Stratigraphic Correlation of Devonian Sequences of Northwestern Darling Basin, New South Wales, Australia

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Abstract— **The study is focused on the Northwestern part of the Darling Basin, and deals with a Stratigraphic correlation. This study involves correlation of the regional stratigraphy in the Darling Basin of western New South Wales that results from deformation of the Devonian sequences. The interpretation based on well logs and lihological data. Integrating well and lithological data to correlate the sequence stratigraphic units, using sequence stratigraphy approach are the main goals of this study. Analyses of lithostratigraphic units from well-logs and lithology data were used to develop a stratigraphic correlation of the northwest Darling Basin. The stratigraphic boundaries of the intervals were defined at marked changes in well-log characteristics and lithology information. Correlation of three wells in the northwestern part of Darling Basin allowed correlation and chronostratigraphic subdivision of Devonian sediments. The lithofacies of three wells Bancannia North-1, Bancanna South-1 and Jupiter-1 have been identified from northwest to southeast. The lithofacies dominated by sandstone and shale sediments mostly in Lower to Middle Devonian age, red sandstone, porous sandstone and shale lithofacies (red beds) of Middle to Upper Devonian sediments. Three stratigraphic units were identified based on well logs characteristics and lithofacies namely A, B and C.**

Index Terms— **stratigraphiy, Darling Basin, stratigraphic correlation, sequence stratigraphy, Devonian sequences, lithofacies.**

I. Introduction

The Darling Basin covers an area of over 100 000 km2 and contains at least four sub-basins and three troughs containing up to 8000 m of mainly clastic sediments that ranges in age from Precambrian to Late Palaeozoic , deposited in a wide range of environments (Alder et al 1998). The Darling Basin is the largest onshore basin in New South Wales and one of the largest in Australia. The Darling Basin is bounded to the west by the Broken Hill Block; to the north by a major subduction zone associated with the Thompson fold belt and to the east by the Cobar Basin (Figure1). To the south its boundary with the Stawell terrane, overlying Tertiary–Cretaceous Murray basin (Pearson 2003). The present day architecture of the Darling Basin appears to be principally the result of structural deformation and erosion. The Darling Basin contains a number of distinct structural depressions. The Darling Basin represents one of the major frontier basinal regions of onshore Australia.

The stratigraphic correlation of Devonian sequences forms the basis for the current study, which focuses on the Northwestern Darling Basin. The study presents evaluation of the regional stratigraphy in north western part of the Darling Basin, western New South Wales, based mainly on well logs, data and information from cutting samples. The study is focused on the Bancannia trough in the Western part of the Darling Basin, and deals with a Devonian sequence.

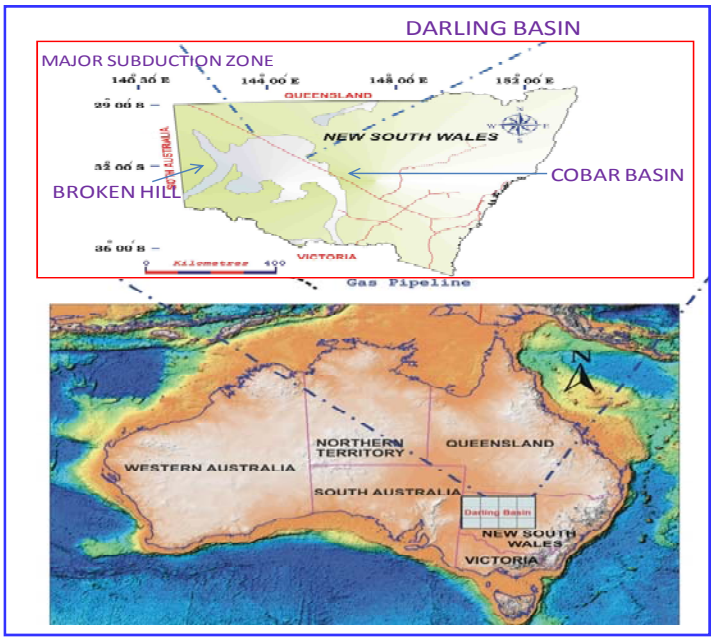

Figure. 1. Darling Basin location (modified after Parson)

