CSG & Geophysics (fundamentals)

Module 4: CSG & Geophysics … some real world examples

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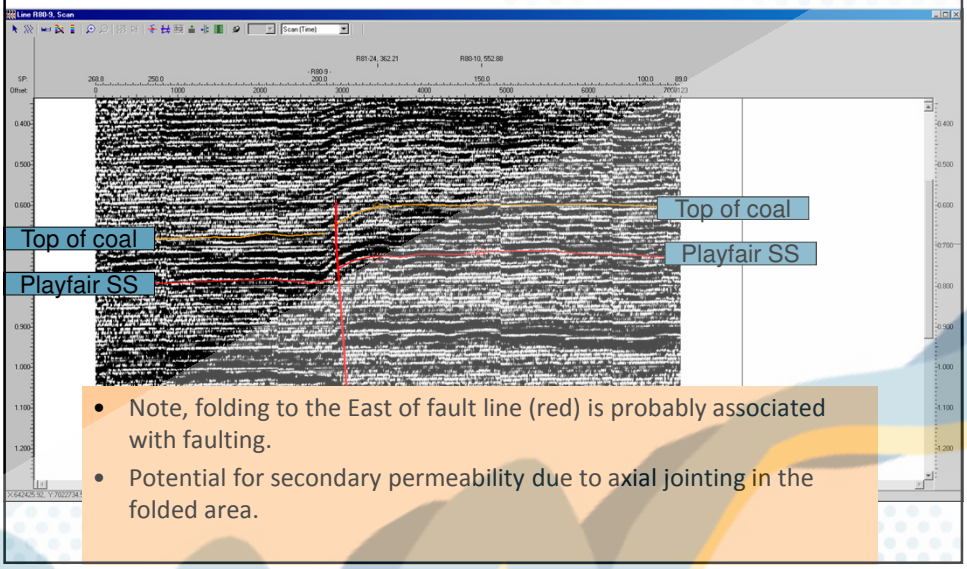
The Purple Star CSG Project

- Located close to successful CSG plays.
- Close to structural flexure responsible for high perms.
- Anecdotal accounts of free flowing gas from water bores in area.
- Previous data: shallow water bores only, some public domain regional 2D seismic to the north of block.

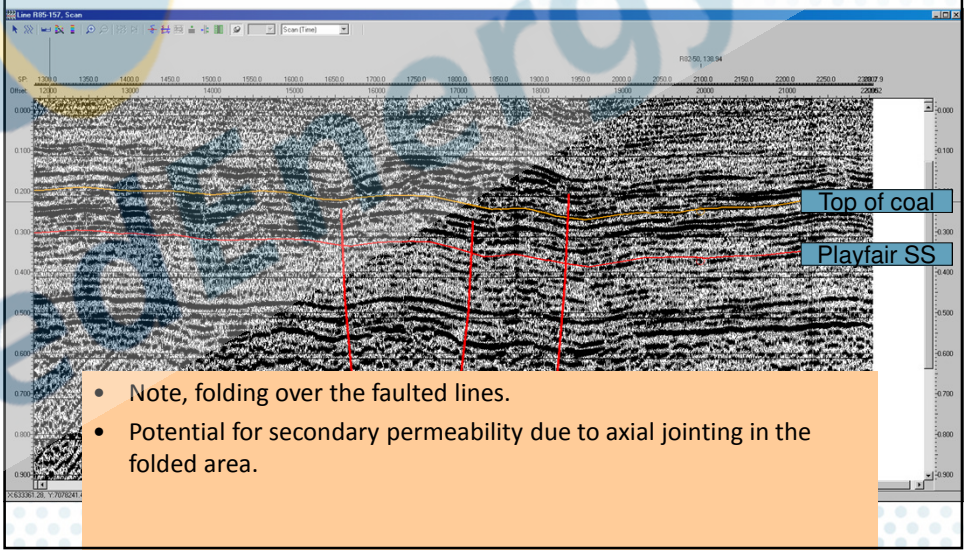
- ***Question? What exploration program should be adopted, and what role for geophysics?***

What the seismic said …



- Note, folding to the East of fault line (red) is probably associated with faulting.
- Potential for secondary permeability due to axial jointing in the folded area.

