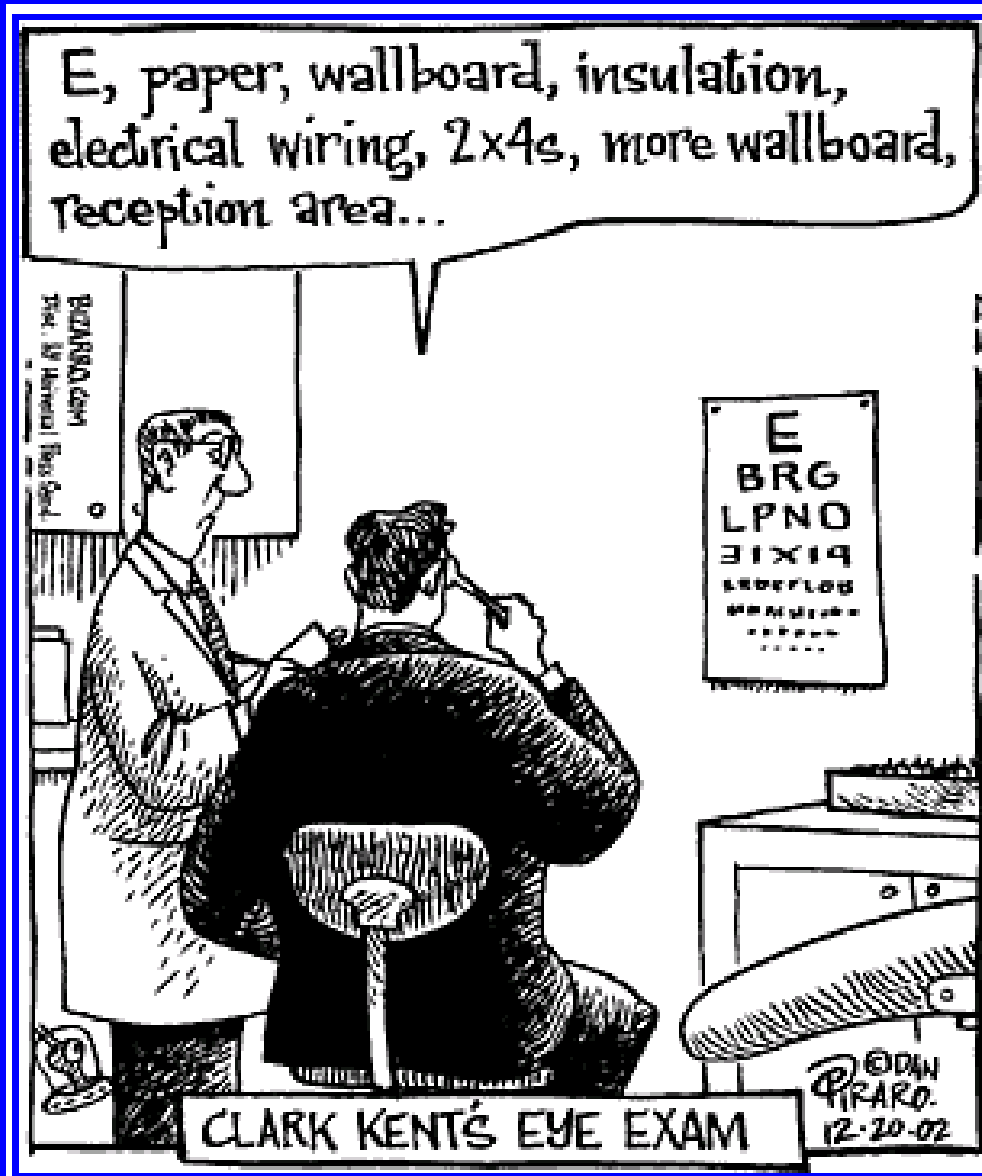


# Geophysical possibilities for outburst prediction and control

Peter Hatherly

CSIRO Exploration & Mining





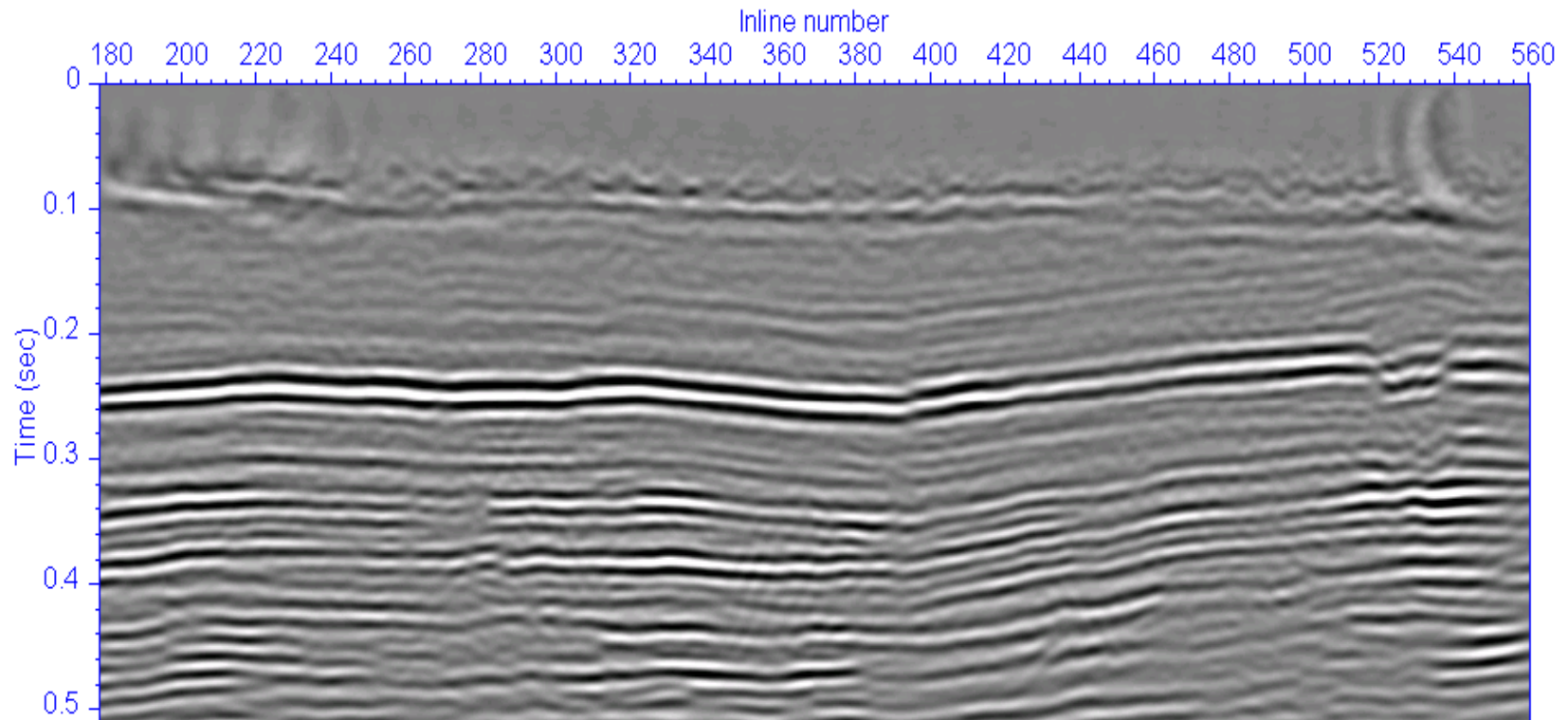
Geophysics  
measures physical  
properties and  
contrasts - without  
them it will fail

