

Provenance of the Springbok Sandstone, Surat Basin, QLD

Cassandra Bein
In preparation for 'Bachelor of Science (Honours)'
Valeria Bianchi, Joan Esterle

INTRODUCTION AND AIMS

The late Jurassic Springbok Sandstone is located within the Surat Basin in Queensland and comprises a thick sequence of fluvial to lithic sandstones interbedded with minor siltstone, carbonaceous mudstone and coal (Green et al., 1997; QGC LTD, 2012; SANTOS GLNG, 2014). Along the basal unconformity of the unit there is a high amount of spatially variable erosion into the underlying Walloon Coal Measures (WCM), a prolific and highly developed Coal Seam Gas (CSG) resource (McKellar, 1996; Hoffmann et al., 2009). The Springbok Sandstone is known to have both aquifer and aquitard characteristics as a result of regional variability in porosity and permeability (Power & Devine, 1970; QGC LTD, 2012). Therefore, the presence of a water bearing formation above and possibly in hydraulic connection with the WCM has the potential to significantly impact the dewatering processes that enable gas to flow. In addition, a clean quartzose sandstone that occurs at the top of the sequence, referred to as the Weald Sandstone, is only mapped on the western side of the basin (SANTOS GLNG, 2014). Its occurrence, provenance and sedimentary origins hold a key to the palaeogeography of the Springbok to Westbourne transition. Overall, this project aims to investigate the provenance of the Springbok Sandstone, in conjunction with the results from a paleoflow analysis, providing detailed models of the drainage pattern within the basin. Through understanding the sediment source there will be a greater understanding of the depositional history of the unit.

PROJECT LOCATION

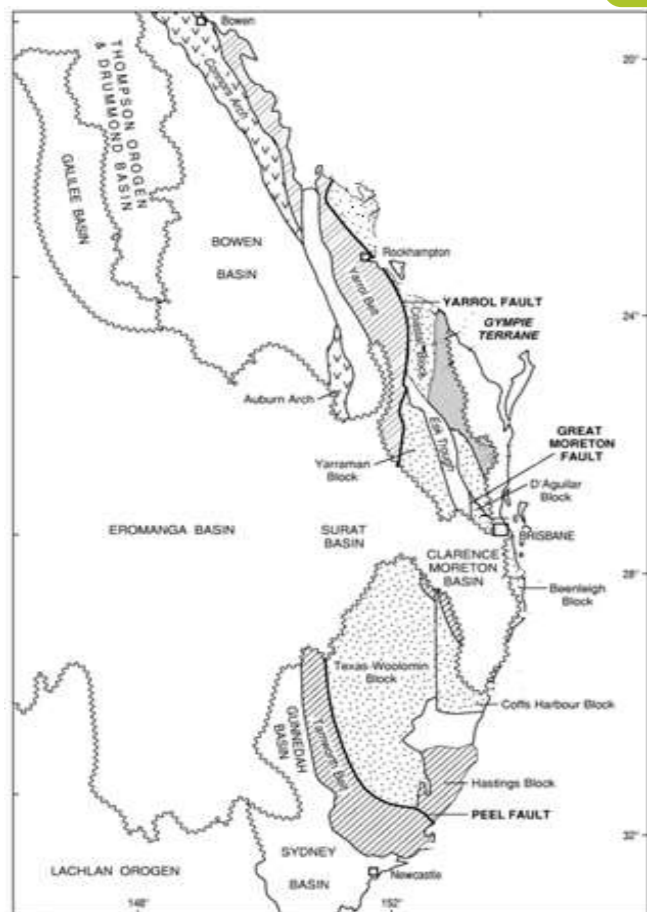


Figure 1. Surat Basin location from Korsh et al., 2009

The Surat Basin extends across south-eastern Queensland into northern NSW covering an area of ~300,000 km² (Fig 1). The Surat Basin unconformably overlies the late Permian to early Triassic Bowen and Gunnedah Basins, as well as two basement terrains to the east and southwest of these basins (Exon, 1976). Respectively, these terrains are the convergent margin New England Fold Belt (NEFB) and the Central West Fold Belt (CWFB) (Exon, 1976).

FACIES ANALYSIS

Sedimentary fill in the Surat Basin occurred within fluvio-lacustrine environments from the early to early-late Jurassic and was overlain by coastal to shallow marine environments from the mid-late Jurassic to early Cretaceous period (Fig 2).

