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Luc Daigle

SCT Operations

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MAPPING TECHNIQUES FOR DETERMINING SANDSTONE ROOF CHANNEL PALEODRAINAGE DIRECTION IN COAL MINES

Luc Daigle

ABSTRACT: Sandstone channels are constant hazards to coal mining operations, the presence of a channel over a seam can result in thinning of the seam, changes in stress orientations, variation in stress intensity, abrasive cutting, roof hangup, faulting, jointing, loading of the face and even wind blasts. Prediction of the trend of a channel is usually difficult as channels tend to meander and follow complex orientations. However, geological mapping of development roadways can provide very good information on where to expect channels.

Mapping paleodrainage indicators at Yancoals' Ashton Coal Mine in the Hunter valley demonstrates channel trends can be projected through analysis of these indicators. Recognising and recording oriented indicators on hazard plans can assist in forewarning where channels may be anticipated. The experience at the Ashton Coal Mine shows how recording these features provide a means of predicting channel trends. Drainage pattern interpretation of the sandstone channels was possible due to excellent exposure of coarse grain channel sediment, levee, and overbank facies deposition. Comparison of the plotted drainage trends with paleodrainage direction indicated by oriented plant debris demonstrates direct correlation, using paleodrainage indicators in the absence of an exposure of the channel base can be used to predict the trend of the channel at a specific location.

INTRODUCTION

Coal seams are the fossil remains of peat deposits formed through the thick accumulation of plant debris in very low energy sedimentary conditions. These former swamps and forests can be compared to modern analogies that are used as models for understanding the distribution and formation of coal seams and their associated sedimentary deposits forming their stone roof and floor. The enclosing sediments forming these roof and floors are critical to mining and the anticipated conditions. Each seam represents a unique depositional event; the pattern of sedimentation and type of sediment present is completely dependent on the conditions that existed at the time the deposits were formed.

Increased sediment load and higher energy deposition characterises the formation of sandstone channels and associated levee and overbank deposits of silt and clay. Geological mapping of the roadways excavated into coal seams can provide detail on these enclosing sediments if the roadways expose the coal seam roof. It is possible to predict sediment trends through mapping the contact changes and analysis of recorded trend indicators whenever possible. Trend indicators at this locality consisted of oriented plant debris present as imprints in the roadway roof and also the orientation of channel edges. Comparison of the mapped sediment distribution pattern to modern analogies provides a basis for interpreting the patterns observed. This paper will look at the mapping completed at the Ashton Coal Mine in the Hunter Valley of New South Wales. At this location the mine has developed and extracted the Pikes Gully Seam and is now moving into a deeper seam to continue mining, this paper examines the data collected from the Pikes Gully Seam. Both geological trends of channel sandstone sediments and analysis of paleodrainage trend indicators were compiled to determine the paleodrainage. Paleodrainage can be described as the drainage distribution channels existing at the time of deposition of the coal seams and their enclosing roof and floor sediments.)

PALEODRAINAGE

Paleodrainage mapping is an important component of basin analysis and is carried out as part of sedimentary rock mapping of coal, oil and gas deposits. Modern channel systems are easily delineated by direct plotting of the recognised facies distribution, as can be viewed in aerial photos and satellite images, the examples used in this paper are images published by Google Earth, the modern Mississippi

River and delta (Figures 1, 2) provides a very good analogy for the distribution of sediment deposits found in many coal basins such as the Sydney Coal Basin and Hunter Valley deposited in the Permian geological period approximately 240 million years ago.

