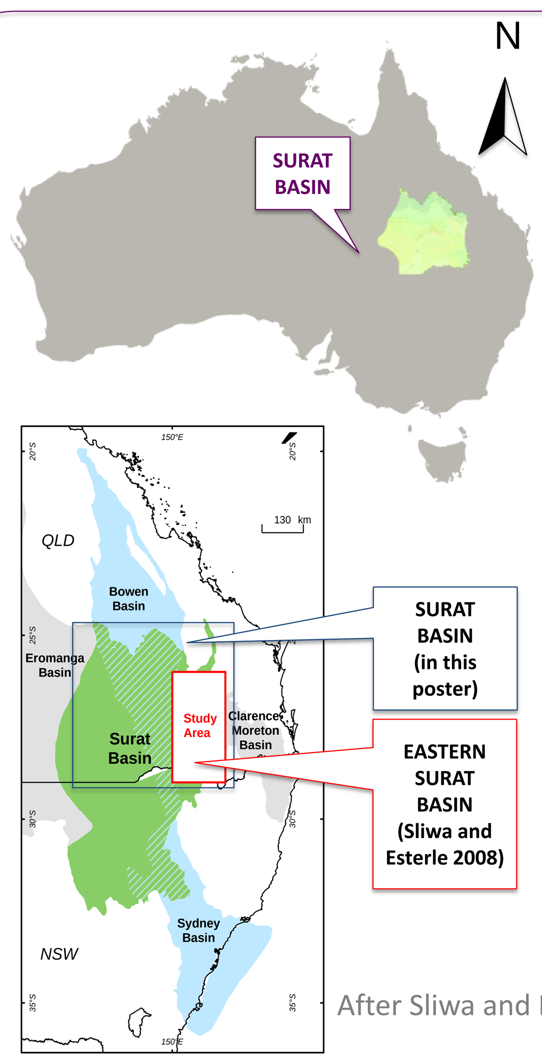
Re-adjusting paleodrainage in the Surat Basin infill from new data

Valeria Bianchi [1], Fengde Zhou[1], Renate Sliwa[2] & Joan Esterle [1]

(1) School of Earth Sciences, University of Queensland, Australia

(2) Integrated Geoscience, Pty. Ltd

ABSTRACT



After Sliwa and Esterle, 2008

Just recently the release of more than 6000 wells in the public domain has provided an opportunity to revisit the thickness distribution of formations within the Surat Basin, from both conventional and unconventional targets. This study expands on previous work from the eastern margin by Sliwa and Esterle (2008), to the whole of Surat Basin.

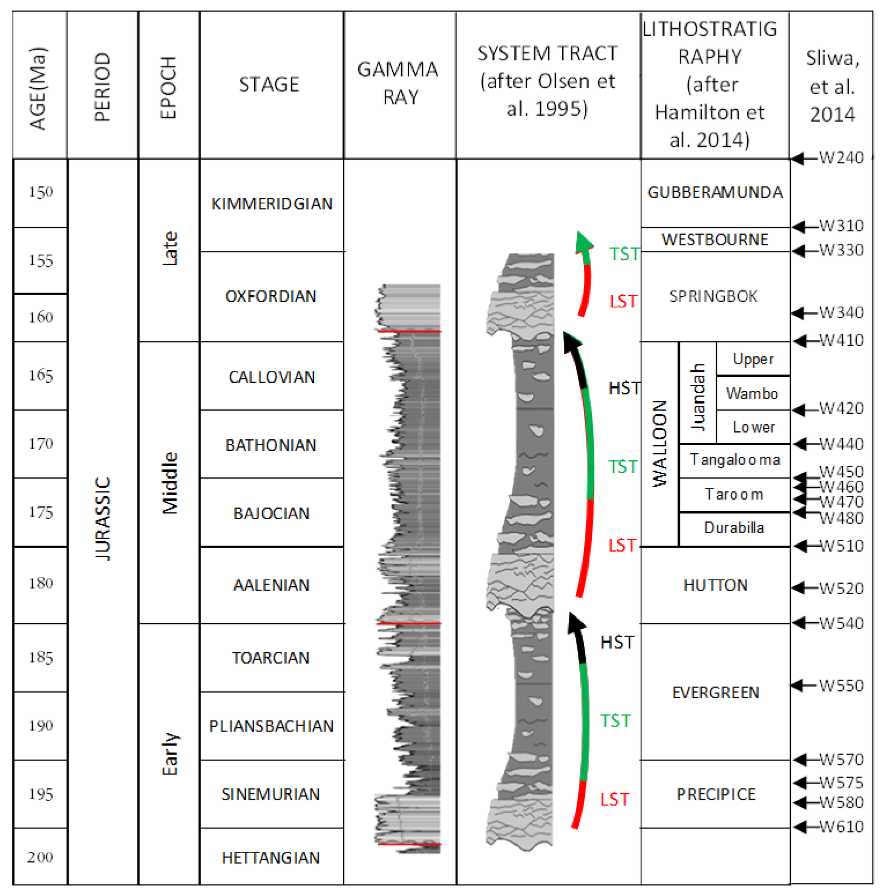
The output is an integrated regional geological model of the Surat Basin interpreted from public domain data including petroleum well and waterbore data, published maps, seismic data and regional magnetic and gravity datasets. The integration of image and acoustic data enriches the paleodrainage information detecting different flow vectors and direction through stratigraphic intervals.