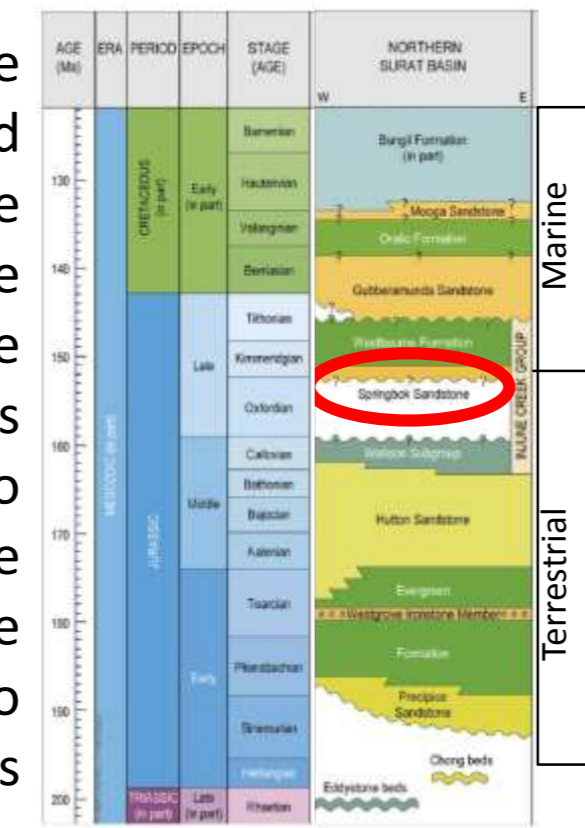


Figure 2. Chronostratigraphic diagram (Hamilton et al., 2014).

SELECTED WELLS

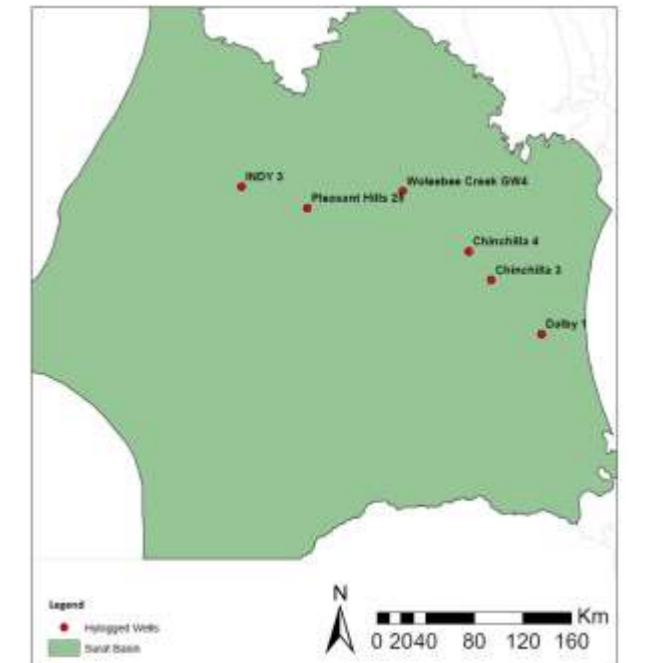


Figure 3. Selected Wells.

The wells selected for detailed analysis in this study (Fig 3) were nominated based on their data availability as well as permitting laterally widespread facies analysis.

