GRETLEY COLLIERY, MINIWALL MINING SYSTEM

By

Michael W. Simes¹ and John B. McKendry²

INTRODUCTION

Gretley Colliery is situated at Wallsend, a suburb of Newcastle in New South Wales and is owned and operated by the Newcastle Wallsend Coal Company, a wholly owned subsidiary of Peabody Coal Limited.

The mine has been an efficient bord and pillar producer by industry standards. However, its continued economic viability was threatened because the bulk of remaining reserves lie in more difficult mining conditions and are of poorer quality.

Alternatives were examined to improve productivity and allow Gretley to become more competitive in the current difficult market environment.

BACKGROUND

Remaining recoverable reserves in the Dudley / Young Wallsend Seam at Gretley total approximately 22 million tonnes. Most of these reserves lie under residential areas at shallow depths of cover, typically 70 to 120 metres.

The seam working thickness varies from 1.8 to 2.5 metres and gradient is moderate to flat. The mine is not gassy or liable to spontaneous combustion.

A system of partial pillar extraction, on a take a row, leave a row basis, has been practised using continuous miners under some of the built up area (refer to Figure 1).

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Maximum subsidence in these panels was typically 20 to 30mm and no damage to surface structures occurred.

This experience, together with research work carried out by A.C.I.R.L., confirmed that the same design parameters for extraction width and supporting pillar width as used for the continuous miner panels could be applied to any alternative mining systems.

The percentage extraction in these partial extraction panels is approximately 68%, compared with 85% in "total" extraction panels where subsidence of up to 1 metre occurs.

ALTERNATIVES TO IMPROVE PRODUCTIVITY

Four alternatives to improve productivity in the remaining areas of Gretley were examined and these were:

Longwall Mining

Longwall is currently regarded as the most productive system of mining, offering the lowest unit cost. However, a high level of investment is necessary for longwall mining equipment and infrastructure. This requires large reserves in regular shaped areas to justify the investment.

Gretley has limited reserves in the remaining areas and these areas have residential development with relatively low depths of cover.

The high capital cost and projected subsidence effects precluded the use of longwall.

Shortwall

Shortwall mining has been practised in
Australia but at the present time there are no such systems in operation. Whilst the system is technically feasible, it is felt there are a number of improvements that have yet to be made to the design of supports to increase roof coverage at the face, stability and ease of operation and transportation.

At Gretley there is a particular need to support the roof close to the face to minimise product dilution from the immediate friable mudstone roof. Shortwall supports do not satisfy this requirement.

Continuous Conveyors

There are continuous conveying systems in use in Australia and results to date are encouraging. As yet, they have not operated in the lower seam heights applicable at Gretley.

Continuous conveyors do remove one of the interruptions to the production cycle where shuttle cars are otherwise used but do nothing to eliminate the interruption when roof supports are erected in continuous miner operations.

In the Gretley situation it was estimated that an improvement of up to 20% in production rates could be achieved on the current system with continuous miners using continuous conveyors. This did not meet the productivity requirements for the extraction system.

Minwall (Short Longwall)

Whereas the shortwall system of mining uses a continuous miner to cut a 3m web from the face, the minwall system uses a single ended ranging drum shearer to cut a 1m web and this is the essential difference.

Roof exposed at the face with the minwall system is better controlled and product dilution should be minimised.

Equipment used is proven longwall mining
equipment and the system, like longwall, provides continuous cutting and loading without interruptions to the cycle for the extraction of support.

Face length can be limited to control surface subsidence and, importantly, the capital cost of the equipment can be justified within the scope of the remaining reserves in Gretley.

MINING SYSTEM CHOSEN

The mininawll system was selected because it provided the most cost effective improvement in productivity for Gretley.

Extraction widths will vary from 25 to 41 metres depending on the depth of cover. Panel lengths are the maximum that can be achieved within the constraints of geological features and lease boundaries so as to minimise frequency of relocation of the equipment.

In the initial area of operation, panel lengths are 32m and each block contains approximately 200,000 tonnes (refer to Figure 1).

To maximise total mine productivity and allow the continuous miners on development to keep pace with the mininawll retreat, it is important to have the optimum ratio of development to extraction, especially with such short extraction widths.

