

Coal Interface Detection

Comparative study of in-seam surveying technology

ACARP project C12024

Scott Thomson

Peter Hatherly

17th November 2004

What is Coal Interface Detection?

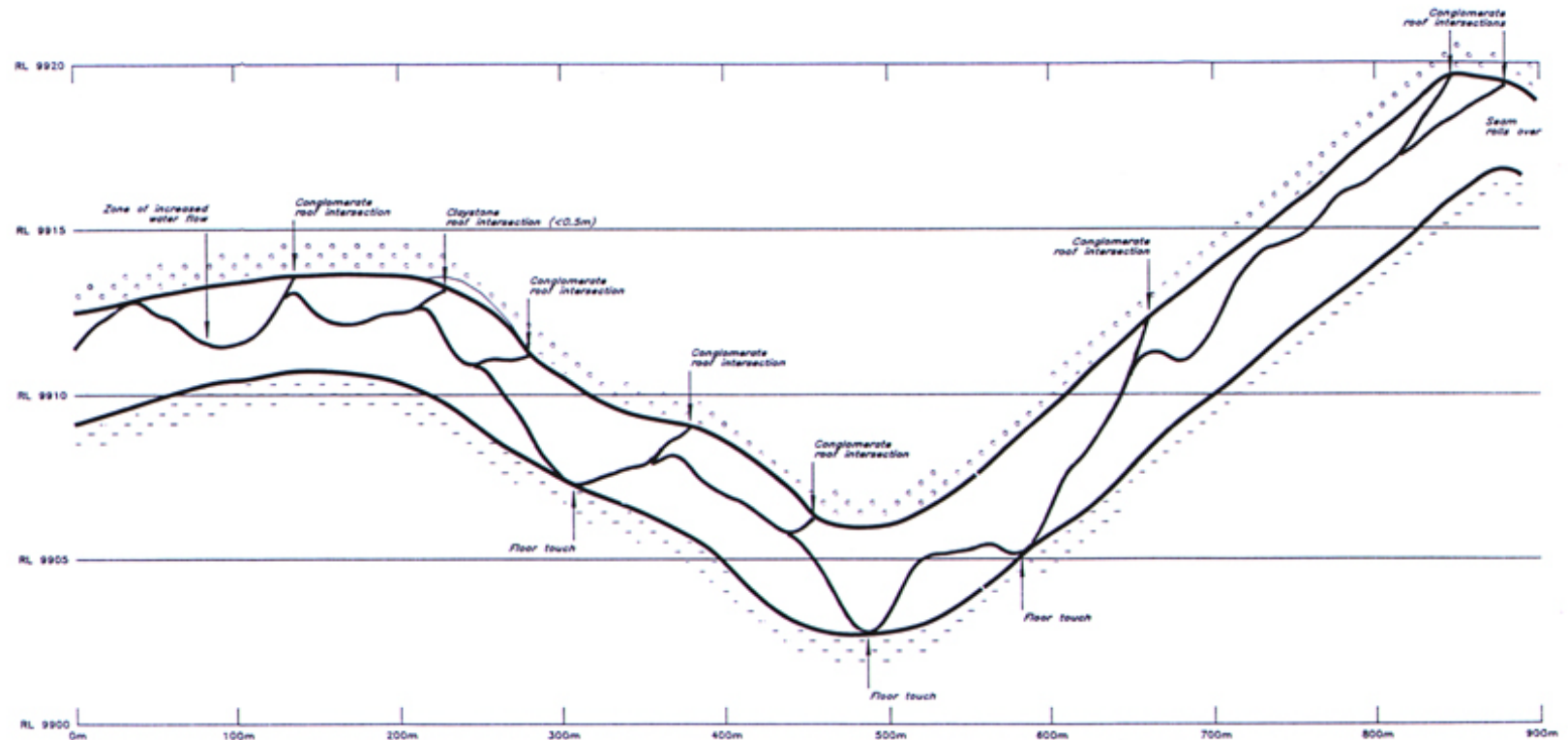
- The ability to detect proximity to roof and floor whilst drilling horizontal directional holes in coal seams

Why is it important?

- To avoid unnecessary branching in horizontal holes
 - Up to 25% increased metres drilled (cost impact to mine)
 - Avoid getting “lost” (navigational difficulties)
 - Improved gas drainage efficiencies
 - Branch points are potential cave zones
 - Reducing the amplitude of drilling (less hills and hollows)



Directional drilling - section



In-seam drilling practice

- 75kW rigs, downhole motors, NQ drill pipe and electronic survey tools
- Hand written logs, 'hard', 'sticky', 'white', 'boggy' etc.
- Periodic deliberate, and unscheduled roof and floor touches





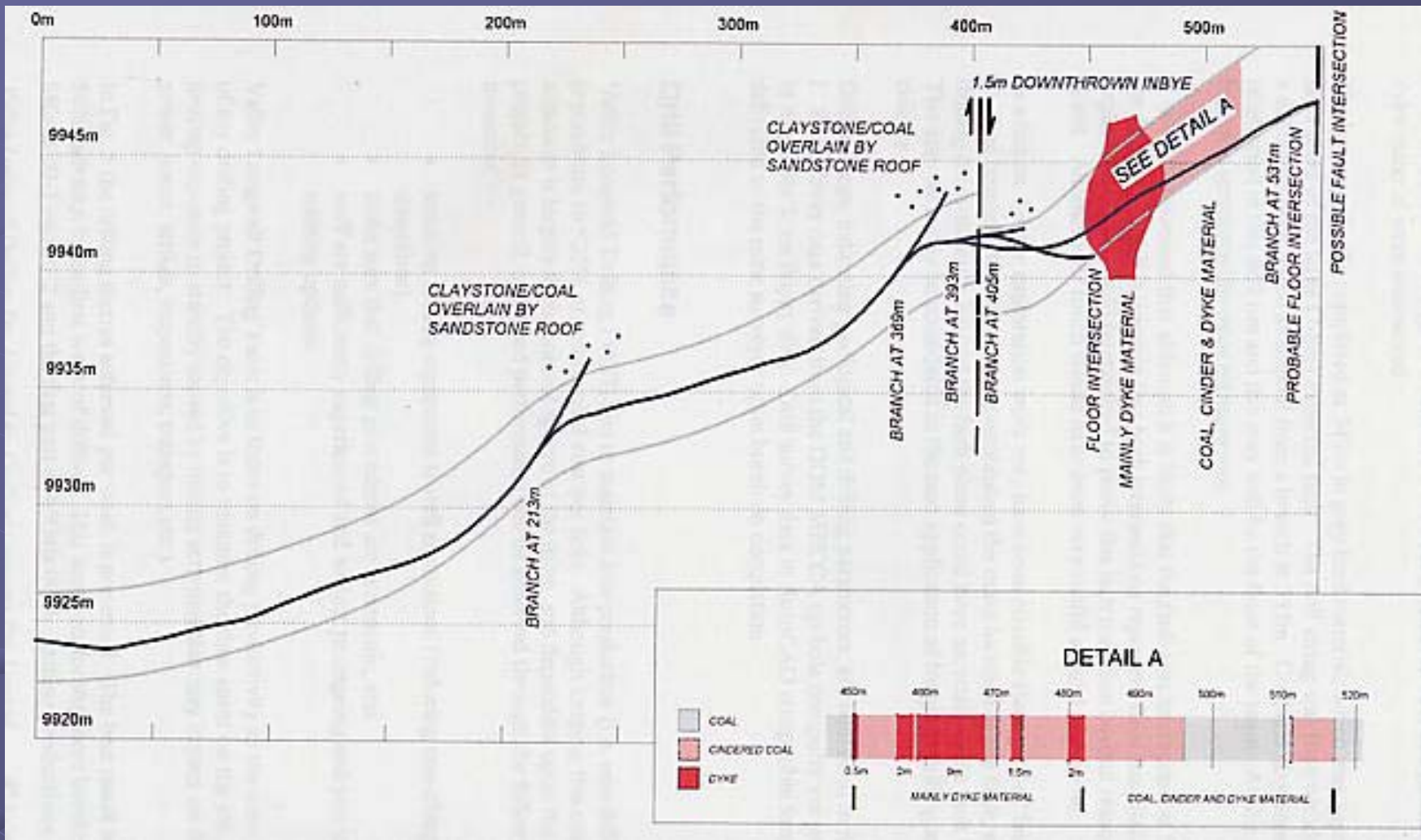
Downhole Motor and Bit



Drill rods with MECCA connection

[illegible]

Turning the sow's ear into a silk purse ...



Problem: too intuitive, reliant on driller's observations

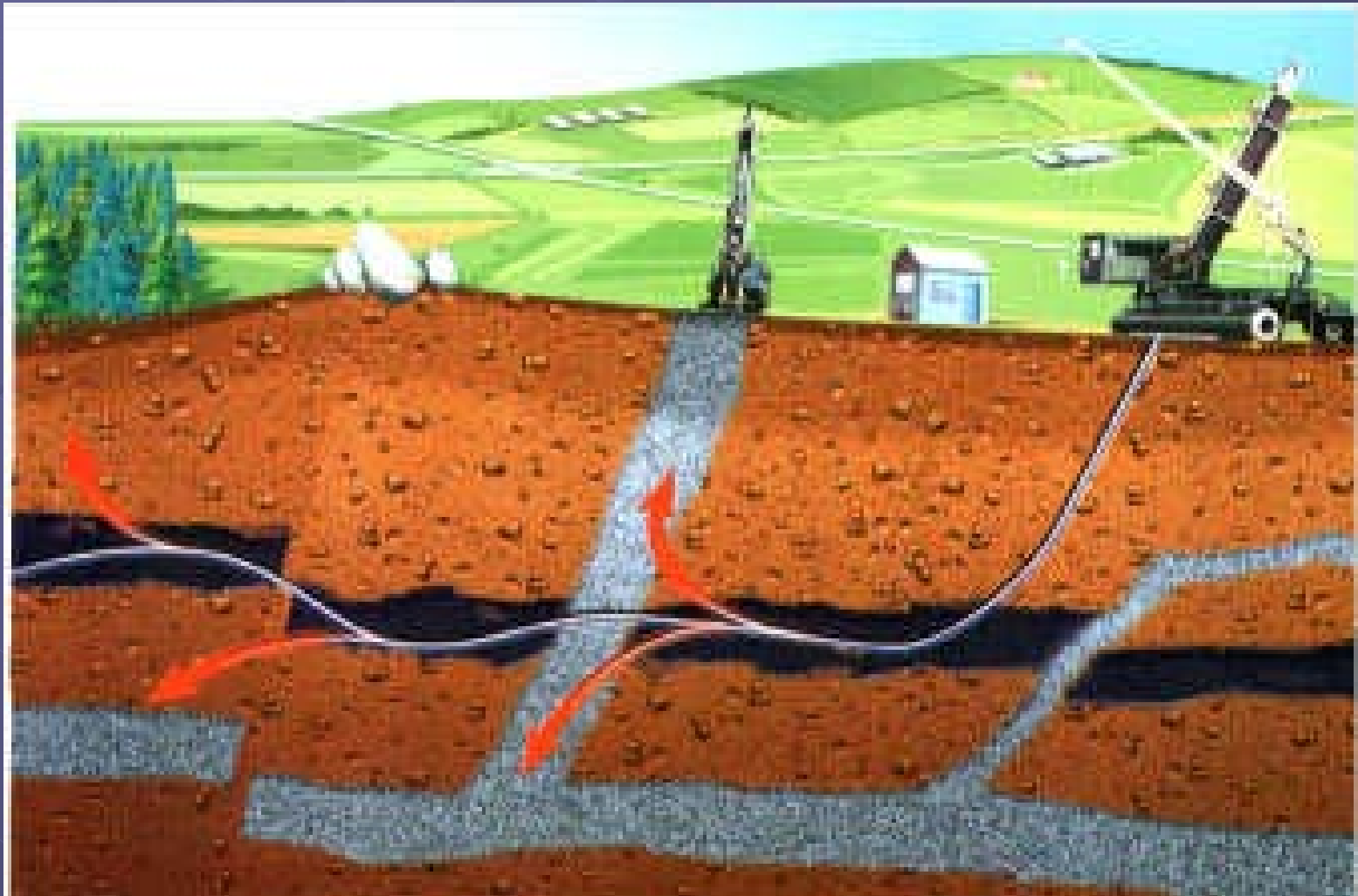
Current weaknesses

- No geophysical data from underground drilling – wasted opportunity for gaining exploration information
- No real time profiling capability (CID), therefore unscheduled branching part of life
- MECCA link rules out ‘pump down’ logging

Compared to oilfield practice our way of doing things belongs in the Jurassic



Coal drilling from surface ...



