Coal Interface Detection

(Comparative study of in-seam surveying technology)
ACARP project C12024

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Participants

- CRC Mining (Scott Adam)
  - CoalBed Concepts (Scott T)
  - CSIRO, Exploration & Mining (Peter H)

- AJ Lucas
- Anglo Coal, German Creek
- DMT
- CSIRO TIP
- Auslog

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
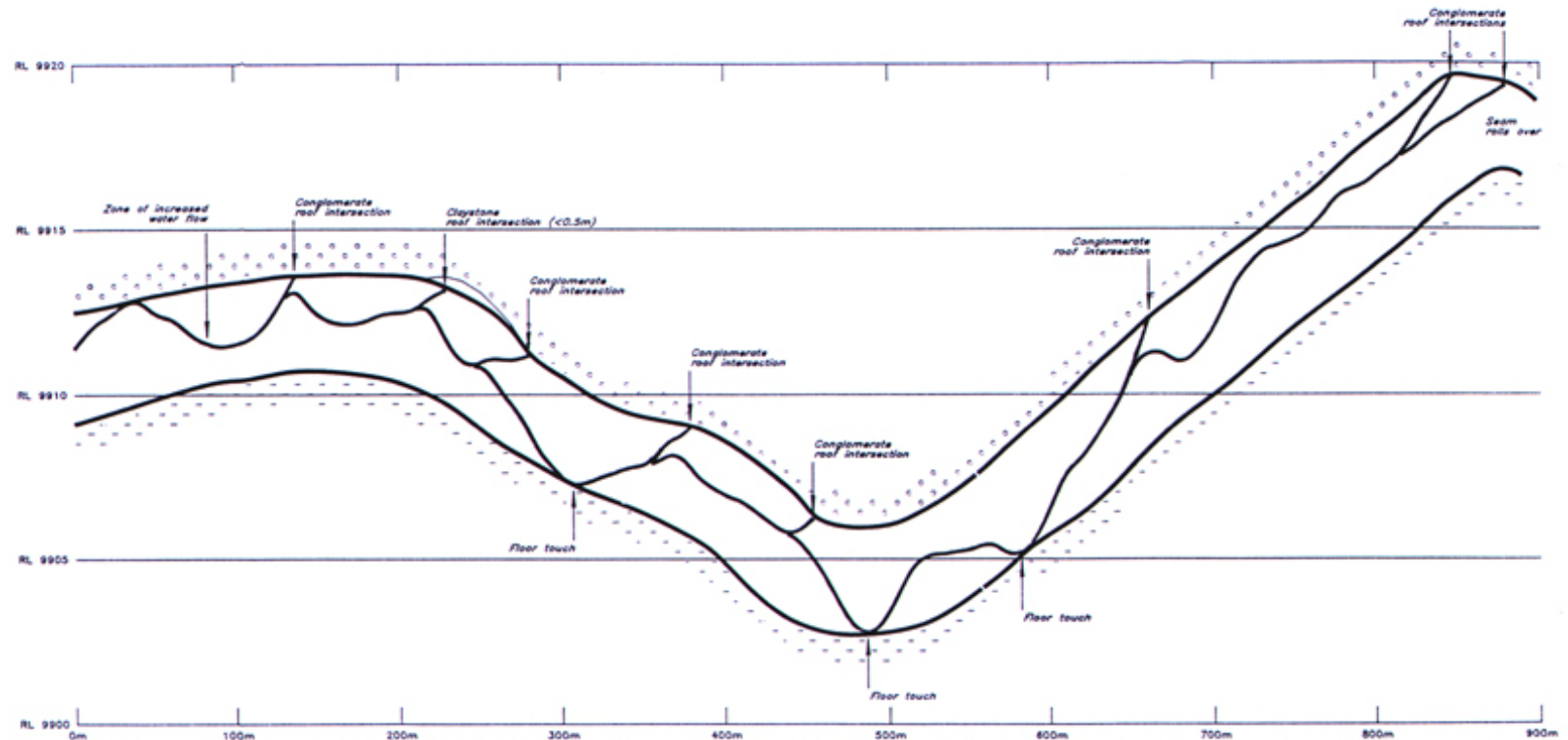
Objectives of project

- 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
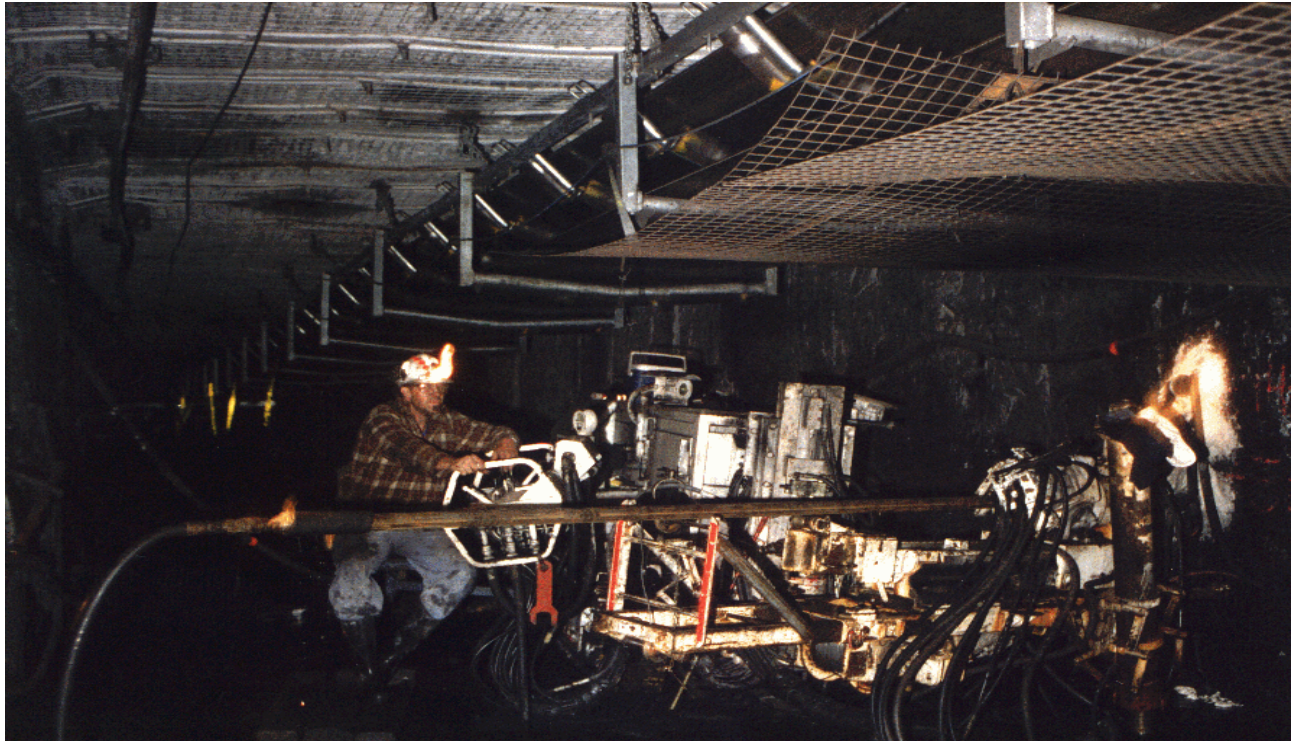 - Spectrometric gamma
  - Directional gamma

Outcomes

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

Inseam drilling practice

- 75kW rigs, downhole motors, NQ drill pipe and electronic survey tools

- Hand written logs, 'hard', 'sticky', 'white', 'boggy' etc.