Another line …



- Note, folding over the faulted lines.
- Potential for secondary permeability due to axial jointing in the folded area.

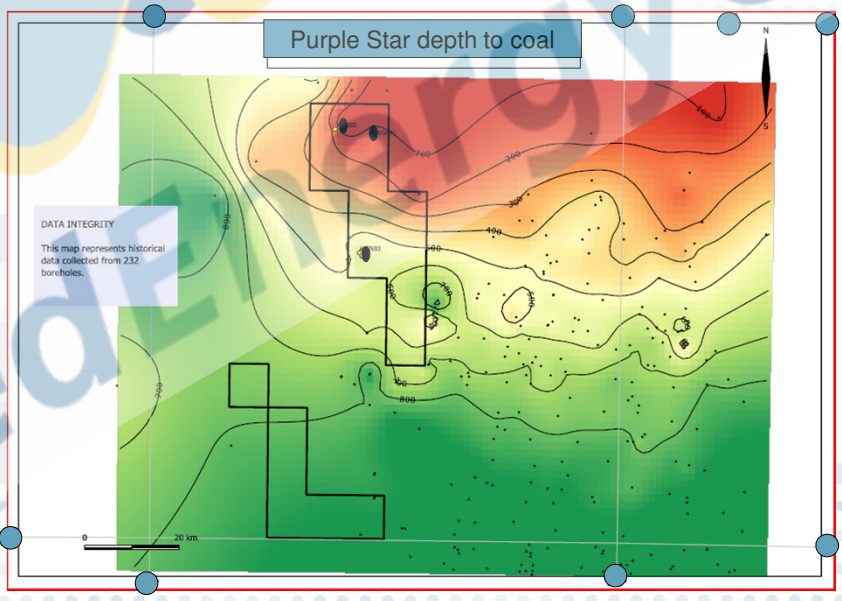
What they did …

- Drilled three core wells; aim: to sample gas content, composition, and do some isotherms. Well testing (maybe).
- Coals expected to be 8-10m thick (net coal).
- Terminated sequence in porous aquifer, the Playfair SS.