MRD taps into civil & oilfield products



Current weaknesses

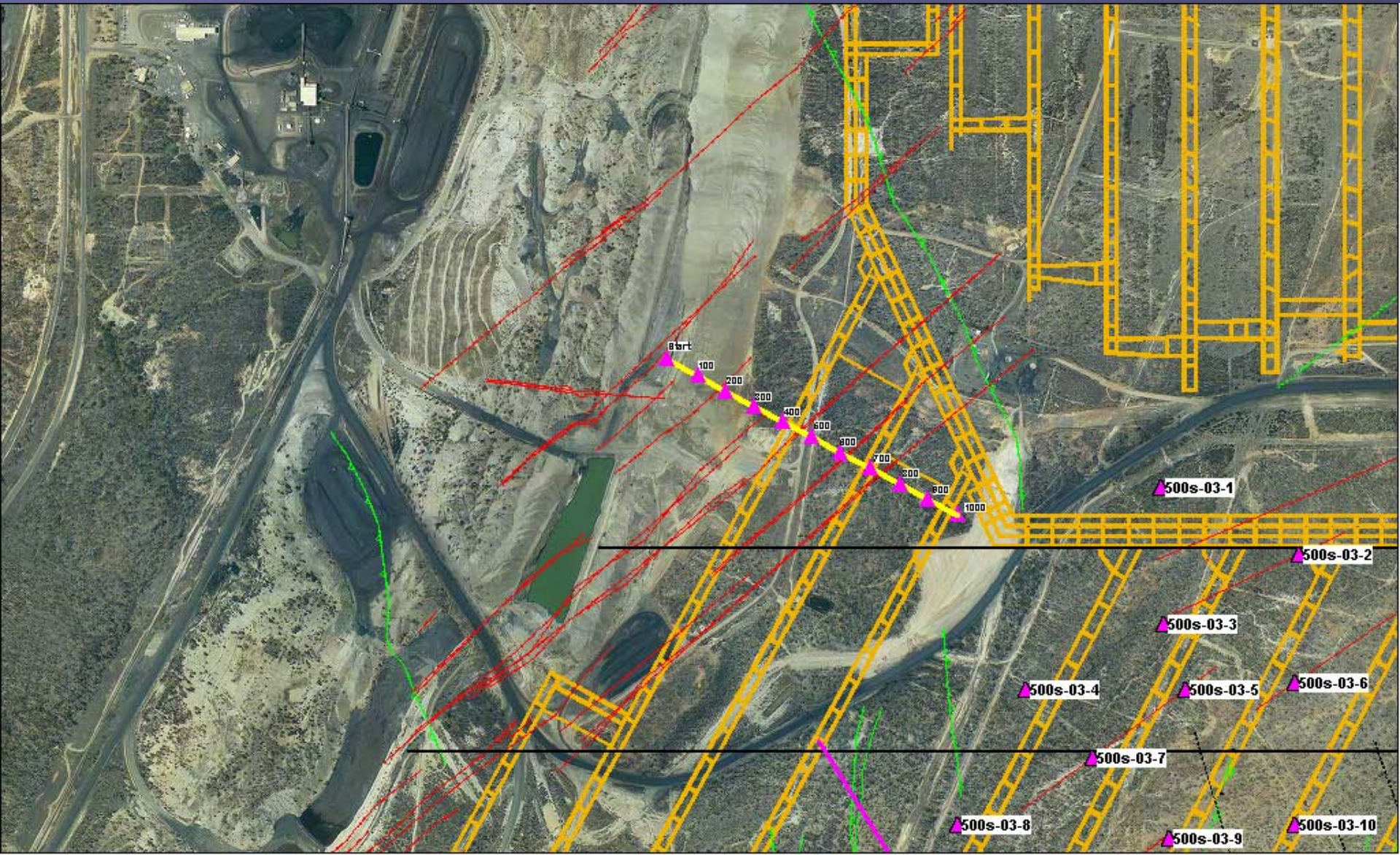
- Limited geophysical & rig performance data from MRD – underutilised opportunity for gaining exploration information

Note: profiling (CID) problem largely solved

Objectives of ACARP project

- Review of state-of-the-art CID technologies
- Comparison of capabilities of existing commercial and R & D CID technologies including:
 - Conventional geophysical wireline tools (gamma, density)
 - Drill string radar
 - Dielectric / conductivity tools
 - Spectrometric gamma
 - Directional gamma

German Creek highwall site



The trial ...

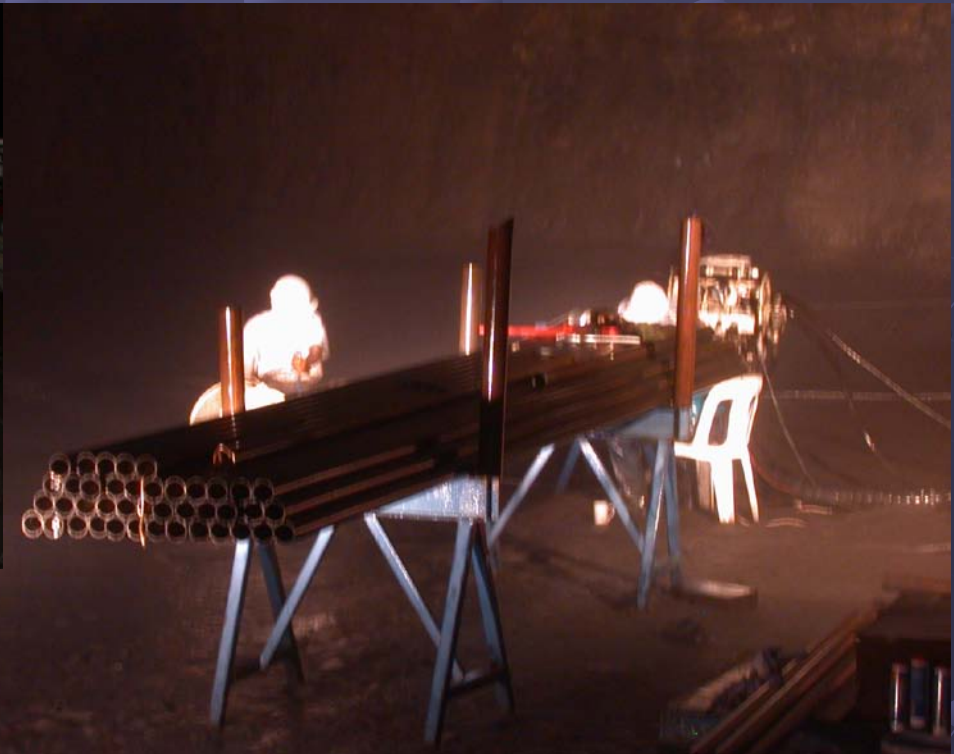


- Lesson: Qld weather can be less than conducive to R & D



Happy researchers ———↑

Five minutes later ———→



The aftermath ...



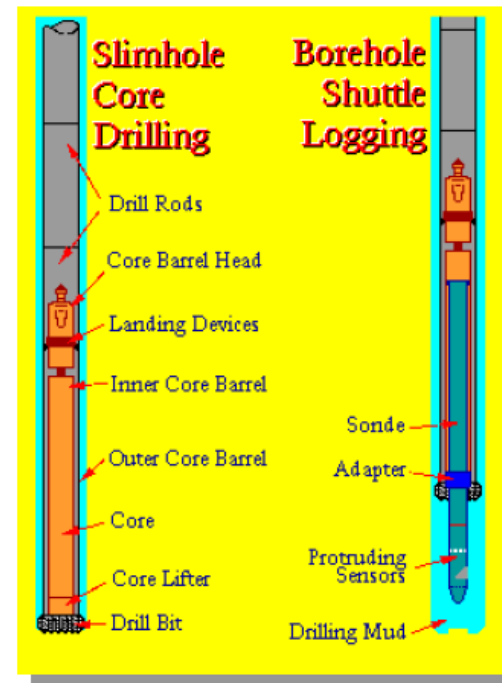
CID technologies trialled at German Creek:

- DMT's Directional Gamma System
- DMT's Borehole Shuttle (with density, gamma and acoustic calliper).
- CSIRO DEM's spectrometric gamma system.
- CSIRO TIP's radar and dielectric tools.
- Auslog's density tool.