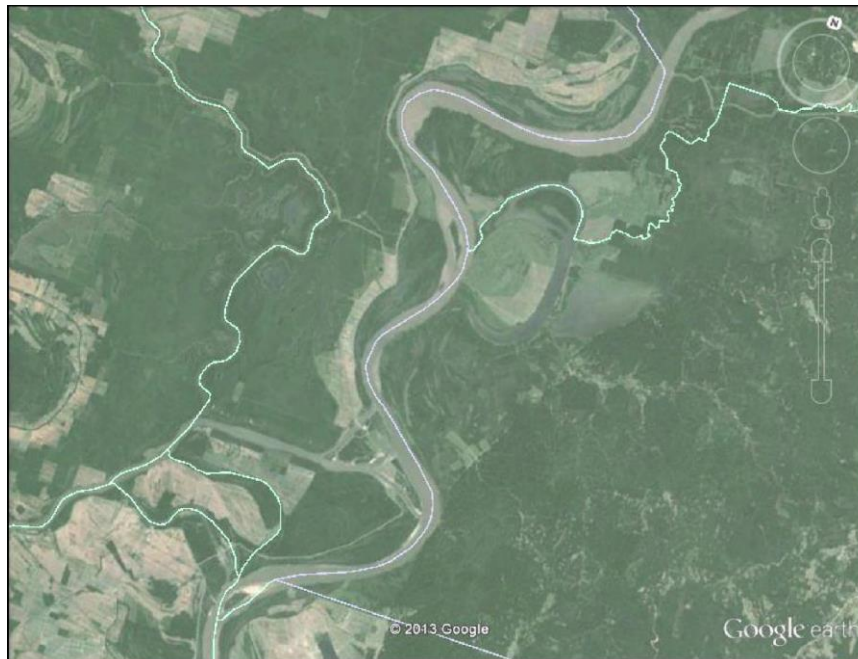


Figure 1 - Main channel, meandering river deposit of the Mississippi River basin

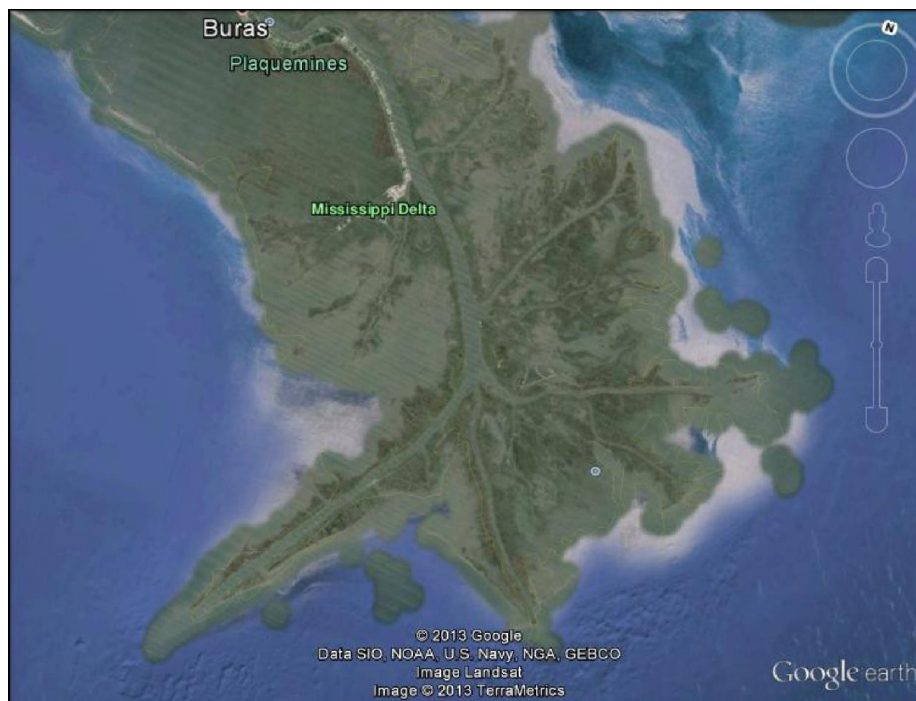


Figure 2 - Deltaic facies channel distribution in a delta Mississippi Delta

Coal forming peat swamps allowing the thick accumulations of organic matter necessary for coal seam formation was a recurring environment within the sedimentary basins of the Hunter Valley, The Ashton Coal Mine has numerous repetitive cycles of peat swamp separated by intervals of coarse sediment burial exhibiting the characteristics of meandering river channels, levees, overbank flood plain deposits of sediment and organic debris.