# 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

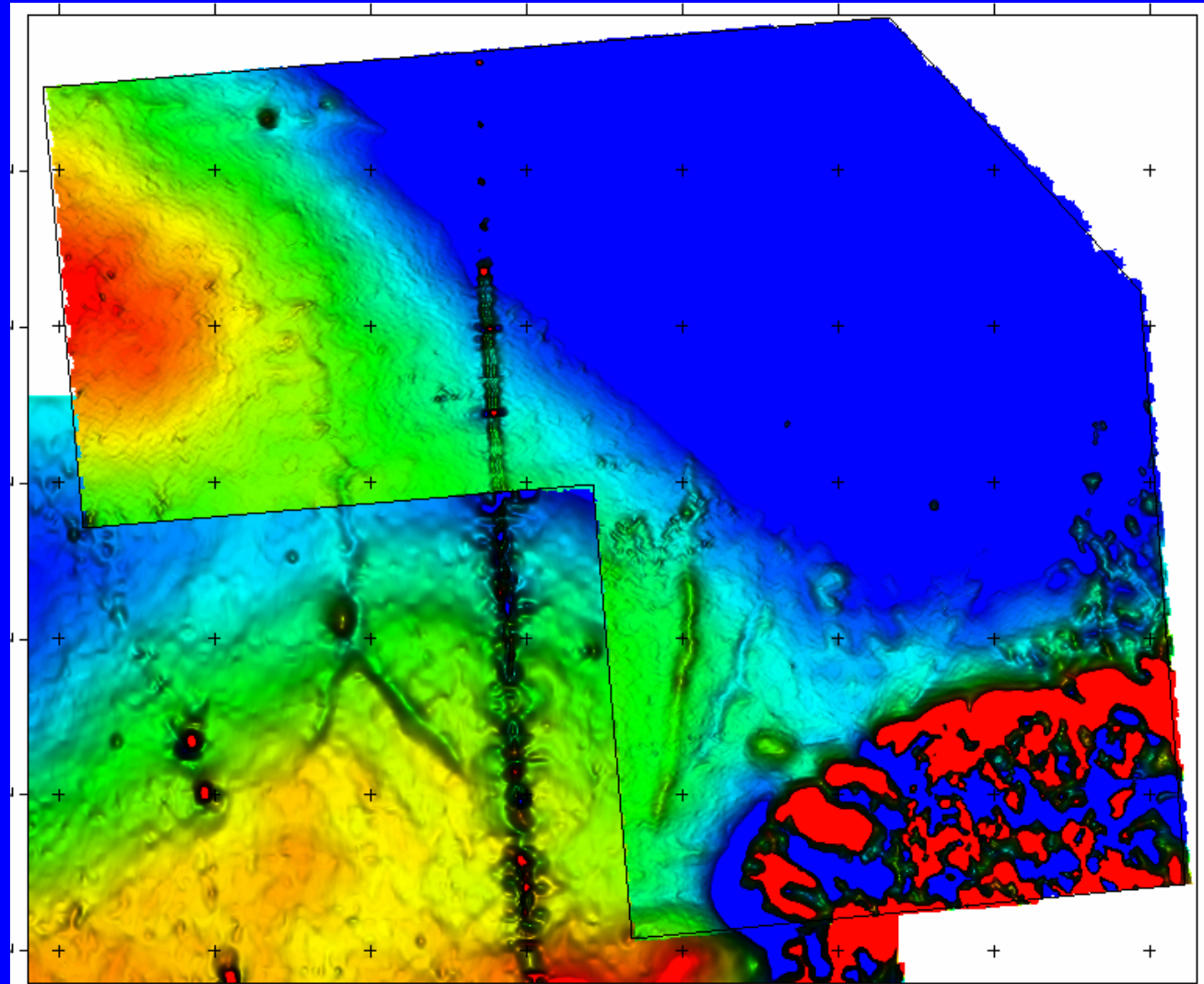
Seismic reflection (changes in density & seismic wave velocity)



X50

# Mapping of general geological structure

- Aeromagnetics  
(changes in iron  
minerals and  
remanent  
magnetisation)