METHODOLOGY

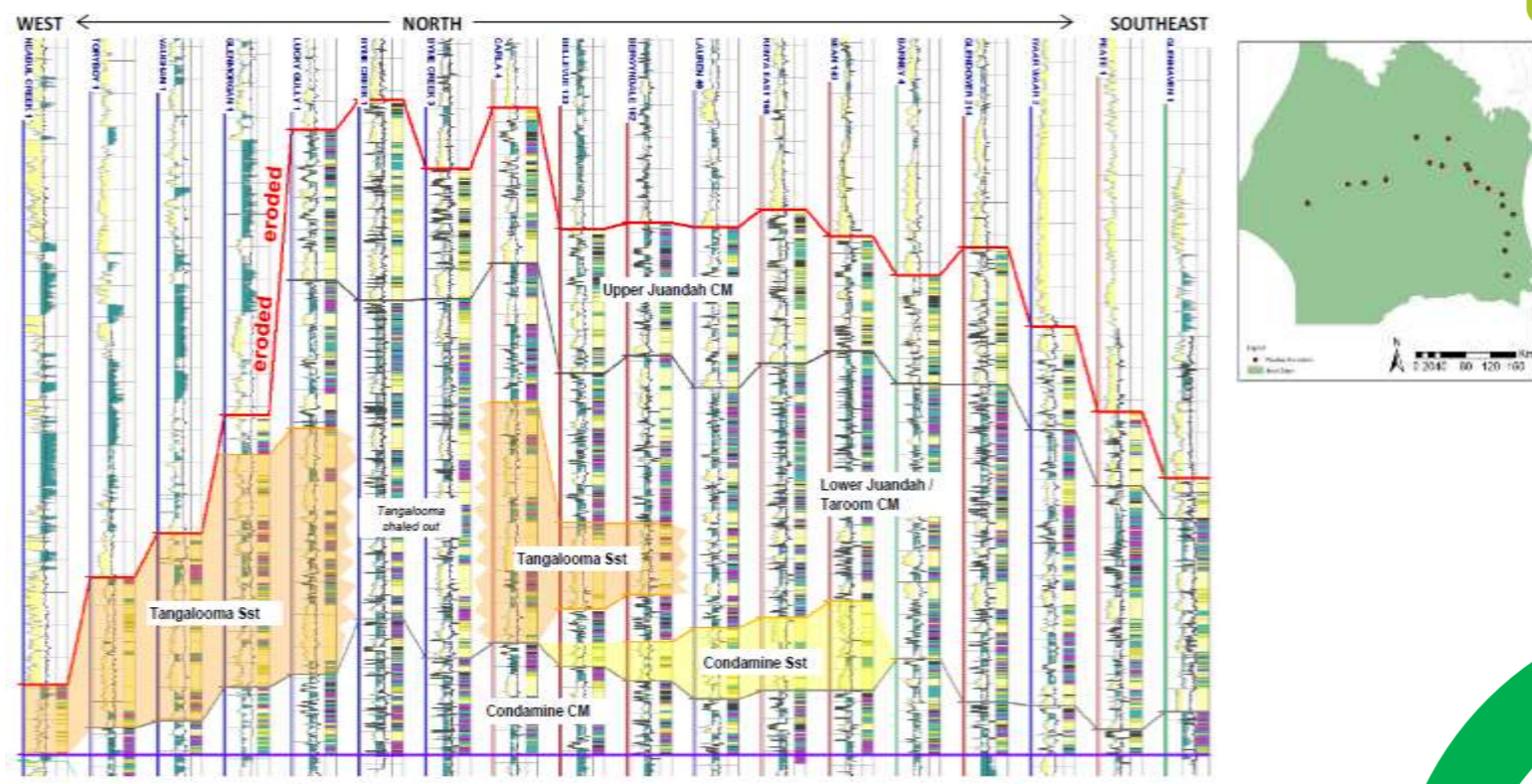


Figure 4. Note the incision of the Springbok Sandstone into the WCM in the west (Sliwa et al., 2013). The map in the top right shows well location.

