THE UNIVERSITY OF QUEENSLAND
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Structural controls on in situ stress and fractures in the Walloon Subgroup, Surat Basin

Saswata Mukherjee, PhD candidate – School of Earth Sciences
Supervisors: Prof J. Esterle, Jeff Copley, Dr. Abbas Babaahmadi
Research Title: Structural controls on the stress and fractures within Walloon Subgroup Surat Basin: A key to understanding Coal Seam Gas reservoir performance

BACKGROUND

Surat basin Coal Seam Gas (CSG) is maturing from exploration to production to meet the targets for the Liquefied Natural Gas projects. This requires effective and predictable reservoir performance that is directly controlled by permeability, gas saturation and matching the well completion technique to the ground conditions. Permeability is a function of stress and fracture, and these will vary at the field scale with the development of larger regional scale faults and folds, and localised "keystone" features. This study will evaluate the role of tectonic reactivation of existing structures within and beneath the Jurassic coal measures sequence and their rheological response to extension, compression and shear as measured by in situ stress and fracture intensity and orientation.

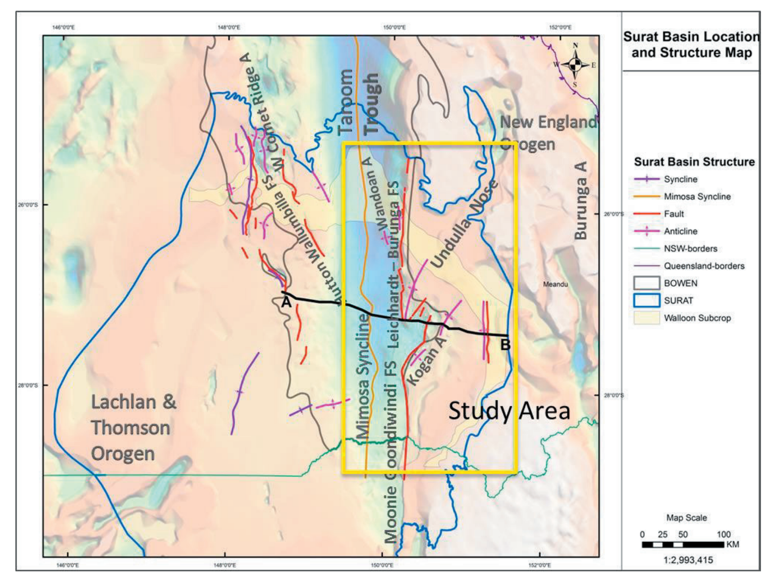

Fig. 1. Location Map of Surat Basin showing major structures within Surat Basin displayed on the Phanerozoic SEEBASE depth to basement map (Oz SEEBASE, 2005)

