



# Surface auger mining at Rietspruit Mine Services (Pty) Ltd

by M.J. Lukhele\* Paper written on project work carried out in partial fulfilment of B.Tech (Mining Engineering) degree

## Synopsis

A number of high wall mining methods were developed over the years to mine coal reserves exposed on the high walls created during surface mining. The auger mining system was initially developed in the early 1940s in the United States of America.

High wall mining is a method of recovering coal from seam exposed either by mechanical excavation methods or natural erosions. This is usually associated with strip-mining (opencast) where the stripping ratio is high and uneconomical to mine using the opencast mining method.

This paper discusses the surface auger mining as deployed at Rietspruit Mine Services Proprietary Limited.

## Introduction

Rietspruit Mine Services Proprietary Limited is a joint venture between Ingwe Coal Corporation and Duiker Mining Limited and is producing approximately 600 000 run-of-mine tonnes. Rietspruit Mine services Proprietary Limited is situated near Kriel in the Mpumalanga Province and was originally established as an opencast mine in 1976. As a result of increase in depth and stripping ratio it was decided to start underground operations in 1991.

Three separate opencast pits were mined, the layout and configuration of these pits resulted in the construction of a number of permanent ramps and haul roads that were constructed to be used until the end of life of the mine.

The combination of opencast and underground mining meant that portions of coal seam could not be extracted from the vertical high wall, and these were regarded as sterilized reserves. The use of the coal recovery auger miner resulted in the mine utilizing the remaining reserves. Approximately 500 000 run-of-mine tonnes on the number 2 and 4 seam has been mined utilizing an auger mining method

## Geology

The Rietspruit lease area is presently towards

the centre and the southern boundary of the Witbank Coalfield, which is part of the main Karoo basin.

The coal bearing strata forms part of the Vryheid Formation of the Ecca Group and of the Karoo Sequence and is of Permian age. Coal seams are discontinuous over a prominent palaeo-topographic high and due to post-Karoo weathering.

The formations underlying the mining area have been affected to varying degrees by chemical weathering processes. The influence of physical weathering processes is believed to be minimal. The depth of weathering varies from 2 metres to more than 18 metres, but may be greater in the low lying vlei areas where deeper penetration of groundwater occurs into the strata.

The geological succession of the Karoo Sequence is represented by sediments of the Dwyka (bottom) and Vryheid Formations and is up to 105 metres in thickness. The pre-Karoo rocks consist of mainly rhyolite (felsite) and gabbro of the Bushveld Igneous Complex. No coal is present towards the southern boundary of the mine as rhyolite outcrops form part of the easterly striking pre-Karoo, Smithfield palaeo-ridge which is also the southern boundary of the Witbank Coalfield. Sedimentation and coal formation occurred initially on undulating surfaces.

The Dwyka Formation underlies the coal seams conformable and consists of 0 to 15 metres thick tillite and diamictite with minor gritty, conglomerate and shale lenses and layers. These sediments cover the Bushveld rocks over most of the area and are the thickest in palaeo-valleys. The six coal seams numbered from 1 at the bottom are all present within the Vryheid Formation. The number 1,2A (a split off from the 2 seam), 3, 4 and 5 seams are limited in extent due to palaeo-topography and/or surface weathering in the

\* *Technikon Witwatersrand.*

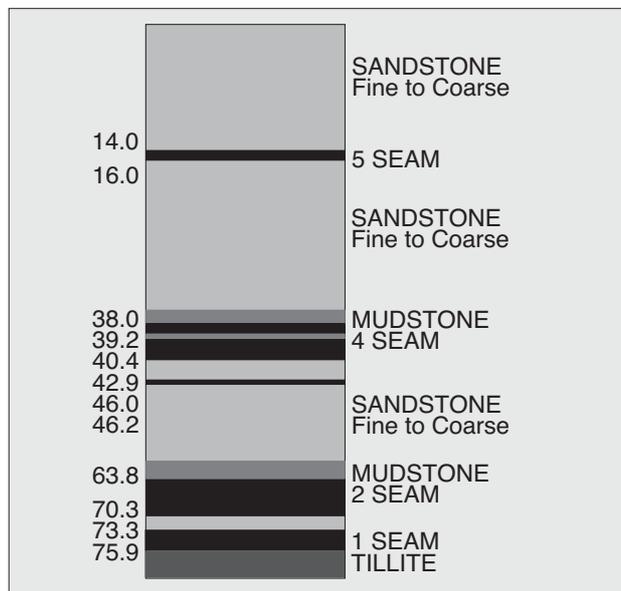
© *The South African Institute of Mining and Metallurgy, 2002. SA ISSN 0038-223X/3.00 + 0.00. This paper was first presented at the SAIMM Student Colloquium in Oct. 2001.*

# Surface auger mine at Rietspruit Mine Services (Pty) Ltd

area. The parting between the number 1 and 2 or 2A seams consists mainly of coarse to gritty sandstone with minor silty lenses and is from 0,1 to 11 metres in thickness. The number 4-seam consists of the 4U (upper) and 4L (lower) seams being separated by mainly a mudstone from 0,4 to 2,3 metres in thickness. The 2-seam is the dominant seam and comprised about 58 per cent of the coal.

