A refined stratigraphic framework for the Neoproterozoic: advances in Officer Basin correlation, Western Australia

by

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Evaluation of hydrocarbon potential requires adequate stratigraphic and structural control. Neoproterozoic Officer Basin correlations and relationships to the Centralian Superbasin and Adelaide Rift Complex are constrained by lack of outcrop, limited seismic coverage, and sparse drillholes. However, the stratigraphy is being refined by the integration of stromatolite biostratigraphy, palynology, and isotope chemostratigraphy. This approach has improved correlation quality, resolved some Australia-wide problems, and provided a framework for Rodinia reconstructions.

Outcrops and drillcore were sampled for stromatolites and palynology and fossil data were reviewed as part of GSWA's Interior Basins Petroleum Initiative. Both stromatolites and palynomorphs produced consistent results, indicating correlation between the Officer Basin succession, and the Savory and Tarcunyah Groups (formerly part of the Yeneena Group). Correlation has been extended to the rest of the Centralian Superbasin and Adelaide Rift Complex (Fig. 1). Rationalization of stratigraphic terminology continues.

Stromatolite biostratigraphy has on occasion been disparaged because of supposed lack of environmental controls. However, effective stromatolite correlation needs to be based on adequate systematic studies and identification to form (i.e.= species level). When this has been done, Australian Neoproterozoic stromatolite taxa demonstrate restricted time distributions. In the Officer Basin, *Basisphaera irregularis* changes from club-shaped to tabular as conditions shallow, but its microstructure remains constant and characterizes it as *Bas. irregularis*. Thus, an individual taxon can retain inherent characteristics regardless of environmental change. Some distributions are environmentally controlled. For example, *Acaciella australica* predominates in sediment-starved carbonate environments and *Bas. irregularis* is rare but becomes more dominant as clastic-sediment input and energy regime increase. Different stromatolite associations occur in similar, but younger, sediment-starved/high-energy environments, so a taxon plots only once on range charts. Such observations are inconsistent with an overriding environmental control, and indicate significant biostratigraphic influence.

Stromatolites are present in all four Neoproterozoic Supersequences in the Centralian Superbasin. Two assemblages occur in Supersequence 1 (basal Centralian Superbasin succession). The older, *Acaciella australica* Assemblage, is dominated by *A. australica* and *Bas. irregularis*. It occurs in the Browne, Woolnough, and Skates Hills Formations. The same assemblage occurs in the Bitter Springs Formation (Amadeus Basin), Yackah beds (Georgina Basin), Ruby Plains Group (Wolfe Basin), and Callanna Group (Adelaide Rift Complex). The younger, *Baicalia burra* Assemblage (upper Supersequence 1), is dominated by *B. burra*, but also contains *Tungussia wilkatanna*, *Conophyton* new form, and a pseudocolumnar stromatolite. This assemblage is present in unnamed carbonates near the Eagle Highway, the Neale Formation and in NJD 1 near Neale Junction, Kanpa Formation in Hussar 1, and the Tarcunyah Group at Constance Headland. It was previously recorded from the Burra Group (Adelaide Rift Complex), and as diamictite clasts in Tasmania, but there are no known equivalents in central Australia. Correlation between the Callanna Group and Bitter Springs Formation is more likely than between the Burra Group and Bitter Springs Formation as in previous interpretations.

Supersequence 2 and 3 stromatolites may eventually prove useful for intrabasinal correlation, but most have restricted geographical distributions. However, incipient columns of *Elleria minuta*, characteristic of the Amadeus Basin Marinoan cap dolomite, were identified in a 50 cm-thick dolomite horizon above a diamictite in Empress 1/1A. Near the top of Supersequence 3, *Tungussia julia* occurs in the Wonoka Formation (Adelaide Rift Complex), Julie Formation (Amadeus Basin), and Egan Formation (Kimberley area). A few forms are present in Supersequence 4, but again localities remain limited.

Palynology is increasingly significant in Centralian Superbasin correlation and provides biostratigraphic control as well as indicating palaeoenvironment and