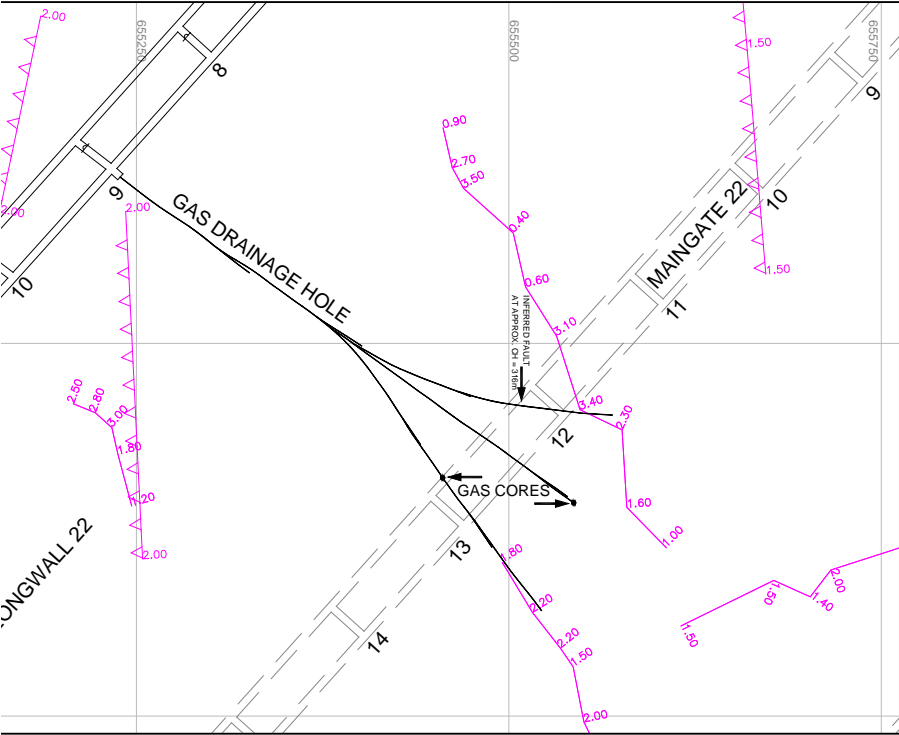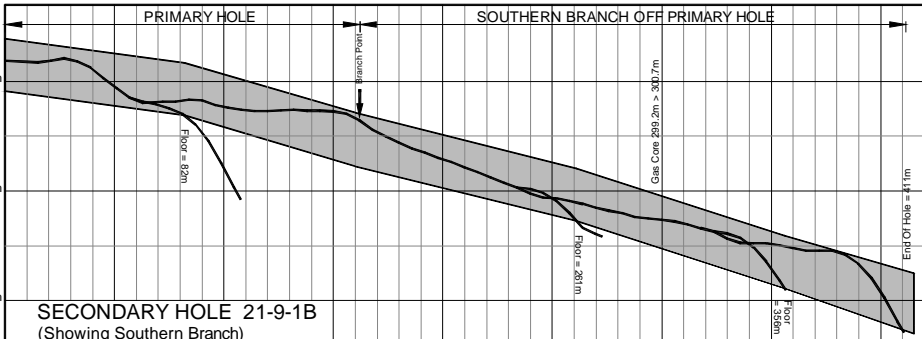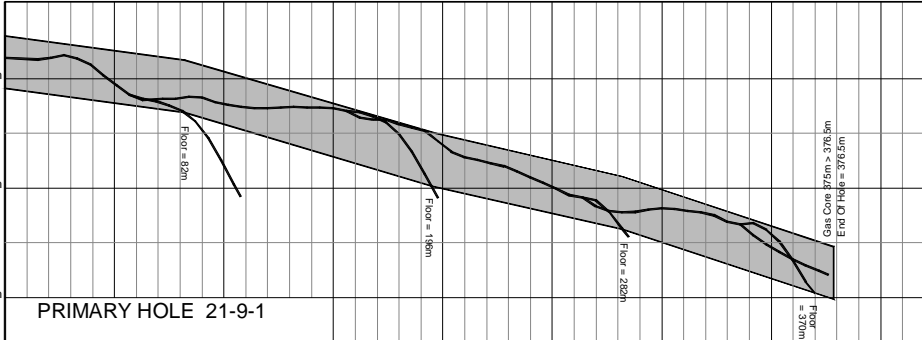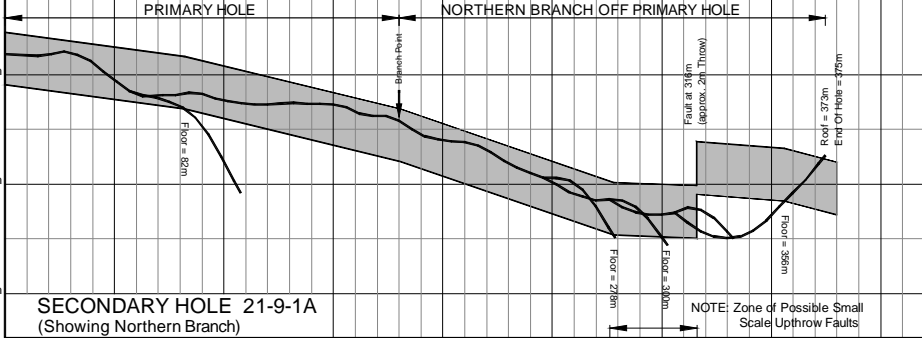- Periodic deliberate, and unscheduled roof and floor touches

Downhole Motor and Bit

Drill rods with MECCA connection

Gas drainage drilling

SECONDARY HOLE 21-9-1A
(Showing Northern Branch)

PRIMARY HOLE | NORTHERN BRANCH OFF PRIMARY HOLE

Floor = 82m
Branch Point
Fault at 316m (approx. 2m Throw)
Roof = 373m
End Of Hole = 375m
Floor = 278m
Floor = 300m
Floor = 356m
NOTE: Zone of Possible Small Scale Upthrow Faults

DISTANCE ALONG HOLE

PRIMARY HOLE 21-9-1

Floor = 82m
Floor = 196m
Floor = 282m
Floor = 370m
Gas Core 375m > 376.5m
End Of Hole = 376.5m

DISTANCE ALONG HOLE

SECONDARY HOLE 21-9-1B
(Showing Southern Branch)

PRIMARY HOLE | SOUTHERN BRANCH OFF PRIMARY HOLE

Floor = 82m
Branch Point
Floor = 261m
Floor = 356m
Gas Core 329.2m > 330.7m
End Of Hole = 411m

DISTANCE ALONG HOLE

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

What does it all mean?
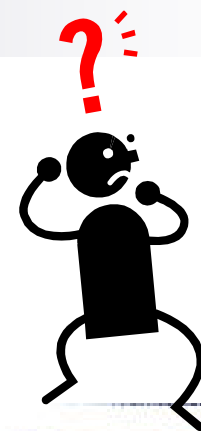
Rod No.	DEPTH From	DEPTH To	COMMENTS	SURVEY Orientation	Depth	Direction	Dip	D/track	Left/Right	Up/Down
2	441	447	coal forward	8.	444	140.0	2.6	443.5	0.3L	17.4u
	447	453	COAL/HARD @ 450n DYKE. MAYBE ½m thick - LIGHT GREY.	317	450.	140.9	3.6	449.3	0.3L	17.8u
	453	459	Coal (Hard) then Grey to white @ 456	348	456	141.2	3.9	455.2	.3L	19.2
	459	465	Coal @459 then White @ 459/Hard	35	462	142.4	4.4	461.2	.2L	18.6
	465	471	Hard light grey & white, Some Soft @ 468 light grey.	Bands 264	468	141.6	4.2	467.2	-1L	19.1
	471	477	Hard @ 472 Soft @ 473.5 White: White grey	294	474	140.0	3.1	473.2	+1L	19.4u
	477	483	Hard @ 480 Dark grey Brown) Black	93	480	141.3	2.9	479.2	-1L	19.8u
	483	489	Coal Grey @ 484 Dark Grey @ 486	205	486	140.9	2.7	485.1	-.0	20.1
	489	495	Dark Grey Hard. Some Brown /Black	40	492	141.2	3.3	491.1	O	20.4
	495	501	Coal Very Soft @ 496 Dark grey Hard	305	498	140.9	3.4	497.1	O	20.7
	501	507	Coal	294	504	138.5	2.6	503.1	.1L	20.1u
	507	513	Coal V Hard @ 511 V Hard grey	17	510	138.7	3.1	509.1	.3L	21.4
	513	519	W Hard light grey (Softer @ 317 coal)	51	516	142.7	3.9	515.1	-3L	21.7
	519	525	Coal	278	522	141.1	3.7	521.1	-.2	22.1
	525	531	Coal Hard @ 528 Softer @ 529	45	529	139.7	.2.7	527.1	-.2	22.5
	531	537	Hard Coal	65	534	140.0	3.3	535.1	.3	22.8
	537	543	Hard @ 539.	72	540	140.5	3.3	539.1	.4	23.1
	543	549	light Brown/Grey Hard .		546	Not Surveyed				
		596							FINAL DEPTH IF HOLE	

