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Modelling Considerations and Correlation of the Walloon Coal Measures, Surat Basin, Australia

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Abstract

Large gas reserves are trapped in the coals of the Middle Jurassic (Callovian) Walloon Coal Measures (lower part of the Injure Creek Group) in the Surat Basin. The series is divided into three; the Juandah Coal Measures (upper), Tangalooma Sandstone and Taroom Coal Measures (lower). The upper and lower units are locally further subdivided. These economically important coals were deposited in an alluvial plain setting within an interior basin, which has no recorded contemporaneous marine influence (Exon and Burger 1981).

A facies model has been established from the analysis of sedimentological core (cf. Fielding, 1993 and detailed in Martin et al., 2012). This was subsequently tested by wireline correlation to allow for the development of a depositional model. Whilst tempting to rely on analogues for developing the depositional and reservoir model the close spacing of the wells, locally only 10s of metres, allows for moderately confident correlation of these dm-scale coals. The geometry of coal and associated clastic facies exhibit a high degree of complexity that can be difficult to interpret let alone model. By studying the relationships of the coals and other facies, fluctuations in accommodation space can be recognized. These intuitively convey information about the scale of the coal bodies, their possible correlatability and ultimately connectivity.

The coaly facies form a continuum from claystones through carbonaceous mudstone to dull coal with low vitrain to dull coal with high vitrain content. These lithologies typically grade vertically from one to another on a cm-m scale but can exhibit sharp boundaries. Martin et al. (2012) recognized two end-member morphotypes of coals in the Walloon Coal Measures (Figure 1):

- Class I: The most vertically continuous of the coals (and intuitively the most laterally extensive), stacking into seams up to 10 m thick. A very homogenous succession with subtle brightening- and dulling-upwards cycles split only by carbonaceous mudstones and tuffs. Where mined these coals extend for 3–5 km. Biostratigraphy from study wells indicates development in forested swamps.
- Class II: a cyclical development of stacked, decimetre–metre scale, upward-coarsening and drying units. These reflect 'drowning' of the mire (from preceding series) by lacustrine laminated claystone development and subsequent drying out a process accelerated by the influx of inferred sheetflood, current-rippled sandstones. Ultimately a mire, the driest facies, develops. These Class II cycles are very common and the stratigraphic series is predictable. Biostratigraphy indicates this style of coal develops associated with herbaceous plants. These might be termed Terrestrialization coals (Diessel et al. 2000).

The relationship between the Class I and II coals is not established; these may be lateral variants of a single type of coal body, or end-members.

