Santos' CSM Activities

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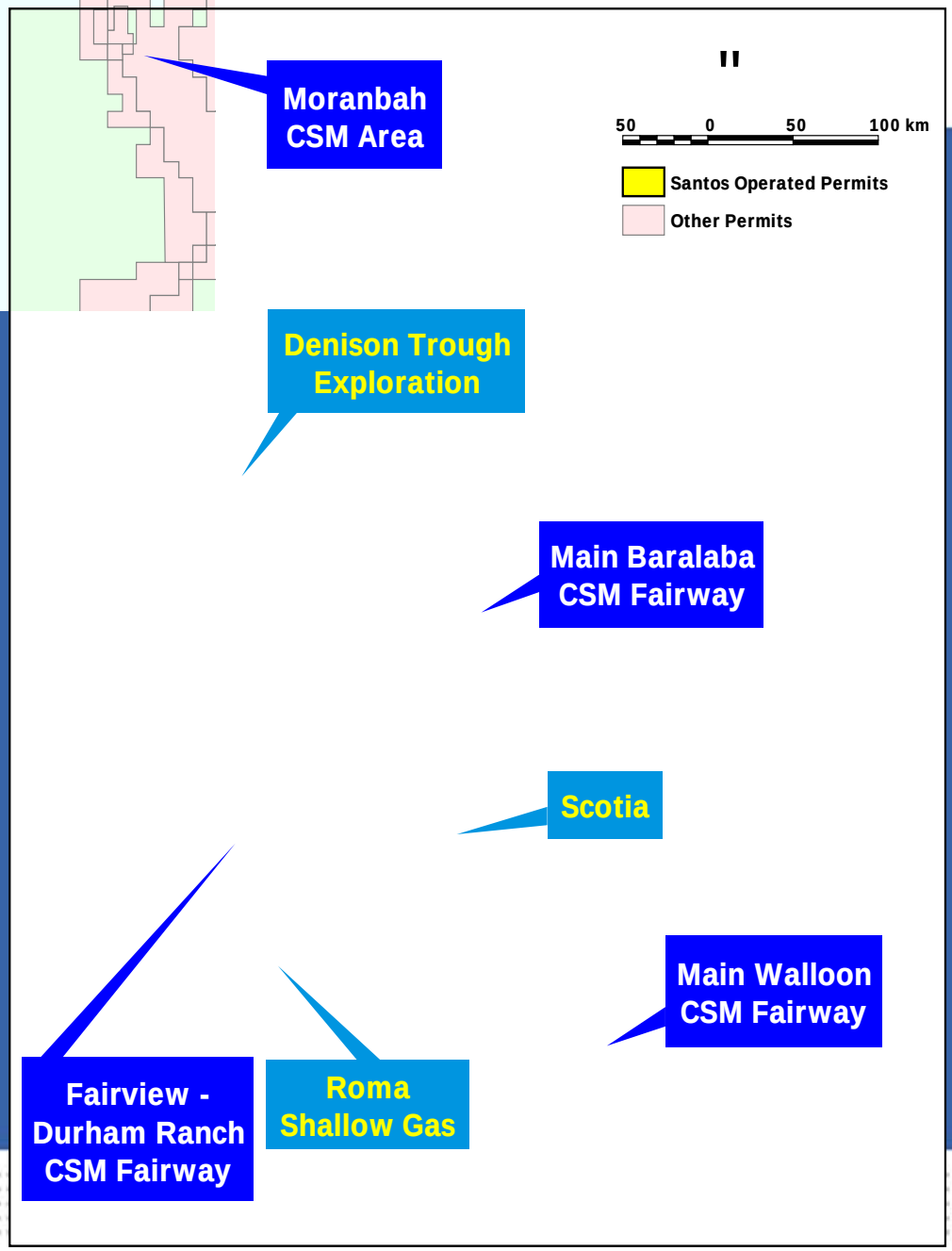
Santos CSM Activities



CSM Exploration

Northern Denison Trough

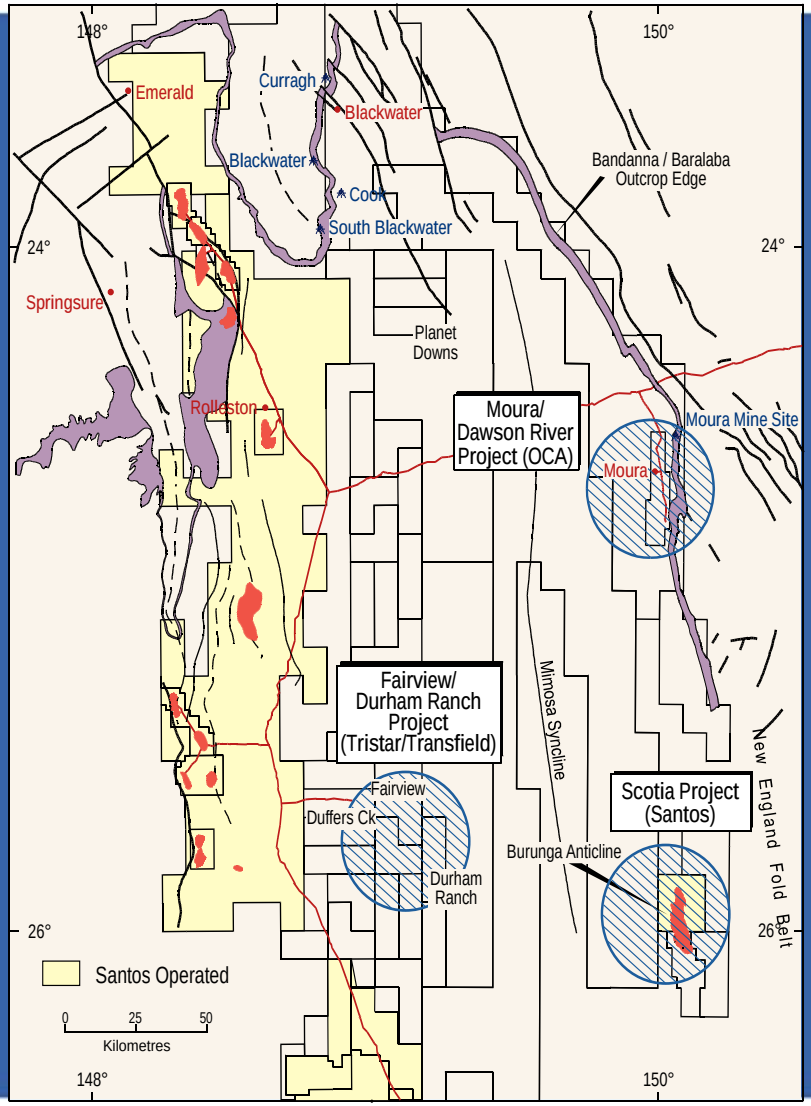
- Predominantly conventional gas in ATP 337P (Santos/Origin); northern area farmed out to Comet Ridge Ltd. for CSM exploration
- Flank of Comet anticline has shallow Rangals Coal Measures (200 – 250m) with a thick Pollux seam (7m)
- Two core holes drilled in April with moderate gas content and indications of free gas
- Anticipated future exploration comprises one test well and additional core holes to further evaluate area