The 3D model was built from a consistent correlation of formation tops and coal seam packages (Sliwa, 2014; Bianchi et al, 2016; Zhou, unpublished) using wireline log data from petroleum and water wells. Wireline logs were normalised to the same API range for interpretation of lithologies, and in some units wireline motif was used to further define depositional elements (primary channel thalwegs and point bars, floodplain, peat mire).

Formation and sandstone thickness maps for twelve subdivision formations present in the Surat Basin show their relationship with the structural setting resulting in the formation of certain paleodrainage. The switching of paleocurrent direction in different formations is an expression of a basin scale tilting.

INTRODUCTION

The Jurassic Surat Basin is partly located above the Permo-Triassic Bowen Basin and the metamorphic basement. The basic stratigraphic units used in this study are shown in the figure to the right. The relict lineaments derived from original basin flanks have an expression on the Moonie-Goondiwindi Fault in the Surat Basin sedimentary succession. Recently, the effect of a far-field subduction takes over the original intracratonic sag basin theory. Those effects are consistent with a dynamic tilting of the platform creating dynamic topography with alternation of subsidence and uplift pulses expressed by internal basin wide unconformities, such as the Springbok unconformity (Bianchi et al., 2016b). Studies by Korsch and Totterdell, 2009 and others (Raza et al., 2009; Waschbusch, 2009; Hamilton et al., 2014) support this hypothesis, which invoke the far-field effect of subduction-related dynamic tilting.



Sequence and litho-stratigraphic subdivisions of the Surat Basin (after Shields and Esterle, 2015)

APPROACH

SOURCE DATA

Public domain data were compiled and quality controlled:

- 2408 wells with digital lithology data;
- Wireline log data;
- Selected seismic lines for structural interpretation;

SOLID CORRELATION DATABASE

OGIA model with welltops (3557 wells on the Springbok unconformity) and horizons

PALEOCURRENT DIRECTION FROM IMAGE LOGS

Springbok Sandstone: 30 wells were interpreted;
Walloon CM: 16 wells were interpreted;
Hutton Sandstone: 6 wells were interpreted;
Precipice Sandstone: 2 wells interpreted plus outcrop information.

