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Prediction of Seals Performance for CSG Production Impact Assessment

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Abstract

Early in the development cycle of onshore gas such as Coal Seam Gas (CSG), operating company Environmental Impact Statements and regulatory agency assessments, need to consider the potential for gas development impacts on other resources including groundwater. Two main considerations are 1) the degree to which de-pressuring the CSG reservoir may also de-pressure adjacent aquifers containing usable water resources; and 2) the effectiveness of production bores in capturing liberated methane from the de-pressured coal reservoir. To a large degree these depend firstly on our ability to forecast the volume of associated water anticipated to be co-produced in de-pressuring the reservoir and secondly on our ability to forecast the continuity and performance of seals (top, bottom, intraformational and fault seal) within the stratigraphic succession. Unfortunately, this is also when there is the least amount of data to constrain the problem and history shows that we tend to overestimate both the volume of associated water and the relative hydraulic continuity of the strata. This was certainly the case for Coal Bed Methane (CBM) development in the US since 1990 and early production data from Queensland suggests that actual associated water volumes are less than originally anticipated and there is less hydraulic connectivity of Great Artesian Basin (GAB) aquifers than anticipated due to the highly heterogeneous nature of the strata.

Basin Resources

The Surat and Bowen basins contain minable high quality black coal, coal seam gas and conventional gas with minor volumes of oil. The upper units of the stratigraphic succession make up part of the geographically more regional GAB groundwater resources from which more than 200 GL/yr is produced from the Surat Basin alone for agricultural, industrial and municipal use (OGIA, 2012). Other resources with future potential include geothermal, shale gas, and carbon storage capacity.

Basin Seals

In order to increase the confidence of forecasting basin resource interaction in the Surat and Bowen basins, predicting the distribution, continuity and performance of the sealing strata is critical. We use basin hydrodynamic characterisation combined with a hydrocarbon systems approach to characterising seals. The stratigraphic architecture is dominated by continental fluvial sedimentation with stacked fining upwards sequences with minor marine influences. Down cutting erosional channels can short-circuit otherwise more regionally continuous seals, thus also affecting seals performance. A majority of the structures in the basin terminates at the top of the Permian, however, in situ stress and sub-seismic strain distribution can be evaluated in relation to hydrodynamic evidence of seal performance. Seals analysis techniques can also be supplemented with the fingerprints of geological time-scale migration pathways that are evidenced in hydrocarbon shows that can be found for

example in drilling mud logs. For example, Figure 1 indicates Surat basin wells with hydrocarbon shows in the Gubberamunda strata on the left and Westbourne strata on the right. These are in the upper part of the sequence above the main source rocks for hydrocarbons. Shows can be seen in relation to the main structural elements.

