

RELATIONSHIP BETWEEN GEOLOGICAL STRUCTURES AND SHORTWALL MINING AT MATLA COLLIERIES, MPUMALANGA

by

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ABSTRACT

In the Matla coal mining area, coal occurs in a palaeo-channel trending northeast-southwest. Three upward-coarsening cycles are each capped by a coal seam.

A study of boreholes and the rocks exposed during underground mining reveal the presence of large sinuous sills called flow rolls that run at right angles to the strike of the palaeo-channel and also at right angles to the high-energy fluvial current direction.

Studies underground revealed that joints formed by compaction occur in the vicinity of the floor rolls. These joints referred to as slips, cause roof failures during the mining operation resulting that the short-wall mining operation in the No. 2 Coal Seam has to stop. This phenomenon can also be explained by referring to the roof rocks e.g. those underlying the No. 4 Coal seam to act as a cantilever during mining operations. When mining is terminated as a result of floor rolls, the cantilever extends and roof failure occurs.

The most important result of the study is that the size, geometry, orientation and distribution of floor rolls must be determined before mining and development operations commence.

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CONTENTS

	Page
ABSTRACT	i
ACKNOWLEDGEMENTS	ii
CONTENTS	iii
LIST OF FIGURES	vi
LIST OF TABLES	ix
EXPLANATORY TERMS	xii
LIST OF ABBREVIATIONS	xiv
CHAPTER 1 : INTRODUCTION	1
1.1 Project Motivation	1
1.2 Locality	1
1.3 Objectives of Study	2
1.4 Methodology	4
CHAPTER 2 : MATLA COAL LTD.	5
2.1 Background	5
2.2 Mining at Matla Coal Ltd.	7
2.3 Production at Matla Coal Ltd.	8
2.4 Short wall Mining at Matla Coal No. 2 Mine	8
2.4.1 Current shortwall	10
2.4.2 No. 2 Coal Seam shortwall	12
2.4.3 Roof supports No. 2 Coal Seam	12

	Page
2.4.4 Shearer	13
2.4.5 Automation	14
CHAPTER 3: GEOLOGY	16
3.1 General Geology of the Highveld Coalfield	16
3.2 Regional Depositional Sequences in the Highveld Coalfield	21
3.2.1 Sequence 1	21
3.2.2 Sequence 2	22
3.2.3 Sequence 3	22
3.3 Matla Coal Ltd. No. 2 Mine Geology	24
3.3.1 Geological structure	24
3.3.2 Stratigraphy and lithology of the Vryheid Formation	24
3.3.2.1 Sequence 1	24
3.3.2.2 Sequence 2	26
3.3.2.3 Sequence 3	27
3.4 Geological Structure	29
3.4.1 Palaeo-topography of the No.2 Coal Seam	29
3.4.2 Palaeo-Channel	30
3.4.3 Macroscopic sedimentary structures associated with the Palaeo-Channel	40
3.4.4 Conclusion	43

CHAPTER 4: RESEARCH RESULTS	44
4.1 Rate of advance	44
4.2 Cantilever Beam	47
4.3 No. 4 Seam Chain Pillar	49
4.4 Surveyed Slips	52
4.5 Description of the Slip zones	55
CHAPTER 5: RATING SYSTEM	61
5.1 Rate of advance	62
5.2 Sandstone Beam	63
5.3 Slip zones	67
5.4 Floor Rolls	71
CHAPTER 6: CONCLUSIONS	76
APPENDIX A	78
APPENDIX B	108
APPENDIX C	111
APPENDIX D	116
REFERENCES	163

LIST OF FIGURES

	page
Figure 1: Map illustrating the locality of Matla Coal Ltd	3
Figure 2: Aerial photograph illustrating the layout of the Mines 89at Matla Coal Ltd	
Figure 3: An illustration of the panel layout at Matla Coal Ltd	11
Figure 4: Locality of Matla Colliery in the Highveld Coalfield	17
Figure 5: Distribution of the Coal Seams in the Main Karoo Basin	20
Figure 6: Locality of the palaeo-channel at Matla Coal Ltd No.2 Mine	25
Figure 7: General stratigraphy and depositional sequences at Matla Coal Ltd	28
Figure 8: Position of the section lines	31
Figure 9: Section 1: Geological section depicting the impact of the palaeo-floor on coal distribution	32
Figure 10: Section 2: Geological section depicting the impact of the palaeo-floor on coal distribution	34
Figure 11: Section 3: Geological section depicting the impact of the palaeo-floor on coal distribution	35
Figure 12: Section 4: Geological section depicting the impact of the palaeo-floor on coal distribution	37
Figure 13: Percentage fines in the interburden	38
Figure 14: Locality of the floor rolls with regard to the panel layout at Matla Coal Ltd. No. 2 Mine	40
Figure 15: The stress distribution ahead of a long wall face	46

Figure 16:	A cantilever beam	48
Figure 17:	Pressure arches caused by standing chain pillars	50
Figure 18:	Panel layout of No. 2 and No. 3 mines at Matla Coal Ltd	51
Figure 19:	Slip zones at Matla Coal Ltd No. 2 Mine	54
Figure 20:	Slip zone 1 at Matla Coal Ltd No. 2 Mine	57
Figure 21:	Slip zone 2 and 3 at Matla Coal Ltd No. 2 Mine	58
Figure 22:	Slip zones 4 and 5 at Matla Coal Ltd No. 2 Mine	59
Figure 23:	Origin of the vertical slips at Matla Coal Ltd No. 2 Mine	60
Figure 24:	Locality Rating of the First Panel	64
Figure 25:	Locality Rating of the Second Panel	65
Figure 26:	Locality Rating of the Third Panel	66
Figure 27:	Slip Zones in the First Panel	68
Figure 28:	Slip Zones in the Second Panel	69
Figure 29:	Slip Zones in the Second Panel	70
Figure 30:	Floor Roll areas in Panel 1	73
Figure 31:	Floor Roll areas in Panel 2	74
Figure 32:	Floor Roll areas in Panel 3	75
Figure 33:	Shearer, roof shields and AFC used in the coal cutting operation at Matla Coal Ltd No. 2 Mine	112
Figure 34:	Shearer used in the coal cutting operation at Matla Coal Ltd No. 2 Mine	113
Figure 35:	Roof supports in the coal cutting operation at Matla Coal Ltd No. 2 Mine	114
Figure 36:	AFC (Automatic Face Conveyor) used in the coal cutting operation at Matla Coal Ltd No. 2 Mine	115

1. INTRODUCTION

1.1 Project Motivation

The Karoo Supergroup forms part of one of the most interesting and widespread sedimentary sequences in the world. The Karoo Supergroup does not only cover a large part of southern Africa but can be correlated with similar Gondwana sequences in India, Australia, Antarctica and South America. Coal is one of the economically important deposits found in the Karoo Supergroup and one of the commodities that is extensively mined in South Africa. The project area is the property of Matla Coal Ltd., part of the Eyesizwe Group, and forms part of the Highveld Coalfield that is located in the northern part of the Karoo Supergroup. The No. 2 Mine at Matla Coal Ltd. mines the No. 2 Coal Seam of the Highveld Coalfield with a short wall operation. The mine has experienced and continues to experience excessive roof failures, which cause huge losses in production. The investigation into the cause of these roof failures forms the basis of this study.

1.2 Locality

Matla Coal Ltd., located 150km east of Johannesburg (Figure 1), is owned by Eyesizwe Mining, South Africa's first major black empowerment coal company. All coal is supplied on long-term contract to power utility company Eskom. Matla Coal Ltd. is located in the Highveld Coalfield and mines the No.'s 2, 4 and 5 Coal Seams of this coalfield.

1.3 Objectives of Study

The objectives of this study are:

1. To study the roof failures at Matla Coal Ltd. No. 2 Mine through correlation of geological and mining data with the localities of the roof failures.
2. To study the floor rolls at Matla Coal Ltd. No. 2 Mine.
3. To correlate roof failures with the floor rolls at Matla Coal Ltd. No. 2 Mine.
4. To study the origin of the floor rolls at Matla Coal Ltd. No. 2 Mine.
5. To correlate the floor irregularities with the slip zones at Matla Coal Ltd. No. 2 Mine.
6. To compile a rating system for face breaks in the mining panels at Matla Coal Ltd. No. 2 Mine based on the research results.



Figure 1: Map illustrating the locality of Matla Coal Ltd.

1.4 Methodology

Data was gathered at Matla Coal Ltd. from various departments. The daily reports were obtained from the control room at the No. 2 Mine. The geological logs and analytical data were obtained from the geology department. Survey data were obtained from the survey department. The data was mostly exported into spreadsheet format, because these files are compatible with Arcview software that formed the base of modeling packages used in the project.

The daily reports were investigated for patterns that may have led to the continued roof failures experienced at No. 2 Mine (Table 4 - 32, Appendix A). A spreadsheet was created where the data is presented as tables in a word document. The dates of roof failures, distance from the start of the panel to the roof failure occurrences and the possible reasons for the roof failures were entered into the spreadsheet.

The borehole information was used with the downhole geophysical logs to investigate the different lithological units. Three different lithological units were investigated between the No. 2 Coal Seam roof and the No. 4 Coal Seam floor. The distribution of certain lithological units was superimposed over the floor topography to establish correlations between the different palaeo-topographic areas and the thickness distribution of the lithological units. This data was used to establish fingerprints for future exploration.

Surveyed data i.e. coordinates and floor elevations were used to compile a floor structure map of the No. 2 Coal Seam. The surveyed data was modeled in Arcview to create the palaeo-floor topography. Boreholes could not be used for modeling due to the large borehole spacing used during drilling programs at the mines. A three dimensional model (Figure 8) was compiled of the floor topography and all related data was superimposed onto this model to illustrate the different relationships between geological variables and floor topography.

Slips are by law surveyed in the mining environment as a safety precaution. The data related to the presence of slip structures were projected in Arcview software together with mine surveyed data and palaeo-floor topography. This data was used to establish possible relationships between slips and floor topography.

Geo-referenced maps of the development areas were obtained from the survey department. These maps were used to locate the areas in which roof failures occurred.

2. MATLA COAL LTD.

2.1 Background

Matla Coal Ltd. was founded in 1973 when Escom awarded a contract to the Trans-Natal Coal Corporation (now Ingwe Coal) and the Clydesdale (Tvl)

Collieries Ltd. (now Goldfields Coal). The contract required the supply of approximately 10.0 million tonnes of coal per year to the 3600 MW capacity Matla Coal Ltd. Power Station. Production has increased steadily since commissioning of No.1 Mine in May 1978. No. 2 mine was commissioned in December 1980 and No. 3 Mine in January 1983.

Between May 1978 and May 1996 Matla Coal Ltd. produced 152 million tons of coal from the three mines. More than 1 million tons of coal per month is produced regularly and the budgeted production for the next 5 year period is 13 million tons per year.

Production is achieved by means of long/short wall sections and conventional continuous miner board and pillar panels. Exploration of this field commenced in 1965 and, since then, more than 500 boreholes have been drilled within the Matla Coal Ltd. mineral rights area.

Mineable in situ coal reserves within the mining rights area total 1 140 million tons from three different coal seams. The No.'s 5, 4 and 2 Coal Seams have average thicknesses of 1.4 metres, 4.9 metres and 4.3 metres respectively for the selected horizons. These seams occur at depths varying from 48, 76 and 105 metres respectively.

Coal from the No. 4 Coal Seam is low-grade bituminous coal, suitable for the generation of power, whereas the coal from No. 5 and 2 Coal Seams, which is high-grade bituminous coal, can, through benefaction, be utilised for metallurgical and export markets as well as power generation.

The mineral rights area is bounded by Amcoal's Kriel Colliery, to the east, South Witbank Colliery to the north, with Khutala and Delmas Collieries to the north - west and west respectively.

2.2 Mining at Matla Coal Ltd.

The mine consists of three separate and independent shaft complexes or mines (Figure 2), and E'tengweni, a box cut operation on the No. 5 Coal Seam. The shaft complexes are not interconnected underground. Should any of the three shafts lose its production capacity, it will be possible to maintain the required production rate from the remaining shaft complexes. The infrastructure of each mine has therefore been designed to handle a tonnage of 50 percent in excess of the planned tonnage should the need arise.

Matla Coal Ltd. was the first mine in South Africa to plan and operate total production from continuous miner sections. At that stage it was a farsighted and courageous step as continuous miners were still unproven in South Africa. The labour and cost advantages have shown that this was the correct decision. The average production from a continuous miner section is 60 000 tonnes per month. In May 1981 a record continuous miner section production of 118794 tonnes was achieved by working on a three-shift cycle.

Access to the reserve is provided by means of three shafts per mine. The service and the ventilation shafts are 11 m diameter vertical shafts. An incline shaft with a height of 2.5 m and a width of 4 m is provided at each mine for the transport of coal. Conveyor belts transport the run-off mine product to a

crushing and screening plant at No. 1 Mine. A final product of -25mm coal is delivered to the power station. No. 2 and 3 mines were the first coal mines in South Africa with sub-bank entrance facilities.

2.3 Production at Matla Coal Ltd.

Although production has increased from 9.5 million to 11.9 million tonnes the labour complement has steadily decreased from 3118 man units in 1983 to 2069 in 1996. Productivity has increased from 254 tonnes per man per month to 478 tonnes per man per month over the same period.

Due to the reliability of supply from Matla Coal Ltd., Escom has on occasions also supplied coal to Kriel and Kendal Power stations and on several occasions sold coal to Sasol (Secunda). Matla Coal Ltd. supplied 7 million tons of coal to Majuba Power Station between 1996 and 2000.

2.4 Short wall Mining at Matla Coal Ltd. No. 2 Mine

At Matla Coal Ltd. Coal No. 2 Mine three successive seams i.e. No. 2, No. 4 and No. 5 Coal Seams occur. At present a 150 m wide short wall is in operation in the No. 4 Coal Seam. The mining height varies from 3.8 m to 4.1 m, at a depth of 75 –100 m. The short wall at No. 2 Mine mines the No. 2 Coal Seam, which was initially mined by board and pillar. The thickness of the No. 2 Coal Seam varies from 3.5 to 5.5 m. The panel layout for short wall development as well as the mined out areas are indicated in Figure 3.



Figure 2: Aerial photograph illustrating the layout of the Mines at Matla Coal Ltd

2.4.1 Current short wall

The decision to use a short wall system on the No. 2 Coal Seam was due to the good production results at Matla Coal Ltd.'s No. 4 Coal Seam long wall system commissioned by DBT, in May 1997. By October 2001 the long wall system had produced a total of about 11.5 Mt/y. The No. 4 Coal Seam long wall system reached a record of 512000t of coal produced in October 2001 in its first year of operation, bearing testimony of the quality and durability of the equipment.

The short wall at Matla Coal Ltd. offers the minimum face length to initiate regular goafing behaviour of the strata and avoid roof hang-ups in the goaf (goafing is the ability of the roof to cave in behind the mechanized mining equipment). Other considerations were the face length required to ensure that development would always stay ahead of face retreat. Matla Coal Ltd. preferred a Roller Curve armoured face conveyor (AFC) because it required the least capital expenditure. The face conveyor and stage loader are combined into one unit with only one dual AFC drive station located in the head gate. The main advantages of this AFC configuration on a short wall are:

1. There are no drives at the face.
2. The MC drives are elevated 1.5 m off the floor in the man gate and are less prone to water ingress.
3. Excellent maintainability of machinery.
4. Can handle large lumps of coal behind the face and stage loader (crusher).

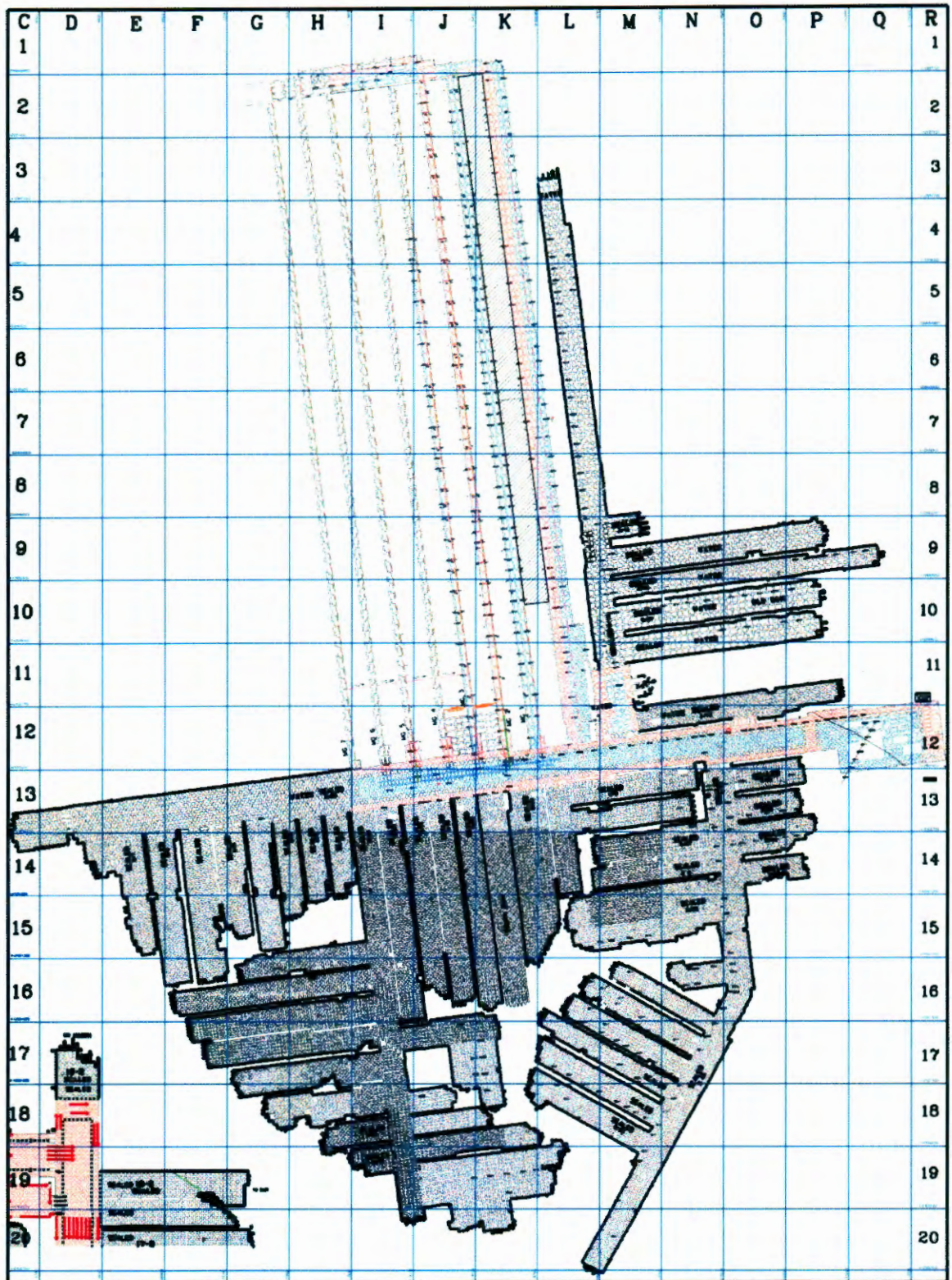


Figure 3: An illustration of the panel layout at Matla Coal Ltd. (Matla survey department)

2.4.2 No. 2 Coal Seam short wall

Equipment tender documents for the new No. 2 Coal Seam short wall were issued by Matla Coal Ltd. in February 2000. After extensive evaluation DBT was selected in December that year to supply the shield support and face conveyor equipment.

The No. 2 Coal Seam short wall is situated below the No. 4 Coal Seam short wall area. This necessitates superposition of the No. 2 and No. 4 Coal Seam panel and development layouts. The effect of the No. 2 Coal Seam panels is such that the chain pillars left in the No. 4 Coal Seam are approximately one third of the way down the face of the No. 2 Coal Seam. The No. 2 Coal Seam short wall is planned to produce a minimum of 6 Mt/y including production from developments.

The project has several technical challenges related to geological features encountered during previous mining in the No. 2 Coal Seam. Specific solutions are required to meet these challenges and to satisfy Matla Coal Ltd.'s performance requirements.

2.4.3 Roof supports No. 2 Coal Seam (Figure 39, Appendix C)

Massive roof layers require massive shield supports. Matla Coal Ltd. No. 2 Mine required 1.75m wide shield supports of greater than 10000 kN yield capacity.

Structural design codes for shield supports stipulate lower safety factors than are customary for more stationary mining machines and equipment, resulting in reduced weight and cost. This is, however, redressed by a careful and sophisticated design process to meet customer requirements and expectations for safety, durability and a service life of 10 to 15 years. Sophisticated design techniques such as finite element analyses and failure mode and effects analysis are used.

2.4.4 Shearer (Figure 37 and Fig. 38, Appendix C)

At Matla's No. 2 Mine best results are achieved by equipment utilisation at constantly high, but not maximum production levels. This is now being demonstrated by the Opti Shearer Cycle method of shearer operation. This is achieved by eliminating the double shuffle process as used in the bidirectional cycle and regulating coal output over the cycle to eliminate peaks forces.

Using the Opti Shearer cycle, the web is extracted in two passes with a lower bench to be extracted on the second pass. With an anti-clockwise tailgate drum rotation the leading drum cuts from roof to floor, the reaction forces on the drum try to lift the leading drum side of the machine.

Using the Opti Shearer Cycle in the No. 2 Coal Seam short wall will make it possible to retain DBT's roller curve principle to combine AFC and stage loader. The heavy-duty conveyor pans are ideally suited to high coal production but will also carry the 120 tonne Eickhoff double drum shearer

fitted with 2.75 m diameter drums. The drums cut 1m deep. When cutting the 5.5 m Coal Seam height some 900t will be mined in one cycle in one pass in 15 to 20 minutes. A DBT Minpro 350 kW crusher is integrated into the conveyor chain between roller curve and AFC discharge. This equipment configuration is able to handle the uniform flow of 2,500 t/h of coal produced by the Opti Shearer Cycle.

2.4.5 Automation

Shield and long wall system automation were high on the list of Matla Coal Ltd.'s requirements and DBT's acclaimed PM 4 electro-hydraulic controls are the heart of the automation system. Most cylinders are fitted with either stroke or pressure sensors to constantly monitor actual conditions and provide feedback to the automation loops. A typical automated mode of operation runs as follows:

1. The shearer cuts the top bench of the seam continuously sending position signals to infra-red receivers in each shield.
2. The shields advance automatically approximately 5 m (the distance is programmable on the face) behind the shearer by lowering support legs and initiating advance ram anchored to the face.
3. At the end of the advance the shield legs are automatically activated (set pressure is programmable) to support expose roof and to let the roof cave in behind the shields.

4. On the return to the head gate, the shearer cuts the bottom bench of the seam and the AFC (Figure 40, Appendix C) automatically advances behind the shearer by means of the advance ram now anchored in each shield.

Monitoring functions serve to maintain alignment of shields and AFC (Figure 41, Appendix C) to prevent the shearer drum and shield flippers colliding and to maintain optimum support cylinder pressure levels.

3. GEOLOGY

Coal is a readily combustible sedimentary rock containing more than 50% by mass and 70% by volume of carbonaceous material, and is formed by the accumulation, compaction and indurations of variously altered plant remains (Gary *et al.*, 1972)

3.1 General Geology of the Highveld Coalfield

The Matla Coal Ltd. coal mining area is situated in the Highveld Coalfield which covers an area of 7000 square km (Fig. 4). The Highveld Coalfield is bordered in the east and north by pre-Karoo granites and felsites from the Bushveld Igneous Complex. Towards the west and south outcrops of granite and sediments of the Witwatersrand Supergroup constitute the geological boundaries.

The Highveld Coalfields comprises sedimentary rocks of the Dwyka Formation and Ecca Group. Sediments of the coal-bearing Vryheid Formation and the overlying Pietermaritzburg Formation constitutes the Ecca Group in the Coalfield.

An ice sheet covered a large portion of the Gondwana continent prior to the coal formation epoch during the Permian. During the northward retreat of the ice sheet the lowermost coal seams i.e. No. 1 and No. 2 Coal Seams and associated sediments were deposited. The impact of this ice sheet on the underlying pre-Karoo rocks is evident by the presence of the undulating pre-

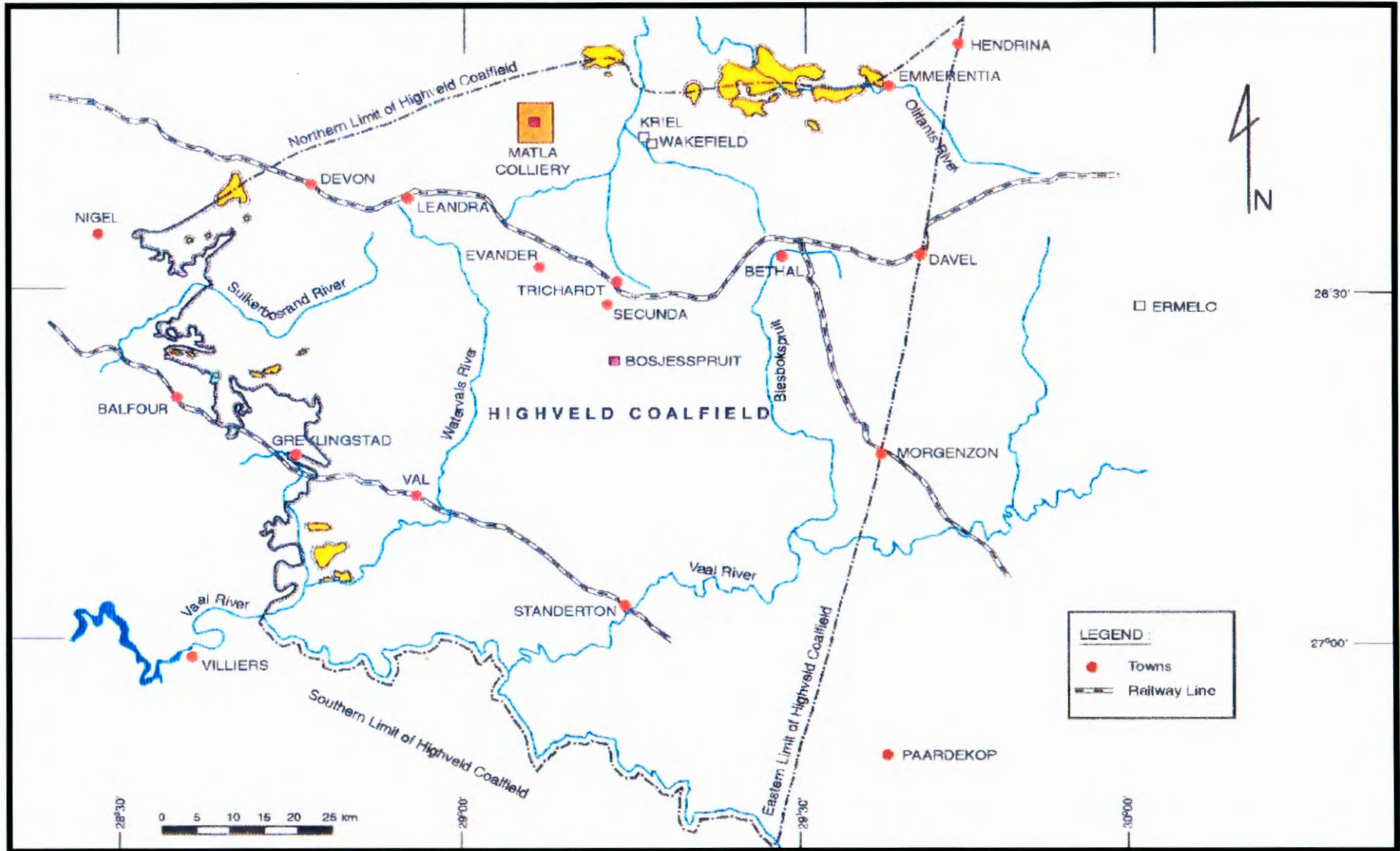


Figure 4: Locality of Matla Colliery in the Highveld Coalfield (SAIMM Vacation School, 1981)

Karoo topography. The resulted glacial valleys and topographical highs impacted directly on the aerial distribution and qualities of the No. 1 and No. 2 Coal Seams.

Following this glacial event, the No.'s 3, 4 and 5 Coal Seams were deposited during deltaic and fluvial depositional conditions.