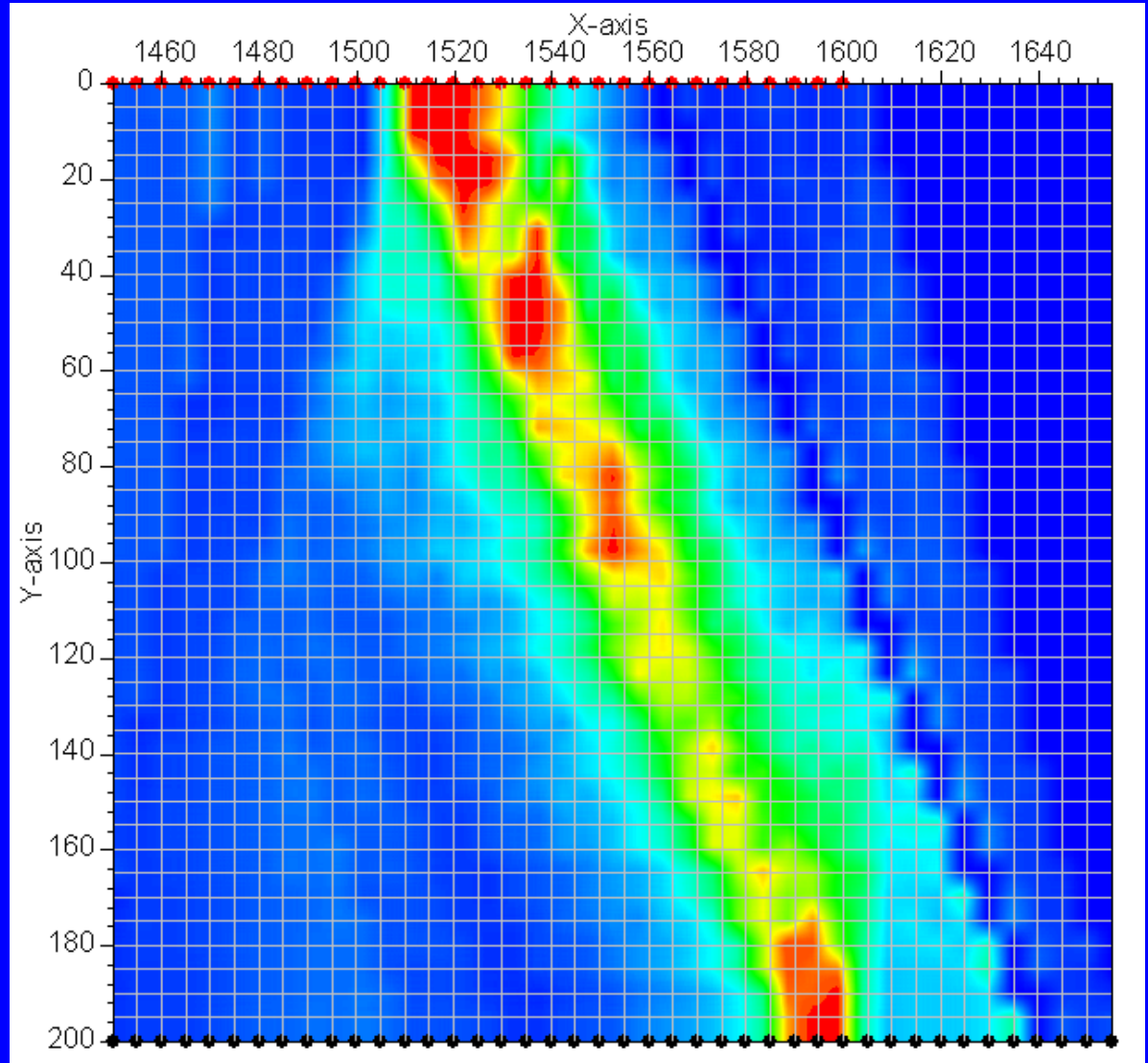


# Mapping of coal seam properties

- What might be the relevant physical properties for outburst assessment?
  - porosity/moisture content?
  - permeability?
  - density?

# RIM image of a dyke

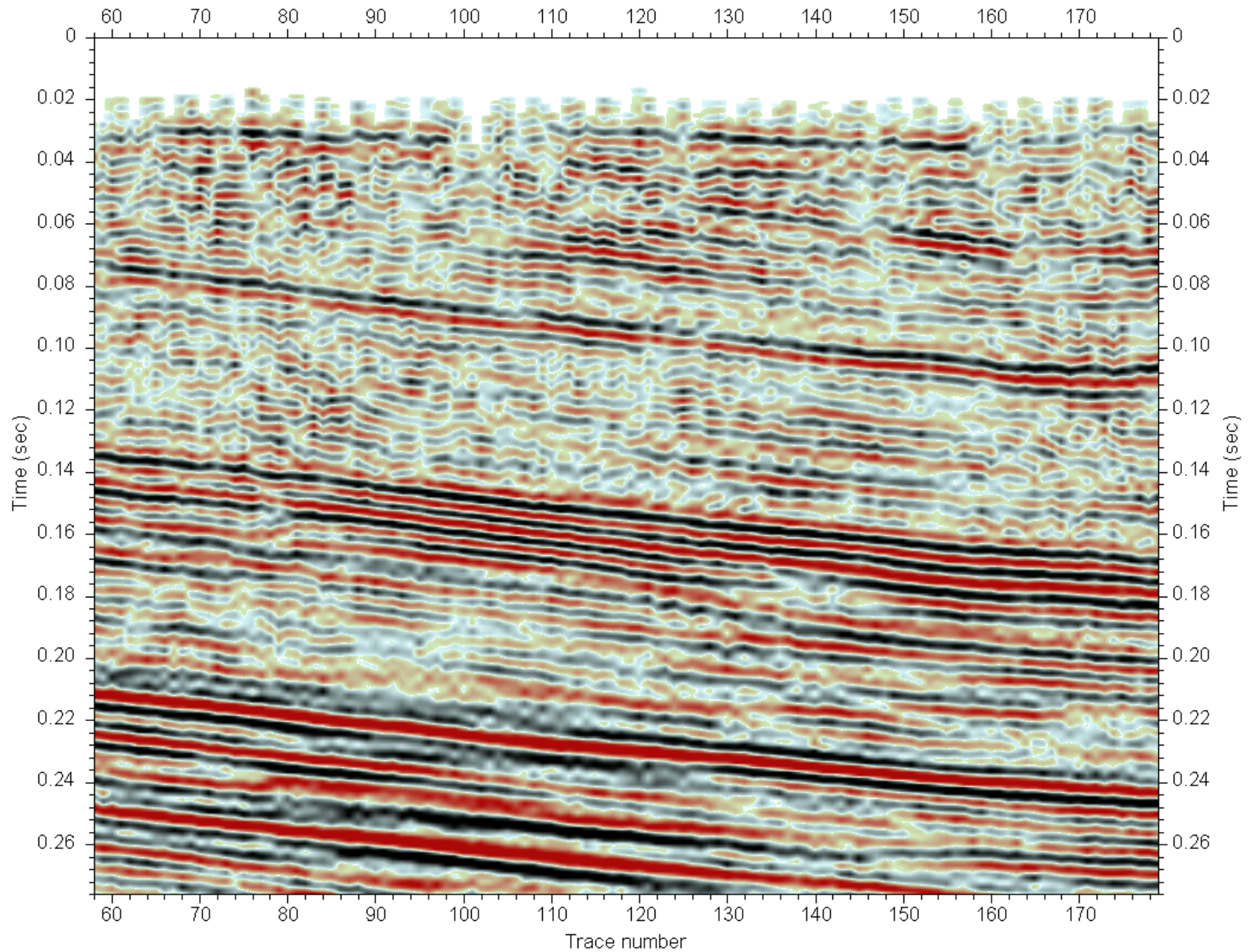
- RIM responds to the electrical conductivity of the rocks
- water has great influence on conductivity





