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Sedimentological and Hydrostratigraphical Characterisation of the Springbok Sandstone

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Abstract

The Springbok Sandstone unconformably overlies the productive Walloon Subgroup on the eastern margin of the Surat Basin. The formation is an important source of water for domestic supply and agriculture. A detailed understanding of the controls on aquifer properties and distribution in the Springbok Sandstone is essential to ensure effective aquifer isolation during coal seam gas (CSG) production and to manage any impacts.

The large dataset available from petroleum development drilling and associated groundwater monitoring includes core from 11 wells and wireline-log data from more than 840, allowing a detailed re-assessment of the characteristics of the Springbok Sandstone. Detailed core description, routine and special core analyses have been integrated to; 1), develop an updated sedimentological model; 2), evaluate the controls on aquifer properties; and 3), investigate spatial distribution of aquifer units. These core observations have been combined with petrophysical interpretation to enable a tenement-wide review of Springbok Sandstone aquifer properties.

This study forms part of a broader work effort within QGC to review and enhance the sedimentological, geological and hydrogeological understanding of those formations proximal to the productive Walloon Subgroup that could be affected by CSG development.

The Springbok Sandstone is a low energy fluvial system, associated with a reduction of accommodation space within the Surat Basin at the start of the late Jurassic (Green et al., 1997). The base of the Springbok Sandstone is an unconformity (Green et al., 1997; Scott et al., 2004) interpreted as a sequence boundary and identified in this study based on a change in sediment composition. The unit crops out in the northern and eastern parts of the study area and deepens towards the main basin axis towards the southwest (Figure 1).

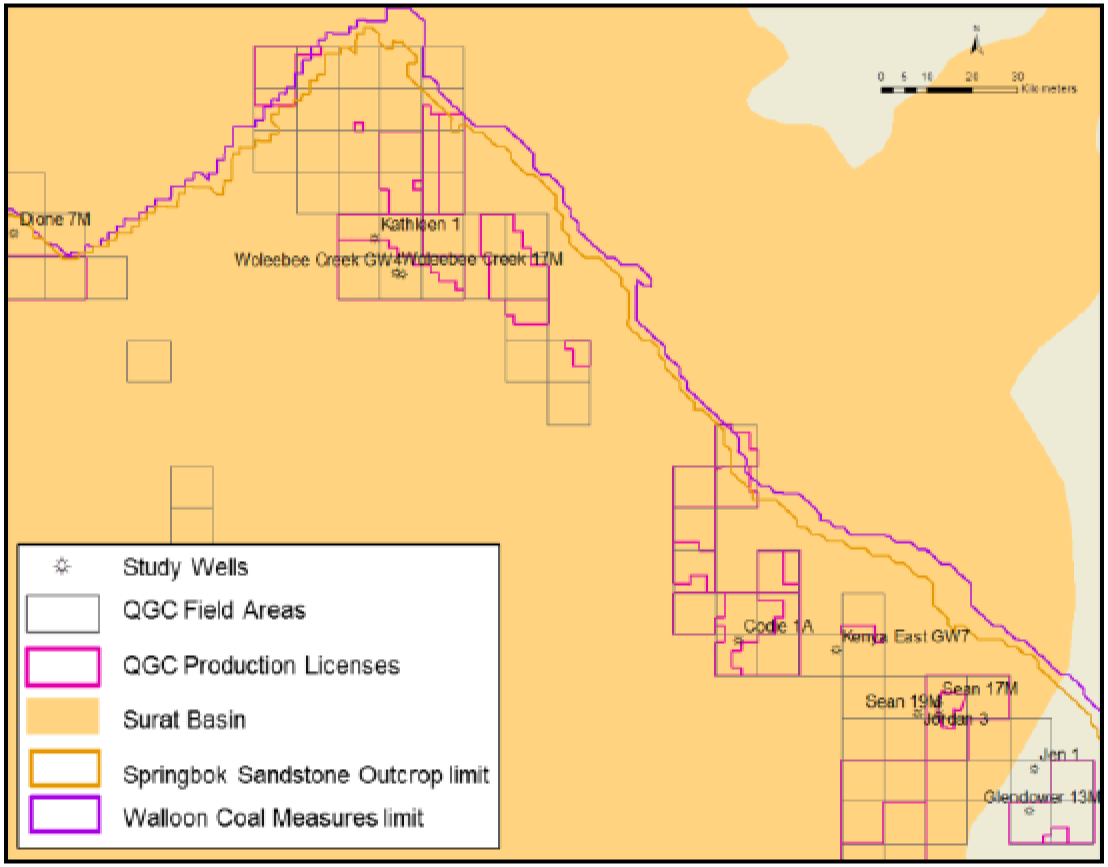

Figure 1. Study Area on northeastern flank of the Surat Basin with key wells highlighted.

Sedimentological core analysis has identified two main facies associations: Channel, which is subdivided into multistory and single storey forms; and Overbank. These associations stack to form a series of upwards fining units that vary in thickness from 8 to 30 m. Routine core analysis highlights that within these units, the higher energy channel deposits typically exhibit the best aquifer properties (higher porosity and permeability) whilst the intervening overbank deposits are baffles or barriers to flow (lower porosity and permeability; Figure 2). However, there is a broad range in measured values associated with both facies associations highlighting that other factors are important in determining aquifer properties. A modified Lorenz plot can be used to highlight the variability within the Springbok Sandstone, highlighting flow units and baffles or barriers to flow (Figure 2). From this, it is possible to group the upwards fining units into four broadly upwards-fining packages (internally referred to as Springbok 10-40) that can be correlated throughout the study area.