The following factors influenced the thickness and distribution of the coal seams (Cadle, 1982):

- a) Palaeo-topographic low lying areas preserve the full sedimentary successions. In the palaeo-topographic elevated areas, the lowermost parts of the sedimentary successions were not deposited or thin towards or pinch out against these basement elevated areas.
- b) The lowermost coal seams attain their maximum thickness on the flanks of the palaeo-valleys. This is attributed to stable conditions and minimum clastic sedimentation which permitted relatively uninterrupted peat accumulation.
- c) The thickness and distribution of the lowermost coal seams are modified by younger braided stream channels.
- d) The thickness and distribution of the No. 3 and 4 Coal Seams are largely influenced by fluvial sedimentation. These coal measures thin against and over the depositional axis of braided stream channels and thicken away from these channels. No seam splitting was encountered.
- e) The distribution of coal seams formed under deltaic sedimentary conditions is controlled by subsidence and sedimentation during peat

accumulation. Coal is only present in these areas where it overlies thick deltaic lobe sediments.

The general geological structure of the Highveld Coalfield is characterised by the presence of three different type and age dolerite sills. Where these sills intruded the Karoo succession, displacement of the strata occurs. Dolerite dykes ranging in thickness from 1,0 m to 4,0 m have been encountered in the colliery workings and they have an important influence on the mine layout (SAIMM Vacation School, 1981). No major faults were encountered during mining in most of the mining areas.

Along the northern and western boundaries, pre-Karoo glacial valleys, trending north-west to south-east, controlled the deposition of plant material and steep slopes occur along the sides of these valleys (Figure 5). Towards the east and south, however, the coal was deposited on a slightly undulating topography with wide valleys and ridges. The valleys joined in a southern direction to form a dendritic pattern (SAIMM Vacation School, 1981).

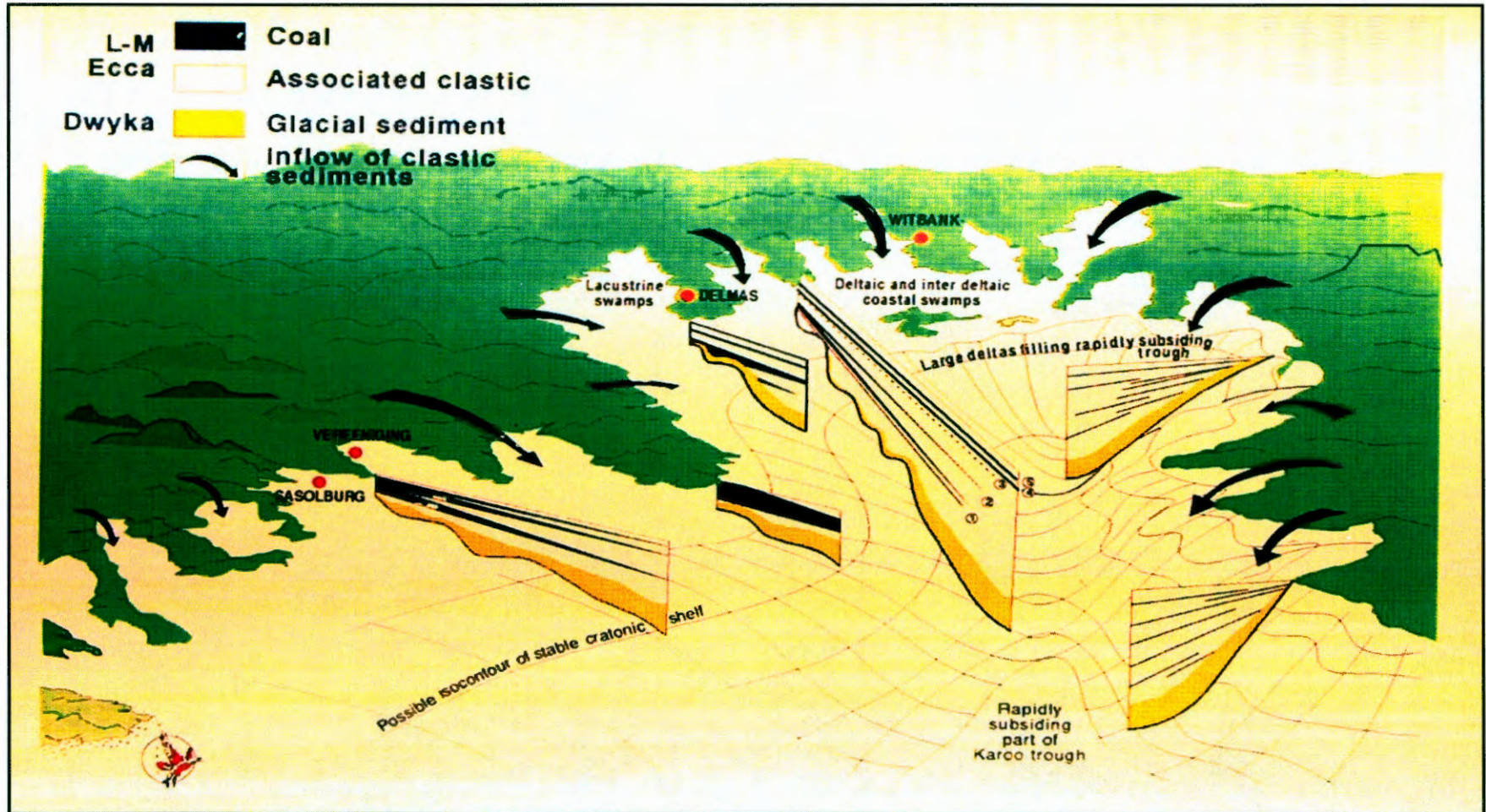


Figure 5: Distribution of the coal seams in the Main Karoo Basin (SAIMM Vacation School, 1981)

3.2 Regional Depositional Sequences In The Highveld Coalfields

Cadle (2005) identified five major depositional sequences in the Vryheid Formation in the Highveld Coalfield. Each sequence is characterised by a basal constructive depositional event followed by a transgressive event. Only three of these sequences were identified in the Matla Coal Ltd. mining area. The depositional sequences identified represents the sediments between the pre-Karoo floor and the top of the No. 2 Coal Seam, the interval between the No. 2 Coal Seam and the top of the No. 4 Coal Seam and the interval between the top of the No. 4 Coal Seam and the top of the No. 5 Coal Seam.

3.2.1 Sequence 1

The first sequence represents the sediments between the pre-Karoo rocks and the No. 2 Coal Seam and includes gravels, sandstones, siltstones and the No.'s 1 and 2 Coal Seams (Cadle, 2005).

This interval attains its maximum thickness within the axes of pre-Karoo palaeo-valleys and pinches out against, and is absent in, areas of elevated topography (Cadle, 2005).

Where the sequence attains its maximum thickness, it comprises a basal massive diamictite nonconformably overlying the pre-Karoo basement, which in turn is overlain by an increment of sediment that coarsens upward. (Cadle, 2005).

3.2.2 Sequence 2

The second sequence starts at the roof of the No. 2 Coal Seam and continues to the top of the No. 4 Coal Seam. The effects of the pre-Karoo floor are still visible in the distribution of the No. 4 Coal Seam as the seam thickens towards the axes of the pre-Karoo paleovalleys and thins out where the pre-Karoo topography is elevated in the northern and north western rim of the basin. (Cadle, 2005).

The sequence coarsens upward and is capped by the No. 4 Coal Seam. The basal unit, which is frequently bioturbated, comprises from the base upwards: carbonaceous siltstone; inter-laminated siltstone-sandstone; and cross-laminated medium-grained, sandstone capped by the No. 3 Coal Seam (Cadle, 2005).

Overlying the No. 3 Coal Seam is a thin coarse grained sandstone unit, which thickens dramatically along linear channel axes where it erodes deeply into the No. 3 Coal Seam and underlying sediments. The sequence is capped by the No. 4 Coal Seam, which is locally split into the 4 upper, 4A and 4B Coal Seams by gravels, coarse-grained sandstones, and siltstones. (Cadle, 2005).

3.2.3 Sequence 3

The third sequence starts at the roof of the No. 4 Coal Seam and continues to the roof of the No. 5 Coal Seam. The pre-Karoo topography and differential compaction has little or no effect on the thickness distribution of the No. 5 Coal Seam.

At the base, the sequence comprises glauconitic mudstone, or a thin, laterally discontinuous, fine-to-medium grained, well-sorted, crosslaminated, glauconitic sandstone. This in turn is overlain by an upward coarsening sedimentary unit, comprising dark-grey mudstone, interlaminated siltstone and a cross-laminated, and crossbedded sandstone capped by the laterally extensive, uniformly thick No. 5 Coal Seam. The glauconitic sandstones and mudstones represent one of the most important stratigraphic markers in the coalfields especially when Coal Seams are absent. (Cadle, 2005).

3.3 Matla Coal Ltd. No. 2 Mine Geology

3.3.1 Geological structure (Figure 6)

There are two palaeo-topographical high areas in the mining area at Matla Coal Ltd. No. 2 Mine with a palaeo-valley that runs between these palaeo-topographical highs. The valley strikes from the north eastern corner to the south western corner of the mining area.

The palaeo-topographical high areas occur in the northern areas of the mining panels at Matla Coal Ltd. No. 2 Mine. The coal seams typically thin towards these palaeo-topographical high areas and become thicker towards the flanks of the palaeo topographical low lying areas.

3.3.2 Stratigraphy and lithology of the Vryheid Formation

In the Matla Coal Ltd. mining area only the lower three depositional sequences as defined by Cadle (2005) for the Highveld Coalfield are present.

3.3.2.1 Sequence 1 (Figure 7)

The basal part of sequence 1 at Matla Coal Ltd. begins with the Dwyka Formation that has a glacial origin. Following the retreat of the Dwyka glacial ice sheets, material was dumped as till and partly reworked and re-deposited by strong flowing currents. The palaeo-topographical low areas were filled with shales and fine-grained sandstones. The crudely stratified gravels, planar cross-bedded and coarse-grained sandstones represent glaciofluvial sediments. Above the coarse grained sandstone the No.1 Coal Seam was

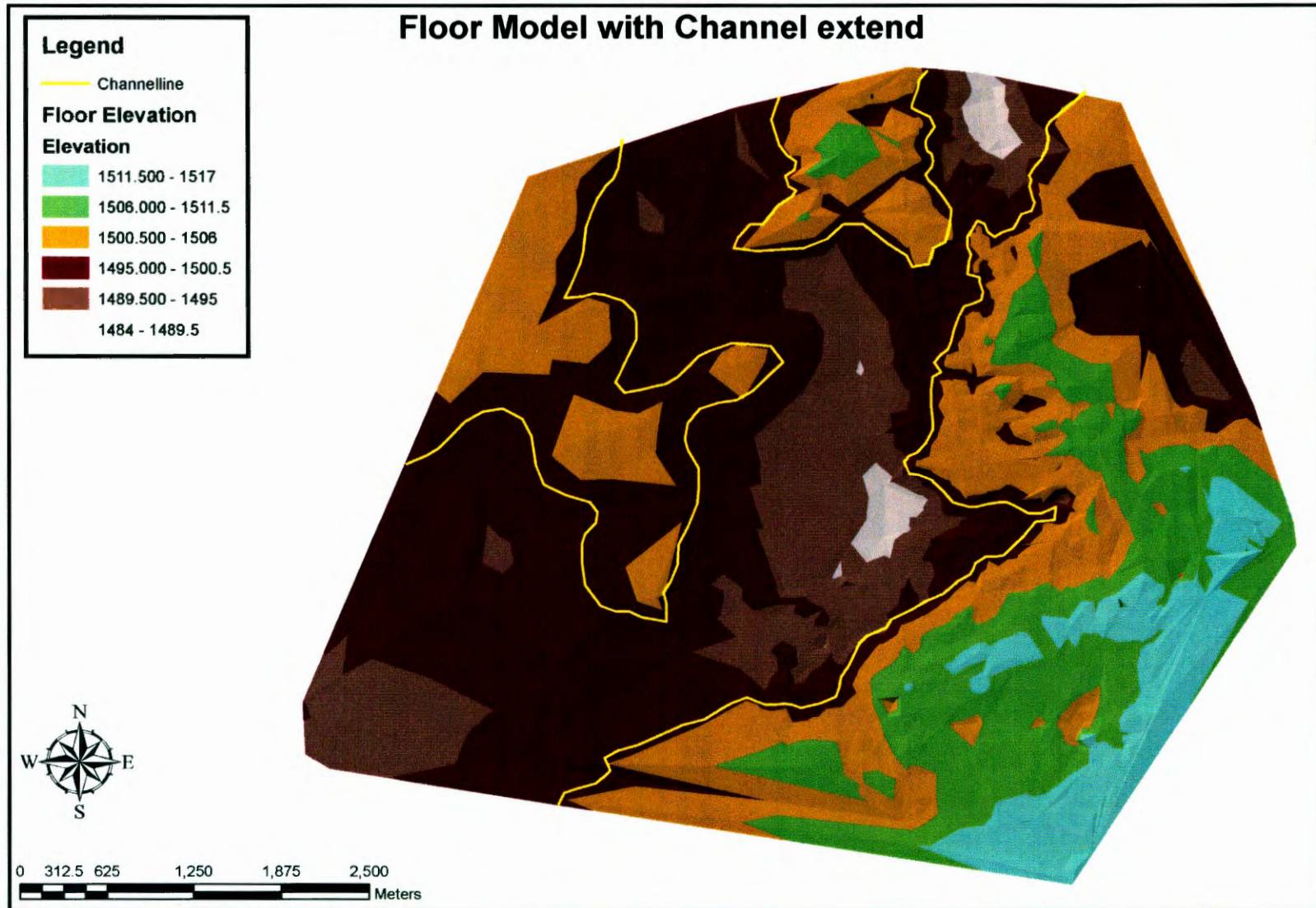


Figure 6: Locality of the palaeo channel at Matla Coal Ltd. No. 2 mine

deposited as a thin irregular seam in the palaeo-topographical low areas. Between the pre-Karoo floor and the first coal seam there is a characteristic upward coarsening sequence. Fine-grained sandstone overlying the No. 1 Coal Seam constitutes the base of a new sequence. This sandstone is overlain by coarse-grained sandstone, which in turn is overlain by a gritty sandstone. The first sequence was terminated by the deposition of the No. 2 Coal Seam. The No. 2 Coal Seam is the thickest and most laterally persistent coal seam and attains its maximum in the topographical low lying areas (Figures 10 - 13).

3.3.2.2 Sequence 2 (Figure 7)

The sedimentation between the No.'s 2 and 4 Coal Seams was initiated by a transgression caused by a basinal subsidence or a rise in the sea level. The peat swamps of the No. 2 Coal Seam became an embayment.

The No. 3 Coal Seam at Matla Coal Ltd. overlies deltaic deposits but as in the case with the No. 1 Coal Seam, the No. 3 Coal Seam is only present as a thin subordinate seam in the palaeo-topographical low areas.

A period of fluvial sedimentation followed the deposition of the No. 3 Coal Seam, which was followed by a long period of basinal stability during which the No. 4 Coal Seam peats accumulated.

3.3.2.3 Sequence 3 (Figure 7)

A major basin wide transgression took place after the No. 4 Coal Seam peat accumulated. This was followed by a period characterized by deltaic sedimentation. The laterally persistent No. 5 Coal Seam overlies these deltaic deposits indicating that stable tectonic conditions prevailed during sedimentation.

Stratigraphy and Depositional Sequences at Matla Coal Ltd.

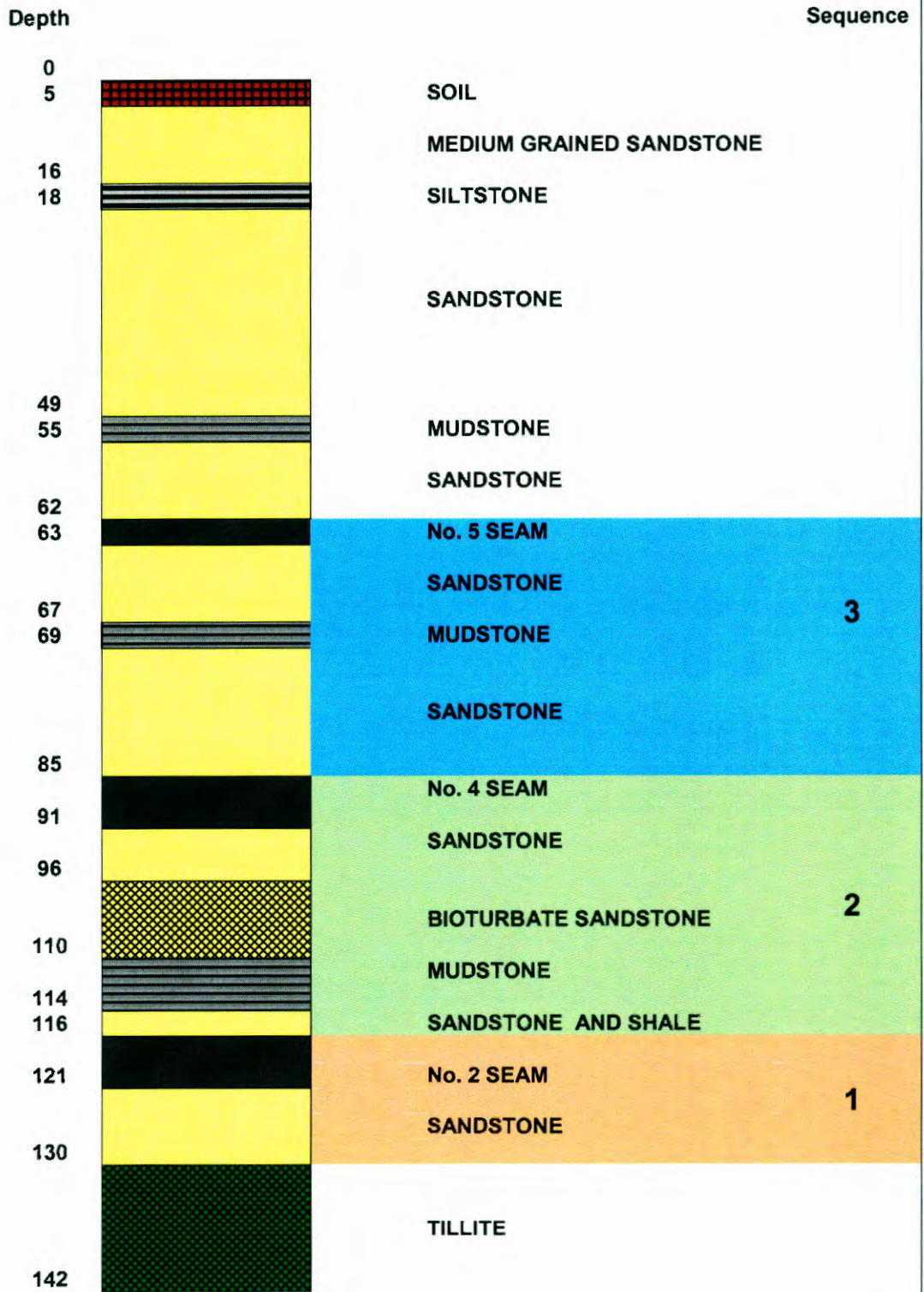


Figure 7: General stratigraphy and depositional sequences at Matla Coal Ltd.

3.4. Geological Structure

3.4.1 Palaeo topography of the No.2 Coal seam

Borehole information and data derived from survey pegs were used to compile a palaeo topographical map of the No.2 Coal Seam. The floor elevation (MAMSL) of the No. 2 Coal Seam was used to compile this map (Fig.6).

The palaeo topography of the No. 2 Coal Seam is characterized by the presence of a topographical low lying area striking north north east to south south west. Towards the north this low lying area is bifurcated by a topographical high lying area.

. The palaeo topographical low is bounded in the east and west by a palaeo topographical high lying areas. Regional studies conducted over the entire Matla Coal Ltd. reserve area revealed that this topographical low lying area extends towards Matla Coal Ltd. No.1 Mine where it impacts on the coal lithology and quality of the No.4 Coal Seam.

The main objective for compiling a palaeo topographical map for the No.2 Coal Seam was to demarcate floor irregularities as these features impact on coal quality, coal thickness distribution, lithology of the interburden between the No.2 and No.4 Coal Seams and mining conditions. In addition to the abovementioned the palaeo-topographical map (Fig. 6) also indicates the main drainage pattern that exists during and before the coal forming event. From Fig. 6 it is deduced that the drainage was from the north-northeast

towards the south-southwest along the topographical low lying area. The palaeo-low lying area thus also constitutes a palaeo drainage channel.

In order to illustrate the impact of the palaeo drainage channel on the coal and interbedded sedimentary sequences, four composite geological sections, perpendicular to the palaeo-channel, were compiled (Fig 8).

3.4.2. Palaeo Channel

(a) Section 1 (Fig. 9)

The floor elevation of the No.2 Coal Seam in Section 1 varies between 1489m in the west to 1511m in the east. The topographical low (A) towards the western part of the section represents the western limb of the bifurcated palaeo channel in the north. Two additional subordinate channels, i.e. B and C occur towards the elevated area in the east.

The No.'s 2 and 4 Coal Seams are draped over the palaeo floor irregularities. The No.4 Coal Seam maintains the same thickness from east to west whereas the No.2 Coal Seam thickens towards the east. The irregular distribution of the No.3 Coal Seam is attributed to the floor irregularities that existed prior to the deposition of this seam.

The immediate roof of the No.2 Coal Seam comprises sandstone and shale. In the western part of the section a fine grained sandstone constitutes the roof of the No.2 Coal Seam. Towards the east this sandstone peters out against

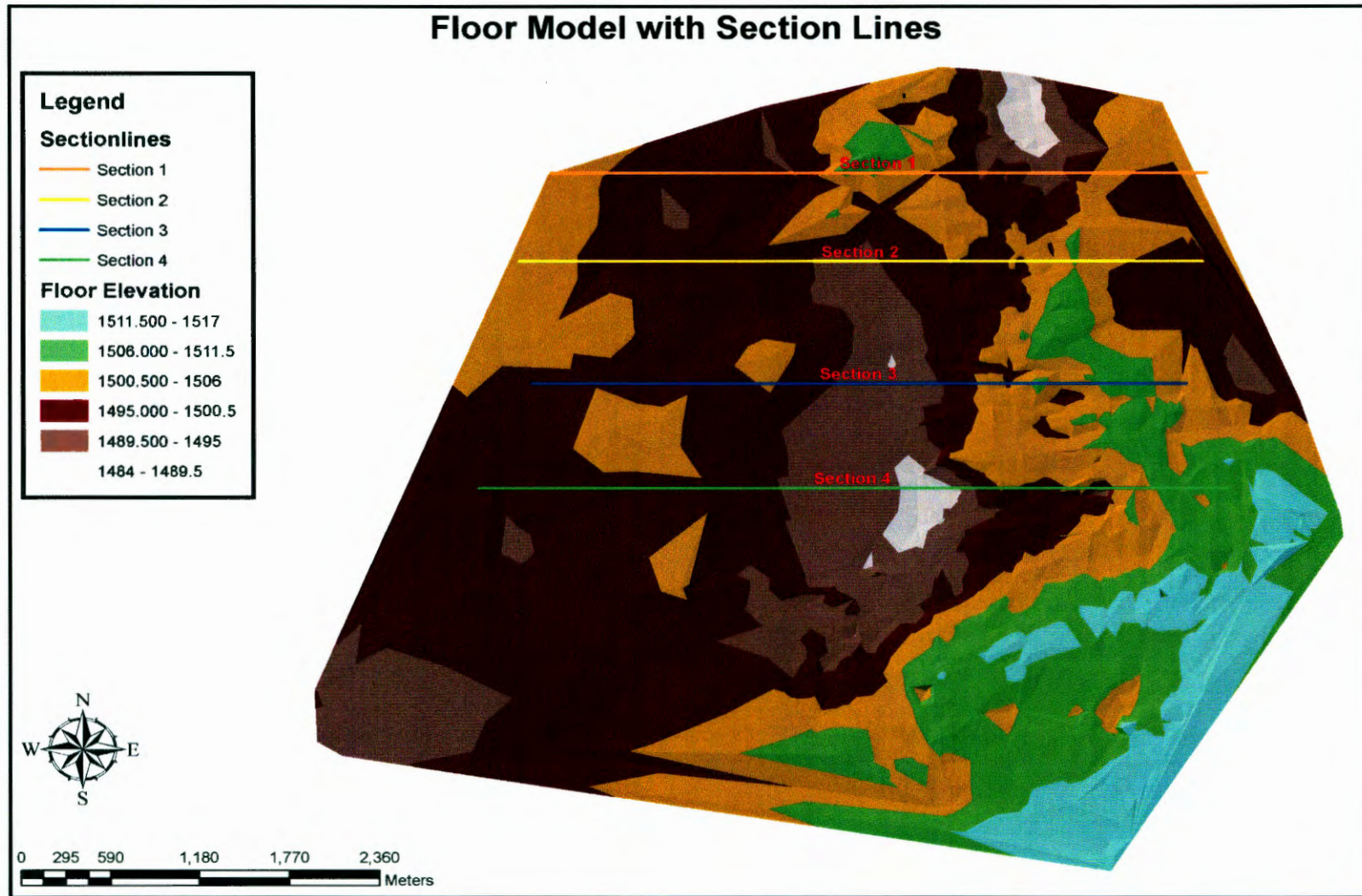


Figure 9: Position of the section lines.

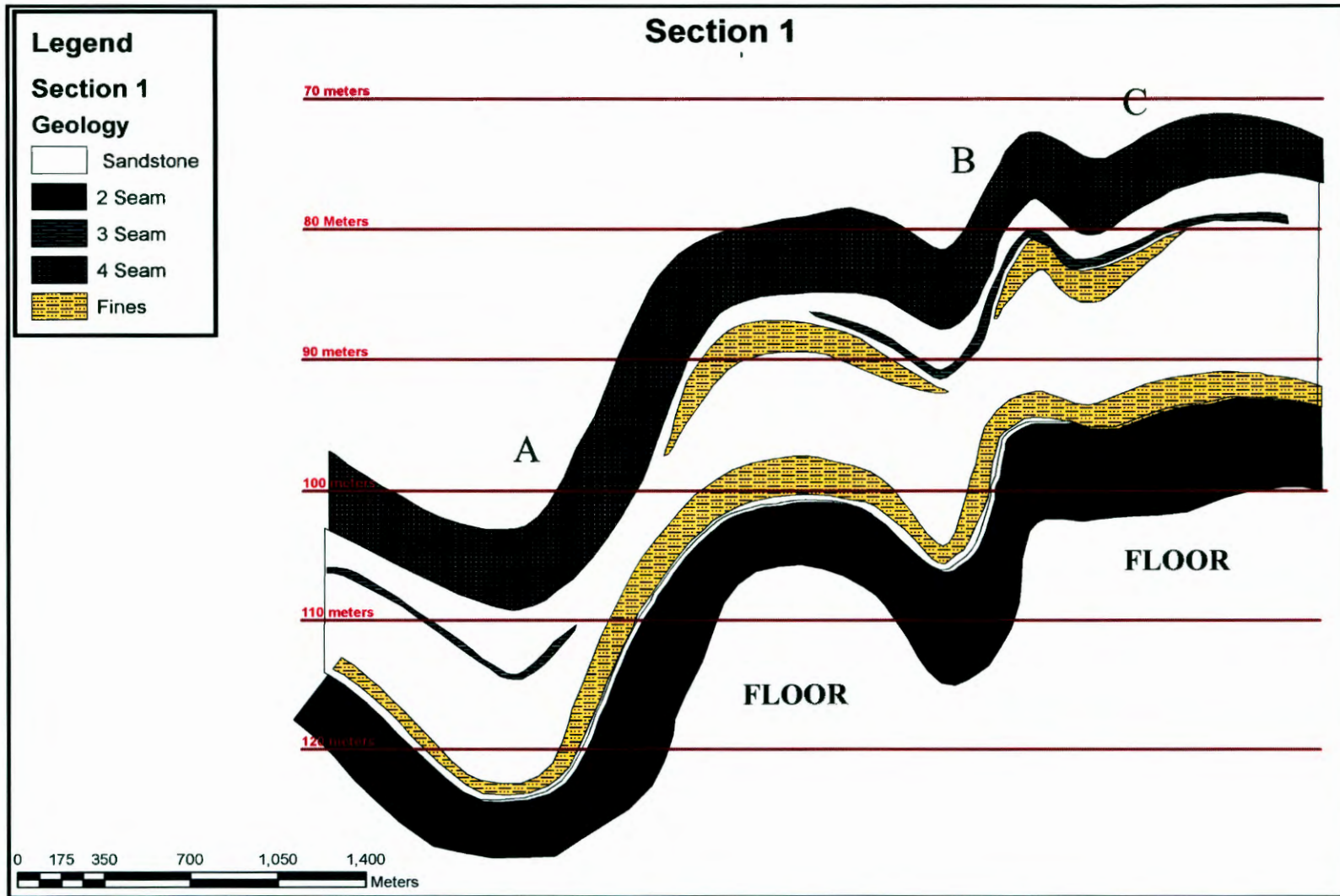


Figure 9: Section 1: Geological section depicting the impact of the palaeo floor on coal distribution

the elevated area resulting that the shale which overlies the sandstone towards the west now constitutes the immediate roof of the No.2 Coal Seam. Section 1 clearly reveals the impact of the palaeo topography on the lateral and vertical variations in coal distribution as well as variations in the associated sedimentary sequences.