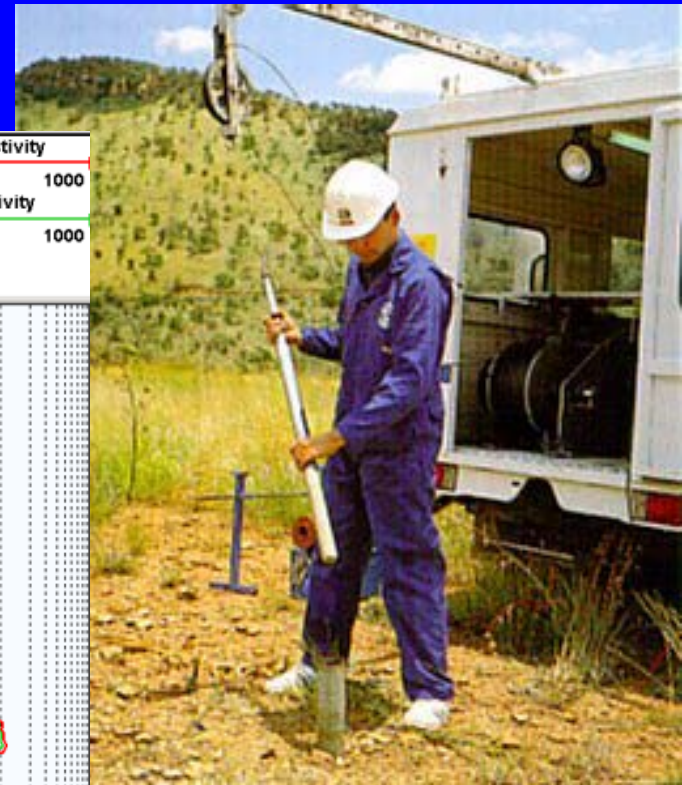
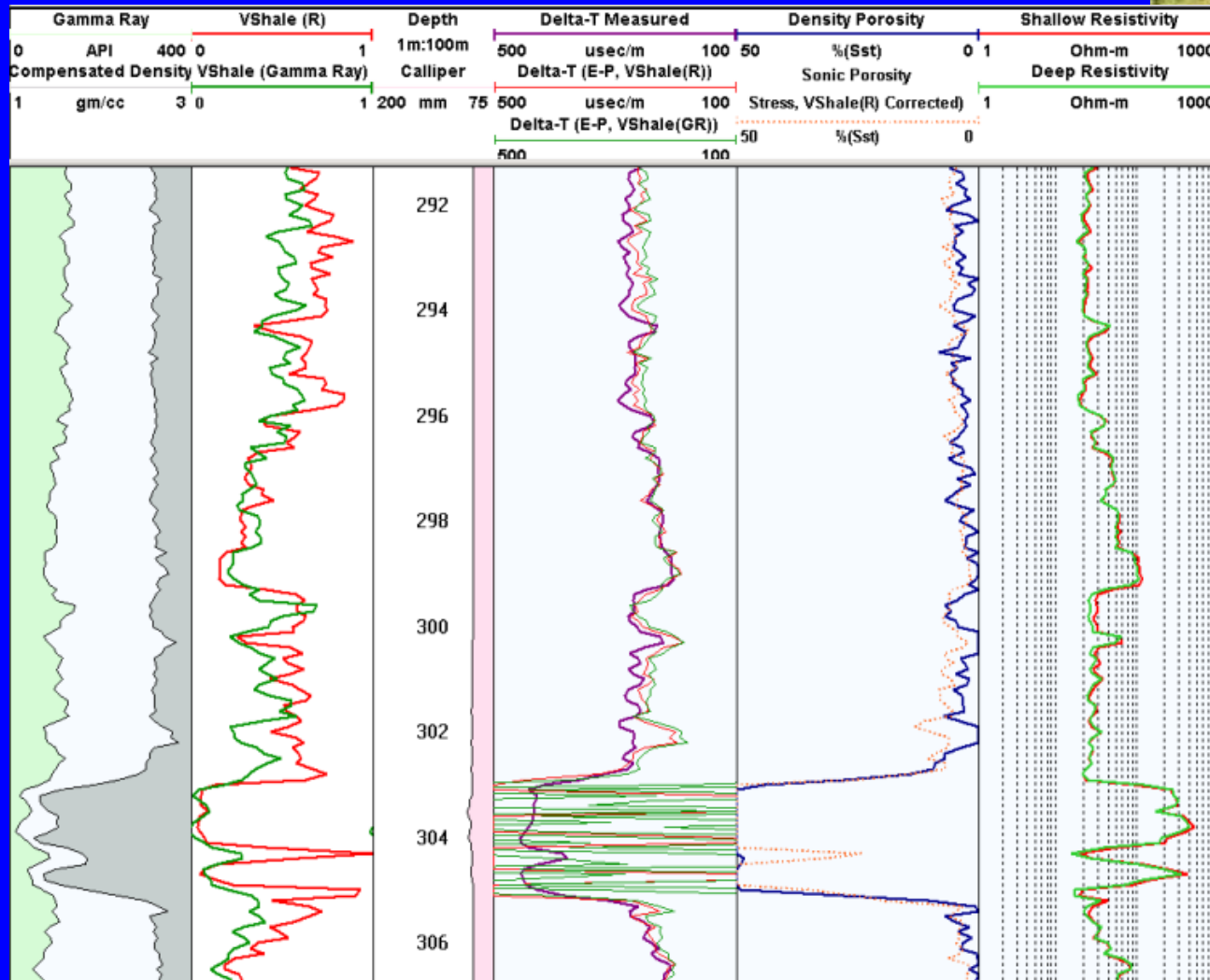
99-06final.sgy