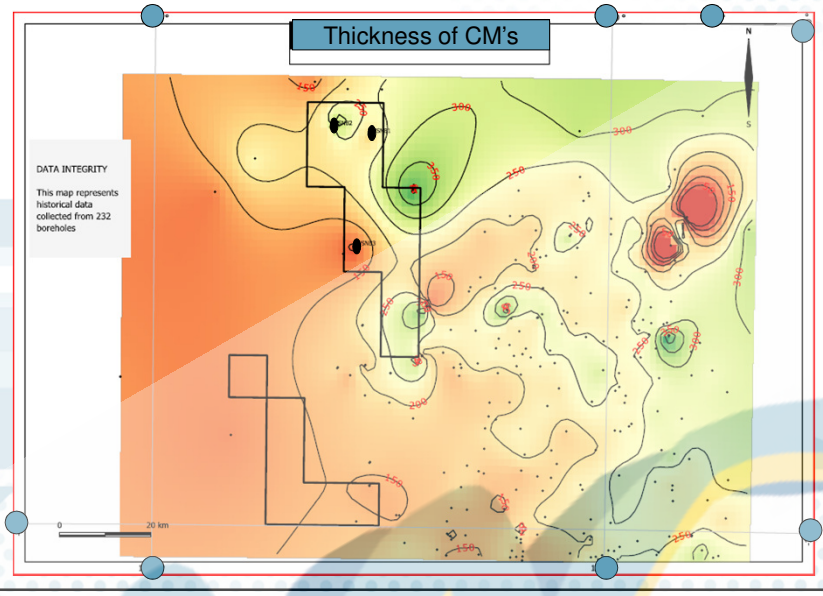
Purple Star 3

Structure contours to roof of coals

Purple Star depth to coal



Thickness of coal measures …

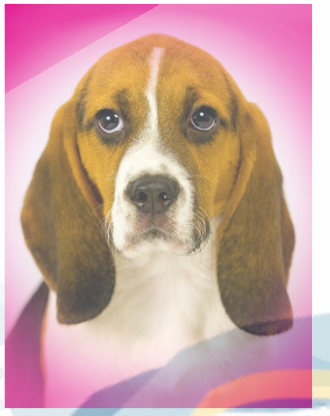


Actual results

- Purple Star #1 reached a total depth of 312m. Rig 1 was used to drill a 6-1/8" hole to 180m before the commencement of HQ coring to total depth. Coals were intersected at 192m, 198m, 205m and 210m with the following thicknesses 0.34m, 0.37m, 0.41m and 0.5m respectively. Total net coal from these seams came to 2.44m. Coal occurred as early as 100m and was last intersected at 365.3m.
- Purple Star #2 reached a total depth of 425m. Rig 1 was used to drill a 6-1/8" hole to 150m before the commencement of HQ coring to total depth. Coals were intersected at 195m, 232m, 265m, 390m and 397m with the following thicknesses 0.42m, 0.5m, 0.95m, 0.75m and 0.37m. These ranged in depth from 205.32 to 384m and the net thicknesses ranged from 0.37 to 0.95m with a total net coal thickness of 2.99m. The entire well had several coal intersections ranging in depths from 98.66m to 384m.
- Purple Star #3 reached a total depth of 790.1m. Rig 1 was used to drill a 6-1/8" hole to 547m before the commencement of HQ coring to total depth. No significant coal was intersected. Three small coal seams of <0.4m were intersected at depths ranging from 582.02 to 676.73m. Total net coal thickness of 0.38m. One sample was taken at 633.18- 633.56 for gas testing, but was returned to the core trays later as it was not producing any gas.

Workshop conundrum

- Project appears to have been a dog …
- What could have been done better?
- Could more geophysics have helped?
- If so, what kind?
- Was the money wasted?



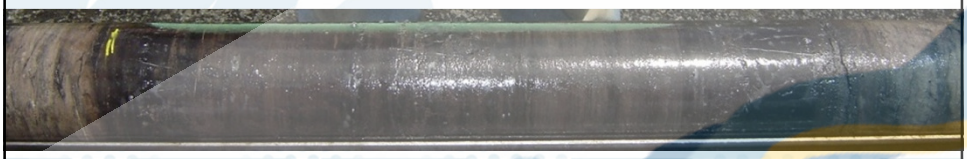
The Spinning Roulette CSG project

- Located nowhere near other CSG plays, but close to potential market.
- Lots of regional seismic from oil & gas exploration thus far.
- Plenty of coal, 24-30m net coal.
- Previous data: shallow water bores, public domain regional 2D seismic, some stratigraphic holes.

- ***Question? What exploration program should be adopted, and <u>what role for geophysics?</u>***