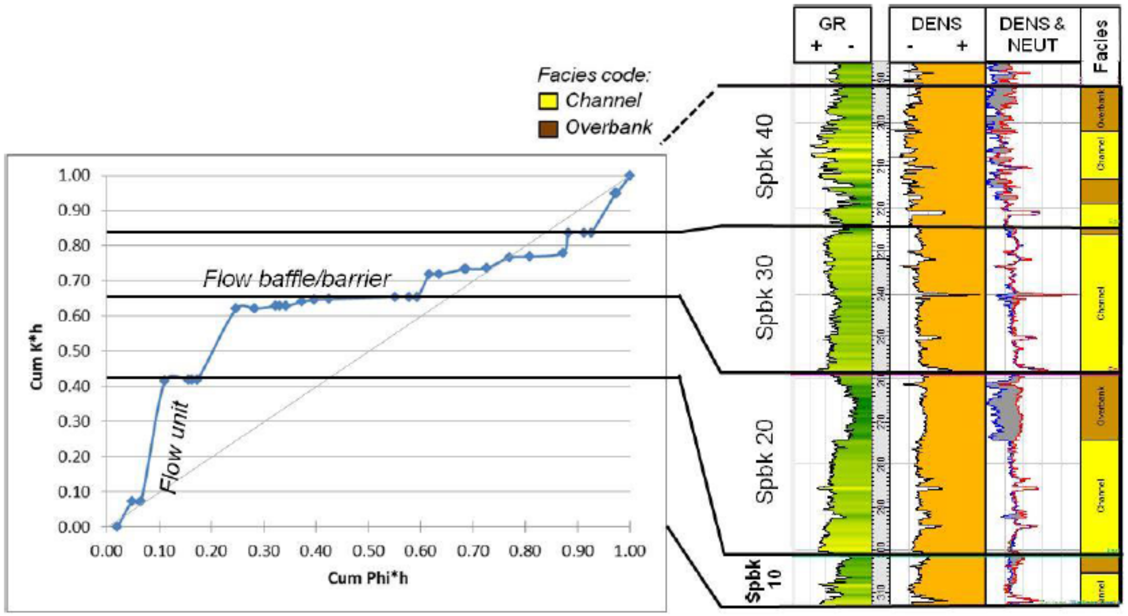

Figure 2. Example of flow units identified from modified-Lorenz plot using RCA derived porosity and permeability data. Note the steep portions of the graph reflect flow units, which correlate to aquifer-prone, channel facies, whilst the shallow or flat sections of the graph correlate to the overbank facies.

Petrographical and multivariate rock quality analyses were used to investigate the controls on rock quality. The dominant controls are identified as composition and, as a corollary, compaction whilst additional minor control is exerted by grainsize, sorting and cementation. Wireline-log data were combined with routine core analysis and mineralogical composition to enable petrophysical calibration to rock properties. Petrophysical interpretation was extended into uncored wells to generate a permeability log. Cut-offs were applied to the permeability log to determine the proportions of aquifer and aquitard within the section, away from core control.

Overall, the interplay of the rock quality controlling factors means the bulk of the Springbok Sandstone is classified as an aquitard, with just 13% of the section studied exhibiting sufficient permeability to be considered an aquifer (Figure 3). The proportion of aquifer-quality intervals varies both spatially and vertically, associated with changes in sediment composition and variability within the depositional system.

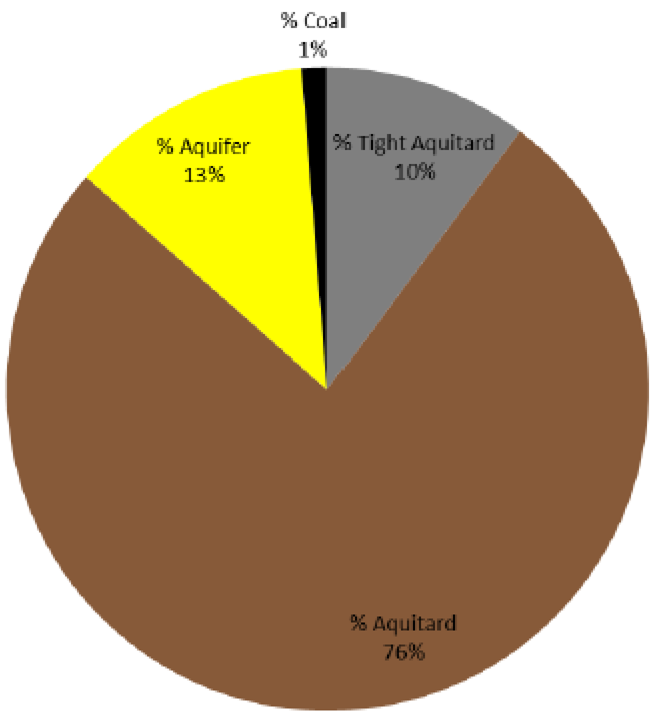

Figure 3. Proportion of aquifer and aquitard units identified from petrophysical interpretation within the Springbok Sandstone in this study area.

The identified flow units within the channel sands are highly heterogeneous comprising interbedded aquifer and aquitard units, interpreted to reflect variations in composition, grain size, sorting and cementation associated with different flow events. Spatial variability is also seen in the proportion of aquifer developed across the study area with higher volumes of aquifer identified to the south and east, attributed to variability in composition. The results of this study forms part of a larger study to improve our understanding of how the risk of aquifer impact varies through the tenements and how to effectively isolate the unit from CSG water extraction from the Walloon Subgroup while maximising access to resource.

References Cited

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