CSM Appraisal

Roma

- Long established conventional gas asset with infrastructure
- Similar depths and coal thickness to Walloons pilot gas projects to east
- Pleasant Hills-8a drilled in 1969 as replacement for Pleasant Hills 8 following blow-out over the Injune Creek Beds
- Well completed in 1988
- Production performance indicates gas is being produced from the adjacent coals

CSM Production - Scotia Field



Bowen Basin Area

Eastern Queensland

Coal Seam Methane

Project Areas

Scotia Exploration History

Geological Background

- Structural setting: Burunga Anticline, Bowen Basin
- Reservoir: Permian Baralaba Coal Measures
  - three to four coal seam reservoirs
  - reservoir depth: 650 to 900 m
  - naturally fractured
  - fracture stimulated to improve productivity
- Gas productive coals: immediate gas flow from coal seams with nil to minimal dewatering
- Gas content approx. 11 m^3/t; permeability 0.1 to 15 md

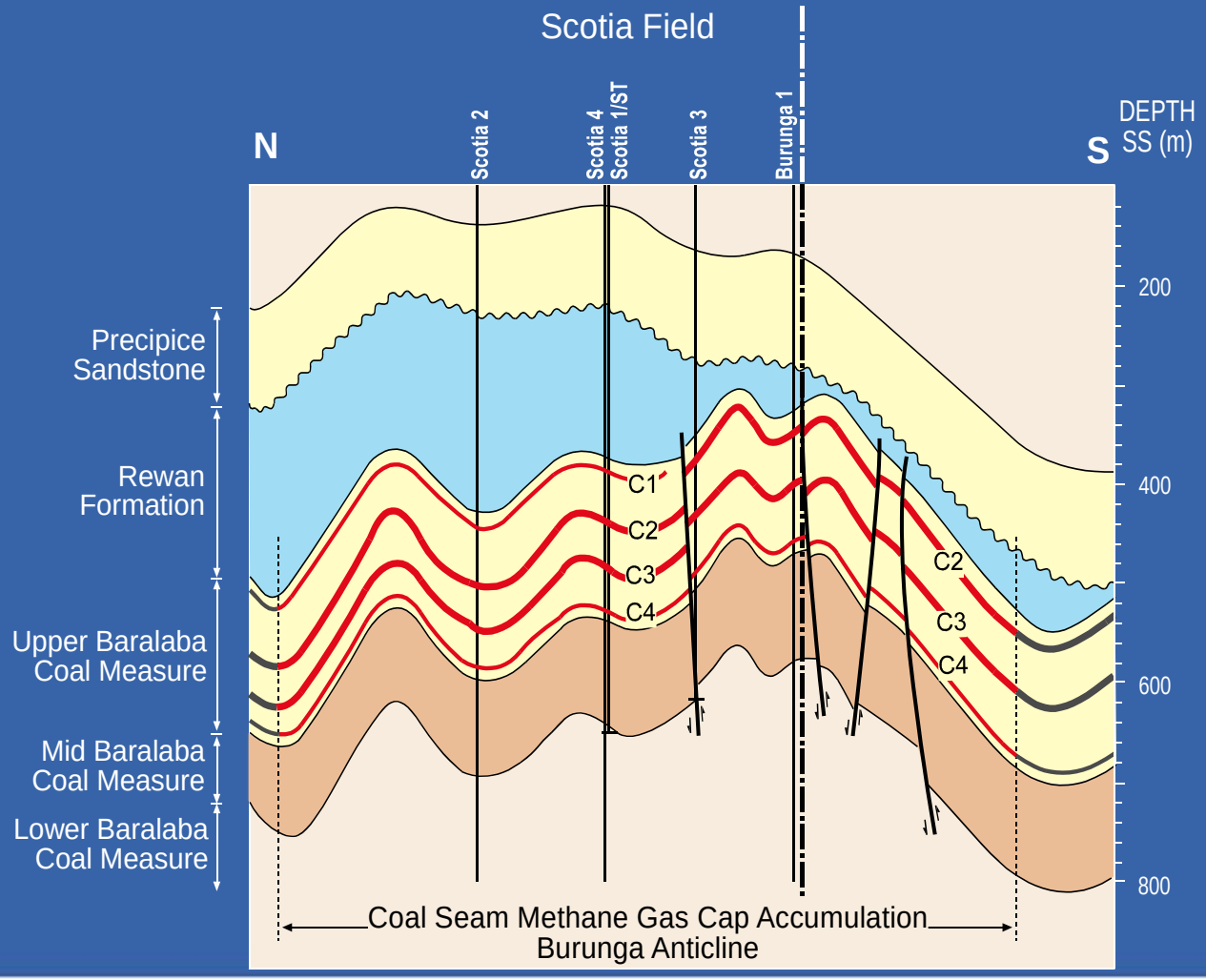
Scotia Exploration History

Scotia Field

- Initial activity target gas in sandstones and volcanics
- Scotia coal seam methane exploration commenced in 1996 following Peat discovery in 1994
- Scotia 3, 4 and 5 drilled between 1996 and 1999 to investigate coal seam methane potential of Scotia Area
- Scotia 6 and 7 drilled in 2000 to confirm reserves for CS Energy gas contract
- Multi-well appraisal and development drilling/frac programme completed in 2001 (Scotia 8 to 16)
- Production startup May 2002

