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BOOK OF ABSTRACTS

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Sequence Stratigraphy of the Eastern Warburton Basin, South Australia

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SUMMARY

The Cambrian Eastern Warburton Basin (Warburton) underlies the bulk of the hydrocarbon producing Permian Cooper Basin in South Australia. The Warburton, like the Cooper Basin, is hydrocarbon bearing with a significant catalogue of hydrocarbon shows recorded from a wide variety of lithologies and stratigraphic intervals. Understanding therefore, the stratigraphic context of hydrocarbon occurrences is critical to unlocking this basin's prospectivity. It is in this context that this seismic-based stratigraphy study (part of a larger Warburton Basin prospectivity project) has been conducted. The key results are:

- The oldest three Warburton sequences fill deep basins with extensive highstand platform carbonates, with lowstand incised valleys and a submarine fan These sequences underwent major uplift and erosion, with the succeeding sequences onlapping their western edge, their depocentres having moved east.
- The fourth sequence has similar highstand platform carbonate fill over basinal muds.
- The youngest Warburton unit is a shallow water succession of highstand shelf sands and silts with some tidal deltaics, interfingering seaward with platform carbonates. Lowstand incised valleys are present at the base and top of this unit.

There are both intrusive and extrusive igneous facies, some of which are coeval to the shelf deltaic facies. These igneous units also intrude (and extrude into) the Permian, Jurassic and younger sediments.

Key Words: Warburton, Carbonates, Igneous, Incised Valleys.

INTRODUCTION

The Cambrian Eastern Warburton Basin (>36,000km2) underlies the bulk of the Permian Cooper Basin in South Australia. Very little seismic work has been published on the basin and there are only about 50 wells that have penetrated Cambrian strata. Of these wells, only 8 have appreciable Cambrian thickness (>200m), with all located a considerable distance from the Area of Interest (AOI)-see Figure 1.

Cores from 35 wells were interpreted regarding depositional environment (DE) and gross depositional environment (GDE) whereby results were integrated with wireline and seismic interpretations.

Of the 55 wells used in this study only 22 had velocity surveys so a regional curve had to be calculated to fit the remaining wells to the seismic T. Rady et al, (2025) *in press*. There is a published stratigraphic column for the Warburton Basin with two papers (Abdullah et al, 2019 and Drexell and Preiss, 1995) having Cambrian chronostratigraphic cross sections through parts of the basin. The result of this current study questions the validity of these published data.

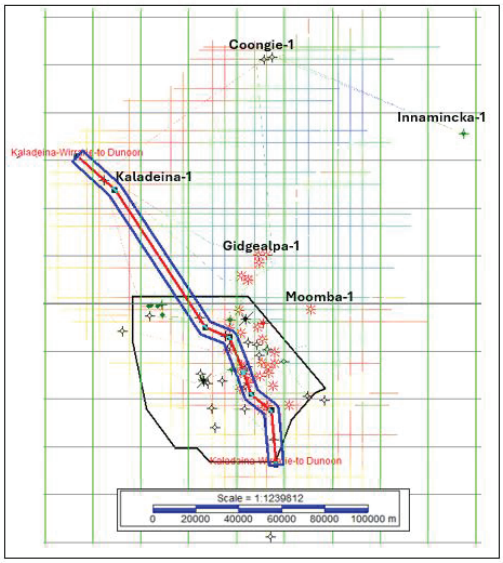

Figure 1-Warburton Basin study area with the AOI (outlined in black) showing the Daralingie Shelf prospectivity focus region. The blue line illustrates a key regional seismic section discussed later in this abstract. Note: all the wells named (above) were used in this stratigraphic study.

METHOD AND RESULTS

Figure 1 shows the seismic picking density (100IL by 100XL) from the whole-of-basin pseudo 3D grid (constructed from 2D and 3D surveys), in all 50,000 line kilometers were interpreted.