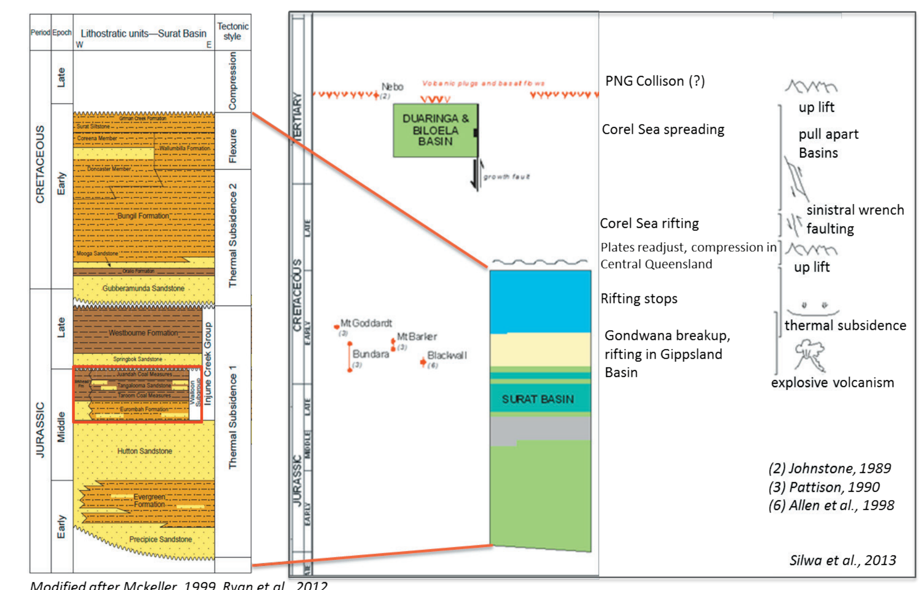

Fig. 2. Surat Basin Stratigraphy and structural events history

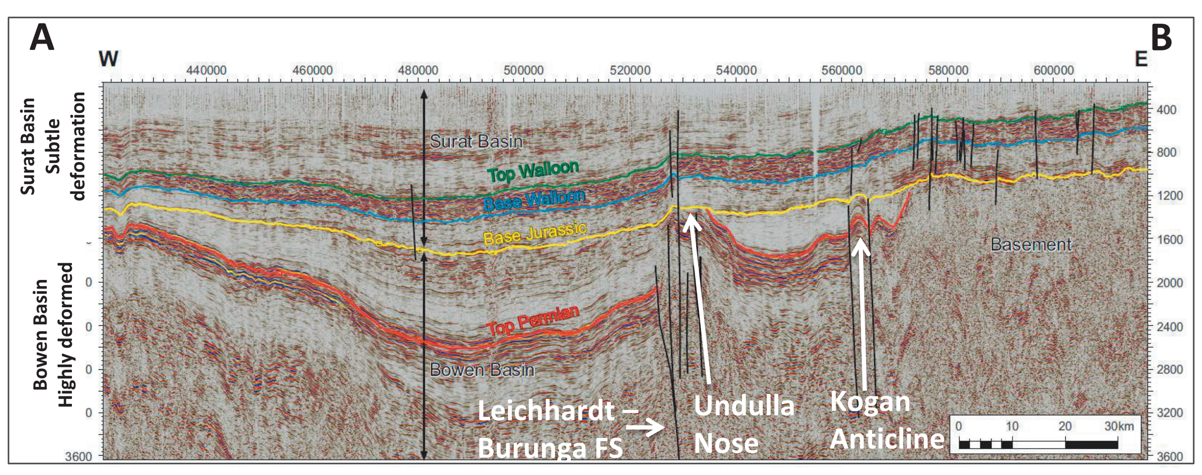

Fig. 3. Regional West – East seismic section (BMR84-14) showing complex Bowen structures and subtle deformation within Surat Basin.

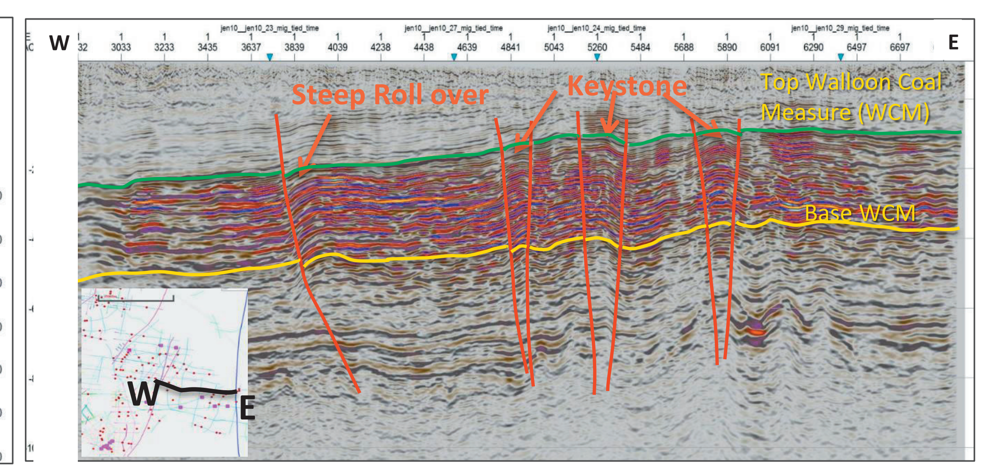

Fig. 4. Examples of "keystone" features observed within eastern part of the Surat Basin. The pink squares on the location map are the keystone features locations and brown points are fault intersection points at base Surat level.