# Turning the sow's ear into a silk purse …
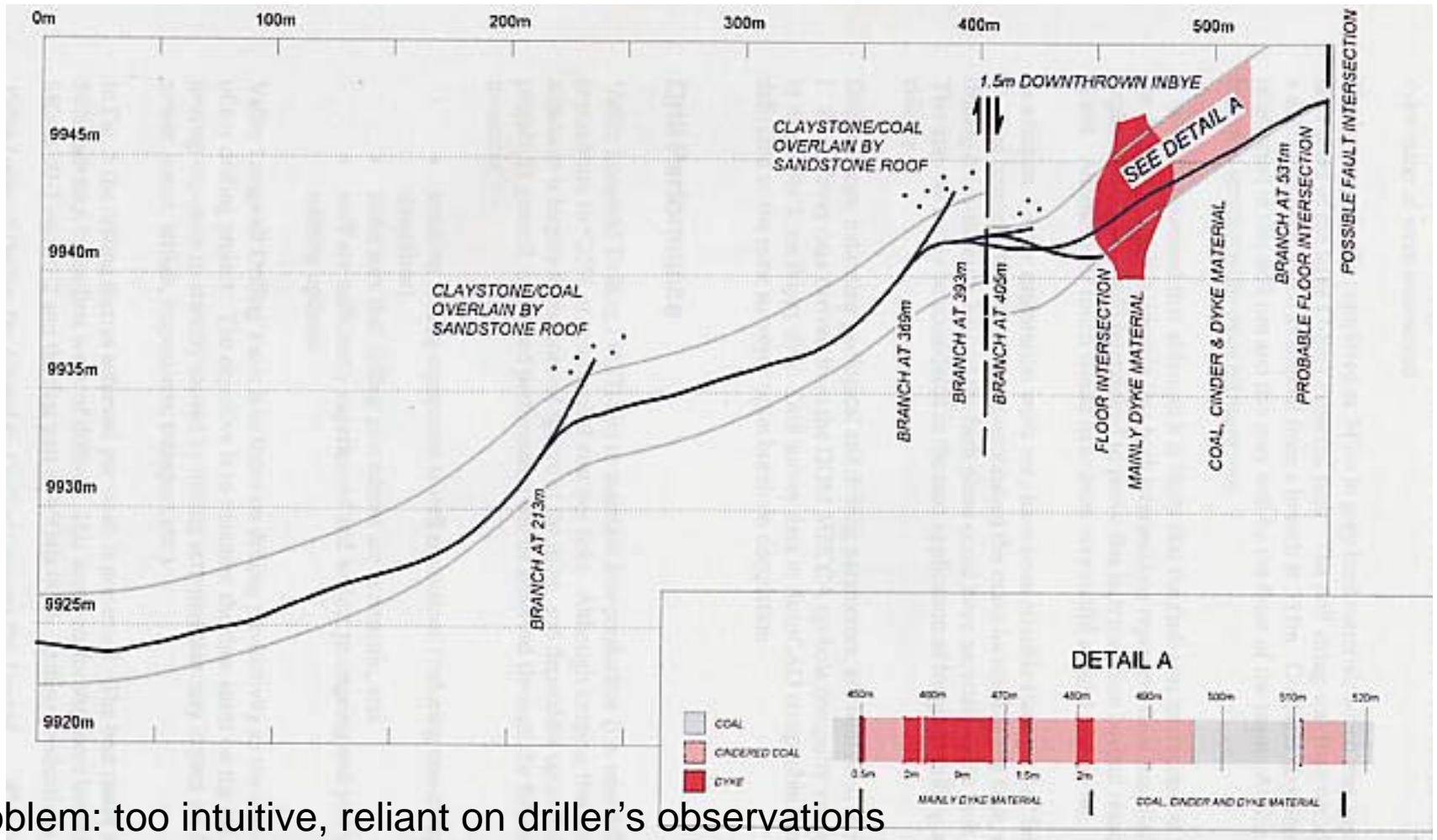
Problem: too intuitive, reliant on driller's observations
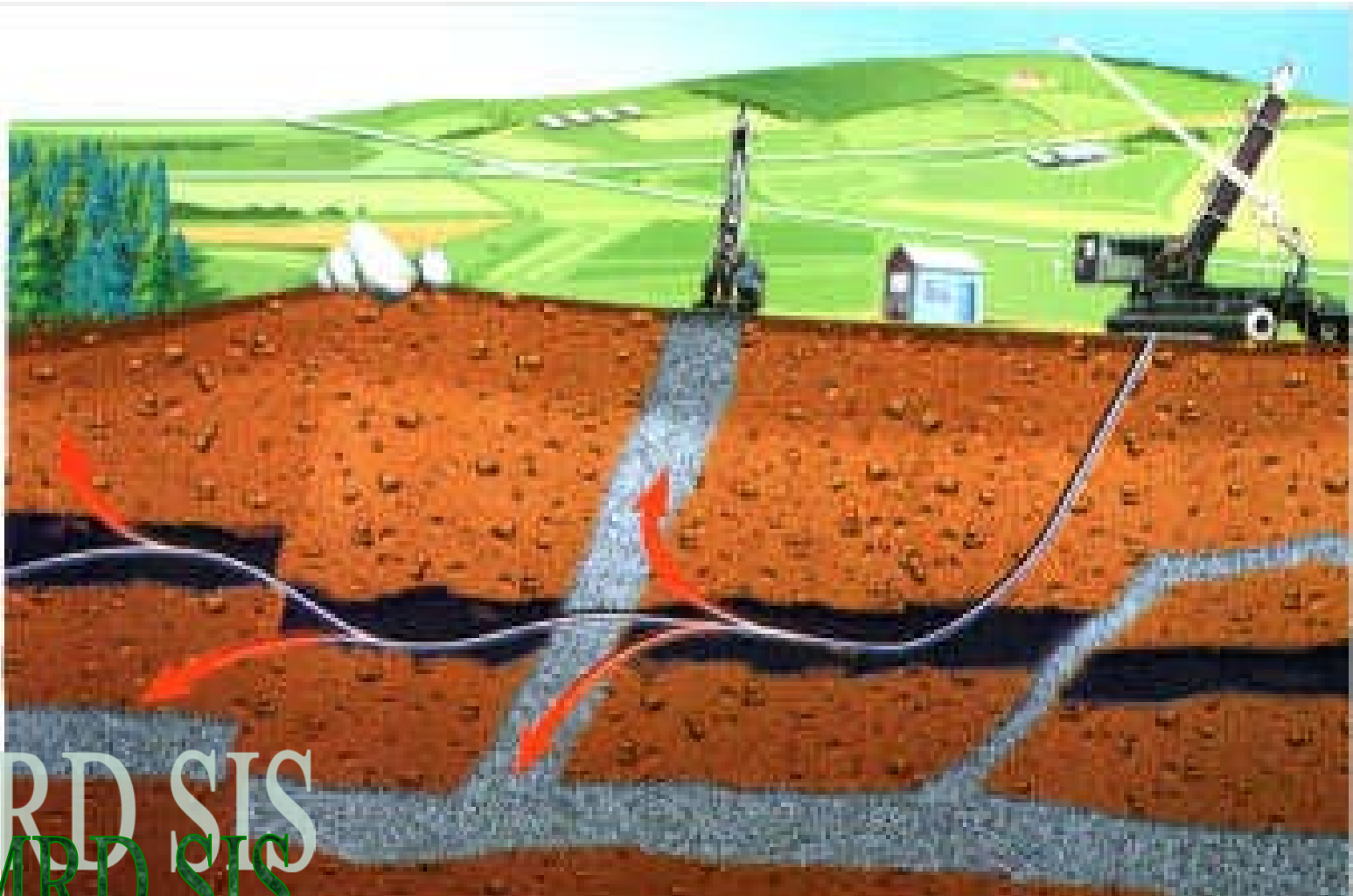
Current weaknesses

- 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
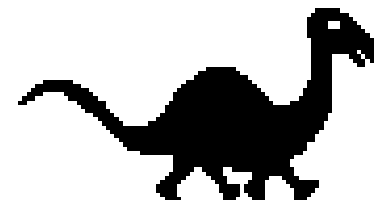
Coal drilling from surface ...

MRD taps into civil & oilfield products

Rack and pinion drive

9m external upset drill pipe

Current weaknesses

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

Note: profiling (CID) problem largely solved

The trial …

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

Happy researchers

Five minutes later

The aftermath …

German Creek high wall
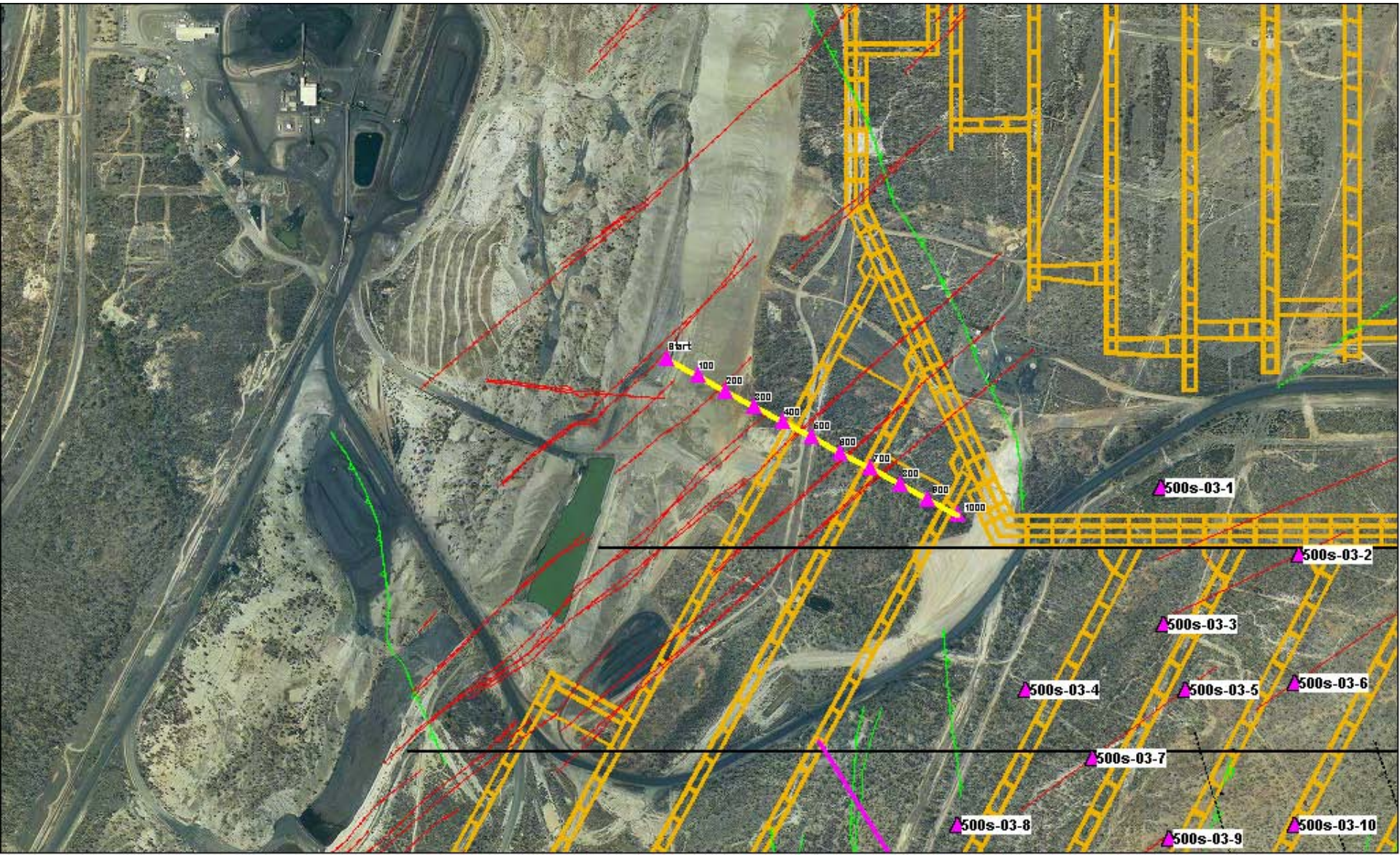
CID technologies trialled at German Creek:

- 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.
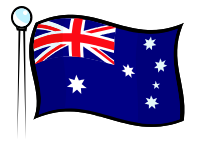
Phase 1: Directional gamma