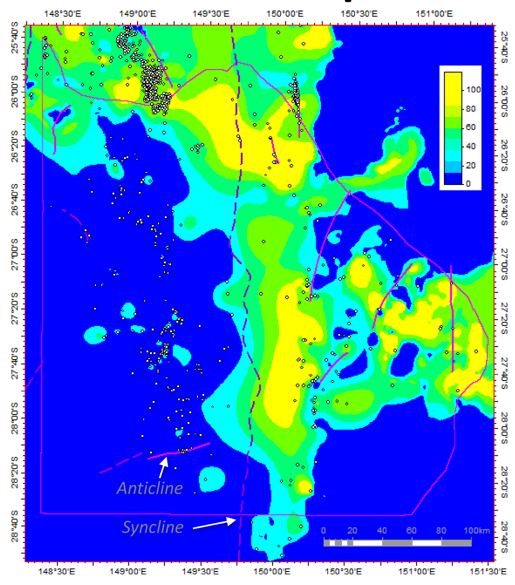
MAPS

- Unit thickness was contoured for all the units in the Surat Basin based on the horizons from the OGIA model;
- Sandstone thickness was contoured for all units in the Surat Basin based on the calculated sandstone thickness at boreholes

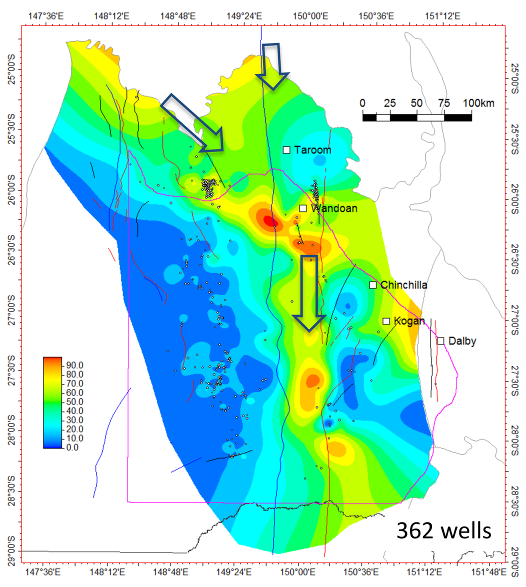
RESULTS

Unit thickness distribution / Sandstone thickness distribution

Lower Precipice



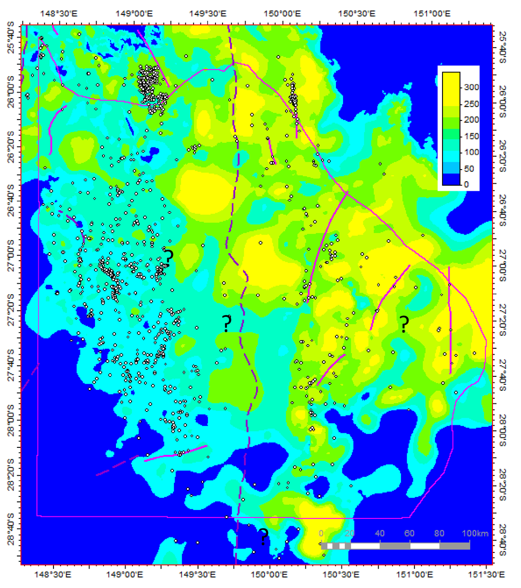
The Lower Precipice Sandstone depocenter follows a NW-SE trend on the north and the Mimosa Syncline on the south.



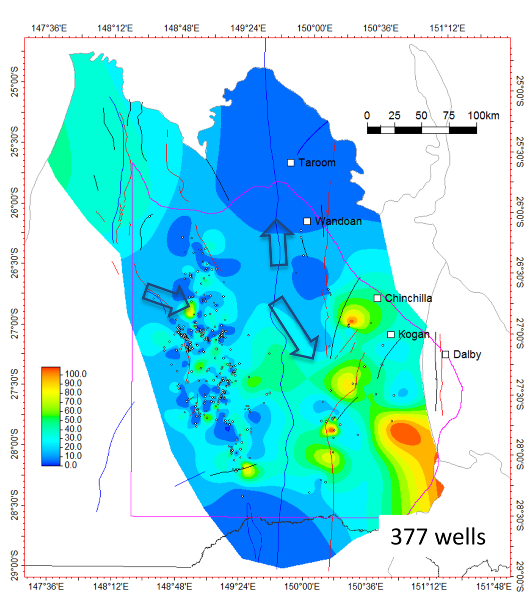
The Lower Precipice Sandstone is sourced from the West and is flowing toward the south in NSW, following the trend of the Mimosa Syncline, from the northern potential tributaries. The thickness distribution reflects the fill of the pre-Jurassic topography and activity on the Moonie-Goondiwindi Faults and the Mimosa Syncline.