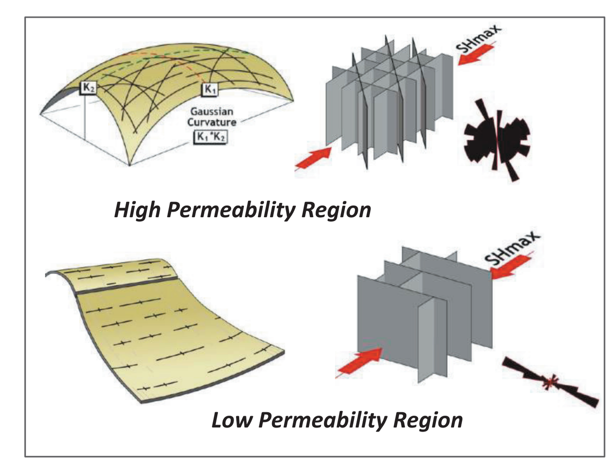

Fig. 5. In situ stress and fracture orientation with permeability (Flottman et. al 2013)

AIMS OF THE STUDY

The major aims of this study are

- To develop regional to local models of the fault and fracture networks relative to major faults, folds and their kinematics;
- To understand controls on the spatial and stratigraphic variability of stress and fracture orientation relative to gas saturation domains (Hamilton et al, 2012) and permeability and their role in known "sweet" and "sour" production spots.
- To link geological variability with reservoir performance in key structural and production domains across the Surat Basin.

