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Stratigraphic and structural architecture of the deep-water Otway Basin — implications for frontier hydrocarbon prospectivity

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Stratigraphic framework and structural architecture of the Upper Cretaceous in the deep-water Otway Basin — implications for frontier hydrocarbon prospectivity

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Otway Basin regional seismic mapping

Geoscience Australia has undertaken regional seismic mapping of the offshore Otway Basin, including the frontier deep-water region. With emphasis on the Upper Cretaceous, the Shipwreck and Sherbrook supersequences and faults were mapped across the offshore Otway Basin, building on the regional sequence framework of Krassay et al. (2004), Romine et al. (2020), Schenk et al. (2021). Seismic interpretation spans 18 000 line-km of new and reprocessed data collected in the 2020 Otway Basin seismic program (Lee et al. 2021) and over 40 000 line-km of legacy 2D seismic data (Fig 1a). The supersequences were tied to eighteen wells with reference to updated well biozonations (MGPalaeo 2020).

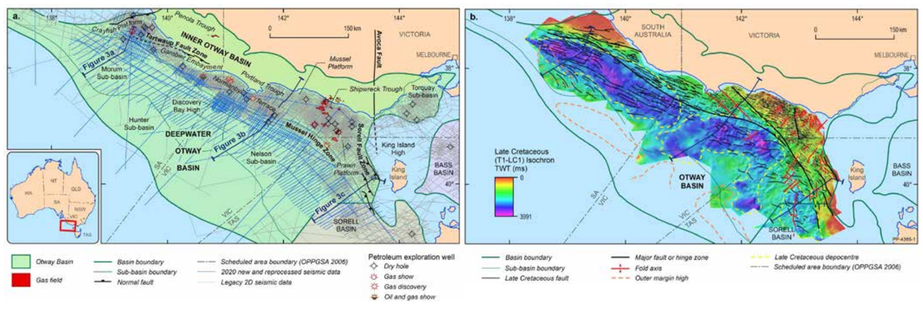

Fig. 1. (a) Structural elements map of the Otway Basin showing the 2020 new and reprocessed seismic data, legacy 2D seismic data, petroleum wells and fields, and the locations of Figure 3 seismic transects. (b) New structural observations overlying the Late Cretaceous (Turonian–Maastrichtian) isochron. Faults on the SE inboard platform areas are sourced from Romine et al. (2020).

Supersequences and depocentres

The Shipwreck Supersequence (Figs 2f and 3, Turonian–Santonian) thickens outboard into depocentres in the Morum and Nelson sub-basins. The Sherbrook Supersequence (Figs 2e and 3, Campanian–late Maastrichtian) also thickens outboard into a Morum Sub-basin depocentre (Fig. 3a) and a thinner depocentre across the southern Nelson Sub-basin (Fig. 3b). Together, the Shipwreck and Sherbrook supersequences form a contiguous Upper Cretaceous depocentre in the deep-water Otway Basin (Figs 1b and 2d) of up to 3 900 ms TWT.