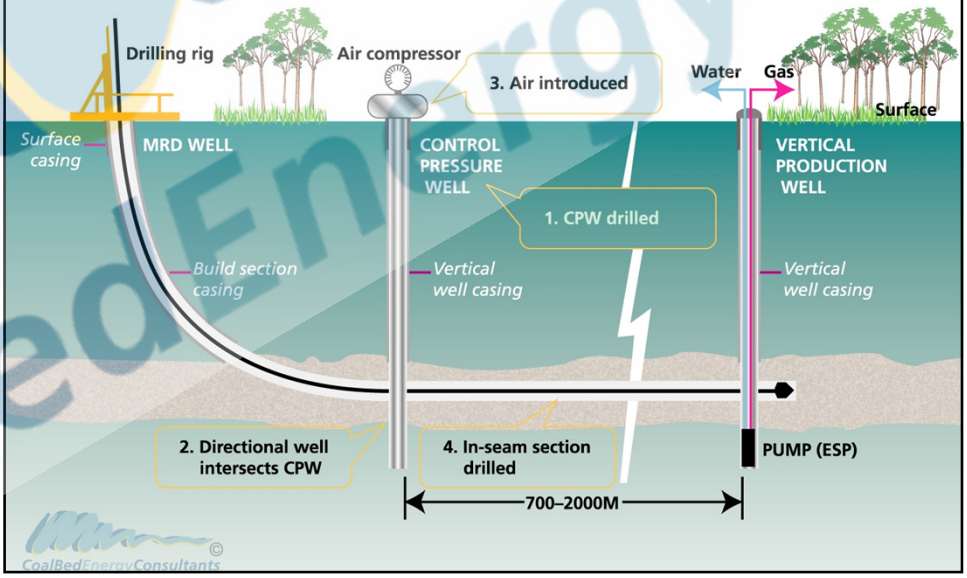
What they did …

- Allocated $5M to drill ten core wells; aim: to sample gas content, composition, and do some isotherms. Did some well testing.
- Proved up thick coal of moderate gas content and high saturation.
- Discovered perm was very low.
- Certified some 2P reserves.
- Undertook a pilot horizontal well trial ($1.5M extra).
- Worked out clays were an issue for drilling.



Spinning Roulette #1

Some MRD SIS layouts – 'conventional'

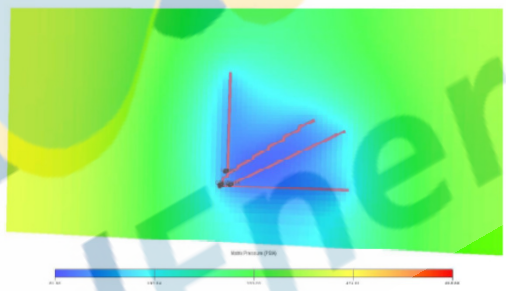


Outcomes from pilot testing …

- Poor response, lower than expected flows, put down to following:
  - Significant near well damage from drilling fluids.
  - Structural location.
  - Length of in-seam section open to production.
- Substantial improvements in well productivity could be made by addressing:
  - Well design;
  - Pilot program design;
  - In seam steering technology;
  - Use of and type of drilling fluids used;
  - Underbalanced drilling;
  - Pumping configuration;
  - Well locations; and
  - In seam length.

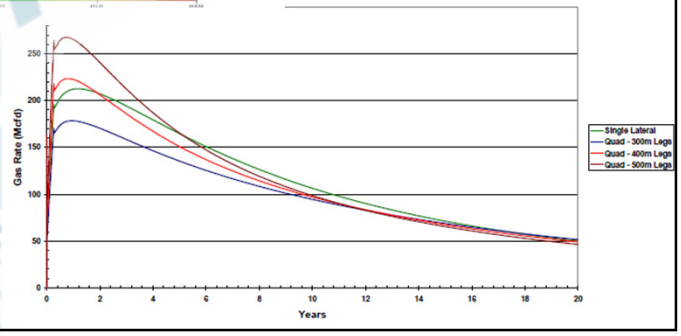
***Note recommendations:** further work needed, but nothing involving geophysics …*

Modelling production …

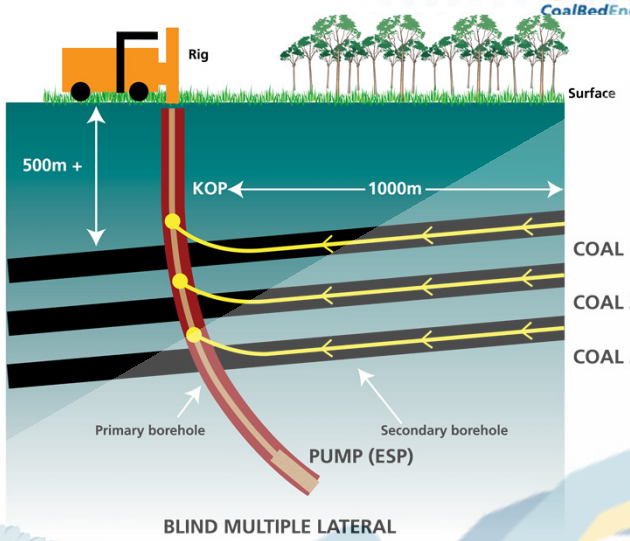


- Proposed multi lateral SIS well configuration.

