Basement influences on structural styles in the Bremer and Eyre Sub-Basins, southern Australia

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SUMMARY

The Bight Basin on the southern margin of Australia is nearly 2000 km wide from west to east and overlies a number of different basement terranes (Figure 1). Major basement terrane divisions occur between the basement of the Ceduna delta and the Eyre and Bremer sub-basins, resulting in changes in structural styles in the overlying basin successions.

The Eyre Sub-Basin overlies the boundaries of the Proterozoic Madura and Coompana basement provinces, which are separated by the Mundrabilla shear zone. The shear zone is a N-S trending, continent-wide structure visible in magnetic data which appears to extend offshore in the Eyre Sub-Basin and is also visible as a north-trending present-day fault scarp in the onshore Eucla Basin. Seismic data interpretation suggests that the shear zone steps to the east in the region of the Jerboa-1 well. Differential movement across the shear zone during Jurassic-Cretaceous rifting may have influenced the location of depocentres within the Eyre Sub-Basin.

Overlying the Albany Fraser Orogen's northern foreland, the Bremer Sub-Basin is dominated by WSW-ENE trending half graben structures and large rollover anticlines associated with Jurassic-Cretaceous rifting. The basin is divided by a N-S trending basement structure, visible in gravity data, and in the overlying sedimentary succession as a broad zone of subsidence with several periods of reactivation. Similarities between this structure and the shear zone in the Eyre Sub-Basin suggest they may have a similar origin.

Key words: Bight Basin, basement, Eyre Sub-Basin, Bremer Sub-Basin, structure.

INTRODUCTION

The Bight Basin is a frontier petroleum province on Australia's southern margin. It evolved through several phases of extension related to rifting during the Middle Jurassic to Late Cretaceous (Totterdell and Bradshaw, 2004). The Bight Basin contains a number of sub-basins, of which the Ceduna Sub-basin is the primary current focus for exploration. Considerably less exploration interest in the western part of the Bight Basin means that these areas are comparatively less understood. This study focuses on the Eyre and Bremer sub-basins, offshore Western Australia (Figure 1). One exploration well, Jerboa-1, was drilled in 1980 in the Eyre Sub-basin, and was found to have a breached hydrocarbon column. No wells have been drilled in the Bremer Sub-basin.

The influence of pre-existing basement structures on Australia's southern margin has been long established (Gibson et al., 2013; Totterdell & Bradshaw, 2004); however a paucity of data in the western part of the Bight Basin means that only general trends are recognised. New onshore interpretations of terranes within the Albany-Fraser Orogen (Spaggiari et al., 2015) have been extended offshore and can provide insight into changes in structural styles observed in the overlying basin successions. Basement structures have been shown to control the position of ocean fracture zones in the eastern part of the Bight Basin (Gibson et al., 2013), and are likely to have a similar influence in the western Bight Basin.

RESULTS

This study uses time-migrated regional 2D seismic surveys across the Eyre and Bremer sub-basins with line spacing of 10 – 20 km. Regional magnetic and gravity datasets were used to correlate the interpretation of offshore basement structures with onshore structural trends. .

Terrane boundaries in the onshore portion of the southern margin of Western Australia have been considerably refined in recent years (e.g. Spaggiari et al., 2015), and many terrane linkages between Australia and Antarctica have been proposed (e.g Fitzsimons, 2003; Jacob & Dyment, 2014), yet the extension of these boundaries immediately offshore is poorly constrained. We have used a combination of potential field and seismic data to suggest offshore continuation of several N-S trending basement structures, including the Mundrabilla Shear Zone and an un-named structure in the Bremer sub-basin.

The Bremer Sub-basin contains a southerly-dipping rift border fault system which changes orientation along-strike from E-W to ENE-WSW (Totterdell et al., 2014). This change in orientation occurs directly south of a N-S trending basement fault interpreted onshore, and extended offshore through interpretation of gravity data (Spaggiari et al., 2013). On seismic data, a N-S trending zone of subsidence in the basin succession suggests transtensional reactivation of this basement fault during rifting. A similar structure is observed in the Eyre Sub-basin, about 100 km east of the position where the N-S trending Mundrabilla Shear Zone would be expected to extend offshore. Location of the Bremer and Eyre Sub-basins appears to be strongly controlled by the presence of these pre-existing basement structures.