Solid pattern

Upper Precipice +Evergreen



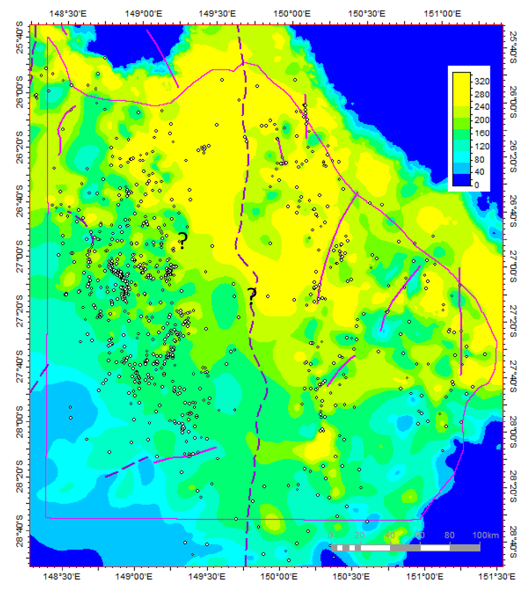
The Upper Precipice Sandstone and Evergreen has a clearer depocenter trending NW-SE as the northern part of the Lower Precipice.



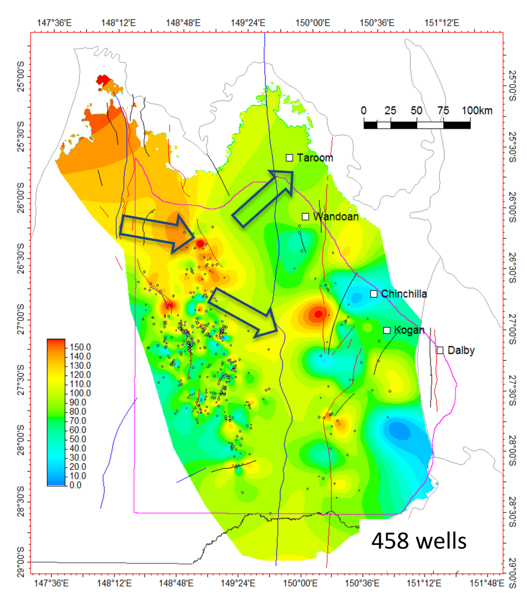
The Upper Precipice Sandstone and Evergreen show a western source but a northward tendency, the southern trunk is still flowing toward the south in NSW.

Deviation/bifurcation northward

Hutton

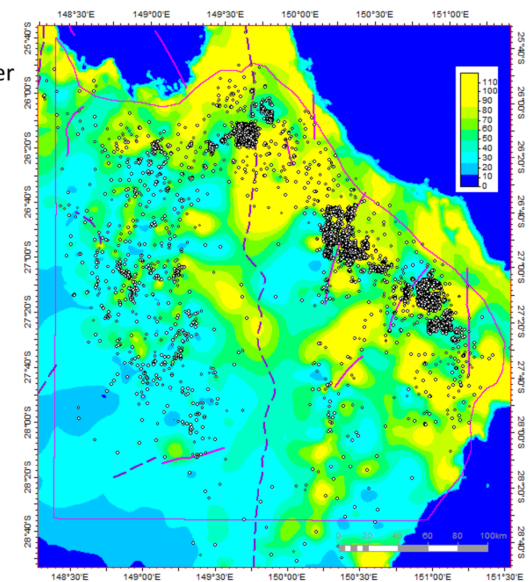


The Hutton Sandstone keeps the relict depocenter trend NW-SE during the Evergreen Formation.

