

# GAS DRAINAGE EXPERIENCE AT THE NORTH GOONYELLA MINE

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*ABSTRACT:* The North Goonyella Coal Mine has been owned in Joint Venture by RAG Australia Coal and Thiess NG Pty Ltd since November 2000. The mine is operated under contract by Thiess. Effective gas drainage is a fundamental requirement for the safe and efficient operation of the mine.

Drainage has been effective since 1999 and with access to Australian and German knowledge, techniques will continuously be improved to enable the mine to economically mine deeper and gasier reserves without compromise in the safety of the mine and its people.

## INTRODUCTION

The North Goonyella Coal Mine in the Bowen Basin was the first underground mine in the Goonyella Middle seam. It was also the first thick seam high capacity longwall operation in Australia.

The seam dips at 1 in 12 and there is a rapid increase in gas content in the mine's northern workings to around 10m<sup>3</sup>/t at 250m in depth. The seam gas is predominantly methane.

The lease is highly structured with a high incidence of both normal and low angle thrust faults. The mine clearly must be regarded as having outburst potential. The mine layout is shown in Fig. 1.

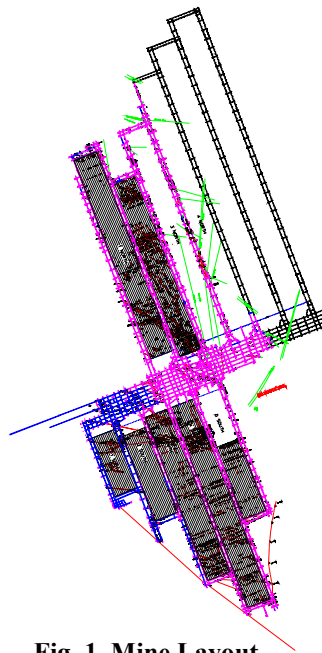


Fig. 1 Mine Layout

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## OUTBURST MANAGEMENT

The majority of Australia's outburst knowledge has been derived from numerous events in the Bulli seam of the New South Wales Southern Coal Field but it must be noted that both methane and carbon dioxide outbursts occurred some years ago at mines to the north and to the south of North Goonyella.

Based on the Bulli seam experience the gas and structural conditions at North Goonyella dictated that outburst management precautions be implemented.

A technical evaluation of conditions at North Goonyella determined the following key outburst management factors;

1. Accept a gas outburst threshold of a Desorption Rate Index of 900 "equivalent to the threshold below which outbursts will not occur in the Bulli seam". This equates closely to 7 m<sup>3</sup>/t at North Goonyella and 9.5 m<sup>2</sup>/t in the Bulli seam.
2. Provide a protection barrier of 15 m around development headings (compared with 5 m in the Bulli seam).

Significant differences from the Bulli seam are the seam height, permeability and seam dip. The application of Bulli seam knowledge to the Goonyella Middle seam must be carried out with great caution.

## GAS DRAINAGE

Gas drainage in advance of development at North Goonyella has been practiced since 1999 to mitigate outburst risk and to control general body gas levels. Drilling commenced from the travelling road of LW1N Maingate through LW2N to pre-drain MG2N development. MG4N is currently being developed. Typical gas drainage patterns are shown in Fig. 2

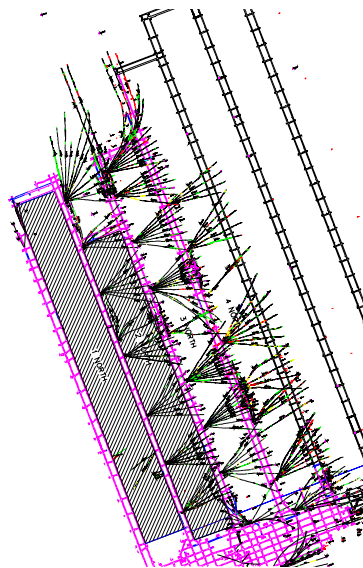


Fig. 2 Gas Drainage Drilling

There is sufficient gas pressure to enable a fan of underground holes to free vent via surface-to-seam boreholes called gas risers. Drilling is via conventional down hole motor technology with continuous survey.

Drilling conditions are challenging due to the prevalence of structure but such drilling provides a valuable addition to the mine's exploration tool box.

Permeability is generally good but two low permeability zones have been encountered. These zones were identified during gas drainage drilling which allowed actions to be implemented to minimise delays to development.

A specialist's report in March 2000 stated "gas drainage under North Goonyella conditions is likely to break new ground in gas drainage understanding". The mine operator is constantly striving to gain that understanding and improve the cost effectiveness of its gas drainage operations.

