

CHAPTER 6

6 SUMMARY AND CONCLUSIONS

6.1 INTRODUCTION

All four objectives of this thesis listed on page six, have been achieved. What follows in this chapter is a summary of the main results.

The investigation focussed on the coal-bearing sedimentary rocks of the Vryheid Formation, situated at the New Denmark Colliery in the Highveld Coalfield of the Karoo Basin. Lithologies were subdivided into facies that were then used to interpret environments of deposition for the various units.

The basic data for this study was obtained from 900 borehole logs, field visits and mine maps. The selected data were used to formulate a three-dimensional stratigraphic framework for the analysis of spatial relationships existing between lithotypes. These data are relatively fundamental and provided basic descriptions of all the lithologies and sedimentary criteria needed for the sedimentological analysis. Once the facies had been defined, facies assemblages were then interpreted to formulate palaeoenvironmental settings. These were then related to different roof conditions that exist above the main mineable No. 4 coal seam.

6.2 STRATIGRAPHY

The No. 4 seam genetic sequence consists of the strata between the No. 2 coal seam, to the roof of the No. 4 coal seam or possible equivalent seam split. Above the No. 4 coal seam is conglomerate, cross-bedded sandstone and siltstone. The glauconitic sandstone and siltstone are particularly valuable as a regional marker horizon, which terminates the No. 4 coal seam depositional sequence.

The No. 5 seam genetic sequence represents strata above the No. 4 or No. 4 A seam and above. This sequence displays an overall coarsening-upward sedimentary interval although fining-upward sandstones are also present. The No. 5 coal seam is thin and laterally persistent towards the east of the study area. A glauconitic sandstone and siltstone bearing sediment represent a marine transgressive event above the No. 5 seam.

6.3 FACIES DESCRIPTION AND INTERPRETATION

Individual sedimentary facies were identified and have been interpreted hydrodynamically. These range from conglomerate, sandstone to siltstone facies types, and coal. Several sub-facies were defined within all of the major facies groups.

The Dwyka Group is primarily represented by the diamictite facies, which contains extrabasinal clasts that are diverse in shape and size. The Vryheid Formation contains coarse-grained facies comprising massive, matrix-supported conglomerate and a very coarse to fine-grained sandstone facies. The coarse nature of these facies is associated with deposition under high-energy conditions, relatively close to the basin margin. The finer grained facies

are carbonaceous mudstones and siltstones deposited under passive conditions. The economic coal facies formed in continental fluvio-deltaic peat swamps.

6.4 PALAEOENVIRONMENTAL INTERPRETATION

Four depositional systems in the study area have been interpreted: glacial, fluvial, deltaic and transgressive shallow-marine deposits. This interpretation was based on the stratigraphy, three-dimensional maps and sections, lithology and vertical and lateral facies assemblages. Therefore, it was possible to produce an overall depositional model, to explain the origin of the coal-bearing succession, and its relationship to the strata above the coal seam, and the associated rock units throughout the region. From the available data, this model enabled the characterization of the No. 4 coal seam, and its relationship to the surrounding strata. This depositional modelling has enabled a better understanding of the coal deposits.

The glacial diamictite sub-facies is associated with the depositional sequence below the No. 2 seam, and was deposited during the retreat of the Permo-Carboniferous ice sheet. Fluvial deposits occur at different stratigraphic levels, namely associated with No. 2 and No. 4 seam depositional sequences. These deposits are associated with planar cross-bedded sandstone sub-facies, conglomerates facies and sandstone. Fluvial system deposits form partings between the No. 4 seam and No. 4 A in the western part of the study area. These linear channel deposits are erosively based and fine-upward from a cross-bedded gravel unit, through cross-bedded and cross-laminated sandstone to siltstone at the top. In the interchannel areas, deposits are a fine-grained facies, such as siltstone overlain by cross-laminated sandstone as a part of crevasse-splay deposits. These crevasse-splay deposits were deposited in backswamp environments during periodic flooding.

High-constructive, lobate deltaic deposits represent the sediments between the No. 2 and No. 3 seams and between the No. 4 and No. 5 seams. Delta facies are interpreted as typically coarsening-upward, from siltstone at the base to sandstone at the top. Intense bioturbation is almost absent in the sequence between No. 4 and 5 seams and these are typically low-energy distal-bar type deposits.

Transgressive shallow-marine deposits constitute the deposits above the No. 4 A and 5 seam depositional sequences. This transgression took place during a change from a continental peat swamp environment to shallow marine sedimentation. The transition from a continental to a marine environment is evidenced by the transgressive glauconite-rich facies, which is an important stratigraphic marker, above the No. 4 A and No. 5 seams. These deposits comprise fining-upward, coarsening-upward and well-sorted sandstone facies.



6.5 GEOLOGICAL FACTORS AFFECTING No. 4 COAL SEAM ROOF CONDITIONS

One of the the primary objectives of this research was to identify depositional features of roof rocks above No. 4 coal seam, that contribute to unstable roof conditions, and to establish directional trends of these rocks, so that the problem areas could be anticipated in advance of mining. The rocks associated with the roof of the No. 4 coal seam vary from conglomerate, through coarse sandstone to siltstone. Some are well-bedded and laminated, some are weakly bedded and some facies are massive. Irrespective of the original state of the facies, some of these beds are altered in form, strength, tenacity and structure, by post-depositional forces such as compaction. Furthermore, post-depositional channeling has removed sections of the stratigraphy above No. 4 coal seam (Figure 5.13).

No. 4 seam roof strata were described and interpreted using borehole logs, borehole core, cross-sections and isopach maps. The study defined specific rock facies types, facies sequences, sedimentary structures and characteristics that correlated directly with roof quality and certain roof attributes. Results of this investigation confirm that several sedimentological factors interact producing a variety of roof conditions, which exert a strong influence on the potential productivity of mining operations. Based on historic mine data of roof types, the presence of rider coals periodically interrupted mine productivity. When rider coals coincide with alternating transitional facies types in the hanging wall, then the most severe and dangerous roof conditions are encountered. Such conditions exist where palaeochannel margin sandstone interfingers with flood plain and backswamp argillites. These factors can be identified in advance of mining through proper geological analysis, and can be mapped and delineated to afford a predictive model for use in mine planning. The major benefits of this approach include increased capability to identify and respond to areas of difficult ground control conditions; to optimize mine design and ground control strategies depending on geological conditions; to estimate the suitability of in-use face equipment for future working conditions at the mine; and to demonstrate rational use of the equipment.

This study identified three depositional roof types, which were found to result in unstable roof conditions:

- Palaeochannel deposits, which can cause conditions that create roof instability. Mining hazards associated with palaeochannels are slickensided roof, micro-fractures, mudstone slips, coal splitting, distorted and deformed bedding and slump deposits.
- Crevasse-splay deposits of thinly interbedded sandstone, siltstone and mudstone. Detachment along bedding planes of these varying facies cause roof collapse.

- Swamp and flood basin deposits are sites of peat accumulation, forming rider coals and fissile bedded mudrock (shale) also cause problems. Bioturbation in fine grained flood plain deposits further reduce the strength of roof rocks.

Roof falls provide critical data that can be used to document roof changes and roof weaknesses. When falls are documented in this manner, they can be compared against case studies of roof falls in the literature, so that solutions to specific problems can be found. If fall types are categorized and mapped separately, then specific roof fall trends can be determined and appropriate changes in mine design and roof support plan can be made in advance of mining.

