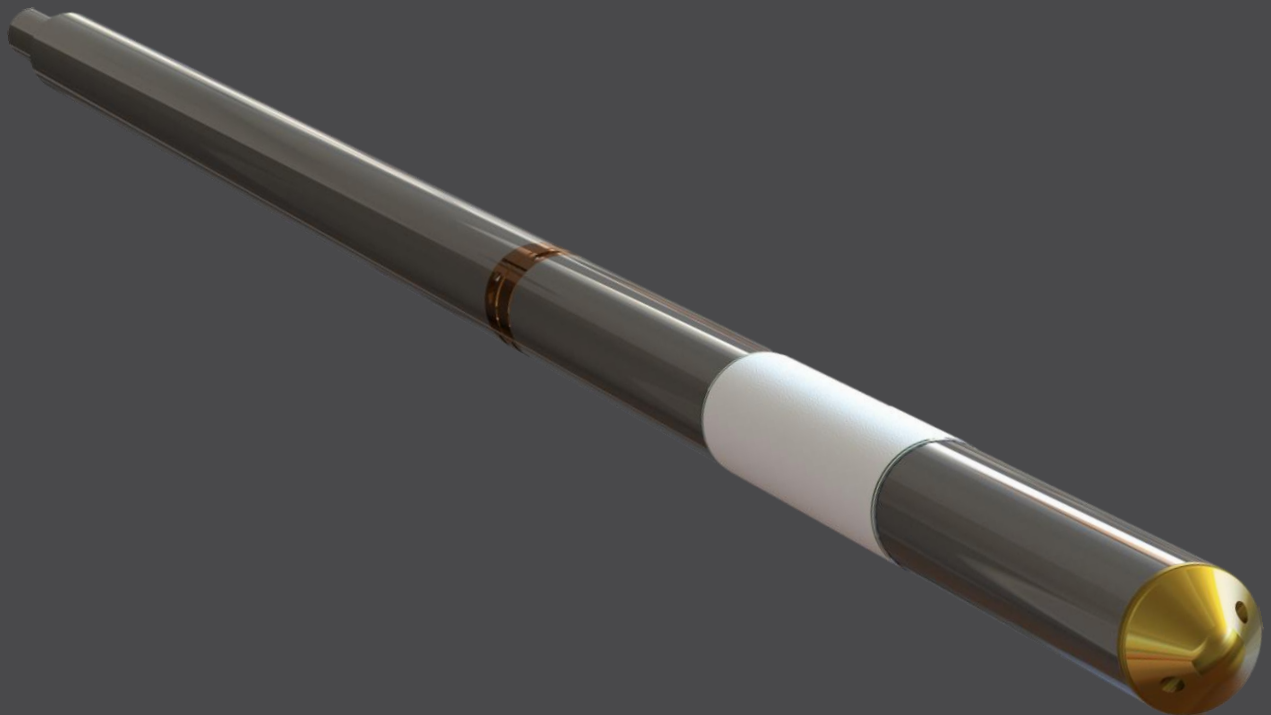




Economic Innovations

BOREHOLE MAGNETIC RESONANCE (BMR)



Borehole Magnetic Resonance

(BMR)



BMR Logging Equipment

Specifications	QL40-BMR-60	QL40-BMR-90
Physical Dimensions		
Tool Diameter	60 mm	90 mm
Tool Length	2.01 m	2.16 m
Operating Pressure	200 bar (Tool Top Adapter)*	200 bar
Operating Temperature	100 °C	100 °C
Vertical Resolution	8 cm	20 cm
NMR Field		
Diameter of Investigation	190 mm, 230 mm or 260 mm	360 mm
Echo Spacing (TE)	320 μ s, 450 μ s or 600 μ s	600 μ s
Wait Time (TW)	Multi	Multi
T2 Distribution	0.5 x TE – 5 seconds	0.5 x TE – 5 seconds
Porosity Range	0 – 100 pu	0 – 100 pu
Total Porosity Precision	2 pu – 2 level averaging	2 pu – 3 level averaging
Well Parameters		
Hole Sizes	75 – 216 mm	122 – 312 mm
Hole Condition	Open hole, FRP or PVC casing	Open hole, FRP or PVC casing

Logging Environments

The BMR Tool has been run in a wide variety of logging environments:

Hard Rock	Iron Ore, Copper, Lead, Zinc, Gold, Diamond Platinum, Coal
In-Situ Recovery	Potash, Lithium, Uranium
Oil & Gas	Coal Seam Gas
Groundwater	State Departments, Water Corporations, Agricultural Irrigation, Local Council Water

In all of these situations, we are measuring only the water content in the pore space of the rock. The measurement is lithology independent and is free of chemical radiation sources.



