Bear Valley Structural Analysis

Abstract

Measurements of bedding, joint, fault and slickenside attitudes were made at the Bear Valley Strip Mine south of Shamokin, PA. A basic geology history of the region was derived, along with a description of the structural geometry through a combination of direct observation and stereonet analysis.

Introduction

The Bear Valley Strip Mine lies in the Valley and Ridge province of the Appalachian foreland fold and thrust belt. The bedding consists primarily of Pennsylvanian shales and sandstones and is rich in anthracite coal. The strip mine is an excellent exposure of third order folds, which also display other features like joints and faults. One aim of this study is to characterize the geometry of the region. Additionally, a brief structural history is outlined based on observation and stereonet analysis.

Fig. 1: Bear Valley Strip Mine (photo courtesy of Eric Portenga)

Methods

Field measurements were made using a Brunton compass and an air photo. We focused on attitude measurements of bedding, fault planes, slickensides and joints. These measurements were then plotted and analyzed on an equal area stereonet using Rich Allmendinger's Stereonet program.

Fold Geometry

There are two main anticline-syncline pairs in the Bear Valley Strip Mine. We used the bedding attitude of the fold limbs to determine the plunge and trend of their fold axes.

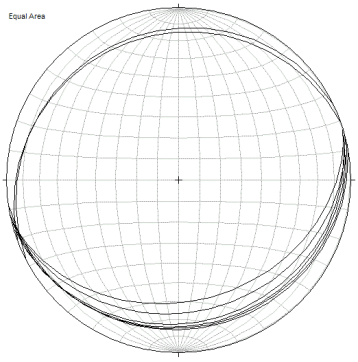


Fig. 2: North Anticline bedding surfaces

Based on stereonet analysis, the North Anticline appears to be a symmetric fold with a fold axis trending 254^{o} and plunging 2^{o}. The fold axis of the North Syncline also trends 254^{o} and plunges 2^{o}. However, the southern wall of the North Syncline dips at a much greater angle than the northern side, indicating an asymmetric fold with vergence to the south.

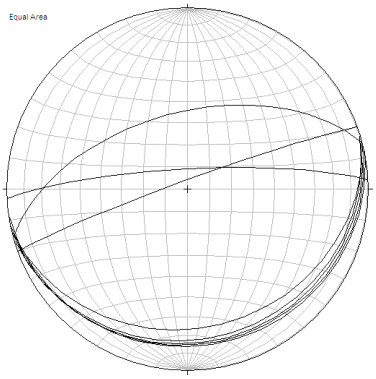


Fig. 3: North Syncline bedding surfaces

The Whaleback Anticline trends 252^{o} and plunges 15^{o}. The difference in dip with respect to the North Anticline is attributed to the locations of measurements made on the fold. Most of the North Anticline attitudes were taken near the crest of the fold, whereas many of the Whaleback bedding attitudes were measured far down the limbs of the fold.

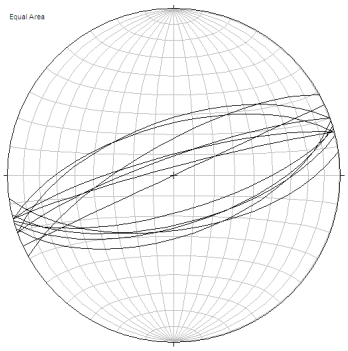


Fig. 4: Whaleback Anticline bedding surfaces

The North facing limb of the Whaleback is steeper than the southern side, indicating a top to the North vergence. The syncline south of the Whaleback also shows bottom to the South vergence and has a fold axis of attitude 248°, 13°.

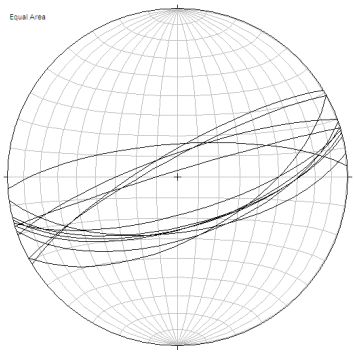


Fig. 5: Whaleback Syncline bedding surfaces

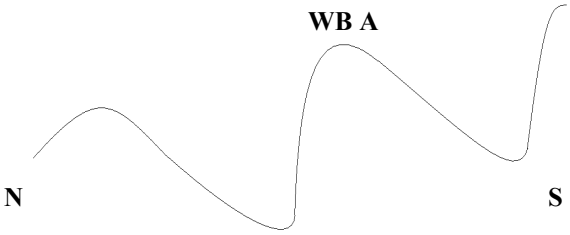


Fig. 6: Schematic N-S cross section showing top to the north vergence on the Whaleback anticline (WB A).

