps).

Acreage release

Historically, the largest hydrocarbon fields have usually been discovered early in the exploration of a petroleum basin. Acreage release blocks in the Bremer Sub-basin provide an opportunity to use these new datasets and interpretations, take advantage of the 150% tax uplift for frontier exploration, and drill the largest prospects in a potential new oil province.

Two designated frontier blocks covering the full extent of the Bremer Sub-basin (W05-23 and W05-24) were included in the Australian Government's 2005 acreage release gazettal (figure 1). These blocks are close to existing onshore infrastructure, including the established port of Albany and a gas pipeline at Esperance. The closing date for submission of work program proposals is 20 April 2006.

The complete seismic coverage of the Bremer Sub-basin is now available from the Geoscience Australia Data Repository at the cost of transfer (phone +61 2 6249 9222, email ausgeodata@ga.gov.au).

References

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