Borehole Shuttle - The Joint of Core Drilling and Logging

- A cableless logging sonde with large data memory is flushed downhole through the drill string
- The sonde uses the inner core barrel as a carrier (borehole shuttle)
- Measurements are taken, when pulling the drill string out of hole (logging while tripping)
- Dip measurements with drill bit-protruding sensors
- No logging restrictions in deviated and horizontal boreholes
- Optimally adapted to slimhole continuous core drilling



Protruding Sensor Part of the HQ-Combi Shuttle



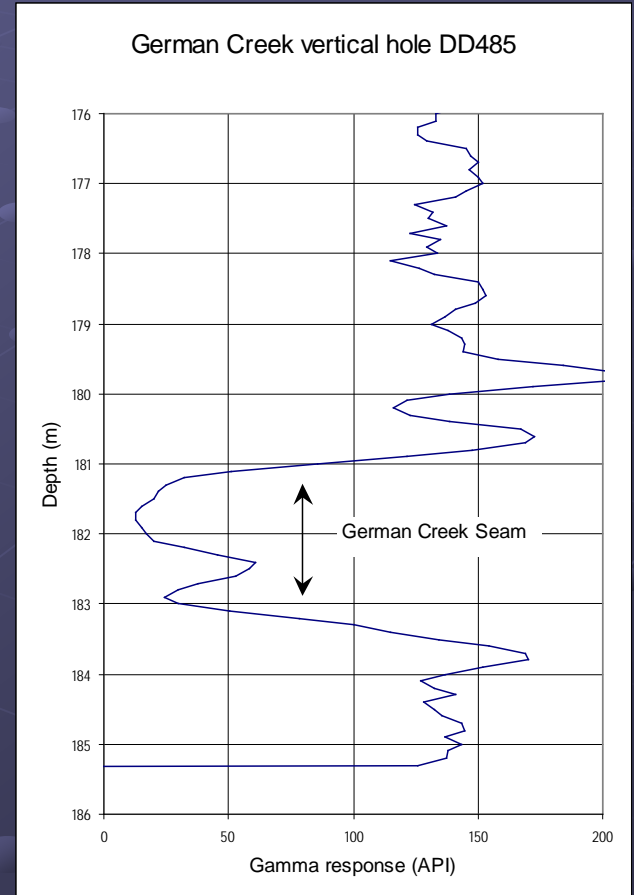
Diamond Drill Bit

Long Space (20") Density Detector

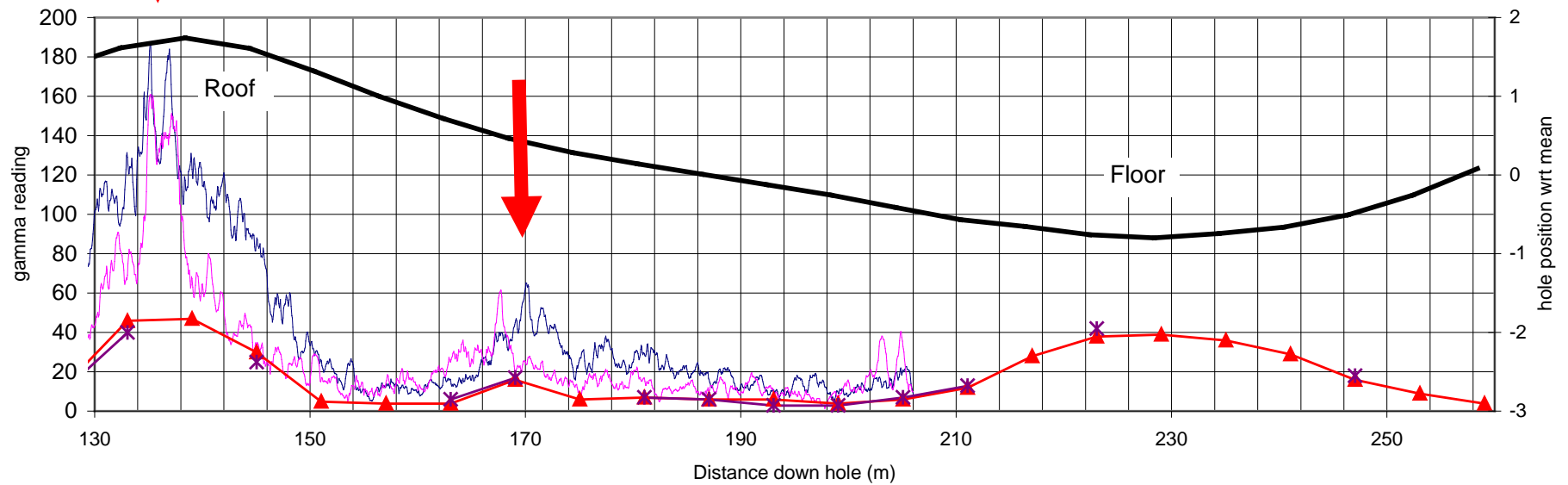
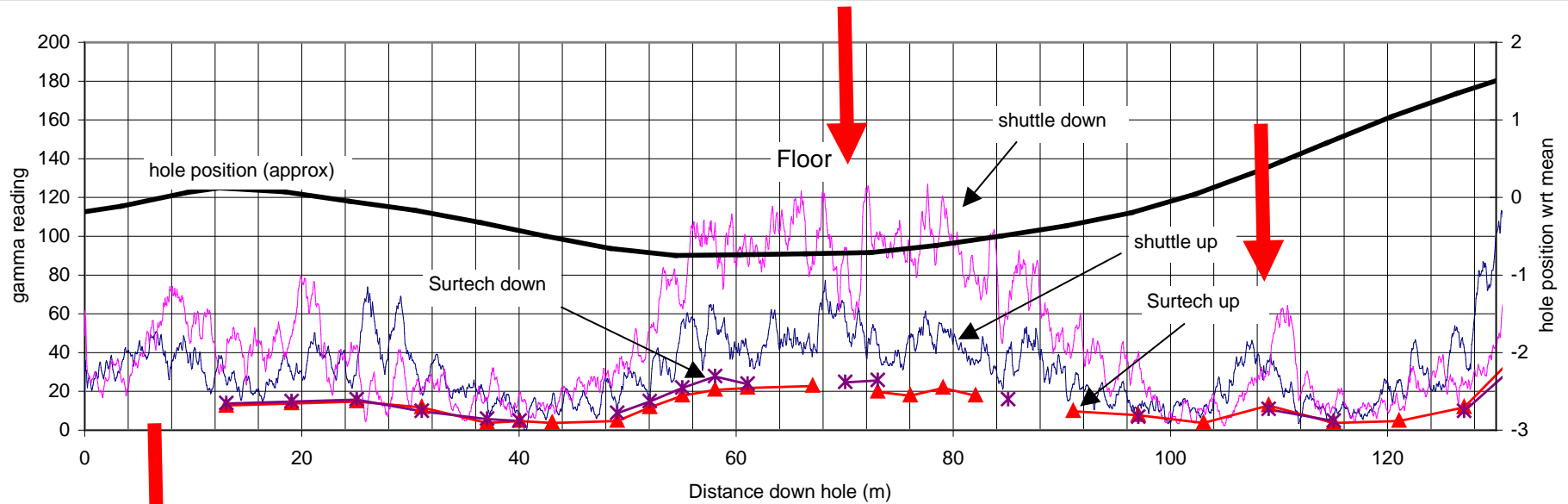
Ultrasonic Dip Sensor