Channel sedimentation seen in the modern analogies demonstrate recognisable trends can be anticipated in the buried sediments of the coal basins. A main channel can be hundreds of metres across with well developed levee deposits and extensive overbank deposit, yet a flood breach (Crevasse splay) in the levee can result in deep cutting channel deposits at right angles to the true sedimentary drainage direction only tens of metres wide (Figure 3).



Figure 3 - Detail of levee and overbank distribution

Recognition of the sediment deposit types in underground mapping requires piecing together the limited exposures of the depositional facies mapped along the extensive network of roadways developed to extract the coal. Subtle indicators are exposed in the roadways which can be recognised and documented as part of the geological mapping conducted along the roadways. In surface geological mapping of sedimentary basins, the most frequently recognised indicators of flow direction include:

- Ripple marks.
- Cross beds.
- Oriented plant debris.
- Parting lineation.
- Channel edges.
- Scours and flutes.
- Imbricated clasts.
- Mapped extent of channel deposits.

Where these features can be recognised in underground mapping, the observer must understand the depositional nature and geometry of these indicators to be able to successfully interpret the drainage trends. Analysis of these data provides a means to recognise the ancient sediment deposition pattern.

MAPPING

This paper looks at geological mapping methods that can be utilised to determine distribution of sandstone channels in the roof strata through direct observation and recording of paleodrainage indicators.

Distribution of sediment channels can prove relatively easy to identify where sufficient exposures of the channel base is exposed in the underground workings or where sufficient drilling from the surface and underground can provide information. Where direct exposure of sediment channels may not be found, additional indicators of the presence of a channel include recognition of paleodrainage direction, distribution of depositional facies, changes in stress direction and intensity, flexure of the seam and other clues such as an increase in water dripping can be noted. The thickness and extent of an individual channel determines how great an impact it may have on mining, this also determines how easily the channel system may be mapped and projected.

Table 1 - Oriented Plant Debris (Tree trunks/Logs) (Measured from grid north) Longwall 2

Azimuth	Azimuth	Azimuth	Azimuth
047	157	142	152
032	045	043	052
163	152	164	121
157	052	153	158
145	022	149	057
138	070		