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II. DEVONIAN STRATIGRAPHY

The Devonian stratigraphy of the Darling Basin has been summarised by Bembrick (1997), Alder et al. (1998) and Willcox et al (2003), and consists of three main tectonostratigraphic units – the Winduck, Snake Cave and Ravendale Intervals – separated by regional unconformities mapped as horizons A, B and C (after Evans, 1977). Horizon A correlates to the base of the rift section, Horizon B to Early Devonian top of the rift section and Horizon C to the Tabberabberan Orogenic event (Figure 2).The upper Silurian to Lower Devonian strata include the Mt Daubeny Formation in the western part of the basin, (Neef, 2003; Bembrick, 1997). Bembrick (1997) and Alder et al. (1998) used three seismic horizons, originally described by Evans (1977), to divide the stratigraphic sequence of the Darling Basin into three informally named 'Intervals,' as an initial reference framework to describe the strata in this poorly exposed and sparsely drilled area. These intervals (Figure 2) are equivalent to the main lithostratigraphic units identified from outcrop studies, but are defined on the basis of seismic marker horizons rather than lithologic criteria. The current study using Bembrick (1997) stratigraphic nomenclature.

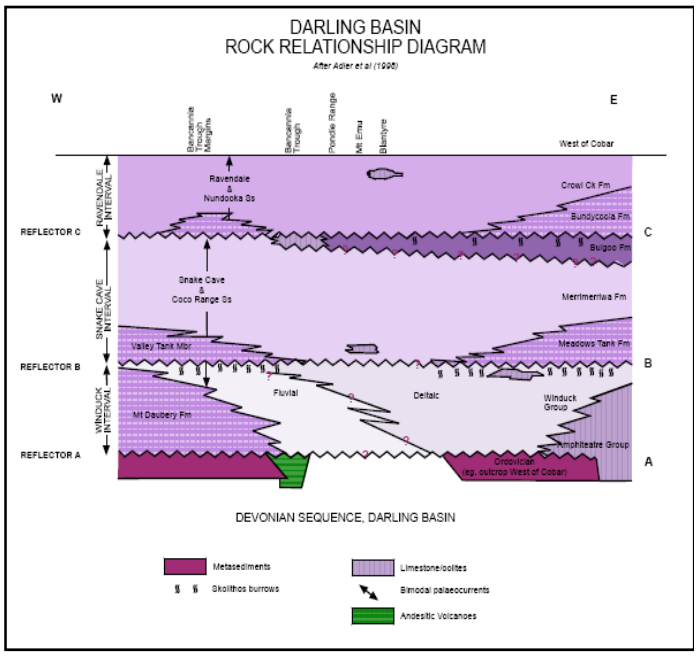


Figure. 2. Main stratigraphic units of Devonian stratigraphy (Bembrick 1997)

III. STUDY AREA

The study area is the Northwestern part of the Darling Basin as shown in Figure 3 consists of Bancannia trough and Scopes Range, which containing mostly sediments up to 6000 m thick (Encom 1995). In its present-day configuration, it is bounded by high-angle fault zones to the east and west, and has undergone uplift on its eastern margin (Hus et al. (2006). The Lower Devonian syn-rift succession indicates that active faults on the eastern margin controlled accommodation during the rift phase. To the west, Middle to Upper Devonian sediments probably extended onto the adjacent Broken Hill basement block (Pearson 2003).

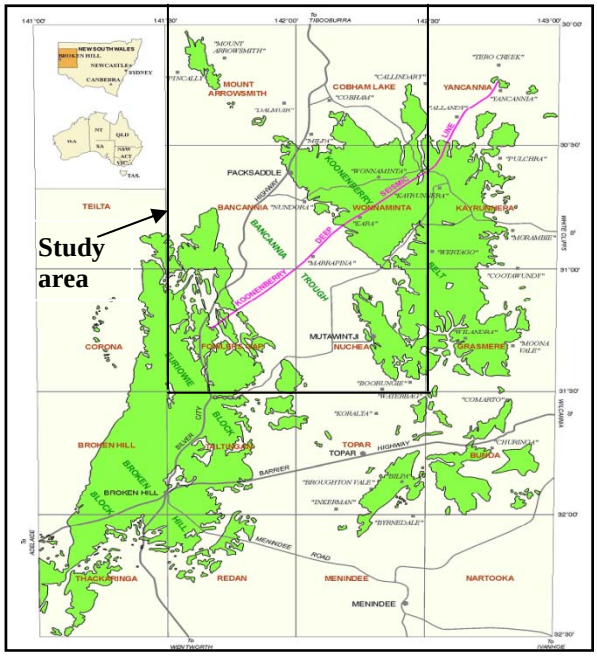


Figure. 3. Showing Study area

IV. DATASET AND APPROACH

The study use stratigraphic nomenclature proposed by Bembrick (1997), recognizing the Snake Cave and Ravendale Intervals and correlations of relevant markers. Evaluation of stratigraphic boundaries from well logs and lithology were carried out, identifying stratigraphic units bounding the Ravendale and Snake Cave formation using the well logs and lithological information. The data include well logs and cutting samples from three wells Bancannia North-1, Bancannia South-1 and Jupiter-1 from Northwest to Southeast.