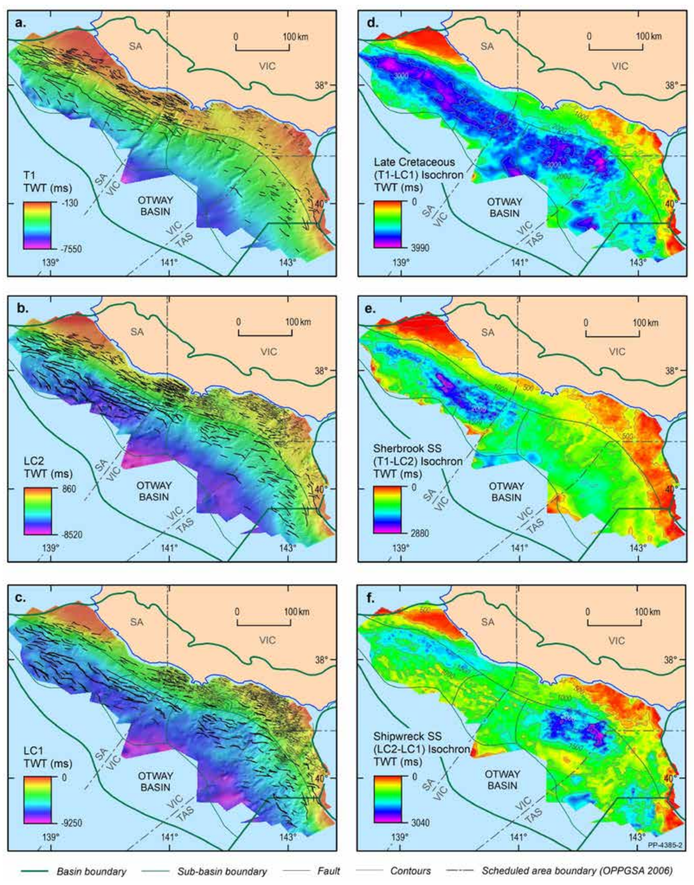

Fig. 2. Seismic horizon structure and isochron maps. Faults on the SE inboard platform areas are sourced from Romine et al. (2020). (a) T1 (base of Maastrichtian–Lutetian Wangerrip Supersequence) structure surface. (b) LC2 (base of Campanian–Maastrichtian Sherbrook Supersequence) structure surface. (c) LC1 (base of Turonian–Santonian Shipwreck Supersequence) structure surface. (d) Upper Cretaceous (LC1–T1, Turonian–Maastrichtian) isochron. (e) Sherbrook Supersequence isochron (T1-LC2). (f) Shipwreck Supersequence isochron (LC2-LC1).

Fault architecture

Fault orientations range from NW–SE in the outboard northwest to WNW–ESE/NW–SE in the outboard southeast, to NNW–SSE in the far southeast (Figs 1 and 2a–c). In deep-water areas, fault growth is predominantly accommodated in the Sherbrook Supersequence in the west and the Shipwreck Supersequence in the east (Figs 2 e–f and 3a–c), showing a westerly shift in the focus of synrift deposition. To the northwest, listric faults detach within the Eumeralla Supersequence (Fig. 3a) while in the southeast, extensional fault growth is dominated by crustal-scale faults stepping down from the outboard platform edges, contributing to Shipwreck and Sherbrook thickening (Figs 3b–c).

Folding

Southerly plunging NE–SW oriented folds have been mapped across the Mussel and Prawn platforms, and to the south in the deep-water region (Fig 1b). In the far southeast, northerly trending folds associated with major faults in the Sorrell Fault Zone exhibit uplifted hanging-wall anticline geometries that indicate inversion (Fig. 3c). In the Normanby Terrace and Portland Trough a large-scale anticline-syncline pair trends NW–SE parallel, to the edge of the Mussel Platform (Figs 1b and 3b).