(b) Section 2 (Fig.10)

Section 2 depicts the area directly south of the palaeo high lying area which causes the bifurcation of the palaeo-drainage system in the north. The floor elevation of the No.2 Coal Seam varies between 1489m in the west to 1511m in the east. Two distinct palaeo topographical low lying areas, i.e. A and B constitute the major floor topographical features.

The No.'s 2 and 4 Coal Seams maintain their thickness from west to east. The No.3 Coal is largely influenced by the floor irregularities as it is draped over the palaeo highs in the central part of the section and peters out towards the east against the elevated area.

The large variation in lithologies pertaining to the interburden between the No.'s 2 and 4 Coal Seams is attributed to the floor irregularities that exist prior to deposition.

(c) Section 3 (Fig.11)

Section 3 reveals the impact of the palaeo topography on coal thickness distribution and variations in the lithology of the No.'s 2 and 4 Coal Seams

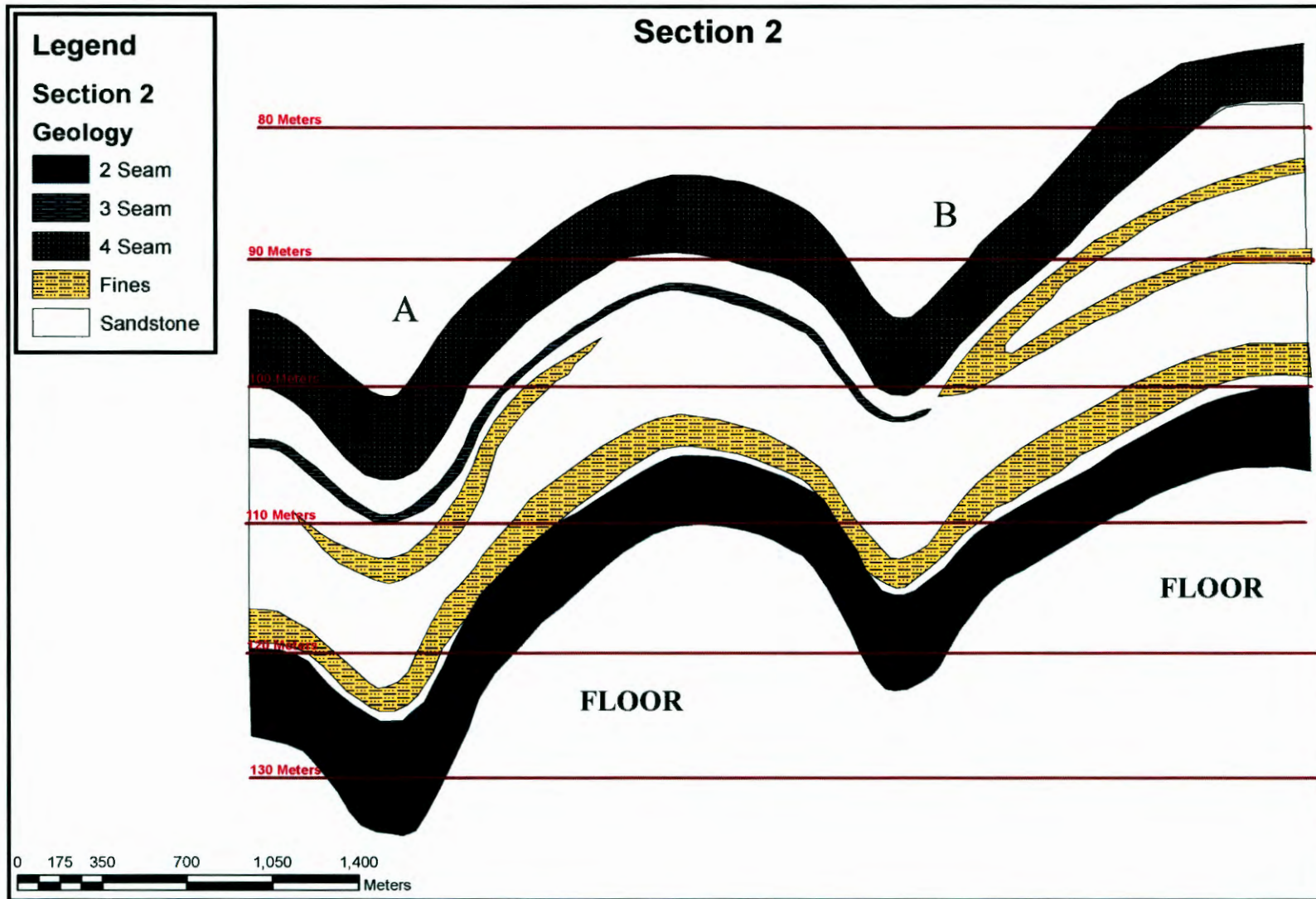


Figure 10: Section 2: Geological section depicting the impact of the palaeo floor on coal distribution

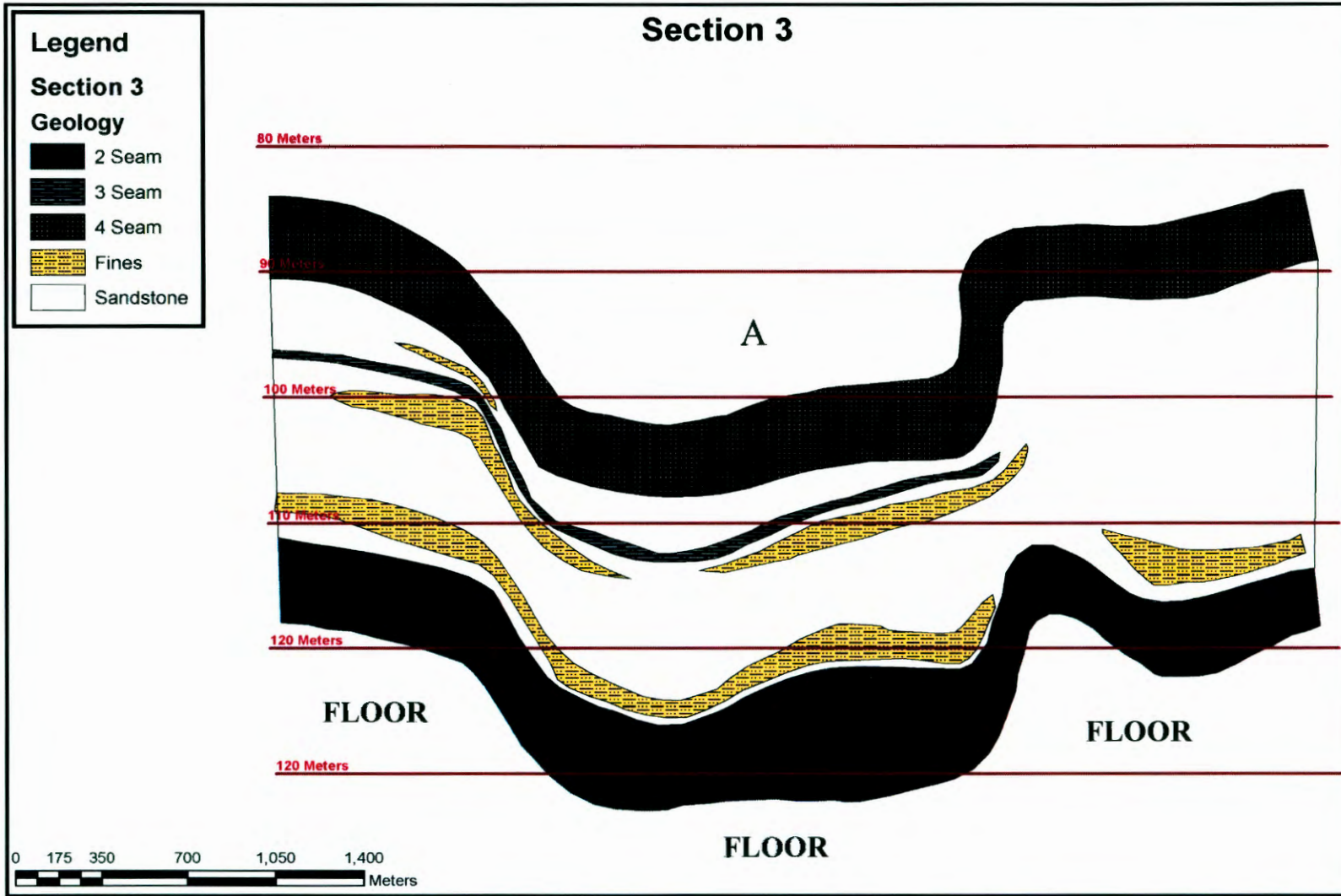


Figure 11: Section 3: Geological section depicting the impact of the palaeo-floor on coal distribution.

interburden. In the western part of the section the floor depth of the No.2 Coal Seam is 112m. Towards the centre of the palaeo channel the depth of the No.2 Coal Seam is 125m. The maximum thickness of the No.2 Coal Seam occurs in the central portion of the palaeo channel and tapers out towards the peripheries of the palaeo channel.

(d) Section 4 (Fig.12)

Section 4 is the most southern section across the project area. The major palaeo channel as described in Section 3 is still present in Section 4 but in a markedly attenuated form (B). A small elevated area occurs towards the western part of the section. The thickness of the No.4 Coal Seam remains constant while the maximum thickness of the No.2 Coal Seam occurs in the palaeo low lying areas. A fairly consistent No.3 Coal Seam characterizes Section 4. An increase in argillaceous material toward the west and central part of the section demarcates the palaeo channel.

The geological sections compiled revealed the presence of argillaceous material in the interburden between the No.'s 2 and 4 Coal Seams especially within the constraints of palaeo channel. A percentage fines map for the research area was compiled (Fig.13) in order to determine the aerial extent of the argillaceous material associated with the interburden. The maximum development of argillaceous sedimentary rocks (fines) occurs within topographical low lying areas. This argillaceous deposit represents fine grained material deposited from suspension load. The deposition of clastic sediments is controlled by the same laws as transportation. Velocity

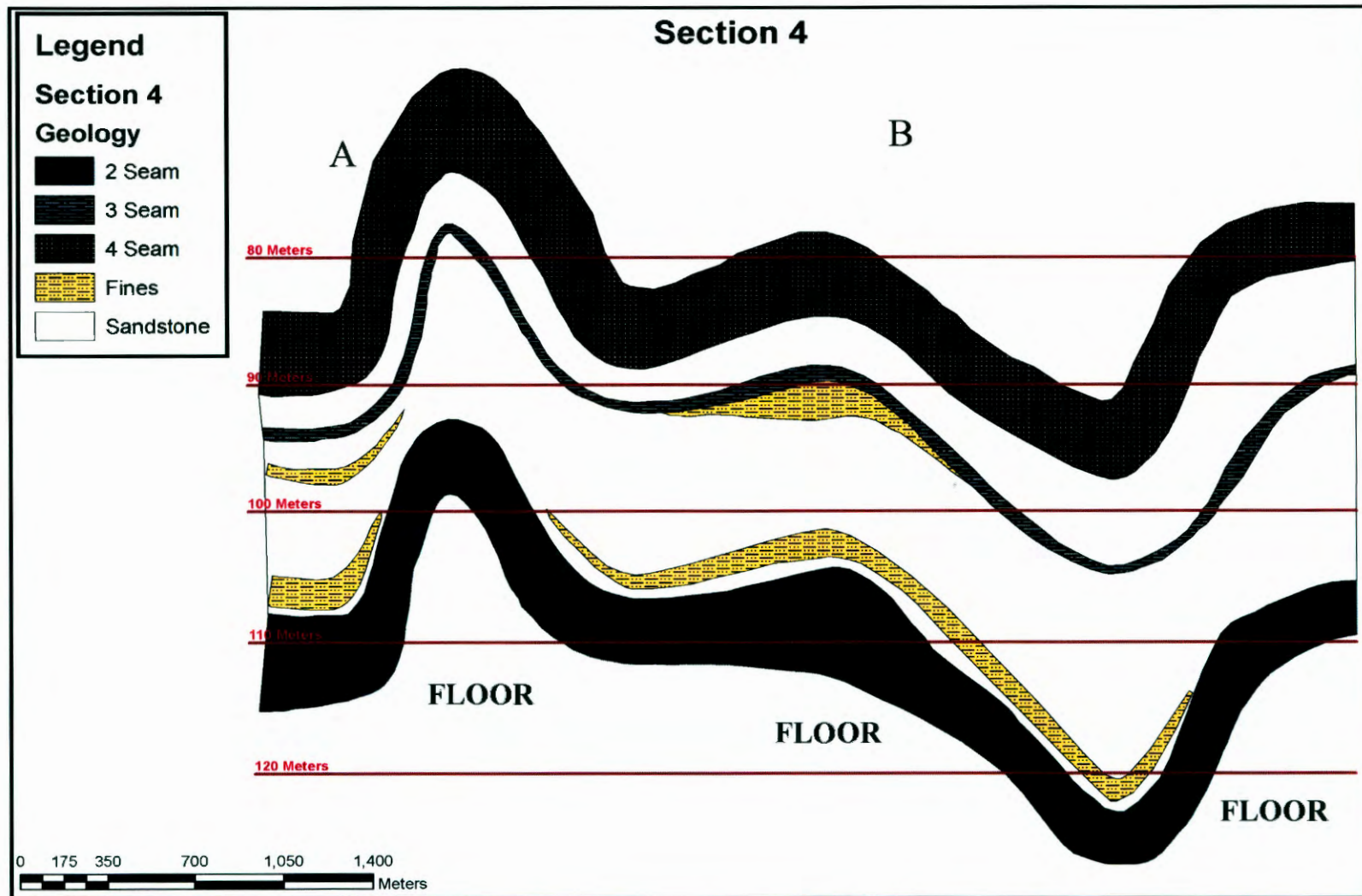


Figure 12: Section 4: Geological section depicting the impact of the palaeo-floor on coal distribution.

Percentage Fines in the Interburden

Legend

Percentage Fines in the Interburden



Fines Contour Value

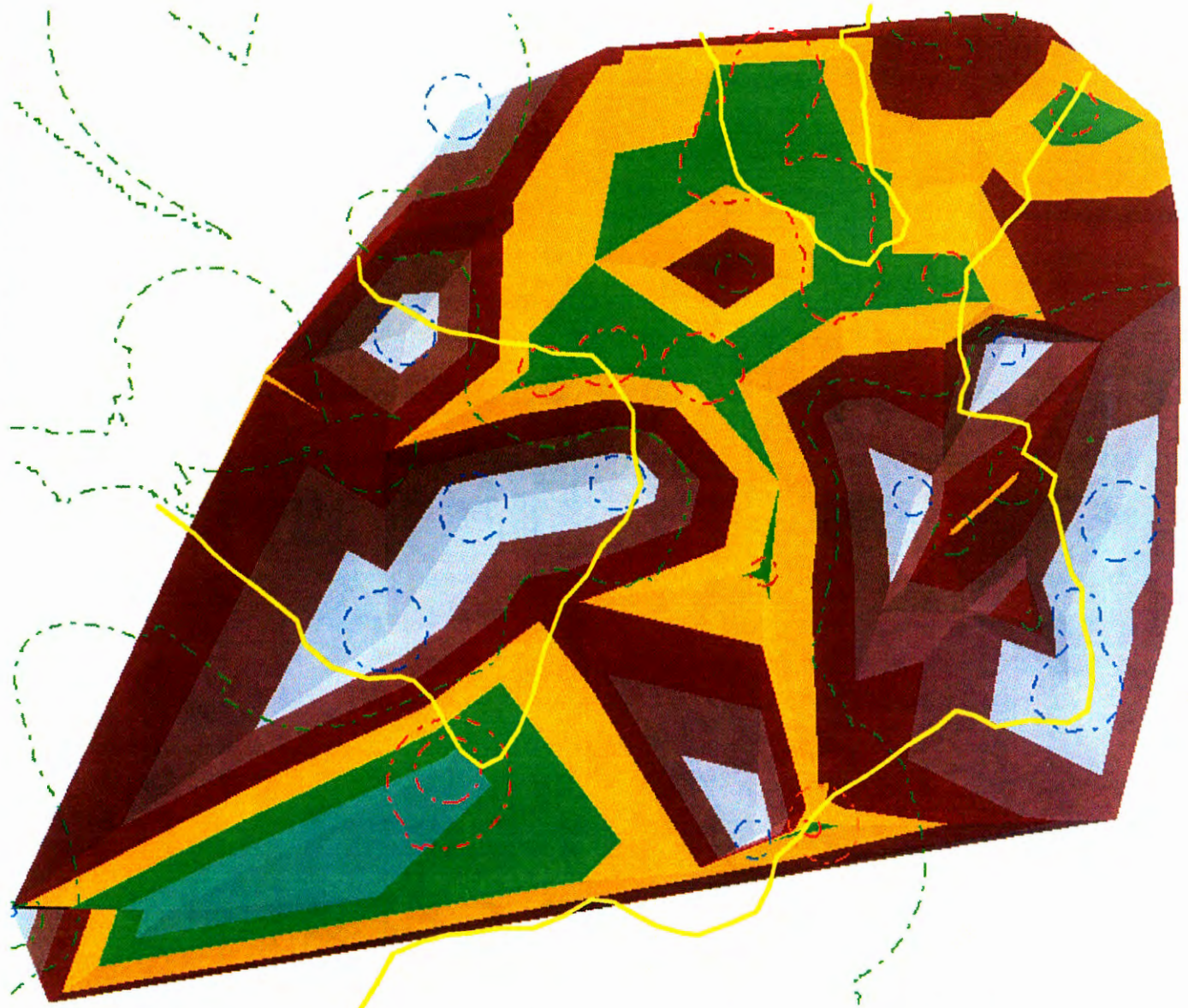
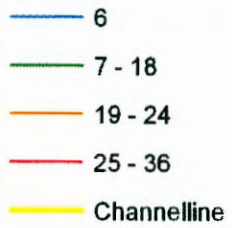
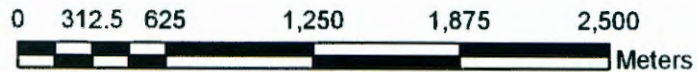


FIG 13. PERCENTAGE FINES IN THE INTERBURDEN



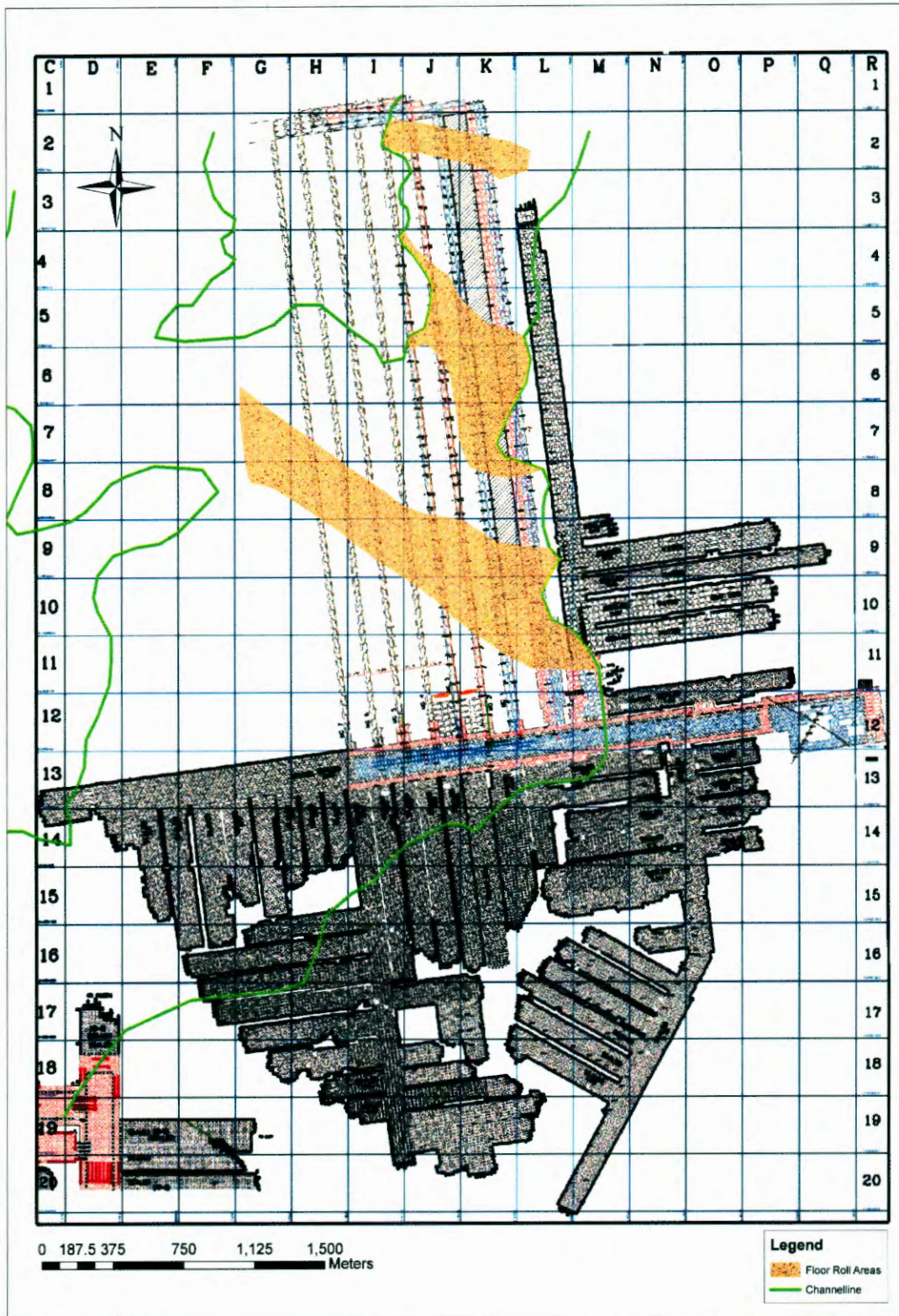


Figure 14: Locality of the floor rolls with regards to the panel layout at Matla Coal Ltd. No. 2 Mine.

turbulence combined with particle setting velocity, determine the movement of particles by suspension, saltation or traction. The same factors acting in an opposite sense, control deposition (Krumbein and Sloss, 1963).

3.4.2 Macroscopic sedimentary structures associated with the palaeo-channel

Elongated, narrow, sub-parallel clastic ridges of floor sediments protruding upwards into the No. 2 Coal occur in the mining area of Matla Coal Ltd. No.2 Mine. These structures represent floor rolls, according to Ward (1983).

Fig... depicts the localities of the floor rolls with regard to the panel layout and the palaeo channel at Matla Coal Ltd. No. 2 Mine.

Very little data pertaining to the internal structure and lithology of these rolls are available as no attention was given to these structures during exploration and mining. The recent study reveals that a very sharp slickensided contact exists between the floor rolls and the No. 2 Coal Seam. The No. 2 Coal Seam is draped over these structures. No pinching out or thinning of individual coal lithologies occur.

Diesel and Moelle (1984) suggest that these structures represent deposits of sediment build-up by continuation of river activity during the early stages of peat accumulation. However, differential compaction of the peat may subsequently take place around the roll, as the overlying part of the seam builds up. From the preceding explanation the structures formed by the mentioned process should have an orientation parallel to the palaeo-drainage

system. In the case of Matla. Ltd. No. 2 Mine, these structures were developed perpendicular to the main flow direction in the palaeo-drainage system (Fig. 6).

Research pertaining to the formation and internal structures of the floor rolls associated with the No. 2 Coal Seam was hampered by the lack of detailed sedimentological data. Exploration boreholes seldom intersected the pre-Karoo floor rocks. Most of the exploration boreholes were stopped 3-4 m in the No. 2 Coal Seam footwall. Floor rolls were encountered only during the mining operations. The geologists at the time of exploration were unaware of the presence and nature of these structures with the result that no data pertaining to these structures is available.

The No. 2 Coal Seam and associated underlying sediments were deposited during the retreat of the Dwyka age ice sheet. During this retreat, fluvio-glacial deposits resulted from the melting ice and were deposited in palaeo-topographical low lying areas.

Boreholes drilled for tensiometer analysis in close proximity of the development area (Fig. 14) intersected a coarse grained to gritty (grain size 2-4 mm) arkosic sandstone directly underlying the No. 2 Coal Seam. The feldspar content of the sandstone and grit is in the excess of 25%. Roundness and sorting is poor and no sedimentary structures were encountered. The source area was mainly granitic and was rapidly eroded. The weathering process in the source area was prolonged which can be attributed to steep

topography and a cold climate. The grain size distribution, grain composition, sorting, roundness and the massive nature of the sandstone-grit indicate deposition in an upper flow regime under rapid depositional conditions.

Walker (1984) acknowledged the fact that the fundamental processes that control whether a river has a braided or meandering pattern are not completely understood. Braiding is formed by rapid discharge fluctuations of a greater absolute magnitude than in meandering rivers. Based on the sedimentological character of the sediments underlying the No. 2 Coal Seam as well as the fact that those sediments were deposited in a fluvio-glacial environment it is concluded that the sediments were transported by a braided river complex.

The morphological elements of braided rivers are complex and include individual bedforms, bars, bar complexes and vegetated islands (Walker, 1984). In the braided channels traverse or oblique bars developed. These bars are formed: (a) as smaller channels discharge into a deeper one, (b) where flow spreads laterally and (c) where the flow is forced by channel patterns upstream to flow obliquely across the main river system.

The orientation of the floor rolls at Matla Coal Ltd. No. 2 Mine as depicted in Fig. 14 revealed an aerial orientation similar to traverse bars as discussed. It is therefore concluded that the floor rolls resemble traverse bars developed in a braided fluvio-glacial river complex prior to the deposition of the No. 2 Coal

Seam. The formation of the floor rolls are related to variables (a) and (b) as discussed.

3.4.3 Conclusion

The variations in the palaeo topography as encountered in the Matla Coal Ltd. No.2 Mine area indicated that:

- (a) The more representative sedimentary successions are preserved in the palaeo topographically low lying areas. In the elevated areas the lowermost parts of the sedimentary successions were not deposited or thin towards or pinch out against the topographically high lying areas.
- (b) The lowermost seam i.e. No.2 Coal Seam attains its maximum thickness towards the flanks of the palaeo channel. This is attributed to stable conditions with minimum clastic sedimentation and relatively uninterrupted peat accumulation.
- (c) No complex seam splitting in the No.4 Coal Seam was encountered indicating that fluvial sedimentation did not influence the No.4 Coal Seam thickness and distribution as in other parts of the Highveld Coal Field.
- (d) The presence of argillaceous sediments associated with the palaeo channel will impact on future mining activities as these sediments in hanging wall constitute instable roof conditions.
- (e) The impact of floor rolls on mining conditions will be discussed in detail in Chapter 4.

4. RESEARCH RESULTS (TABLES 46-48, APPENDIX D)

The first area that will be investigated is the mining techniques at Matla Coal Ltd. No. 2 Mine. The reasoning behind the development of a short wall has been discussed. The effect of mining on the occurrence of roof failures at Matla Coal Ltd. No. 2 Mine will be discussed separately from the geological factors in order to get a clear understanding of these factors and how they influence the occurrence of roof failures. The rate of advance, the length of the cantilever beam and the existing No. 4 Coal Seam chain pillar will have been identified as the main factors contributing to roof failures.