V. LITHOFACIES DISTRUBITUTION

The lithofacies at Bancannia North-1 exploration well, which is mostly Lower to Middle Devonian sediments dominated by sandstone and minor shale (Figure 4). The Cretaceous sequence persisted to a depth of 350 meter and was underlain by Devonian to Carboniferous red beds. The well remained in red beds, of Middle to Upper Devonian age, at total depth. The contact between the Snake Cave and Ravendale Intervals is best seen in Bancannia South-1. The upper part of the Snake Cave Interval is relatively sandy, whereas the lower part of the Ravendale Interval consists of more porous sandstone and siltstone sediments in Bancannia South-1, with a slightly higher gamma-ray response at 1120 m (Figure 5).

Nortwest, Ravendale and Snake Cave Interval well preserved with Devonian sediments dominated by red sandstone, porous sandstone, shale, Mudstone and a few siltstones in Jupiter-1 well (figure 6). Lithological descriptions of cutting samples taken from the three wells Bancannia North-1, Bancannia South-1 and Jupiter-1 indicate that the rocks in the Snake Cave Interval are mainly sandstone with a few Siltstone and Mudstone.

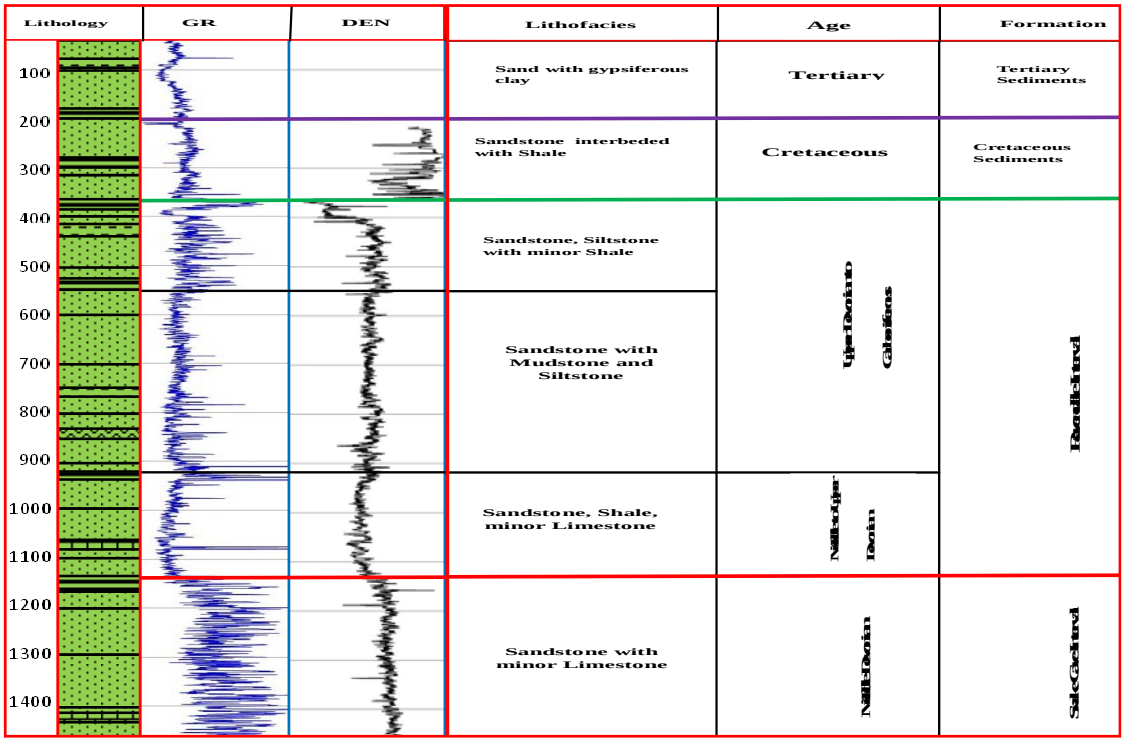


Figure. 4. showing lithofacies at Bancannia North-1 exploration well.

