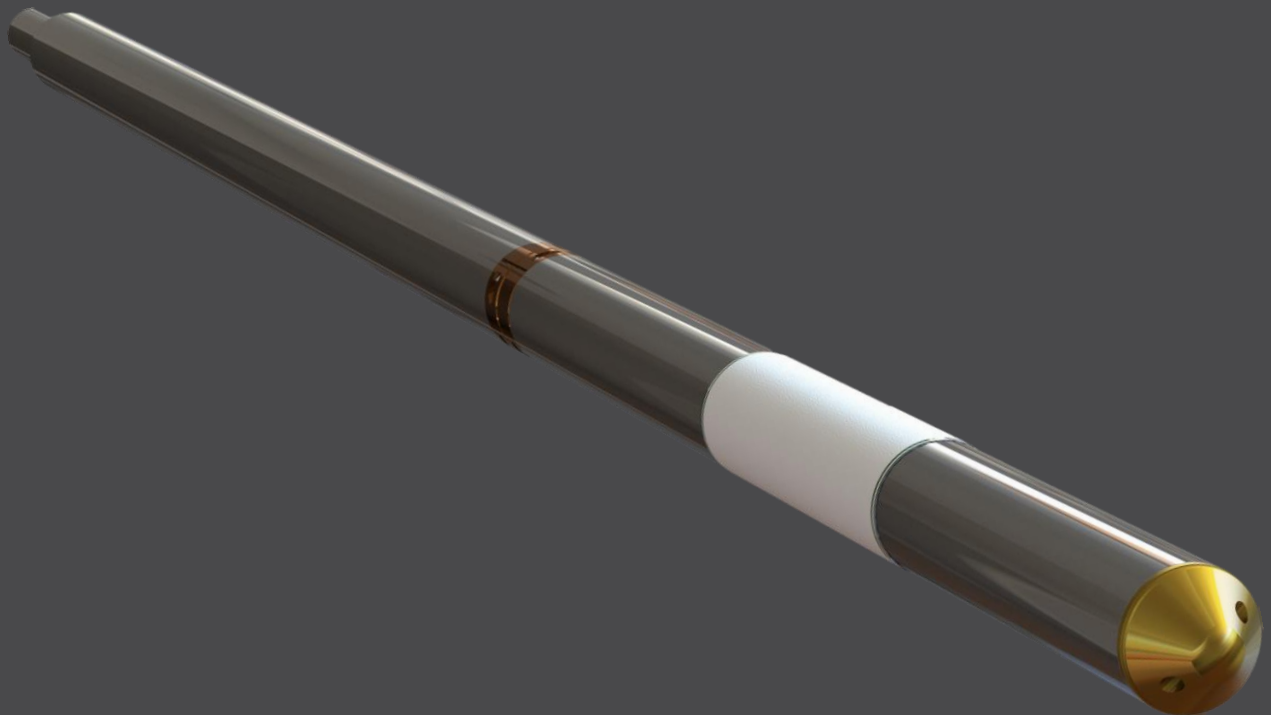




Economic Innovations

# BOREHOLE MAGNETIC RESONANCE (BMR)



# Borehole Magnetic Resonance

(BMR)

## BMR Logging Equipment

Specifications	QL40-BMR-60		QL40-BMR-90			
<b>Physical Dimensions</b>						
<b>Tool Diameter</b>	60 mm	2 3/8 in	90 mm	3 5/8 in		
<b>Tool Length</b>	2.01 m	6.6 ft	2.16 m	7.1 ft		
<b>Operating Pressure</b>	200 bar	2,900 psi	200 bar	2,900 psi		
<b>Operating Temperature</b>	100 °C	212 °F	100 °C	212 °F		
<b>NMR Field</b>						
<b>Diameter of Investigation*</b>	230 mm	9 1/16 in	360 mm	14 1/8 in	220 mm	8 5/8 in
<b>Vertical Sensor Aperture</b>	11.5 cm	4 1/2 in	23.8 cm	9 3/8 in	9.8 cm	3 7/8 in
<b>Echo Spacing (TE)</b>	450 µs		600 µs		250 µs	
<b>Wait Time (TW)</b>	Multi		Multi			
<b>T2 Distribution</b>	0.5 x TE – 5 seconds		0.5 x TE – 5 seconds			
<b>Porosity Range</b>	0 – 100 pu		0 – 100 pu			
<b>Total Porosity Precision</b>	2 pu – 2 level averaging		2 pu – 3 level averaging			
<b>Well Parameters</b>						
<b>Hole Sizes</b>	75 – 186 mm	3 – 7 1/4 in	122 – 312 mm	122 – 176 mm		
			4 3/4 – 12 1/4 in	4 3/4 – 6 7/8 in		
<b>Hole Condition</b>	Open hole, Fiberglass or PVC casing					

\* Other diameters of investigation possible in consultation with Qteq.