Radioactive Source

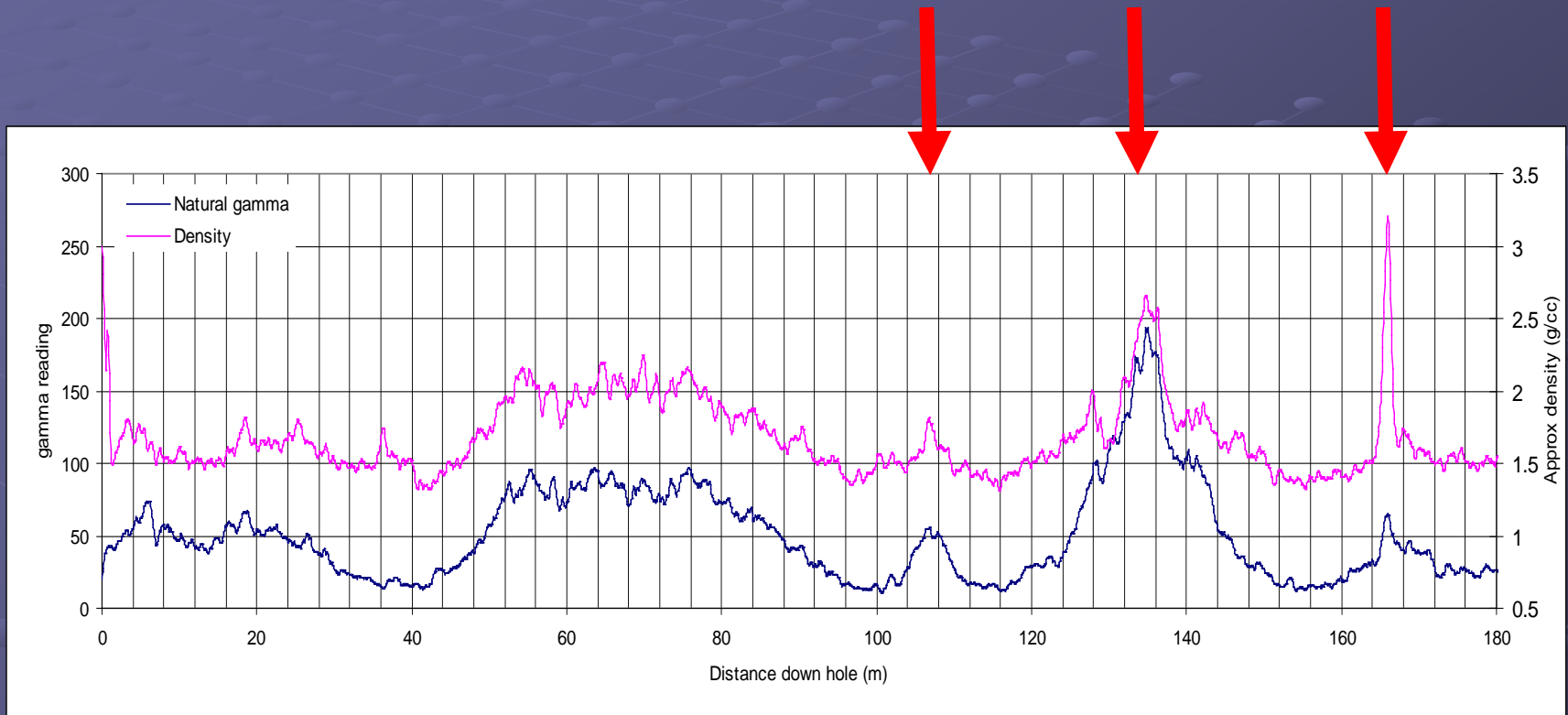
Phase 1: Directional gamma



Directional Gamma



Gamma & density



Low in seam

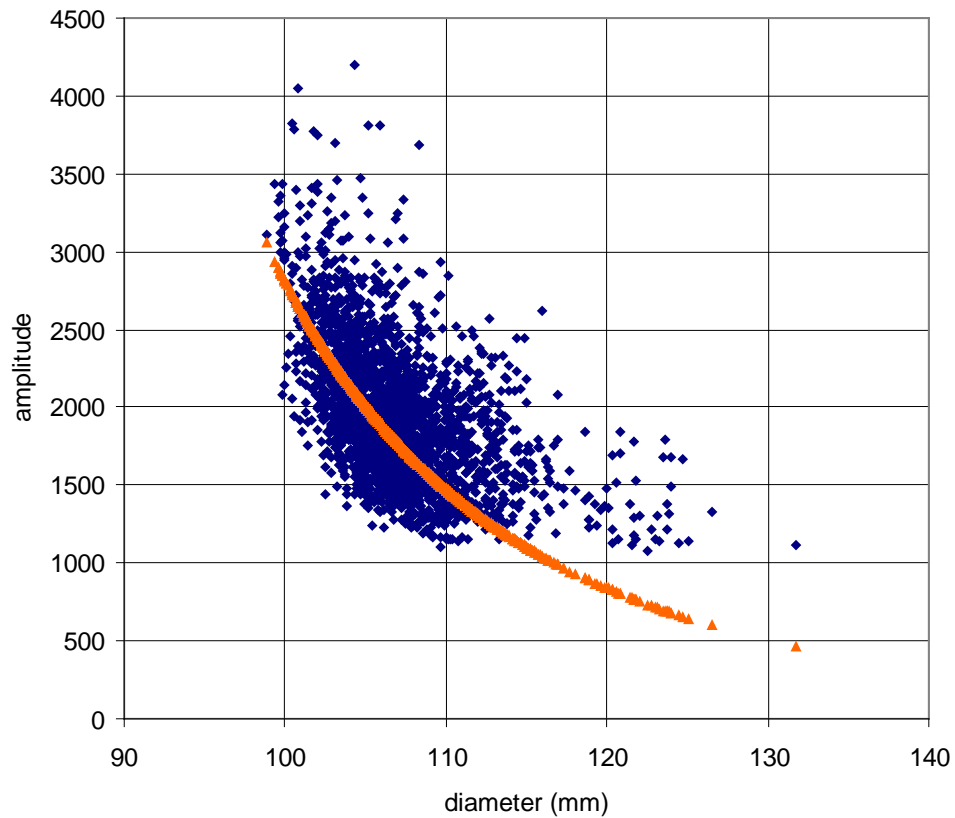
Mid seam band

Dyke

Floor

Roof

Acoustic caliper

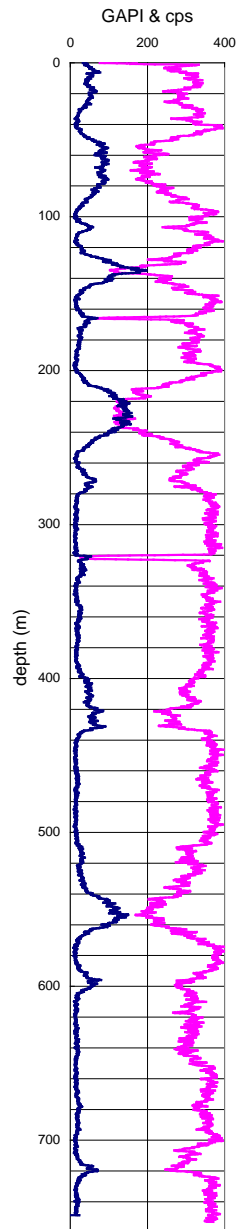


Together, you
have a definitive
answer

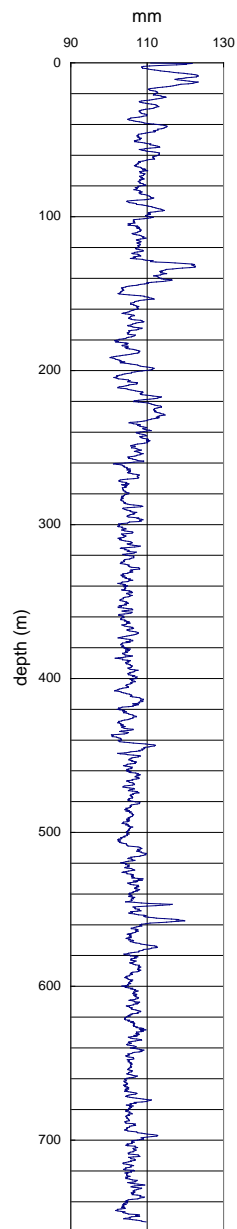
“Many arrows
needed in quiver”
(Hiawatha)



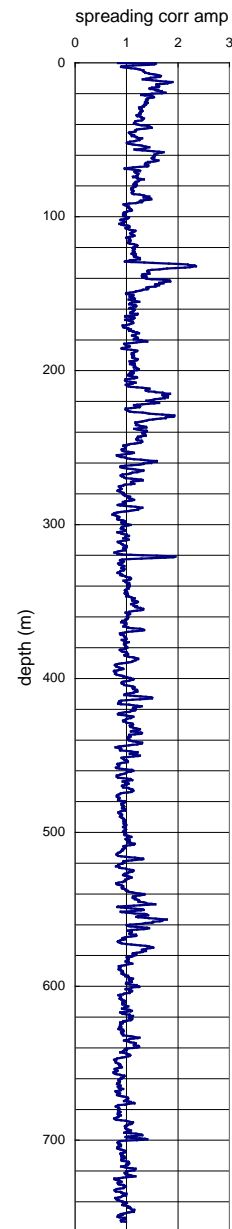
gamma & density



diameter



amplitude



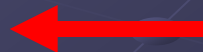
Strong reflection
hard material



Dyke



Missed?



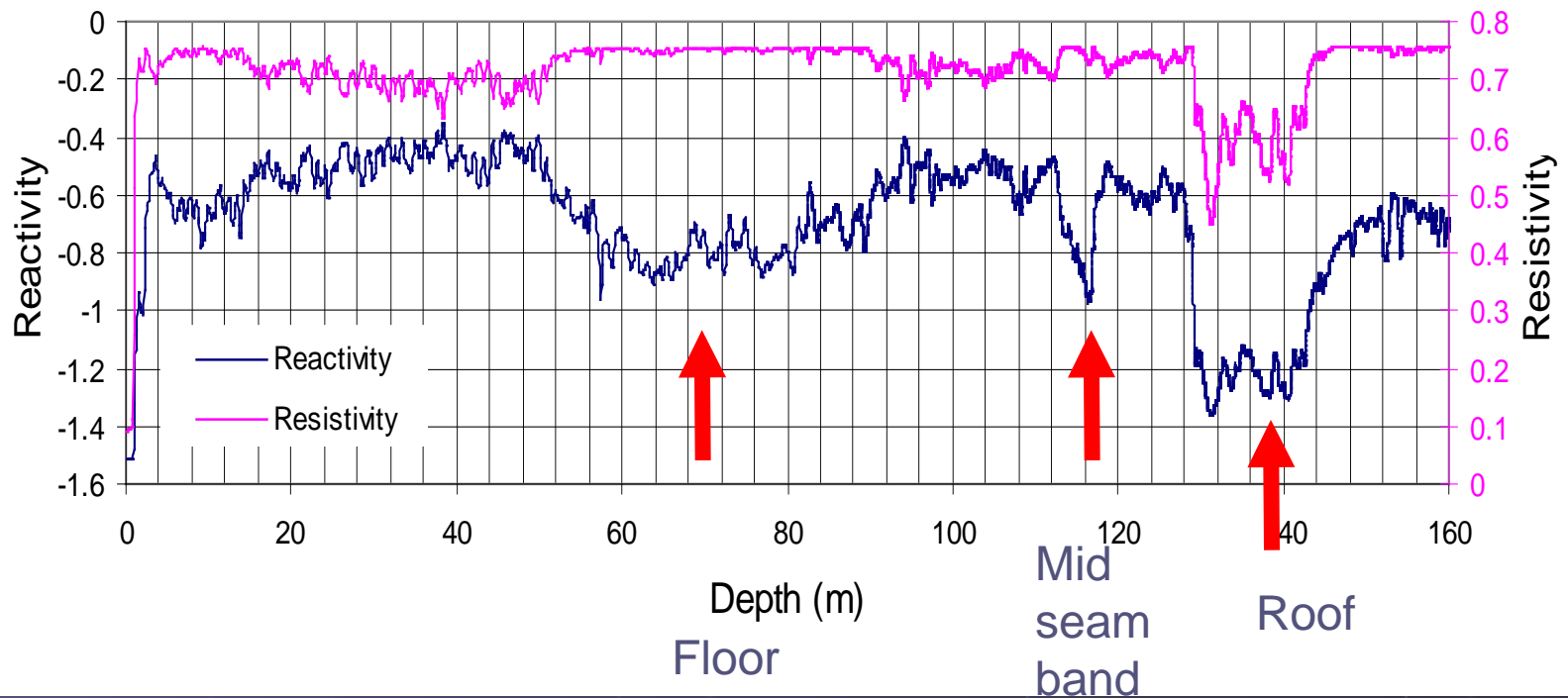
Floor



Dielectric

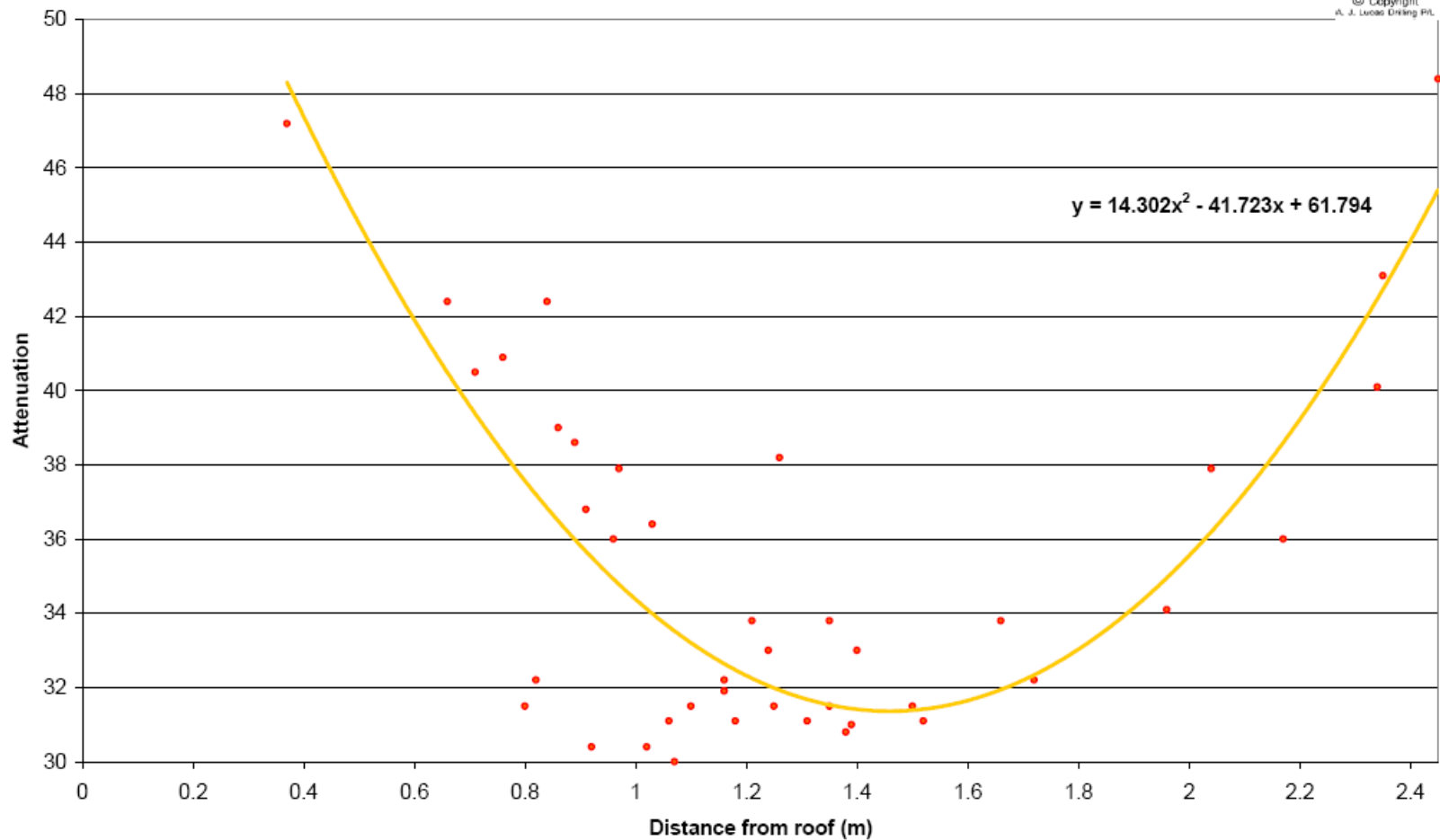
Resistivity – measures current flow in strata