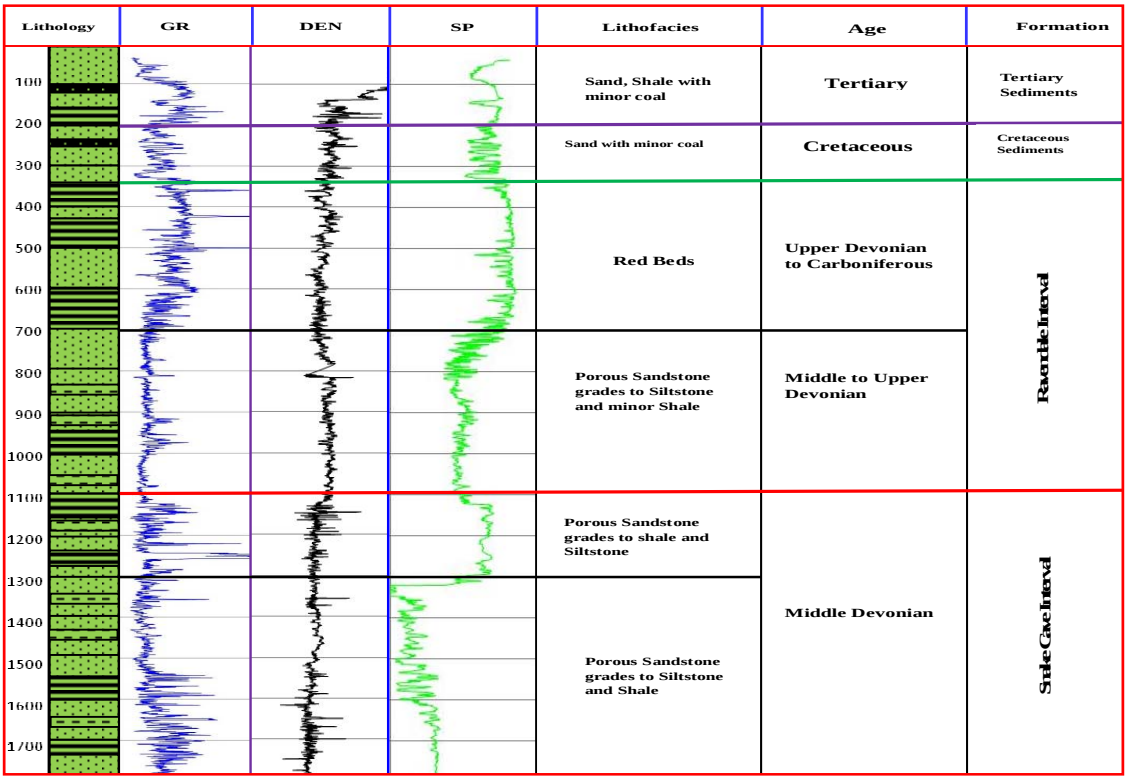


Figure. 5. showing lithofacies at Bancannia South-1 exploration well.