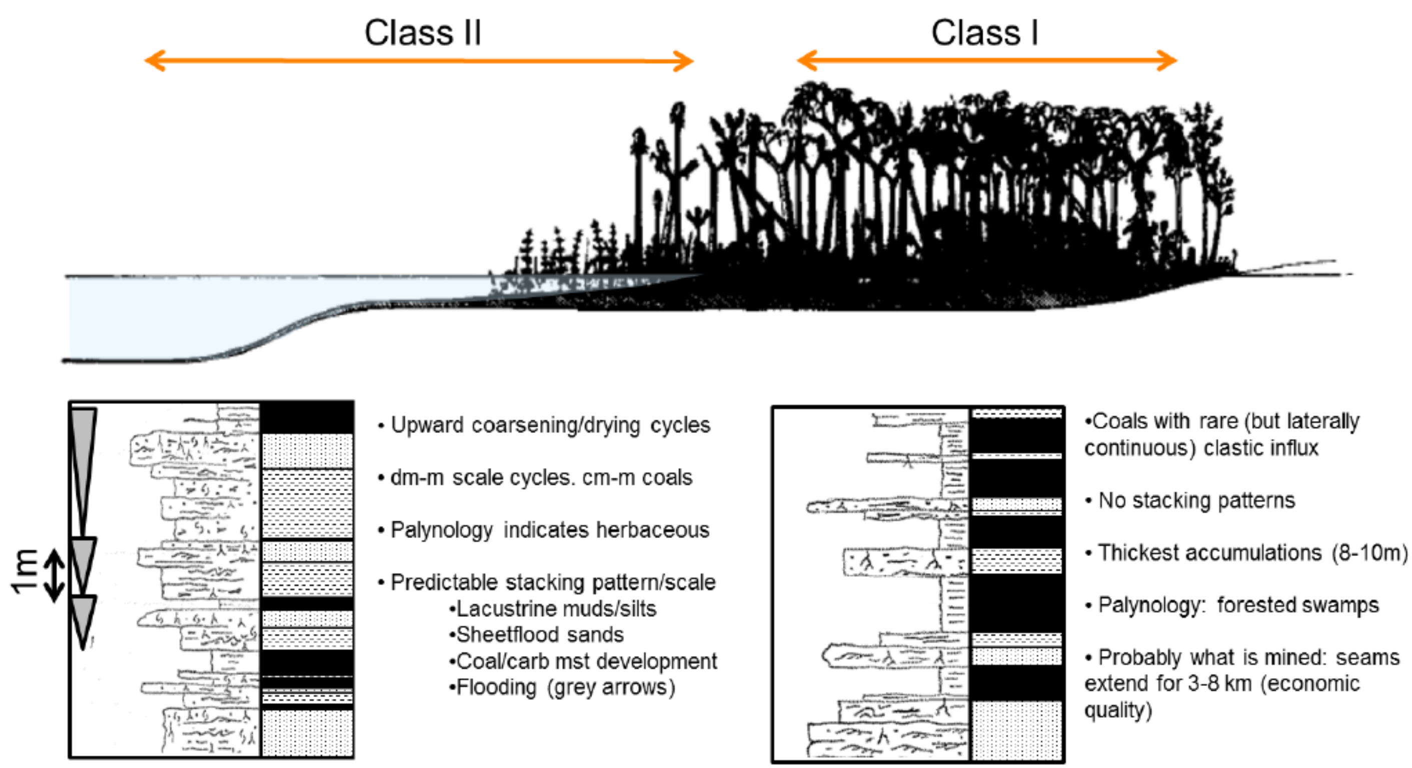

Figure 1. Potential relationship of Class I and II coals and representative core description (both at the same scale). Modified from Teichmüller (1989) and Martin et al. (2012).

Within this study, 59 coal horizons from the Walloon Coal Measures were correlated over a license block (approx. 55km2) with a large number (100+) of wells. From this, a seam area / thickness relationship for the Walloon CM was established (Figure 2). Coals average 30 cm and reach up to 10 m thick.