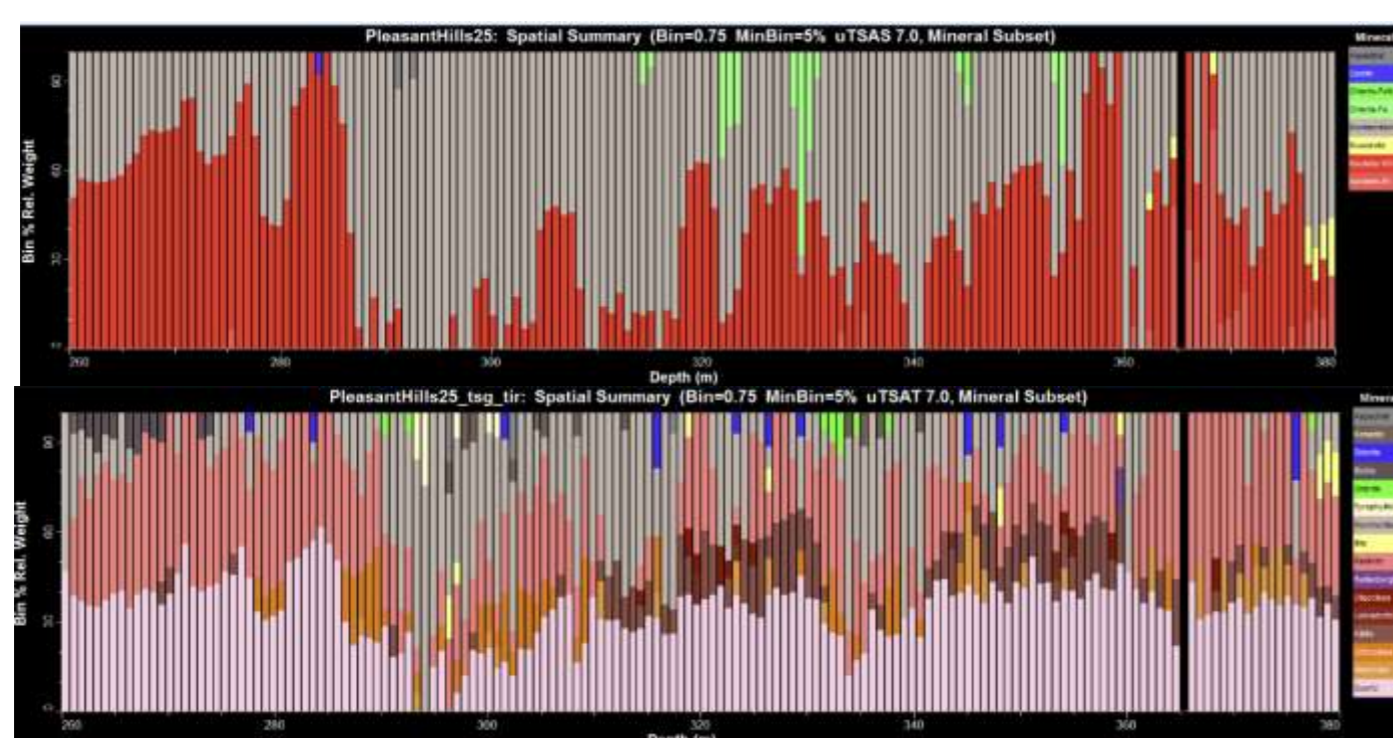


Figure 5. Preliminary hyperspectral results for Pleasant Hills 25

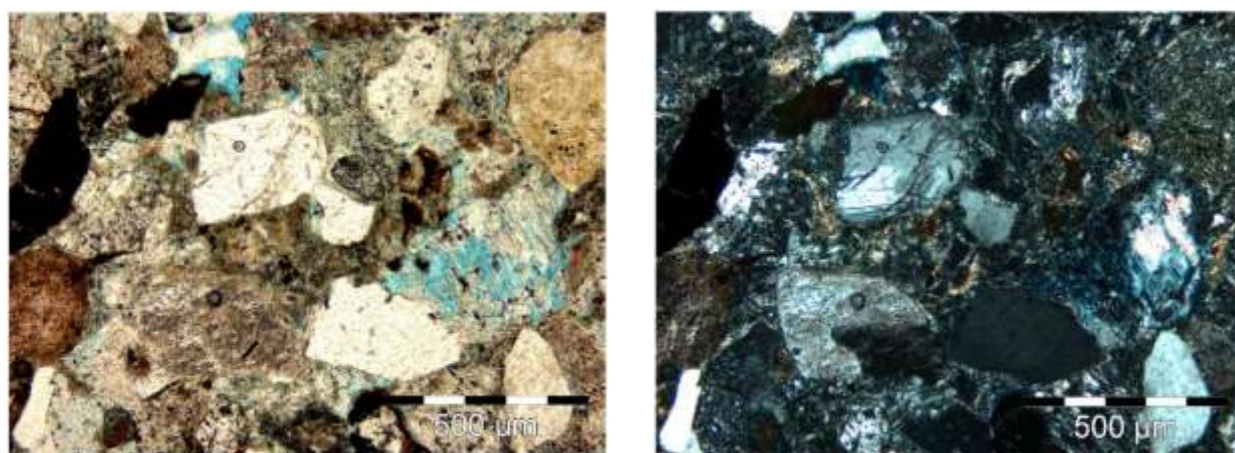


Figure 6. Feldspathic Litharenite: Angry Jungle 1, 550.35m (Santos GLNG, 2012)

Wireline Log Correlation

HyLogger

Thin Section Analysis

Zircon Dating

Current evidence indicates that the Springbok Sandstone / WCM interface is an erosional unconformity as indicated by the red line in Figure 4 (Sliwa et al., 2013). This study will continue on the work by Sliwa et al., (2013) through providing information on the depositional controls for the Springbok Sandstone.