Dielectric (Reactivity) – capacitive properties of strata



Attenuation profiling

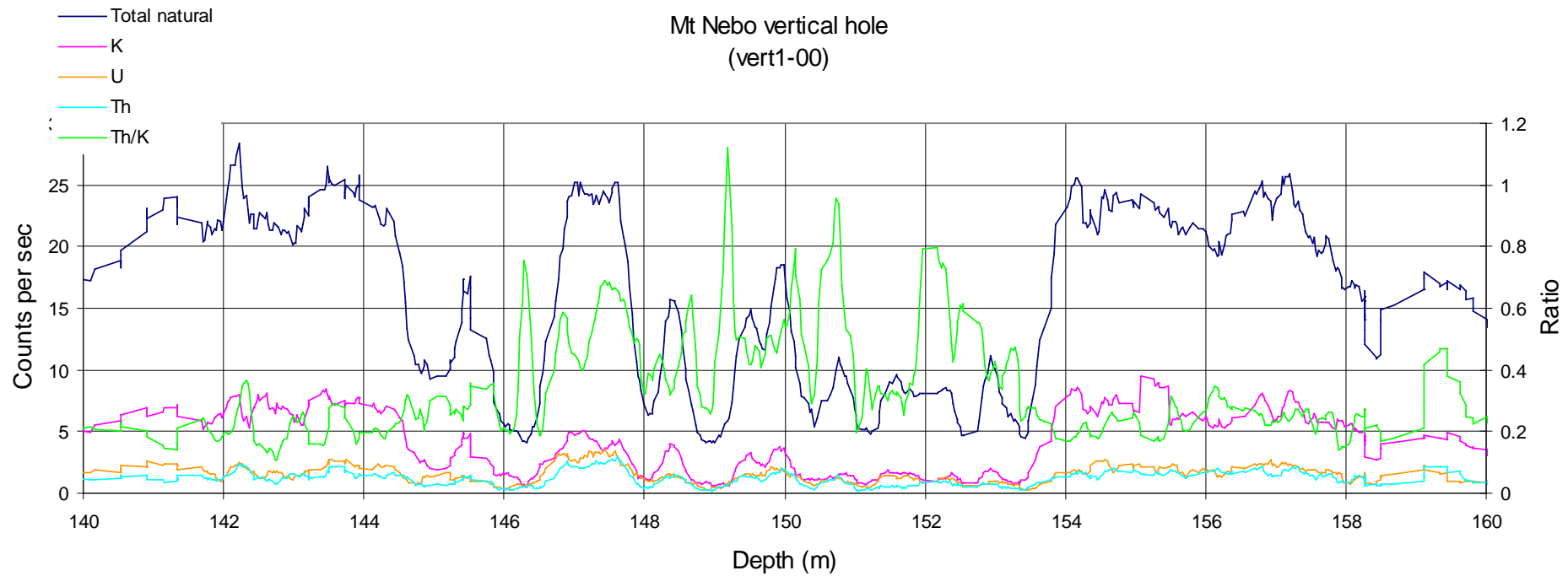
Vertical Seam Position - EM signal Attenuation

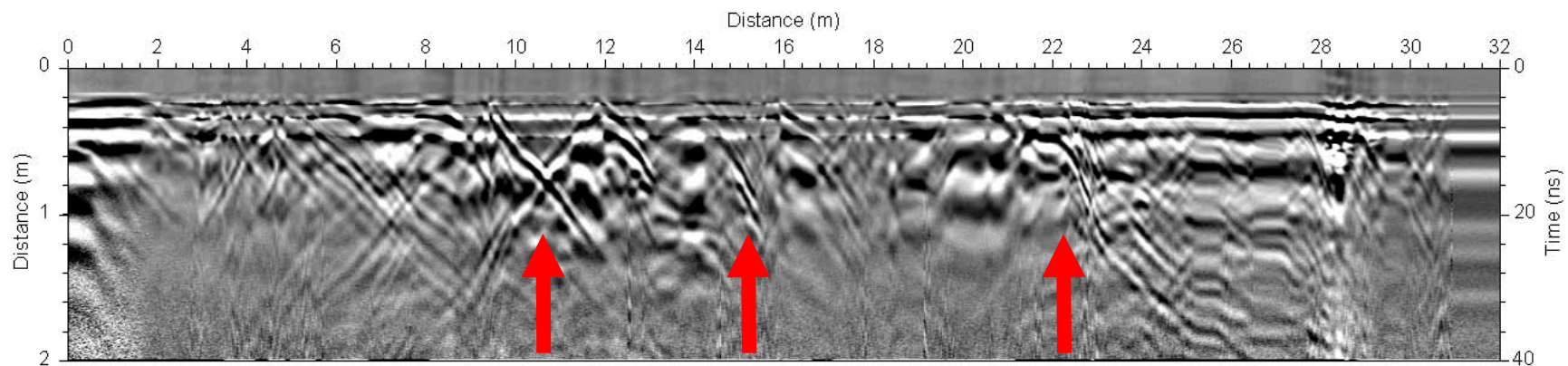
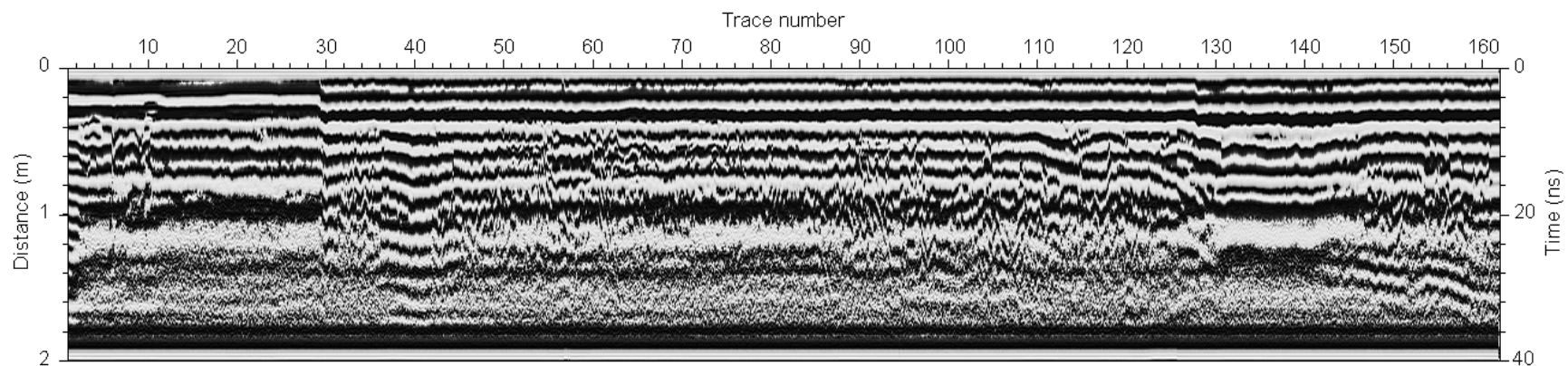
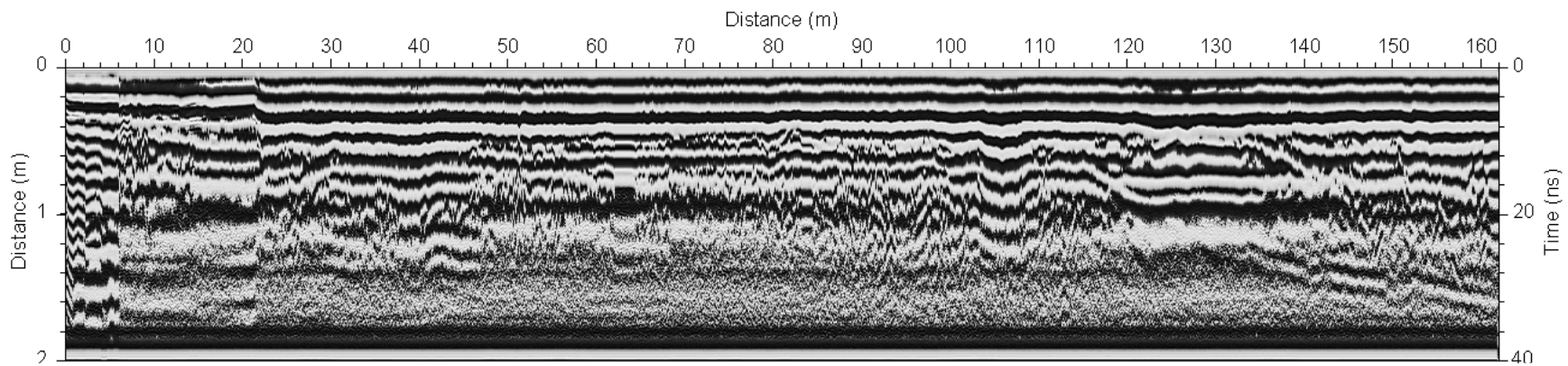


Spectrometric gamma

- CSIRO DEM tool did not perform well, calibration problem
- Spectral work in vertical boreholes at German Ck and elsewhere suggest it should work
- K & Th present related to depositional environments, a 'signature' is possible!