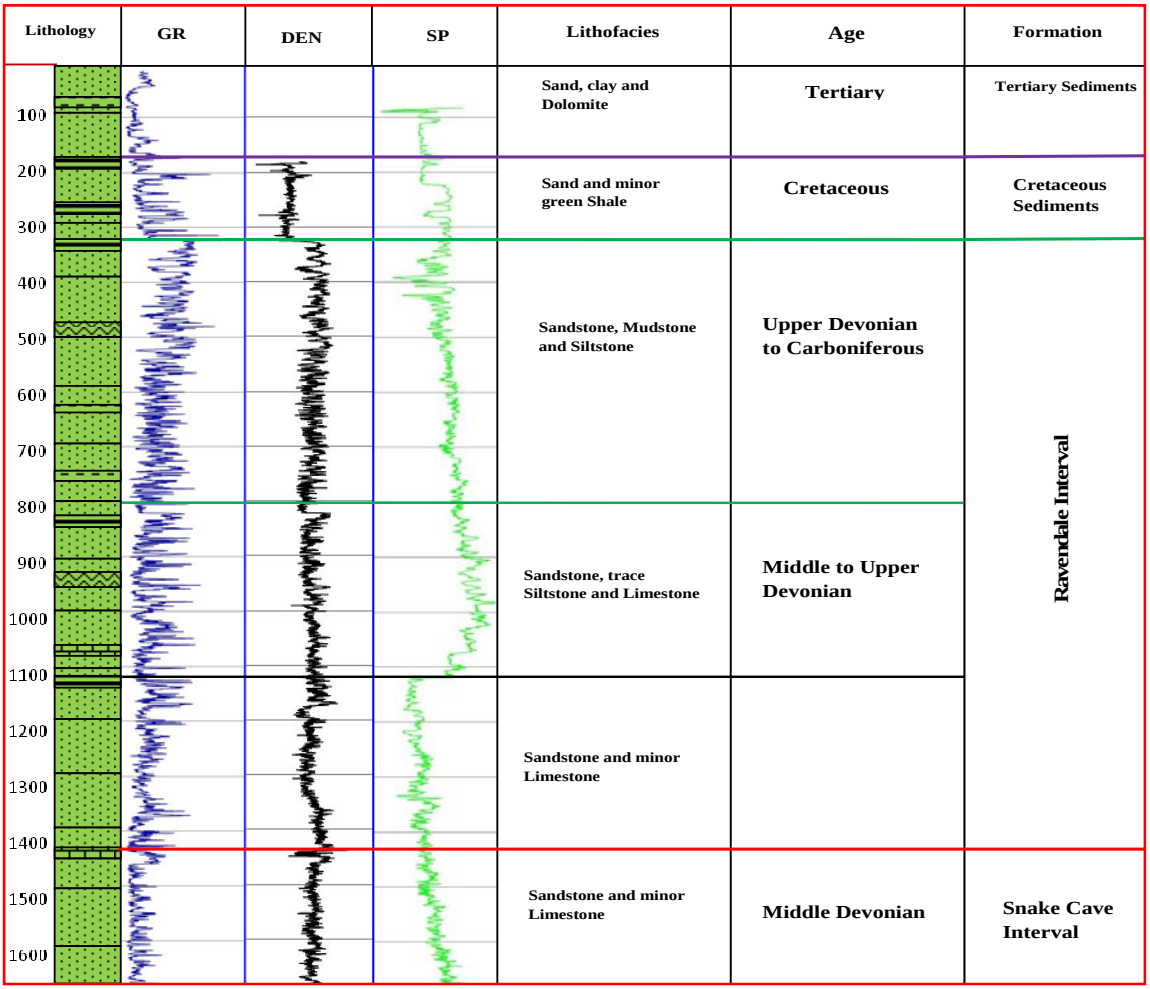


Figure. 6. Showing Ravendal and Snake Cave formations and lithofacies at Jupiter-1 exploration well.

VI. WELL CORRELATION

The stratigraphic correlation is constructed through northwestern part of the Darling Basin (Figure 8) using gamma-ray and spontenous potential logs integrated with lithological data from wells cutting. The correlation datum line is base Tertiary. The correlation is carried out with three exploration wells, Bancannia North-1, Bancannia South-1, and Jupiter-1.

Analysis of lithostratigraphic units from well-logs and lithology data were used to develop a stratigraphic correlation of the northwest Darling Basin. The stratigraphic boundaries were defined at marked changes in well-log characteristics and lithology, in Bancannia North-1, Bancannia South-1 and Jupiter-1 (Figure 8) from Northwest to southeast. Stratigraphic correlation of three wells in the northwestern part of Darling Basin allowed correlation and lithostratigraphic subdivision of northwest Darling Basin.

The study used Bembrick 1997 stratigraphic nomenclature, that divide the Devonian stratigraphy in the study area into three tectonostratigraphic intervals, Ravendale, Snake cave and Winduck intervals. The contact between the Snake Cave and Ravendale Intervals through the Bancannia North-1, Bancanna South-1 wells, shown in figure 7.The boundary is marked in Bancanna South-1 by a sharp decrease in gamma-ray log value at depth of 540 m in Bancannia North-1 and at depth of 700 m at Bancannia South-1 well (Figure 7), and by changes in the relevant cutting samples. However, there is an abrupt lithological change at the contact with the Intervals in Bancanna South-1 well shown in Figure 7.

