Re-evaluation of structure and sedimentary packages in the eastern Surat Basin

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After a long well established history of conventional gas exploration, the eastern Surat Basin has now re-emerged as an active regional exploration target for thermal coal, coalbed methane, underground coal gasification and carbon dioxide sequestration sites. This study was initiated by CSIRO Exploration & Mining to re-evaluate the structure and sedimentary architecture of the eastern Surat Basin as part of a broader evaluation of underground coal gasification. The output is a new integrated regional geological model of the eastern Surat Basin interpreted from public domain data including petroleum well and waterbore data, published maps, seismic data and regional magnetic and gravity datasets. Particular focus was given to a characterisation of the Walloon Coal Measures, particularly the regional correlation of coal seam packages.

Most of the effort to build a 3D model of formation tops and coal seam packages went into compiling, checking and re-correlating wireline data from petroleum and water wells. The existing borehole data as published is up to 40 years old, and contains major inconsistencies and miscorrelations which needed to be reinterpreted to feed into a consistent model. Comparison of the new well-based model to an older seismic horizon model built by Geoscience Australia showed a reasonable match, although the match is not good enough to fully integrate the two models.

The eastern Surat Basin for the most part lies directly on older metamorphic rocks, and is characterised by significantly thinner sediments than further west. Evidence of onlap margins for the Precipice Sandstone and Evergreen Formation suggests proximity to the basin margin at least during the early stages of basin formation.

Formation isopachs for the 10 formations present in the eastern Surat Basin highlight the presence of five sequences, each consisting of thick north-south trending channelised sandstone units followed by broader, more sheet and wedge shaped units containing finer grained sediments deposited by meandering streams and lake deposits. Differential compaction caused inheritance in sediment deposition patterns resulting in upsection offset stacking of thick channelised units. The apparent northward thickening of the Walloon Coal Measures is caused by erosion rather than deposition, recording the only significant unconformity in the Surat Basin.

Correlation of wireline logs within the Walloon Coal Measures show the presence of five coal-rich intervals separated by sandstone-rich intervals. The topmost three intervals are progressively eroded to the south highlighting the unconformable contact with the overlying Springbok Sandstone. The study demonstrated that the known coal deposits do not directly correlate, but are positioned within the different coal-rich intervals that exhibit differing depositional styles up section. The coal-rich intervals record an evolution from laterally continuous, thin to thick unsplit seams to discontinuous and split seams to very thick coal seam pods that split rapidly into thick interburden sandstones. This vertical pattern is consistent with a southerly prograding fluvio-deltaic model for the Walloon Coal Measures.

Structure in the region is dominated by the Leichardt-Moonie structure and its subsidiary faults. The structure initiated as an active scarp during the Triassic (Moolayember Formation), and remained gently active throughout most of the Surat Basin fill deposition controlling facies distribution and the offset stacking observed in the channelised units. The faults reactivated later to cause brittle faults that may be related to gentle folding.

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