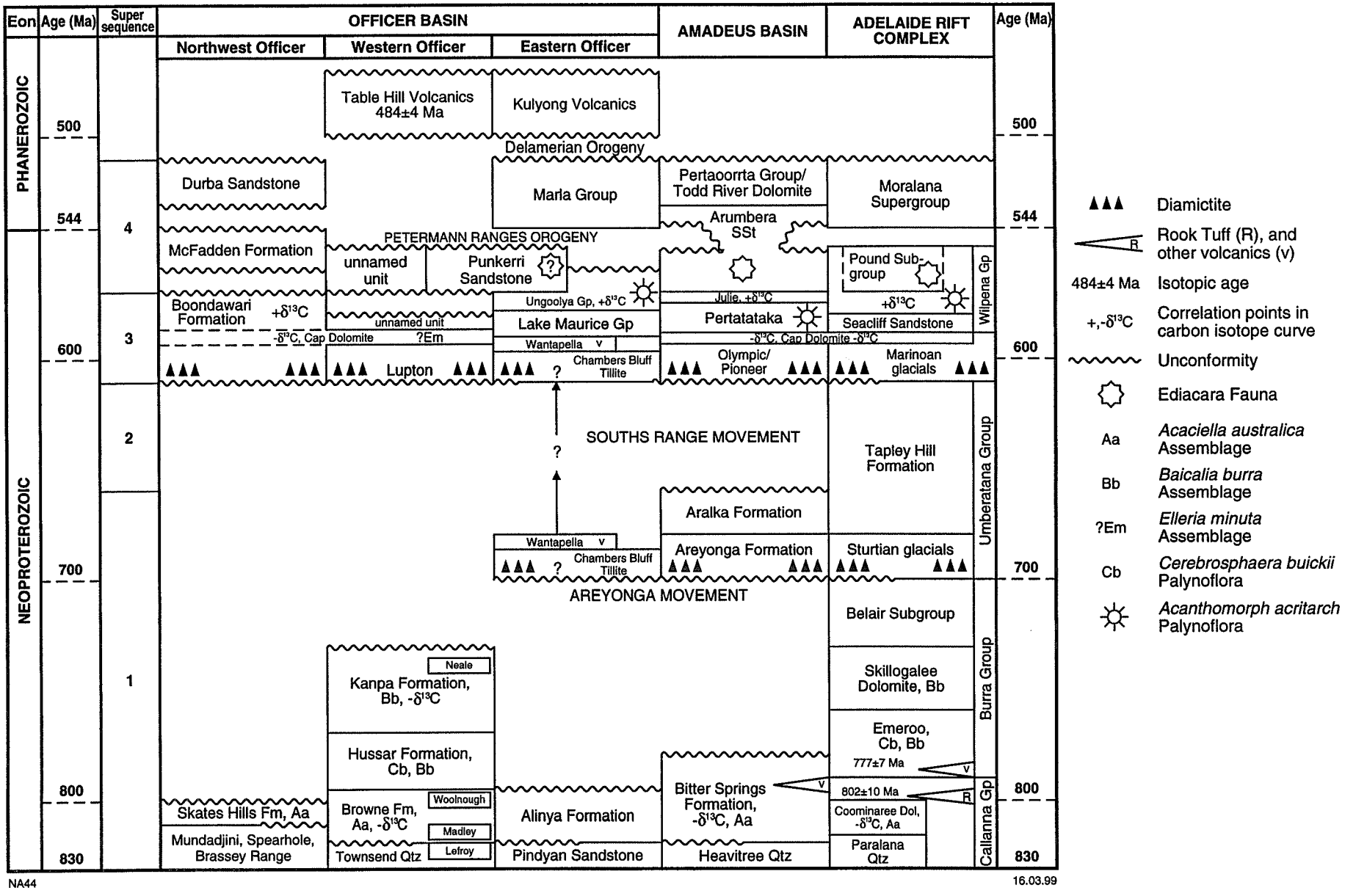

Figure 1. Stratigraphic correlation of the Officer and Amadeus Basins and Adelaide Rift Complex

thermal maturity. Supersequence 1 is dominated by leiospheres, filaments and mat fragments; all conservative, long-ranging species that have simple morphologies. However, a few morphologically distinct species have short ranges. For example, *Cerebrosphaera buickii* is a marker species for upper Supersequence 1, and in the Officer Basin consistently first appears about the middle Hussar Formation. It occurs at about the same level in the Burra Group (Adelaide Rift Complex), but has not been recognized in Amadeus Basin drillholes. Supersequence 2 assemblages are poorly known throughout Australia, but middle Supersequence 3 is characterized by a highly distinctive, morphologically complex, acanthomorph acritarch assemblage. Four assemblage zones allow correlation between southern and central Australia, but have not so far been observed in the western Officer Basin. Upper Supersequence 3 and Supersequence 4 mark a return to leiosphere assemblages. However, Supersequence 4 is characterized by the development of the Ediacara fauna.

Neoproterozoic correlations based on isotope chemostratigraphy are well advanced in central and southern Australia (Calver, 1995; Calver and Lindsay, 1998; Hill 1998). In particular, the $\delta^{13}C$ curve is very distinctive and, especially when combined with other curves (such as $\delta^{18}O$ and $^{87}Sr/^{86}Sr$), allows global correlation. Isotope chemostratigraphy provides an independent method of testing biostratigraphic correlations.

Biostratigraphic schemes derived from outcrop and existing drillholes were tested by stratigraphic drillhole GSWA Empress 1/1A. The 1624.6 m drillhole contains over 70 stromatolite horizons, with the *Baicalia burra* Assemblage present in the Kanpa and upper Hussar Formations and the *Acaciella australica* Assemblage in the Browne Formation. *Cerebrosphaera buickii* first appears in the middle Hussar Formation. Both stromatolites and palynomorphs fit the field-derived biostratigraphic models.

Empress 1/1A contains numerous carbonate horizons, and presented an opportunity to test biostratigraphic results using isotope chemostratigraphy (Walter and Hill, 1999). The $\delta^{13}C_{carb}$ values support biostratigraphic correlations. In particular, the values from the Browne Formation matched those of the Bitter Springs Formation and Callanna Group, and those from the Kanpa Formation matched the Burra Group. Additionally, the 'cap dolomite' values from Empress 1/1A are consistent with those obtained from Marinoan cap dolomites elsewhere in the Centralian Superbasin.

Improved correlation should enhance both hydrocarbon and mineral exploration in Neoproterozoic successions, and provide a better framework for model development for hydrocarbon prospectivity in the Officer Basin. It should also increase understanding of the stratigraphic and tectonic setting of the Centralian Superbasin and Adelaide Rift Complex.

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