Abstract 31

Topic: Evaluation of the unconventional resources including shale gas, shale oil, coal bed methane, and gas hydrate

Effect of organic matter on geothermal gradients: an example from the Surat Basin (Jurassic), Australia and implications for coal seam gas reservoirs

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The established geothermal gradient for the Surat Basin ranges from 21° to 35°C (Raza et al., 2009). The main target for mining and coal seam gas (CSG) is the Walloon Subgroup, which is on average about 300 m thick and can have a net coal thickness of over 35 m (Ryan et al., 2012). The Walloon Subgroup is commonly divided into five intervals: the Upper Juandah Coal Measures; the Juandah sandstone (or an equivalent); the Lower Juandah Coal Measures; the Tangalooma Sandstone and the Taroom Coal Measures. To establish a basin-wide hydrogeological model, two wells were drilled to conduct high-resolution temperature measurements. Both wells penetrated the Walloon Subgroup as well as formations above and below and were left undistributed until temperature had equilibrated. Temperature measurements were made every 5 cm as the probe was being lowered.

From the high-resolution temperature measurements in the two wells, it is apparent that the geothermal gradient through the Walloon Subgroup is underestimated. The geothermal gradients for formations above and below the Walloon Subgroup are within the expected basin average. The average gradient through the Walloon Subgroup in the two wells are 48° and 53°C/km, respectively. However, the range between the individual coal measures (i.e. Upper Juandah, Lower Juandah, Taroom) is 48° to 63°C/km (Fig. 1). The high geothermal gradients are a result of the low thermal conductivity of carbon. The gradient variation between coal measures has a strong and positive linear correlation (r^2 = 0.89) with % net coal (Fig. 2). Although more data would be optimal, it seems feasible to predict geothermal gradient variation through the Walloon Subgroup by use of the formula y=122.2x+38.662, where 'x' is % net coal.

Higher geothermal gradients through the coal measures will result in higher temperatures in the reservoir (Fig. 3), which will reduce maximum gas holding capacity. Four adsorption isotherm samples run at the original calculated reservoir temperature and then re-run at the new calculated reservoir temperature all had reduced maximum gas holding capacities. As would be expected, with lower maximum gas holding capacities, all four samples increased in % gas saturation. The increase varied from 2-6% between the four samples. Although % gas saturation estimates are inherently imprecise (Mares et al., 2009), the upper range of variation documented in this study could be significant, especially when estimating the generally under-saturated Taroom Coal Measures. Additional analysis indicates that CSG reservoirs with the lowest ash yield will have the greatest sensitivity to changes in gas holding capacity, and thus gas saturation, as a result of any change in reservoir temperature (Fig. 3).

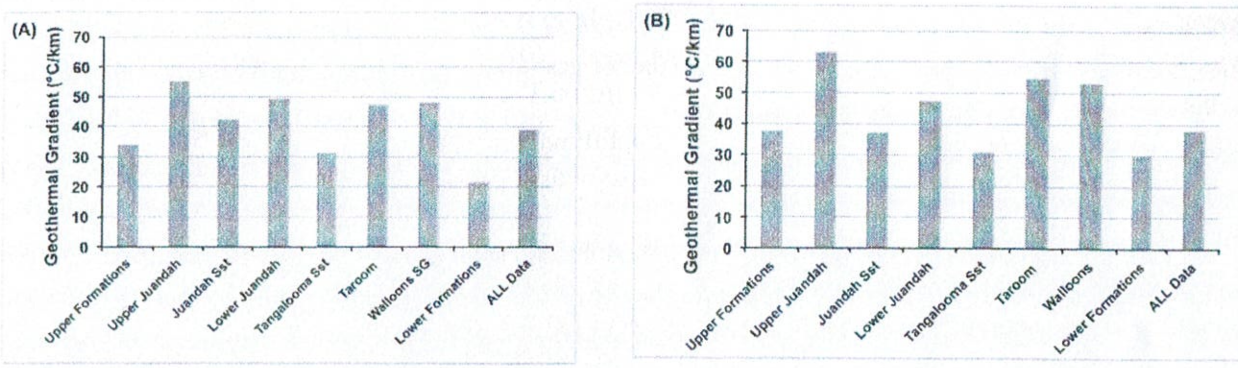

Fig. 1. Geothermal gradients through different formations in the Surat Basin. (A) and (B) refer to Wells 'A' and 'B', respectively.