German Creek vertical hole DD485

German Creek Seam
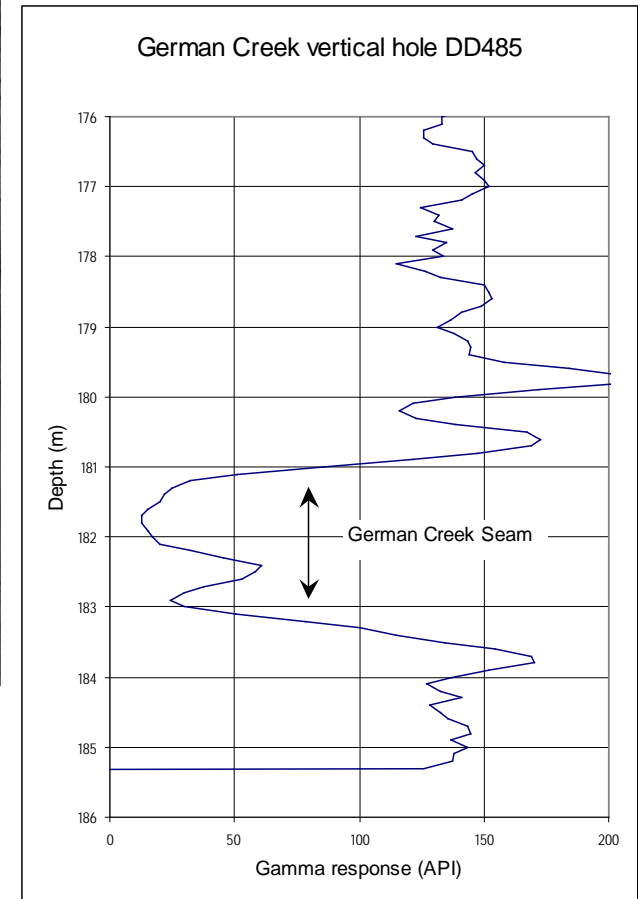
Directional Gamma

Test hole section – BG & AG

Test hole

Structure shown in Green in Project Dykes
Structure in Brown, is "As Drilled" Dykes
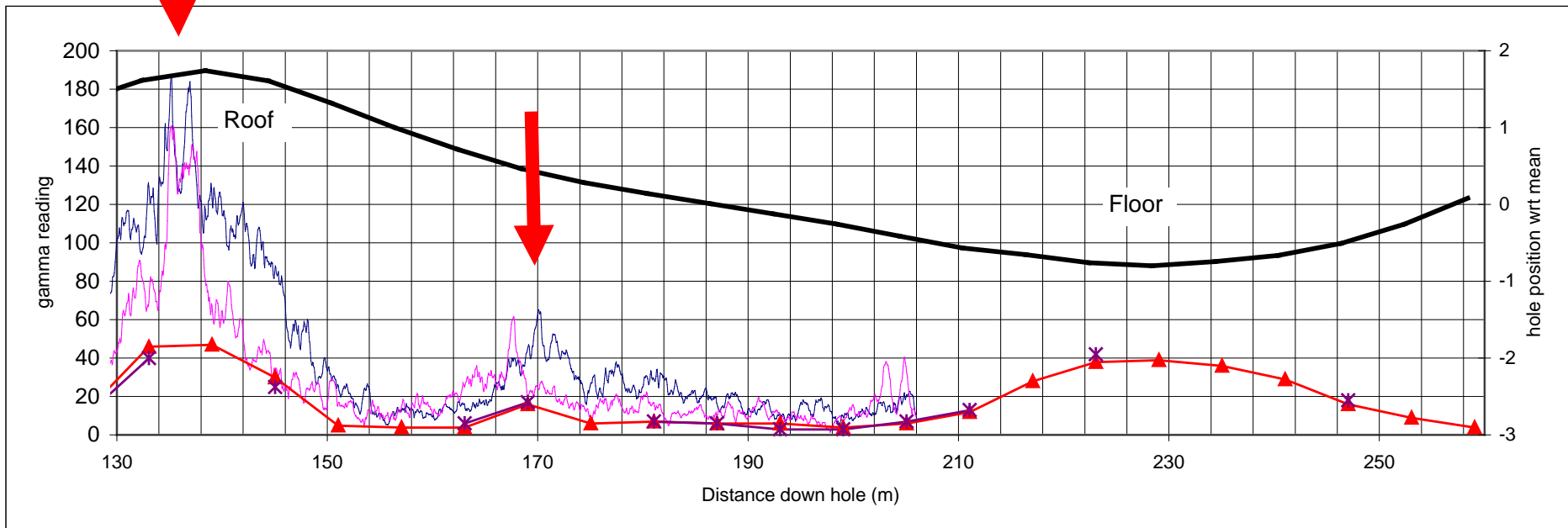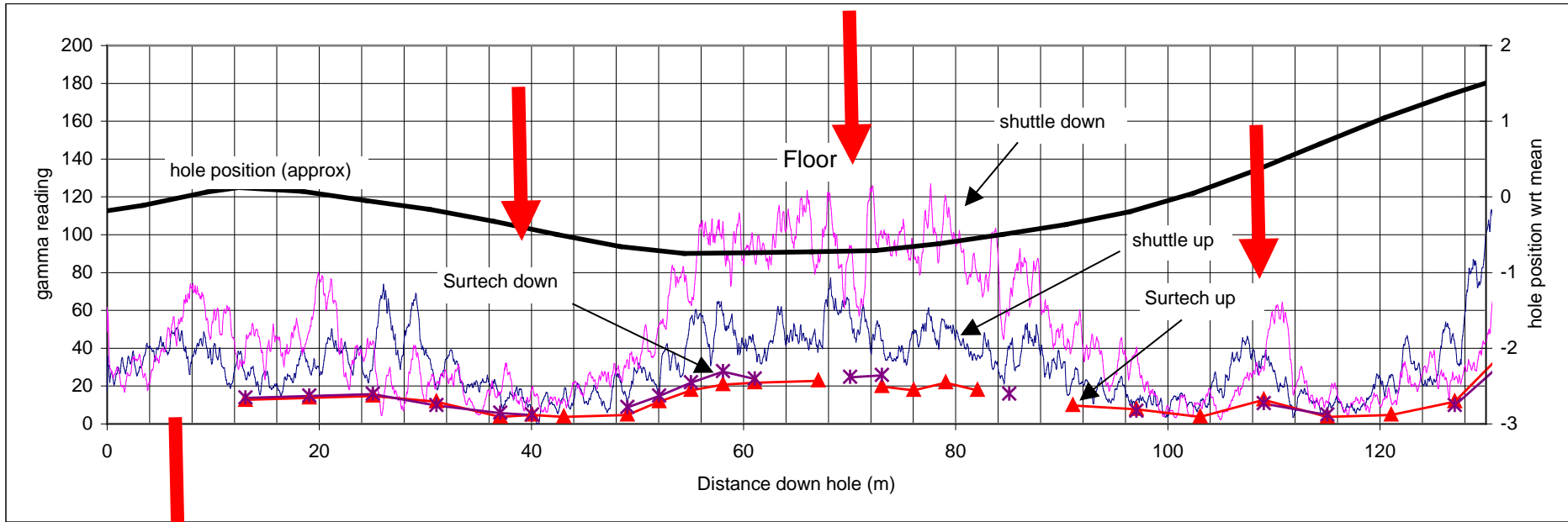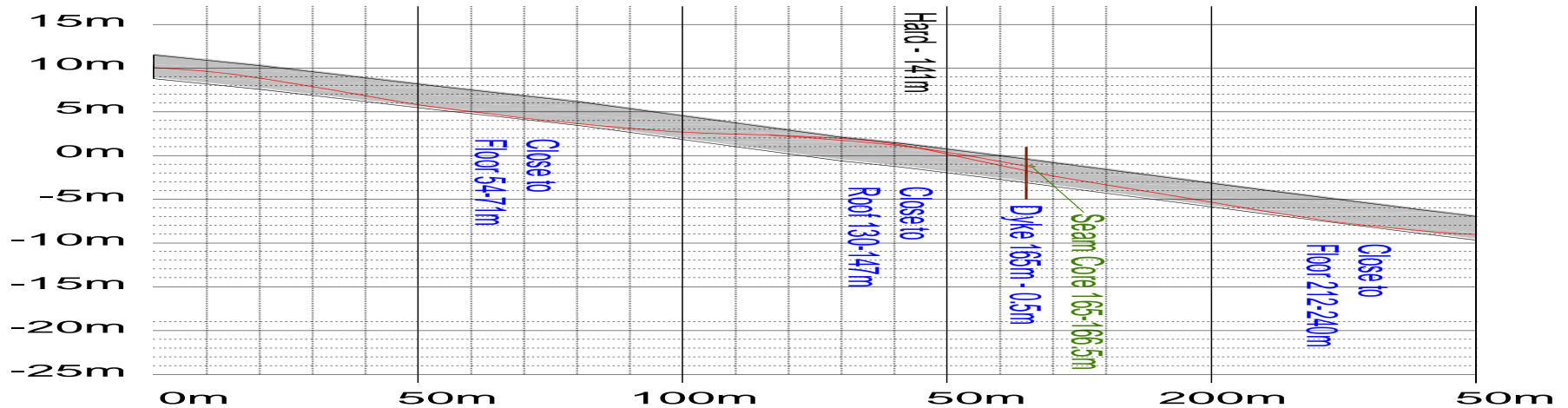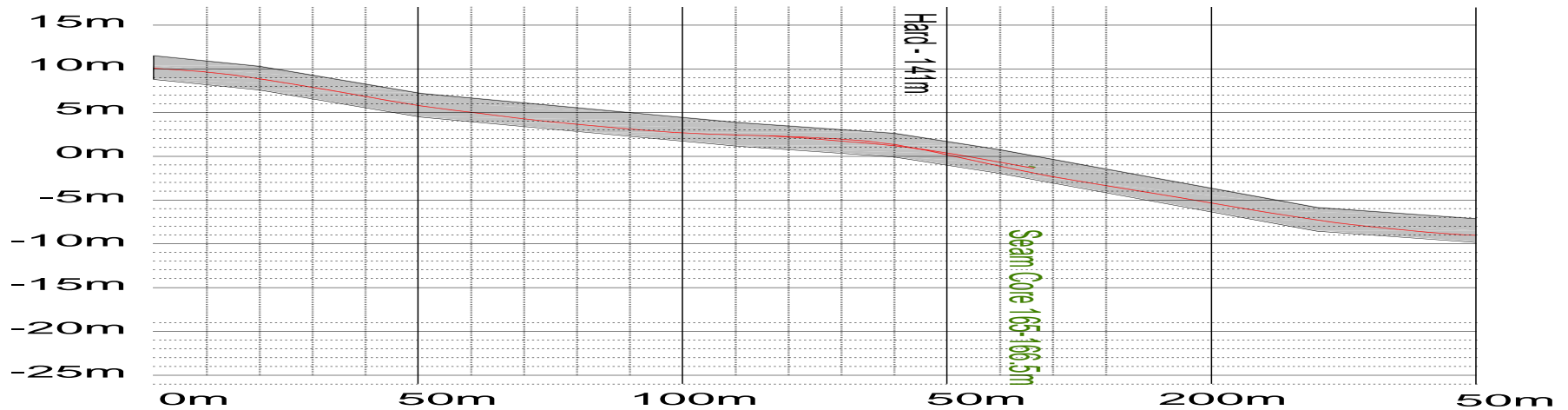
Comparison of gamma readings
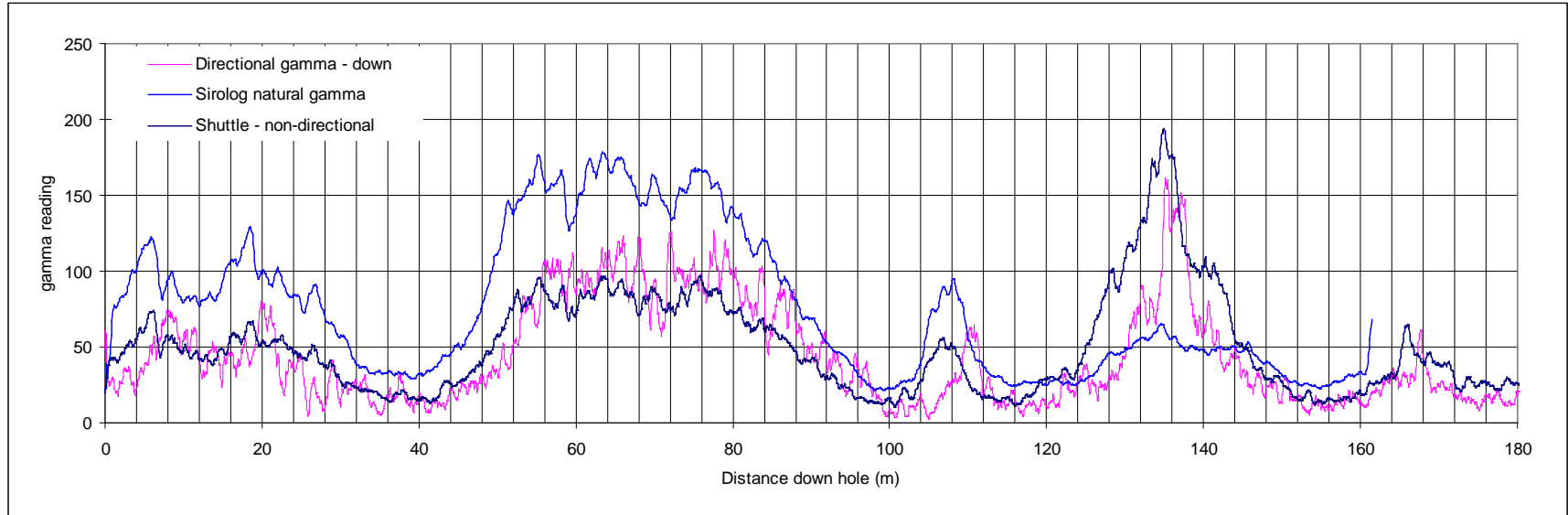
- Sirolog, DMT shuttle comparison
- All three gamma loggers similar
- Sirolog loses the plot near end of hole