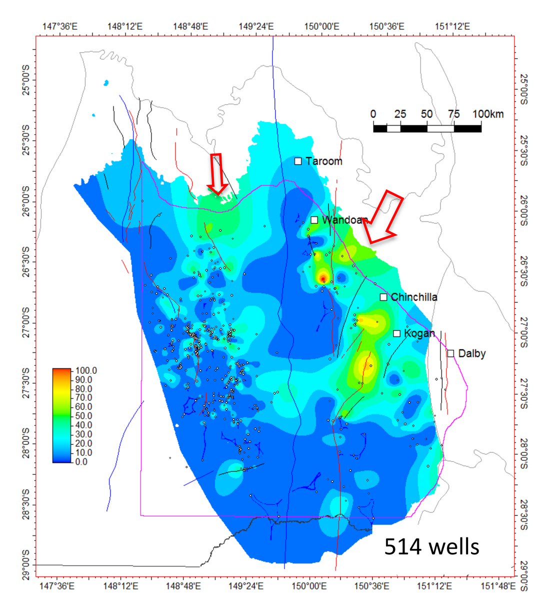


The Hutton Sandstone has a radial dispersal pattern from the NW and it expands radially towards the east. Together with The Upper Precipice and Evergreen it represents an uncertain period for drainage of the basin.

Durabilla



Durabilla's thicker part mimics the previous depocenters with a NW-SE trend

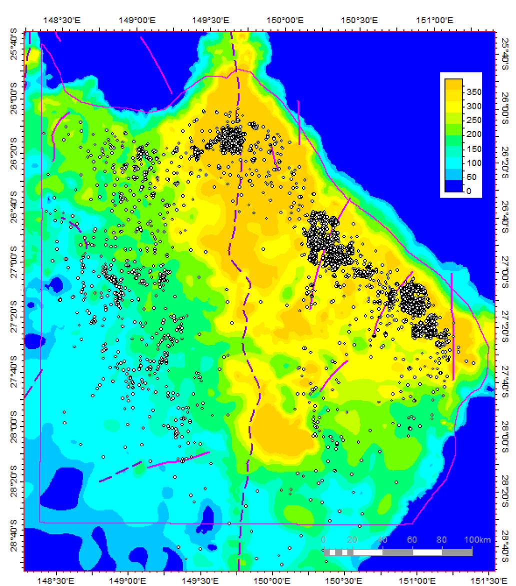


Durabilla is mainly sourced from the NE, has a radial dispersal pattern from the NW and it expands radially towards the east.

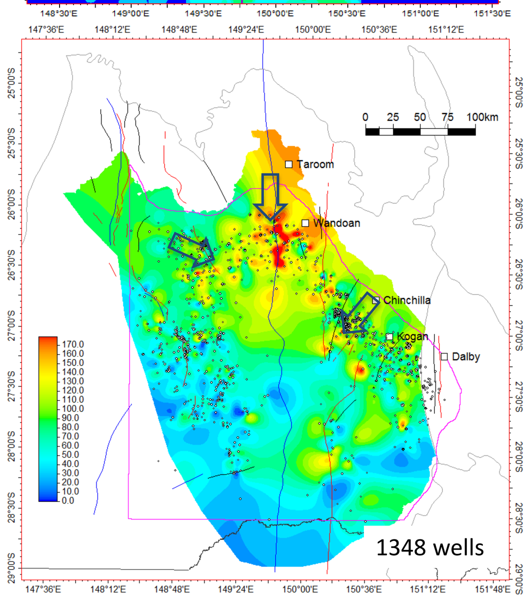
Internal radial pattern

Thicker depocentres aligned with the Moonie-Goondiwindi fault with trend NW-SE in the eastern part of the basin, in all formations from Precipice to Springbok