4.1 Rate of Advance (Table 37 -39, Appendix D)

The history of face breaks indicate that a face break is regularly preceded by an unplanned stoppage of more than a day. One possible explanation is that during prolonged standing time, the transient high stress zone ahead of the face remains in the same place for a long time. (Nielen van der Merwe, 2002). The rate of advance at Matla Coal Ltd. No. 2 Mine has been poor due to unforeseen problems related to mining and geology (Table 4 -32, Appendix A). The mining problems were mostly caused in panels due to a lack of experience regarding the shearer and the operation of the mining equipment. During the mining operation the large shearer was stuck in shale mixed with water that had collected in the low lying area between two of the floor rolls. The same problems were encountered in other panels. All these problems

caused by the equipment led to long standing times resulting in a build-up of pressure in the face.

Rock failure is time dependent. One way to minimize rock damage is to allow the high stress zone to move through the rock mass as quickly as possible. This can only be achieved by moving the face forward as quickly as possible. Whenever the face remains stationary, there is a probability for the enlargement of the rock fractures in the roof above the face. When mining resumes, the damage has already been done and the face merely advances into the pre-existing fractures (Figure 14). (Nielen van der Merwe, 2002). If the rate of advance was the only problem it would have been possible to predict the occurrence of the next roof failure using the poor rate of advance as a criteria. The fact is that roof failures were not always the result of a poor rate of advance. In some areas a poor rate of advance did not cause a roof failure, and in other areas a roof failure occurs despite a good rate of advance.

The impact the rate of advance has on the face at a short wall mining operation can be determined using the following scenarios: (a) if the rate of advance is even and fast enough, the mining operation will proceed as planned, causing the length of the cantilever beam not to exceed the critical length and therefore not exert excessive pressure on the face, (b) When the rate of advance is slow the length of beam caused by undermining the No. 4 Coal Seam would apply pressure to the face. The pressure applied by the beam continues to increase as long as the rate of advance is poor. This pressure opens fractures or slips that will impact on roof stability. Nielen van

der Merwe, (2002) indicated that the face will advance in pre-existing fractures and this will result in roof failure. This is valid in areas where pre-existing fractures occur. The applied pressure to the face will open these fractures and a roof failure is inevitable. Therefore, if a poor rate of advance is maintained in an area that has pre-existing slips or fractures the chances of roof failure are elevated. If a poor rate of advance is maintained in an area that does not have pre-existing fractures or slips the chance of a roof failure is less.

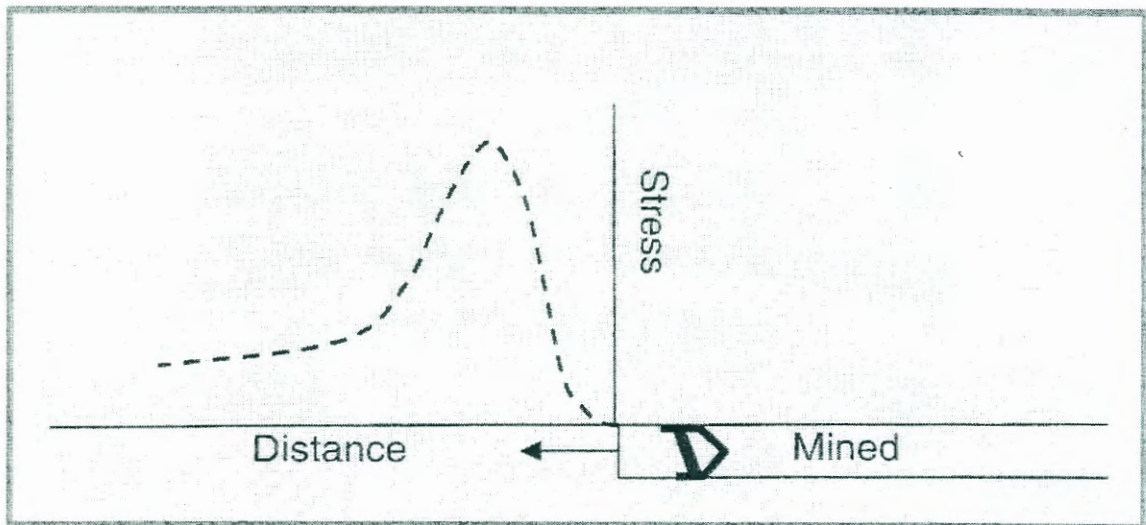


Figure 15: The stress distribution ahead of a long wall face. The zone of increased stress can extend as far as 30 to 50m ahead of the face (Nielen van der Merwe, 2002).

Mining related factors and geocigal structures therefore resulted in The unstable roof conditions encountered at Matla No. 2 Mine.

4.2 Cantilever Beam

The Vryheid Formation is a well stratified sedimentary succession. These stratified units will behave like plates. When the length of a plate is significantly greater than its width, its behaviour approaches that of a beam. (Nielen van der Merwe, 2002) When only the one end of the beam is clamped it is called a cantilever beam (Figure 15).

Undermining the No. 4 Coal Seam causes the interburden between the No.'s 2 and 4 Coal Seams at Matla Coal Ltd. to act as a cantilever beam. The longer the cantilever beam gets, the higher the pressure on the face becomes. The length of the beam can be increased depending on the rate of advance and the type of lithological unit encountered in the interburden. When the rate of advance is slow the beam would break before it could reach a critical length. A fast rate of advance could cause the cantilever beam to reach a critical length before breaking. The thicker the clastic component in the beam between the No. 2 and 4 Coal Seams becomes, the stronger the beam would be. The type of material the beam consists of is another factor that could influence the length of the cantilever beam (Table 40–42, Appendix D). Between the No. 2 and 4 Coal Seams the percentage shale and sandstone varies between 90% shale and 90% sandstone. The thicker the sandstone, the stronger the beam. The pressure exerted on the face by the sandstone beam has an effect on the slips in the face area. The increased pressure on a slip in the roof immediately results in six times the tensile stress, at a point at the top of the beam that is not visible. This implies that if a

slip is present in the roof that the slip would open up and could cause a fracture.

The length of the beam could therefore increase the pressure on the face but on its own could not cause a roof failure. The length of the beam is directly related to the thickness and the sandstone component in the interburden and the rate of advance. Ratings based on the thickness and the composition of the beam will be compiled, but the rating for the rate of advance will be calculated as a separate factor.

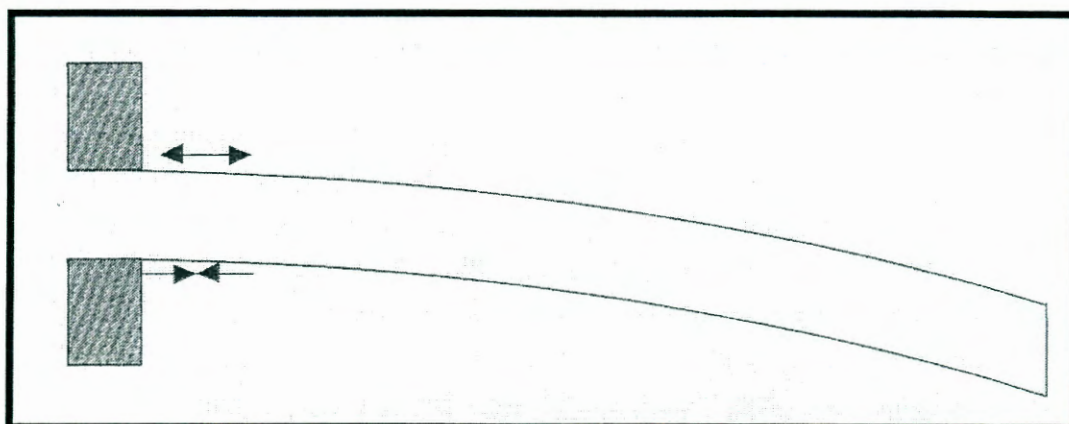


Figure 16: A cantilever beam (Nielen van der Merwe, 2002).

4.3 No. 4 Coal Seam Chain Pillar

Matla Coal Ltd. No. 3 Mine mines the No. 4 Coal Seam of the Highveld Coalfield, which is stratigraphically situated above the No. 2 Coal Seam. The areas mined at No. 3 Mine and No. 2 Mine overlap sometimes causing the No. 3 Mine to overmine some areas of No. 2 Mine. In most of the long and short wall operations the bottom seam is mined first followed by the overlying seam. When designing the development of over or undermining it is crucial to keep the distribution of pressure resulting from the chain pillars in mind. Chain pillars are designed to absorb most of the pressure from the roof and to allow access to and from the face of operations. The chain pillars cause stress on the seam below or above the one that is mined. The manner in which the stress is distributed is known as a pressure arch (Fig.17). At Matla Coal Ltd. No. 2 mine the standing chain pillar that is located above the No. 2 Coal Seam exerts a lot of pressure down onto the roof of the No. 2 Coal Seam. The pressure area is located in the middle of the No. 2 Coal Seam panel (Figure 18). The downward pressure exerted on the face by the pillar would elevate the pressure already placed on the face by the cantilever beam effect. The pressure caused by the No. 4 Coal Seam chain pillar could be the cause of the roof failures but then the roof failures would not be limited to certain areas. The chain pillar is situated either down the side or middle of the panels which would result in roof failure along the total length of the panels and not restricted to certain areas only. In the first two panels roof failures were less than in the third panel due to the pillar being located down the middle of the first two panels and more to the eastern side of the third panel. The pillar has

therefore had more of an effect when it was located in the middle of the panel than when it was located towards the side of the panel. This theory is however opposite to what should happen when the area where the pressure arches apply most of the pressure is considered (Figure 17). According to the pressure arches the best position for the chain pillar to be is in the middle of the panel.

The chain pillar can however not be included in the rating system as it is present throughout the length of all three panels. As this would only allow for a single once-off rating that would not have an effect on different areas in the panels.

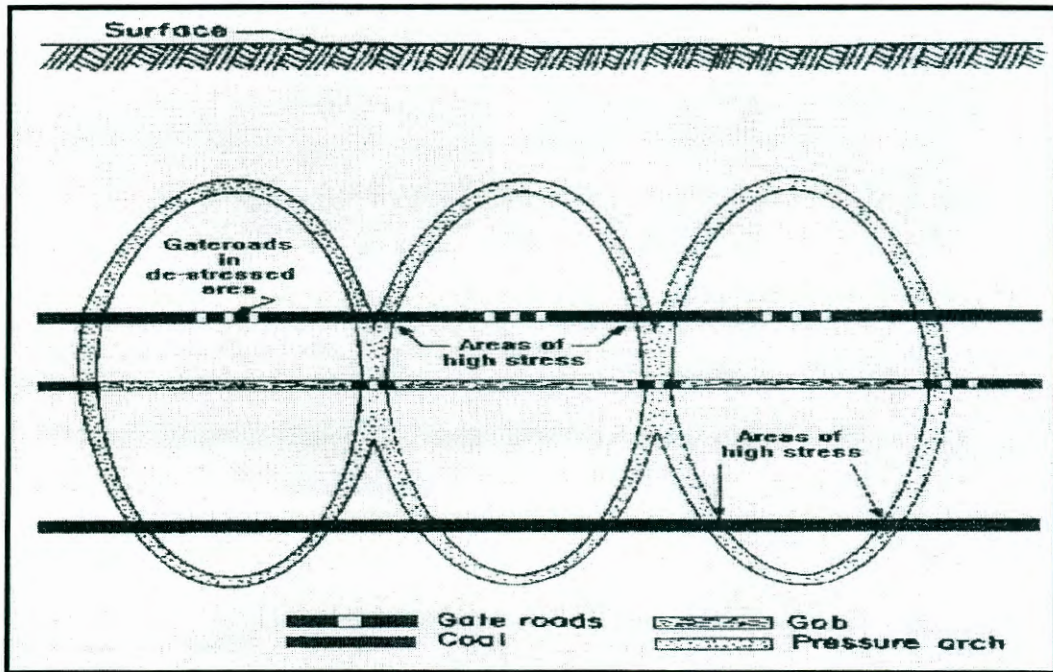


Figure 17: Pressure arches caused by standing chain pillars (After Stemple, 1956).

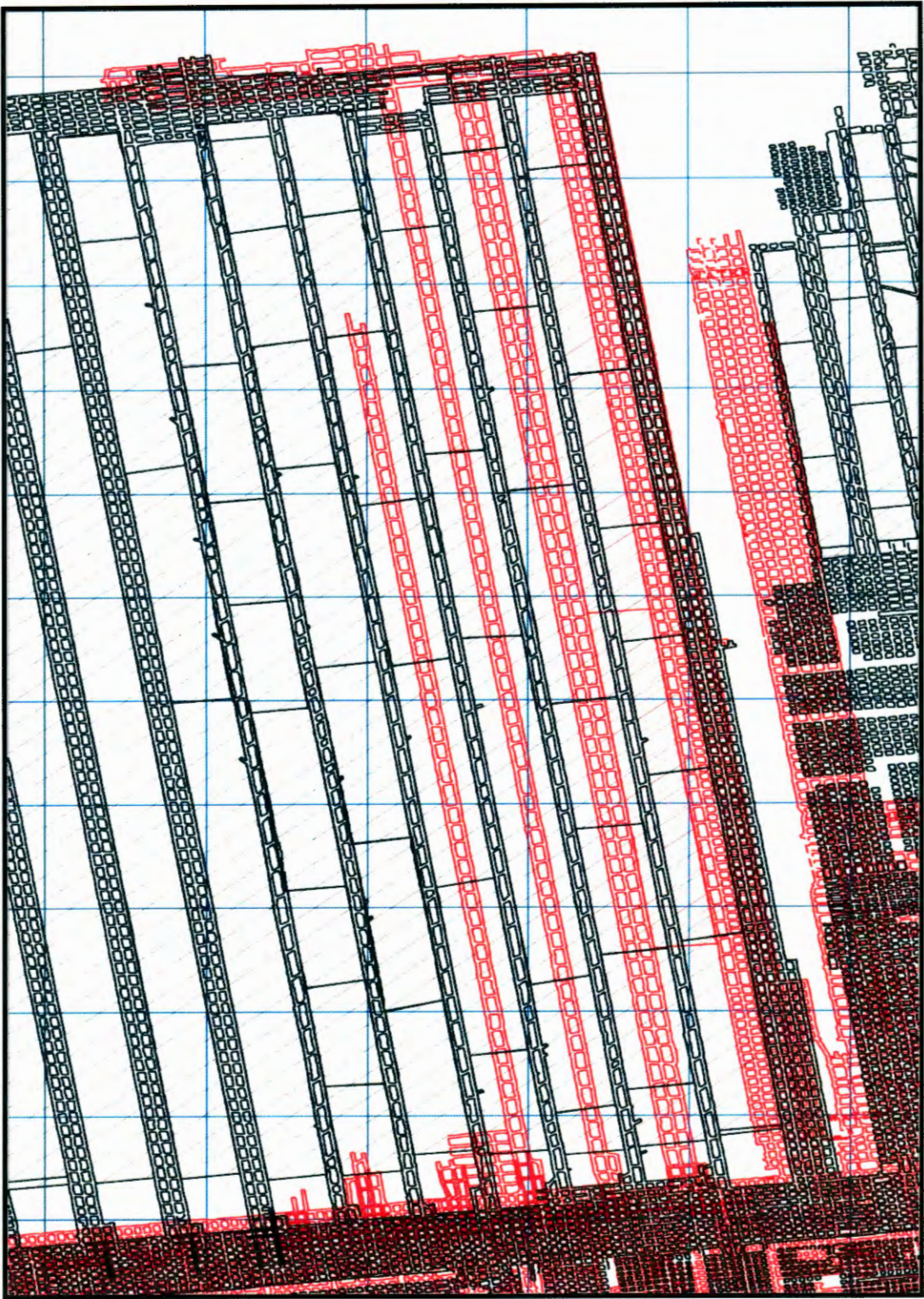


Figure 18: Panel layout of No. 2 (Black) and No. 3 (Red) mine at Matla Coal Ltd. (Matla Coal Ltd. survey department).

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4.4 Surveyed Slips

Prior to short wall mining operations commences a stress system was already emplaced. The vertical component was caused by the overlying rock exerting stress at a certain point underground. The horizontal stress is complicated to calculate and is considered as part of the vertical stress and expressed as the k-ratio. (Nielen van der Merwe, 2002).

Slips are openings that are caused by stresses. When movement occurs in a slip after it was formed it is renamed as a slickenside. The movement is caused when the stress in the surrounding area is disturbed. A number of slips were found and surveyed at Matla Coal Ltd. No. 2 mine (Figure 19). The origin of the slips relate to the depositional environment of the coal layers and the redistribution of the stresses by the mining activities.

Compaction slips were formed during and after the deposition of the coal. The No. 2 Coal Seam floor has a large number of floor rolls and with the deposition of the coal on top of these rolls differential compaction slips were formed. The slips always dip away from the axis of the floor roll and seem to be draped over the sandstone floor roll (Figure 20 - 22).

Expansion slips are formed when a large load of material is removed and the stress on the underlying rocks released (Figure 23). Expansion slips form parallel to stratification in lithological units resulting in block caving. The normal strong roof is now split into individual smaller partings that are not as

coherent as the original composite unit. The expansion slips most probably formed due to the extraction of the two upper seams, i.e. No.'s 4 and 5 Coal Seams.

When slips are present in the roof strata of the coal seam it magnifies the beam stresses by a factor of six. (Nielen van der Merwe, 2002). The beam stress is caused by the cantilever effect that is created by a clamped beam. The cantilever effect comes into the equation when the mining activities are at a halt effectively placing more pressure on the face resulting in the activation of the slips in the panel.

If the compaction slips should extend upwards into the roof and link-up with expansion slips, due to load being placed on the face during a long period of standing time or the cantilever beam effect, it could cause roofs failure.

The slips at Matla Coal Ltd. No. 2 Mine could be the reason for roof failures. However, slips have only been surveyed in the operational areas. The fact remains that slips can only be surveyed in the development roads and not in the direct roof of the panel which implies that more slips may be present. The presence of slips remains a problem and when magnified by a slow rate of advance, roof failure is imminent.

Slip Zones

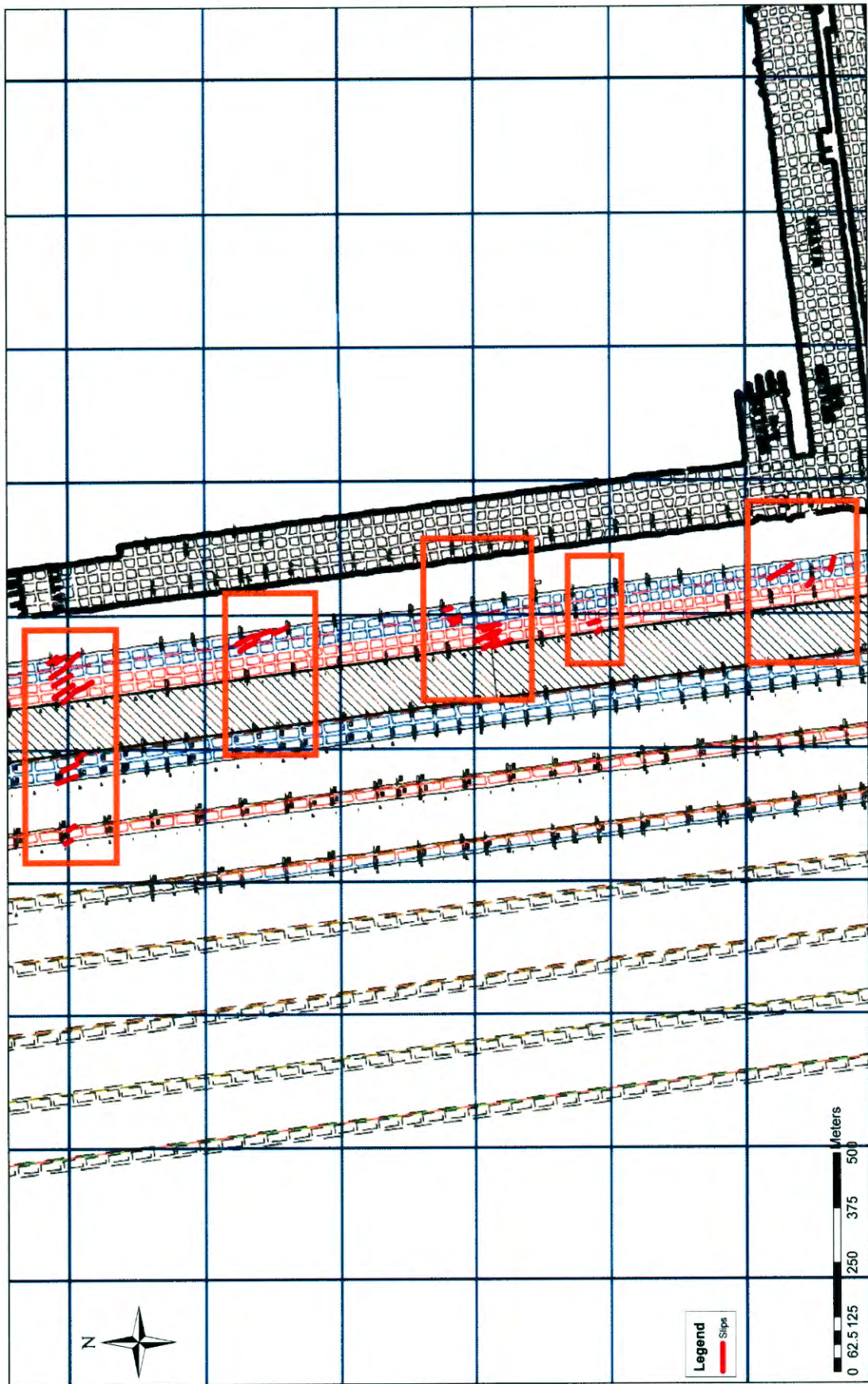


Figure 19: Slip zones at Matla Coal Ltd. No. 2 Mine.

4.5 Description of the Slip Zones

Zone 1: 500 – 700 metres (Figure 20)

There are three separate slips sets in this area comprising twelve separate slips, being regarded as one slip zone. The slips all have a north-west to south-east orientation and can thus be viewed as one set of slips. Zone 2 is situated on the edge of an elevated transition zone where the floor rises from a low lying area in the north-east to topographically high areas.

Zone 2: 900 – 1150 metres (Figure 21)

This zone contains only one set of slips and these are found in the tailgate side of Panel 1. The slips all have a north-west to south-east orientation and the most northern slip has a fork-like structure.

Zone 3: 1400 – 1650 metres (Figure 21)

There are two slips sets in this zone comprising nine separate slips. The slips in this zone have a north-west to south-east orientation. The slips are located on the edge of a transition zone where the channel elevation increases from fairly flat in the middle of the channel to the elevated areas located in the south-eastern side of the channel. The channel depth decreases from west to east in this area.

Zone 4: 1730 – 1830 metres (Figure 22)

There is only one slip set in this zone comprising two separate slips. The slips in this zone have a north-west to south-east orientation. This represents the smallest slips set in the project area.

Zone 5: 2130 – 2350 metres (Figure 22)

There is only one slip set in this zone comprising three separate slips. The slips in this zone have a north-west to south-east orientation. The area is in a topographically low area.

Table 1: Slip zones identified at Matla Coal Ltd. No. 2 Mine

Slip Zones		
Zone	From (m)	To (m)
Zone 1	500	700
Zone 2	900	1150
Zone 3	1400	1650
Zone 4	1730	1830
Zone 5	2130	2350

Slip Zone 1



Figure 20: Slip zone 1 at Matla Coal Ltd. No. 2 Mine associated with the palaeo topography.

Slip Zone 2 and 3

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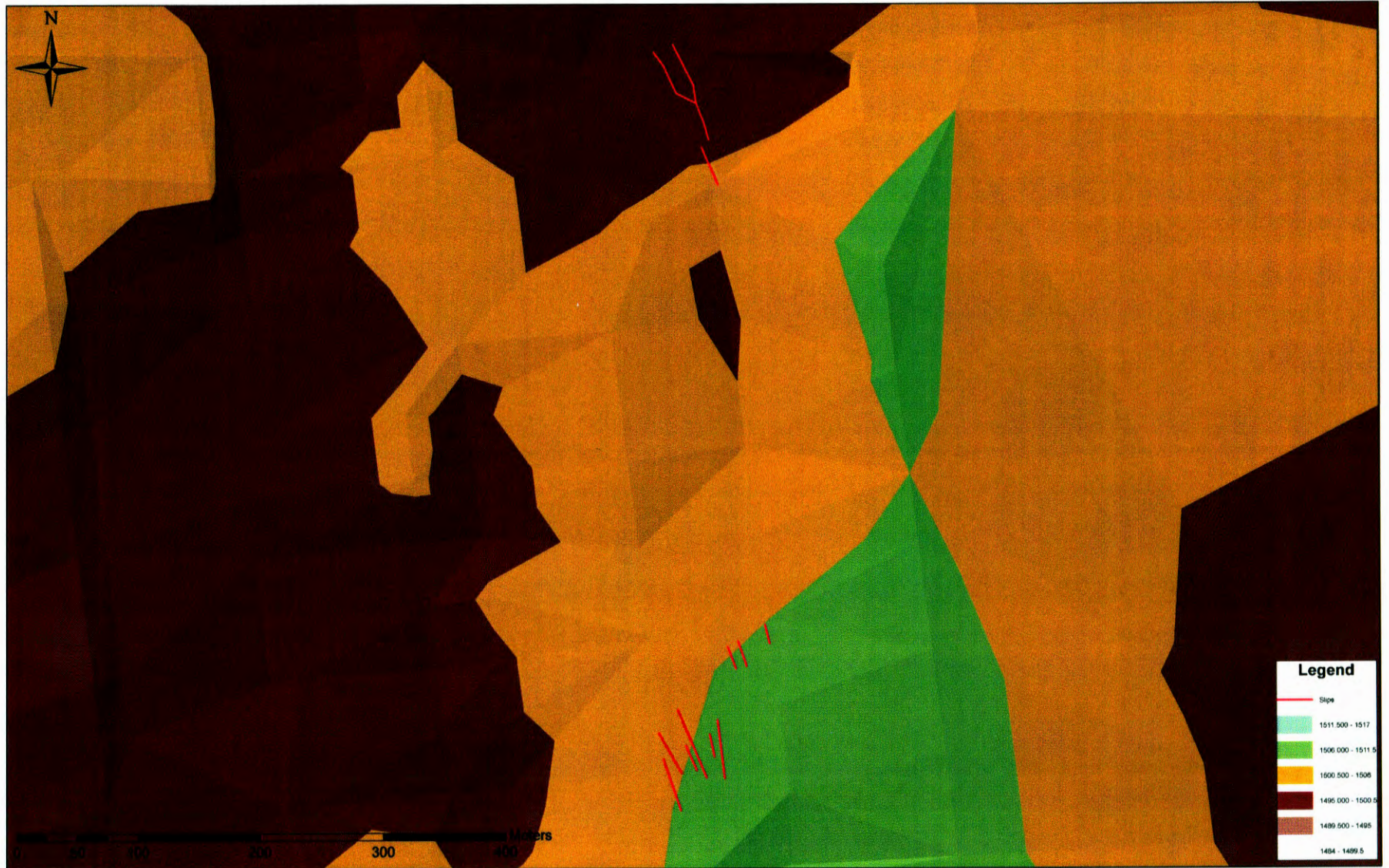


Figure 21: Slip zone 2 and 3 at Matla Coal Ltd. No. 2 Mine associated with the palaeo topography.