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!
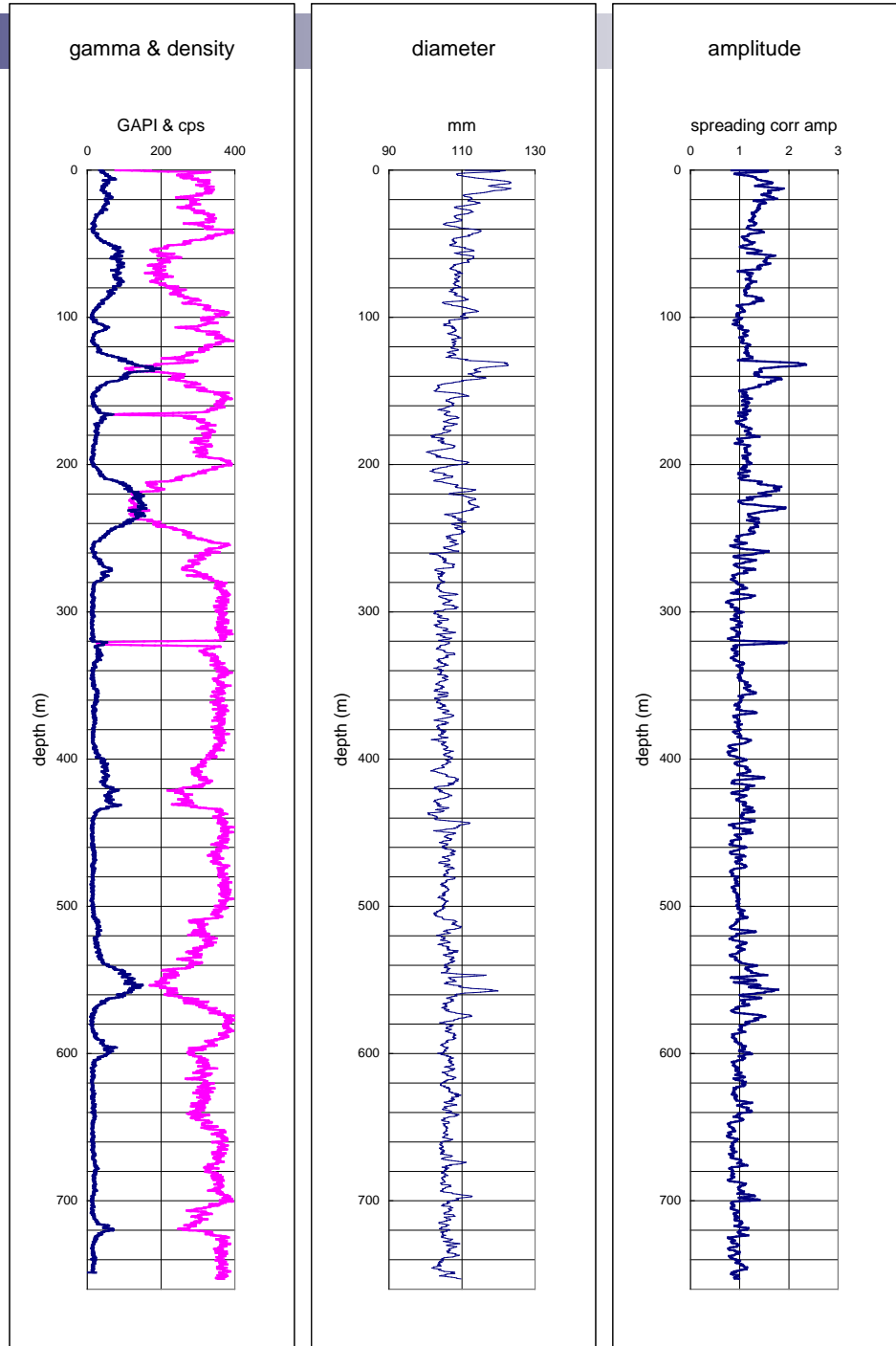
Gamma & density
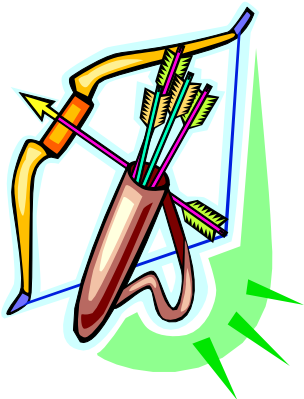
DMT Shuttle WellCAD display
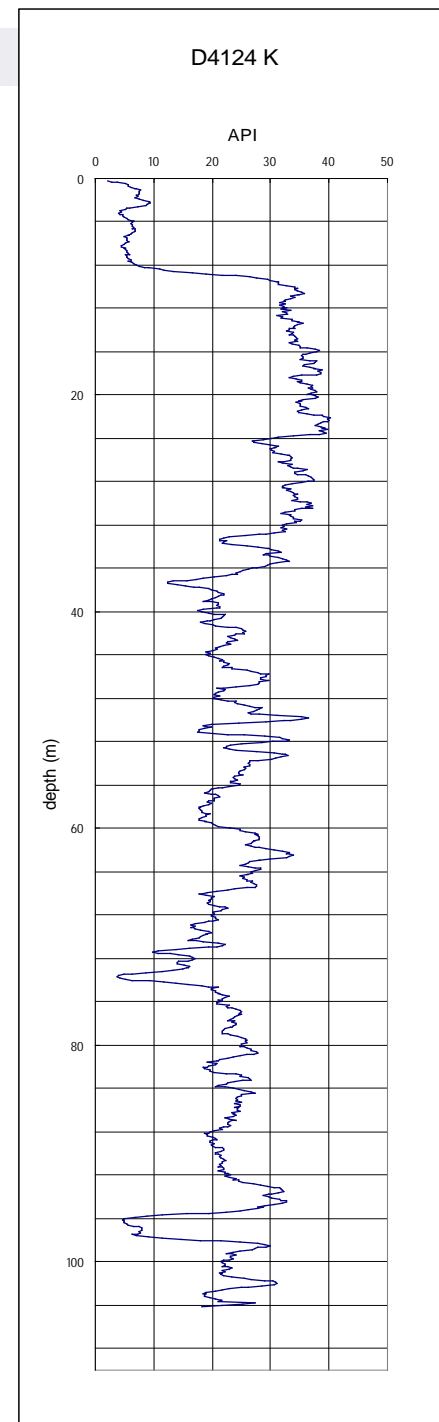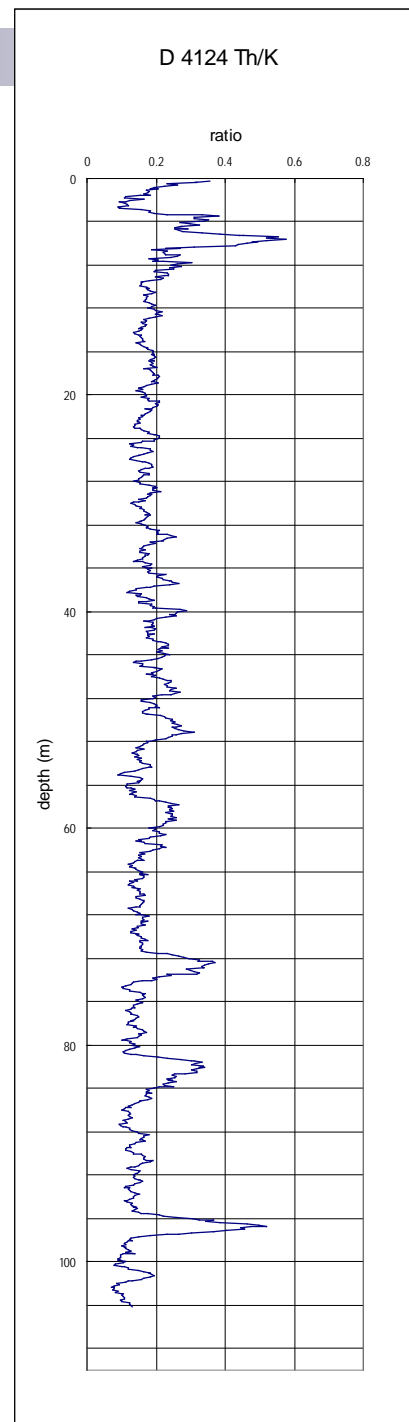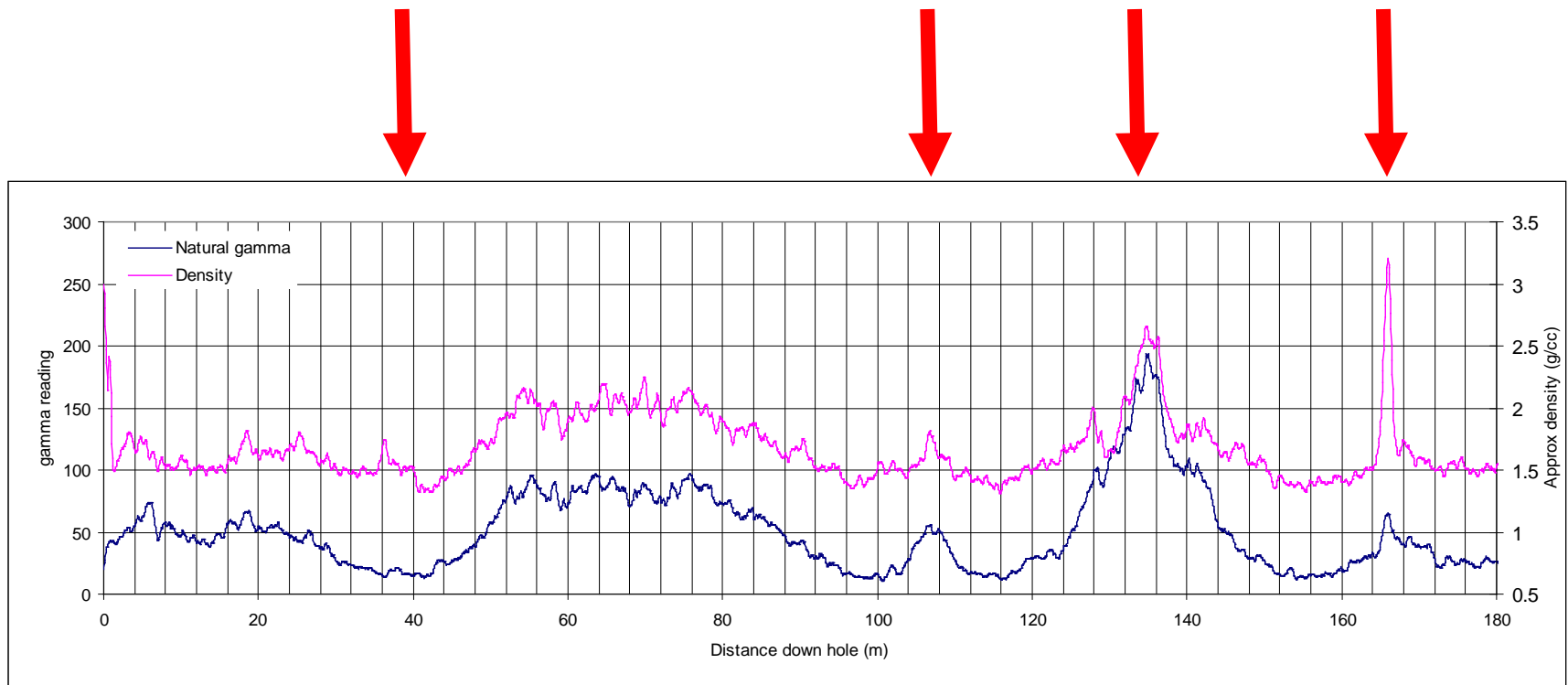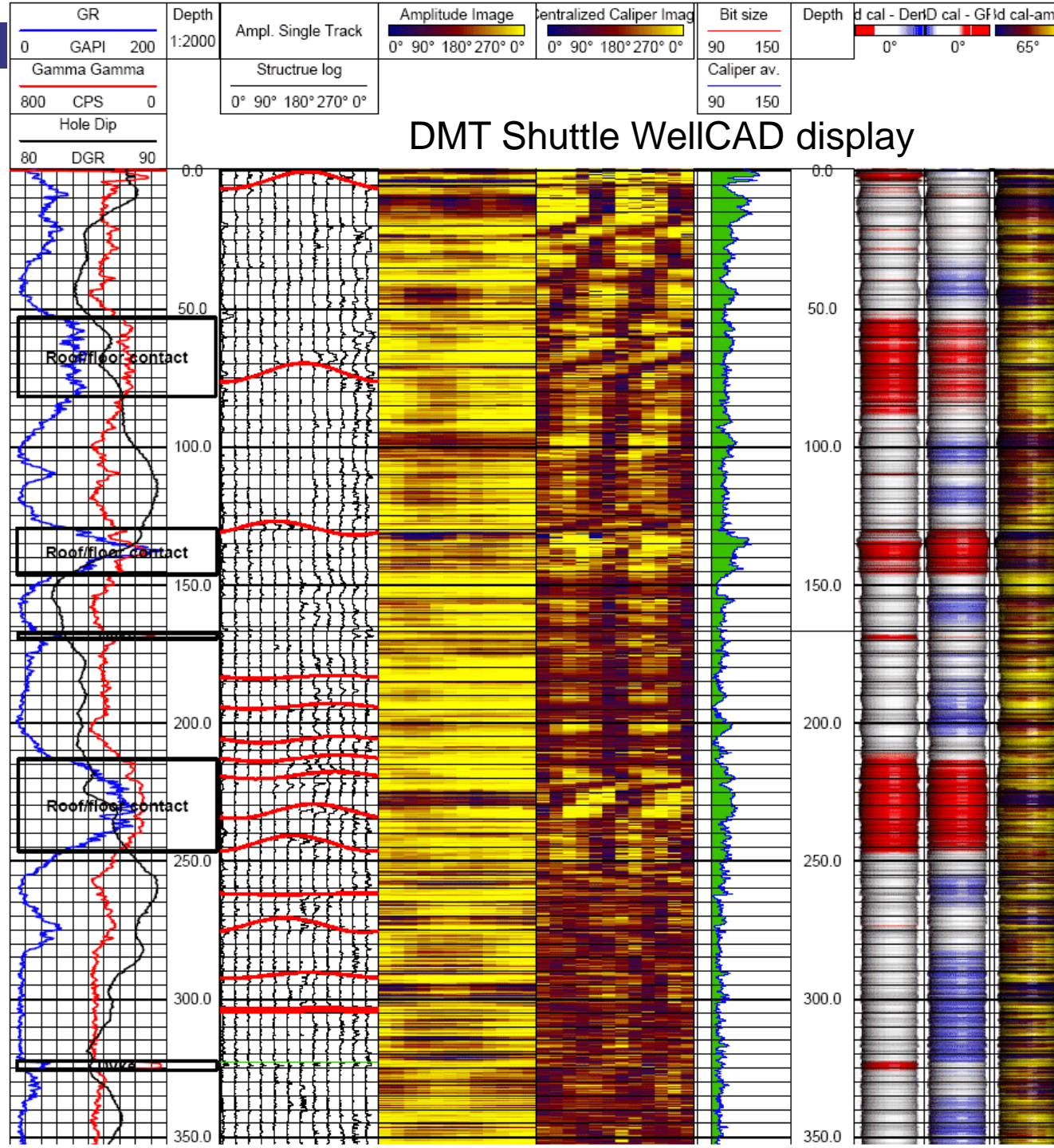
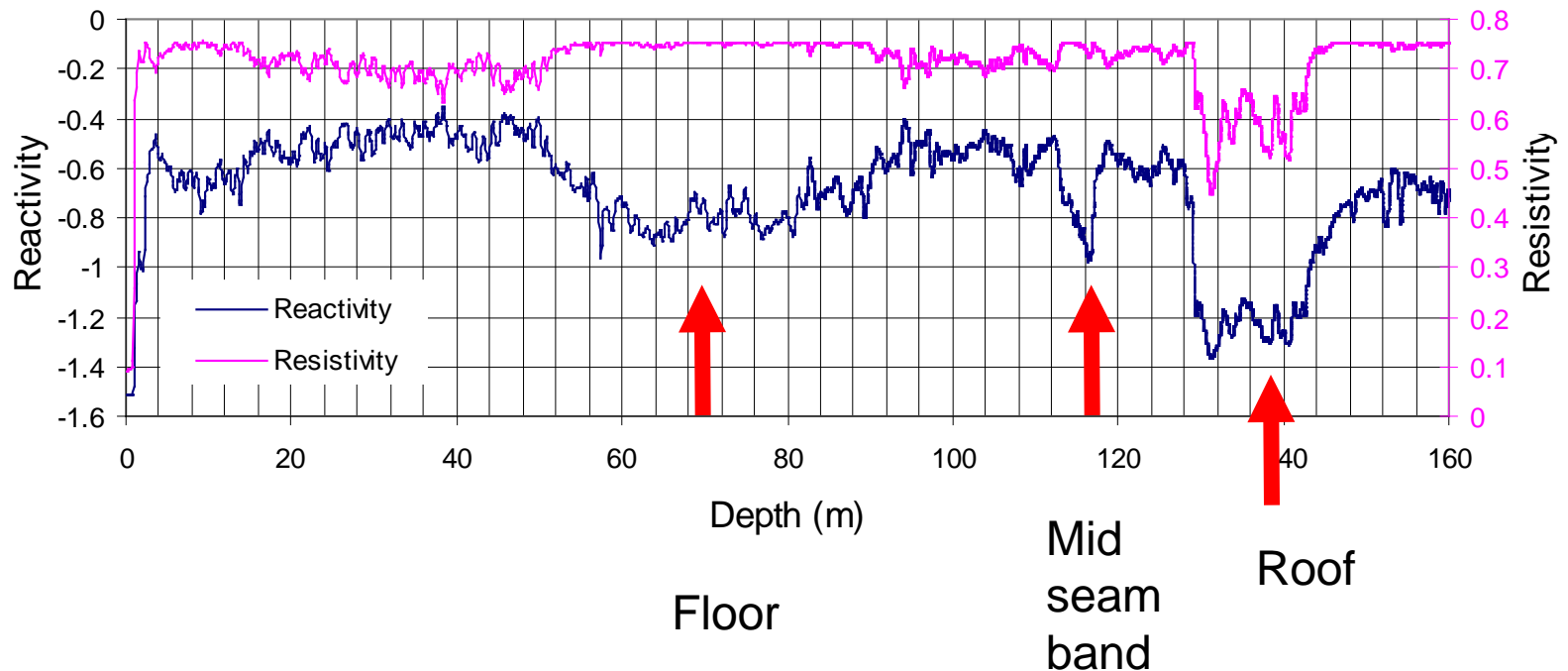# Acoustic caliper
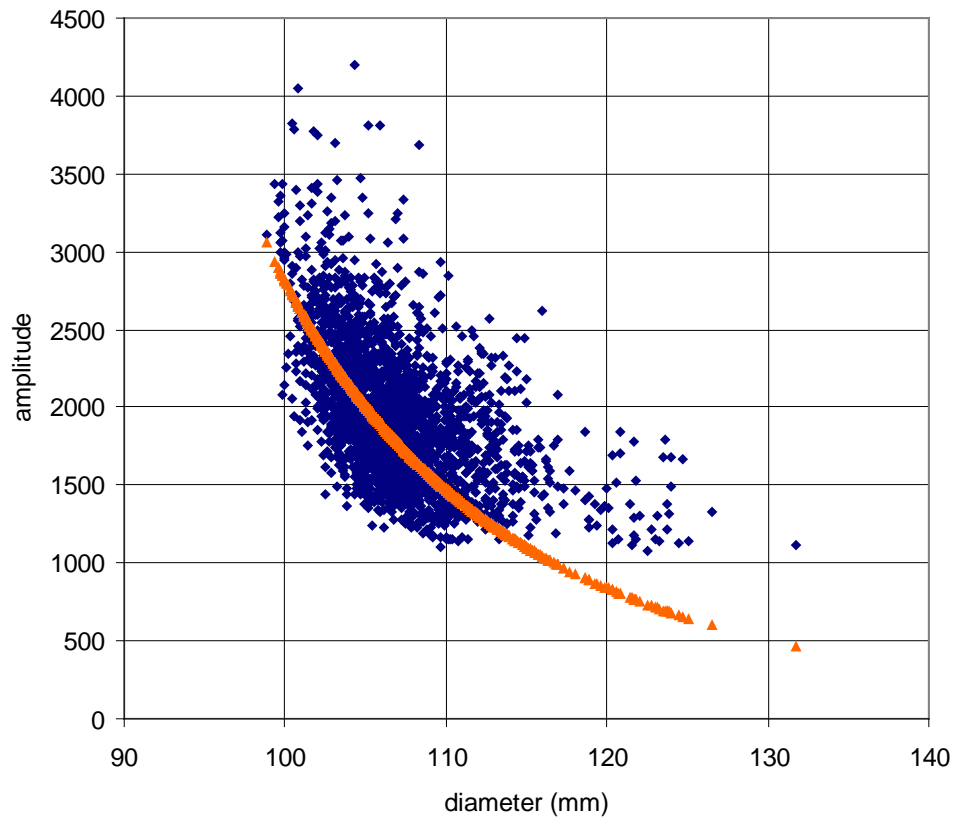
Together, you have a definitive answer