Trace number

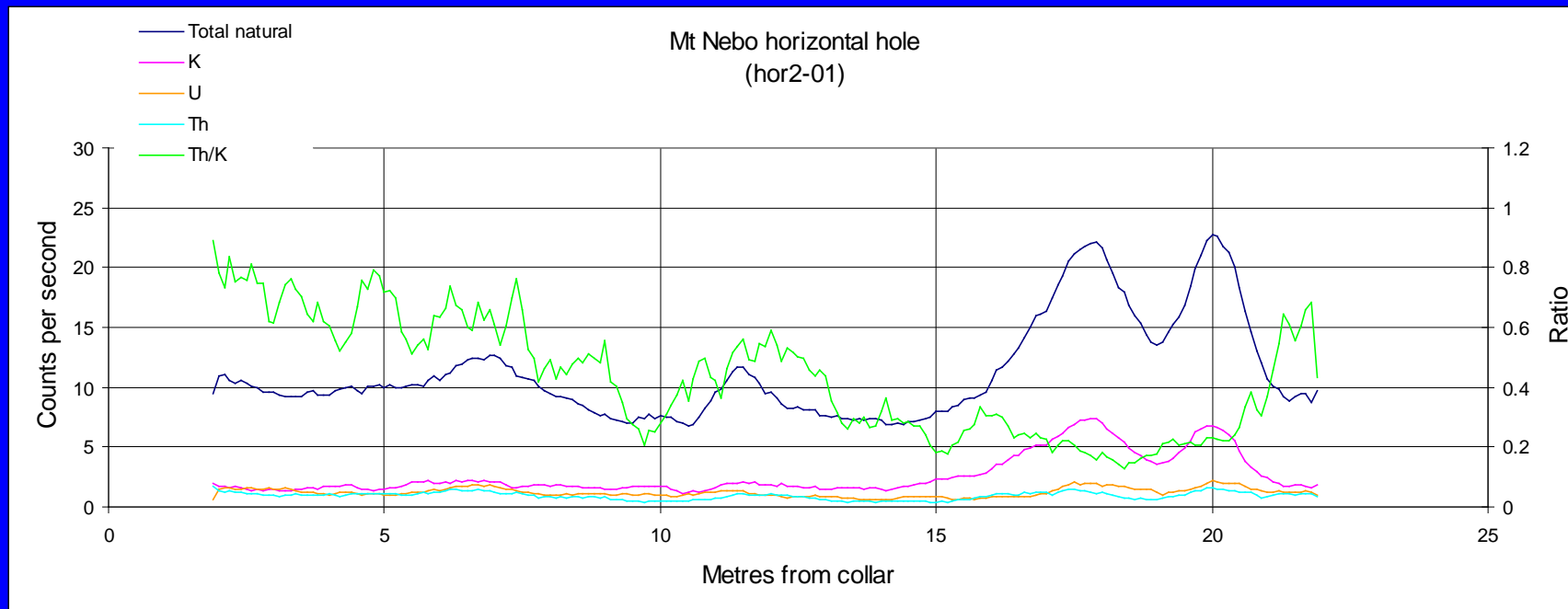




# Wireline logging



# Spectral gamma ray



# ACARP C12024 – in-seam logging trials @ German Creek

Date	Activity	LUCAS	DMT	AUSLOG	SIGRA	CSIRO EM	CSIRO TIP
Sat 6th Dec	<b>Auslog 800m / Lucas day off for drillers? S.T. Arrive</b> Deploy/ Retract Auslog density and gamma into 800m hole with pump down cup (Leaving HRQ String in Hole)			Dec-06			
Sun 7th Dec	Day off/Finish Auslog/contingency						
Mon 8th Dec	<b>DMT</b> Pump Down DMT shuttle Retract HRQ Rod String whilst logging DMT parameters		Dec 7th pm arrive Capcoal				
Tue 9th Dec	<b>LUCAS Reposition Rig</b>		Oakey Ck				
Wed 10th Dec	<b>Sigra - Lucas Drill Rotary Hole</b> Install Sigra device in NRQ rotary string Drill hole to max depth of 200m - Retract String		Dec 10 am depart		Dec 9th pm arrive		
Thu 11th Dec	<b>Lucas Demobilise</b> Demob Lucas Rig & Demob 250kVa Genset <b>Rod Pusher - Setup rod pusher in highwall shield</b>	11th Dec depart			Dec 11th am depart		
Fri 12th Dec	<b>Auslog Second tool</b> Deploy Gamma, Resistivity (Guard) into second hole to 200m			Dec 12th			
Sat 13th Dec	<b>CSIRO EM</b> Deploy Spectrometric Gamma - 200m 2 holes					On site 13th Dec am	
Sun 14th Dec	Deploy Spectrometric Gamma - 200m 2 holes					Depart 14th Dec pm	
Mon 15th Dec	<b>CSIRO TIP</b> Deploy Radar - 200m - 2 holes						Dec 14th pm arrive
Tue 16th Dec	Deploy Dielectric Tool - 200m 2 holes						