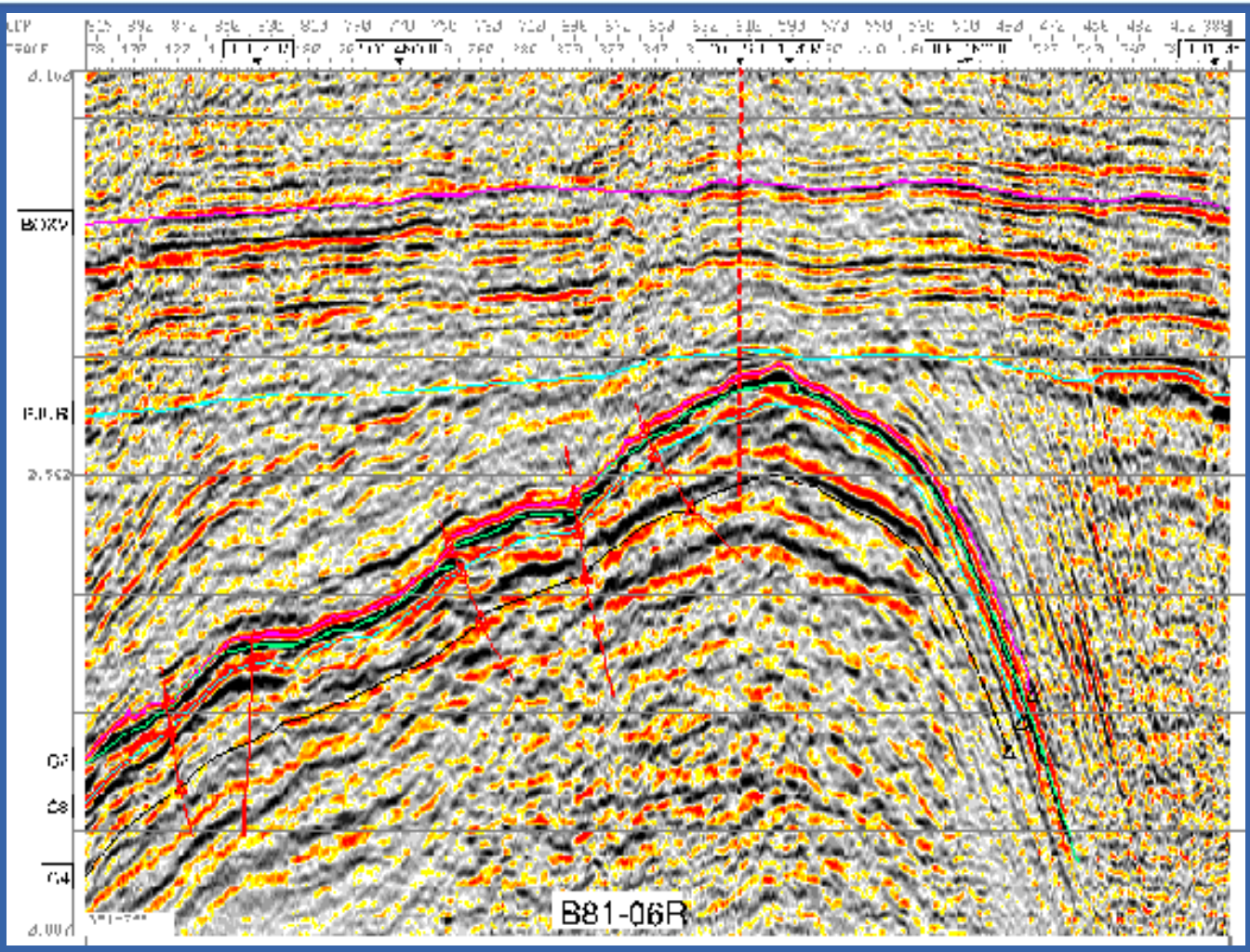
Scotia – Schematic cross-section

Structural style: anticlinal structure in compressive stress regime



Scotia – West-Seismic line

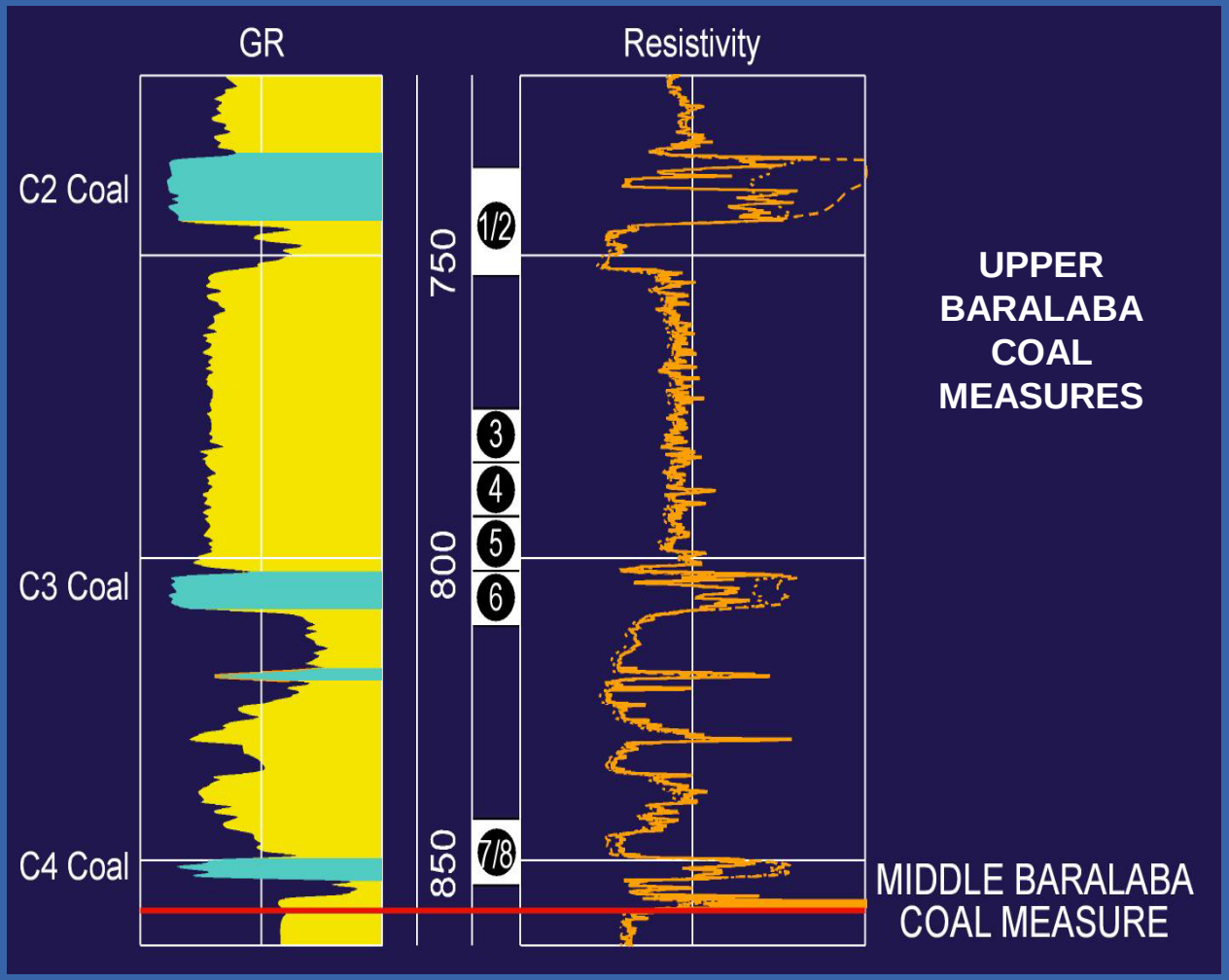
West



East

2D Seismic Section

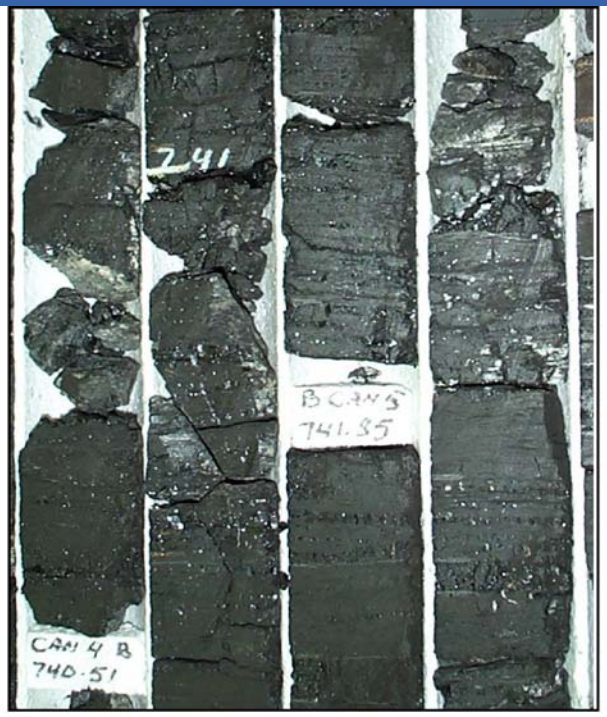
Scotia 4 Well Log Section