Sandstones, siltstone, mudstone and shale with associated coal seams (nos 3, 4U, 4L and 5) represent the Vryheid formation above the 2 seam coal and generally consist of upward coarsening sequences between the coal horizons. Carbonaceous mudstones usually form the roofs of coal seams. The number 3-seam is sporadically developed with a maximum thickness of 0,7 m and is of no economic interest. Variations in thickness of both coal and sedimentary units are common and seam splitting with intra seam sedimentary layers and lenses are

## Stratigraphic column



## The auger miner

This refined auger miner can recover a high percentage of the reserves from the coal seam within the high wall depending on the hole spacing design, and can operate on benches as narrow as 18 metres. The auger miner is an entirely self-contained production unit and using only diesel and hydraulic oil pressure is able to operate in remote parts of the mine without impacting on other operations.

The BryDet 2348-72 coal recovery auger used at Rietspruit Mine Services (Pty) Ltd weighs 84 tonnes, and is driven by a 1000 horsepower diesel engine. The large-diameter 1,8 metre cutting head is able to drill into the coal seam at a rate of approximately 1,2 metres per minute. The flight conveyor hauls the coal from the cutting face to a side discharge pan conveyor and onto a crawler conveyor, then deposited beside the auger. This coal in turn is loaded out to a stockpile, or directly onto tipper-truck (Rear Dump Truck).

Approximately every four-and-a-half minutes an additional 2,5 tonne, 5,4-metre long flight is added at the drive end by means of a boom hoist. In total, 22 scrolls are used to drill the 120-metre hole into the coal seam.

## Auger holes

Ingwe Rock Engineering Department designed all auger holes resulting in various extraction factors in different areas to provide the required safety factors as shown in Figures 1, 2, 3, and 4. In order to ensure sufficient support of the overburden, a half-a-metre (0.5 m) thick septum of coal separates individual holes with a stabilizing pillar between each cluster of holes.

The auger hole configuration depends on the safety factors of different areas and this results in different recovery rates as shown in Figures 1, 2, 3 and 4. Ingwe's unique methodology has enabled Rietspruit to extract coal under haul roads and in close proximity to underground workings.