The preferred layout is shown in Figure 2. Two development headings service two mininawll blocks. Both roadways access the face while the first block is being extracted. Ventilation passes across the face, beyond the last support at the blind end and returns across the extracted area.

When the first block is completed, the equipment is moved a short distance to the second face to extract in the opposite direction. One roadway services the face during this operation. Ventilation again passes through the extracted area.

For the initial period of operation of the mininawll, a modified panel layout will be used to provide two access roadways up the face at all times (refer to Figure 3). Conditions in the extracted area and access roadways will be monitored while the first three faces are being extracted.

A comparison of development rates needed for different layouts to keep pace with the mininawll retreat at expected extraction rates is given in Table 1.

<table>
<thead>
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<th>Table 1</th>
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<tbody>
<tr>
<td>Development rate (metres per unit shift)</td>
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<td>Main and tail</td>
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<tr>
<td>gate layout</td>
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<td>40</td>
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The AusIMM Illawarra Branch, 21st Century Higher Production Coal Mining Systems—Their Implications, Wollongong, NSW, April 1988
Michael W. Simes and John B. McKendry

In the future, it is contemplated that single entry development and extraction panels using the miniwall system will be employed to extract smaller irregular shaped blocks of coal. The development rate requirement is similar to that needed with the preferred layout.

The actual development rate achieved to date since 1986, using single pass fixed head continuous miners, is 14.8 metres per unit shift.

THE FACE OPERATION

The face and main gate layout is shown in Figure 4. The production cycle begins with the shearer in the main gate. A full web is cut in the top section of the seam across the face to the blind end.

At the end of the face, the shearer ranges down to cut and load the bottom section of the seam, which is mined on the return run to the main gate.

When the shearer is withdrawn into the main gate, the entire APC and shearer are pushed forward 1 metre. This elimination of "smaking", as practised on longwall faces, is expected to provide a simpler face operation and better control of face line.

One complete cycle is estimated to take about 15 minutes and to produce 100 tonnes of coal. This gives a production potential of 2,400 tonnes per shift without downtime and after excluding travelling time.

MINIWALL MINING EQUIPMENT

Proven longwall equipment has been adapted to the miniwall system.

Whilst the system allows continuous operation, there are a number of essential differences to conventional longwall that need to be recognised in the design of equipment and panel layout.

These are:

- rapid rate of retreat

With approximately 100 tonnes mined in a web the rate of retreat is projected to be 40m to 60m per day. This compares to 7m to 15m...
per day with a conventional longwall. Some of
the design parameters adopted are:

To minimise the number of cables and hose
in the outbye monorail system by using an
inbye pump station.

To minimise the number of pantechnicon
slides and locate crib room, fitters tool
box and other equipment in the adjacent
roadway.

Cary HT cable and water hose on a
lightweight monorail system.

More frequent moves

In the first area to be mined, miniwall
blocks contain approximately 200,000 tonnes
and there may be 4 moves of equipment each
year.

Moves are planned to be completed in 3
days.

Support spacing of 2m in lieu of the
conventional 1.5m has reduced the number of
components to be relocated.

Supports

The powered roof supports are 400 tonne
capacity, Dowty 2 leg chock shields. Supports
are set at 2m centres across the face and each
support weighs 15 tonnes.

1.2m long flipper bars on the canopies
can be folded down to provide a collapsed
transport length of 4m. This allows supports
to be transported "side on" by fork lift in
the 5m wide prop free roadways and to be
quickly removed from the face at the
completion of each panel.

Side shields are fitted to fully close
the gap between supports and provide a
ventilation barrier parallel to the face line.

Electro hydraulic control is fitted with
a multi function capability provided by a
computer located in the main gate. On such a
short face with a relatively rapid operating
cycle, part automation of support and APC is
considered essential.

Lighting is provided on each support and,
the number of interlock cables and hoses kept
to the absolute minimum.

APC

The 160kW APC has an ultimate capacity of
800 tonnes per hour. This Halbach & Braun APC
is unique in that it does not discharge onto a
stage loader but instead the chain passes
around a 90 degree roller curve and continues
along the main gate to discharge onto the
panel belt conveyor.

A lump breaker is located in the main
gate section of the APC.

The drive unit is in the main gate, clear
of the face. Face supports can be identical
and set in a straight line across the face.