Joint Orientations

By measuring the attitudes of joints and the attitudes of folds we can "unfold" the bedding to return the joints to their original orientation.

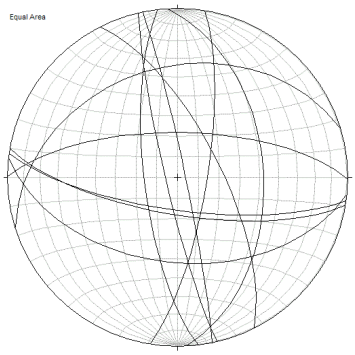


Fig. 7: Joint orientations after unfolding of bedding

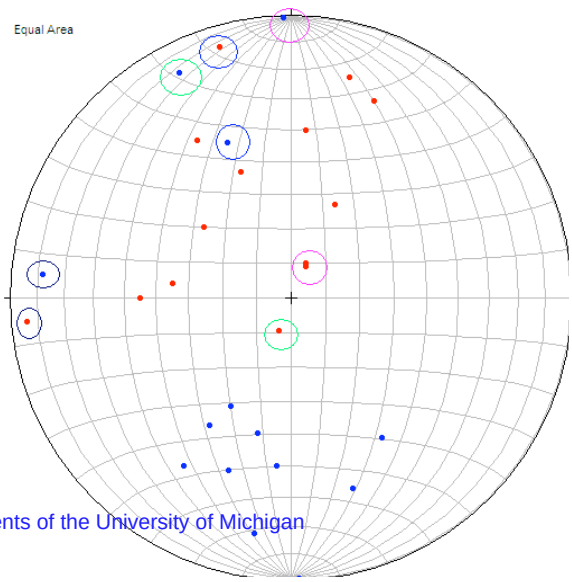
After rotating the joints back to horizontal many of their orientations match up well with the regional joint sets, as shown below. This indicates that the joints occurred before the strata were folded.

Table 1: Comparison of measured joint strikes to regional joints from Nickelsen and Hough

Measured Joint Strike (°)	Regional Joint Strike (°)
99.6	103
357.3	347
351.7	347
283.5	283
178.9	184
272.1	283
98.0	103
261.5	283
308.0	301

Slickenside Orientations

Similar to the joints, the slickenside



orientations can be rotated back to horizontal by unfolding the bedding. If the rotated slickenside points are clustered on the stereonet, then faulting occurred before folding. On the other hand, faulting occurred post-folding if the rotated slickensides are spread out over the stereonet.

The slickensides measured at the Bear Valley Strip Mine show that faulting may have occurred both before and after the folding event. The cluster of rotated slickensides in the lower half of the stereonet may represent pre-folding compressional faults.

The circled points on the plot mark the extensional faults observed on the surface of the Whaleback Anticline. These faults most likely occurred after or during the folding, and could be the result of buckling as the beds were folded.

Conclusions

A brief geologic history of the area can be drawn from this analysis. The regional jointing most likely formed first, possibly followed by compressional faulting as the Alleghanian orogeny began. The beds were then folded into a widespread set of synclinorium. This resulted in extensional faulting along the outer surfaces of folds. This hypothesis could be confirmed by going back to the field site and making more measurements of slickensides and joints. We could also look for other exposures of folds in area to characterize their geometry and geologic history.

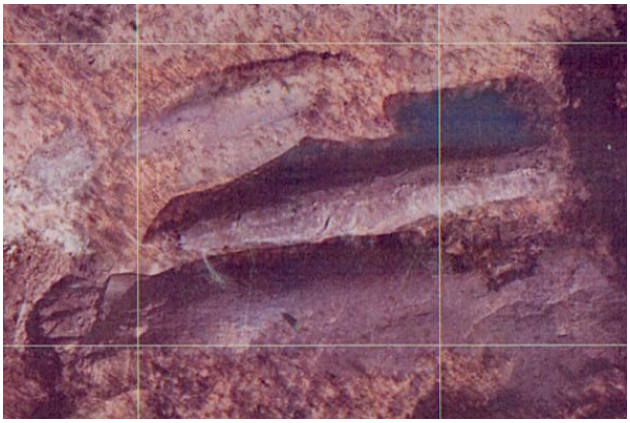


Fig. 8: Stereonet of slickensides. Red points are unrotated, blue lines are rotated. Circled points correspond to extensional faults observed in the field.

Fig. 9: Air photo of Bear Valley Strip Mine