Wongawilli Seam





Outcomes

- Review of technologies has been completed, potential techniques selected
- Trial successfully completed in highwall at German Creek
- Report due out by end of year
- MWD / LWD is now within our grasp – some of this should be routine for MRD & possible for underground drilling



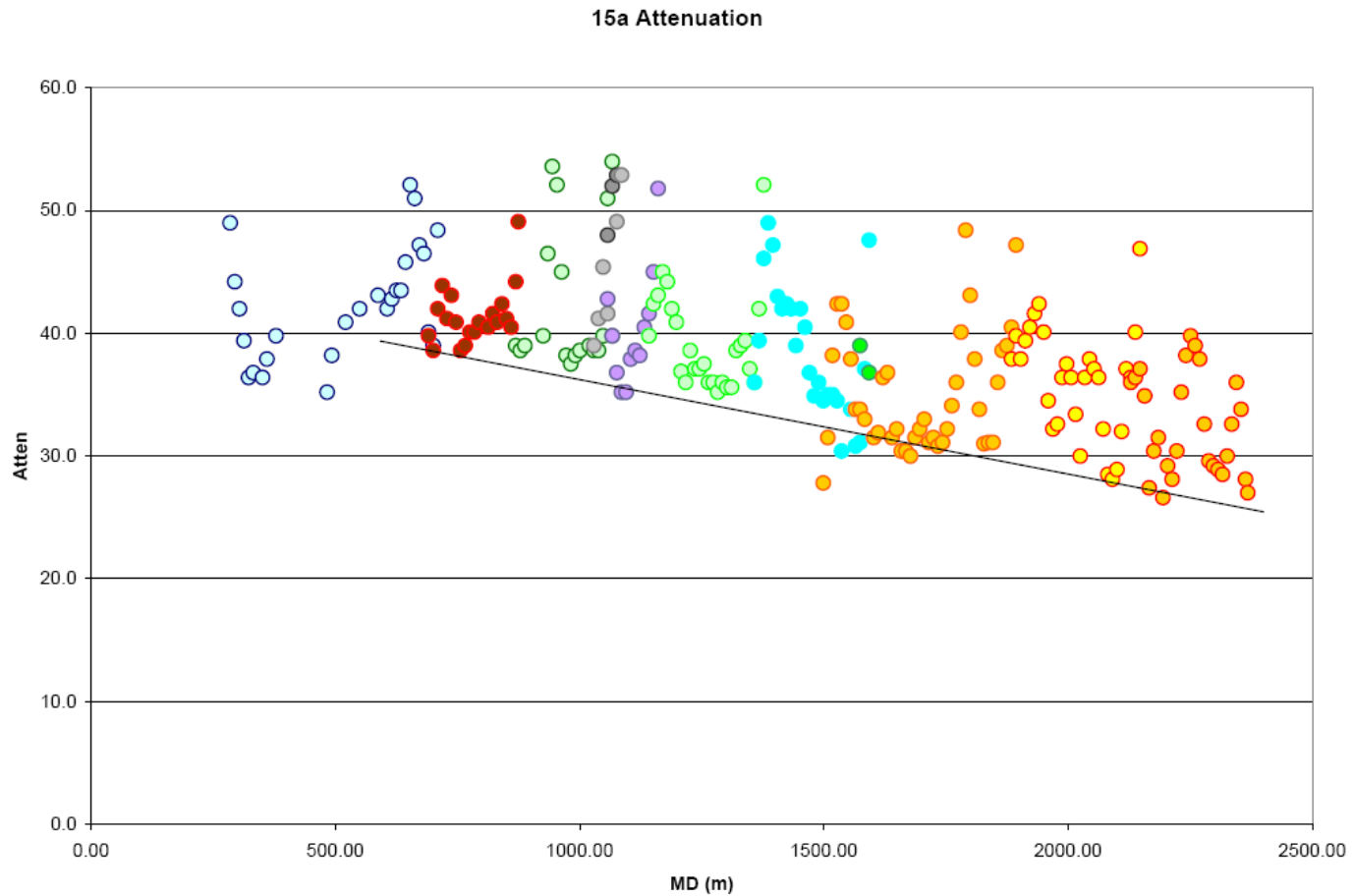
Conclusions

- Density, gamma (directional), dielectric, acoustic caliper all useful – should be part of inseam drilling
- Spectrometric gamma and radar did not perform
 - Radar appears a 'no go' (no more work needed)
 - Spectrometric gamma has potential – needs further development
- No excuses for not integrating at least some of these tools into everyday MRD and underground drilling
 - Mines need to think about how to utilise the new data
 - Drillers need to provide the service
 - Interpretation & flow of data needs to be streamlined
- Need mine ownership on the integration of this data with geological model

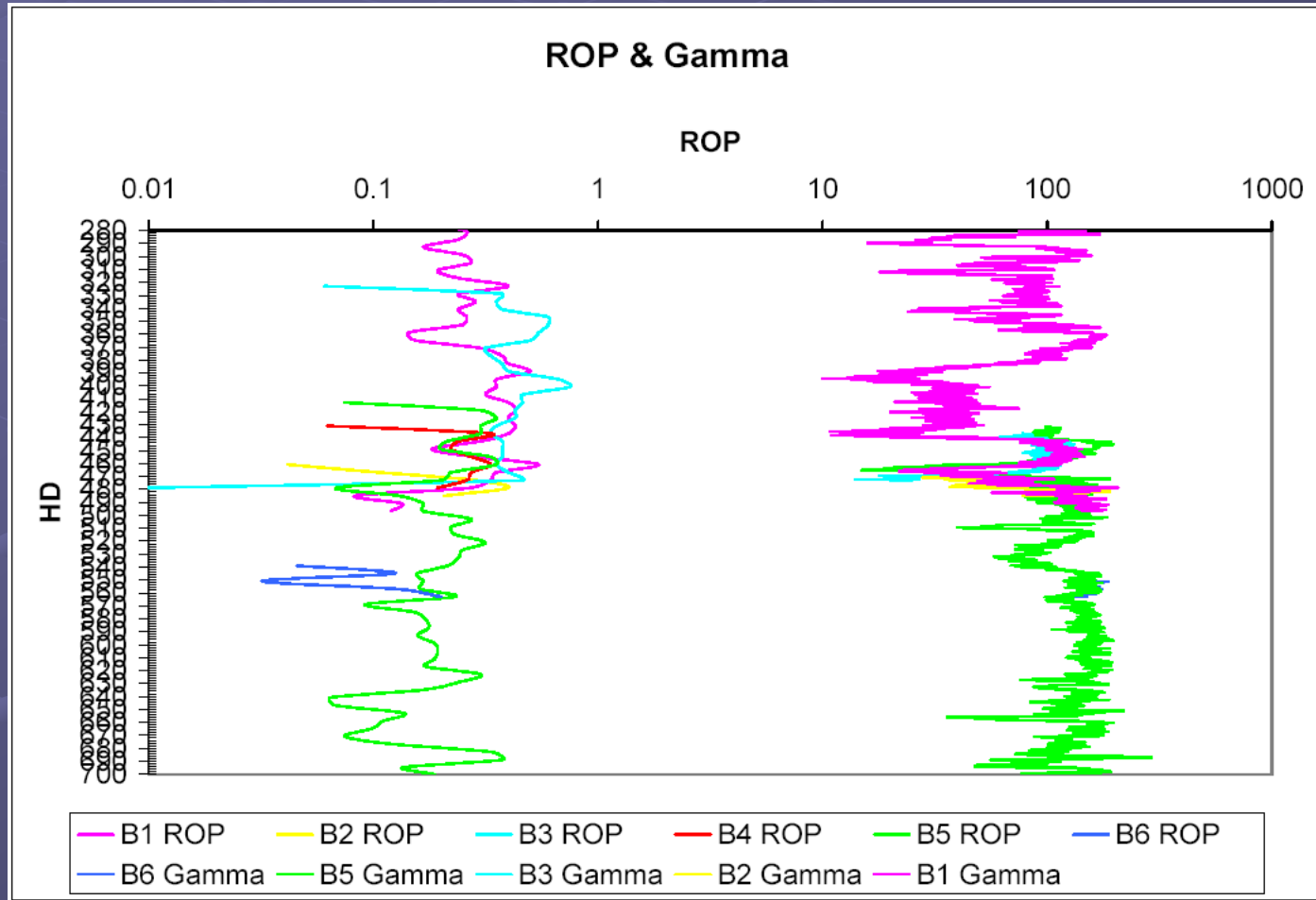
Participants

- CRC Mining (Scott Adam)
 - CoalBed Concepts (Scott T)
 - CSIRO, Exploration & Mining (Peter H)
- AJ Lucas
- Anglo Coal, German Creek (Darren Pisters)
- DMT
- CSIRO TIP
- Auslog

Profiling using EM signal



The 'here and now', ROP and gamma



Once you have the data, then you can image it ...