Well cores will be scanned using the HyLogger Technology; a system which uses reflectance spectroscopy and high resolution imagery to obtain detailed mineralogical analysis of the core. This non-destructive method will provide quantitative and objective mineralogical data which eliminates errors often encountered by visual interpretation. Figure 5 shows results from Pleasant Hills 25 for the Springbok Sandstone interval.

Previous investigations have indicated that the Springbok Sandstone is predominantly Feldspathic Litharenite in composition. Figure 6 is an image of a thin section created by Santos from Angry Jungle 1 and shows the sample in plane (left) and cross (right) polarised light. The blue colouring depicts secondary porosity due to dissolution of feldspar grains.

Radiometric dating, such as zircon dating, will enable a geological age constraint to be applied to the sediment and will assist in understanding the geological age gap that is constrained by the erosional unconformity. This age will be compared to pre-depositional tectonic and volcanic events experienced by the surrounding topography.

STRATIGRAPHY

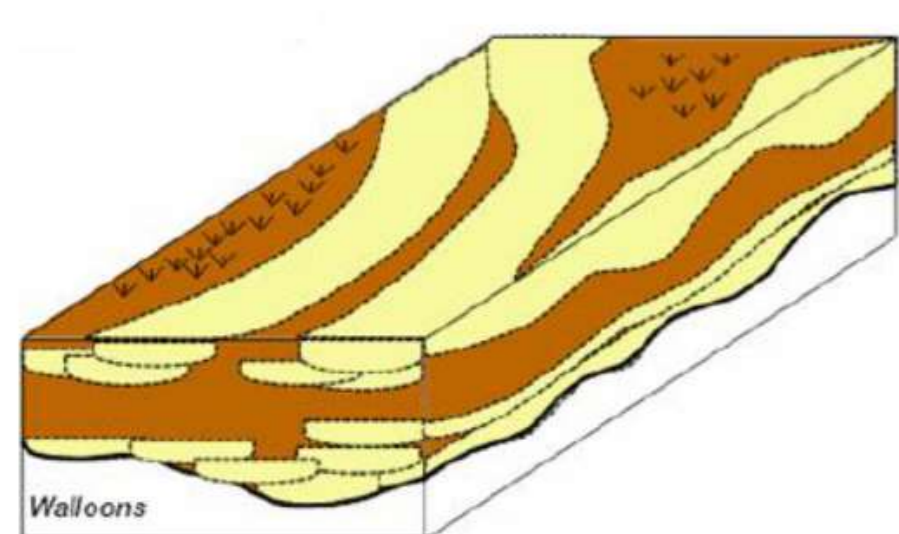


Figure 7. Cross section depicting the amalgamated channels of the lower Springbok Sandstone and less amalgamated channels of the upper Springbok Sandstone (QGC Ltd, 2012).

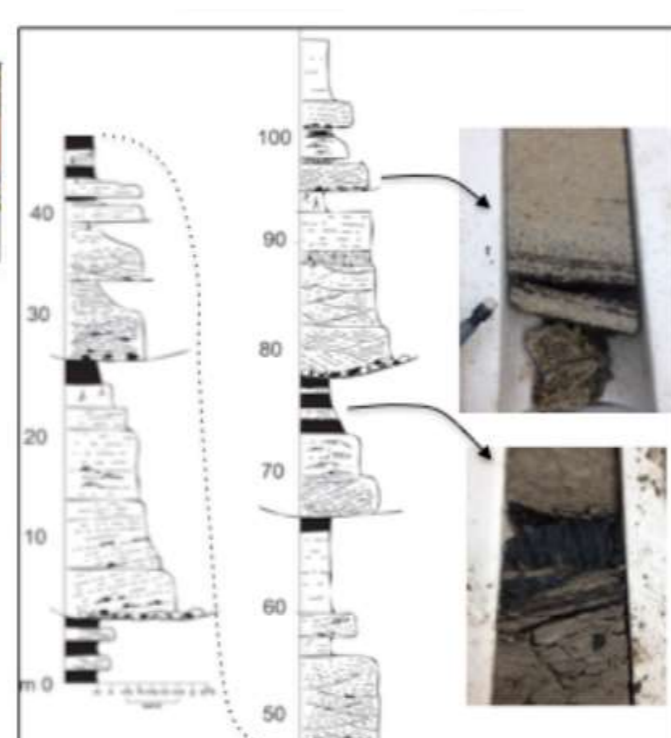


Figure 8. Core log depicting stratigraphy within the Springbok Sandstone (Bianchi et al., 2015).