Slip Zone 4 and 5

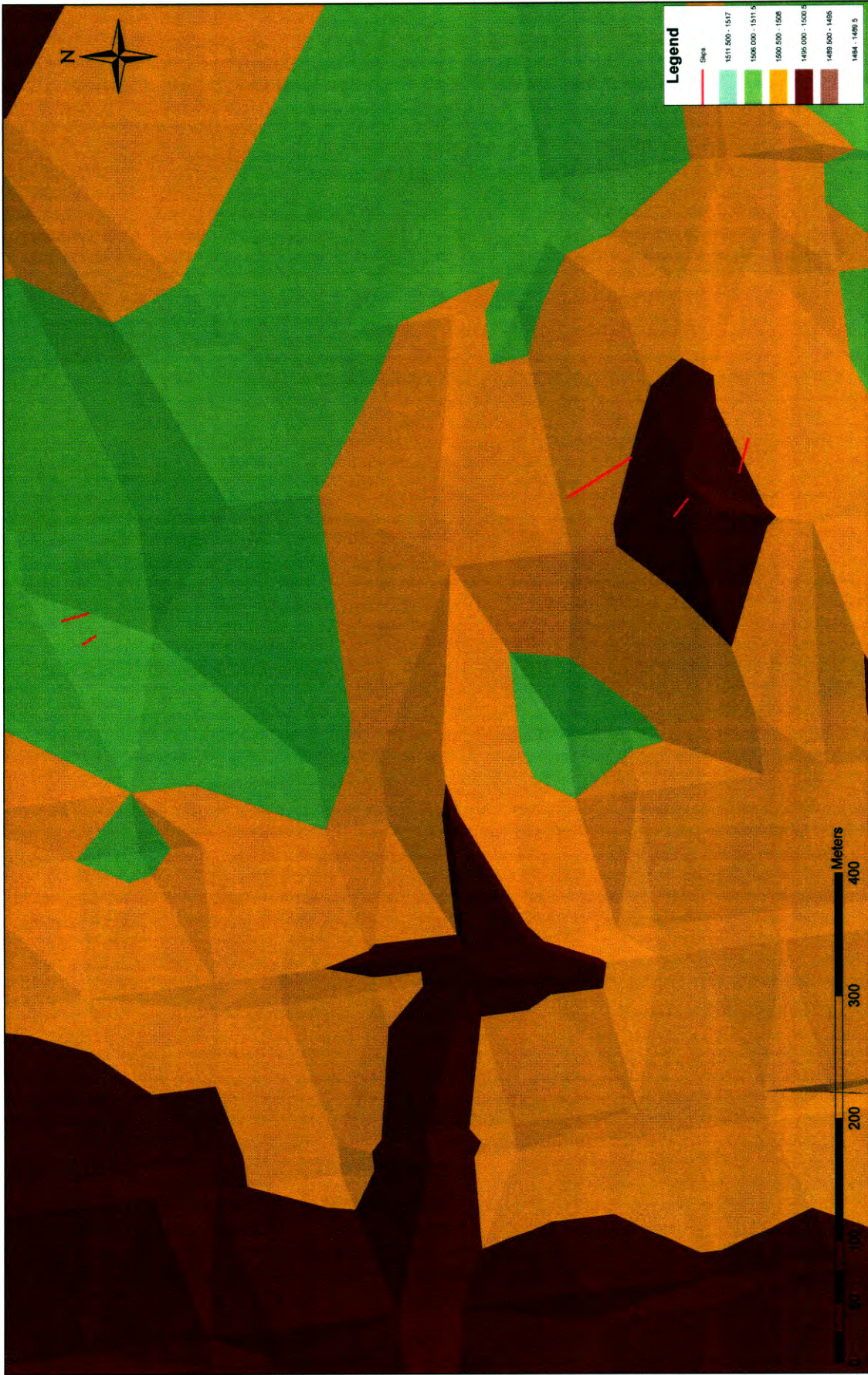


Figure 22: Slip zones 4 and 5 at Matla Coal Ltd. No. 2 Mine associated with the palaeo topography.

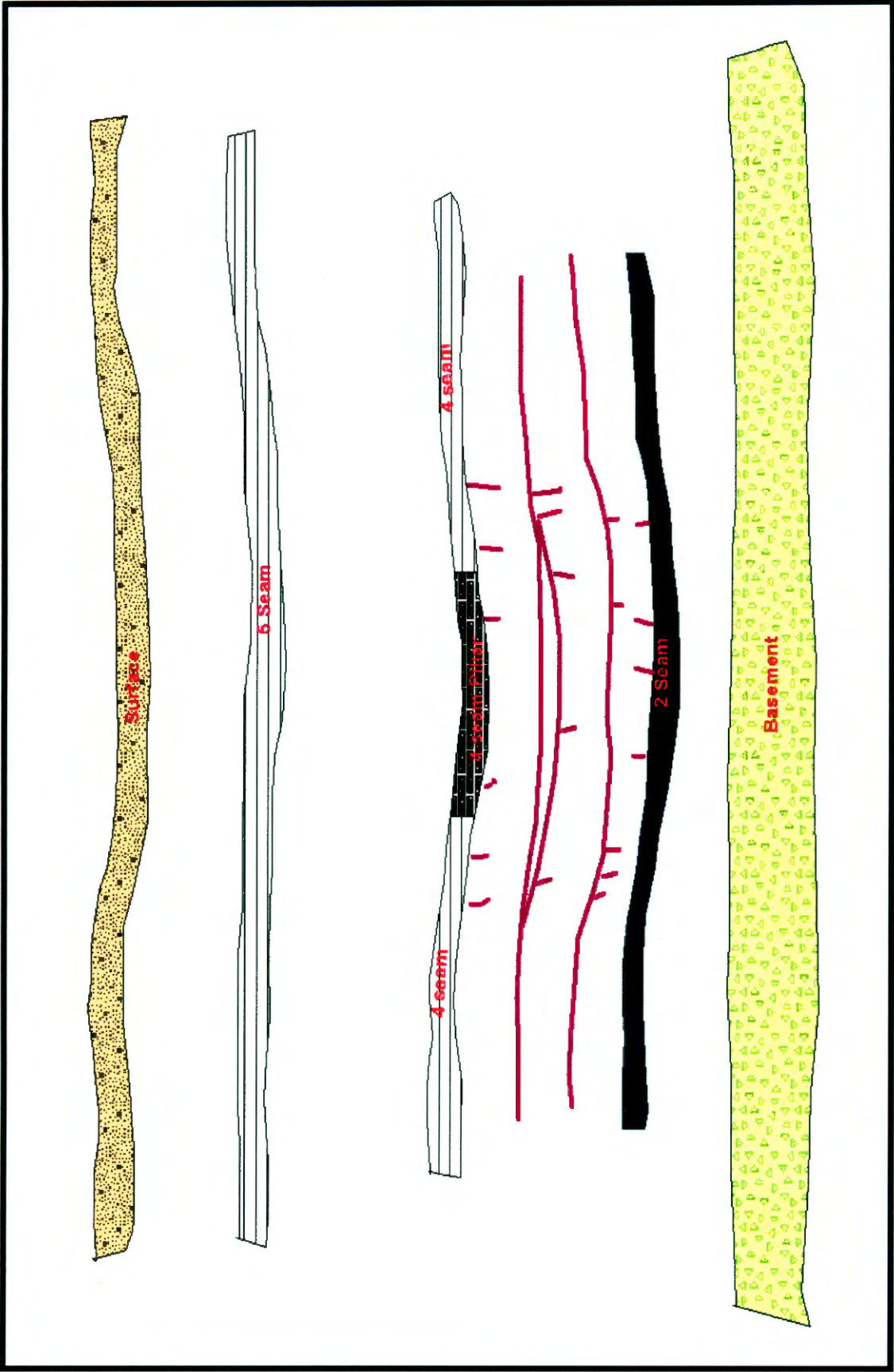


Figure 23: Origin of the vertical slips at Matla Coal Ltd. No. 2 Mine.

5. RATING SYSTEMS

Over the years a number of Coal Mine Roof Rating system have been developed to rate the roof of a coal mine before the development underground starts. The Coal Mine Roof Rating system does however only rate the macro mine environment and could not be used to determine areas where roof failures could occur. The reason for this is the limited information available during planning. An innovative rating system was needed especially for Matla Coal Ltd. in order to determine the areas where the risk of a roof failure was the highest. The rate of advance, sandstone beam thickness, slip zones, floor rolls were used as variables to compile a rating system for the micro environment at Matla Coal Ltd. No. 2 mine.

The rating system relates to the number of roof failures in an area caused by the mentioned variables and the total number of the roof failures encountered in the same area. This rating system emphasises the importance of a specific variable and the impact thereof on the overall rating applicable to a specific area. The following equation was used in the rating:

$$\text{Rating} = \text{TRRF I} / (\text{TNRF} * 100/1 \%) \quad \text{Equation 1}$$

Where: TRRF I = the total number of roof failures related to a specific variable

TNRF = the total number of roof failures encountered

Instead of using a percentage a single number which relates to the percentage calculated was allocated to indicate the rating of a specific area (TABLE 43, APPENDIX D).

Face breaks were rated separately from roof failures as roof failures resulted from geological condition such as argillaceous sediments in the hangingwall and unstable conditions resulted from mining operations.

Equation 2 was used to rate face breaks:

$$\text{Rating} = \text{TRFB I} / (\text{TNRFB} * 100/1 \%) \quad \text{Equation 2}$$

Where: TRFB I = the total relevant face breaks related to a variable

TNRFB = the total number of face breaks.

Tables 44 (TRRFI) and 45 (TRBI) (Appendix D) is a summary of the ratings applicable to the different variables regarding TRRFI and TRBI respectively.

5.1 Rate of Advance (Table 37 – 39)

The rate of advance is the only mining related factor that could be taken into account when rating a specific area. The rate of advance could however not be included in the rating system, as one does not know the rate of advance before hand. The rate of advance will have a greater effect in areas with slips zones and floor rolls compared to areas that do not contain any of these geological features. The results have shown that if the rate of advance is very low (standing time of two days or more) the occurrence of a roof failure is imminent. However, there are areas where the rate of advance was very low with no roof failures, which correlated with the absence of slips and/or floor rolls.

5.2 Sandstone Beam (Figure 24 – 26) (Table 43 - 45, Appendix D)

Undermining the No. 4 Coal Seam causes the interburden between the No.'s 2 and 4 Coal Seams at Matla Coal Ltd. to act as a cantilever beam. The longer the cantilever beam gets the higher the pressure on the face becomes. The length of the beam can be increased by the rate of advance and the lithologies in the interburden. When the rate of advance is normal the beam would break before it could reach a critical length. The strength and thickness of the beam could increase the length of the cantilever beam along with the help of a normal rate of advance. If the thickness of the sandstone beam increases, then its strength increases, causing the length of the overhang to increase. The thickness of the sandstone beam in the interburden between the No.'s 2 and 4 Coal Seams has a maximum thickness of 21.96m, a minimum thickness of 10.21m and an average thickness of 18.31m (Table 33a and 33b, Appendix B). The percentage sandstone in the interburden affects the strength of the interburden as, the higher the percentage sandstone in the interburden the stronger the unit becomes. All the roof failures occurred in areas that had a rating of 1 or 0.8. In the areas with a rating of one, 48 % of the roof failures occurred while 52% occurred in the areas with a rating of 0.8 indicating the impact of the sandstone beam on roof failures.

Locality Rating: Panel 1

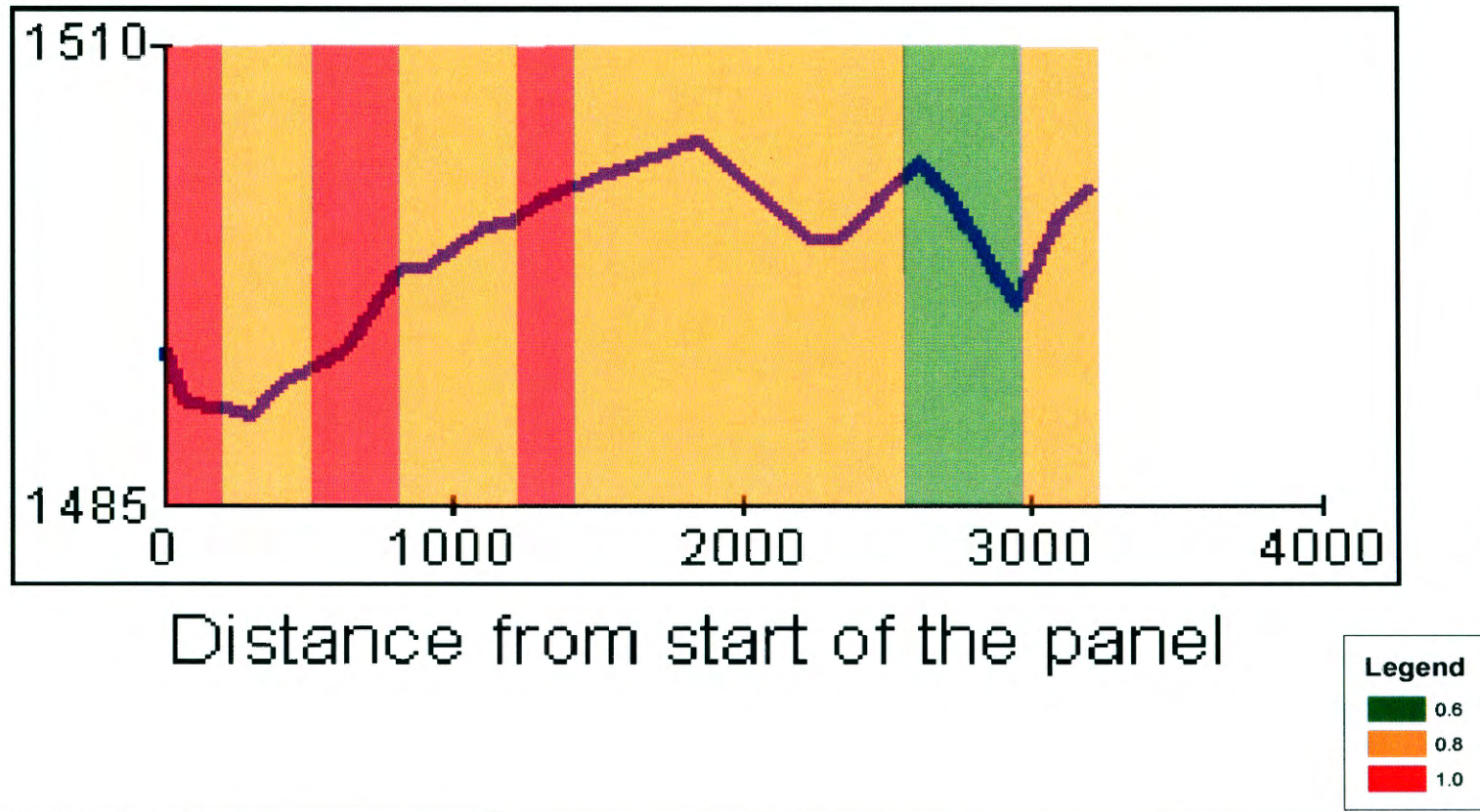
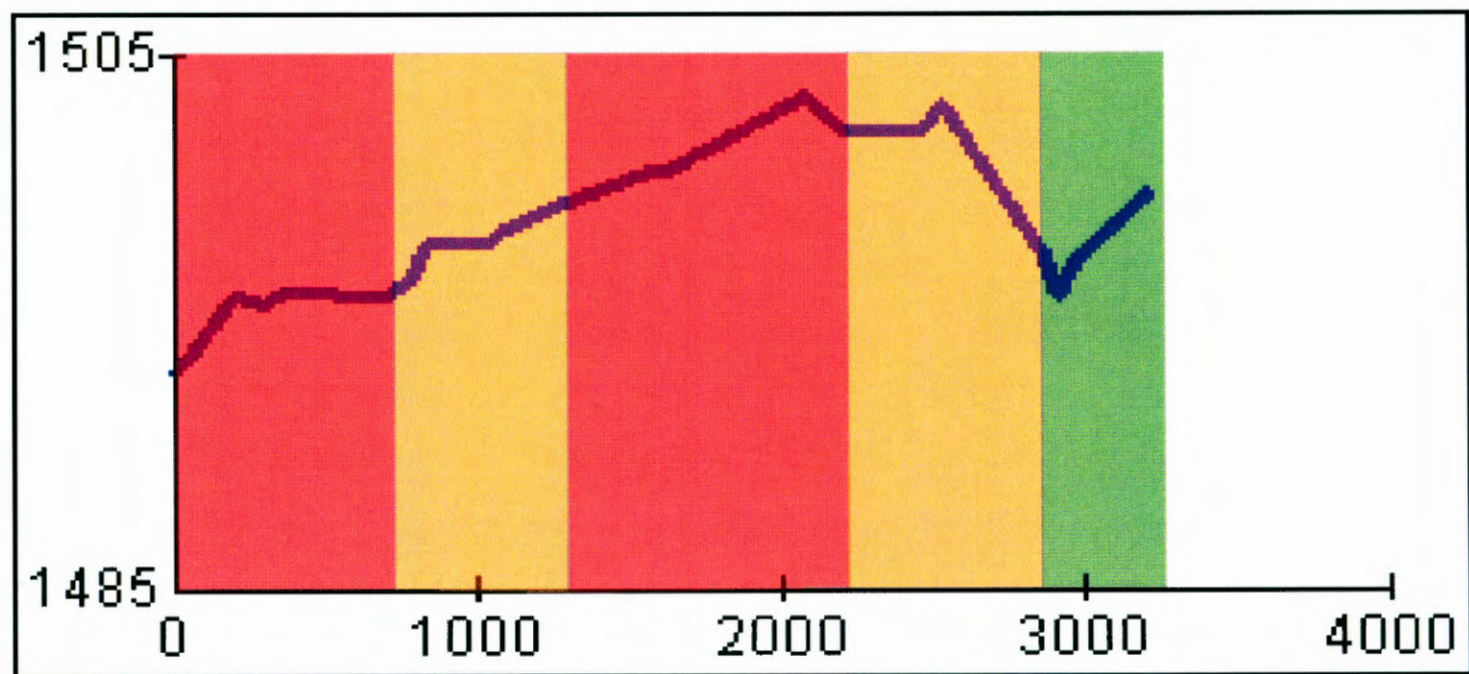


Figure 24: Locality Rating of the First Panel.

Locality Rating: Second Panel



Legend

- 0.6
- 0.8
- 1.0

Figure 24: Locality Rating of the Second Panel

Locality Rating: Third Panel

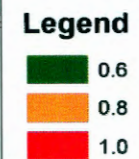
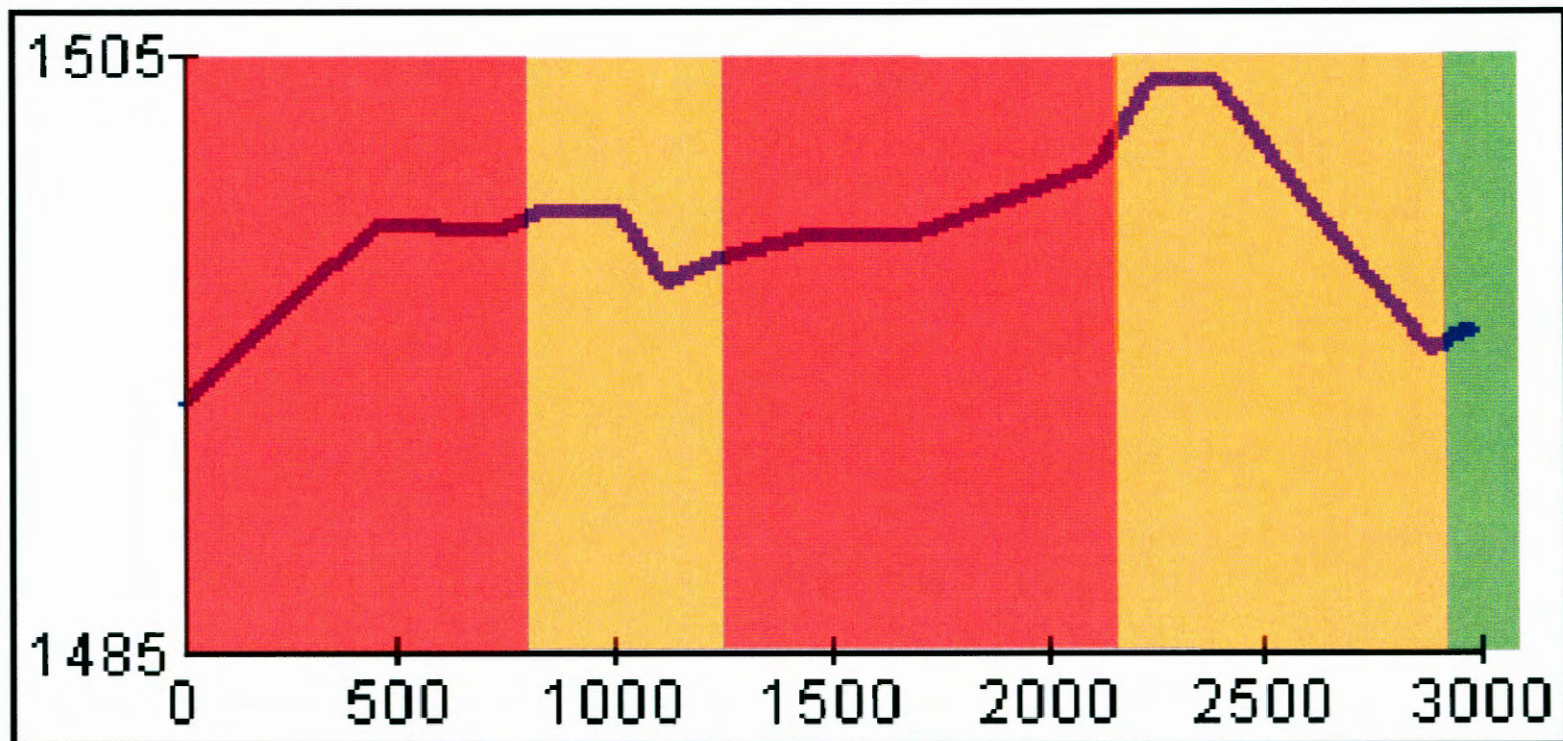
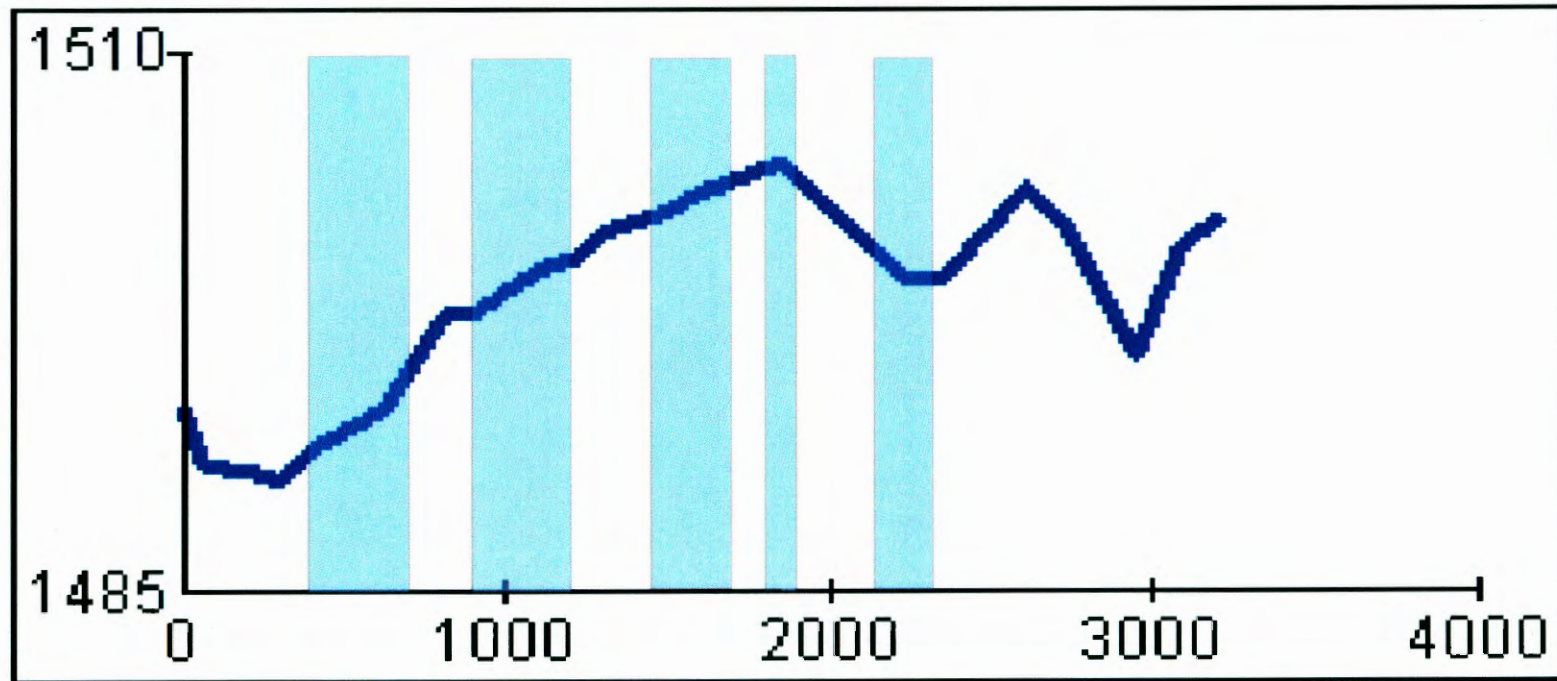


Figure 26: Locality Rating of the Third Panel

5.3 Slip Zones (Figure 27 - 29)

A mine is compelled by law to survey all slips underground and to compile the information on the relevant maps. Slips in the roof of an underground coal mine magnify the beam effect by a factor of six. (Nielen van der Merwe, 2002). There are five surveyed slip zones in the No. 2 mine area (Table 1). The slips play a major roll in the occurrence of the roof failures associated with the rate of advance. When there is a slow rate of advance or standing time of a day or longer there is a build up of pressure that causes fractures to develop or existing fractures to increase in size. The cause of the slips can be found in the depositional history of the coal seams. Only 43% of the face breaks occurred in areas that contained slips. The main reason for the low percentage of face breaks in these areas has to do with the orientation of the slips. If the slips were perpendicular across the panel then the effect would have been much higher than when the slips were parallel with the panel as is the case at Matla Coal Ltd. No. 2 Mine.