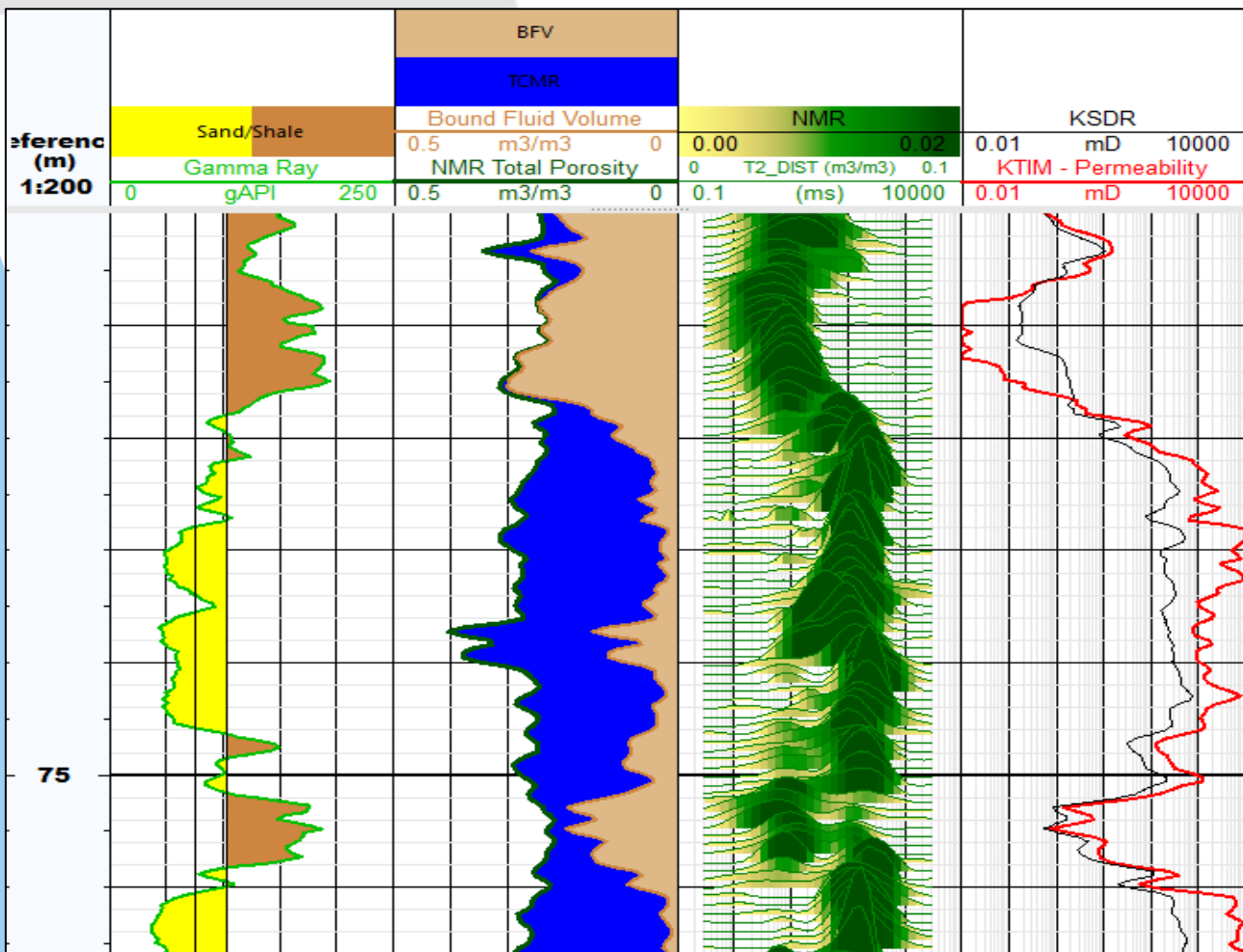
BMR Answers

Measured Parameters	Computed Parameters
Total porosity	Permeability
Pore size distribution (PSD)	Dry weight density (need bulk density)
Free water porosity (specific yield)	Adsorbed and free gas content of coals
Capillary-bound porosity	Multi-mineral modelling (with other log suites)
Clay-bound porosity	Specific retention (capillary + clay bound porosity)

Basic BMR Log

Shallow Sandstone Aquifer

- NMR data is inverted to give a continuous T2 distribution for the logged interval
- T2 distribution readily interrogated to derive:
 - Total Porosity
 - Bound Fluid (specific retention)
 - Free Fluid (specific yield)
 - Permeability (hydraulic conductivity)
 - Track 3 is the NMR T2 distribution, which represents a pore size distribution (small pores at left, large pores at right)