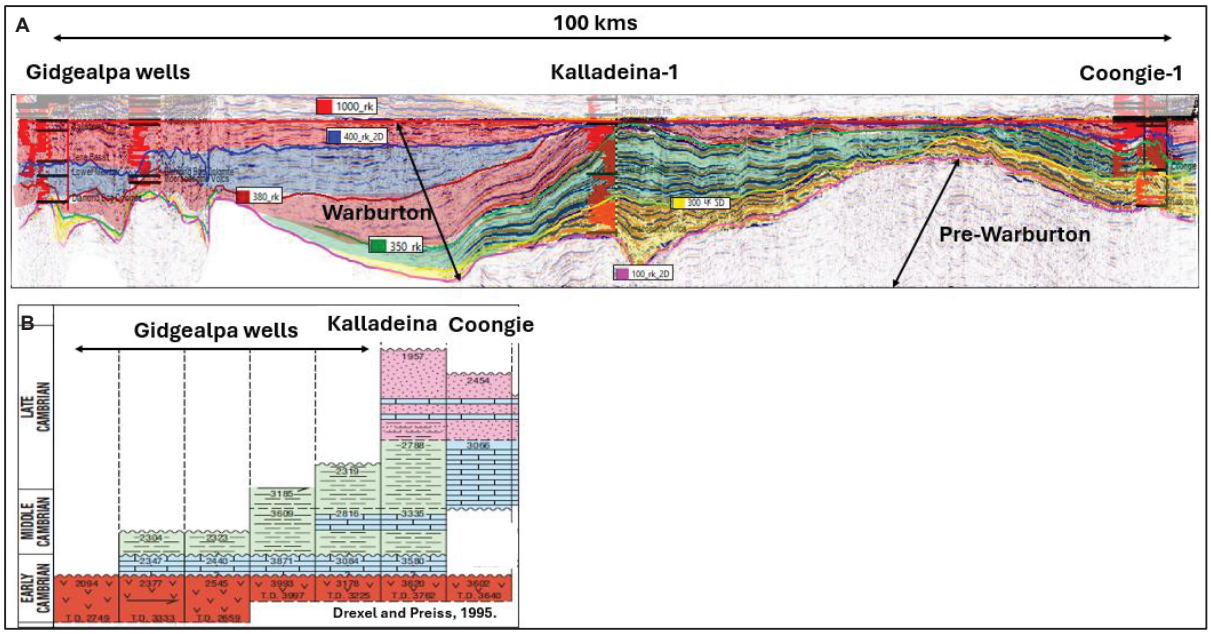

Figure 2 A) Gidgealpa-Kalladeina-Coongie interpreted seismic line with interpreted units-datumed on top Warburton. B) published (Drexel and Preiss, 1995) chronostratigraphy of the Eastern Warburton basin.

The blue line of section (Figure 1) represents the arbitrary seismic line through key wells to create a new chronostratigraphic section ("Wheeler Diagram") for the (Daralingie Shelf) area-Figure 4.
The seismic line of Figure 2 (A) shows the five sequences interpreted in this study. Note the older units are in Kalladeina and Coongie with much younger units in the Gidgealpa wells. This is the opposite to what is reported in the published (Drexel and Preiss, 1995) chronostratigraphic chart of Figure 2 (B). Figure 3 shows the seismic facies variations of the oldest interval, near Kalladeina-1. The oldest four sequences are deepwater basins each with extensive highstand platform carbonates (high amplitude and continuity). This oldest unit has a lowstand submarine fan with associated incised valleys. The oldest rocks in this first sequence are the Mooracoochie Volcanics-a thin package that onlaps within 20 kms onto the edge of the basin. It is proposed that carbonate

interval formation names from oldest to youngest be so named; Lower Kaladeina Limestone, Upper Kaladeina Limestone, Diamond Bog Dolomite and Gidgealpa Limestone (see Figure 4).

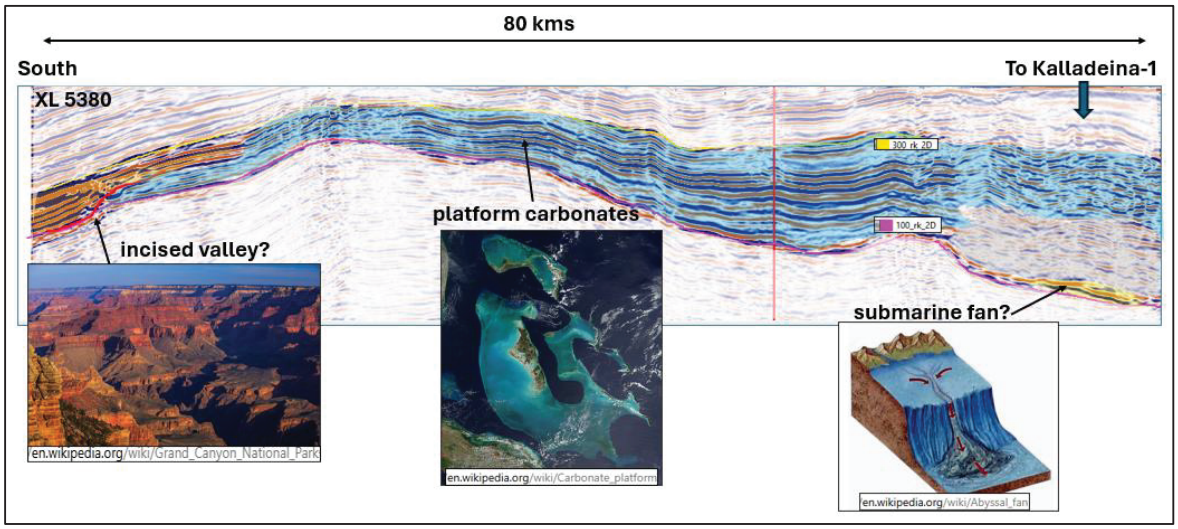

Figure 3-seismic facies character of the oldest Warburton sequence with analogue environments.