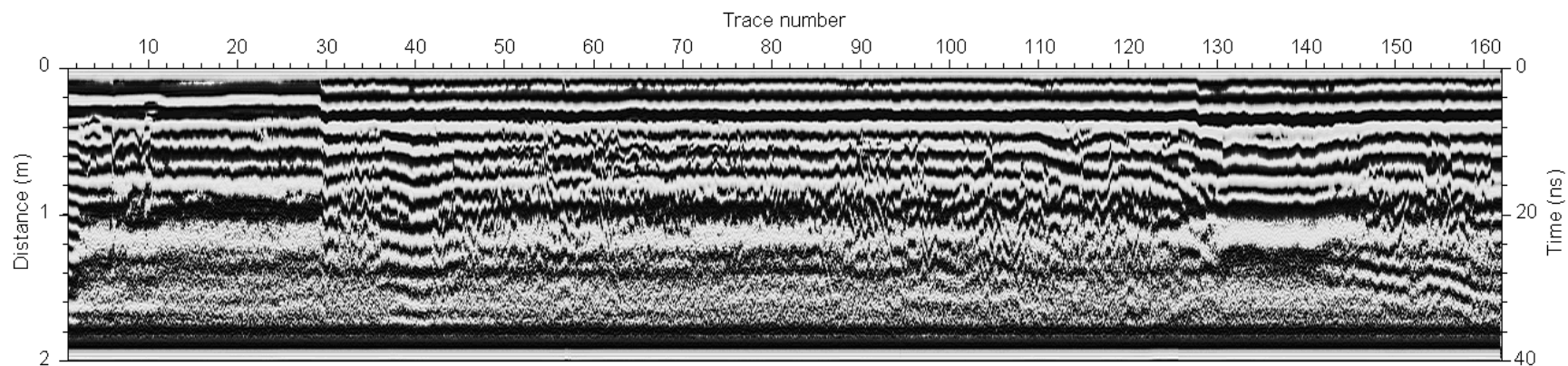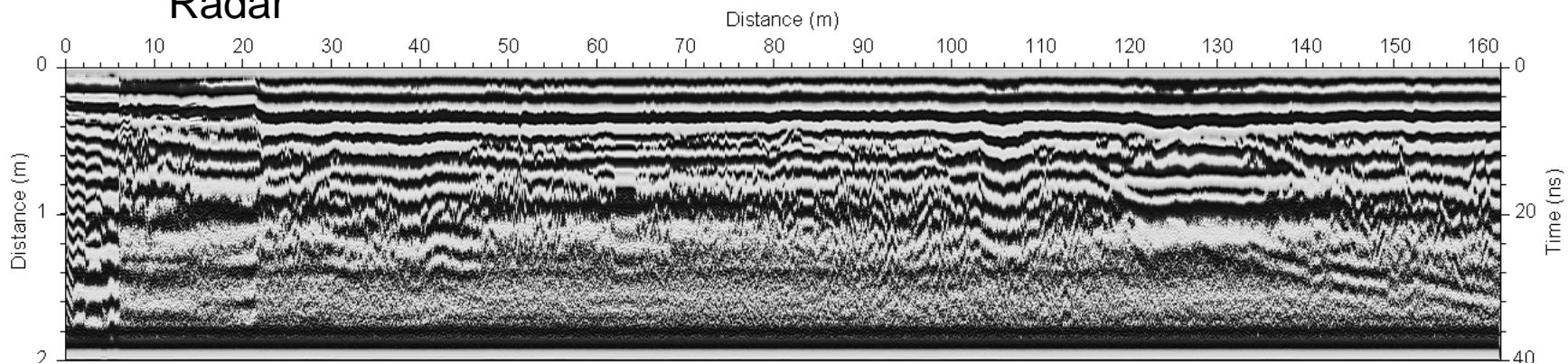"Many arrows needed in quiver" (Hiawatha)