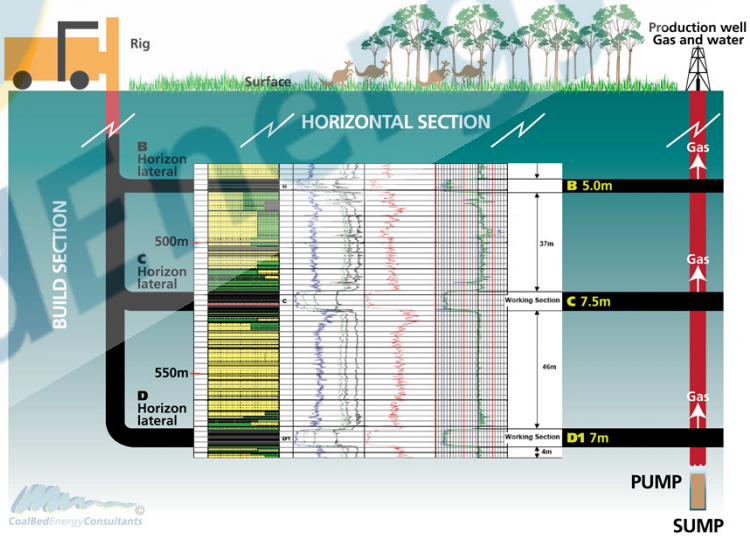
- Modelled performance.

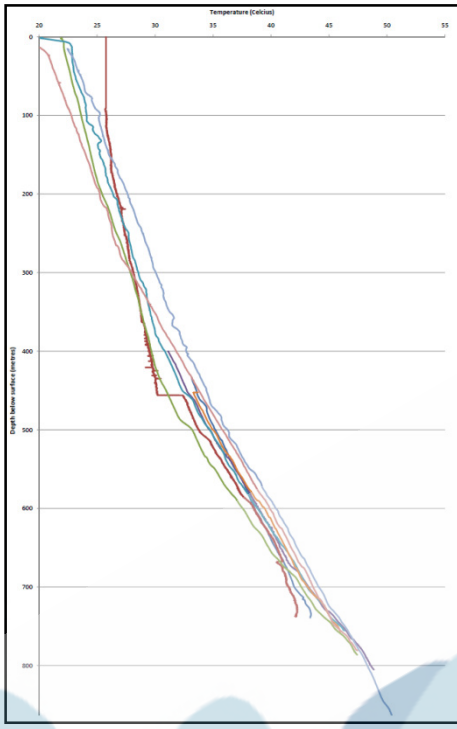


Options: the 'blind' multiseam SIS well



Multiseam completion to single vertical





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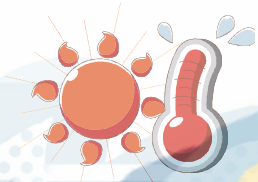
Temperature logs

- Needed for isotherms.
- Eight holes show consistent geothermal gradient.



CoalBedEnergyConsultants

Key exploration issues … perhaps pertinent to geophysics

- **Low perm …**
- Intrusions and rank / saturation relationships.
- Steering lateral pilots.
- Seam continuity.

What can we do?