Panel 1: Slip Zones



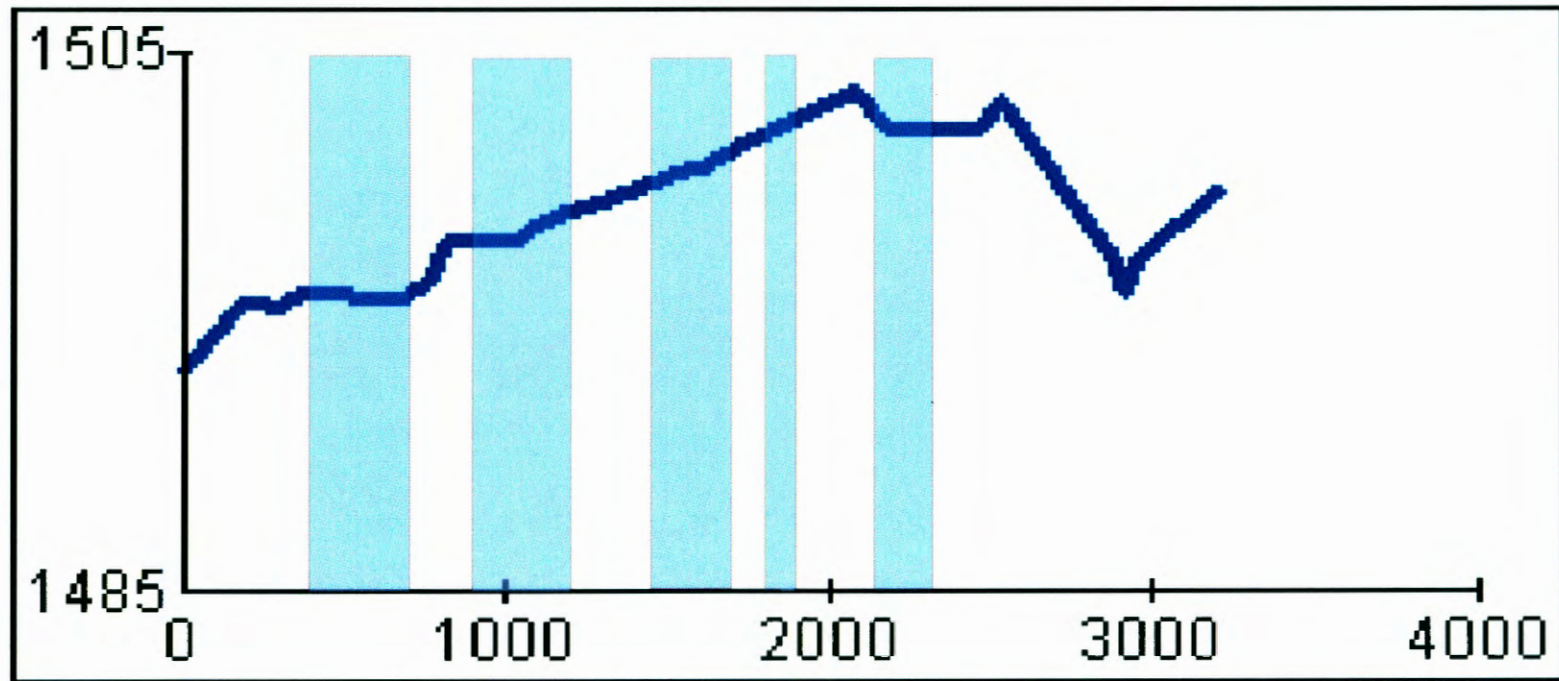
68

Distance from Start of the Panel



Figure 27: Slip Zones in the First Panel

Panel 2: Slip Zones



Distance from Start of the Panel

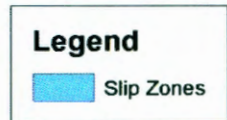
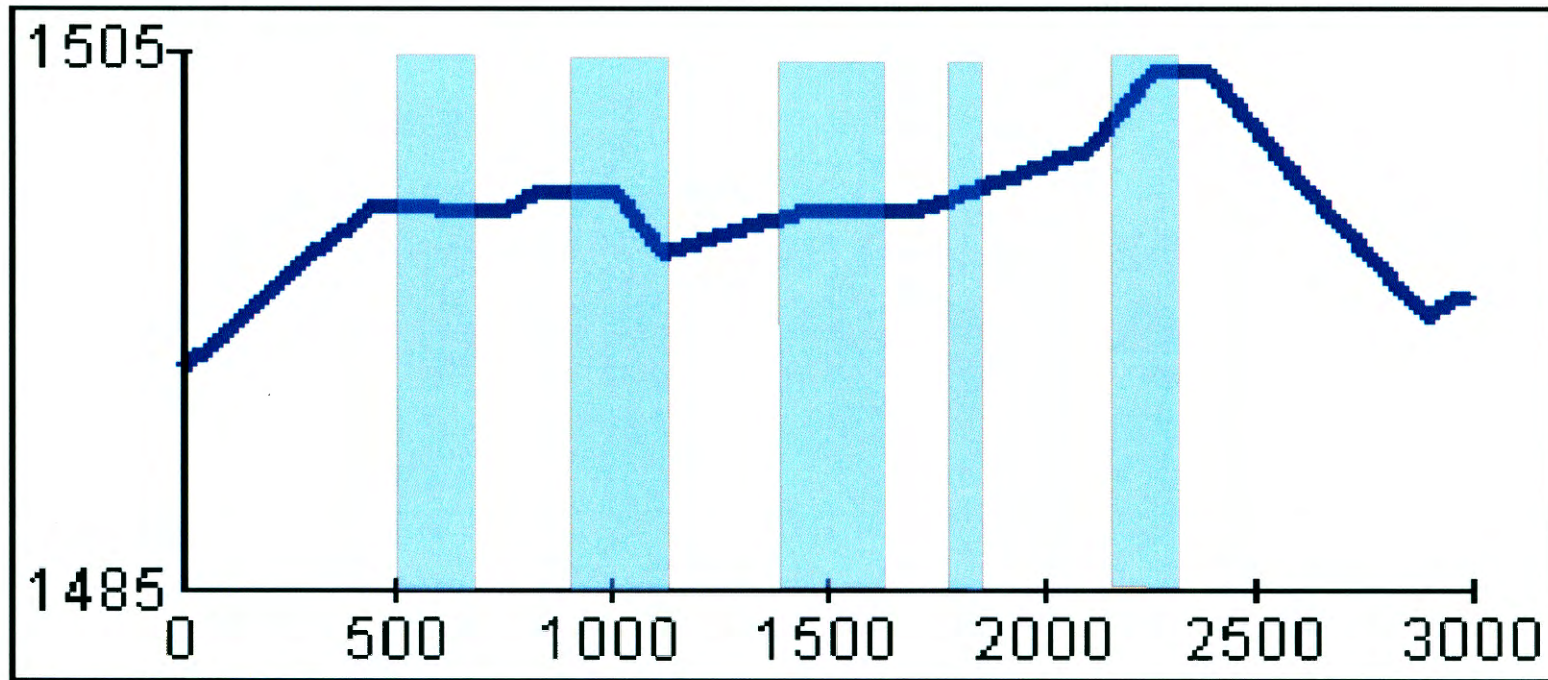


Figure 28: Slip Zones in the Second Panel

Panel 3: Slip Zones

70



Distance from Start of the Panel

Legend

Slip Zones

Figure 29: Slip Zones in the Second Panel.

5.4 Floor Rolls (Figure 30 - 32)

A large number of elevated areas are found in the floor of No. 2 Mine (Table 25). The origin of these structures can be found in the depositional history of the area. The research results indicate that the floor rolls have caused or have been instrumental in causing most of the roof failures at Matla Coal Ltd. No. 2 Mine due to the relationship between the floor rolls and the slips. In order to illustrate the impact of floor rolls on the mining conditions at Matla Coal Ltd. No. 2 Mine, the areas where floor rolls are present were correlated with the areas where roof failures occurred. In the first panel 100% of the roof failures occurred in areas where floor rolls are present; in the second panel 88% of the face breaks occurred in these areas and in the third panel 83%.

Table 3: Floor rolls identified at Matla Coal Ltd. No. 2 Mine.

Floor Rolls	
Panel 1	
From	To
0	100
200	400
800	2000
2300	2800
Panel 2	
From	To
200	600
800	900
1100	1780
2100	2700
Panel 3	
From	To
300	1100
1400	1670
2000	2500

Panel 1: Floor Roll Areas

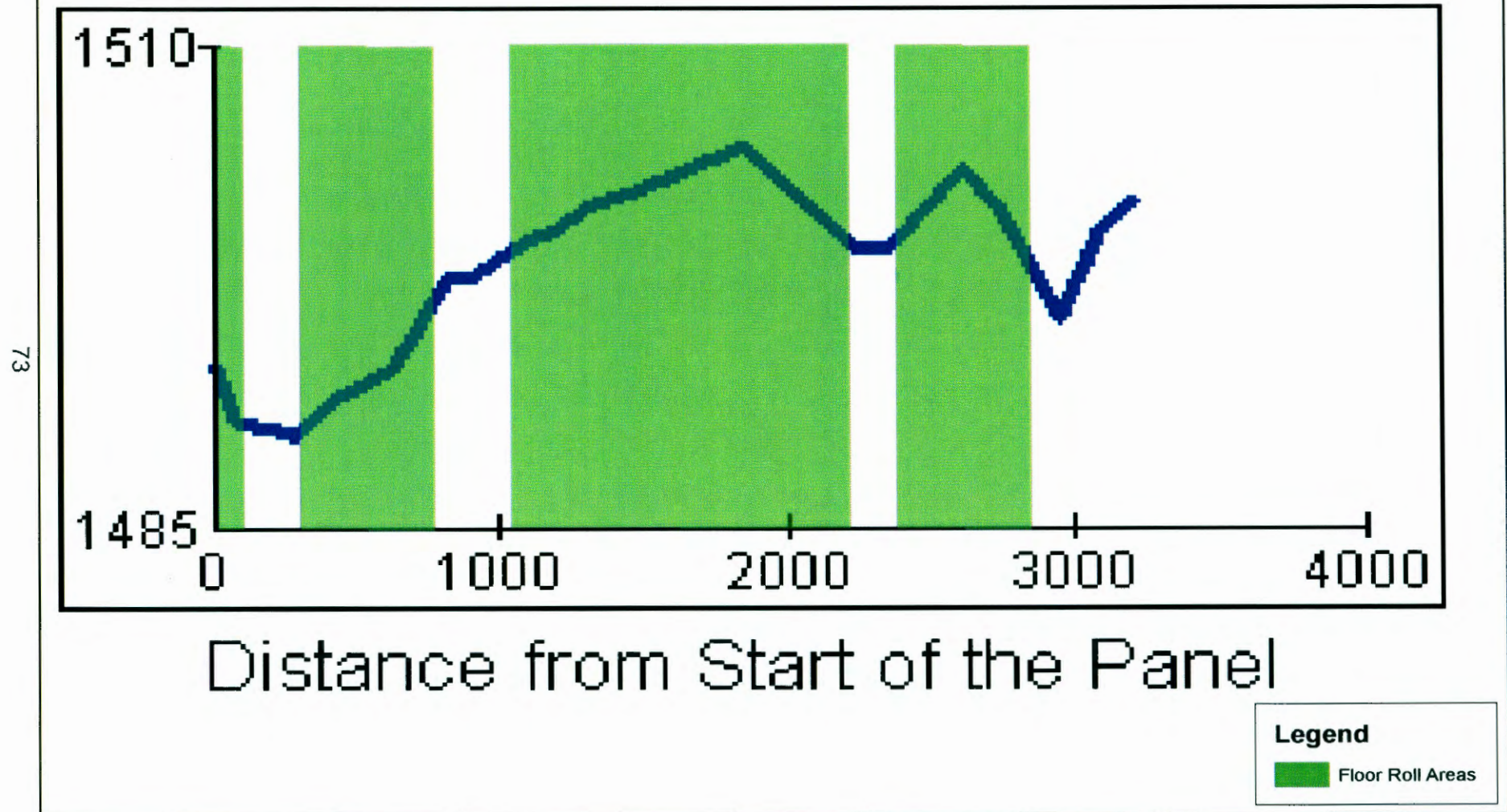


Figure 30: Floor Roll areas in Panel 1

Panel 2: Floor Roll Areas

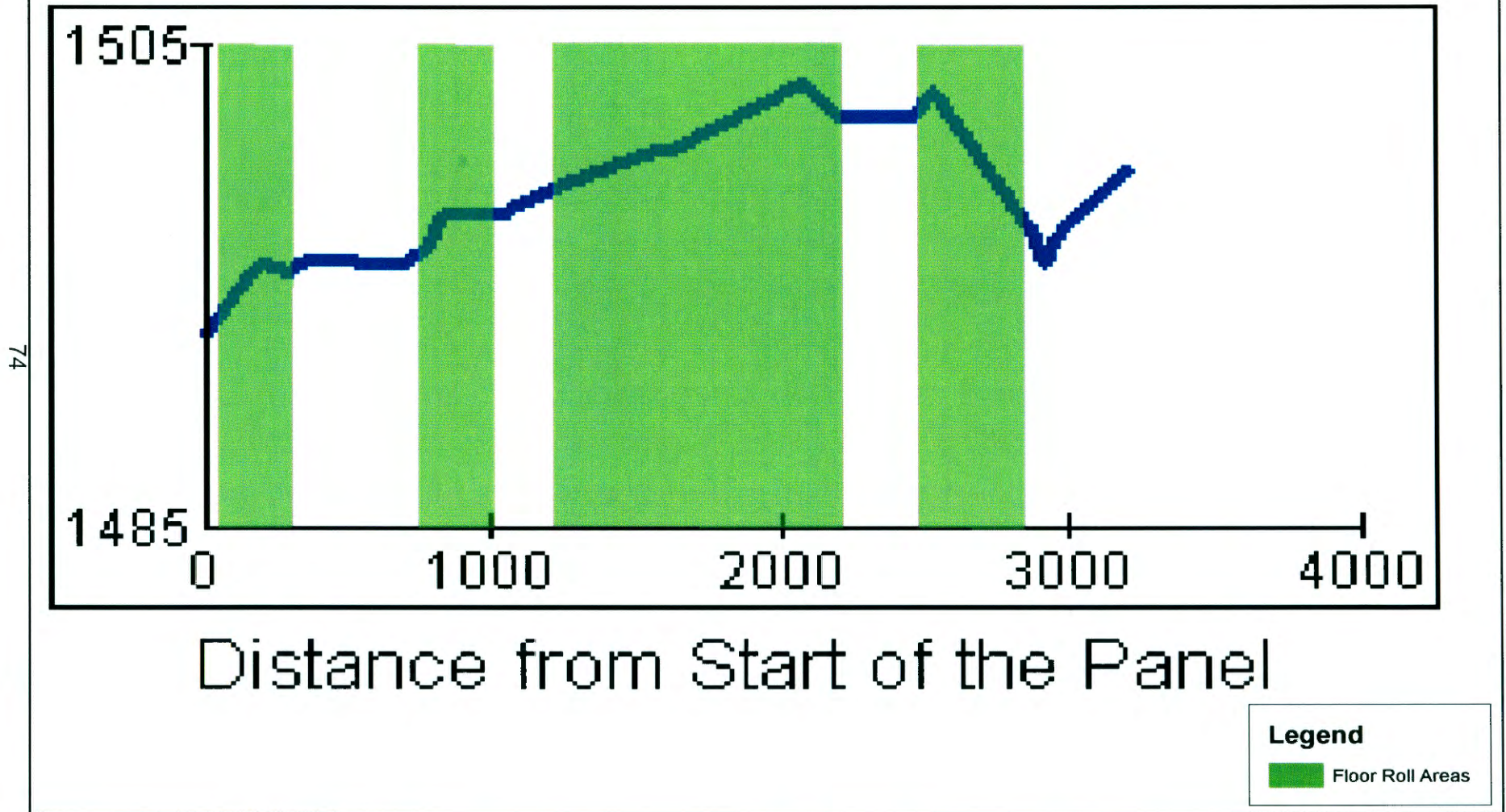


Figure 31: Floor Roll areas in Panel 2

Panel 3: Floor Roll Areas

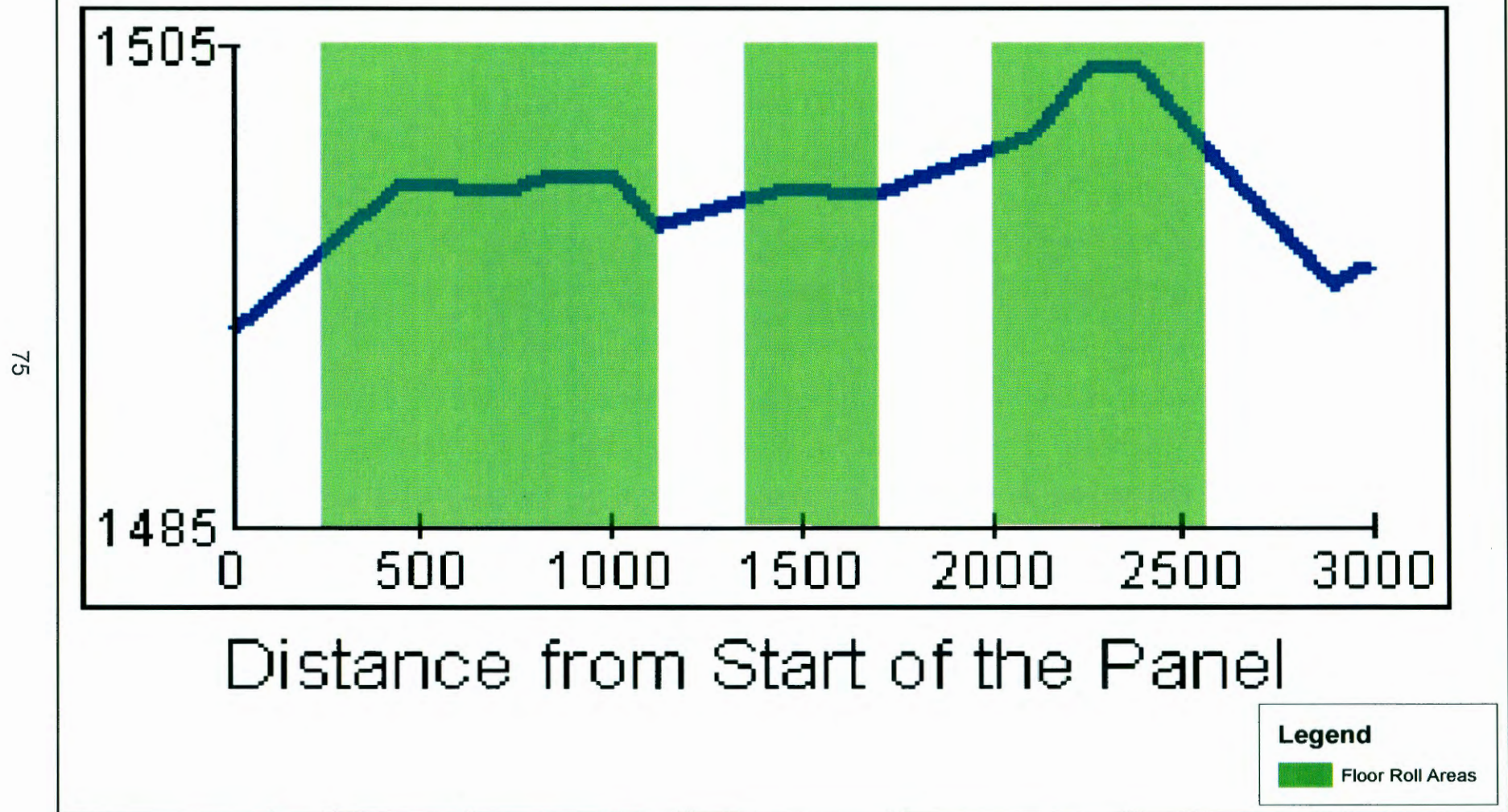


Figure 32: Floor Roll areas in Panel 3

6. CONCLUSIONS

1. The most important conclusion drawn from the research was that roof failures, and even more so, face breaks are not the result of mining, or of geological factors. It is essential that when a rating system is developed for a mine that both the geological and mining conditions as well as the interaction between these two variables be taken into consideration. For this research the rate of advance was the most important aspect from the mining side but could not be taken into account in the rating system as discussed.
2. The slip zones were found to correlate with the floor rolls. This differential correlation confirms the existing theory that the slips result from compaction of the No. 2 Coal Seam after deposition.
3. Floor rolls have an adverse effect on roof stability of underground mines and on the rate of advance during short wall mining. Only 3 face breaks occurred in zones where the rating was 1.8 and all three of these were caused by irregularities in the floor. An eighty percent correlation was observed between face breaks and floor rolls.
4. The stress zone identified by Nielen van der Merwe (2002) resulted in 98% of roof failures. Although not all standing time resulted in roof failures, those that occurred did so after a period of no face advance.
5. The No. 4 Coal Seam chain pillar causes higher levels of pressure on the face because it has been hanging for a longer period than in other areas along the face.
6. The chain pillar also has the effect of distributing the stresses unevenly along the face, causing high levels of pressure in the middle of the

panel. The middle of the panel is where most of the unstable roof conditions occur.

7. The size of the drilling grid on the mine can also hamper the identification and evaluation of floor rolls. In order to address this constraint, the following is recommended:

(a) The lithology, internal sedimentary structures and the geometry of the No. 2 Coal Seam floor must in all instances be investigated and described in detail. Differences in the elevation of the No. 2 Coal Seam should be determined by using geological sections that are compiled by using borehole and underground mapping data.

(b) If development is done on the same level where production takes place, pegs in the development roads can be modelled to provide an illustration of the floor topography that can be expected in the panels. The surveyed points in the main and tailgate sides should also be used to obtain data regarding the panels still to be mined in order to predict the problem areas.

APPENDIX A

Table 4: Production tons for August 2002.

Production Tons 2002:

August 2002					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	1	1	1627	1	1630
3	1	1	1	1	4
4	1	1	1	3864	3867
5	1118	1	1	1	1121
6	1	1	1	1	4
7	1	1	1	1	4
8	1	1	1	1	4
9	1	1	1	2898	2901
10	1	1	1	3203	3206
11	1	1	1	8846	8849
12	4067	4270	4423	1	12761
13	3152	1830	2338	1	7321
14	5185	4016	4016	1	13218
15	1017	1830	1271	1	4119
16	1	1	1830	1	1833
17	2440	935	1	1	3377
18	1	1	1627	1	1630
19	5419	5236	2389	1	13045
20	2338	1373	1017	1	4729
21	6914	3304	4270	1	14489
22	1627	7473	5897	1	14998
23	5236	5592	1	1	10830
24	1	1	1	10167	10170
25	1	1	1	5084	5087
26	1118	1118	1423	1	3660
27	1	1932	1	1	1935
28	1	1	1	1	4
29	1	4206	5731	1	9939
30	7117	4806	1386	1	13310
31	3189	5500	1	1	8691

Table 5: Production tons for September 2002.

September 2002					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	508	4437	2403	1	7349
3	1	1386	2218	1	3606
4	4298	1	1	1	4301
5	1109	5315	3004	1	9429
6	2727	2773	7071	1	12572
7	5777	1433	1	1	7212
8	1	1	1	1	4
9	3281	5731	1849	1	10862
10	9012	3697	7394	1	20104
11	4991	462	508	1	5962
12	3605	7903	6932	1	18441
13	1	5222	5916	1	11140
14	1	3448	1	1	3451
15	1	1	1340	10537	11879
16	1	4529	924	1	5455
17	1	1	2542	1	2545
18	6193	4113	3143	1	13450
19	1	3327	4806	1	8135
20	3050	9936	924	1	13911
21	1	1	1	9104	9107
22	1	1	1	1155	1158
23	3651	4021	1	3882	11555
24	1	1	1	8226	8229
25	5037	2588	4945	1	12571
26	3651	3004	1	1	6657
27	2680	5361	4159	1	12201
28	5777	3605	1	1	9384
29	1	1	4159	1	4162

Table 6: Production tons for October 2002.

October 2002					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	5731	2218	1	1	7951
2	3928	6932	1	1	10862
3	3928	5315	2315	1	11559
4	878	1	3156	1	4036
5	2851	6655	1	7487	16994
6	1	1	1	1	4
7	3235	5130	3512	1	11878
8	1	1	6470	1	6473
9	3790	6008	6655	1	16454
10	3004	3096	4067	1	10168
11	6100	2912	5084	1	14097
12	1	2265	1	1	2268
13	1	1	6008	1	6011
14	7625	6932	4344	1	18902
15	6868	6026	6655	1	19550
16	1	7292	2717	1	10011
17	7428	7382	2310	1	17121
18	928	3736	906	1	5571
19	1	1	1	14674	14677
20	1	1	1	1313	1316
21	5480	1	1	1	5483
22	3125	1	1	1	3128
23	1	3714	7654	1	11370
24	8243	5616	1	1	13861
25	906	1993	906	1	3806
26	3487	1	1	1	3490
27	1	1	1	1	4
28	4846	1993	45	1	6885
29	1087	91	1857	1	3036
30	4756	6794	3850	1	15401
31	1902	6658	1630	1	10191

Table 7: Production tons for November 2002.

November 2002					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	996	3804	5661	1	10462
2	1	1	1	7835	7838
3	1	1	1359	1	1362
4	4484	6884	1	1	11370
5	5571	4574	8243	1	18389
6	1	2582	4121	1	6705
7	13497	3442	1	1	16941
8	8288	3958	4919	1	17166
9	1	1	1	1	4
10	1	1	1	12772	12775
11	3139	1481	9602	1	14223
12	8877	5571	1495	1	15944
13	6839	1	9058	1	15899
14	6884	5254	3216	1	15355
15	1	10598	6341	9466	26406
16	9285	951	1	1	10238
17	1	1	1	1	4
18	1	1	1	1	4
19	1993	10553	906	1	13453
20	1766	9602	5616	1	16985
21	3578	7745	3306	1	14630
22	6612	10870	7247	1	24730
23	1	1	1	23506	23509
24	1	1	6341	7790	14133
25	6974	3895	1812	1	12682
26	2763	9556	9420	1	21740
27	10744	5948	4387	1	21080
28	11190	5651	4015	1	20857
29	4275	5502	1561	1	11339
30	1	1	1	7733	7736

Table 8: Production tons for December 2002.

December 2002					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	11227	11230
2	2863	1	1	1	2866
3	1	2565	1004	1	3571
4	6841	4127	7212	1	18181
5	1883	5617	5865	1	13366
6	2514	2833	1	1	5349
7	1	1	1	9097	9100
8	1	1	1	4987	4990
9	7700	5147	6264	1	19112
10	8777	1676	1317	1	11771
11	4030	9097	2434	1	15562
12	1	798	1	1	801
13	1	1	1915	1	1918
14	1	1	1	2234	2237
15	1	1	1	5265	5268
16	1	1	1	10772	10775
17	1	5865	6463	1	12330
18	5625	5785	3192	1	14603
19	7261	399	4788	1	12449
20	8099	8578	7181	1	23859
21	1	1	1	24816	24819
22	1	1	1	1	4
23	1	1	1	15600	15603
24	1	1	1	5466	5469
25	1	1	1	1	4
26	1	1	1	6543	6546
27	1	1	1	4309	4312
28	1	1	1	1	4
29	1	1	1	1	4
30	1	1	1	958	961
31	1	1	1	6304	6307

Table 9: Production tons for January 2003.

Production Tons 2003:

January 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	1	1	1	10174	10177
3	1	1	1	6902	6905
4	1	1	1	1	4
5	1	1	1	1	4
6	6891	5622	3627	1	16141
7	4216	2312	3400	1	9929
8	5622	1	544	1	6168
9	1	1	952	1	955
10	2584	1	1	1	2587
11	1	1	1	9068	9071
12	1	1	1	1	4
13	1541	2675	6166	1	10383
14	453	3491	4624	1	8569
15	5078	1088	2539	1	8706
16	725	907	4262	1	5895
17	4670	1043	5032	1	10746
18	1	1	1	907	910
19	1	1	1	1	4
20	3627	3400	3355	1	10383
21	1	589	1768	1	2359
22	1	453	816	1	1271
23	2403	907	453	1	3764
24	1859	5486	2584	1	9930
25	1	1	1	9566	9569
26	1	1	1	1	4
27	1360	1	499	1	1861
28	2811	2811	6257	1	11880
29	9204	4080	1	1	13286
30	1	1	2539	1	2542
31	2766	2766	5214	1	10747

Table 10: Production tons for February 2003.

February 2003					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	7390	7393
2	1	1	1	12332	12335
3	1126	6841	4380	1	12348
4	1	6340	2711	1	9053
5	5285	6734	5114	1	17134
6	5412	2472	4219	1	12104
7	1279	5668	2173	1	9121
8	1	1	1	6648	6651
9	1	1	1	8694	8697
10	1619	2259	3793	1	7672
11	9887	1	3026	1	12915
12	1	3282	1747	1	5031
13	1	1875	6861	1	8738
14	5753	1705	3154	1	10613
15	1	1	1	1	4
16	1	1	1	1	4
17	2088	4262	2216	1	8567
18	7032	5966	5412	1	18411
19	1	2429	5455	1	7886
20	6052	3026	2387	1	11466
21	1	1	1	7756	7759
22	1	1	1	1	4
23	1	1	1	5839	5842
24	6393	3409	2642	1	12445
25	1	1492	8353	1	9847
26	3836	5412	6904	1	16153
27	6435	2003	1151	1	9590
28	2259	426	5498	1	8184
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0

Table 11: Production tons for March 2003.

March 2003					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	10612	10615
2	1	1	1	1	4
3	2600	1492	2728	1	6821
4	1	1960	213	1	2175
5	10953	682	1	1	11637
6	1	1	426	1	429
7	1960	3537	2131	1	7629
8	1	1	1	1	4
9	1	1	1	5114	5117
10	3026	3452	4986	1	11465
11	3750	1	4049	1	7801
12	3196	5157	3750	1	12104
13	5583	3068	5753	1	14405
14	2003	1	1	1	2006
15	1	1	1	1	4
16	1	1	1	4603	4606
17	5370	4986	4944	1	15301
18	6052	5199	3708	1	14960
19	1	6691	1	1	6694
20	384	3793	3537	1	7715
21	1	1	1	13765	13768
22	1747	1	1	0	1749
23	1	1	1	7586	7589
24	5071	3196	2216	1	10484
25	1	1	6137	1	6140
26	5199	767	852	1	6819
27	3921	4049	3708	1	11679
28	3409	4176	6947	1	14533
29	4986	1	1	1	4989
30	1	1	1	1	4
31	4049	4049	1	1	8100

Table 12: Production tons for April 2003.

April 2003					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	4134	5114	1	1	9250
2	1	7458	5157	1	12617
3	9248	1279	4603	1	15131
4	6563	3580	2983	1	13127
5	6009	1	1	14149	20160
6	1	1	1	1	4
7	1	1	426	1	429
8	8822	3409	5753	1	17985
9	767	810	2257	1	3835
10	3282	2557	2557	1	8397
11	3793	6307	2259	1	12360
12	426	1	1	1	429
13	1	1	1	1	4
14	2557	852	426	1	3836
15	3068	4347	5966	1	13382
16	3921	1	2301	1	6224
17	1	1	1492	1	1495
18	1	1	1	2301	2304
19	938	1	1	1	941
20	1	1	1	1	4
21	1	1	1	1	4
22	426	3836	426	1	4689
23	426	3196	2557	1	6180
24	1	426	1	1	429
25	1	724	2387	1	3113
26	1	1	1	1	4
27	1	1	1	1	4
28	1	1	1	1279	1282
29	1	1747	554	1	2303
30	2173	2387	852	1	5413

Table 13: Production tons for May 2003.

