Coal as a Correlation Tool in Terrestrial Sediments

Wadsworth, Jennifer A.[1], Ron Boyd[2], Claus Diessel[2] (1) Baker Atlas, Perth, Australia (2) University of Newcastle, Callaghan, Australia

Terrestrial sediments are difficult to correlate because they lack easily identifiable chronostratigraphic surfaces. However, based on studies at different sites across a foreland basin, we have been able to identify systematic variations in coal petrographic properties that respond to changes in local accommodation. These properties enable us to distinguish between transgressive and regressive peat cycles, based on their wetting- and drying upward behaviour linked to variations in the groundwater table. We also recognize a range of sequence stratigraphic surfaces, unique to coal-bearing terrestrial sediments.

Results show that: 1) Coals contain internal sub-units, analogous to ultra-high resolution parasequences, indicating either regressive or transgressive styles. Recognition of this is critical when trying to determine if a coal is initiating or terminating a larger scale parasequence. 2) Coals comprising multiple transgressive and /or regressive sub-units are compound coals; they span more than one accommodation cycle and may contain internal discontinuity surfaces including sequence boundaries. 3) The petrographic signature of coal sub-units appears to be laterally consistent over long distances and has the potential to record relative proximity to marine influence. 4) Multivariate analysis of coal sub-unit parameters (petrography, thickness, stacking pattern, and magnitude of internal changes) indicates that coals have a distinctive suite of characteristics at different positions across the foreland basin, and can potentially be used as a diagnostic indicator of the regional accommodation setting.

In summary, distinctive high-resolution sequence stratigraphic signatures in terrestrial rocks can be recognized when coal petrography is viewed in context with the facies characteristics of the surrounding terrestrial and marginal marine rocks. This in turn provides a previously unavailable ability to correlate stratigraphic units from their downdip marine position and into the terrestrial realm.

A Review of the Application of Sedimentology, High Resolution Sequence Stratigraphy and the Use of Modern and Ancient Analogues to Improve Reservoir Models in the Cooper Basin, Australia

Hill, Adam James[1], Nathan Ceglar[2], Simon C. Lang[3], Rajendra Singh[4] (1) Santos Ltd, Adelaide, Australia (2) Baker Hughes, Perth, Australia (3) University of Adelaide, South Australia, Australia (4) Origin Energy, Brisbane,

In 1999 Santos Ltd initiated a reservoir study of the Permian age fluvial deposits in the Baryulah area of the Cooper Basin, Southwest Queensland, to assist in the future planning of development and appraisal of the area. This study utilised the application of high-resolution sequence stratigraphy and 3D seismic to build geological reservoir models, a common work practice within the petroleum industry; in addition, reservoir analogues from highly constrained datasets within similar geological settings were used to reduce reservoir uncertainty away from well control.

Detailed facies maps were constructed for 11 Permian chronostratigraphic intervals using data from the existing nine wells, suitable reservoir analogues and 3D seismic amplitude maps imaging high sinuosity features interpreted to be meandering channel forms.

The study recommended focusing future development and appraisal effort on two prospective facies types. Of particular interest were the lowstand intervals within the Patchawarra and Toolachee Formations, interpreted to provide excellent reservoir connectivity; additionally the transgressive/highstand intervals of the upper Patchawarra Formation were identified as potential stratigraphic targets.

Since the study concluded, a further 24 wells have been drilled within the area providing a good opportunity to review actual results against the study conclusions - the most productive intervals within the area to date have been the lowstand deposits of the mid Patchawarra Formation with much of the recent development activity focussing on these reservoirs. The study also correctly identified the potential for stratigraphic trapping within the area; with development and appraisal drilling confirming the presence of a large stratigraphic reservoir unit within the Toolachee Formation.

Late Triassic-Early Jurassic Non-Marine to Marginal Marine Sequence Stratigraphy and Palaeogeography of the Rankin Trend and Surrounds, Northwest Shelf, Australia

Marshall, Neil G.[1], R. Kirk[2], S. Lang[3], R. J. Seggie[4], D. B. Alsop[4] (1) Woodside Energy Ltd, Perth, Australia (2) Rob Kirk Consulting, (3) Woodside Energy Ltd, (4) Woodside Energy Ltd, Australia

The Greater Rankin Trend area is unique on the Northwest Shelf in that there appears to be a continuous stratigraphic record from the Upper Triassic I unit to the top of the Lower Jurassic C unit that has been penetrated by the drill bit [upper Mungaroo Fm-North Rankin Fm]. This produces a composite stratigraphic section of over 2000 m of nonmarine–nearshore marine strata of which much of the upper 600 m has been continuously cored. A major problem in trying to reconstruct this stratigraphic section for the Dampier Sub-basin is that when the older part of the section is penetrated, the younger sequences are often truncated by a major Oxfordian unconformity termed the MU event. When the younger sequences are preserved, the older ones are not drilled. The older Triassic sections that are deeply eroded and capped by the MU event are often difficult to place stratigraphically because of poor biostratigraphic control in the predominantly nonmarine settings. Despite these problems, the extensive drilling in the Greater Rankin Trend provides what appears to be a complete composite stratigraphic section within a confined area.

A revised sequence stratigraphic model is proposed for the region based on detailed well coverage on the Rankin Trend and a regional grid of key wells covering much of the Dampier Sub-basin. This covers events ranging from regional 2nd – 3rd order surfaces to 4th order or higher, reservoir specific cycles on the Rankin Trend. These surfaces are then used to slice the stratigraphy in a time related context to produce a set of semi-regional paleogeographic maps illustrating sediment source direction and potential sand distribution.

Depositional Analogues and Sequence Stratigraphy for Late Triassic Fluvial Reservoir-Prone Successions of the Rankin Trend, Northwest Shelf, Australia

Lang, Simon C.[1], R. J. Seggie[2], Neil Marshall[2], David Alsop[2], Chris Cubitt[2], Robert Kirk[3] (1) Woodside Energy Ltd, Perth, Australia (2) Woodside Energy Ltd, Australia (3) Rob Kirk Consulting,

The Late Triassic of the Goodwyn-North Rankin trend on the NW Shelf, Western Australia, consists of a thick non-marine to marginal marine succession. The region contains several large gas fields hosted mainly within the Mungaroo Formation and overlying Brigadier Formation, forming a large scale back-stepping succession (2nd order transgressive sequence set).

The Mungaroo succession comprises numerous stacked fining-upward successions bounded by 3rd order and 4th order sequence boundaries, typically beginning with multistorey high nett-gross, mainly coarse-grained, cross-bedded, bedload-dominated, fluvial channel sandstones. These lie within discrete incised valley fairways based on seismic amplitude horizon slices using 3D seismic. These are overlain by more isolated fluvial channel sandstones (low-sinuosity avulsion belts) and associated crevasse splays, encased within grey to variegated, fine-grained floodplain sediments. Several key fine-grained intervals include carbonaceous paleosols (gleysols) grading to coal, overlain by laminated lacustrine shales that occur throughout the succession marking maximum accommodation intervals that facilitate correlation between wells. In some places more mature variegated and reddened paleosols highlight sequence boundaries developed on interfluves, and are interpreted to correlate laterally to sandstone filled incised valleys.

Analogues used to assist understanding of reservoir geometry and likely connectivity include the fluvial systems of the Gulf of Carpentaria, northern Australia. This region contains low sinuosity sandy rivers that lie within discrete incised valleys and multilateral channel-belts, associated with broad crevasse-splay/channel margin facies that grade into floodplain with increasing paleosol development away from the channel belt. The lower alluvial plain grades into coastal plain where higher sinuosity channels, swamps and shallow lakes predominate.