Walloon



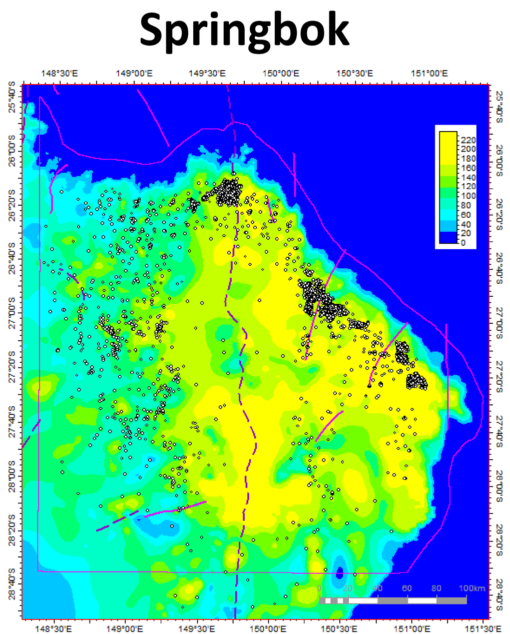
The Walloon Subgroup thicker zone is located on the north and it is triangle-shaped N-S-SE.



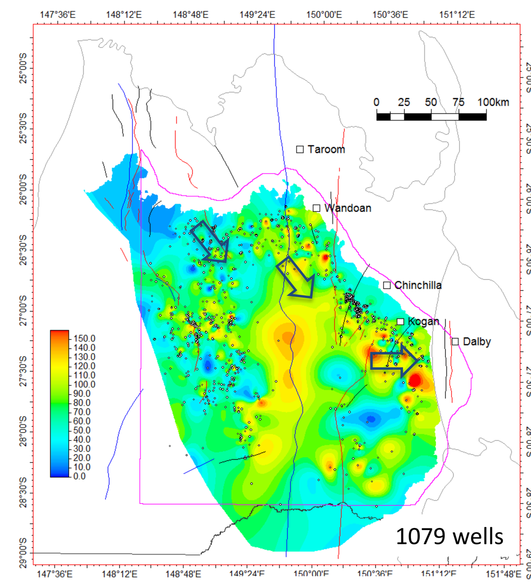
The Walloon Subgroup has an internal radial dispersal pattern mainly from the north and from the east. It is clearly an internal drainage, consistent with the Lake Walloon concept.

Internal radial pattern

Springbok



The Springbok Sandstone has a thick depocenter on the northeastern flank, however it is clearly the beginning of a middle-basin area relevant to the deposition.

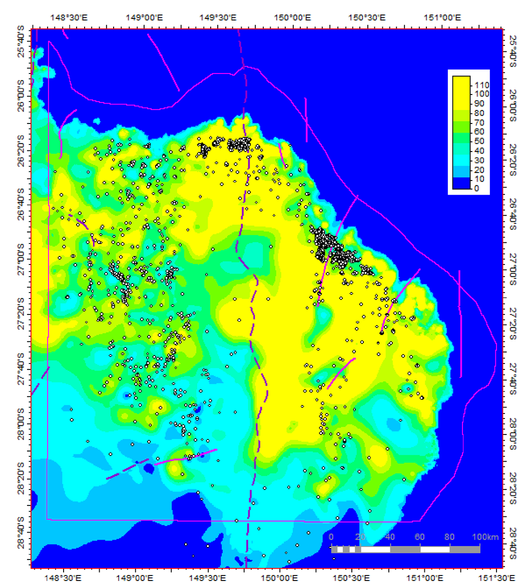


The Springbok Sandstone is sourced from the NW and is flowing in an eastward direction towards the Clarence-Moreton Basin. Again, above the basal unconformity the pattern shows a solid direction to exit from the basin.