The gas drainage system implemented initially has proven very effective to date and the only improvements made have been:

1. Riser diameter has been increased to reduce back pressure because hole flows increase with depth.
2. Surface and underground "plumbing" has been similarly increased in size.
3. Hole lengths have been increased to ensure the 15 metre zone around development headings are effectively drained. The build-up of fines at the end of the holes limits the effectiveness of the hole ends and the extremities of the holes are being recharged by gas from depth. Holes are now drilled 70 metres beyond the development headings. The effect of hole ends on drainage is shown in Fig. 3.

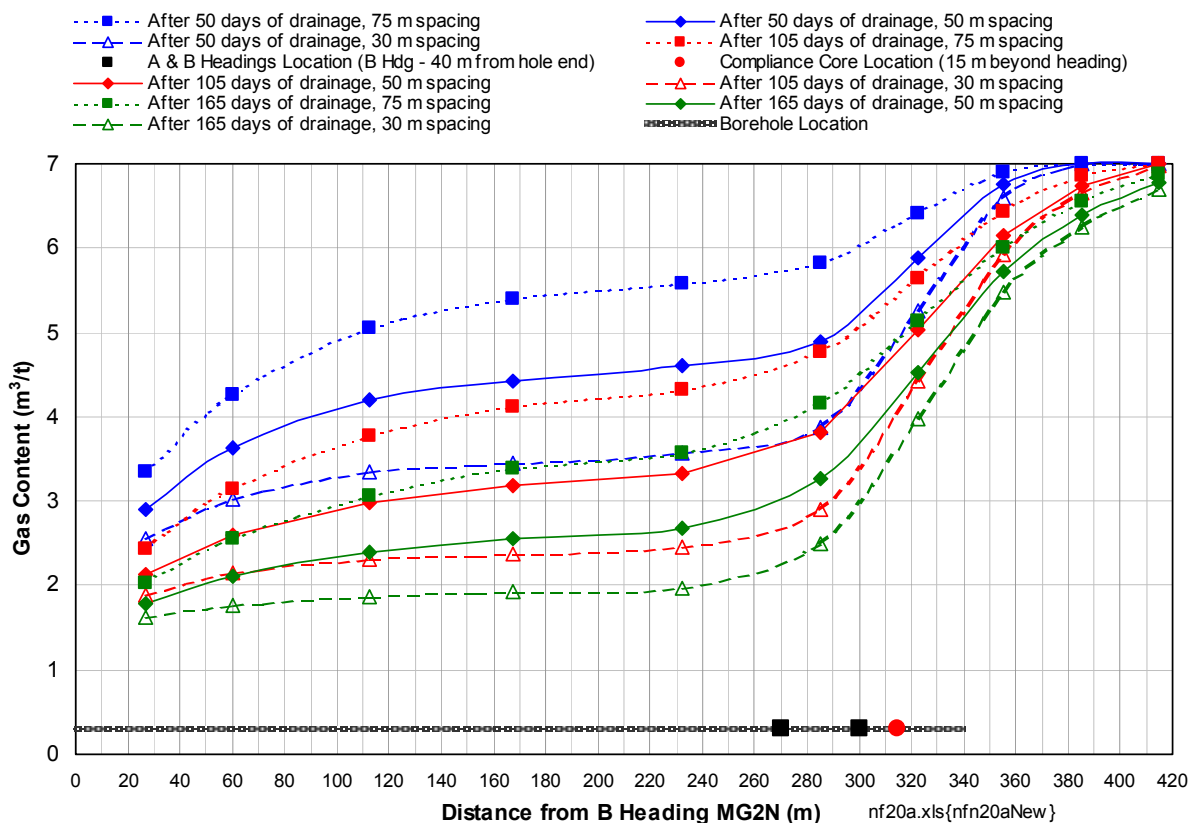


Fig. 3 Hole End Effects

### GAS CONFORMANCE

Gas conformance cores are taken to the edge of the 15 metre protection zone at nominally 100 metre spacings. Cores are generally taken from the surface and the full coal seam is cored. Vertical variability within the seam is up to 2 m<sup>3</sup>/t. The lower third of the seam generally has the highest residual gas content. The core from the lower third of the seam is analysed and if its content + 2 m<sup>3</sup>/t confirms with the 900 DRI, no further analysis is carried out. The cores from the upper two thirds of the seam will be analysed if the lower core fails. If any core fails the area is deemed inadequately drained and no mining will proceed until gas contents have been further reduced and compliant cores obtained. In the two low permeability zones encountered so far numerous additional drainage

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holes were drilled and cores taken before mining in the compliant adjacent heading proved effective in enhancing permeability.

In-seam cores are taken on occasions, again targeting the lower third of the seam. Cores will be taken at a number of horizons if there is any doubt regarding the representiveness of the initial cored horizon.