● Data Vs window
Angle Vs depth
“See” the borehole wall

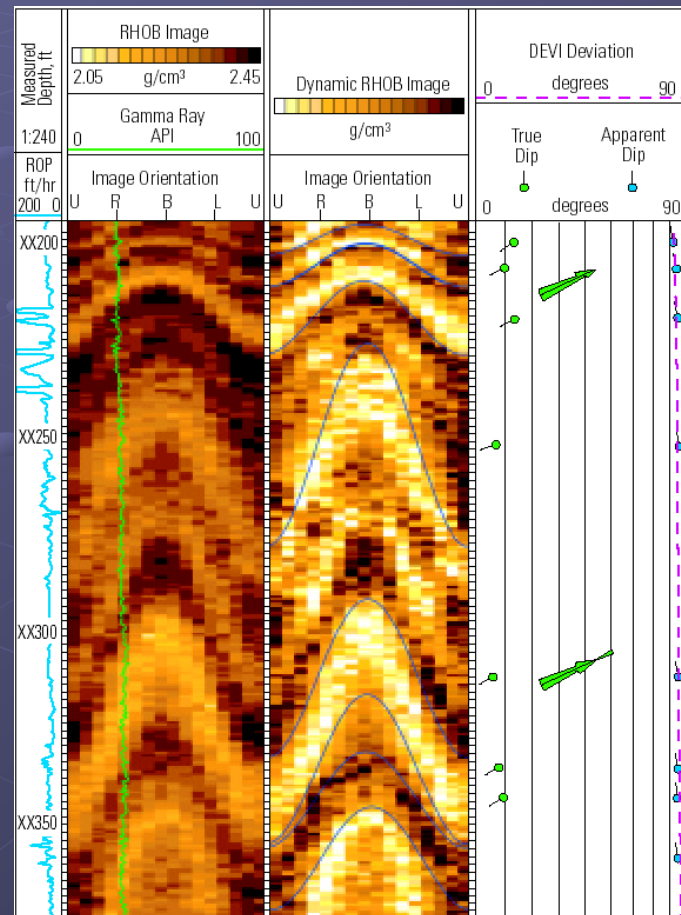
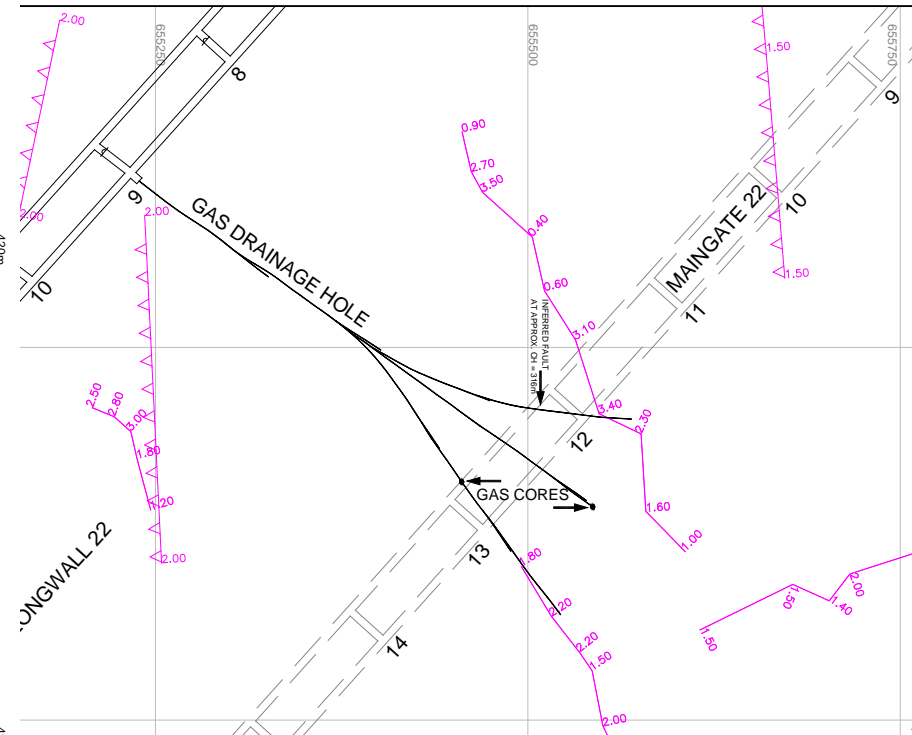
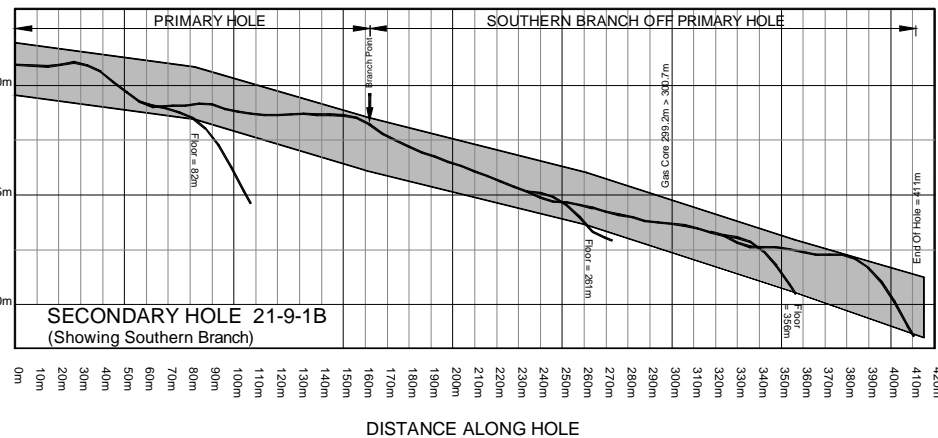
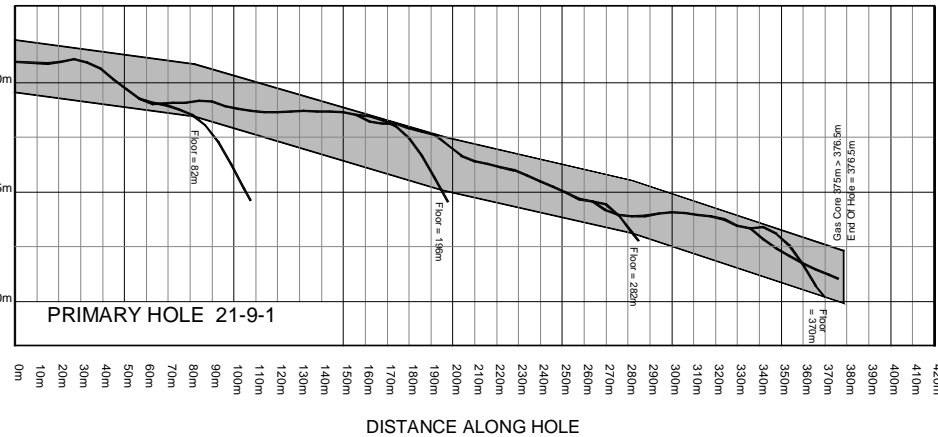
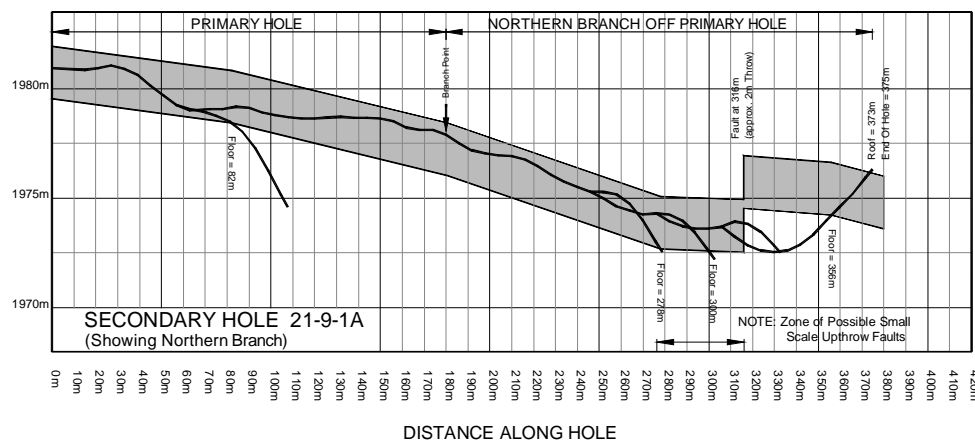


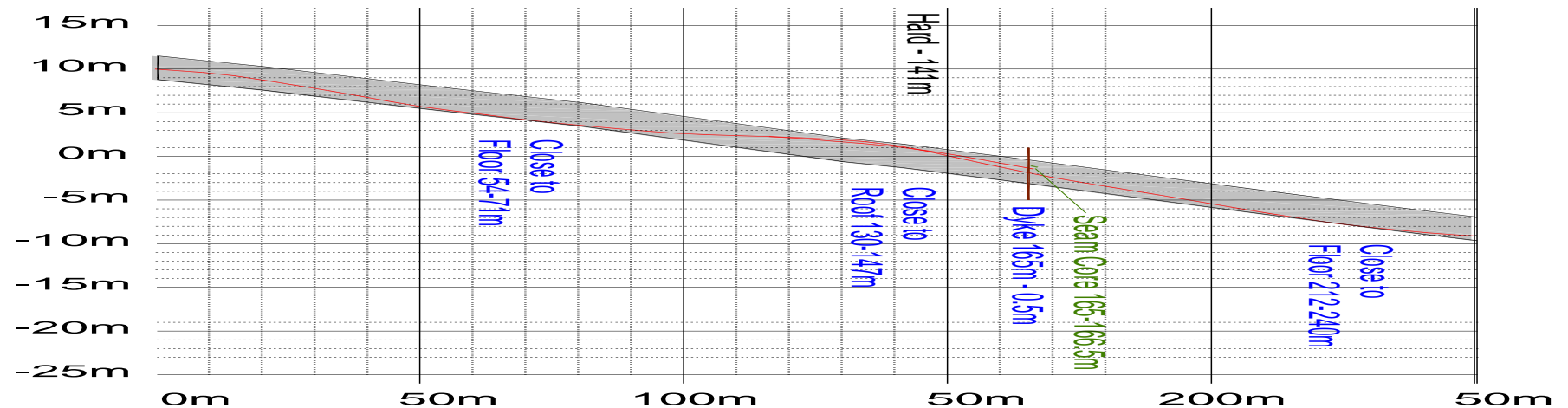
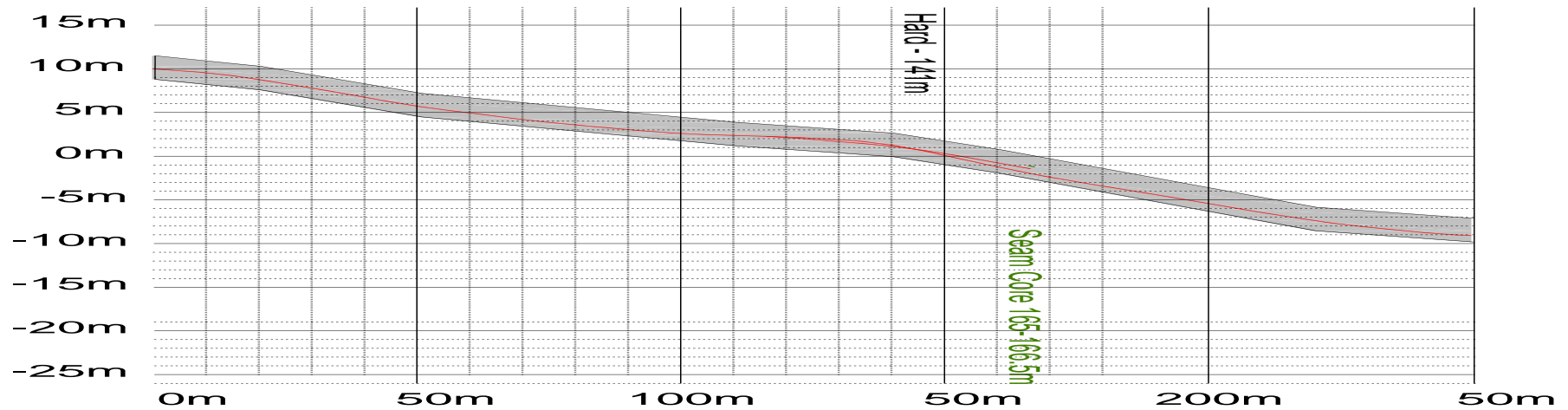
Image from Schlumberger

Gas drainage drilling

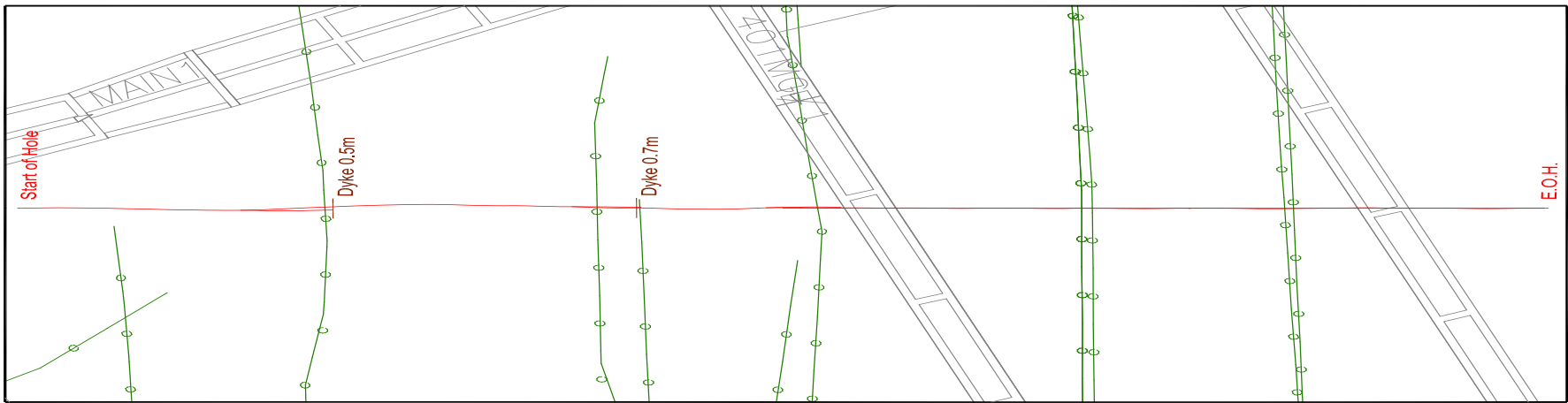


Structures shown in **PURPLE**, are Inferred from either Seismic Work or Borehole Data.

