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

Bruce McConachie[1], Peter Stanmore[1], Michael Creech[1], Lucas McLean Hodgson[1], Anargul Kushkarina[1], and Edward Lewis[1]

[1]SRK Consulting, Level 6, 141 Queen Street, Brisbane, Queensland, 4000, Australia

Abstract

SRK Consulting has undertaken many unconventional gas estimation projects in Australia plus China, USA, Canada, Botswana and South Africa. Our experience with projects indicates many potential pit falls in the estimation of both Resources and Reserves can lead to either overstating or underestimating potential. Geology is a significant control and the 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 in most eastern Australian basins and we have observed that the impact of coal quality and depositional environments are commonly underestimated and some potential gas upside is not necessarily captured from other aspects associated with coal seam gas analysis. The coal seam environment is complex comprising fluvial deposition in upper to lower delta plain settings where the complex interaction of sedimentary deposition 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. 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 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 common relatively small faults (<5 metres) to 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). Deeper coals can be significantly undersaturated 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 poor permeabilities that require lateral wells to achieve reasonable productivity.

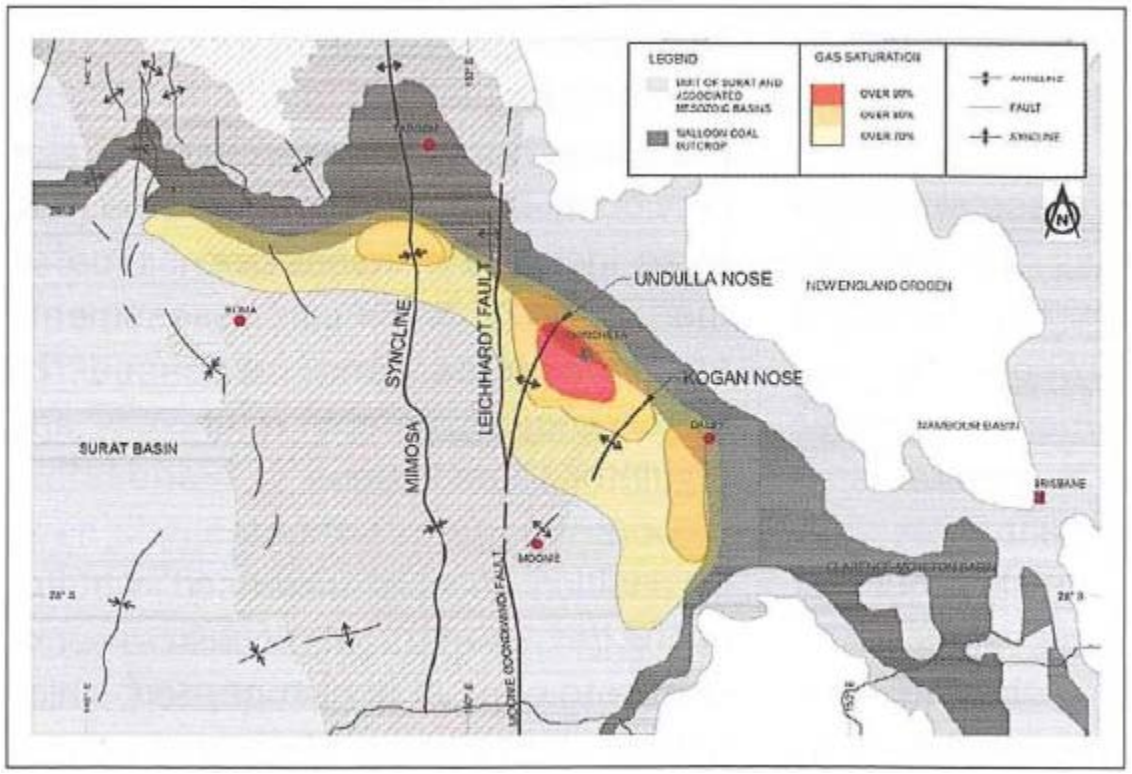

Figure 1. Surat Basin methane saturation trend (modified after Hamilton et al., 2012).

In shallow CSG reservoirs, it is common for methane distribution to oppose 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 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.

