Geophysical possibilities for outburst prediction and control

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CSIRO Exploration & Mining
Geophysics measures physical properties and contrasts - without them it will fail.
Outline

• Mapping of general geological structure
• Mapping of coal seam properties
• Mapping of small-scale geological structures
• Monitoring precursors to outbursts
Mapping of general geological structure

Seismic reflection (changes in density & seismic wave velocity)
Mapping of general geological structure

- Aeromagnetics (changes in iron minerals and remanent magnetisation)
Mapping of coal seam properties

• What might be the relevant physical properties for outburst assessment?
  – porosity/moisture content?
  – permeability?
  – density?
RIM image of a dyke

- RIM responds to the electrical conductivity of the rocks
- water has great influence on conductivity
Wireline logging
Spectral gamma ray
<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Location</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Sat 6th Dec</td>
<td>Auslog 800m / Lucas day off for drillers? S.T. Arrive</td>
<td></td>
<td>Deploy/Retract Auslog density and gamma into 800m hole with pump down</td>
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<td>cup (Leaving HRG String in Hole)</td>
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<tr>
<td>Sun 7th Dec</td>
<td>Day off/Finish Auslog/contingency</td>
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<tr>
<td>Mon 8th Dec</td>
<td>DMT</td>
<td></td>
<td>Pump Down DMT shuttle</td>
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<td>Retract HRG Rod String whilst logging DMT parameters</td>
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<tr>
<td>Tue 9th Dec</td>
<td>LUCAS Reposition Rig</td>
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<tr>
<td>Wed 10th Dec</td>
<td>Sigra - Lucas Drill Rotary Hole</td>
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<td>Install Sigra device in NRG rotary string</td>
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<td>Drill hole to max depth of 200m - Retract String</td>
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<td>Thu 11th Dec</td>
<td>Lucas Demobilise</td>
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<td>Demob Lucas Rig &amp; Demob 250kVa Genset</td>
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<td>Rod Pusher - Setup rod pusher in highwall shield</td>
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<td>Fri 12th Dec</td>
<td>Auslog Second tool</td>
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<td>Deploy Gamma, Resistivity (Guard) into second hole to 200m</td>
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<td>Sat 13th Dec</td>
<td>CSIRO EM</td>
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<td>Deploy Spectrometric Gamma - 200m 2 holes</td>
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<td>Sun 14th Dec</td>
<td>Deploy Spectrometric Gamma - 200m 2 holes</td>
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<td>Mon 15th Dec</td>
<td>CSIRO TIP</td>
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<td>Deploy Radar - 200m - 2 holes</td>
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<td>Tue 16th Dec</td>
<td>Deploy Dielectric Tool - 200m 2 holes</td>
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Mapping of small-scale geological structures

• mylonite zones and intrusions using geophysical tools in in-seam boreholes
Borehole radar intersecting mylonite zone
Dielectric probe intersecting mylonite zone
Measurement-while-drilling
Monitoring precursors to outbursts

- Microseismics – Styles (UK), CSIRO, Eastern Europe, ?fracing? …
- Electromagnetic emissions – Vozoff (Mooney ACARP), Eastern Europe

ISSUE - If coal is normally predrained, will anything be seen?
Cynheidre

from Styles, 1993
Geothermal events
EARLY WARNING OF GOAFIG

“GoafWarn”, a prototype device to provide early warning of goafing in collieries has been developed and is undergoing underground testing.

Attempts to provide warnings or predictions of earthquakes have been almost universally unsuccessful, with extremely few well-documented successes. Prediction of mine seismic events has also only shown patchy success because seismic events in deep-level mines are highly similar to earthquakes.

Seismicity in stooping sections was recorded using Miningtek’s Ground Motion Monitor (GMM). Accelerated rates of seismicity preceded goafing and showed great promise for providing warnings of impending goafing. The reasons for this success might be related to differences in the mechanisms of goafing compared to the mechanisms driving earthquakes and deep mining events.

The GoafWarn is easily installed on a roofbolt, operates (for 22 days) on rechargeable batteries and is programmed to provide warning lights during times of significantly increased hazard and goaf potential.

As uncertainty in the times of goafing is one of the major problems in underground coal mining, this unit has great potential for improving both productivity and safety.

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“GoafWarn” provides early warning of goafing.
Conclusions for geophysics

• Mapping of general geological structure
  – can be used to map causative structures

• Mapping of coal seam properties
  – does allow in-situ property measurement

• Mapping of small-scale geological structures
  – can be done in by in-seam boreholes and mwd

• Monitoring precursors to outbursts
  – seismic (and electromagnetic) pre-cursors can be detected

• Various tasks are underway but as far as outburst management is concerned, there is no coordinated effort
On deployment

• Tools will only be deployed if it is perceived that they contribute to outburst management

• It is essential that their deployment has a minimal effect on production