May 2003					
Date	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	4488	4491
2	1	4310	2666	1	6978
3	1422	1	1	1	1425
4	1	1	1	7998	8001
5	3288	3554	4754	1	11597
6	6665	1333	1	1	8000
7	1	1	444	1	447
8	5332	5332	6220	1	16885
9	2932	3554	5998	1	12485
10	444	1	1	8664	9110
11	1	1	1	9064	9067
12	1688	2666	3510	1	7865
13	889	4443	3599	1	8932
14	4443	1422	3021	1	8887
15	3954	4488	4443	1	12886
16	844	3554	5332	1	9731
17	6043	1	1	10752	16797
18	1	1	1	1	4
19	1	1	1	1	4
20	2755	1	1	1	2758
21	4532	3554	1733	1	9820
22	5376	5376	2533	1	13286
23	4887	3554	4488	1	12930
24	2399	0	0	4576	6975
25	1	1	1	5154	5157
26	889	5865	3821	1	10576
27	1333	2621	444	1	4399
28	3777	4799	3999	1	12576
29	1	1	1	1	4
30	1022	4754	1022	1	6799
31	1	1	1	0	3

Table 14: Production tons for June 2003.

June 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	1555	1244	844	1	3644
3	1200	2844	444	1	4489
4	2399	1200	1200	1	4800
5	4443	977	3021	1	8442
6	5110	444	4221	1	9776
7	2088	5198	1	1	7288
8	1	1	1	7953	7956
9	3155	1377	4443	1	8976
10	1777	4843	5021	1	11642
11	1644	4399	3243	1	9287
12	1	4310	4221	1	8533
13	1333	1555	2488	1	5377
14	1	1	1	2222	2225
15	1	1	1	1	4
16	1	1	1	1	4
17	2310	889	2133	1	5333
18	533	3554	1	1	4089
19	2977	444	1	1	3423
20	3466	3155	3554	1	10176
21	2266	1	1	1	2269
22	1	1	1	3066	3069
23	1	1	1	1	4
24	2888	1	5554	1	8444
25	4843	1	5776	1	10621
26	1	1	1777	1	1780
27	889	1	933	1	1824
28	444	1	1	1	447
29	889	1	1	1	892
30	1	1	1	1	4

Table 15: Production tons for July 2003.

Jul-03					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	889	1	444	1	1335
3	933	1	889	1	1824
4	889	1	1	1	892
5	Face Move				
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

Table 16: Production tons for August 2003.

August 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	Face Move				
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18	666	444	444	1	1555
19	1688	1	1155	1	2845
20	1	1911	444	1	2357
21	1	1	1	1	4
22	1466	1	1	1	1469
23	1	1	1	1	4
24	1	1	1	1	4
25	1377	889	444	1	2711
26	889	1200	3554	1	5644
27	1422	3777	4088	1	9288
28	3643	4576	3554	1	11774
29	1333	489	4088	1	5911
30	2355	889	1	1	3246
31	2399	1	1	1	2402

Table 17: Production tons for September 2003.

September 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1693	2244	827	1	4765
2	1772	4843	6379	1	12995
3	4764	3623	3662	1	12050
4	1181	3308	2835	1	7325
5	4725	4253	4056	1	13035
6	1654	1	1	1	1657
7	1	1	788	1	791
8	3189	6969	3544	1	13703
9	3071	6536	4134	1	13742
10	2993	4568	1221	1	8783
11	5710	6458	2481	1	14650
12	4056	7560	2363	1	13980
13	394	2717	1	1	3113
14	1	1	1	1	4
15	788	3583	6615	1	10987
16	1	3150	5119	1	8271
17	4174	6497	3938	1	14610
18	1	1181	4725	1	5908
19	4882	4725	5119	1	14727
20	1	1	1	11222	11225
21	1	1	1	5276	5279
22	4213	3465	2368	1	10047
23	5709	2993	1	5473	14176
24	1	1	3938	10670	14610
25	3544	6221	5119	1	14885
26	4410	1969	1260	1	7640
27	3977	2363	1	1	6342
28	1	1	4134	1	4137
29	7009	5825	2126	1	14961
30	7048	3583	5276	1	15908

Table 18: Production tons for October 2003.

October 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	9056	6576	3504	1	19137
2	1181	7402	5749	1	14333
3	10749	7245	2323	1	20318
4	7560	7087	1	1	14649
5	1	1	1	1	4
6	5709	4607	6812	1	17129
7	6064	5906	5670	1	17641
8	3268	1	2363	1	5633
9	2481	2363	6891	1	11736
10	2048	5788	5749	1	13586
11	3623	4331	1	1	7956
12	1	1	5513	5709	11224
13	6891	6891	1654	1	15437
14	4686	394	4489	1	9570
15	8584	8623	6418	1	23626
16	3583	4882	6221	1	14687
17	1	9214	5434	1	14650
18	394	7206	1	1	7602
19	1	1	5513	9568	15083
20	12246	1	354	1	12602
21	6103	10316	4134	1	20554
22	8229	8899	7324	1	24453
23	8938	9568	1575	1	20082
24	3504	9371	1	1	12877
25	1	1	1	24334	24337
26	1	1	1	1575	1578
27	1654	2087	2047	1	5789
28	6418	8899	5316	1	20634
29	6182	4961	10789	1	21933
30	1221	1	788	1	2011
31	2914	5788	1575	1	10278

Table 19: Production tons for November 2003.

November 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	5591	1	1	5198	10791
2	1	1	788	8623	9413
3	394	2756	2953	1	6104
4	4134	2874	4449	1	11458
5	6261	6536	8111	1	20909
6	4883	4253	9726	1	18863
7	2874	3347	5119	1	11341
8	1	5513	1	13151	18666
9	1	1	1	4134	4137
10	2363	4568	11104	1	18036
11	1	7796	7009	1	14807
12	11891	7324	4961	1	24177
13	6339	6812	6536	1	19688
14	9017	4922	2874	1	16814
15	10080	3426	1	1	13508
16	1	1	1575	1	1578
17	1	866	4804	1	5672
18	6300	6969	2481	1	15751
19	2246	7652	11057	1	20956
20	3721	6809	4668	1	15199
21	4739	9653	6669	1	21062
22	1	1	1	16041	16044
23	1	1	1	10249	10252
24	7266	3405	2492	1	13164
25	6634	5581	702	1	12918
26	1	1	1	1	4
27	4703	6283	2633	1	13620
28	2668	5160	7020	1	14849
29	1	1	4984	23342	28328
30	1	1	1860	1	1863

Table 20: Production tons for December 2003.

December 2003					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	3731	6370	5314	1	15416
2	4560	1922	7161	1	13644
3	1	377	4334	1	4713
4	8141	5126	1	1	13269
5	3430	7990	5277	1	16698
6	1809	1809	1	1	3620
7	1	1	1	1	4
8	4410	5201	11118	1	20730
9	8216	7123	4749	1	20089
10	5540	5163	1093	1	11797
11	4787	4372	8292	1	17452
12	1	1	5227	1	5230
13	3995	1131	1	1	5128
14	1	1	377	1	380
15	1998	7086	1	11759	20844
16	1	1	6558	24800	31360
17	7841	6201	6700	1	20743
18	6700	6451	2994	1	16146
19	7734	356	5097	1	13188
20	1	1	1	19781	19784
21	1	1	1	1	4
22	1	1	1	13757	13760
23	1	1	1	18783	18786
24	1	1	1	8483	8486
25	1	1	1	1	4
26	1	1	1	10158	10161
27	1	1	1	8839	8842
28	1	1	1	1	4
29	1	1	1	14007	14010
30	1	1	1	15076	15079
31	1	1	1	8197	8200

Table 21: Production tons for January 2004.

Production Tons 2003:

January 04					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	7841	7844
2	1	1	1	9269	9272
3	1	1	1	9730	9733
4	4740	2138	1	1	6880
5	356	1	1	1	359
6	2602	4812	3778	1	11193
7	2887	2245	2566	1	7699
8	4562	3136	5703	1	13402
9	1	1	1	9374	9377
10	1	1	1	7698	7701
11	6415	3742	2566	1	12724
12	632	1	1860	1	2494
13	8740	5765	5207	1	19713
14	7550	4723	4240	1	16514
15	1	1	1	1	4
16	1	1	1	1	4
17	1	1	1	1	4
18	3905	6657	744	1	11307
19	4054	4277	4017	1	12349
20	6949	6871	4005	1	17826
21	6360	5575	7813	1	19749
22	5104	1806	1335	1	8246
23	1	1	1	5968	5971
24	1	1	1	6988	6991
25	8088	9697	4083	1	21869
26	2591	5850	6164	1	14606
27	6596	4868	4240	1	15705
28	4476	9462	5536	1	19475
29	5968	6399	5732	1	18100
30	1217	2356	1	1	3575

Table 22: Production tons for February 2004.

February 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	5889	6164	7970	1	20024
3	7773	5850	3769	1	17393
4	1	1	942	1	945
5	1	1	1	1	4
6	1	1	1	1	4
7	1	1	1	1	4
8	1	1	1	1	4
9	393	1	1	1	396
10	2356	8362	864	1	11583
11	5339	7734	5065	1	18139
12	2356	2552	5653	1	10562
13	6046	5771	8598	1	20416
14	6242	3808	1	1	10052
15	1	1	1	1	4
16	6439	4240	5300	1	15980
17	9540	4868	1	1	14410
18	3455	1	5575	1	9032
19	1	2748	2002	1	4752
20	4515	4436	393	1	9345
21	1	1	1	2552	2555
22	1	1	1	1	4
23	8009	6517	9226	1	23753
24	1649	1	1	1	1652
25	1688	9894	8794	1	20377
26	2787	6910	5025	1	14723
27	7459	6753	4319	1	18532
28	1	1	1	10875	10878
29	1	1	1	1	4

Table 23: Production tons for March 2004.

March 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	785	393	6321	1	7500
2	6674	7263	1	1	13939
3	1	3219	1	1	3222
4	2356	785	4986	1	8128
5	6085	3533	1	1	9620
6	1	1	1	19630	19633
7	1	1	1	5889	5892
8	7106	4986	2670	1	14763
9	3416	6242	2787	1	12446
10	1	3180	5182	1	8364
11	5771	824	3376	1	9972
12	5928	3102	4044	1	13075
13	1	1	1	10797	10800
14	1	1	1	13780	13783
15	6125	5614	1	1	11741
16	785	1296	4044	1	6126
17	8441	1	4083	1	12526
18	6831	1	1	1	6834
19	785	1	2199	1	2986
20	1453	1	785	1	2240
21	1	1	1	1	4
22	1178	1	1	1	1181
23	393	1	1178	1	1573
24	746	1	1	1	749
25	Face Move				
26					
27					
28					
29					
30					
31					

Table 24: Production tons for April 2004.

April 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21	1	1	833	1	836
22	1	1	2040	1	2043
23	2997	1	1	1	3000
24	1	1	1	1	4
25	1	1	416	1	419
26	1707	2414	1	1	4123
27	1	1	2914	1	2917
28	3788	3164	416	1	7369
29	8492	6369	2914	1	17776
30	5828	4829	1	1	10659

Table 25: Production tons for May 2004.

May 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1249	1	1	9449	10700
2	1	1	1	1665	1668
3	5120	3830	3538	1	12489
4	1	1	1	1	4
5	2914	2081	4620	1	9616
6	3746	4870	833	1	9450
7	1	1	1	1	4
8	1	1	1	1	4
9	1	1	1	1	4
10	1	2498	5952	1	8452
11	4163	4454	3830	1	12448
12	4204	4454	4163	1	12822
13	6240	7284	2081	1	15606
14	1	1998	2498	1	4498
15	416	1	1	1	419
16	1	1	1	1	4
17	3996	2498	2747	1	9242
18	6868	6827	6244	1	19940
19	8659	8075	1	1	16736
20	4121	8325	6618	1	19065
21	2498	5703	3080	1	11282
22	1	1	1	1	4
23	1	1	1	8491	8494
24	2123	5078	5286	1	12488
25	2414	3372	5952	1	11739
26	6535	9074	6190	1	21800
27	4537	2289	7576	1	14403
28	6702	5495	5078	1	17276
29	2165	1	1	1	2168
30	1	1	1	1	4
31	833	7784	4038	1	12656

Table 26: Production tons for June 2004

June 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	3660	1	1	1	3663
2	833	3164	1	1	3999
3	2289	1832	416	1	4538
4	3455	5453	1249	1	10158
5	2289	1	1	1	2292
6	1	1	1	1	4
7	5578	4204	5037	1	14820
8	3496	4662	333	1	8492
9	1665	4620	4287	1	10573
10	4163	4412	2914	1	11490
11	6494	4745	4912	1	16152
12	1	1374	1	1	1377
13	1	1	1	1	4
14	5952	250	416	1	6619
15	416	4704	1	7160	12281
16	1	1	3330	11988	15320
17	5078	3913	9782	1	18774
18	3413	3413	833	1	7660
19	1	1	1	2914	2917
20	1	1	1	1	4
21	1	416	1249	1	1667
22	1124	1	833	1	1959
23	1	1	416	1	419
24	957	1915	1	1	2874
25	2706	4912	4287	1	11906
26	1665	1	1	1	1668
27	1	1	1	6327	6330
28	2747	2664	8117	1	13529
29	4287	1	1	1	4290
30	1	6868	6452	1	13322

Table 27: Production tons for July 2004

July 2004					
Days	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	6660	8325	4995	1	19981
2	1665	4537	3705	1	9908
3	1	1	1	25225	25228
4	1	1	1	15068	15071
5	3455	1	1	1	3458
6	2165	2123	8325	1	12614
7	6119	2831	6660	1	15611
8	1	6910	9407	1	16319
9	7950	1665	8075	1	17691
10	1	1	1	5952	5955
11	1	1	1	3164	3167
12	6036	4704	2706	1	13447
13	2955	1	1	1	2958
14	1249	5661	1	1	6912
15	1	1	1	1	4
16	1	6618	2081	1	8701
17	1	1	1	10947	10950
18	1	1	1	2539	2542
19	957	5078	6119	1	12155
20	11738	6660	2789	1	21188
21	6868	7118	5453	1	19440
22	6036	5494	1	1	11532
23	1	1249	1	1	1252
24	1	1	1	8117	8120
25	1	1	1	1	4
26	6119	6493	3080	1	15693
27	2997	3830	5245	1	12073
28	6535	3538	4412	1	14486
29	9574	8658	10281	1	28514
30	9033	3163	9074	1	21271
31	1	1	1	13903	13906

Table 28: Production tons for August 2004

August 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1249	1252
2	1665	12488	6702	1	20856
3	4246	5411	2456	1	12114
4	1	1	1	1	4
5	2081	2914	9116	1	14112
6	4163	7076	2830	1	14070
7	1	1	1	21437	21440
8	1	1	1	9407	9410
9	1	1	1	1	4
10	2289	1	916	1	3207
11	8492	1707	833	1	11033
12	9033	5869	5619	1	20522
13	12363	3247	1	1	15612
14	1	1	1	1	4
15	1	1	1	1	4
16	2165	7825	7409	1	17400
17	6494	1	416	1	6912
18	2165	3663	8825	1	14654
19	5120	3496	1	1	8618
20	1	1956	5037	1	6995
21	1	1	1	9574	9577
22	1	1	1	1	4
23	1374	2581	3497	1	7453
24	4121	4163	5914	1	14199
25	3413	4495	3330	1	11239
26	1207	1	833	1	2042
27	1	1	1	1	4
28	1	1	1	1	4
29	1	1	1	1	4
30	1	1	1	1	4
31	1	1	1	1	4

Table 29: Production tons for September 2004

September 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	1	1	1	1	4
2	1	1	1	1	4
3	1	1707	1249	1	2958
4	5744	1	1	1	5747
5	1	1	1	1	4
6	916	416	1249	1	2582
7	5578	7534	9241	1	22354
8	5328	2331	1	1	7661
9	5994	416	416	1	6827
10	1165	1707	1249	1	4122
11	1998	1	1	1	2001
12	1	1	1	1	4
13	4038	2289	1082	1	7410
14	5162	1707	1790	1	8660
15	5245	1	1	1	5248
16	4995	7617	1374	1	13987
17	416	458	1665	1	2540
18	1	1	1	1	4
19	1	1	1	1	4
20	4412	833	833	1	6079
21	2914	416	416	1	3747
22	1	1	1665	1	1668
23	1249	1	1	1	1252
24	1	1	1	1	4
25	1	1	1	1	4
26	1	1	1	1	4
27	833	3746	1249	1	5829
28	833	833	833	1	2500
29	833	1	1	1	836

Table 30: Production tons for October 2004

October 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	833	416	3330	1	4580
2	1	1	1	1	4
3	1	1	1	1	4
4	4079	10531	5453	1	20064
5	6160	4829	416	1	11406
6	416	2081	3996	1	6494
7	1665	5911	6743	1	14320
8	1665	4870	4246	1	10782
9	1	7950	1	1	7953
10	1	1	4163	1	4166
11	1	1	1	1	4
12	1	1	1	1	4
13	1	1	1	1	4
14	1	1	1	1	4
15	1	1	1	1	4
16	2706	1	1	1	2709
17	1	1	1	1	4
18	2997	1	1	1	3000
19	833	5703	1	1	6538
20	3163	3746	6285	1	13195
21	7909	5828	5536	1	19274
22	5578	5578	6660	1	17817
23	1	1	1	8325	8328
24	1	1	1	416	419
25	6535	3288	7701	1	17525
26	9158	11239	6160	1	26558
27	1665	833	1498	1	3997
28	5286	9657	708	1	15652
29	1665	3205	3788	1	8659
30	4745	6493	1	1	11240
31	1	1	1	3496	3499

Table 31: Production tons for November 2004

November 2004					
Day	Day Shift	Afternoon Shift	Night shift	Zama	Total
1	5078	8658	3746	1	17483
2	1	1	1	1	4
3	1	2498	6244	1	8744
4	13154	9907	4163	1	27225
5	8991	7950	6660	1	23602
6 Sat	2081	1	1	1	2084
7 Sun	1	1	1	1	4
8	6327	7451	9033	1	22812
9	2747	7076	5203	1	15027
10	8824	5828	9990	1	24643
11	9699	1	1	1	9702
12	6077	5703	8242		20022
13 Sat	4246	6077	1	5994	16318
14 Sun	1	1	1	13736	13739
15	4995	2498	4454	1	11948
16	4579	11405	9241	1	25226
17	9740	10614	9158	1	29513
18	5578	7326	7201	1	20106
19	9657	1665	2872	1	14195
20 Sat	1	1	1	26515	26518
21 Sun	1	1	1	2331	2334
22	Face Move				
23					
24					
25					
26					
27 Sat					
28 Sun					
29					
30					

- Bad Roof
- Face Break

APPENDIX B

Table 33a: Description of lithologies in the interburden between the No. 2 and No. 4 seam at Matla Coal Ltd No. 2 mine

Area between:		Roof unit	2nd Unit	3rd Unit	4th Unit
R062125	R062120	0.24m thick sandstone laminated with shale	1.72m of shale	15.85m of sandstone	
R062120	R062124	0.25m thick sandstone laminated with shale	1.77m of shale	16.2m of sandstone	
R062124	R062119	0.31m thick sandstone laminated with shale	1.89m of shale	14.52m of sandstone	
R062119	R062123	0.46m of shale	0.12m thick sandstone laminated with shale	2.18m of shale	14.47m of sandstone
R062123	R062118	0.15m thick sandstone laminated with shale	2.46m of shale	13.34m of sandstone	
R062118	R062117	0.35m of shale	0.13m thick sandstone laminated with shale	2.17m of shale	10.30m of sandstone
R062117	R062121	0.40m of shale	0.37m thick sandstone laminated with shale	2.44m of shale	10.21m of sandstone
R062121	R062116	0.25m of shale	0.30m thick sandstone laminated with shale	2.50m of shale	13.36m of sandstone
R062116	R062115	1.06m of shale	0.27m thick sandstone laminated with shale	2.39m of shale	12.23m of sandstone
R062115	R062114	0.45m thick sandstone laminated with shale	2.65m of shale	19.24m of sandstone	

Table 33b: Description of lithologies in the interburden between the No. 2 and No. 4 seam at Matla Coal Ltd No. 2 mine.

Area between:		Roof unit	2nd Unit	3rd Unit	4th Unit
R062114	R062113	0.50m thick sandstone laminated with shale	4.70m of shale	20.40m of sandstone	
R062113	R062112	0.06m thick sandstone laminated with shale	0.05m of shale	23.50m of sandstone	
R062123	R062122	0.46m of shale	0.12m thick sandstone laminated with shale	2.18m of shale	14.47m of sandstone
R062122	R062126	0.06m thick sandstone laminated with shale	2.55m of shale	21.65m of sandstone	
R062126	R062121	0.15m thick sandstone laminated with shale	2.70m of shale	19.03m of sandstone	
R062121	R062054	0.25m of shale	0.30m thick sandstone laminated with shale	2.50m of shale	13.26m of sandstone
R062054	R062109	0.23m thick sandstone laminated with shale	2.57m of shale	13.36m of sandstone	
R062109	R062049	0.31m thick sandstone laminated with shale	2.62m of shale	18.93m of sandstone	
R062049	R062110	0.35m thick sandstone laminated with shale	1.70m of shale	19.50m of sandstone	
R062110	R062111	0.37m thick sandstone laminated with shale	2.59m of shale	18.34m of sandstone	

APPENDIX C



Figure 32: Shearer, roof shields and AFC used in the coal cutting operation at Matla Coal Ltd No. 2 Mine

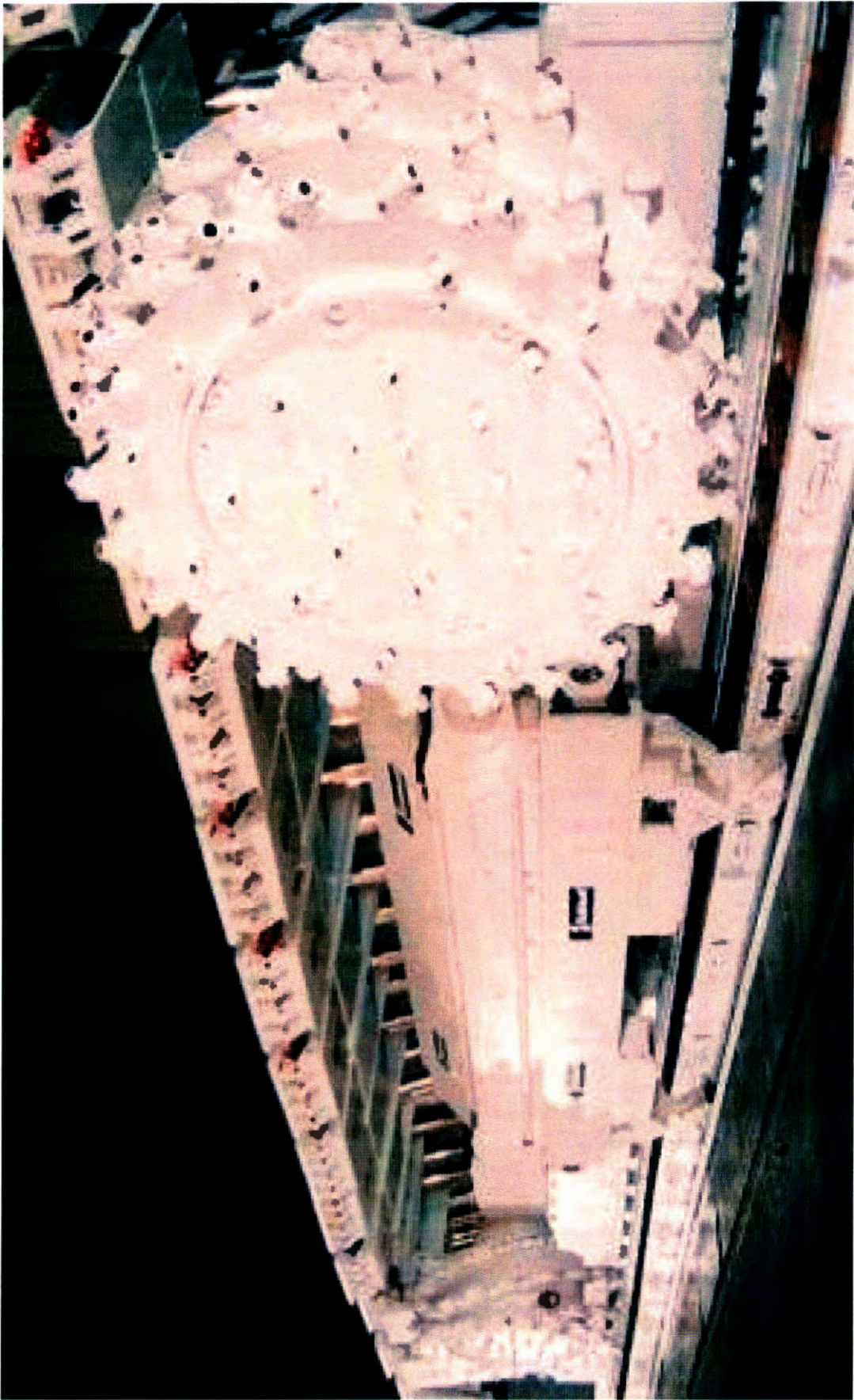


Figure 33: Shearer used in the coal cutting operation at Matla Coal Ltd No. 2 Mine

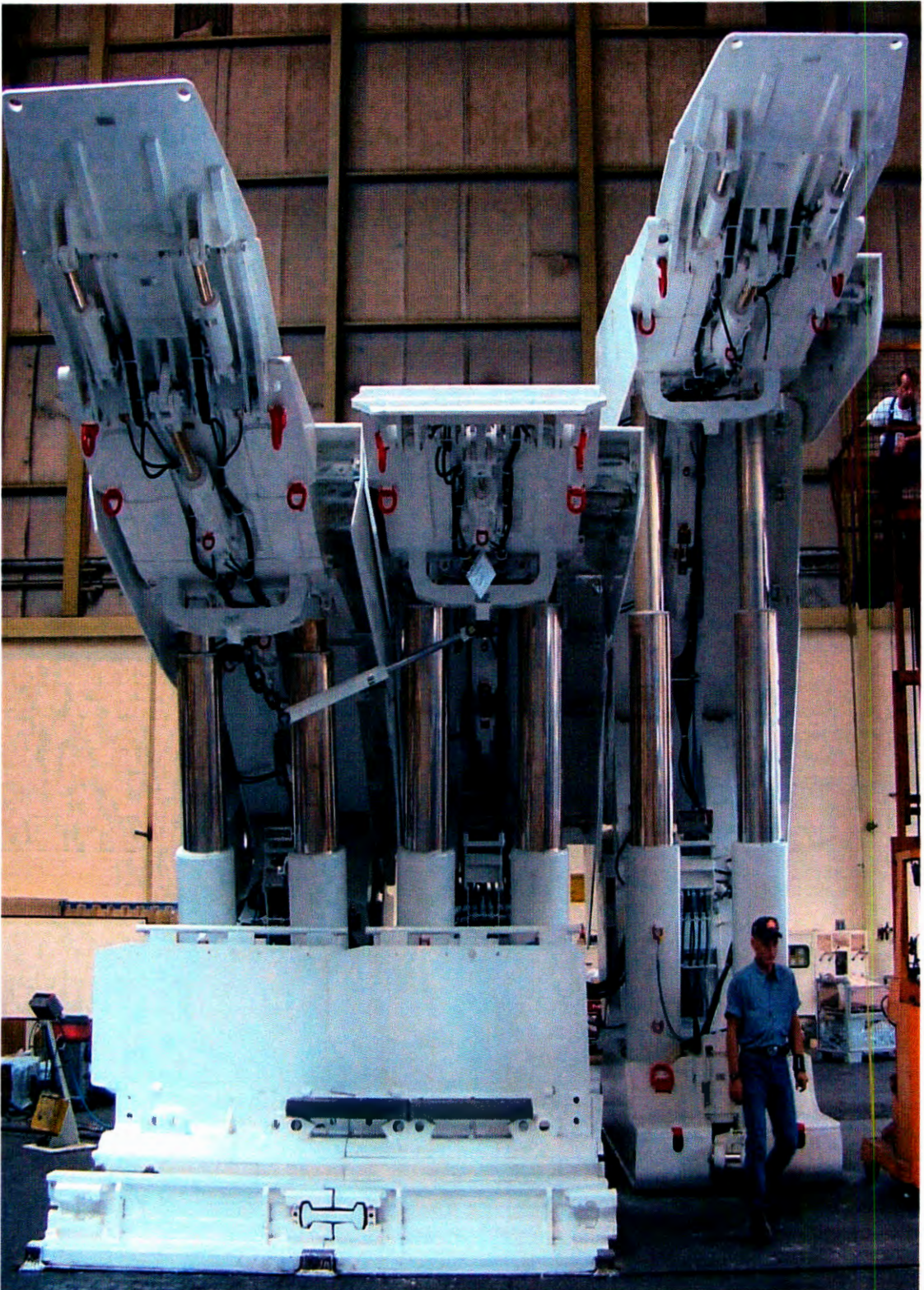


Figure 34: Roof supports in the coal cutting operation at Matla Coal Ltd No. 2 Mine



Figure 35: AFC (Automatic Face Conveyor) used in the coal cutting operation at Matla Coal Ltd No. 2 Mine.