Major uplift and erosion took place at the end of the third sequence, with the depocentres of the fourth and fifth sequences moving to the east. The fifth and youngest sequence has good well control, including cores. whereby tidal delta and shelf sands of the Pando Formation and shelfal silts and muds of the Lycosa Formation interpreted. These shelf siliciclastics interfinger seaward with carbonate platforms-as seen in Koree South-2 and the Gidgealpa wells. Several wells/cores intersected igneous lithologies (generally airfall), often misnamed “Mooracoochie Volcanics,” (which are much older). Furthermore, occasional small mounded seismic facies are interpreted as volcanoes, out of which the tuffs emanated. Some basalts are also imaged, including their intrusive sill feeders. Additionally, the Big Lake Suite of granites are poorly imaged on the seismic, possibly due to their narrow, column-like, nature. The results of this study have placing these varied lithologies and depositional environments (and associated hydrocarbon shows) into stratigraphic context with Figure 4 illustrating the results of this work.

Figure 4 (upper) shows the seismic horizons through wells from the blue line on Figure 1. Figure 4 (lower) is a sketch chronostratigraphic section (or “Wheeler Diagram”) made using the seismic line. We can consider the seismic to be in “depth units” and the chrono diagram to be in “arbitrary” time units. The time aspects are not taken from any isotope or biological dating-purely from onlaps and truncations with some knowledge of time gaps, such as between top Cambrian and base Permian. Also, several igneous intrusives and extrusives have been mapped and are shown schematically on the figure.

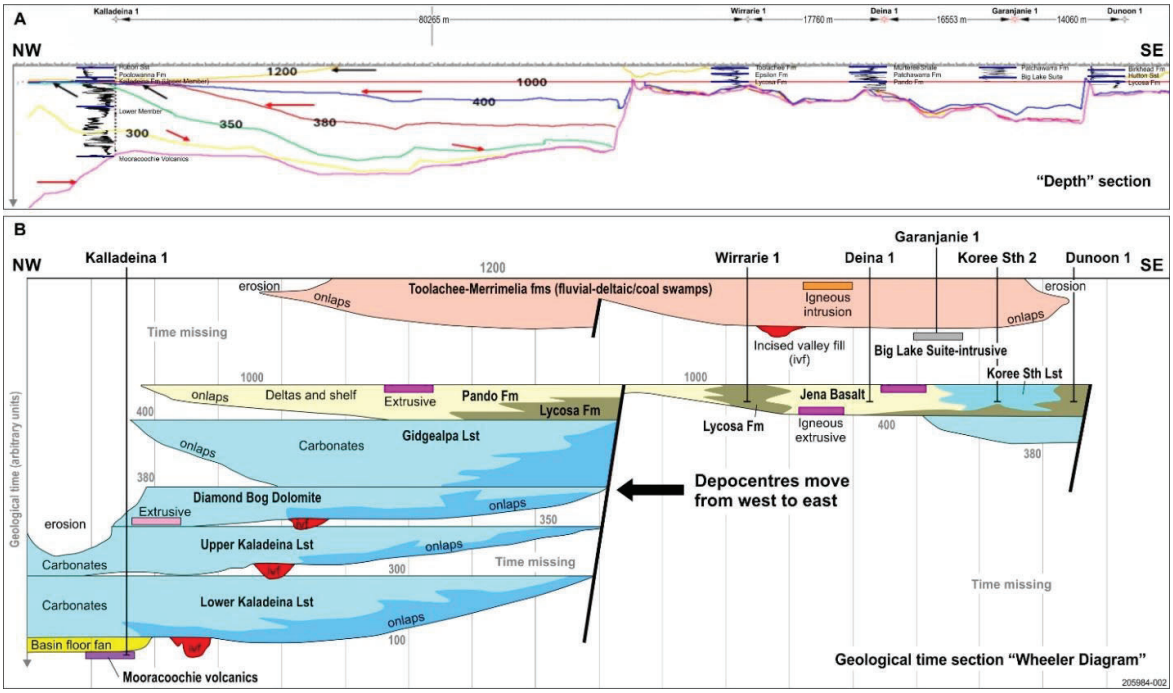

Figure 4-A) Type section Warburton Basin showing seismic horizons and (B) resulting chronostratigraphic section ("Wheeler Diagram").

CONCLUSIONS

The Eastern Warburton Basin is made up of at least five sequences. The oldest four have extensive highstand platform carbonate platforms with occasional basal lowstand incised valleys and one submarine fan candidate. The fifth and youngest sequence is characterised by shelf sands and tidal deltas of the Pando Formation and finer grained facies of the Lycosa Formation. There are some volcaniclastics coeval to the Pando Formation and they have been often misnamed as Mooracoochie Volcanics which are only present in the oldest sequence. There is good evidence for igneous intrusions and extrusions of various ages, including up to the near surface. These may warrant further study as there are implications for hydrocarbon maturity/generation as well as for hydrothermal fluid occlusion of porosity and permeability.

Conflicts Of Interest And Declaration Of Funding

No conflicts of interest exist between these authors and any other person or organisation. No funding from external organisations was received for this project.

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