Borehole Magnetic Resonance

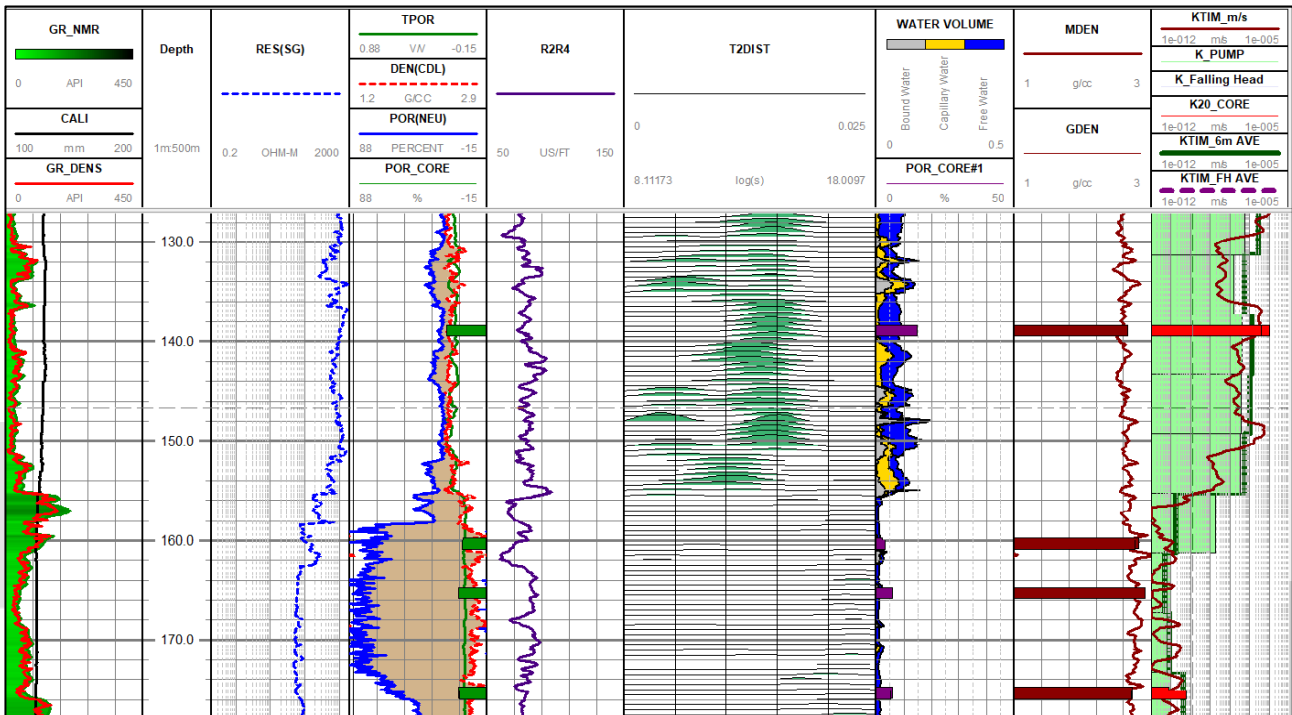
(BMR)