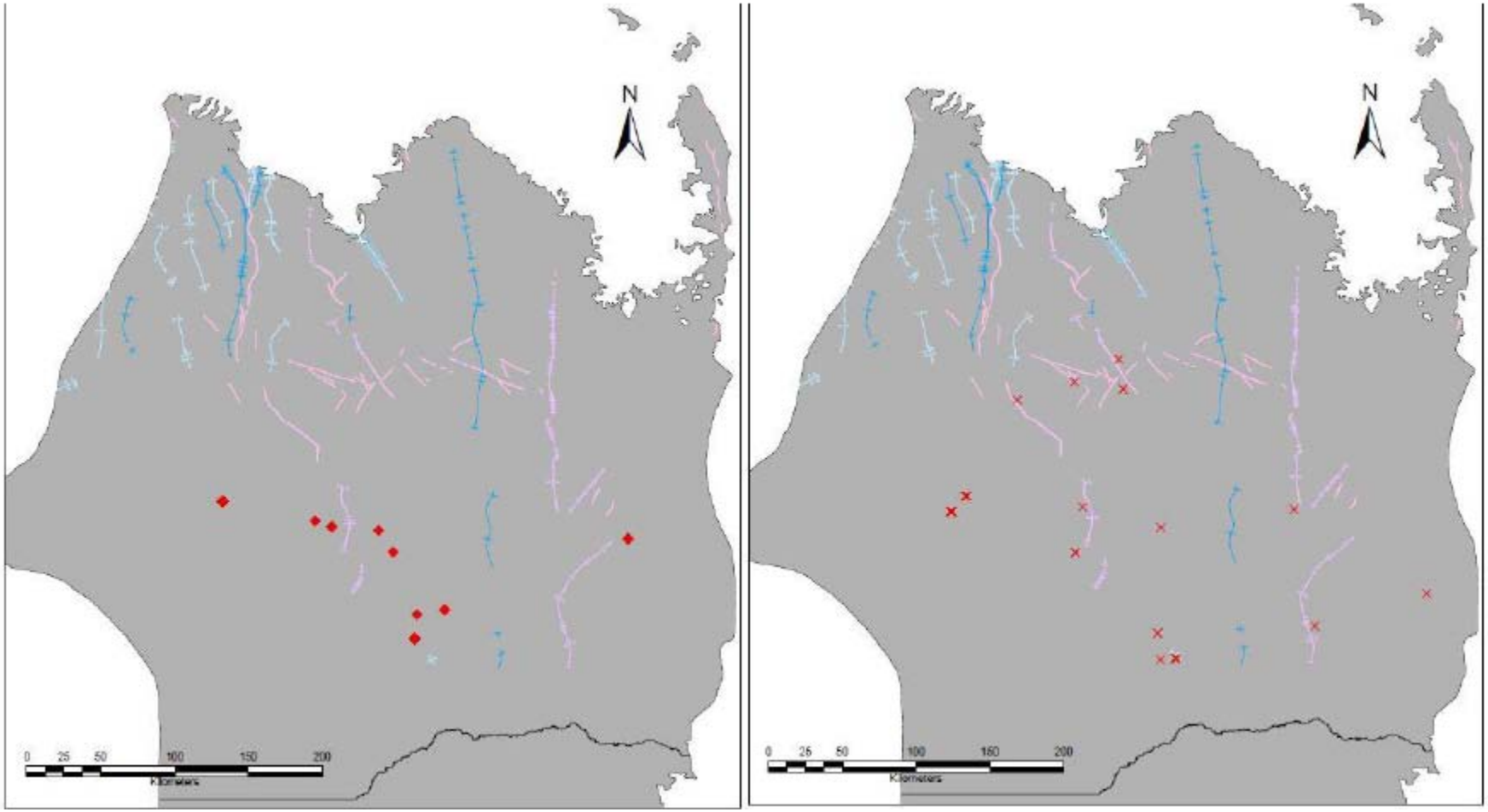

Figure 1. Surat basin wells with hydrocarbon shows in the Gubberamunda strata on the left and Westbourne strata on the right. Structural elements are indicated with anticlines and synclines in light and dark blue and faults in pink.

Application

With an improved understanding of the nature and performance potential of seals in the basin architecture that is grounded in the evidence of a hydrocarbon systems analysis, we have the basis of a better parametrisation of regional dynamic reservoir and basin models. This should lead to improved estimates of pressure decline impacts on aquifers adjacent to the CSG reservoirs. The hydrocarbon systems analysis will also identify natural hydrocarbon migration pathways between source rocks and the surface. The flux of methane given the complication of historical GAB water level decline could be modelled where total methane flux to surface is a combination of 1) natural migration, 2) methane coming out of solution from saturated groundwater, 3) non-economic coals that have been reduced below their critical desorption pressure, and 4) shallow methanogenisis. These modelled fluxes would give context to surface measurements and help assess the risk that methane emissions are fugitive to CSG operations or not. Finally, the results of this work could help design optimal monitoring design for both aquifer water levels and surface or soil gas methane flux.

Reference Cited

OGIA, Queensland Water Commission 2012, Underground water impact report. 224 p.