

Reserves Estimation and Influences on Coal Seam Gas Productivity in Eastern Australian Basins

Bruce McConachie, Peter Stanmore, Michael Creech, Lucas McLean Hodgson, Anargul Kushkarina and Edward Lewis

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Abstract

SRK Consulting has undertaken many unconventional gas resource estimation projects in Australia as well as China, USA, Canada, Botswana and South Africa. Our experience with these and other projects highlighted the many potential pit falls in the estimation of both Resources and Reserves that can lead to either overstating or underestimating potential. Geology plays a significant role in the likely success of these ventures and understanding the geological context of gas estimations is critical to ensure their delivery as economic Reserves.

Reserves Estimation and the influence of Geology

SRK Consulting has experience of coal seam gas (CSG/CBM) Reserve and Resource estimation in most eastern Australian basins. We have observed that the impact of coal quality and depositional environments are commonly underestimated and some potential gas upside is not captured because other aspects associated with coal seam gas analysis are not appropriately addressed. The coal seam environment is complex, comprising fluvial deposition in upper to lower alluvial to delta plain settings where the interaction of complex sedimentary depositional processes is compounded by variations relating to the original peat swamp environment.

The nature of the peat-forming environment and the genesis of the contained methane in shallow CSG reservoirs often results in highly variable gas saturations, both vertically and laterally. By understanding these processes and identifying the geological features responsible for high-frequency variations in gas contents, exploration can be better targeted. Individual coal seam reservoirs typically split and coalesce laterally within hundreds of metres but seam characteristics such as ash content can also vary over similar distances. The thin nature of the CSG reservoir also provides the potential for the development of many relatively small faults (<5 metres) that can fully displace the coal seam and effectively compartmentalise the reservoir.

It is important to have a good understanding of the origin of the methane and how it has been stored in the reservoir. SRK has undertaken several projects in the Surat Basin where shallow coals are often highly gas productive (Creech and McConachie, 2014). However, these same coals can be significantly undersaturated at depth resulting in lower gas contents and significant dewatering requirements to achieve first gas (Figure 1). Lack of meteoric influx due to geometry and permeability barriers can result in minimal biogenic gas enhancement resulting in poor reservoir properties that require the drilling of more expensive lateral wells to achieve reasonable productivity.

In shallow CSG reservoirs it is common for methane distribution to demonstrate a reverse trend compared to the traditional oil and gas scenario of upward migration and trapping. Gas contents may appear higher in synforms rather than antiforms and higher on the upside of faults rather than the downside. This is true of the San Juan Basin in the USA (Scott et al., 1994) as well as the Surat Basin (**Figure 2**). During all phases of

exploration, reserve estimation and production it is important to have a good understanding of the origin of the methane and how it was stored in the reservoir in order to maximise the value of the resource.

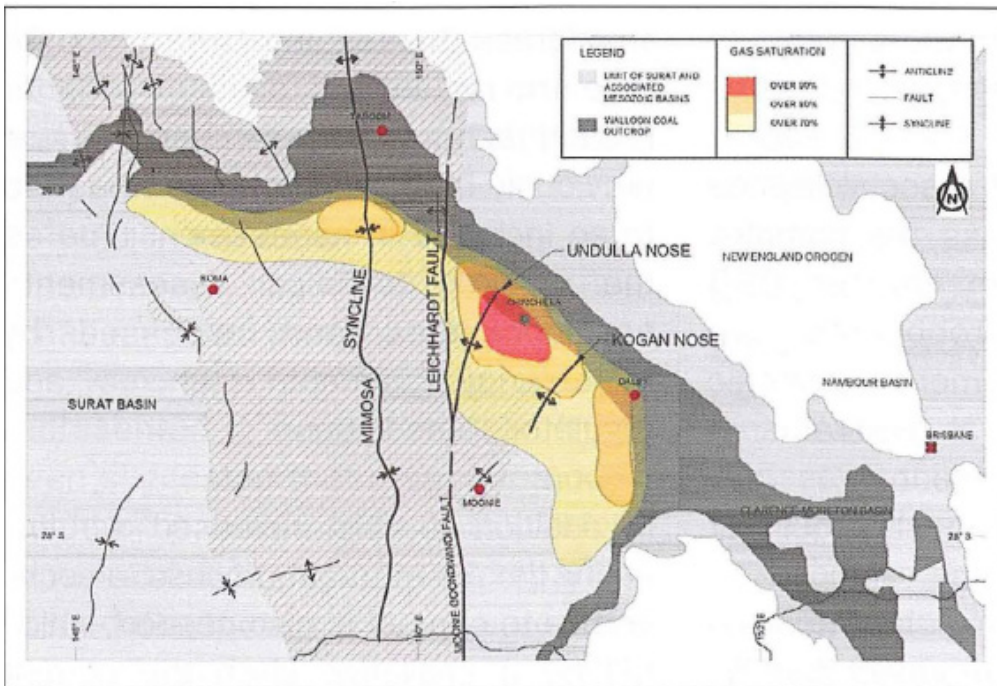


Figure 1: Surat Basin methane saturation trend (Modified after Hamilton et al., 2012)