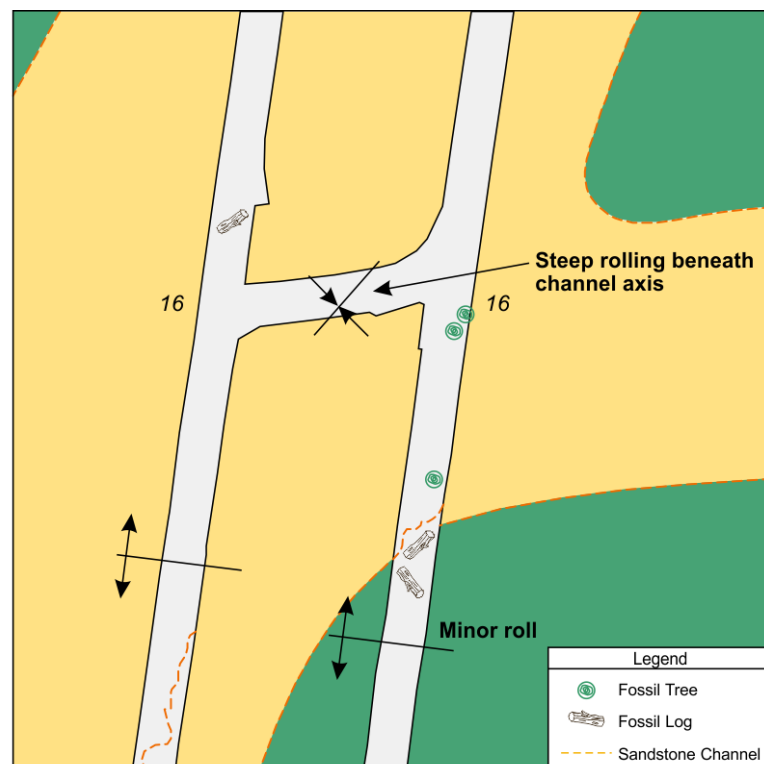


Figure 4 - Typical roadway mapping detail from Ashton Coal Mine

Most well developed channels are bounded by levee and overbank deposits. Levee deposits are often characterised underground by the abundance of fossil tree bases, root systems and hummocky layering within the deposit. The overbank deposits can exhibit a variety of sub facies, with drier overbanks having abundant siderite cement, siderite nodules, plant imprints and rootlets while wetter overbank deposits may have greater amounts of carbonaceous plant debris and oxbow filled deposits. Logs and any other long linear plant debris may be found as imprints in all these deposits, in nature plant debris with a long axis is found oriented either parallel to the direction of flow, or at right angles to the flow direction. These features are recorded directly as a mapped oriented feature on the mine plan, or as a compass azimuth reading. Statistical analysis of oriented plant debris is completed by plotting groups of recorded data in rosette diagrams for a specific location and thus represent the direction a channel trends through that area of observation.

At Ashton Coal Mine, since the mine opened to extract the Pike Gully Seam, geological mapping has been completed systematically. Geological detail mapped includes rock type, contact trends,

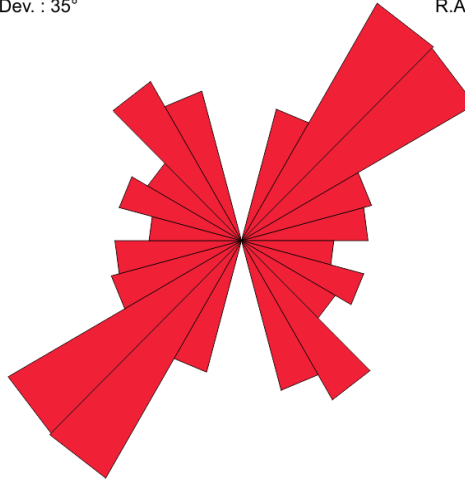
geotechnical condition, and features such as oriented plant debris, and tree stumps (Figure 4). Compilation of the data progressed as mining progressed and was provided to the mine for their running operations, mining is now nearly complete in this seam. Paleodrainage was progressively determined through the analysis of channel edge alignment and oriented plant debris which can be found throughout the workings particularly adjacent channels and mainly in the adjoining levee deposits. Analysis was accomplished by direct plotting the location and orientation of these features onto the mine geological plan (Figure 5). Oriented features can be located and read directly from the mine geological map as an azimuth reading (Table 1), an area of the workings can be selected and the associated data within that area plotted as a rosette graph (Figure 6). This creates a representation of drainage direction at that specific locality, complete analysis of the indicators mapped throughout the completed mapping of the Pike Gully Seam, results in a full analysis of drainage distribution that shows a very positive correlation between the mapped channel distribution and the paleodrainage indicated orientation of the channel (Figure 7).



Figure 5 - Distribution of mapped channel exposures and distribution of levee deposits in Ashton underground roadway development headings