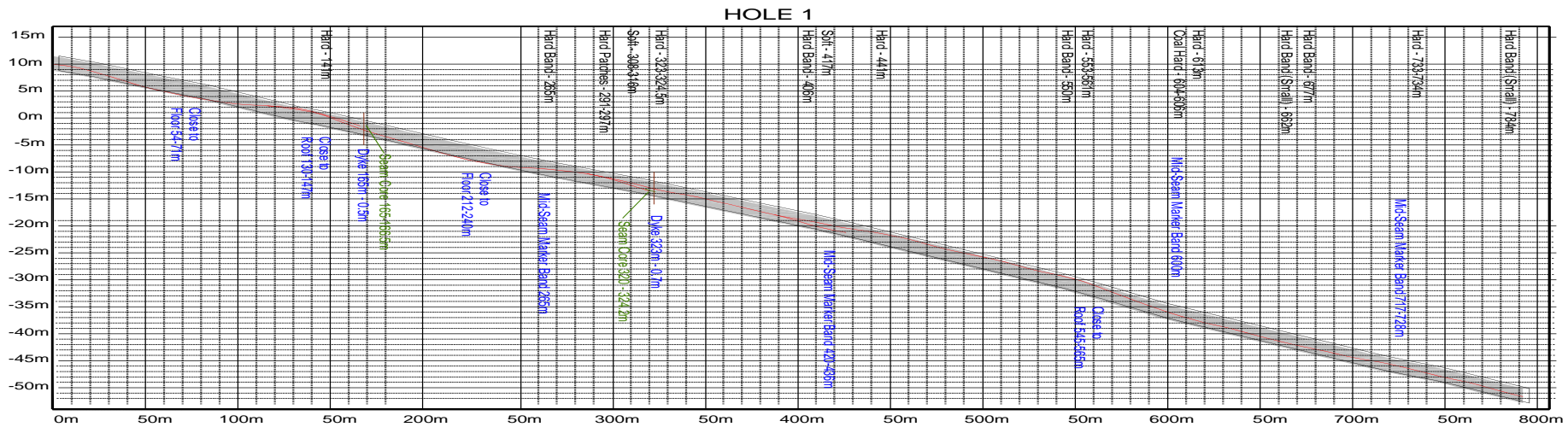
Test hole section – BG & AG

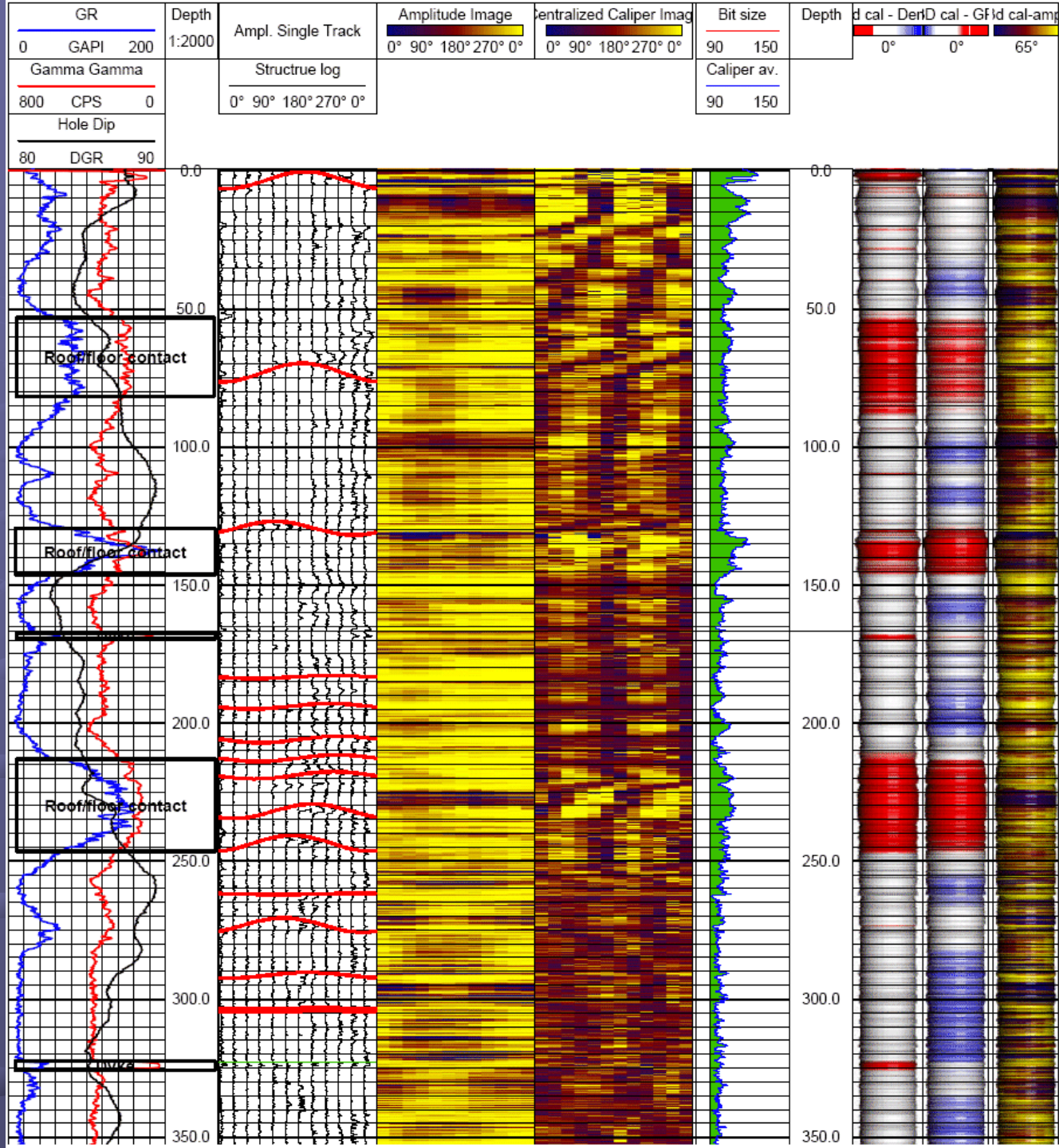


Test hole

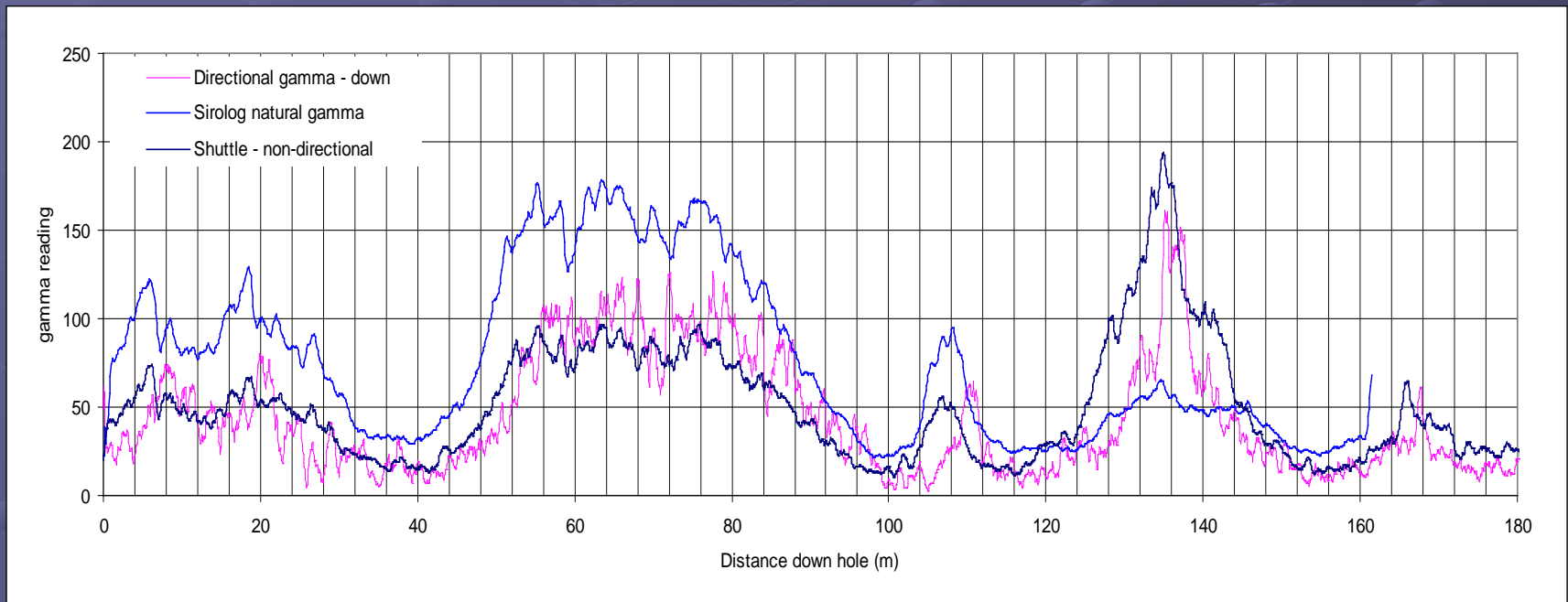


Structure shown in Green in Project Dykes
Structure in Brown, is "As Drilled" Dykes





Comparison of gamma readings



- Sirolog, DMT shuttle comparison
- All three gamma loggers similar
- Sirolog loses the plot near end of hole

Questions

John Hanes – does anyone have plans to advance the tools or to provide logging services?

Peter – We gave recommendations on this in our report to ACARP, but we have not yet had a reply from the ACARP monitors. If ACARP wish to advance borehole logging, it can be done, but I am not sure of the mechanics of doing so.

Henk Verhoef, AMT – The tools you described were pump-down tools which need to be run after drilling finishes. I do not believe they can be incorporated into the string for use while drilling.

Peter – I agree. In the context of petroleum drilling, the tools sit behind the bit. In our trial, the aim was to test the technology.

Henk – It is a very difficult task to downsize oilfield technology.

Peter – Adapting the gamma tool should be relatively easy.

Henk – In underground drilling, the tool needs to be incorporated into the string and used while drilling. We already can incorporate gamma in our survey tool, but the others are very difficult if not impossible to incorporate into the string. The big problem is that the market for any devices is very small.

Peter – If the gamma can be used, it will generate some useful data, but if a density tool could be run it would be even better. The concern is with a density tool and its radioactive source becoming stuck. However, the potential for this problem exists in vertical hole exploration drilling and it hardly occurs. If a density tool is stuck in a vertical hole, it must be recovered or the coal around it is sterilised for mining.

David Carey – If you can prove that the coal to be mined is free from structures, then outburst management is easier with higher thresholds. Surely this is a good incentive for mining companies to support development of geophysical logging in underground holes.

Peter – In the trial, several dykes had been predicted from surface geophysics in the ground to be covered. The logging showed that only a couple of the predicted dykes actually occurred. So the mine got good financial benefit from the logging of the hole.