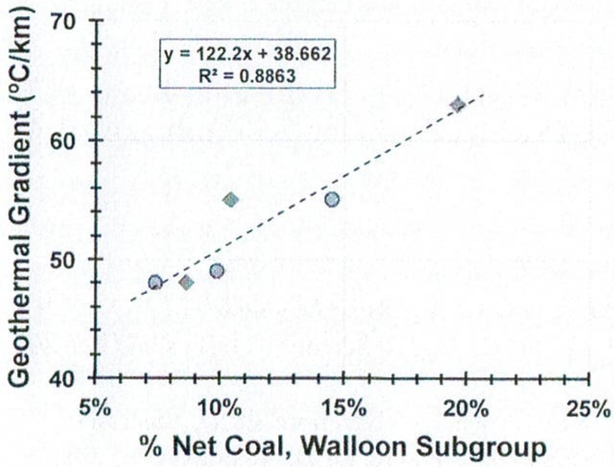

Fig. 2. Geothermal gradient versus %net coal in the Upper Juandah, Lower Juandah and Taroom Coal Measures (orange circles = Well 'A'; red diamonds = Well 'B').

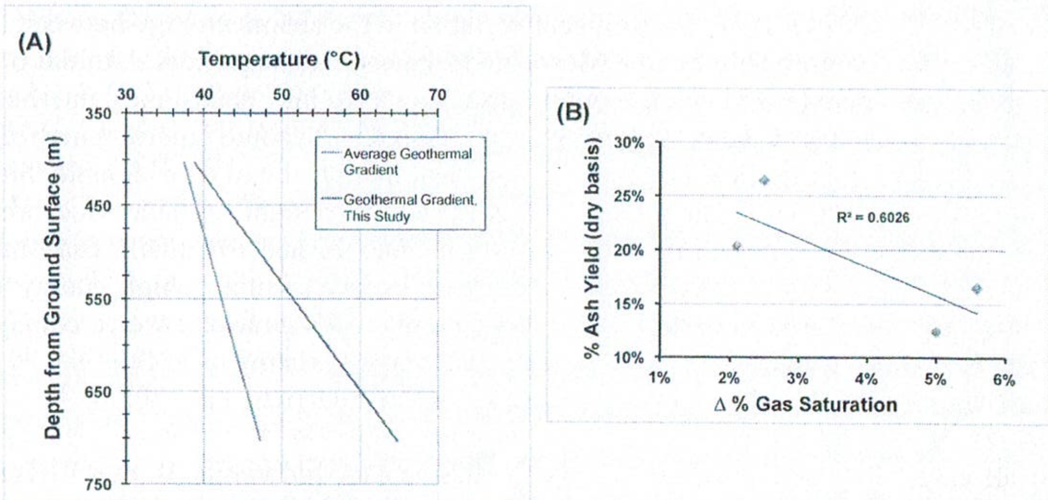

Fig. 3. (A) Blue line is temperature through the Walloon Subgroup using the average geothermal gradient for the Surat Basin for Well 'B'; red line is temperature through the Walloon Subgroup using gradients in Fig. 1B. (B) Relationship between %ash yield and change (Δ) in %gas saturation resulting from different adsorption test temperatures. Note the new, temperature-adjusted adsorption curves always resulted in higher gas saturation.

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Abstract 32

Topic: Coal geology, resources, and utilization

Volcanic and volcanogenic sediments in the coal-bearing Tanjung Formation (Late Eocene), Senakin Peninsula, South Kalimantan (Borneo), Indonesia

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In Southeast Asia the Paleogene was a time of rifting. Indonesia, in particular, is characterised by rift sediments beginning in the middle to late Eocene (Cloke et al., 1999; Doust and Noble, 2008; Pubellier and Morley, 2014). There is significant variation in the sedimentology between basins, but overall basal units unconformably overlie Mesozoic to Palaeozoic sequences. Initial deposits are coarse, often conglomeratic and grade conformably upwards into sandstones interbedded with siltstones and mudstones. These sediments progressively become more interbedded with organic-rich intervals and then coal beds are often present that can be of considerable thickness (>3 m) and lateral extent (>20 km). The presence of coal beds is thought to mark widespread coastal plain environments. Overlying sediments are mostly mudstones and eventually carbonates, marls and marine shales. The sequence is interpreted as transgressive, initially high energy freshwater fluvial at the base, to a broad coastal plain setting bordered by brackish water embayments, to shallow marine environments, then finally full open marine environments at the time of maximum subsidence (Doust and Noble, 2008; Friederich et al., 1999; Friederich et al., 2016).

In almost all cases, Eocene-age rift sediments in Kalimantan, Indonesia (Borneo) have not been reported to contain volcanic or volcanogenic sediments. A notable exception is the Nyaan volcanics in the upper Kutai basin in East Kalimantan (Pieters et al., 1993), which have been dated at 48.6-50 Ma (Soeria-Atmadja et al., 1999).

The Late Eocene-age Tanjung Formation (and lateral equivalents) in southeastern Kalimantan can be considered a typical rift-fill sequence. Numerous studies have been conducted that focus on the