# Mapping of small-scale geological structures

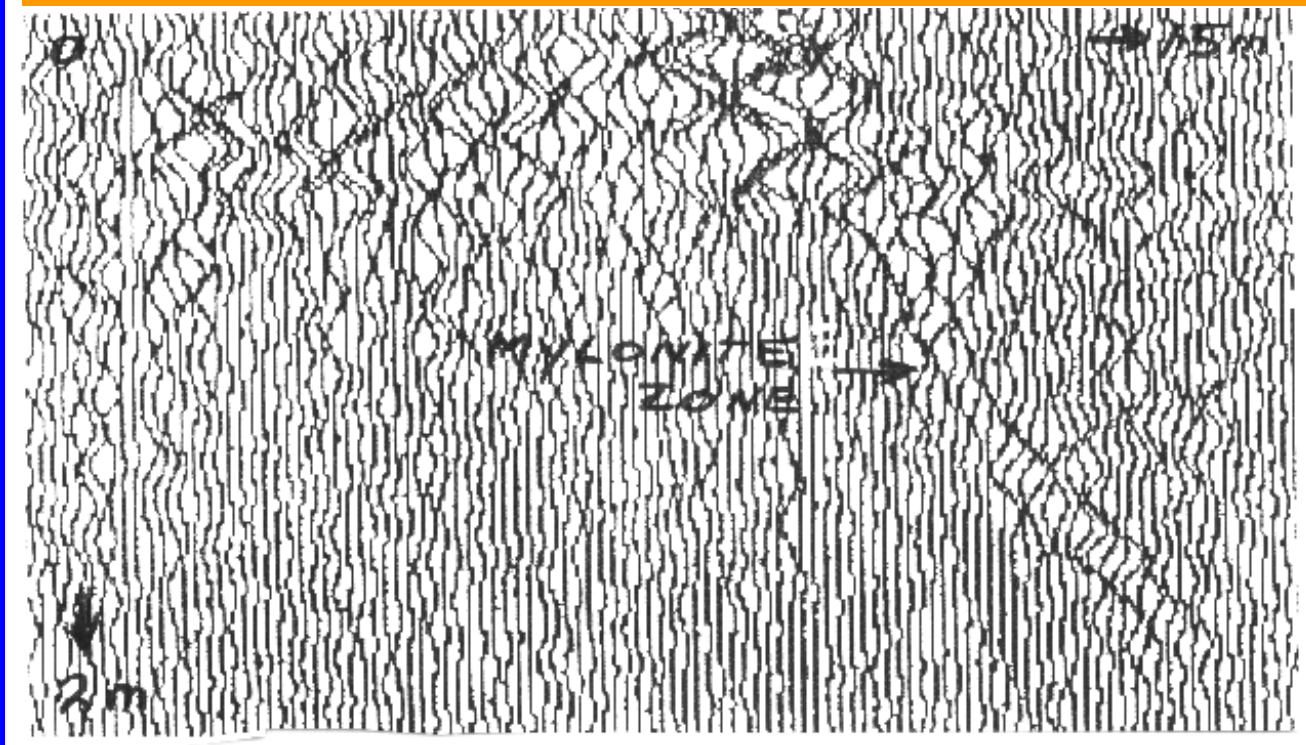
- mylonite zones and intrusions using geophysical tools in in-seam boreholes