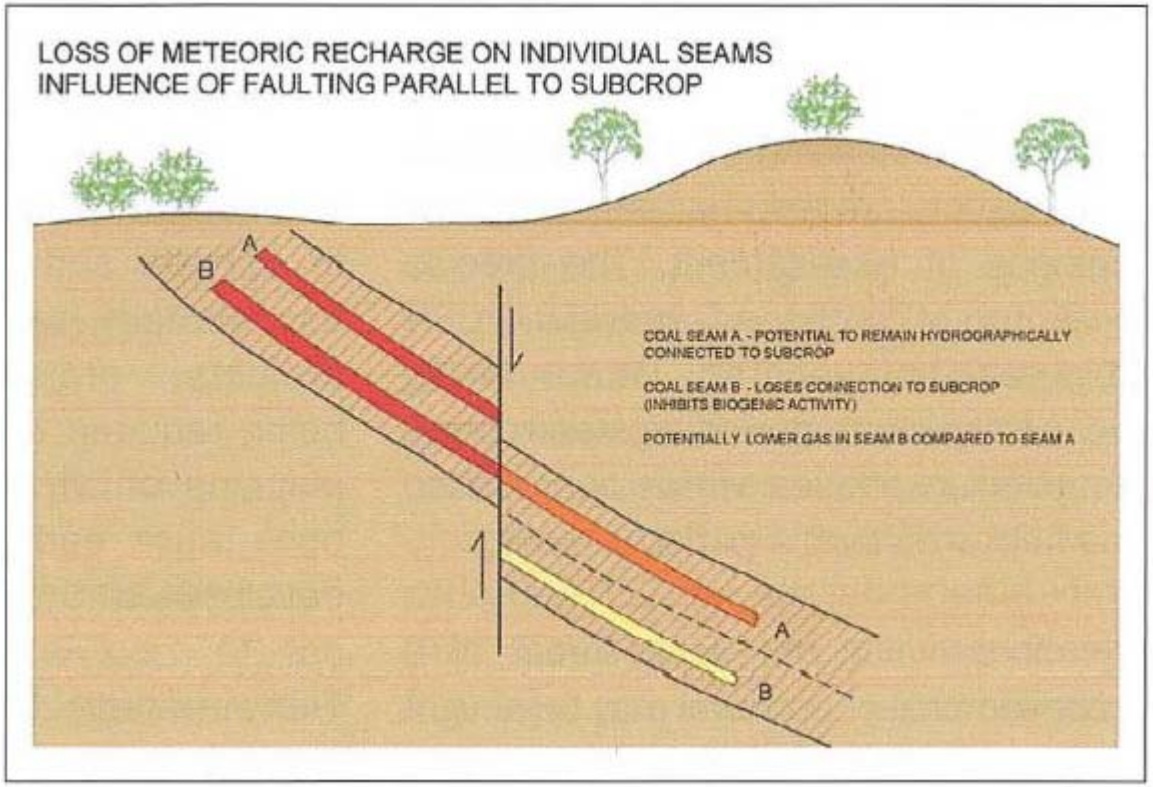

Figure 2. Potential impact of a fault on biogenic recharge.

In the southern Sydney Basin, meteoric influx is an important aspect to identify the productive basin areas and ethane presence 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 CO_2 occurrences that can increase with depth. By comparison, to the nearby Hunter Valley, 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 (Figures 3 and 4).

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

Figure 4. Coal seam gas typically bubbling from core 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 that the 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.

The associated gases in coal and their influence on reserves designations is particularly important in the Gunnedah Basin where early production and even well test data may not reflect the gross reservoir gas compositions. A typical production composition change is shown in Figure 5.

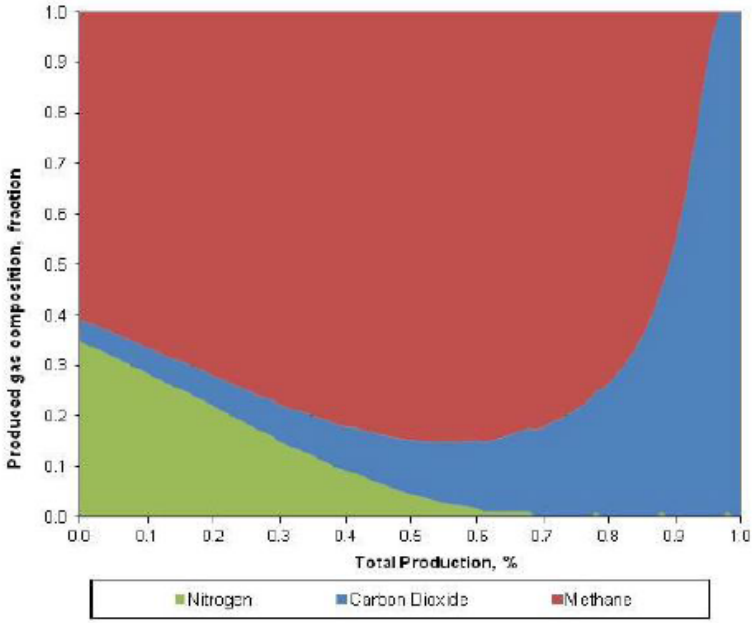

Figure 5. Preferential production of less strongly bound components leads to changes in the composition of the produced gas with time (Barker, 2012).

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.

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,

well cleated; vitrinite-rich coal ply's interbedded with carbonaceous shale, tuffs and mudstones. Average ash contents from samples taken to measure gas content often overestimate the ash content as samples are generally 0.5–1m thick therefore interbeds are sampled along with the brighter cleaner coal, which comprises the main gas-producing unit. An extensive dataset of coal petrology core wells shows the Clarence Moreton Basin coals are commonly vitrinite-rich but only a small proportion of samples have any appreciable amounts of liptinite identified at high levels of maturity that can be used to focus sweet spot identification.

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.

References Cited

Barker G., 2012. CBM Geology & Well Design 5th Annual CBM & Unconventional Gas Wednesday 27 June 2012.

Creech, M and McConachie, B., 2014. Reserve estimation and the influence of coal seams on coal seam gas productivity. AusIMM Bulletin Issue 1 (Feb 2014).

Hamilton S K, Esterle J S and Golding S D, 2012. Geological Interpretation of Gas Content Trends , Walloon Subgroup, Eastern Surat Basin, Queensland, Australia international Journal of Coal Geology 101 (2012) 21-35.

Scott A R, Kaiser W R and Ayers W B Jr, 1994. Thermogenic and Secondary Biogenic Gases, San Juan Basin, Colorado and New Mexico - Implications for Coalbed Gas Producibility AAPG Bulletin, Vol 78, No 8 (August 1994), pp 1186-09.