The Ravendale and Snake Cave formations at Bancannia South-1 exploration well, which is mostly Upper to Middle Devonian sediments dominated by red sandstone and shale lithofacies (Figure 5). Three mega stratigraphic units were identified A, B and C based on well logs characteristics and lithofacies (Figure 8). stratigraphic unit A is Upper Devonian to Carboniferous dominated by red bed sandstone, equivalent to Ravendale Interval from Bembrick, 1997 nomenclature, stratigraphic unit B and C are Middle to Upper Devonian, equivalent to Snake Cave formation (Figure 8).

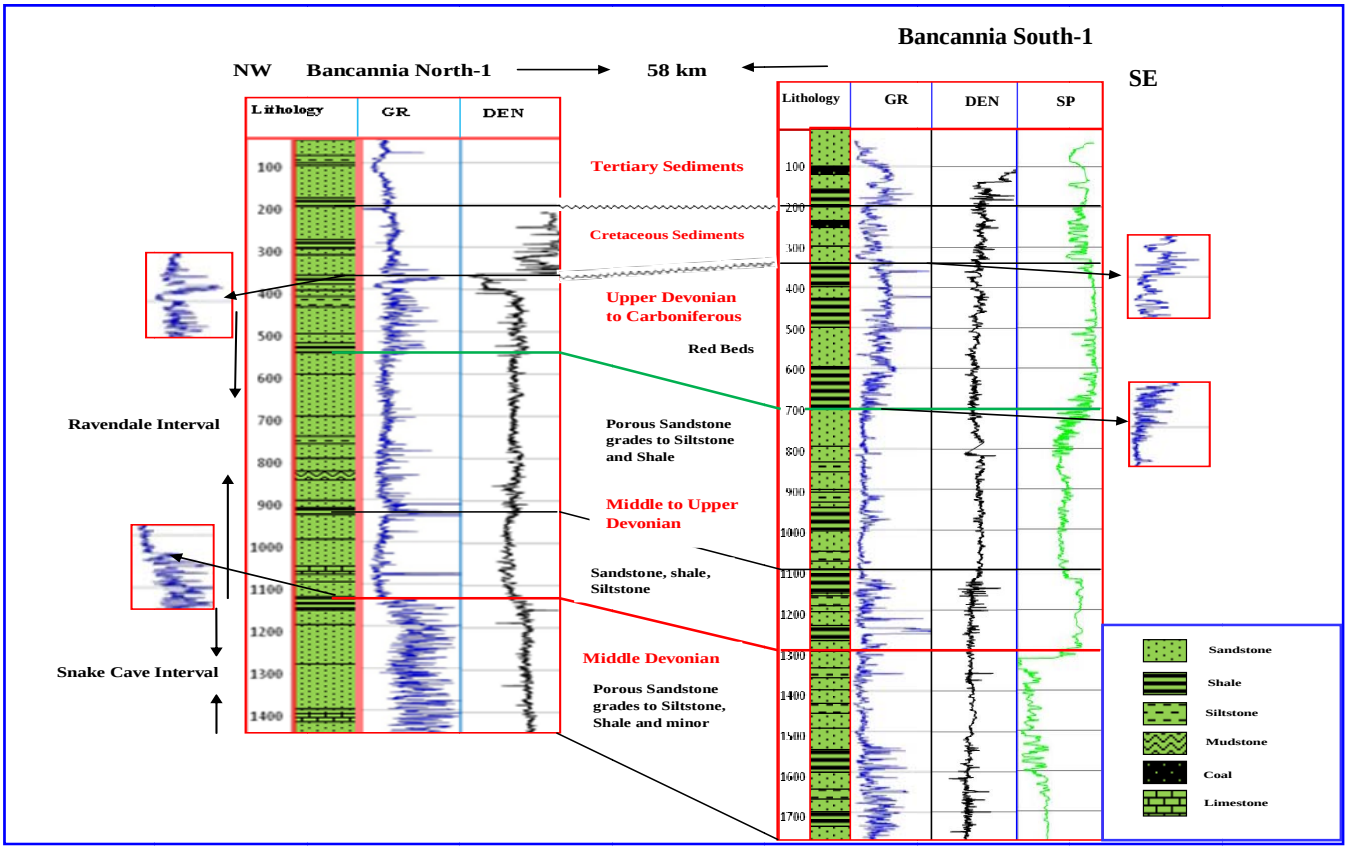


Figure. 7. Showing the correlation of Ravendal and Snake Cave formations and lithofacies at Bancannia North-1 and Bancannia South-1 exploration wells.