BMR Logging in Coal Overburden

Comparison of BMR vs Packers and Lab Core

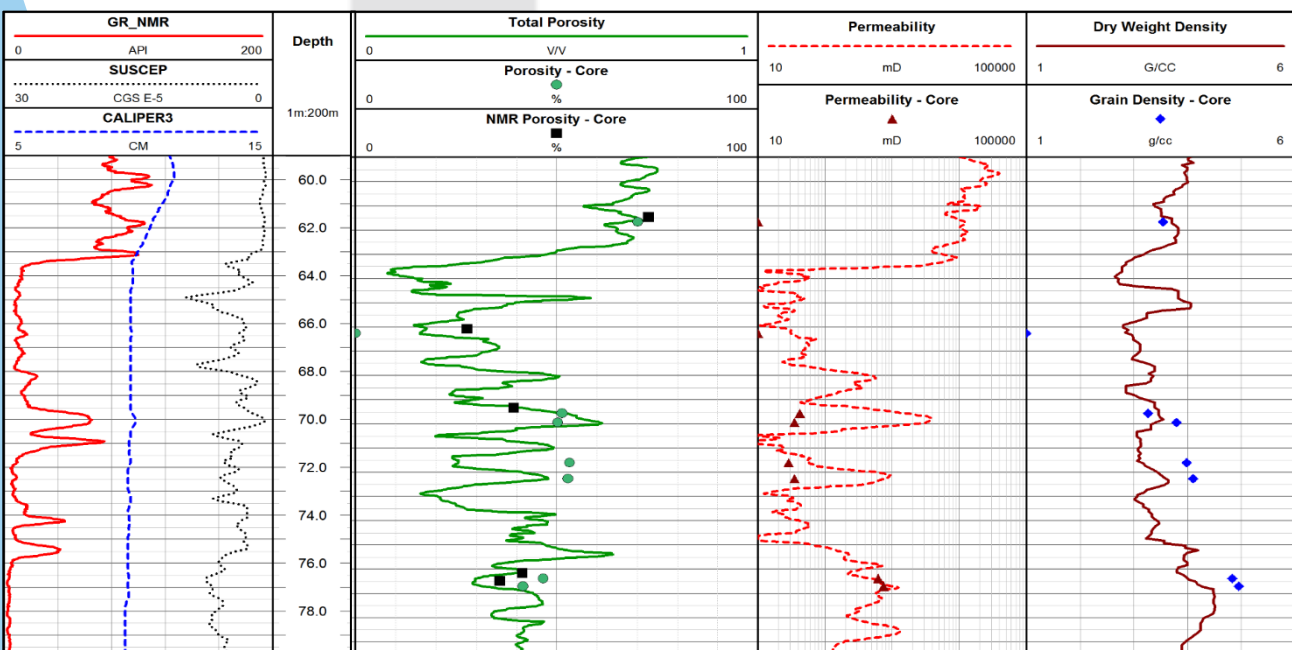
- Shaded green (far right track) is the 6m interval packer tests
- Solid green line is average BMR hydraulic conductivity over the same 6m intervals
- Red line is the continuous NMR permeability
- Lab results on cores are solid bars



BMR in Banded Iron Formation (BIF)

BIF BMR Logs

- BMR has been extensively tested in BIF formations with hundreds of logs performed
- This data was validated using core plugs measured in the laboratory



Borehole Magnetic Resonance

(BMR)



Key Benefits of BMR Measurement

Measure

- Lithology Independent measure of **total porosity**
- Can divide total porosity into:
 - Bound Water (Specific Retention)
 - Free Water (Specific Yield)