### The number 4-seam hole design

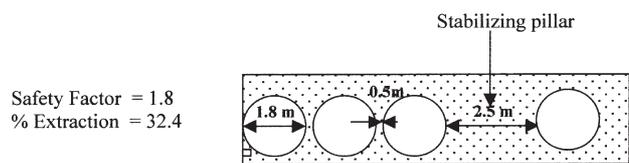


Figure 1

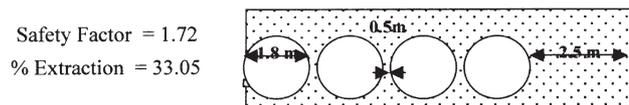


Figure 2

### The number 2-seam hole design

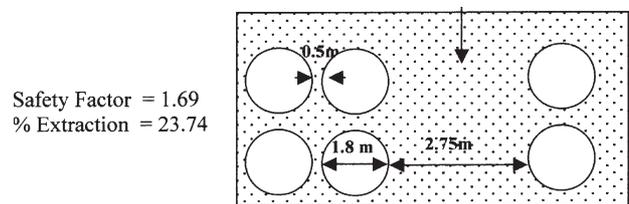


Figure 3

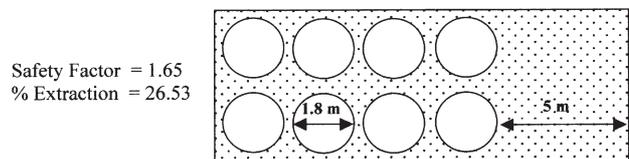


Figure 4

### Methodology of determining the safety factor for auger mining method

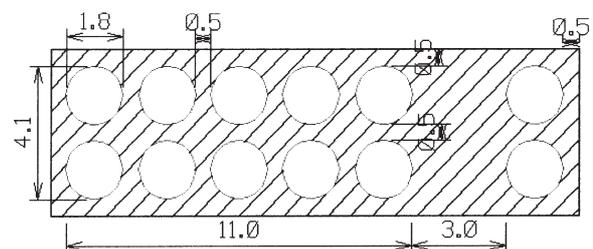


Figure 5

## Surface auger mine at Rietspruit Mine Services (Pty) Ltd

Safety factor	=	$\frac{\text{Strength}}{\text{Load}}$	0.46
Strength	=	$\frac{7200 \cdot W}{0.66 \cdot H}$	0.46
	=	$\frac{7200(2 \cdot 3)}{0.66}$	4.1
	=	6469 kpa	
W-effective pillar width (m)		H-depth from surface	
h-height of excavation (m)		A-Area indicated on Figure 5 with a depth of 1 m	
		A2-Area between holes with a depth of 1 m	
Load	=	$\frac{25 \cdot H \cdot A}{A2}$	
		$25 \cdot 30 \cdot (1.8+0.5+1.8+0.5+1.8+0.5+1.8+0.5+1.8+3) \cdot 1$	
Load	=	$\frac{3 \cdot 1}{3 \cdot 1}$	3500 kpa
Safety factor	=	$\frac{6469}{3500}$	1.84

### Auger mining system operation

The BryDet auger system consists of 1000 diesel horse power and the hydraulic pump with the drilling pressure between 500 and 2000 psi which varies between machine action. The auger mining system consists of the following

- Cutting head
- Auger flights
- Latching mechanism
- Auger fork.

### Cutting heads and flights

These are the 'tools' the auger used to recover coal. As the cutting head scrolls into the hole, the rotating auger flights transfer the coal backwards toward the hole opening. The coal is transferred into a pan conveyor and to the crawler conveyor. Auger mining operations are remotely controlled by controls from the operator's cab. The cutting head consists of the following components; rear wear bend, cut-down bit socket, front wear bands, bit socket, dust bends, centre breaker, wedge breaker, lighting and outer cutting barrel.

### Latching and fork mechanisms

Auger mining requires that a number of auger flights need to be secured to the cutting head for penetration. The cutting head and auger flights are joined by a square pinned male shank which connect to the female socket that ensures a secure link between the cutting head and the auger flight. Once the auger flight is disconnected, a hoist mechanism is used to remove or add the auger flights. The rear latch mechanism operates the latching on the drive chuck as well as on the female end of the auger flight. This is used when removing an auger flight from the auger string.

The main components are; latch pin, rear latch actuator and latch pin lever.

The front latch mechanism operates the latch pins on auger flight. This is used when removing an auger flight from the string to disconnect an auger flight from another auger flight.

### The operator cab

The operator's cab is where the auger control functions are initiated and is ergonomically designed to meet safety requirements and promote efficient operation.

### Auger alignment and movement

The BryDet auger miner is equipped with the components for elevation and alignment functions that provide manoeuvrability in a variety of pit conditions. The control system includes *inter alia*

- Front and rear skids
- Front and rear jacks
- Auger level
- Auger guide
- High wall guard.

The typical procedure for moving the auger miner to its drilling location at the high wall and for aligning the auger with the coal seam is as follows:

- Extend/retract the hydraulic jacks and skids as necessary to move the auger miner to its new location
- Using various combinations of hydraulic jack and skid functions can move the auger parallel to its original position or allow the auger miner to position itself at any angle.

