Oaky Creek Coal
Outline

Characteristics of the German Creek seam

The Issue – slow to drain

Management plan of attack

• Trial fraccing with sand proppant
• Implement some tightly spaced inseam drainage
• Consider contingencies of remote mining or grunching
• Maintain safe and efficient mining

The Action: what was actually undertaken

Gas Drainage Outcome

Conclusions
The problem zone, mid-panel Maingate 33A

- Faulting
- Dominant CO2 (>80%)
- E-Ply split
The German Creek Main and the E Ply

**German Creek Main section:**
- Comprised of the F & G Plies
- Permeability 7 - 8mD at nearby test hole

**Carbonaceous Mudstone band (Split):**
- Thickness range of 0 to 11cm over the problem zone

**German Creek E ply:**
- Lower permeability: 2 - 3mD at nearby test hole
- Higher ash content
- Higher outburst threshold than the Main section
The German Creek Main and the E Ply – specific thresholds

**German Creek Main:**
900 DRI determined threshold line runs between:
- 5.7m³/t @ 100% CO₂, and
- 7.7m³/t @ 100% CH₄

**German Creek E ply:**
900 DRI determined threshold line runs between:
- 5.81m³/t @ 100% CO₂, and
- 7.53m³/t @ 67% CH₄, flat thereafter to 100% CH₄ until sufficient high methane coal samples become available.
The Pre-Drainage story

• Long term SIS drainage in place in late 2012 to mid 2013.
• Design flaws identified in August 2013.
• Infill UIS cross-block pattern drilled from MG33 December 2014.
• Infill UIS failed to drain adequately.
  • Down-dip to target zone through existing drained (de-pressurised) areas.
  • Low desorption pressure CO2 struggled to self de-water.
  • Some blockage issues around fault intersections.
• Became obvious that more drainage was required
  • More cross-block holes were rejected.
  • Elected to drill a tight spaced parallel pattern ahead of development.
• Slow drainage still!
• Intersections compromised some boreholes soon after drilling
History: Situation in late 2012 showing 3D seismic predicted structures, and inseam portions of SIS drilling

Original gas content data:
7 – 7.5m³/t @ >85% CO₂
Pre-drainage phases: SIS followed by 2 sets of UIS

- **SIS** - May 2013
- **UIS** - Dec 2014
- **UIS** - June 2015

- **SIS** - Dec 2012
- **UIS** - June 2015
Sample section view of the down-dip cross-block UIS holes

Old SIS inseam hole locations:
Zones depleted of water and gas

De-watering head:
16m (160kPa)

Target drainage area
• Cores were 80 to 85% CO2
• Borehole drainage was very slow
• Area appeared to have a very low permeability
• Development forecast was not achievable with existing draining system results
Mining ceased at the 21ct line

- A sea of red ‘failed’ compliance cores ahead in amongst the SIS drainage gap.
- The additional UIS phases (not shown) had not rectified the situation.
- Inbye of 24ct through to 43ct, all core results were below threshold.
Where to?

• Would additional UIS be successful, given the lack of results to date?

• Fracring? With or without sand proppant? Water only fraccing used previously, elected to trial sand.

• Fraccing lead time!
  • Sourcing of gear, and hire agreements
  • Transport to site, and site introductions, RAs and procedures.
  • Transport u/g, commissioning, and training.

• Meanwhile one heading was intensely drilled while the other prepared with a single branch-free fracc hole.

• While drilling and fraccing, grunching was scoped out, and remote mining was risk-assessed and relevant procedures developed.
Critical Fraccing Issues

• Sourcing a suitable water pump
  – Longwall Salvage Pump utilised

• Adapting existing fracc procedures to include the changes introduced by the use of the sand-adder

• Sourcing of appropriate sand

• Supply of hardware from CSIRO and ACIM

• Lead time for equipment mobilisation to site

• Introduction to site process

• Suitable downhole fracc locations
  • Clear of branches or close proximity to adjacent holes
  • Avoid zones of weakened or fractured coal
Planned Fraccing portions – C Hdg borehole

Fraccing zones (highlighted in blue) were kept clear of other inseam holes and expected faults.
Sand Fracching Equipment

Sand Adder – used to feed sand into the high pressure water lines

Down Hole packer assembly and fraccing sub
Sand Fracching Equipment ctd

Longwall salvage pump
Water fracc

Placing fractures using a straddle packer tool

Fracc Sub

Injection string

Packer

borehole

Hydraulic fracture
Hydraulic Fracture Propped with Sand
Drill-drain and Drill-fracc-drain phases: UIS from 21ct stubs

Expected faulting prior to drilling:
No go zones for packers & fraccing

Single centreline fracc hole without branches ahead of C hdg

Tight spaced drainage ahead of D hdg
Fraccing operational notes

• Safety
  • pressure rated hardware
  • emergency isolation points
  • packer inflation and deflation

• Separate air split for the sand adder
  • sand spec, no more than 4% > 600µm, no more than 10% < 250µm

• Discharge pipework set up to cope with potentially high flows

• Manage interaction with existing drainage holes

• Monitor outcomes
  • gas flows
  • water make
  • sand make

• Hole cleaning and lining at end of fraccing phase
There were increased gas flows in some boreholes post fraccing, but generally low and sporadic.
Abandoned planned fracc ahead of D heading

- The fraccing process ahead of C heading did demonstrate connectivity with flanking boreholes.
- Gas flows from adjacent holes did show increases, but never to the expected magnitude and not sustained.
- Decision made to halt the fraccing programme once the C heading hole was completed.
- Meanwhile, the initial flow data ahead of D heading suggested that mining could recommence there in the short term.
Compliance story

9 July – 3 August  19 August – 27 August – full compliance
Mining completed: Section view of as-mined grade plan
D22A C/T +49m Horst Pillar Rib
Learnings - why did the zone fail to drain?

• SIS design had some weaknesses which the excellent drainage time (>2 years) could not compensate for.
• Down-dip cross-block UIS pattern struggled to de-water the seam.
• Geological mapping revealed less jointing, no change in cleat angles or frequency.
• No real indications that joints or cleats were infilled with minerals

Summary:
• Original drainage had flaws, replacement patterns still inadequate.
• Ground tighter than normal – locally lower perm(?)
• Low pressure CO2 and low flow rates unable to self de-water in an area where several grade changes complicated the de-watering process.
Learnings – Fraccing experience with sand proppant

• The water pressure certainly opened up paths through the seam.

• Water travelled from the fracc hole across to the furthest flanking borehole on the very first fracc, and rapidly.

• Sand also travelled into adjacent boreholes despite attempts to halt the injection flow as soon as the sand exited through the fracc sub.

• The whole process was managed by mine personnel and drilling contractors after training by an external expert.
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