APPENDIX D

Floor Details of Panel 1, 2 and 3

Table 34: Details of the dip of the floor in Panel 1.

Panel 1				
Profile	From	To	Floor Dip	No of RF
Profile 1	0	150	2.9	1
Profile 1	150	350	0	2
Profile 1	350	650	0.7	3
Profile 1	650	800	1.75	2
Profile 1	800	950	0	0
Profile 1	950	1150	1.02	1
Profile 2	1150	1850	0.57	5
Profile 2	1850	2250	1.14	2
Profile 2	2250	2400	0	0
Profile 2	2400	2550	1.3	0
Profile 2	2550	2950	1.87	1
Profile 2	2950	3150	1.87	0

Table 35: Details of the dip of the floor in Panel 2.

Panel 2				
Profile	From	To	Floor Dip	No of RF
Profile 1	0	250	0.9	1
Profile 1	250	700	0	1
Profile 1	700	850	0.9	0
Profile 1	850	1500	0.4	6
Profile 2	1500	2050	0.3	3
Profile 2	2050	2200	0.72	1
Profile 2	2200	2450	0	2
Profile 2	2450	2500	0.72	1
Profile 2	2500	2950	1.03	4
Profile 2	2950	3150	1.07	0

Table 36: Details of the dip of the floor in Panel 3.

Panel 3				
Profile	From	To	Floor Dip	No of RF
Profile 1	0	450	0.73	4
Profile 1	450	750	0	2
Profile 1	750	850	0.6	2
Profile 1	850	1050	0	2
Profile 1	1050	1150	0.58	0
Profile 1	1150	1400	0.48	3
Profile 2	1400	1500	0.77	2
Profile 2	1500	1950	0	4
Profile 2	1950	2200	0.3	0
Profile 2	2200	2400	1.4	0
Profile 2	2400	2600	0	0
Profile 2	2600	3050	1.08	0
Profile 2	3050	3150	0.62	0

Roof Failures in Panel 1

Description of the roof failures in panel 1

BR = Unstable Roof Conditions

FB = Face Breaks

RF = Roof Failures

Profiles were drawn down the panels and this allowed the floor to be investigated in detail. The profiles revealed the dip of the floor at different intervals and this the area in which the roof failures occurred.

20 August 2002

The roof failure occurred at the beginning of the panel at 79m (Table 8) and the reason for the roof failure was the poor rate of advance on 16 August 2002 when only 2.2 webs were cut for the entire day. At that stage the cantilever beam had reached a critical length and this could have placed pressure on the face. The first goaf is the critical goaf and this is where the cantilever beam reaches its maximum length of the entire panel. The roof failure took place at 79m and this implies that the length of the beam was the same. A beam of 79m is very long and exerts much pressure on the face. The standing time resulted in fractures in the face to open up and this would have led to the roof failure. Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

16 September 2002

The second roof failure occurred on the 16 September 2002, 320 metres into the face direction (Table 4 and 5). The reason for this roof failure was the poor rate of advance on 14 and 15 September 2002. The poor rate of advance led to a build up of pressure in the face and this caused the fractures in the face to open up and this caused the roof failure. Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

17 September 2002

The reason for the roof failure that occurred on 17 September 2002 was the poor rate of advance on 14 and 15 September 2002 due to roof failures. This poor rate of advance placed pressure on the face and caused existing fractures to open up and the roof failure followed. From 14 September to 17 September 2002 the face advanced 49 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

24 September 2002

The roof failure occurred 397 metres into the face production. On 22 and 23 September no webs were cut and this led to the roof failure on 24 September (Table

8). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

28 September 2002

The cause of the roof failure was that there were no webs cut on 24 September 2002. From 24 September, 43 webs were cut up to 28 September when the roof failure occurred. According to Nielen van der Merwe (2002) if there is a standing time of a day or more, the beam puts pressure on the face and fractures will open up in the direction of production. Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

02 October 2002

The reason for the roof failure that occurred on 02 October 2002 was because no webs were cut on 29 September 2002. This poor rate of advance placed pressure on the face and caused existing fractures to open up and the roof failure followed. From 29 September to 02 October, the face only advanced 33 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

24 October 2002

The reason for the roof failure that occurred on 24 October 2002 was that only 2 webs were cut on 20 October 2002. This poor rate of advance placed pressure on the face and caused existing fractures to open up and the roof failure followed. From 20 October to 24 October the face only advanced 42 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

04 November 2002

The reason for the roof failure that occurred on 04 November 2002 was that only 4 webs were cut on 29 October 2002. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. From 29 October to 04 November, the face only advanced 53 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

18 November 2002

The reason for the roof failure that occurred on 18 November 2002 was that the rate of advance on 17 November 2002. This poor rate of advance placed pressure on the

face, causing existing fractures to open up and the roof failure followed. The roof failure occurred in a zone that contains a number of joints, and for this reason this was a high risk area for roof failures. Due to the poor rate of advance on the day this roof failure will be classified as a face break and will be used in the final rating system.

06 December 2002

The reason for the roof failure that occurred on 06 December 2002 was that only 4 webs were cut on 03 December 2002. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. The roof failure that occurred on 06 December 2002 occurred in a slip zone which made the possibility of a roof failure that much greater. From 03 December to 06 December the face only advanced 48 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

12 December 2002

The reason for the roof failure that occurred on 12 December 2002 was the poor rate of advance on 06 December 2002. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. From 06 December to 12 December, the face advanced 60 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due

to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

05 January 2003

The reason for the roof failure that occurred on 05 January 2003 was the poor rate of advance on 01 January 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. From 01 January to 05 January 2003, the face only advanced 17 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

17 January 2003

The reason for the roof failure that occurred on 17 January 2003 was that no webs were cut on 12 December 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. The roof failure that occurred on 17 January 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. From 12 January to 17 January, the face advanced 52 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

01 February 2003

The reason for the roof failure that occurred on 01 February 2003 was that no webs were cut on 26 January 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. From 26 January to 01 February the face advanced 56 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

16 February 2003

The reason for the roof failure that occurred on 16 February 2003 was that no webs were cut on 15 February 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

14 March 2003

The reason for the roof failure that occurred on 14 March 2003 was that only 0.5 webs were cut on 08 March 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. From 08

March to 13 March the face advanced 50 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

21 May 2003

The reason for the roof failure that occurred on 21 May 2003 was that no webs were cut on 18 May 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure followed. From 18 May to 21 May the face advanced 15 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

Table 37: Details of the roof failures that occurred in Panel 1.

Panel 1			
Dates of the roof failure	Distances	Possible Reasons for the Face Breaks	Classification
20-Aug-02	79 m	16 Aug (2.2 webs) - 20 Aug: 29 webs	BR
16-Sep-02	320 m	14 + 15 Sep: 4 webs	BR
17-Sep-02	325 m	14 + 15 Sep: 4 webs	FB
24-Sep-02	397 m	21 + 22 Sep: 0 webs	BR
28-Sep-02	434 m	24 Sep (0 webs) - 28 Sep: 43webs	BR
02-Oct-02	472 m	29 Sep (0 webs) - 02 Oct: 41 webs	BR
24-Oct-02	701 m	20 Oct (1.6 webs) - 24 Oct: 42 webs	BR
04-Nov-02	784 m	29 Oct (3.6 webs) - 04 Nov: 53 webs	BR
18-Nov-02	978 m	17 & 18 Nov: 0 webs cut	FB
06-Dec-02	1280 m	03 Dec (4 webs) - 06 Dec: 48 webs	FB
12-Dec-02	1360 m	Good Rate of Advance	FB
05-Jan-03	1590 m	05 Jan (0 webs) - 05 Jan: 20 webs	FB
17-Jan-03	1660 m	12 Jan (0 webs) - 17 Jan: 52 webs	BR
01-Feb-03	1760 m	26 Jan (0 webs) - 01 Feb: 56 webs	BR
16-Feb-03	1960 m	15 + 16 Feb: 0 webs cut	FB
14-Mar-03	2160 m	Good Rate of Advance	FB
21-May-03	2707 m	18 + 19 May (0 webs) - 21 May: 15 webs	BR

Roof Failures in Panel 2

Description of the roof failures in panel 2

10 September 2003

The reason for the roof failure that occurred on 10 September 2003 was that only 3 metres were cut on 06 and 07 September 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure which followed. From 01 June to 09 June, the face advanced 31 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

08 October 2003

The reason for the roof failure that occurred on 08 October 2003 was that no webs were cut on 05 October 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 05 October to 08 October, the face advanced 34 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

27 October 2003

The reason for the roof failure that occurred on 27 October 2003 was the poor rate of advance on 26 October 2003. The roof failure that occurred on 27 October 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 26 October to 27 October the face advanced 7 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

02 November 2003

The reason for the roof failure that occurred on 02 November 2003 was the poor rate of advance on 30 October 2003. The roof failure that occurred on 02 November 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 30 October to 02 November, the face advanced 23 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

07 November 2003

The roof failure that occurred on 07 November 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

09 November 2003

The roof failure that occurred on 09 November 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

15 November 2003

The roof failure that occurred on 15 November 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

17 November 2003

The reason for the roof failure that occurred on 17 November 2003 was the poor rate of advance on 16 November 2003. The roof failure that occurred on 17 November 2003 occurred in a slip zone which made the possibility of a roof failure that much greater. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 16 November to 17 November, the face advanced 7 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

06 December 2003

The reason for the roof failure that occurred on 06 December 2003 was the poor rate of advance on 03 December 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 03 December to 06 December, the face advanced 34 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

13 December 2003

The reason for the roof failure that occurred on 13 December 2003 was the poor rate of advance on 12 December 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 12 December to 13 December, the face advanced 10 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

14 December 2003

The reason for the roof failure that occurred on 14 December 2003 was the poor rate of advance on 12 December 2003. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 12 December to 14 December, the face advanced 11 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

12 January 2004

The reason for the roof failure that occurred on 12 January 2004 was the poor rate of advance on 05 January 2004. This poor rate of advance placed pressure on the

face, causing existing fractures to open up and the roof failure that followed. From 05 January to 12 January 2004, the face advanced 60 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

22 January 2004

The reason for the roof failure that occurred on 22 January 2004 was the poor rate of advance on 15 – 17 January 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 15 January to 22 January 2004, the face advanced 60 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (Figure 6). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

23 January 2004

The reason for the roof failure that occurred on 23 January 2004 was the poor rate of advance on 22 January 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 22 January to 23 January 2004, the face advanced 13 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due

to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

04 February 2004

The reason for the roof failure that occurred on 04 February 2004 was the poor rate of advance on 01 February 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure that followed. From 01 February to 04 February 2004, the face advanced 38 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

20 February 2004

The reason for the roof failure that occurred on 20 February 2004 was the poor rate of advance on 15 February 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 15 to 20 February 2004, the face advanced 53 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

01 March 2004

The reason for the roof failure that occurred on 01 March 2004 was the poor rate of advance on 29 February 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 29 February to 01 March 2004, the face advanced 8 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

04 March 2004

The reason for the roof failure that occurred on 04 March 2004 was the poor rate of advance on 29 February 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 29 February to 04 March 2004 the face advanced 24 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

07 March 2004

The reason for the roof failure that occurred on 07 March 2004 was the poor rate of advance on 29 February 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 29

February to 07 March 2004, the face advanced 60 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (Figure 6). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

Table 38: Details of the roof failures that occurred in Panel 2.

Panel 2			
Dates of the roof failure	Distances	Possible Reasons for the Face Breaks	Classification
10-Sep-03	166m	6 - 7 (3 webs) Sep - 9 Sep: 31 webs	BR
08-Oct-03	560m	5 Oct (0 webs) - 7 Oct: 34 webs	BR
27-Oct-03	903m	26 Oct (1.5 webs): 1.5 webs	BR
02-Nov-03	998m	30 Oct (2 webs) - 1 Nov (21 webs): 23 webs	BR
07-Nov-03	1074m	Good Rate of Advance	BR
09-Nov-03	1114m	Good Rate of Advance	FB
15-Nov-03	1248m	Good Rate of Advance	FB
17-Nov-03	1257m	16 Nov (1.5 Webs) + Face Break on 15 Nov: 1.5 webs	BR
06-Dec-03	1602m	3 Dec (4.5 webs) - 6 Dec: 34 webs	FB
13-Dec-03	1713m	12 Dec (5 webs) - 13 Dec: 10 webs	FB
14-Dec-03	1714m	12 Dec (5 webs) - 14 Dec: 10 webs	FB
12-Jan-04	2140m	05 Jan (0.3 webs) - 12 Jan: 60 Webs	FB
22-Jan-04	2254m	15 - 17 Jan (0 webs) -22 Jan: 60 webs	FB
23-Jan-04	2287m	Face Break on 22 Jan	FB
04-Feb-04	2473m	1 Feb (0 webs) - 04 webs: 38 webs	FB
20-Feb-04	2633m	15 Feb (0 webs) - 20 Feb: 53 webs	FB
01-Mrt-04	2754m	29 Feb (0 webs) - 1 March: 8 webs	BR
04-Mrt-04	2786m	29 Feb (0 webs) - 4 March: 24 webs	BR
07-Mrt-04	2828m	29 Feb (0 webs) - 7 March: 60 webs	BR

Roof Failures in Panel 3

Description of the roof failures in panel 3

09 May 2004

The reason for the roof failure that occurred on 09 May 2004 was the poor rate of advance on 04 May 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 04 to 09 May 2004, the face advanced 19 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

14 May 2004

The reason for the roof failure that occurred on 14 May 2004 was the poor rate of advance on 09 May 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 09 to 14 May 2004, the face advanced 52 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

21 May 2004

The reason for the roof failure that occurred on 21 May 2004 was the poor rate of advance on 16 May 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 16 to 21 May 2004, the face advanced 65 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

06 June 2004

The reason for the roof failure that occurred on 06 June 2004 was the poor rate of advance on 30 May 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 30 May to 06 June 2004, the face advanced 35 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

14 June 2004

The reason for the roof failure that occurred on 14 June 2004 was the poor rate of advance on 12 June 2004. This poor rate of advance placed pressure on the face,

causing existing fractures to open up and the roof failure to follow. From 12 to 14 June 2004, the face advanced 6 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

05 July 2004

The reason for the roof failure that occurred on 05 July 2004 was the poor rate of advance on 26 June 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 26 to 30 June 2004, the face advanced 49 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

10 July 2004

The reason for the roof failure that occurred on 10 July 2004 was the poor rate of advance on 05 July 2004. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 05 to 10 July 2004, the face advanced 65 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of

advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

11 July 2004

The reason for the roof failure that occurred on 11 July 2004 was the poor rate of advance on 09 and 10 July 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 09 to 11 July 2004, the face advanced 25 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

18 July 2004

The reason for the roof failure that occurred on 18 July 2004 was the poor rate of advance on 15 July 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 15 July to 12 July 2004, the face advanced 21 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

23 July 2004

The reason for the roof failure that occurred on 23 July 2004 was the poor rate of advance on 18 July 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 18 to 23 July 2004, the face advanced 65 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

10 August 2004

The reason for the roof failure that occurred on 10 August 2004 was the poor rate of advance on 05 August 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 05 to 10 August 2004, the face advanced 50 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

26 August 2004

The reason for the roof failure that occurred on 26 August 2004 was the poor rate of advance on 24 August 2004 due to roof failures. This poor rate of advance placed

pressure on the face, causing existing fractures to open up and the roof failure to follow. From 24 to 26 August 2004, the face advanced 34 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

09 September 2004

The reason for the roof failure that occurred on 09 September 2004 was the poor rate of advance on 05 September 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 05 to 09 September 2004, the face advanced 39 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

19 September 2004

The reason for the roof failure that occurred on 19 September 2004 was the poor rate of advance on 13 September 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 13 to 19 September 2004, the face advanced 40 metres which means that the roof failure occurred in the stress zone described by Nielen

van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

23 September 2004

The reason for the roof failure that occurred on 23 September 2004 was the poor rate of advance on 19 September 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 19 to 23 September 2004, the face advanced 13 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

05 October 2004

The reason for the roof failure that occurred on 05 October 2004 was the poor rate of advance on 02 October 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 02 to 05 October 2004, the face advanced 31 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

06 October 2004

The reason for the roof failure that occurred on 06 October 2004 was the poor rate of advance on 02 October 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 02 to 06 October 2004, the face advanced 38 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the average rate of advance on the day, this roof failure will be classified as unstable roof conditions and will not be used in the final rating system.

18 October 2004

The reason for the roof failure that occurred on 18 October 2004 was the poor rate of advance on 11 October 2004 due to roof failures. This poor rate of advance placed pressure on the face, causing existing fractures to open up and the roof failure to follow. From 11 to 18 October 2004, the face advanced 6 metres which means that the roof failure occurred in the stress zone described by Nielen van der Merwe (2002). Due to the poor rate of advance on the day, this roof failure will be classified as a face break and will be used in the final rating system.

Table 39: Details of the roof failures that occurred in Panel.

Panel 3			
Dates of the roof failure	Distances	Possible Reasons for the Face Breaks	Classification
09-May-04	112m	4 May (0 webs) - 09 May: 19 webs	FB
14-May-04	173m	9 May (0 webs) - 14 May: 52 webs	FB
21-May-04	258m	16 May (0 webs) - 21 May: 65 webs	BR
06-Jun-04	423m	30 May (0 webs) - 06 June: 35 webs	FB
14-Jun-04	500m	12 June (1 web) - 14 June: 6 webs	FB
05-Jul-04	730m	Good Rate of Advance	FB
10-Jul-04	810m	Good Rate of Advance	FB
11-Jul-04	815m	Face Break on 10 July	FB
18-Jul-04	870m	15 July (0 webs) - 18 July: 21 webs	FB
23-Jul-04	950m	19 July (0 webs) - 23 July: 65 webs	FB
10-Aug-04	1197m	5 Aug (0 webs) - 10 Aug: 50 webs	FB
26-Aug-04	1374m	24 Aug (0 webs) - 26 Aug: 34 webs	FB
09-Sep-04	1432m	05 Sep (0 webs) - 09 Sep: 39 webs	FB
19-Sep-04	1486m	13 Sep (0 webs) - 19 Sep: 40 webs	FB
23-Sep-04	1501m	19 Sep (0 webs) - 23 Sep: 13 webs	FB
05-Oct-04	1560m	02 Oct (0 webs) - 05 Oct: 31 webs	BR
06-Oct-04	1566m	02 Oct (0 webs) - 06 Oct: 38 webs	BR
18-Oct-04	1623m	11 Oct (0 webs) - 18 Oct: 6 webs	FB

Locality Description for Panel 1, 2 and 3

Table 40: Description of the areas between the boreholes in the first panel.

Locality Description for the First Panel				
Locality	Total thickness of Interburden	Percentage Sandstone in Interburden	Percentage Shale in Interburden	Thickness of sandstone beam
R062125–R062120	17,81m	90	10	15,85m
R062120–R062124	18,22m	90	10	16,20m
R062124–R062119	16,72	89	11	14,52m
R062119–R062123	17,23	85	15	13,43m
R062123–R062118	16,04	85	15	14,47m
R062118–R062117	12,95	80	20	10,30m
R062117–R062121	13,42	79	21	10,21m
R062121–R062116	16,31	83	17	13,26m
R062116–R062115	15,95	78	22	12,23m
R062115–R062114	22,34	88	12	19,24m
R062114–R062113	25,6	82	18	20,40m
R062113–R062112	24,05	78	22	18,29m
R062112–EOP	27,05	83	17	21,96m

Table 41: Description of the areas between the boreholes in the second panel.

Locality Description of the Second Panel				
Locality	Total thickness of Interburden	Percentage Sandstone in Interburden	Percentage Shale in Interburden	Thickness of sandstone beam
R062125–R062123	17,81m	90	10	15,85m
R062123–R062122	16,04m	85	15	13,45m
R062122–R062126	24,65m	88	12	21,65m
R062126–R062121	21,88m	88	12	19,03m
R062121–R062054	16,31m	83	17	13,26m
R062054–R062109	16,61m	82	18	13,36m
R062109–R062049	21,86m	88	12	18,93m
R062049–R062110	21,55m	92	8	19,50m
R062110–R062111	21,30m	88	12	18,34m
R062111 - EOP	27,14m	80	20	21,25m

Table 42: Description of the areas between the boreholes in the third panel.

Locality Description of the Third Panel				
Locality	Total thickness of Interburden	Percentage Sandstone in Interburden	Percentage Shale in Interburden	Thickness of sandstone beam
R062125–R062123	17,81m	90	10	15,85m
R062123–R062122	16,04m	85	15	13,45m
R062122–R062126	24,65m	88	12	21,65m
R062126–R062121	21,88m	88	12	19,03m
R062121–R062054	16,31m	83	17	13,26m
R062054–R062109	16,61m	82	18	13,36m
R062109–R062049	21,86m	88	12	18,93m
R062049–R062110	21,55m	92	8	19,50m
R062110–R062111	21,30m	88	12	18,34m
R062111 - EOP	27,14m	80	20	21,25m

Locality Description for Panel 1, 2 and 3

Table 43: Ratings of the areas between boreholes based on the lithological units present in these areas.

Locality rating for the first panel					
Locality	Percentage Sandstone in Interburden	Sandstone Beam Thickness	From	To	Total Rating
R062125–R062120	0.5	0.5	0	220	1
R062120–R062124	0.5	0.3	220	380	0.8
R062124–R062119	0.3	0.5	380	600	0.8
R062119–R062123	0.5	0.5	600	670	1
R062123–R062118	0.5	0.5	670	830	1
R062118–R062117	0.3	0.5	830	1125	0.8
R062117–R062121	0.3	0.5	1125	1270	0.8
R062121–R062116	0.5	0.5	1270	1430	1
R062116–R062115	0.3	0.5	1430	1650	0.8
R062115–R062114	0.5	0.3	1650	2290	0.8
R062114–R062113	0.5	0.3	2290	2675	0.8
R062113–R062112	0.3	0.3	2675	2980	0.6
R062112–EOP	0.5	0.3	2980	3200	0.8

Table 44: Ratings of the areas between boreholes based on the lithological units present in these areas.

Locality rating for the Second panel					
Locality	Percentage Sandstone in Interburden	Sandstone Beam Thickness	From	To	Total Rating
R062125–R062123	0.5	0.5	0	660	1
R062123–R062122	0.5	0.5	660	850	1
R062122–R062126	0.5	0.3	850	1100	0.8
R062126–R062121	0.5	0.3	1100	1250	0.8
R062121–R062054	0.5	0.5	1250	1600	1
R062054–R062109	0.5	0.5	1600	2160	1
R062109–R062049	0.5	0.3	2160	2330	0.8
R062049–R062110	0.5	0.3	2330	2500	0.8
R062110–R062111	0.5	0.3	2500	2900	0.8
R062111 - EOP	0.3	0.3	2900	3200	0.6

Table 45: Ratings of the areas between boreholes based on the lithological units present in these areas.

Locality rating for the Third panel					
Locality	Percentage Sandstone in Interburden	Sandstone Beam Thickness	From	To	Total Rating
R062125–R062123	0.5	0.5	0	660	1
R062123–R062122	0.5	0.5	660	850	1
R062122–R062126	0.5	0.3	850	1100	0.8
R062126–R062121	0.5	0.3	1100	1250	0.8
R062121–R062054	0.5	0.5	1250	1600	1
R062054–R062109	0.5	0.5	1600	2160	1
R062109–R062049	0.5	0.3	2160	2330	0.8
R062049–R062110	0.5	0.3	2330	2500	0.8
R062110–R062111	0.5	0.3	2500	2900	0.8
R062111 - EOP	0.3	0.3	2900	3200	0.6

Rating of the areas in Panel 1, 2 and 3

Table 46: Ratings of the areas in the first panel.

Rating for the First Panel						
From	To	Floor Roll	Locality rating	Total Rating	No RF	FB
0	50	1	1	2	0	0
50	100	1	1	2	0	0
100	200	0	1	1	0	0
200	220	0	1	1	0	0
220	300	1	0.8	1.8	0	0
300	380	1	0.8	1.8	1	1
380	400	1	0.8	1.8	1	0
400	500	1	0.8	1.8	2	0
500	600	1	0.8	1.8	0	0
600	670	1	1	2	0	0
670	700	1	1	2	0	0
700	800	1	1	2	2	0
800	830	0	1	1	0	0
830	900	0	0.8	0.8	0	0
900	1050	1	0.8	1.8	1	1
1050	1125	1	0.8	1.8	0	0
1125	1150	1	0.8	1.8	0	0
1150	1270	1	0.8	1.8	0	0
1270	1400	1	1	2	2	2
1400	1430	1	1	2	0	0
1430	1650	1	0.8	1.8	1	1
1650	1730	1	0.8	1.8	1	0
1730	1830	1	0.8	1.8	1	0
1830	2000	1	0.8	1.8	1	1
2000	2130	1	0.8	1.8	0	0
2130	2210	1	0.8	1.8	1	1
2210	2290	1	0.8	1.8	0	0
2290	2300	1	0.8	1.8	0	0
2300	2350	1	0.8	1.8	0	0
2350	2660	1	0.8	1.8	0	0
2660	2675	1	0.8	1.8	0	0
2675	2800	1	0.6	1.6	1	0
2800	2980	1	0.6	1.6	0	0
2980	3200	0	0.8	0.8	0	0

Table 47: Ratings of the areas in the second panel.

Rating for the Second Panel						
From	To	Floor Roll	Locality rating	Total Rating	No RF	FB
0	200	1	1	2	1	
200	500	1	1	2		
500	600	0	1	1	1	
600	660	0	1	1		
660	700	0	1	1		
700	750	0	1	1		
750	800	0	1	1		
800	850	1	1	2		
850	900	1	0.8	1.8		
900	1050	1	0.8	1.8	2	
1050	1100	0	0.8	0.8		
1100	1150	0	0.8	0.8	1	1
1150	1250	1	0.8	1.8	1	1
1250	1400	1	1	2	1	
1400	1600	1	1	2		
1600	1650	1	1	2	1	1
1650	1730	1	1	2	2	2
1730	1780	1	1	2		
1780	1830	1	1	2		
1830	2100	1	1	2		
2100	2130	1	1	2		
2130	2160	1	1	2	1	1
2160	2330	1	0.8	1.8	2	2
2330	2350	0	0.8	0.8		
2350	2500	0	0.8	0.8	1	1
2500	2700	1	0.8	1.8	1	1
2700	2900	0	0.8	0.8	3	
2900	3200	0	0.6	0.6		

Table 48: Ratings of the areas in the third panel.

Rating for the Third Panel						
From	To	Floor Roll	Locality rating	Total Rating	No RF	FB
0	300	0	1	1	3	2
300	500	1	1	2	1	1
500	660	1	1	2	1	
660	700	1	1	2	0	
700	750	1	1	2	1	1
750	850	1	1	2	2	2
850	900	1	0.8	1.8	1	1
900	1100	1	0.8	1.8	1	1
1100	1150	0	0.8	0.8		
1150	1200	0	0.8	0.8	1	1
1200	1250	0	0.8	0.8		
1250	1400	1	1	2	1	1
1400	1600	1	1	2	5	3
1600	1650	1	1	2	1	1
1650	1670	0	1	1		
1670	1730	0	1	1		
1730	1830	0	1	1		
1830	1930	0	1	1		
1930	2000	0	1	1		
2000	2130	1	1	2		
2130	2160	1	1	2		
2160	2330	1	0.8	1.8		
2330	2350	1	0.8	1.8		
2350	2500	1	0.8	1.8		
2500	2630	1	0.8	1.8		
2630	2900	0	0.8	0.8		
2900	3200	0	0.6	0.6		

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