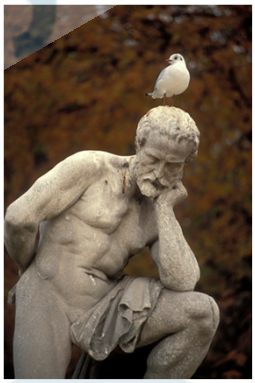
The Rugby Tour CSG project

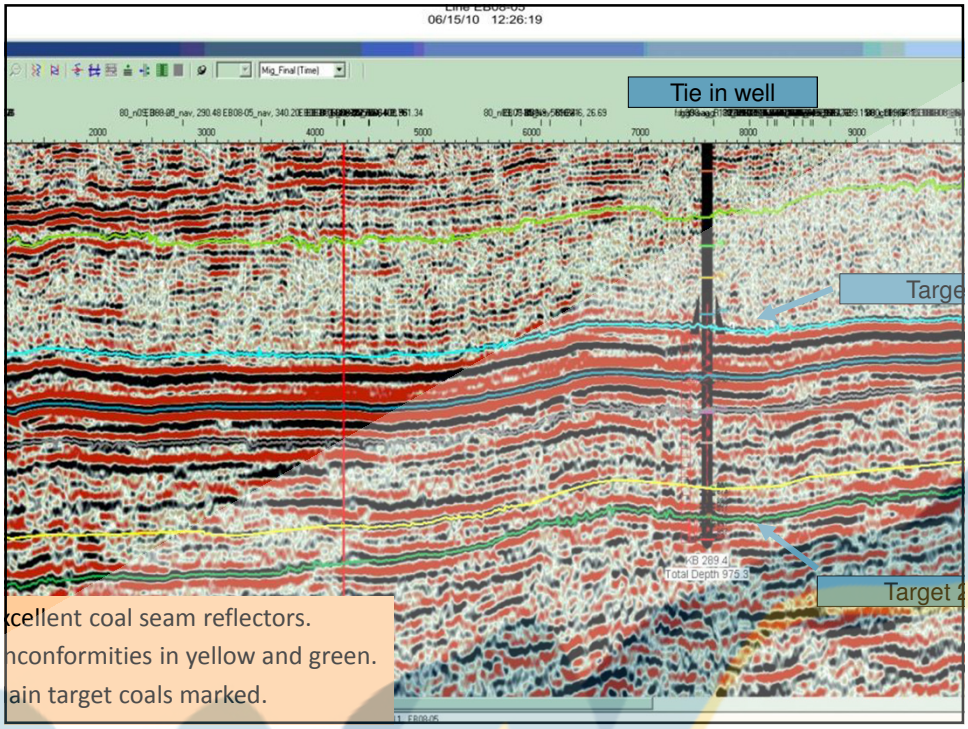
- Located nowhere near other CSG plays, but potentially huge resource.
- Plenty of coal, some in thick individual seams (up to 11m). Net coal of order of 50m.
- Gas content also looks good; 9-13m3/t daf, and saturated.
- Previous data: shallow water bores, coal exploration boreholes, public domain regional 2D seismic, some stratigraphic holes.
- Good control on regional dip (to west).
- Coals known to be dull, inertinite rich, with marked vertical jointing.

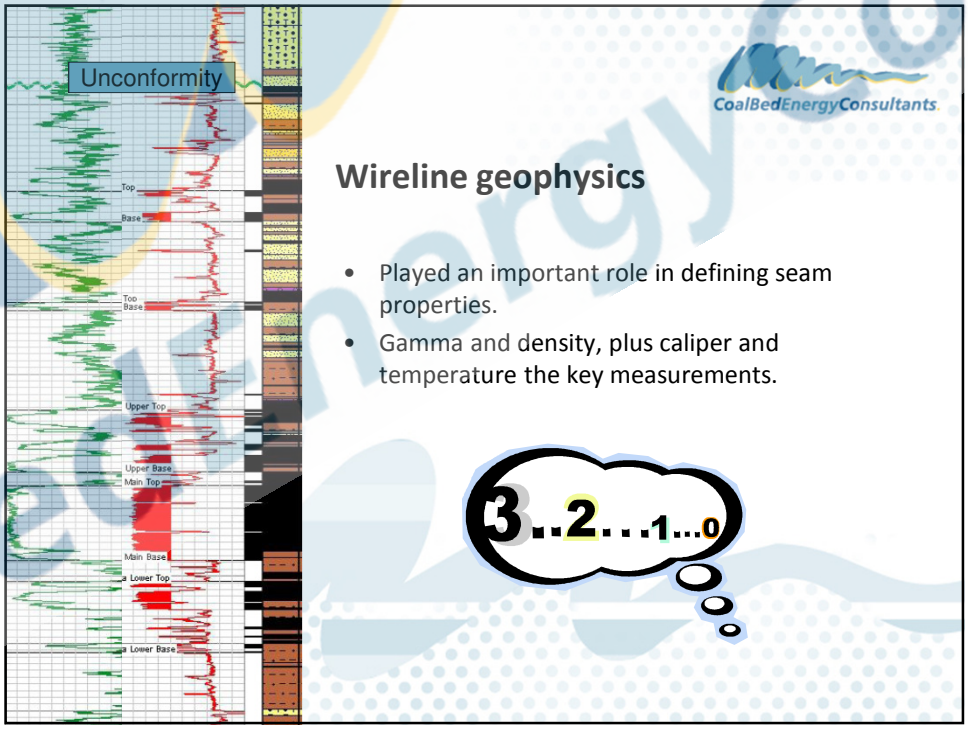
- ***Question? What exploration program should be adopted, and what role for geophysics?***

What they did …

- Phased program that involved mainly core wells; aim: to sample gas content, composition, and do some isotherms. Did some well testing.
- Undertook some regional seismic.
- Proved up thick coal, multiple seams of moderate gas content and high saturation.
- Measured some promising perm results.
- Certified some 2P reserves.
- Undertook multilateral pilot horizontal well trials.