Resultant : 112
Ang. Dev. : 35°

Area Scaling
R.A. Window : 20



Total Data : 13
Largest Freq : 12.64%

Figure 6 – Analysis of orientated plan debris forming a paleodrainage rosette

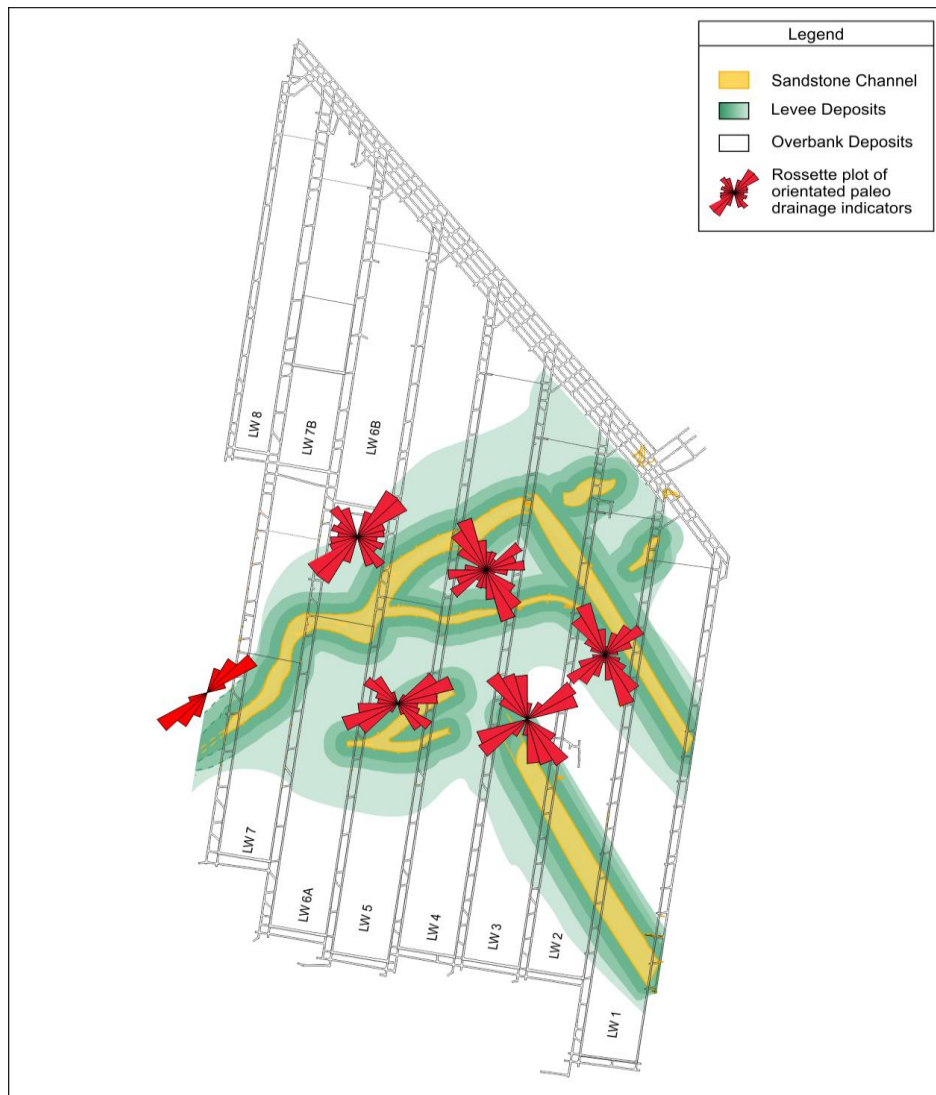


Figure 7 – Completed drainage analysis for the Pike Gulley Seam Ashton Coal Mine

A total of 74 oriented paleodrainage indicators were used to characterise the drainage at seven locations within the Pikes Gulley Seam at Ashton Coal Mine. These were identified in the gateroads within the interpreted levee deposits adjacent sandstone channel exposures.

From the analysis completed, rosette plots of oriented paleodrainge indicators usually show two distinct trends, typically oriented at approximately 90° to each other. The two oriented sets show there is a dominant trend and a lesser secondary trend. Comparison with the mapped distribution of the sandstone channel exposures, the dominant trends are found to correlate with the trend of the main channel while the lesser trends correlate to smaller channels which likely represent flood breaches (Crevasse splays) of the levee facies as seen in modern drainages (Figure 3).

CONCLUSIONS

Exposures of sandstone channel within Yancoals' Ashton Coal Mine, Pikes Gulley Seam development roads was sufficient to project the paleodrainage drainage distribution and permit comparison with the mapped oriented drainage direction indicators. Mapping sedimentary facies types and paleodrainage analysis of oriented plant debris defined the sediment deposition trends at Ashton Coal Mine. These are useful methods for projecting the location of sandstone channels and for determining main channel trends and secondary channels. Comparison with modern analogies such as the Mississippi River Basin provides the ability to recognise depositional patterns. Understanding the nature of the channels identified and their distribution can provide valuable information for risk evaluation of the potential impact of the channels on mining and the resultant conditions that may be encountered.