Core frequency is increased around identified structures or in areas where hole flow measurements indicate an area may have poor drainage.

In simple terms, cores are taken where the highest residual gas is expected.

### **OUTBURST MINING PROCEDURES**

No procedures exist or have been contemplated for mining in non-compliant areas.

### **VALIDITY OF BULLI SEAM KNOWLEDGE**

Standards adopted for the Bulli seam have been used as a basis for setting conditions for North Goonyella

#### **Barrier Pillar Sizing**

There was little science behind the determination of the 15 metre protection barrier for North Goonyella.

This assumption has been recently challenged with two considerations.

1. Is the 15 metre barrier excessive at current depths?
2. Is the 15 metre barrier adequate for greater depths?

A study was initiated to look at the geomechanical strata behaviour and gas fluid flow mechanics as they are expected to vary with depth.

The behaviour at 400 metre depth was then compared with the Bulli seam.

The study suggests that the North Goonyella behaviour is quite similar to the Bulli seam thus the application of Bulli seam knowledge may be quite valid.

The study is yet to be finalised.

### **THRESHOLD LIMIT**

The Desorption Rate Index (DRI) is a measure of gas desorption rate derived from GeoGAS's method of fast desorption gas content testing. In its determination, a standard mass of coal (200 g) is crushed at a standard rate of crushing. The quantity of gas desorbed after 30 seconds crushing is used as a relative indicator of desorption rate. From gas content thresholds successfully applied in the outburst prone Bulli seam mines a DRI of 900 has been identified as a threshold below which outbursts will not occur, regardless of the structural state of the coal. For the Bulli seam, a DRI of 900 is equivalent to a gas content of 9.5 m<sup>3</sup>/t pure CH<sub>4</sub> and 6.0 m<sup>3</sup>/t pure CO<sub>2</sub>.

For the same gas content, the Goonyella Middle seam at North Goonyella has a higher rate of gas desorption. The 900 DRI occurs at a gas content of 7.0 m<sup>3</sup>/t for essentially pure CH<sub>4</sub> and has been accepted as gas content threshold applying to mining at North Goonyella.

There has been no reason to challenge the validity of this threshold for North Goonyella.

## EFFECTIVENESS OF GAS DRAINAGE

The 900 DRI threshold equates closely to  $7\text{m}^3/\text{t}$ . Gas drainage is designed to reduce gas to  $<4\text{m}^3/\text{t}$  and the mine ventilation system is designed for  $5\text{m}^3/\text{t}$ .

Residual gas contents at the development headings, in practice, are rarely greater than  $2\text{-}3\text{m}^3/\text{t}$ .

Intersection of gas drainage holes by the continuous miner creates little problem with general body gas levels but often causes problems with water seepage on to a floor which degrades badly. Drainage holes in roof coal in close proximity to the development roof horizon cause more difficulties because they are difficult to seal.

## OUTBURST HISTORY

An outburst was recorded on 22<sup>nd</sup> October 2001.

The continuous miner had ceased cutting and was positioning to commence bolting when the operators noticed coal flowing from the face "like black water with waves in it". The miner is set up with two gas detectors. The detector at the cutting heads detected 3.5% but the detector at the tail which is set to trip the machine in a general body of 1.25% detected no increase.

By the definition of an outburst as a "sudden release of coal and gas under pressure" the event was arguably not an outburst. Fig. 4 shows outburst material at the drill rig.

Irrespective of the interpretation of definitions the event has been regarded by site management as an outburst and a thorough investigation into the event has been carried out and gas drainage and outburst management practices reviewed.

The initial observations at the site showed;

1. Approximately 6 tonnes of pulverized, dry coal loosened from the face.
2. No significant variation in mining conditions prior to the event.
3. Presence of an outburst "cone" in the roof of the cavity.
4. No sign of structure.



**Fig 4 Material at Drill Rig**

The site was cleaned and supported to allow a thorough investigation. This investigation identified;

1. The presence of a strike slip fault.
2. Mylonite in the fault.
3. Red discolouration of coal in another heading along the projection of the fault.

All employees on roster were taken to see this set of "classical" Bulli seam outburst indicators.

A comprehensive program of core sampling in three horizons identified no abnormal gas variances in the vicinity of the structure.

It certainly appears that conditions existed which may have resulted in a sizeable outburst had gas drainage not been effective.

### CONCLUSIONS

North Goonyella experience to date with gas drainage and outburst management practices is not inconsistent with the Bulli seam.

The mine however is continuing to increase in depth (and has a potentially mineable lower seam) and will continue to increase its understanding of gas and structural behaviour. This knowledge, combined with predictive tools will endeavour to establish practices and procedures for managing the changing circumstances at the mine prior to those changes becoming detrimental to the safe and efficient operation of the mine.