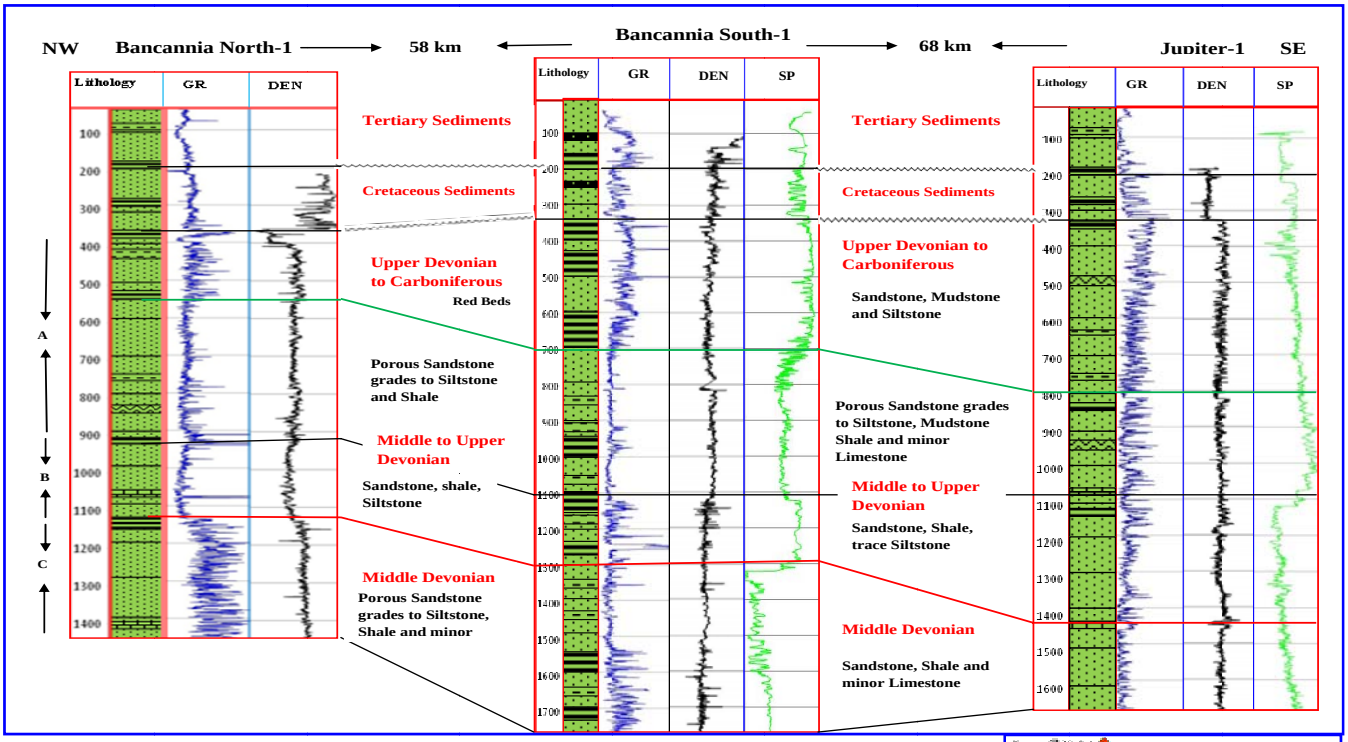
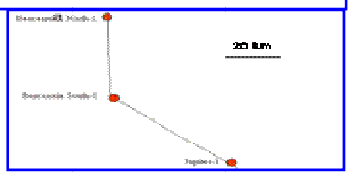


Figure. 8. Showing the stratigraphic correlation of major lithostratigraphic units in Northwest Darling Basin. Correlation is based on well logs and lithology



VII. CONCLUSIONS

This paper has integrated the data from well logs and lithology in order to correlate the stratigraphy of Nortwest Darling Basin. The study has also provided the basis for an improved lithostratigraphic subdivision of the Ravendale Interval and Snake Cave. Integration of well logs with lithological information on the bases of the Snake Cave and Ravendale Intervals suggests that three major stratigraphic units can be identified A, B and C. The lithofacies of three wells Bancannia North-1, Bancanna South-1 and Jupiter-1 have been identified from northwest to southeast. An improved stratigraphic interpretation should lead to a better understanding of the architecture and stratigraphy of the northwestern part of the Darling Basin.

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