- Drilled 1997 to obtain coal cores for gas desorption and reservoir characterisation
- C2 seam fracture stimulated in 1999

Fracture Characterisation

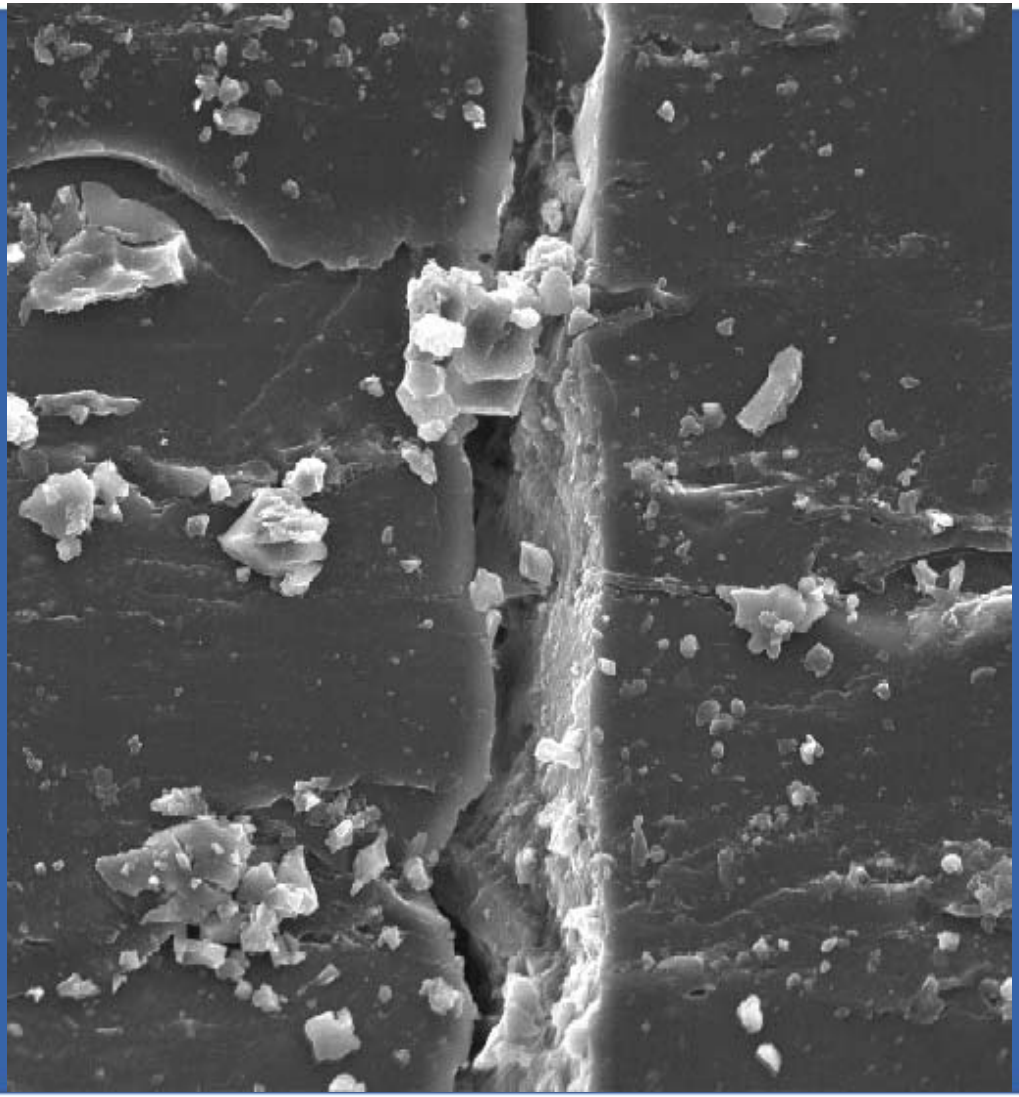
- Cleat system, microfractures (base permeability)
- Natural Fractures (enhanced permeability)
- Faults (stress distribution)