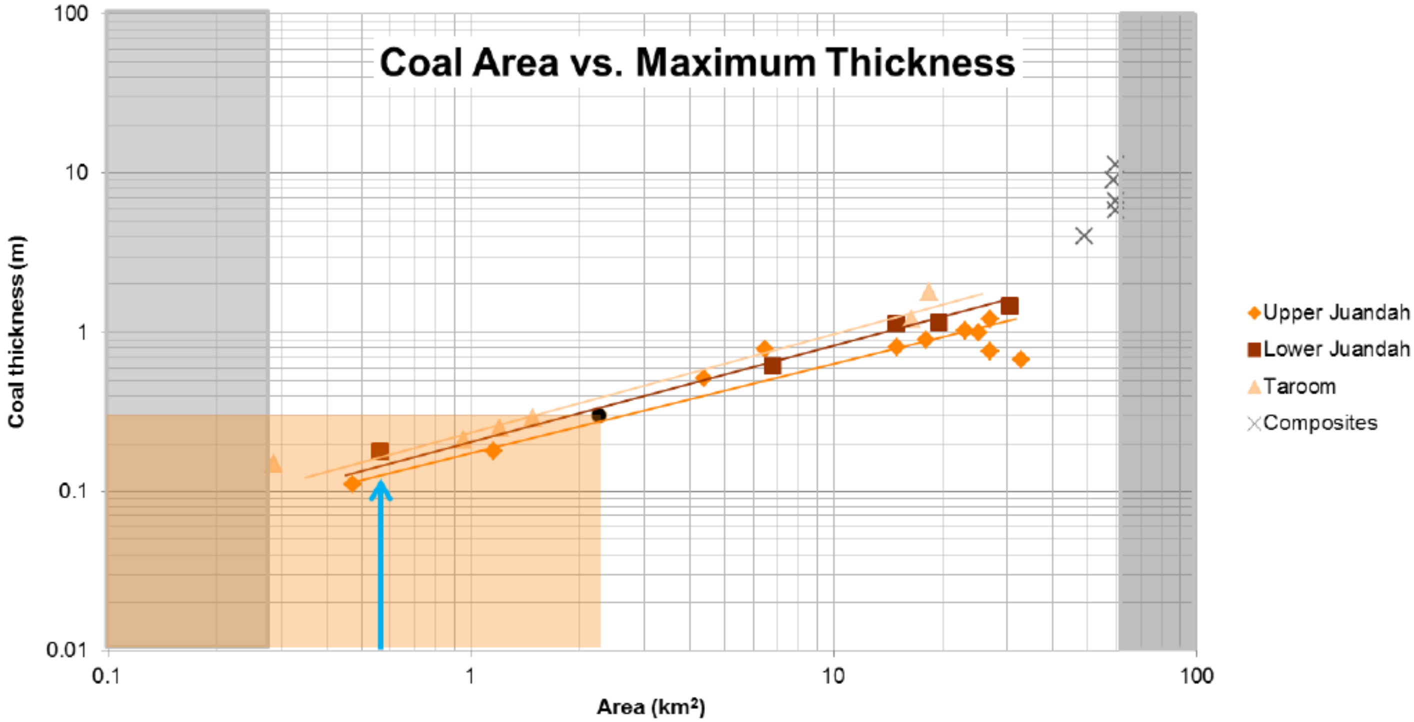

Figure 2. Plot of maximum coal thickness (penetrated in an individual seam) vs. area of that seam. Grey borders highlight the limits of the well spacing (left) and block area (right). The orange area highlights the average coal thickness (30cm) which equates to an area of 2.25 km^2. The blue arrow marks 0.5625 km^2 the current development well spacing (0.75 by 0.75 km).

Once the seam correlations were established, the distribution of the argillaceous-coaly facies could be observed. This indicated, at a production well-spacing scale, that the facies change sufficiently quickly between coal-rich and clay-rich to impact gas flow (Figure 3). In this heterogeneous succession, it is evident that coal correlation does not necessarily equate to coal connectivity.

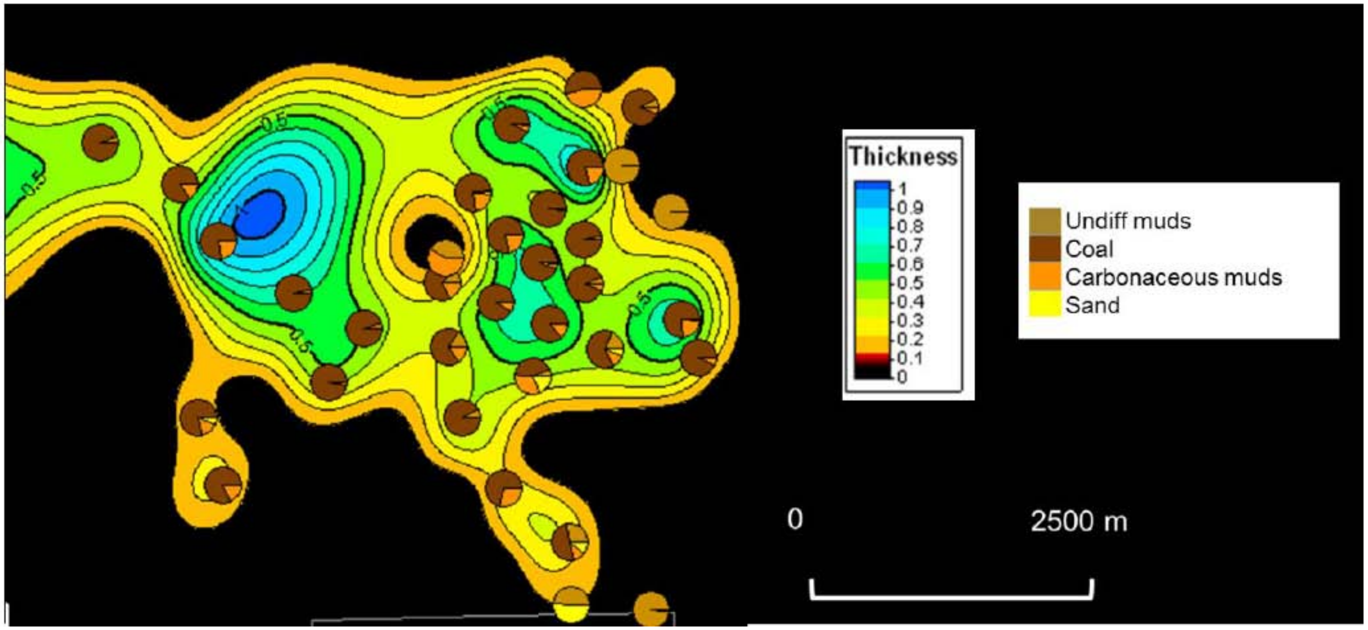

Figure 3. Map of one seam showing variation in thickness (isopach colours) and lithotype (pie charts, at each well location).

In 2010, during a gas storage pilot test, “instantaneous” offset well pressure response to gas injection in a centrally-located well provided evidence for the degree of coal connectivity. These observations are being considered in the geomodelling efforts.

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