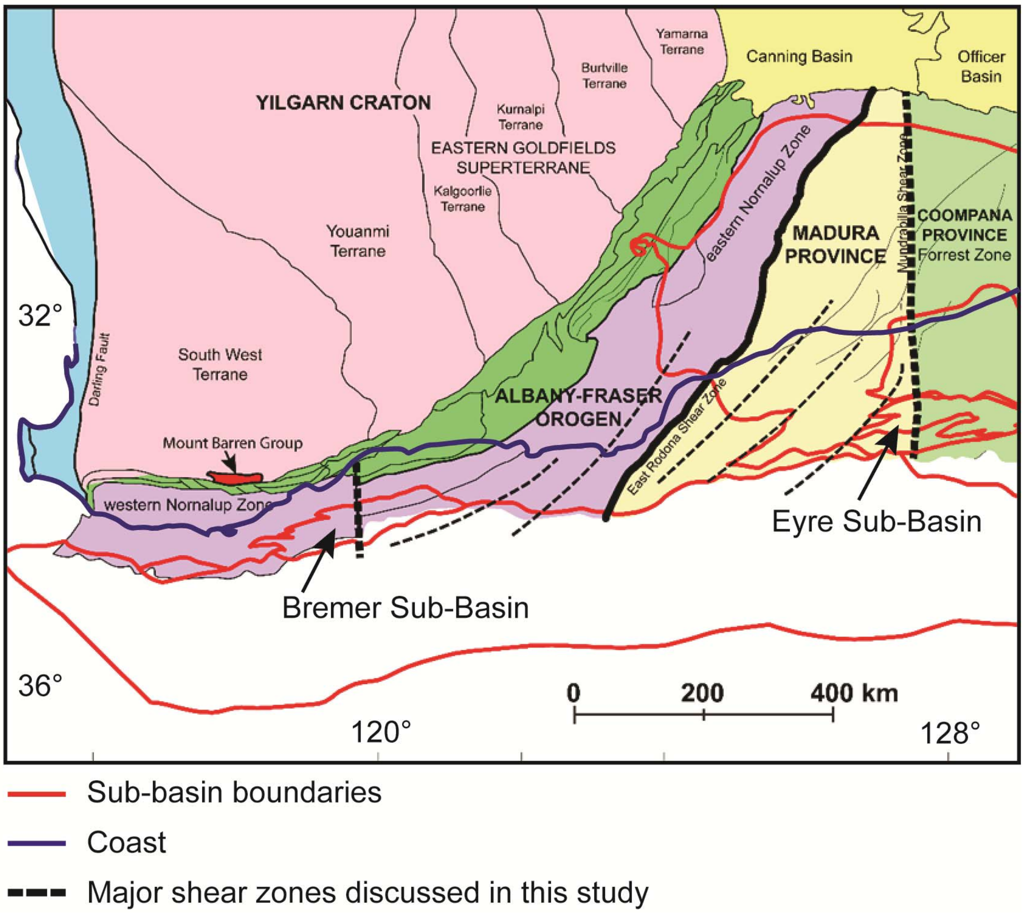

Figure 1: Location of the Bremer and Eyre Sub-Basins, underlying terrane boundaries extended offshore, and major shear zones discussed in this study. Modified from Spaggiari et al. (2015) and Totterdell and Bradshaw (2004).

CONCLUSIONS

Basement terrane boundaries underlying the western portion of the Bight Basin are poorly constrained and not well imaged in seismic data. A new interpretation which integrates the interpretation of regional seismic and gravity data from the Eyre and Bremer sub-basins suggests that N-S trending basement structures were reactivated during Jurassic-Cretaceous rifting and controlled the location of depocentres.

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