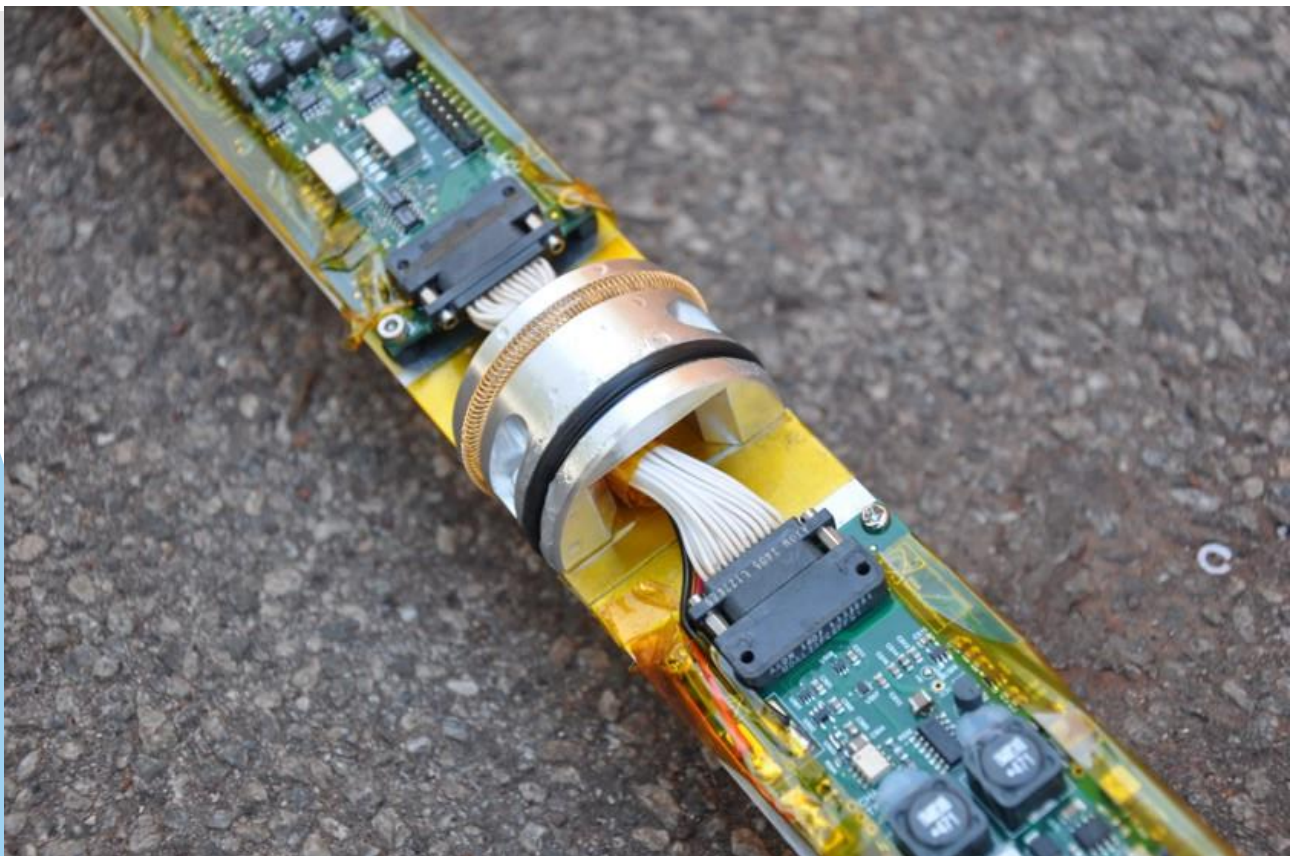
Calculate

- Can obtain continuous permeability / hydraulic conductivity log
- Grain size distribution

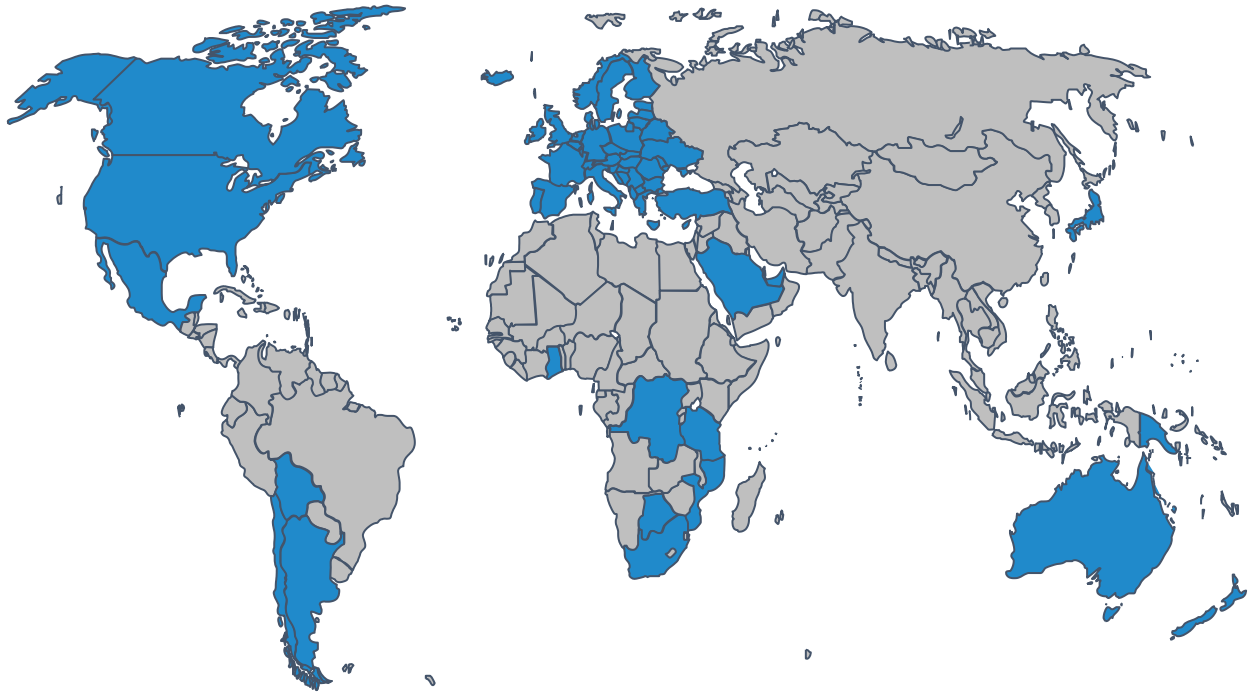
Cost Savings

- Reduces / replaces need for pump testing / packer tests
- Removes need for use of chemical sources (density / neutron)

Completely safe – no chemical sources, no radiation, no worries...



MEASURE MONITOR MANAGE MITIGATE



Economic Innovations



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