Scotia 4 C2-drillcore C2 coal, notice fracture system

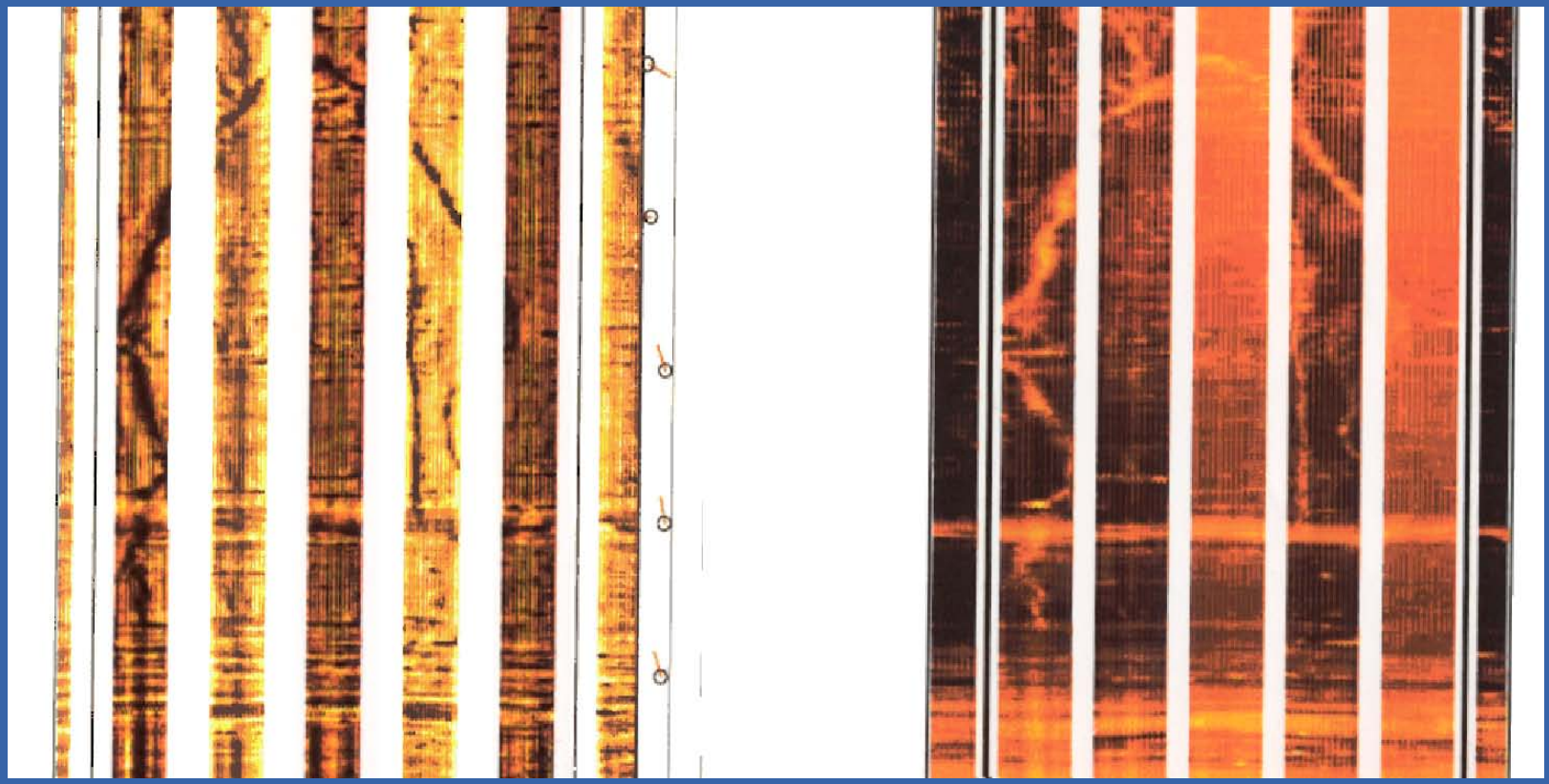
Scotia 4 drillcore shear fracture with slickenside in sandstone at 848.7 m