BOREHOLE IMAGE LOG ANALYSIS & PRELIMINARY RESULTS

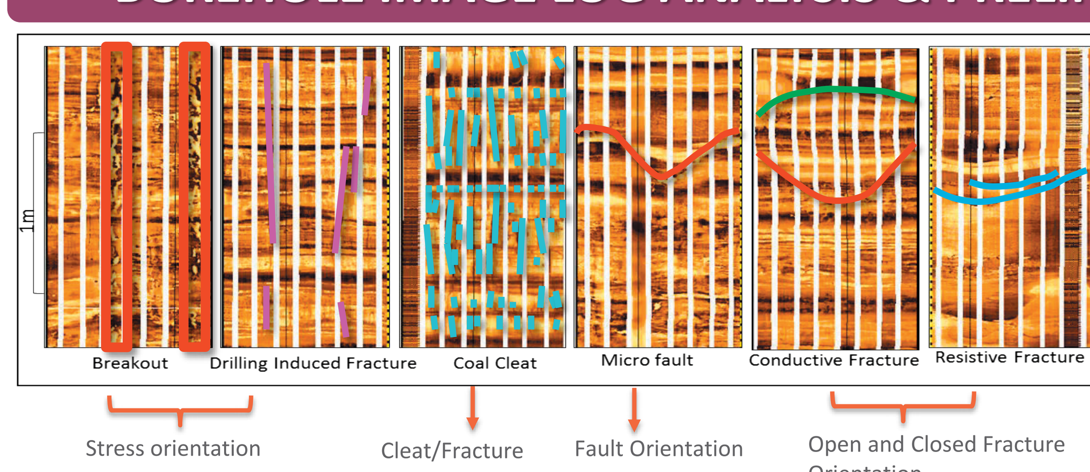

Fig. 6. Examples of structural features observed in borehole image logs

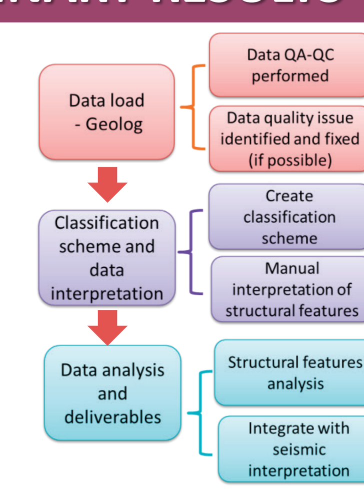

Fig. 7. Image log analysis methodology

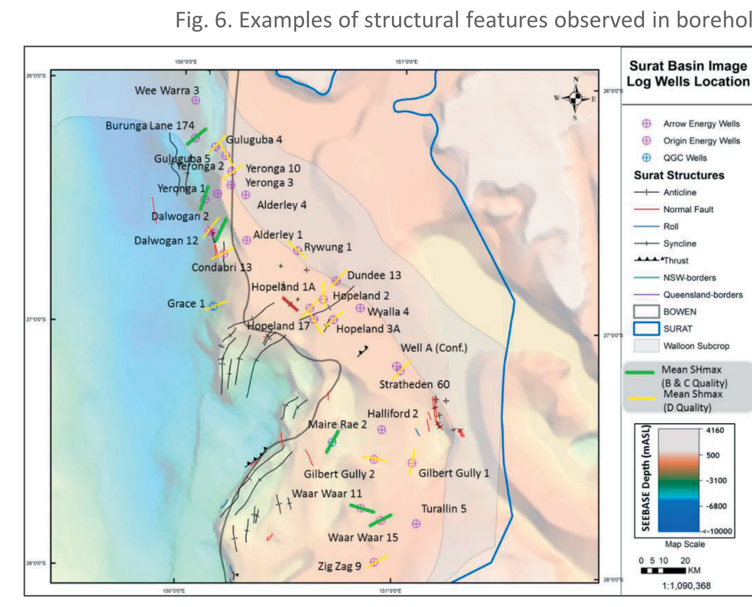

Fig. 8: Map showing Mean Stress Orientations (SHmax) from the interpreted wells

- Overall Mean Maximum Principal Stress (SHmax) is showing NE-SW orientation with stress orientation variation near major basement structures and faults.
- In situ stress orientation change also observed along depth within a well and the variation mainly due to the presence of faults nearby.

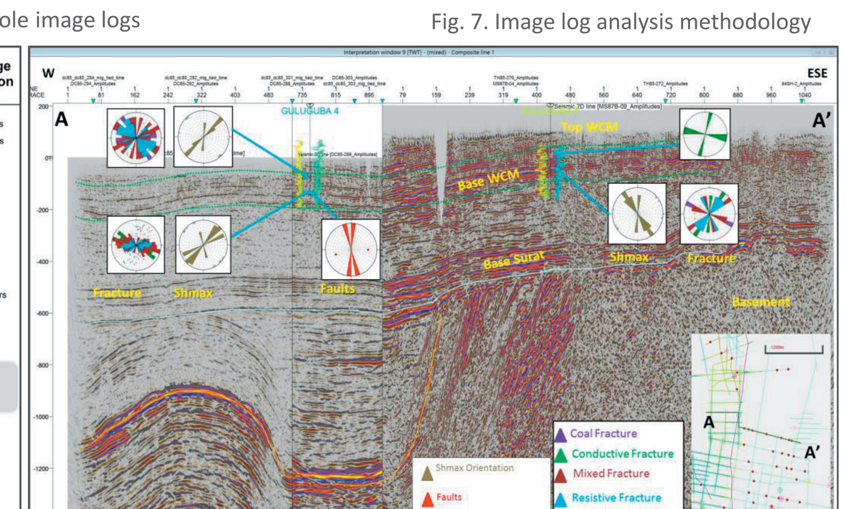

Fig. 9. Seismic section showing in situ stress and fracture variation in the Leichhardt – Burunga Fault System

Western part of the seismic section shows the broad anticlinal features in the deeper Bowen Basin sediments causing gentle flexure within Surat sediments. Also develop lot of fracture within Surat sediments. The stress orientation within Guluguba 4 well dominantly NE-SW but vary slightly with depth.

In the eastern part Surat sediments directly overlies the Palaeozoic basement rock shows rotation in SHmax probably due to stress perturbations from the basement.