# Borehole radar intersecting mylonite zone

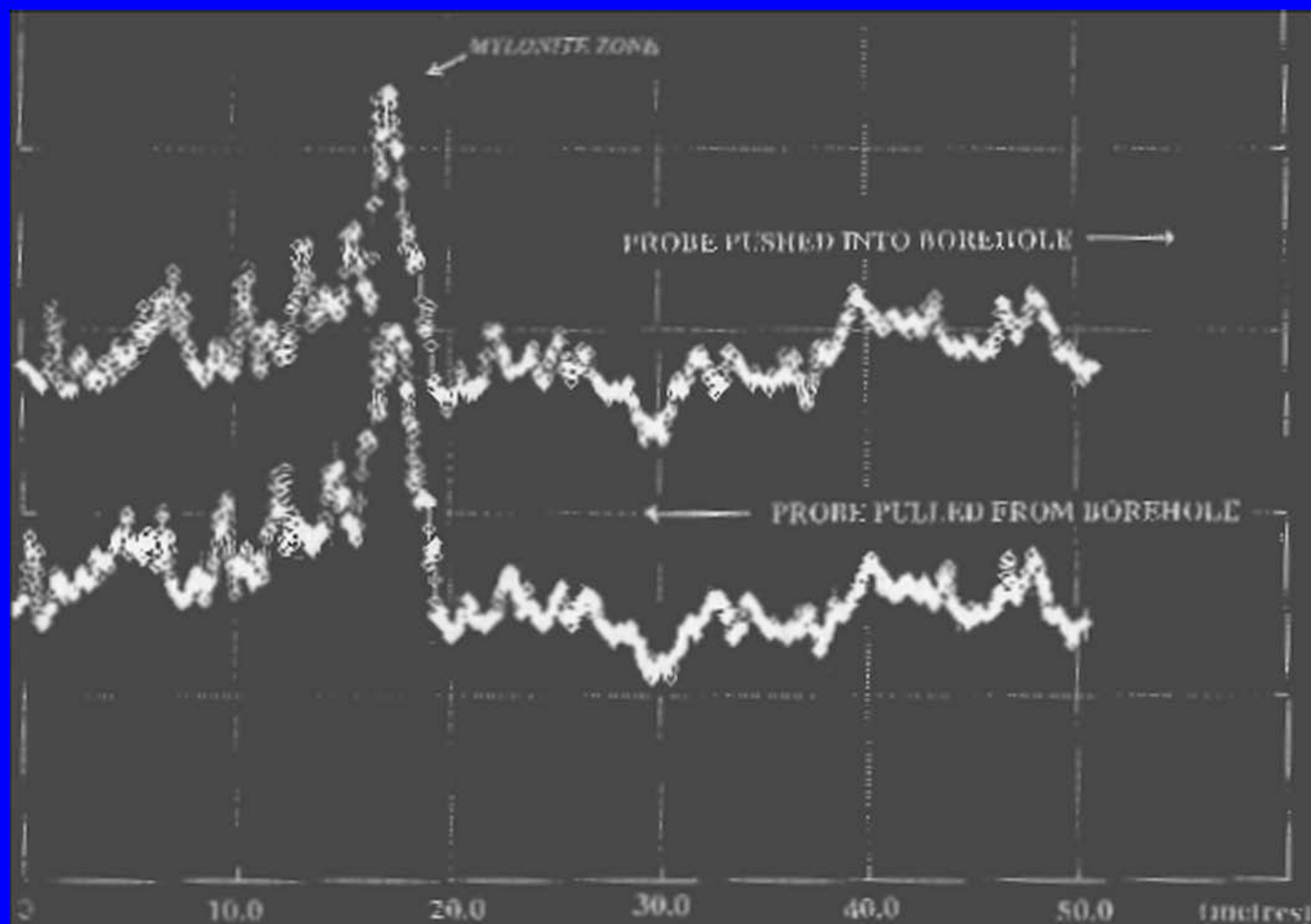
0

in-seam borehole

15

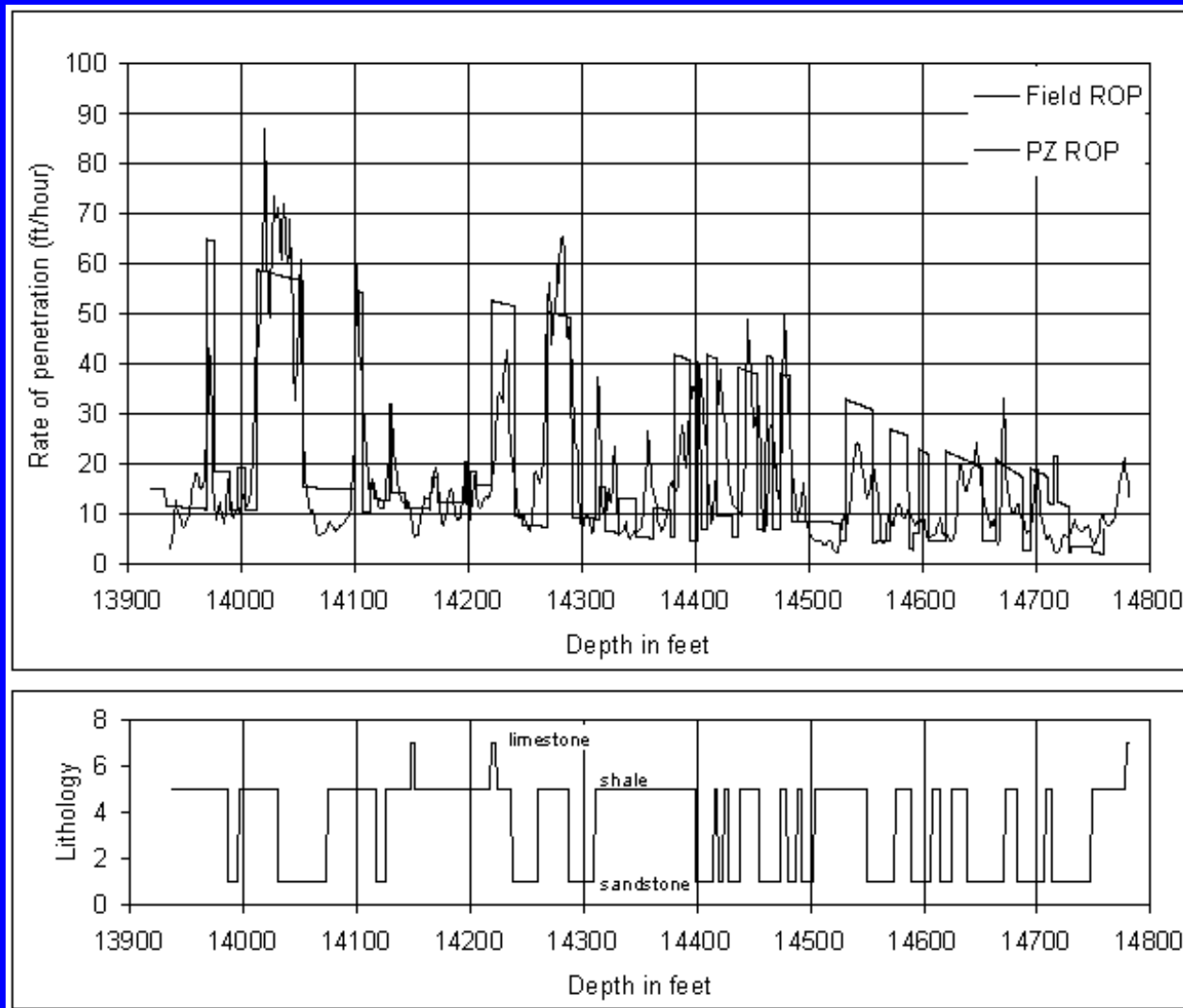


# Dielectric probe intersecting mylonite zone





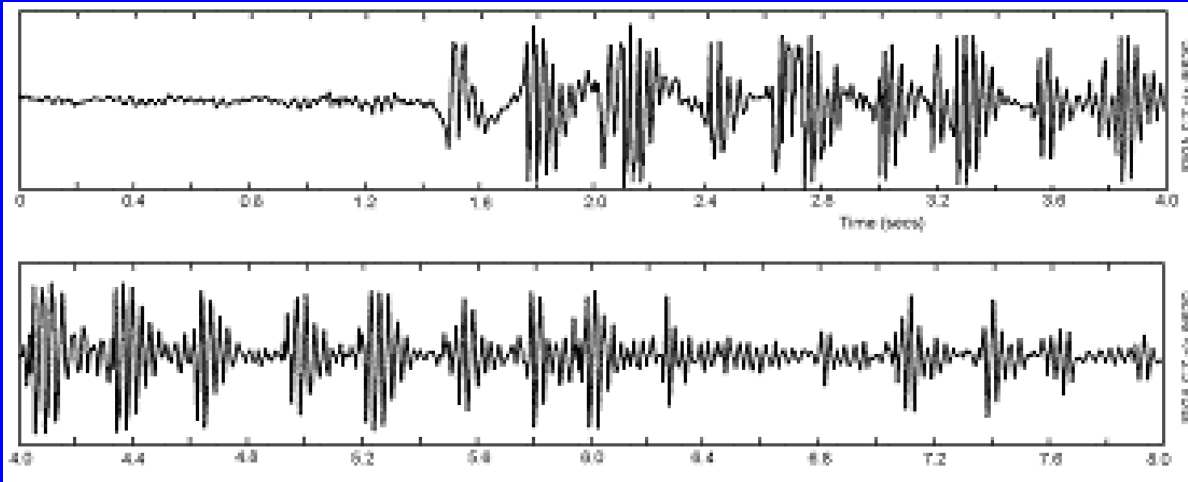
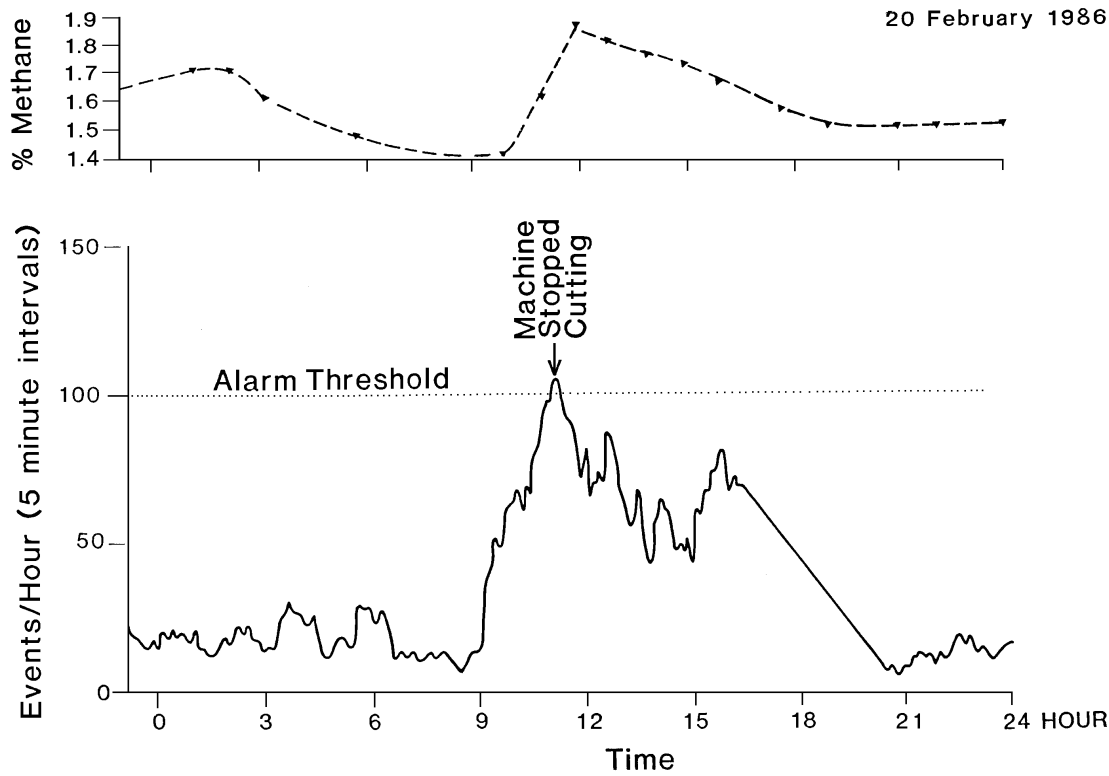
# Measurement-while-drilling



# Monitoring precursors to outbursts

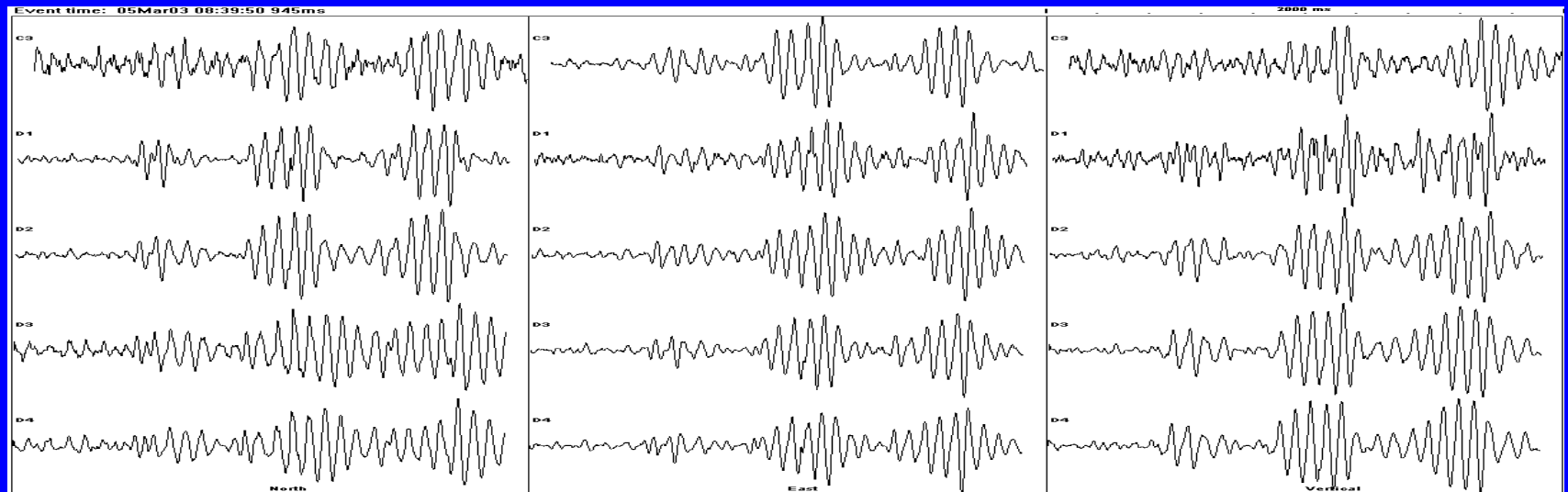
- Microseismics – Styles (UK), CSIRO, Eastern Europe, ?fracking? ...
- Electromagnetic emissions – Vozoff (Mooney ACARP), Eastern Europe
- ISSUE - If coal is normally predrained, will anything be seen?

# Cynheidre



from Styles,  
1993

# Geothermal events



# EARLY WARNING OF GOAFING

"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 steeping 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.

## Enquiries

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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