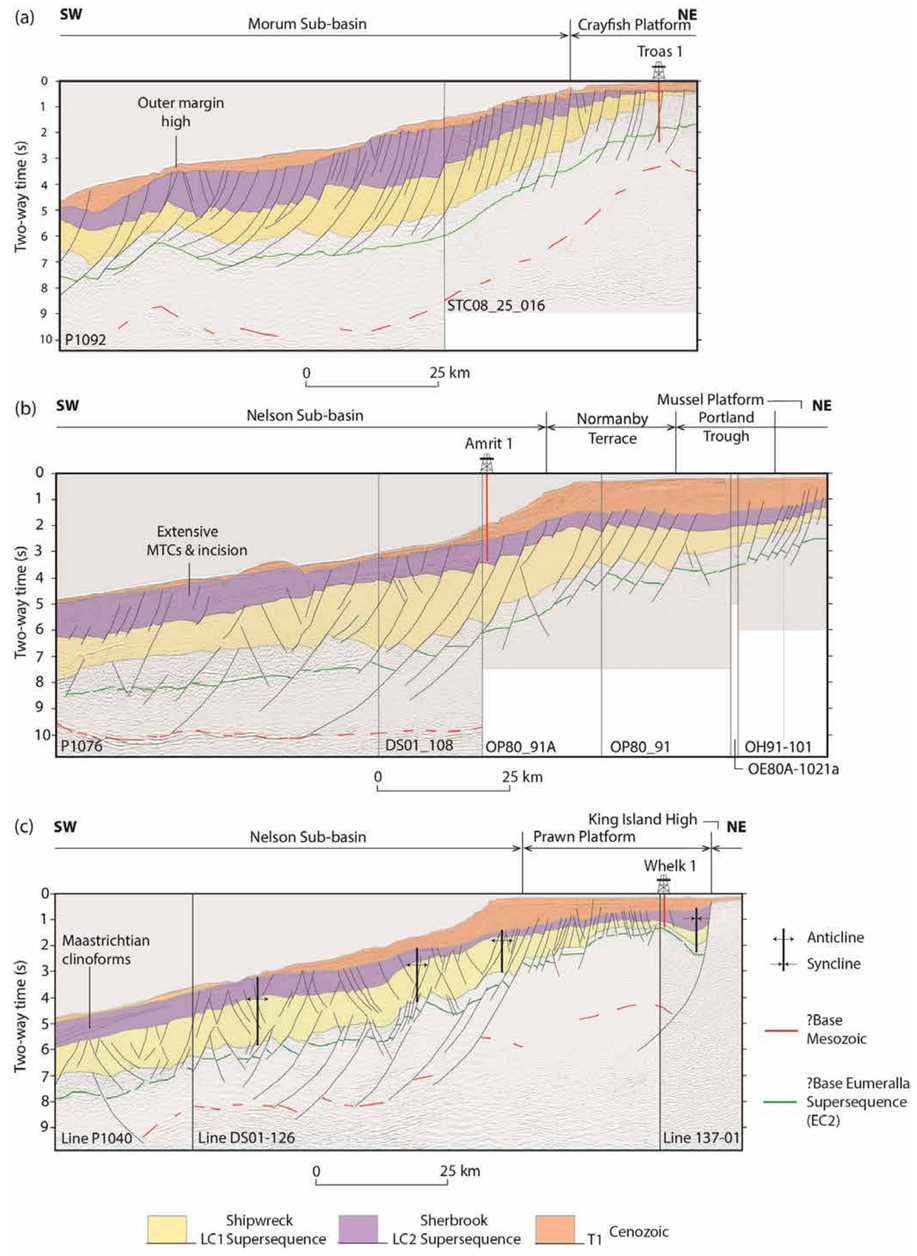

Fig. 3. Seismic transects (see Fig. 1. for locations). (a) Showing outboard listric faulting detaching in the Eumeralla Supersequence and prominent outer margin high. (b) Showing folding, Shipwreck and Sherbrook supersequence sediments thickening into a growth-wedge outboard of the platform edge, and a zone of mass transport complexes within the Sherbrook Supersequence. (c) Showing uplifted hanging-wall anticlines above crustal scale faults that offset the base-Mesozoic reflector, and Sherbrook clinoforms.

Discussion

- This work highlights the need for a detailed review of previously recognised structural elements across the offshore Otway Basin and implementation of updates to exisiting data sets. For example, the Discovery Bay High (Fig. 1a) is a zone of thin sedimentation separating Shipwreck Supersequence depocentres rather than a complex NNE-SSW oriented structural high, as depicted by previous workers.
- Shipwreck depocentres are bounded to the north and east by the Tartwaup and Mussel hinge zones (Fig. 2f), while the Sherbrook depocentre in the Morum Sub-basin is bounded to the northeast by the Normanby Terrace (Fig. 2e), emphasising both the southward and westerly shift in extensional regime between these supersequences.
- Petroleum systems modelling (Schenk et al. 2021) indicates that the Austral 3 (i.e. Upper Cretaceous) system has the potential to generate hydrocarbon accumulations in the deep-water part of the basin. Observations presented here have implications for the modelling of this system.
- Structure surfaces and isochrons produced in this study are available for download from Geoscience Australia's product catalogue website and via QR code.

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Acknowledgements

Tom Bernecker and Victor Nguyen reviewed this poster. Bianca Reese drafted Figs 1 & 2. This poster is published with the permission of the CEO, Geoscience Australia.

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