METHODOLOGY

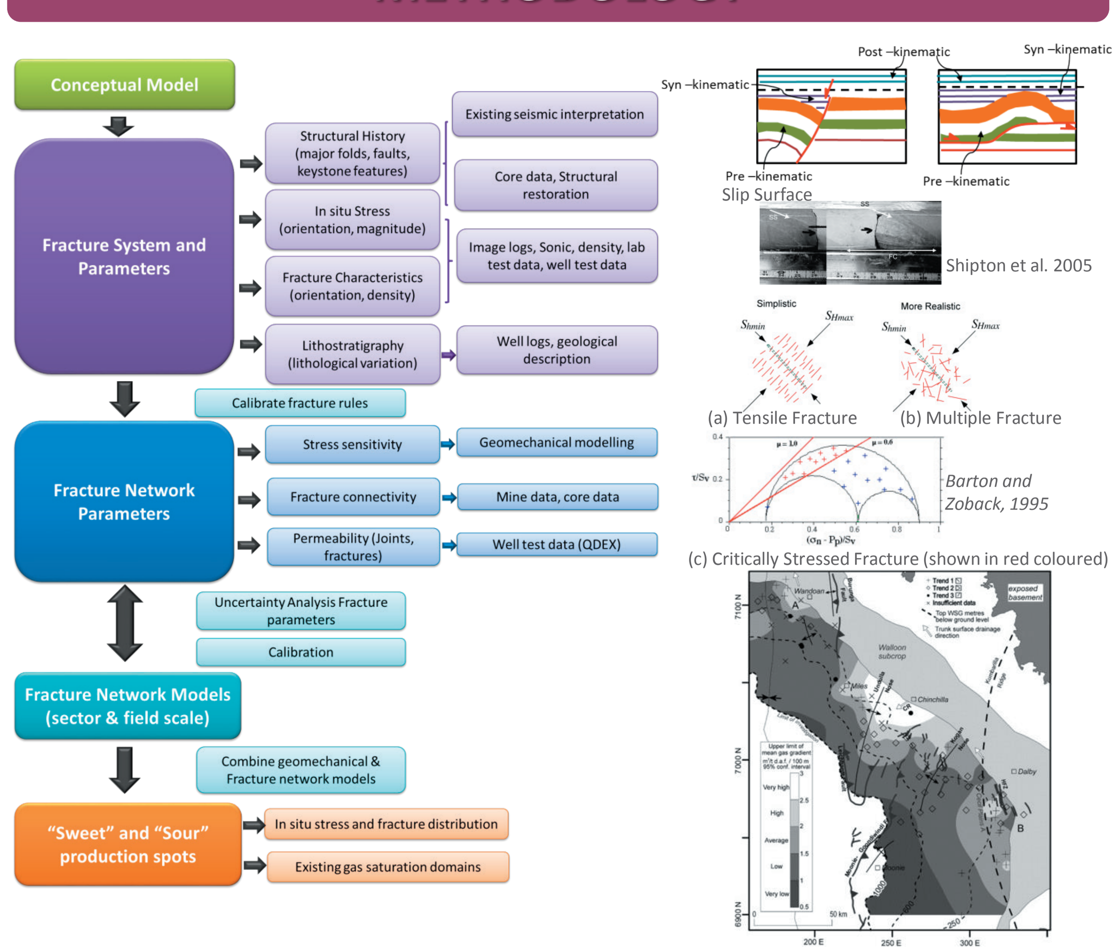

Fig. 10: Methodology

Upper limit of the mean gas gradient map within Walloon Coal Measures (Hamilton et al, 2012)

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CONCLUSIONS

- Deformation in the Surat Basin is characterized by normal faults, folds and 'keystone' features, and developed fractures within Walloon Subgroup which along with the in situ stress controls permeability.
- Present day mean SHmax shows overall NE-SW orientation coinciding with the far field stress.
- SHmax orientation also affected by the near field stress perturbations and deviate from the regional stress orientation near major basement structures, faults.
- Near major basement structures, folds and faults within Surat Basin, fracture character varies spatially and stratigraphically.
- 'Keystone' features are abundant in the eastern part which may develop from the reactivation of the basement structures or oblique slip movement.

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