The unit is divided into two overall fining upwards sequences known as the upper Springbok and the lower Springbok Sandstone (Figure 7 and 8) (QGC Ltd, 2012). The blocky log signatures of the lower Springbok Sandstone are suggestive of basin wide, amalgamated stacked channel sequences, where the lower proportion of muds suggests deposition occurred within braided river settings (QGC Ltd, 2012). The heterogeneous log signatures of the upper Springbok Sandstone are suggestive of less amalgamation of the channels and the increase of lower energy facies is indicative of a meandering river environment (QGC Ltd, 2012).

REFERENCES

- Bianchi V, Esterle J, Salles T. 2015. Stratigraphic Forward Modelling for Investigating hidden reservoir geometries and connectivity: Springbok Formation (Surat Basin, Queensland). In *AAPG International Conference and Exhibition*. Melbourne, Australia
- Exon NF. 1976. *Geology of the Surat Basin in Queensland*. Australian Government Publishing Service
- Exon NF, Burger D. 1981. Sedimentary cycles in the Surat Basin and global changes of sea level. pp. 153-9. Bureau of Mineral Resources Journal of Australian Geology & Geophysics
- Fielding CR. 1996. *Mesozoic Sedimentary Basins and Resources in Eastern Australia - A Review of Current Understanding*. Presented at Mesozoic 9, Mesozoic Geology of the Eastern Australia Plate Conference, Brisbane, Australia
- Gallagher V. 2012. *Reservoir Characterisation of the Jurassic Springbok Sandstone, Surat Basin, Queensland*. University of Adelaide, Adelaide, SA
- Hamilton S, Esterle J, Sliwa R. 2014. Stratigraphic and depositional framework of the Walloon Subgroup, eastern Surat Basin, Queensland. *Australian Journal of Earth Sciences* 61: 1061-80
- Korsch R, Totterdell J. 2009. Subsidence history and basin phases of the Bowen, Gunnedah and Surat Basins, eastern Australia. *Australian Journal of Earth Sciences* 56: 335-53
- McKellar JL. 1998. *Late Early to Late Jurassic palynology, biostratigraphy and palaeogeography of the Roma Shelf area, north-western Surat Basin, Queensland, Australia: including phytozoogeographic-palaeoclimatic implications of the Callialasporites dampieri and Microacarydites microfloras in the Jurassic-Early Cretaceous of Australia, based on an overview assessed against a background of floral change and apparent true polar wander in the preceding late Palaeozoic-early Mesozoic*. University of Queensland
- Power PE, Devine SB. 1970. Surat Basin, Australia - Subsurface stratigraphy, history and petroleum. *The American Association of Petroleum Geologists Bulletin* 54: 2410-37
- QGC Ltd. 2012. *Appendix F Springbok Sandstone characterisation Study*
- Sliwa R, Esterle J. 2008. Re-evaluation of structure and sedimentary packages in the eastern Surat Basin. In *Eastern Australasian Basins Symposium III*, ed. Blevin J. E., BB E., U. C., pp. 527. Perth, WA: Petroleum Exploration Society of Australia
- Sliwa R, McKillop M, Esterle J, Foster L. 2013. A consistent regional correlation for the Surat Basin, SE QLD. Department of Natural Resources and Mines Office of Groundwater Impact Assessment
- Totterdell J, Moloney J, Krassay A, Korsch R. 2009. Sequence stratigraphy of the Bowen-Gunnedah and Surat Basins in New South Wales. *Australian Journal of Earth Sciences* 56: 433-59
- Yago J, Fielding CR. 1996. *Sedimentology of the Middle Jurassic Walloon Coal Measures in the Great Artesian Basin of eastern Australia*. Presented at GEOLOGICAL SOCIETY OF AUSTRALIA ABSTRACTS
- Yago JVR. 1996. *Basin analysis of the middle Jurassic Walloon coal measures in the Great Artesian Basin, Australia*. University of Queensland