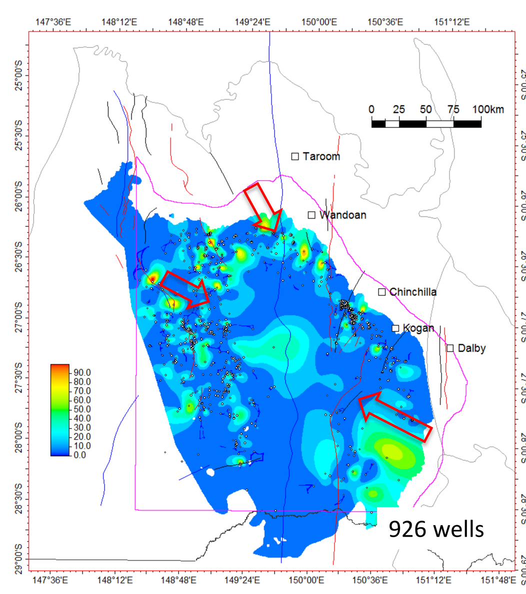
Solid pattern

Thicker depocentres with trend NW-SE in the eastern part of the basin

Westbourne

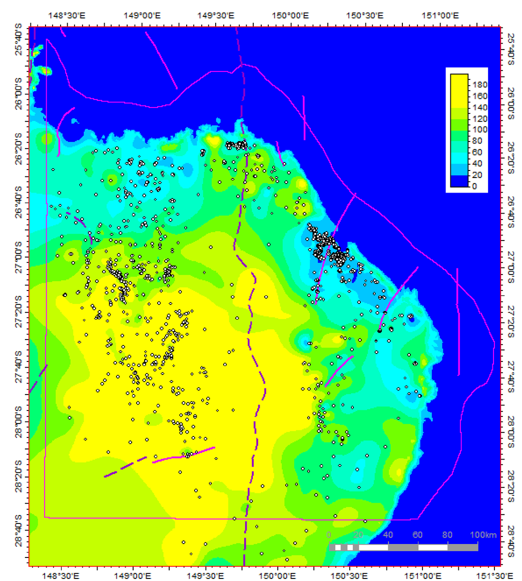


The Westbourne Formation thickness map shows a depocentral thicker area which starts to migrate in the middle of the basin.

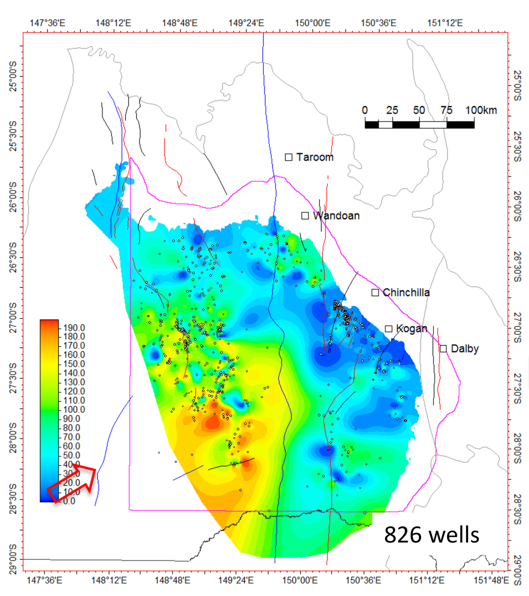


The Westbourne Formation paleodrainage could potentially have a radial pattern as shown in the Walloon Subgroup. Paleocurrent directions here are inferred based on the trend of the main sandy trunks. Unfortunately the nature of the Westbourne doesn't highlight clear sandy trunk, meaning it is probably not-well drained.

Gubberamunda



The Gubberamunda Sandstone thickness map shows a depocentral thicker area in the middle of the basin, as previously shown with Westbourne.



The Gubberamunda could potentially be sourced by the SW in line with the sandy fan shape on the SW.

Measured paleocurrents

Inferred paleocurrents

Thicker depocentres aligned with the middle of the basin in all formations after the Westbourne deposition (although data distribution is sparse in places)

CONCLUSIONS: The depocenters changed in trend and position through the stratigraphy of the Surat Basin, in particular they changed from the basal Precipice to the Springbok Sandstone. The depocentres are aligned with the eastern flank of the basin, probably due to the subtle activity of the Moonie-Goondiwindi Fault system. The Upper Precipice, Evergreen and Hutton show a tendency of the drainage to bifurcate as they have flow vectors northward and southward, possibly due to some dynamic platform tilting. Above every regional unconformity (Precipice and Springbok), the trunk is more clear and has a solid direction. In the Westbourne and Gubberamunda formation the depocentre distribution is located in the middle of the basin, without a particular trend, however, the data are not as well distributed.

ACKNOWLEDGEMENTS: This research has been conducted with the support of the Centre for Coal Seam Gas (UQ) and its industry members – APLNG, Arrow Energy, QGC and Santos. We want to also thank the Office of Groundwater Impact Assessment