Scotia Coal Seam Reservoir Characteristics

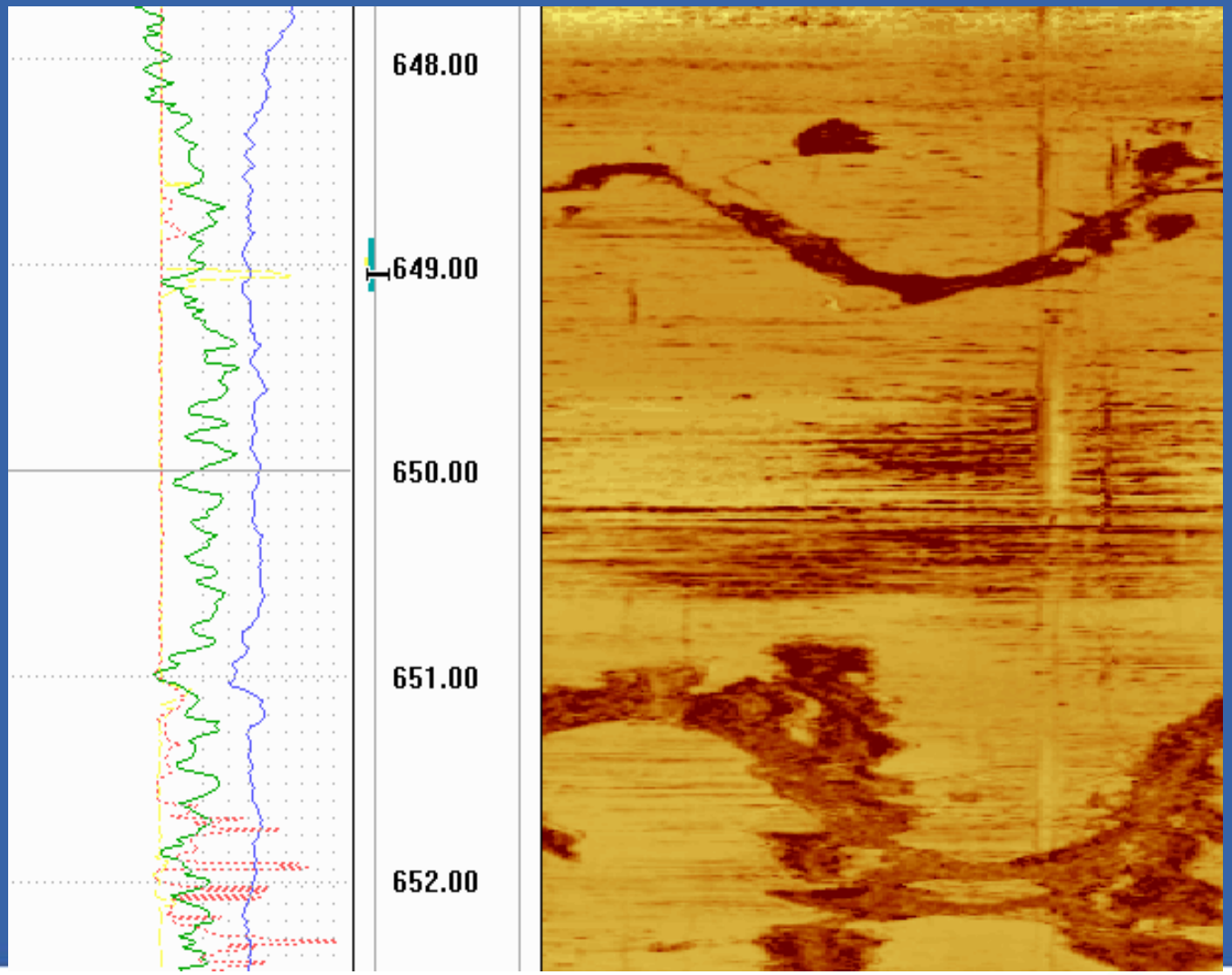


SEM Image of bright coal showing unmineralised cleat development

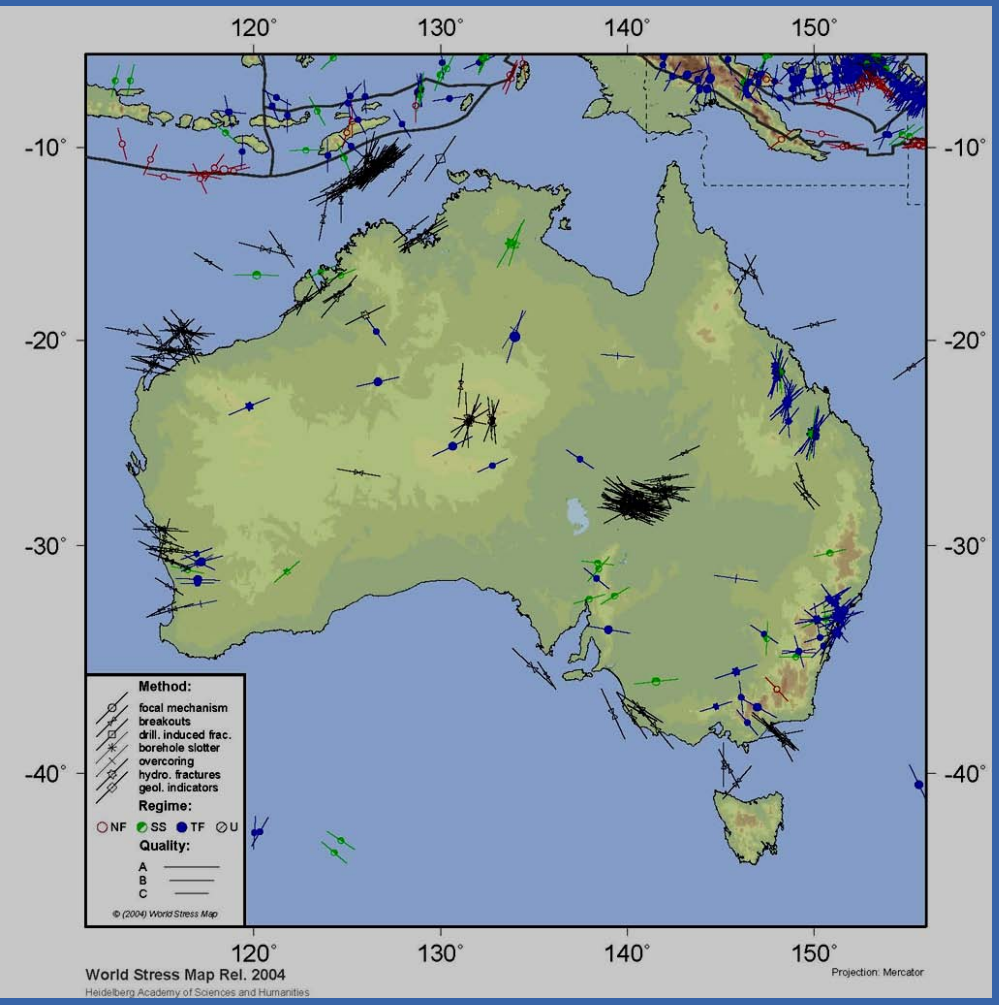
Scotia Image Log - Coal Seam Fracture