Dielectric

Resistivity – measures current flow in strata
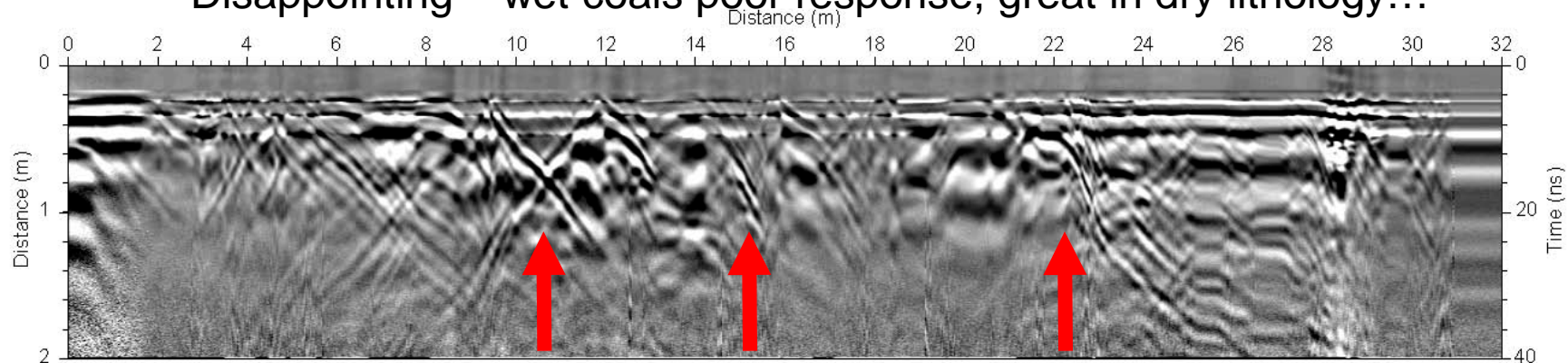Dielectric (Reactivity) – capacitive properties of strata