06/15/10 12:26:19
Tie in well
Targe
Target 2
xcellent coal seam reflectors.
nconformities in yellow and green.
ain target coals marked.


Unconformity
Top
Base
Top
Base
Upper Top
Upper Base
Main Top
Main Base
Lower Top
Lower Base
CoalBedEnergyConsultants
Wireline geophysics
Played an important role in defining seam properties.
Gamma and density, plus caliper and temperature the key measurements.
3..2...1...0

Coal character …

- Blocky coals, with well developed pervasive joint (cleat).
- High in inertinite.

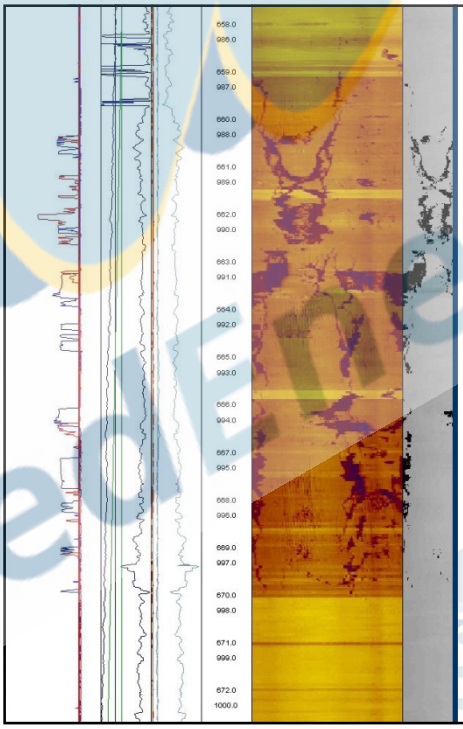
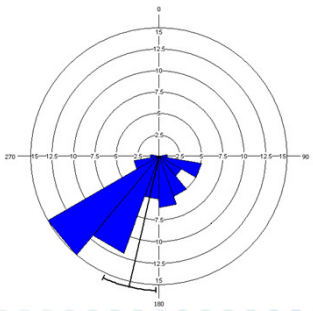


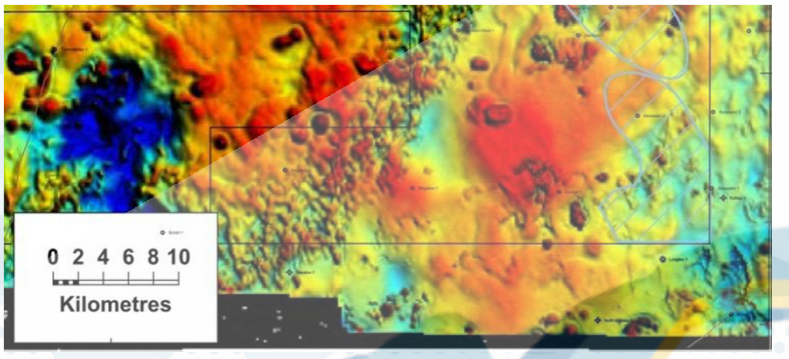
Image logs

- Used to quantify level of primary cleating.
- Used to establish vertical extent – do they in fact cross into interburden?
- Used to assess stress field magnitude.



Regional magnetics

- Useful for defining likely position of intrusions.
- Relationship between intrusions and magmatic CO2? High risk areas?



Key exploration issues … perhaps pertinent to geophysics

- Uncertain state of regional perm … 'pervasive cleat hypothesis'.
- Gas composition proved to be variable – can we quantify extent of CO2?
- Intrusions and rank / saturation relationships.
- Steering lateral pilots – what best direction?
- What should be the exploration and P & C model to adopt for future?

What can we do?

End of 'real world' module …

"Yeah I got the low down, CSG, geofizzical, fraccin' blues …"