Scotia Image Log – Interseam Fracture



Australian stress map

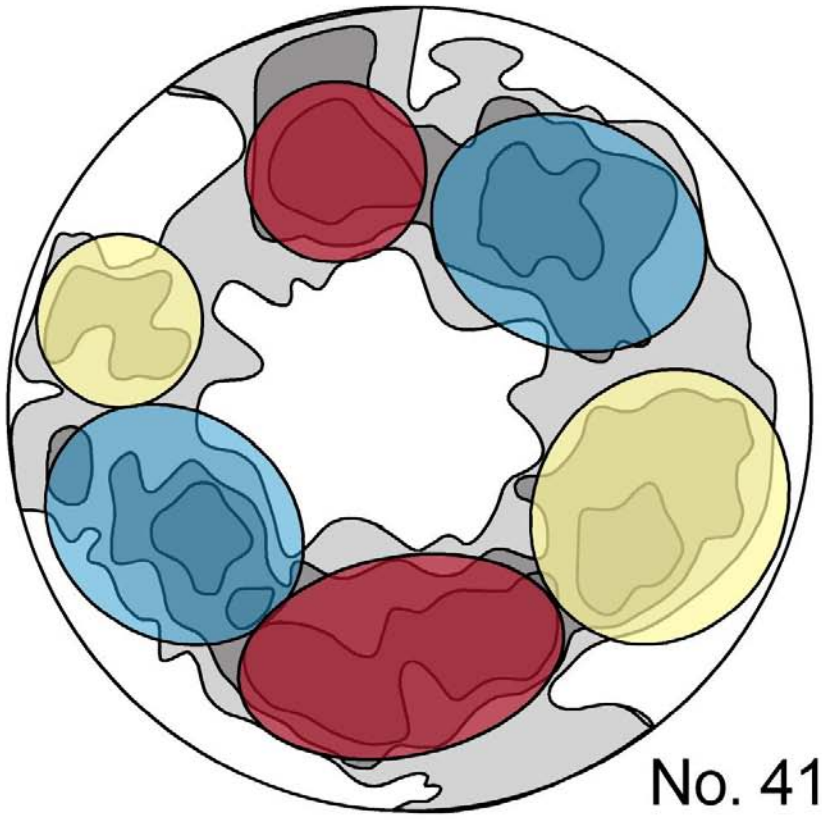


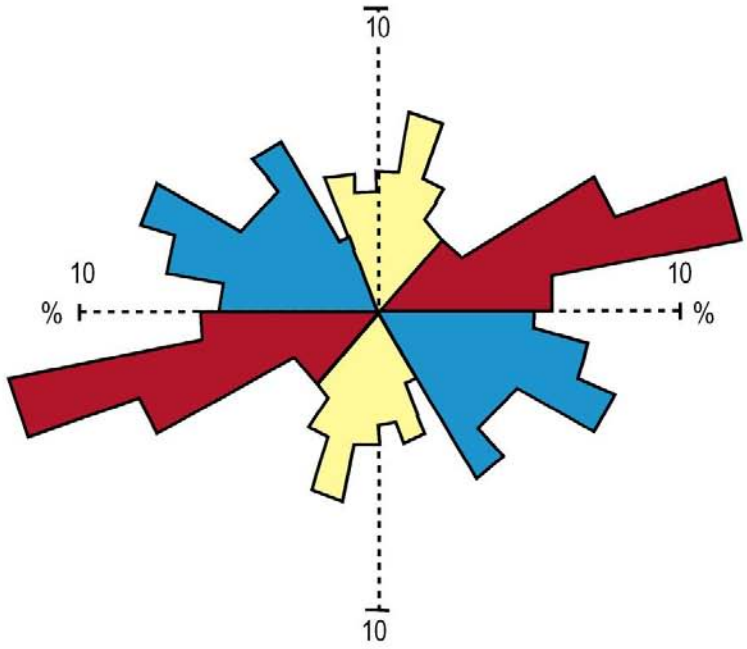
- σHmax~ 30 degrees
- complex stress regime, at cusp between strike slip and reverse:

σv<σh<<σH

σh<σv<<σH

Fracture Distribution, Reservoir

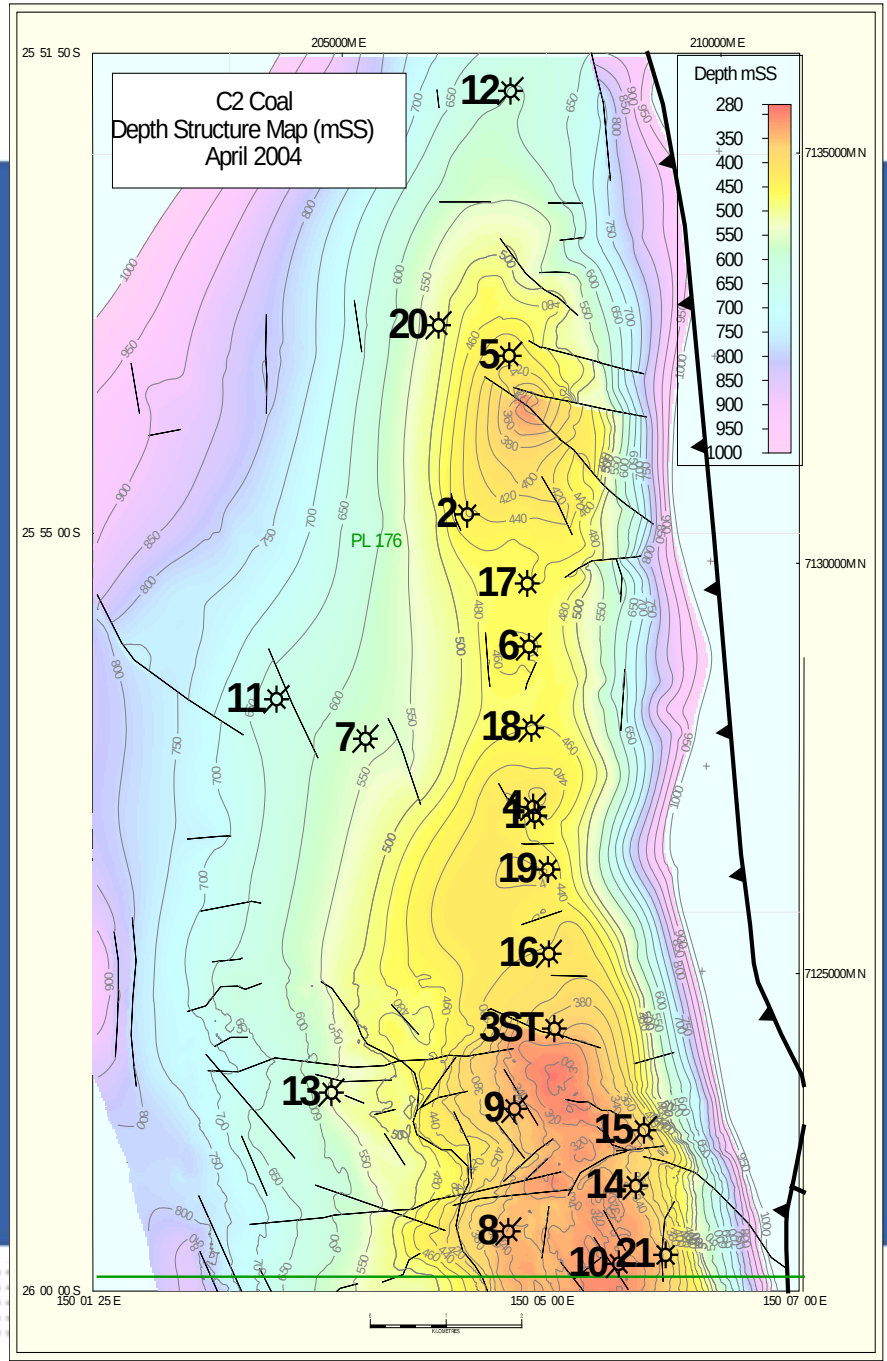




Three orientations, each consisting of a conjugate set

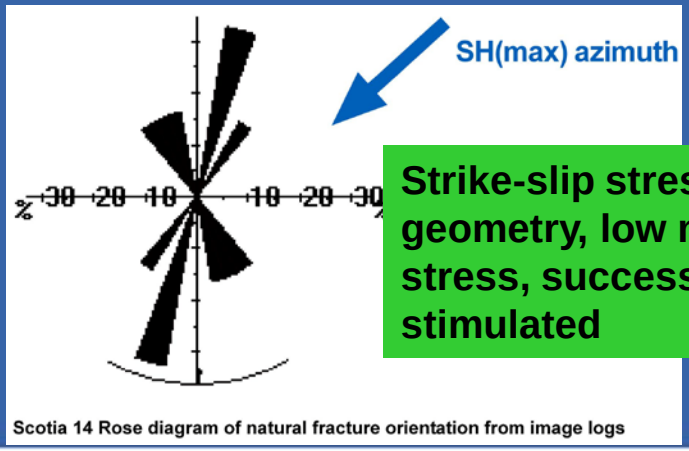
Scotia

- Geomechanical modelling conducted to predict fracture distribution
- Fracture sets in Scotia are
  - fold-related
  - NW and NE conjugate sets
  - intensity related to curvature due to local faulting
- Stress distribution modelled using stress tensor from wells



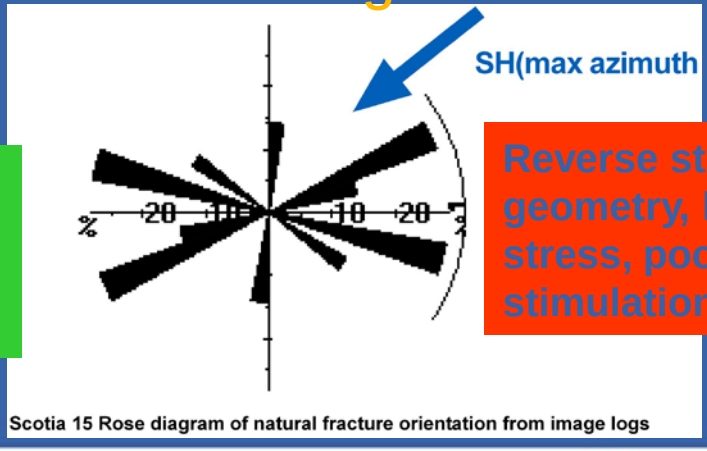
Conclusions

- In-Situ stress varies over field
  - Variations due to presence of small faults
- Poor stimulation/production in areas of reverse stress regime regardless of:
  - Mean & deviatory stress
  - Natural fracture density
- In-situ stress tensor is the controlling factor



Scotia 14 Rose diagram of natural fracture orientation from image logs

Strike-slip stress geometry, low mean stress, successfully stimulated



Scotia 15 Rose diagram of natural fracture orientation from image logs

Reverse stress geometry, high mean stress, poor stimulation

Mechanical Issues

- Stress regime affects stimulation efforts
- Stimulation and draw-down induced faulting

Good Scotia Well - 7.8 MMcf/d