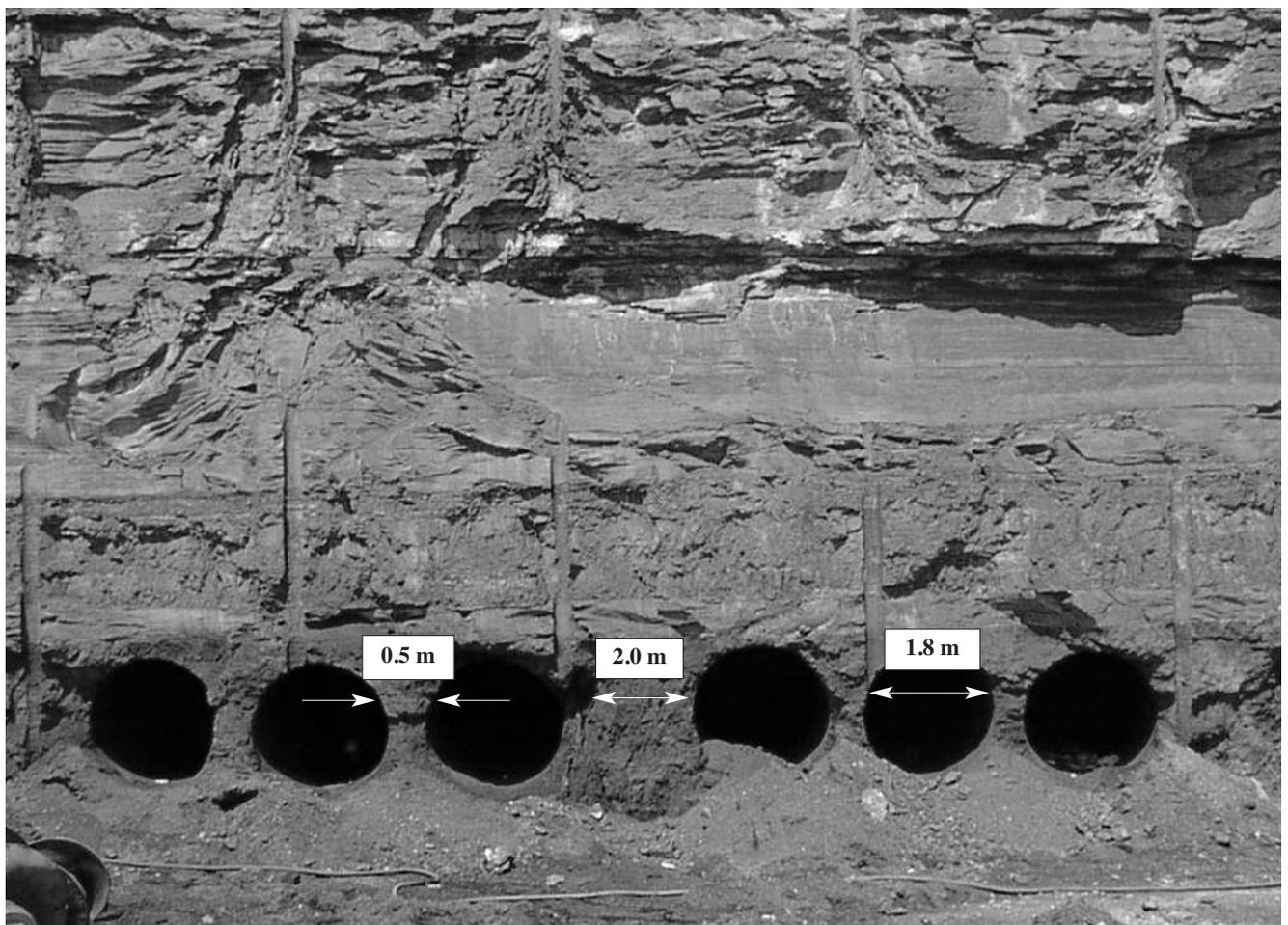
### Hydraulic skids

The two hydraulic skids under the auger miner are essentially the 'feet' of the machine enabling the auger miner to walk, to turn and traverse through rough terrain. Each skid can be operated independent from the other skid.

### Operating sequence

- Lower the auger frame until it rests on the ground
- Use the hydraulic jack controls in the operator cab to lower the auger frame. Make sure the jacks are retracted completely so that there is no weight on the skids
- Extend the skids to the left out from under the auger frame
- Use the skid controls in the operator cab to extend the skid cylinders. Fully extend both skids
- Raise the auger from the ground
- Before continuing, make sure no part of the auger frame is in contact with the ground
- Move the auger to the left or right
- Use the skid controls to retract the skid cylinders
- As necessary repeat until the auger is at its new position
- The distance the auger is moved is determined by the diameter of the holes being cut and the desired width of the coal seam support pillars
- Check the new position of the auger against the marker stakes. The front and rear corners of the auger should be exactly the same distance from the corner stakes. If the distances are not the same, use the skid controls to adjust the position.

# Surface auger mine at Rietspruit Mine Services (Pty) Ltd



# Surface auger mine at Rietspruit Mine Services (Pty) Ltd

## Hydraulic jacks and auger level

The auger miner has four hydraulic jacks that level the machine at the proper elevation and angle for the coal seam.

## Auger guide

The adjustable auger guide serves as the cutting head 'guide' when starting a new hole in the coal seam. It also serves as a 'bridge' transfer pan to help move recovered coal coming out of the hole for the short distance from the hole opening to the auger miner's pan conveyor.

## High wall guard

The high wall guard serves as a shield to protect the auger miner and the personnel from objects (rocks, etc.) that fall off the high wall.

The overall guard is made of three components namely: stationary top high wall guard attached to the top of the high wall guard support structure and an adjustable front high wall guard attached to the front of the support structure, hydraulic cylinders attached to the front high wall guard and the high wall guard support structure can be used to tilt the front high wall guard at different angles to suit the characteristics of the high wall contours.

## Starting the hole

The levelling and alignment of the machine is essential

before starting the hole and if not correctly done it may result in short holes or may take longer than necessary to complete the hole.

## Adding auger flights

The first auger flight must be added to the drive train in order to continue operations. Adding the first auger and subsequent auger flight to the drive train involves disconnection, alignment, and reconnection operations.

The auger flights are lifted into position using the auger hoist mechanism.

## Conclusions

The auger mining method is suitable to extract coal that was previously sterilized using the conventional mining method. The auger miner concept has been utilized at several other collieries in South Africa. In an attempt to maximize the extraction of reserves auger miner can be considered.

## Acknowledgements

The author would like to thank the General Manager of Rietspruit Mine Services and Auger Mining South Africa for the information and assistance that made the paper possible. ♦