Because of the roller curve
configuration, the shearer can pass over the
roller curve frame without ramping up. This
allows the shearer to be fully withdrawn into
the main gate and the APC bank pushed to
simplify the face operation. At the
completion of each miniwall block, the same
configuration allows the shearer to be taken
off the face quickly and without removing any
major components.

The APC has a single 35mm centre chain,
bottom closed pans with bottom inspection
plates and 35mm thick top deck plate.

Shearer

The single ended ranging drum shearer is
the B.J.D. Ace, powered by a single 300kW
motor and fitted with hydraulic haulage and
radio control. An on-board computer is
provided and the machine has an advanced
control and diagnostic system.

For the miniwall system, the single ended
shearer has the advantage of compact
dimensions and is capable of being fully
withdrawn into the 5m wide main gate.

All coal mined must pass under the
shearer so that careful attention has been
paid to the size and shape of the underframe
tunnel.

The shearer is supported on 3 shoes, 2 on
the goaf side and 1 on the face side. This
provides a clear path for the coal on the APC when the shearer is passing over the rollover curve unit.

With the shearer fully withdrawn into the main gate and the APC bank pushed, the shearer can take the full 1m web across the face. On the main cutting run from the main gate to the blind end, the shearer haulage speed will be pre-set by the on board computer to provide the maximum conveyor belt capacity. (approx. 5m/min). On the clean up run from blind end to main gate, the maximum shearer speed of 10m/min can be utilized.

The 3 start drum is fitted with radial and lumping picks, is 1.5m in diameter and rotates at 45 R.P.M.

Main Gate Equipment

The pantechincon comprises 4 sleds; communication and control equipment, hydraulic pump and tank, transformer and puller sleds. Other equipment such as the crib room, fitters work bench, spares and so on are to be handled using the mines present materials handling system in the adjacent roadways.

The 11kV cable and water hose supplying the face are to be carried on a monorail system outbye of the pantechincon slides.

Lighting is provided in the main gate area on the pantechincon slides.

Equipment has been kept to a minimum to facilitate rapid retreat and face changeovers.

The panel conveyor boot end is attached to the discharge end of the APC without any overlap. The boot end unit has facilities for levelling and horizontal alignment.

Panel Conveyor

The panel conveyor is 1050mm wide and has a capacity of 800 t.p.h.

The drivehead is 225kW and the automatic loop storage unit has 170m of live belt storage. A hydraulically operated belt rolling station has been fitted. The system is of modular construction.

Modules are 4m length and are designed with self levelling feet to facilitate rapid transport and installation.

PRODUCTIVITY AND COST EFFECTIVENESS

Table 2 provides productivity and cost comparisons of the longwall, miniwall and continuous miner extraction systems. The figures presented relate to Gretley mining conditions, seam thickness and so on. The longwall information is an assessment based on the assumption that longwall mining can be carried out, that is, the surface constraints have been ignored.

<table>
<thead>
<tr>
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<th>Longwall</th>
<th>Miniwall</th>
<th>Cont.</th>
<th>Miner</th>
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<tbody>
<tr>
<td>Daily av. prod. (t)</td>
<td>6000</td>
<td>3600</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>Face manning (24hrs)</td>
<td>35</td>
<td>32</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Face output/man (t)</td>
<td>171</td>
<td>112</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Annual tonnes (mt)</td>
<td>1.25</td>
<td>0.78</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Cap.cost ($m)</td>
<td>20</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Cap.cost/annual t($/t)</td>
<td>16</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Operating cost (approx. relativity)</td>
<td>2 : 3 : 5</td>
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</table>

The figures demonstrate that the miniwall provides a reasonable compromise between productivity, or operating cost, and capital cost. Where reserves are limited, such as at Gretley, the miniwall concept provides a cost effective method of coal extraction.

CONCLUSION

The miniwall was chosen for Gretley as a means to improve the mine's viability over its remaining life.

The layout and system, as selected, is site specific to the special circumstances applying at Gretley. Nevertheless, the principle and equipment have wider application, especially to mines with limited reserves where major capital expenditure is not warranted or where geological or surface constraints preclude normal longwalls.

Similar face lengths, as proposed for
Gretley, are operating successfully in West German and U.K. coal mines. Production levels similar to those budgeted for Gretley have been achieved in the U.K. using a single entry system.

The first Gretley face is expected to commence production in early May, 1988.