Radar

Disappointing – wet coals poor response, great in dry lithology…

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

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

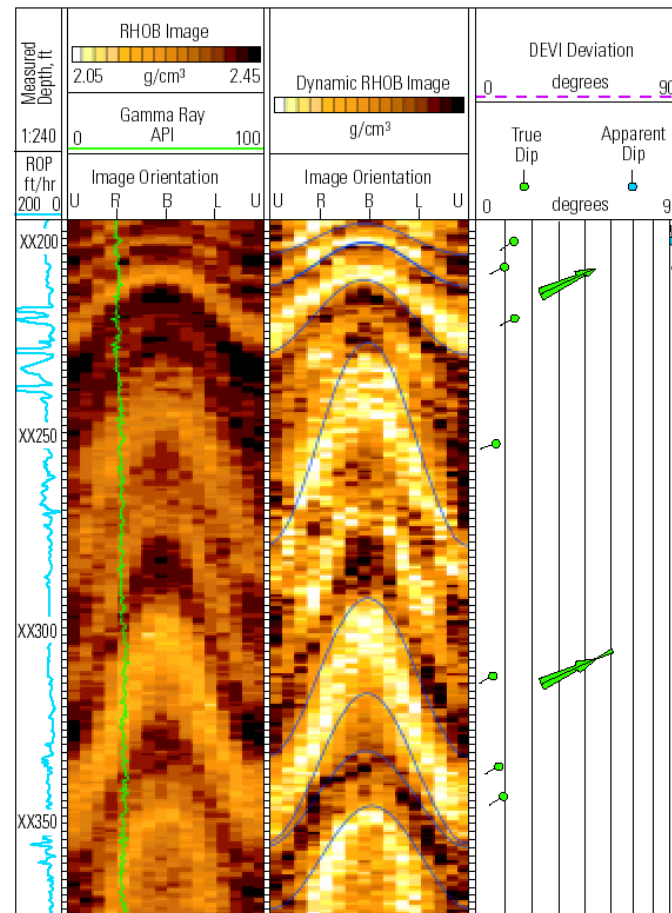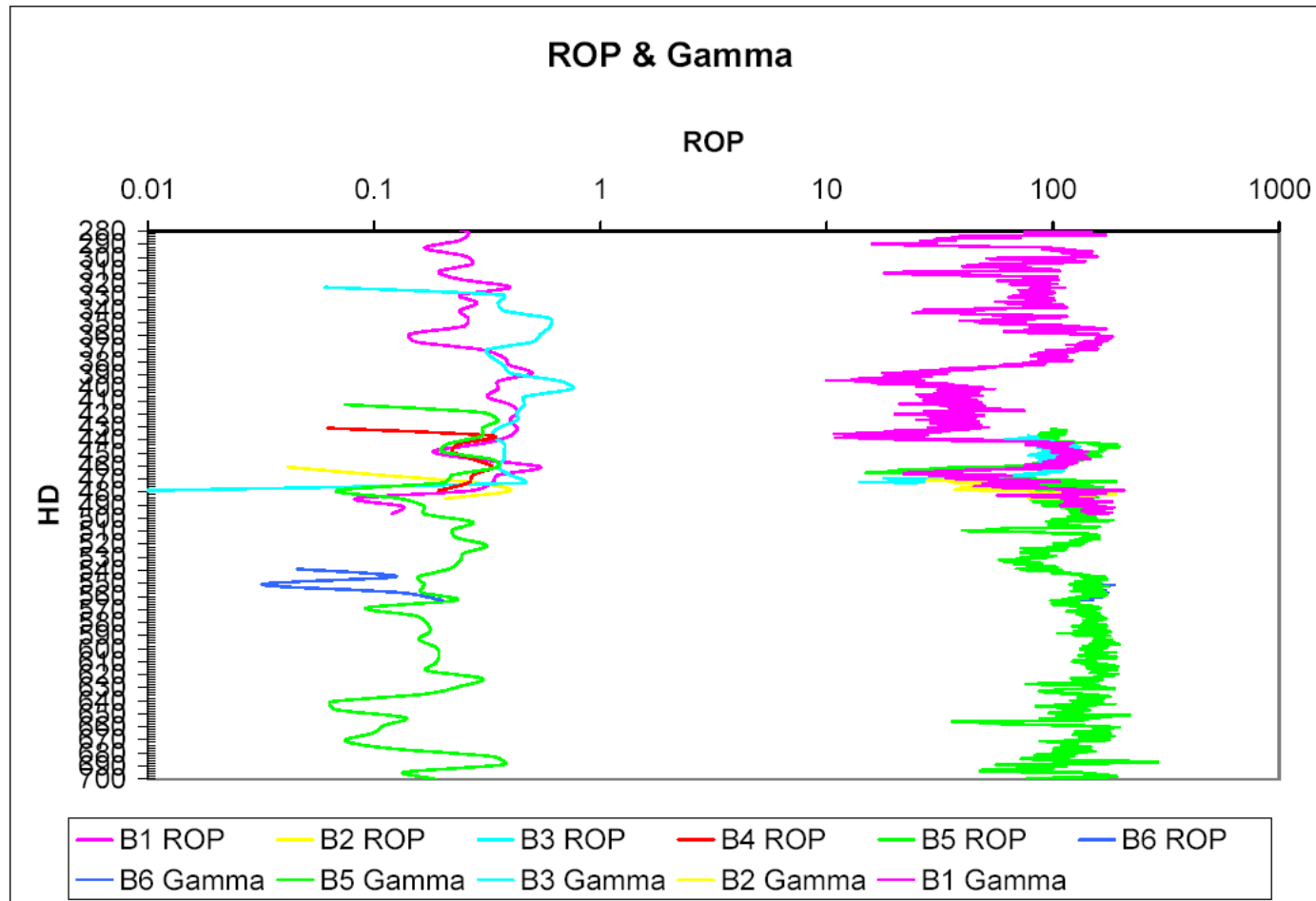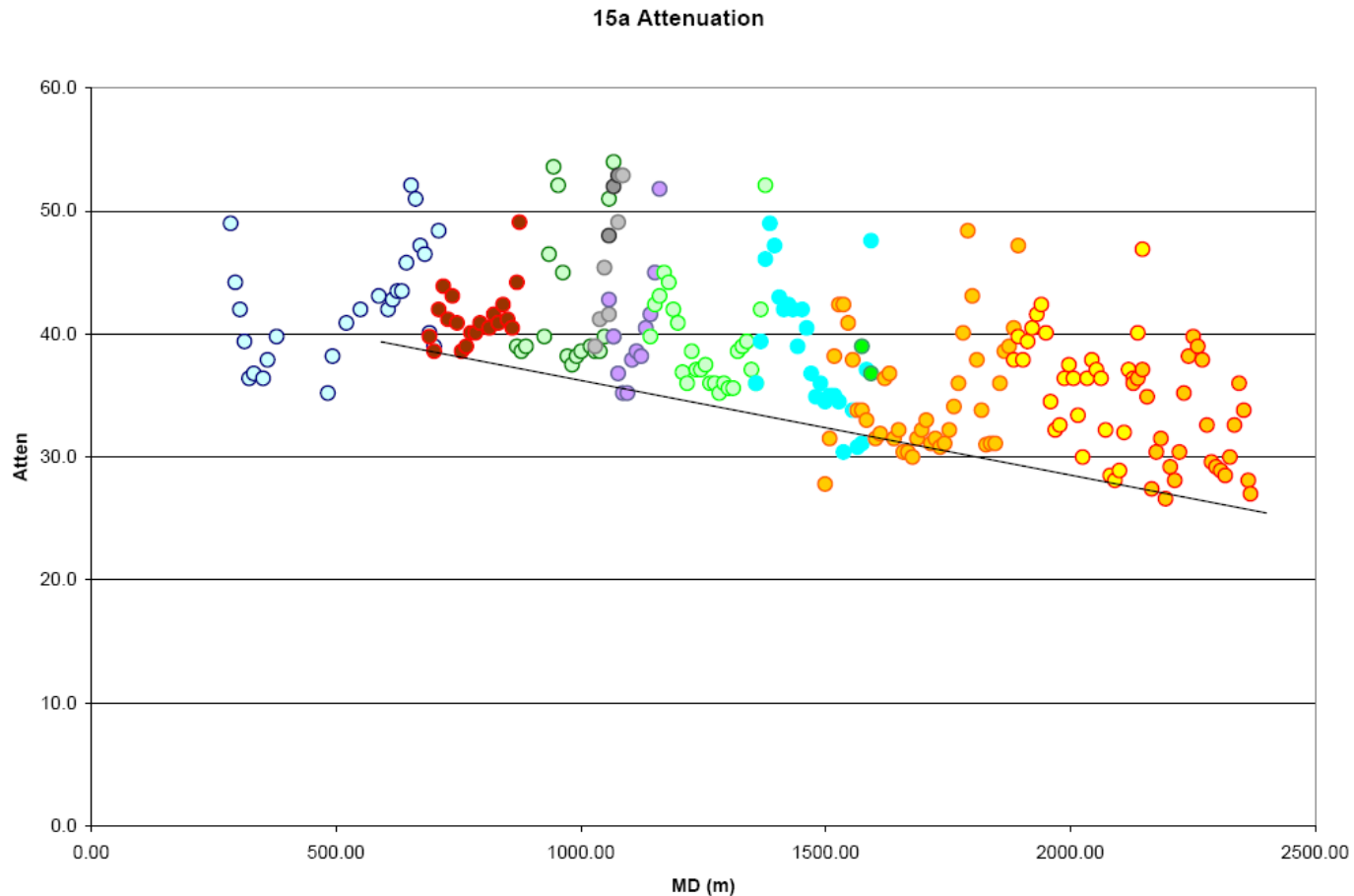■ Data Vs window

Angle Vs depth

"See" the borehole wall

Image from Schlumberger

The 'here and now', ROP and gamma

Profiling using EM signal

15a Attenuation

Attenuation profiling

Vertical Seam Position - EM signal Attenuation

$y = 14.302x^2 - 41.723x + 61.794$