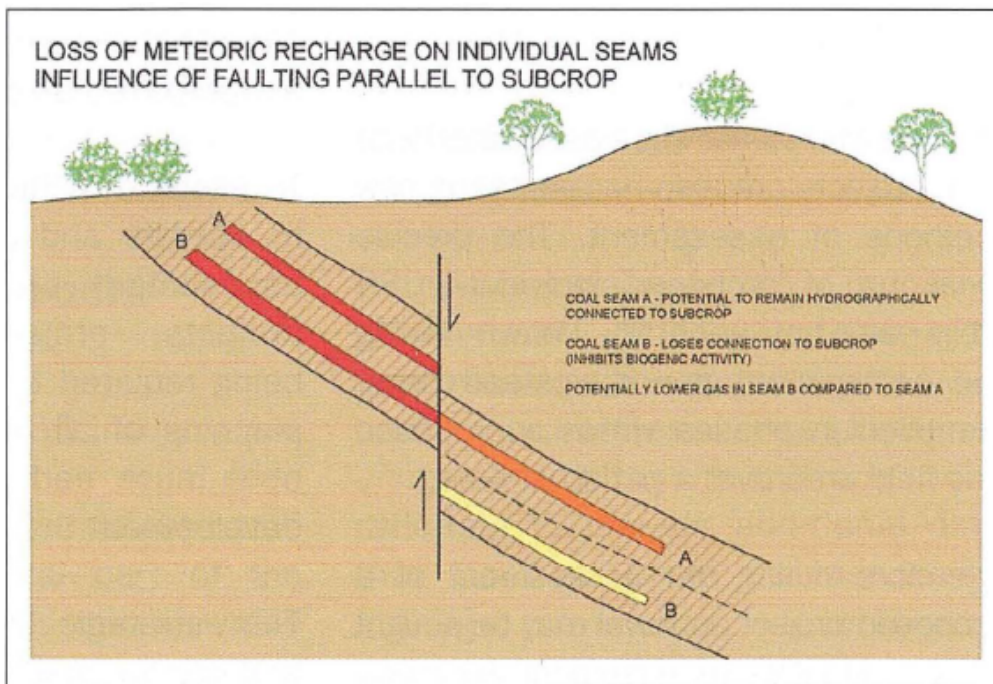


Figure 2: Potential impact of a fault on biogenic recharge

In the southern Sydney Basin, meteoric influx is an important aspect to consider in order to identify the productive basin areas while recognition of the presence of ethane is a reliable indicator of the significant change in basin reservoir conditions. In the Hunter Valley area, the Sydney Basin coals require consideration of structurally controlled CO₂ occurrences that can increase with depth. By comparison the Gloucester Basin has excellent coal gas productivity and high methane gas contents.

Work undertaken in the southern Bowen Basin by SRK demonstrated the tight character of the coals which commonly have calcite infill in cleats and typically degas very slowly indicating fracture stimulation will likely be required to achieve good production rates and improve well EUR's.

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Figure 3: Calcite cleat infill in southern Bowen Basin Bandanna (Rangal) coal

In the Gunnedah Basin, widespread presence of carbon dioxide associated with intrusions can mean that the energy content of a gas is much lower than that of a similar methane filled equivalent volume. For this reason it is unreasonable to report gas by energy content without specifying the volumes or inert content of the estimated gas Reserves.

In the Galilee Basin, relatively low gas saturations can occur but these coals still provide coal gas productivity in favourable basin settings. The widespread occurrence of the overlying Hutton Sandstone aquifer will be an important consideration in the development of Galilee Basin coal seam gas particularly where it is in direct hydrogeological communication with the coal.

In the Clarence Moreton Basin, cores taken for gas content measurement in the Casino area demonstrated that the Walloon Coal Measures have high average ash contents. This high ash content is mainly attributed to the thinly interbedded nature of the coal seams which contain bright, often well cleated, vitrinite-rich coal ply's interbedded with carbonaceous shale, tuff and mudstone, suggesting ephemeral mire conditions and volcanic input into the depositional environment (Doig and Stanmore, 2012). Average ash contents in samples taken to measure gas content are often overestimated as they are typically 0.5–1m thick and therefore the non-coal interbeds are sampled along with the brighter, cleaner coal which contains the majority of the gas. Further, an extensive dataset of CSG and coal core wells shows that the Walloon coals in the Clarence Moreton Basin are commonly vitrinite-rich but only the low maturity samples have any appreciable amounts of liptinite identified from petrographic maceral analysis. This is because at the higher levels of maturity seen in the central portion of the basin in NSW the more labile exinitic macerals have been transformed during the coalification process such that they cannot be distinguished from the vitrinite. This maturation trend can be linked to gas content and permeability distribution to focus exploration and sweet spot identification.

Beyond Australia, work undertaken by SRK at Luling in Qinshui basin indicated difficult low permeability conditions related to coal rank. In other Chinese basins, the Panzhuang and Mabi projects are located in China's coal-rich Shanxi Province in the Qinshui Basin, SRK has observed many sedimentary setting issues but efficient pilot production testing was successfully applied to provide good understanding of the gas production issues.

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