CHAPTER 1

INTRODUCTION

1.1 PROBLEM STATEMENT AND OBJECTIVE

In the Southern Coalfield of New South Wales there is particular concern about subsidence impacts on incised river valleys – valley closure (the two sides of the valley moving horizontally towards the valley centreline), upsidence (upward movement of the valley floor), and the resulting localised loss of surface water under low flow conditions (Figure 1.1 and Figure 1.2). The resulting visual effects of subsidence impacts on river valleys can be quite dramatic with visible presence of water loss, and cracking and buckling of river beds and rock bars. Most of the reported cases have occurred when the river valley is directly undermined but there are a number of cases where valley closure and upsidence have been reported above old mined longwall panels and unmined coal. These latter events are especially significant as they influence decisions regarding stand-off distances and hence mine layouts and reserve recovery.

To date, the explanations offered for these valley closure and upsidence events above unmined coal and old longwall panels involved an increase of undefined horizontal compressive stresses, en masse rock movements and movement along discontinuities. There has been no published study which verifies any of these proposed mechanisms.

The horizontal compressive stress model of Waddington and Kay (2002) can be considered valid when a river valley is situated in the sagging portion of the subsidence profile, as horizontal compressive stress conditions are anticipated when the ground surface deforms in the sagging mode due to the horizontal shortening of the ground surface over the longwall panel. In other portions of the subsidence profile the dominant horizontal stress change is tensile and when the valley is not located above the longwall panel, the traditional horizontal stress redistribution model appears inappropriate.

Fig. 1.1 – Water level reduction in river valley affected by longwall mining

Fig. 1.2 – Unsightly cracking of rock bars in river valley affected by longwall mining

For this thesis, two alternative explanations were considered.

The first alternative explanation for valley closure and upsidence in the tensile portion of the subsidence profile (the hogging phase) includes a redistribution of compressive stresses in the horizontal plane. In this case, compressive stress increases above unmined coal and decreases above mined panels provided that the stress concentrations for valleys are aligned radial to the goaf. This does not explain the valley closure and upsidence events observed above old longwall panels, and will not be pursued further.

The second alternative involves block movements. It is proposed that the horizontal shortening of the ground surface in the sagging phase results in blocks of rock being pushed up the side of the subsidence bowl and into the free face provided by the valley, resulting in valley closure and possible upsidence over unmined coal. This alternative could also explain why valley closure and upsidence occur over old longwall panels as well.

The objective of this thesis is to investigate with numerical modelling whether the block movement proposal is feasible, and if so, provide a credible alternative explanation to the currently used horizontal compressive stress theory.

1.2 METHODOLOGY

There were seven distinct phases in this project:

- The first phase (Chapter 2) involved a review of subsidence theory with particular reference to the Southern Coalfield.
- The second phase (Chapter 3) reviewed valley closure, upsidence and the associated empirical prediction technique. The shortcomings of the currently used model were identified and a new theory of block movements was introduced.
- The third phase (Chapter 4) established the principles of developing a numerical modelling approach. A review of modelling papers related to mining subsidence was also conducted to assist in the selection of the numerical modelling code.
- The fourth phase (Chapter 5) was centred on developing a full scale UDEC subsidence model for isolated single longwall panels that was able to be verified

with empirical data. An audit was conducted on the models (Appendix A) and an example of the modelling code is contained in Appendix B.

- The fifth stage (Chapter 6) involved using the key characteristics from the full scale subsidence models and the creation of a simplified set of models that simulated river valley response with respect to river valley position compared to longwall position. The results from the river valley models were compared to the empirical predictions and kinematic concepts detailed in Chapter 3. A parametric study on the joint properties was also performed. Examples of the code are contained in Appendix C and Appendix D.
- The sixth stage (Chapter 7) applied the voussoir beam analogue and a plate buckling solution to test the numerical models against analytical solutions. The voussoir beam theory is contained in Appendix E.
- The seventh and final stage (Chapter 8) of the project saw the formulation of a summary and conclusion.

1.3 OUTCOMES AND POTENTIAL APPLICATIONS

The expected outcomes of this project are:

- A subsidence prediction tool for isolated longwall panels in flat terrain,
- A greater understanding of the mechanisms behind mining induced subsidence in the Southern Coalfield,
- A feasible explanation for valley closure based on numerical modelling, and
- The confirmation that valley closure and the onset of valley base yield can be assessed with analytical solutions.