## Logging Environments

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

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

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



# Borehole Magnetic Resonance

(BMR)

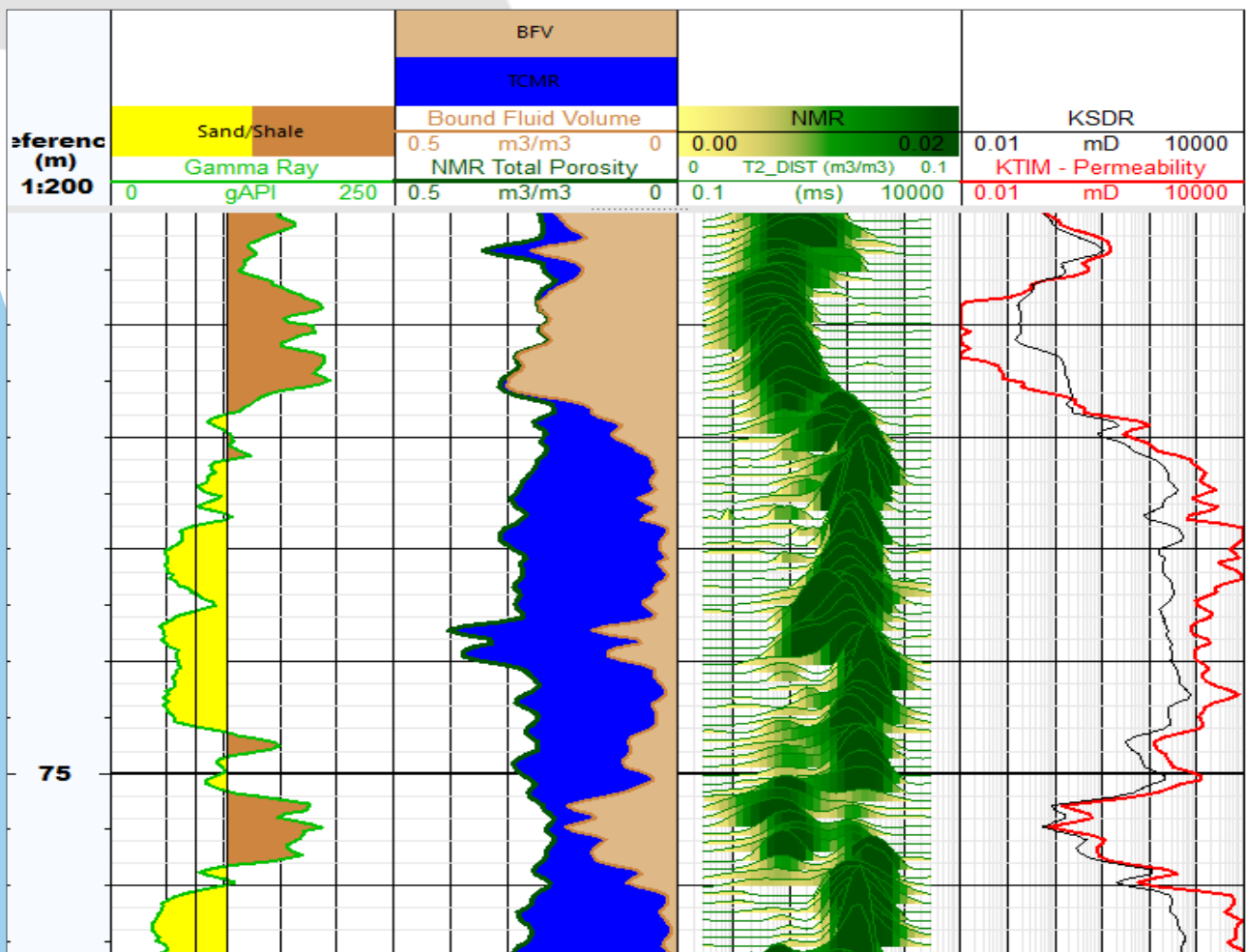
## BMR Answers

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

### A shallow Sandstone Aquifer example

- 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).



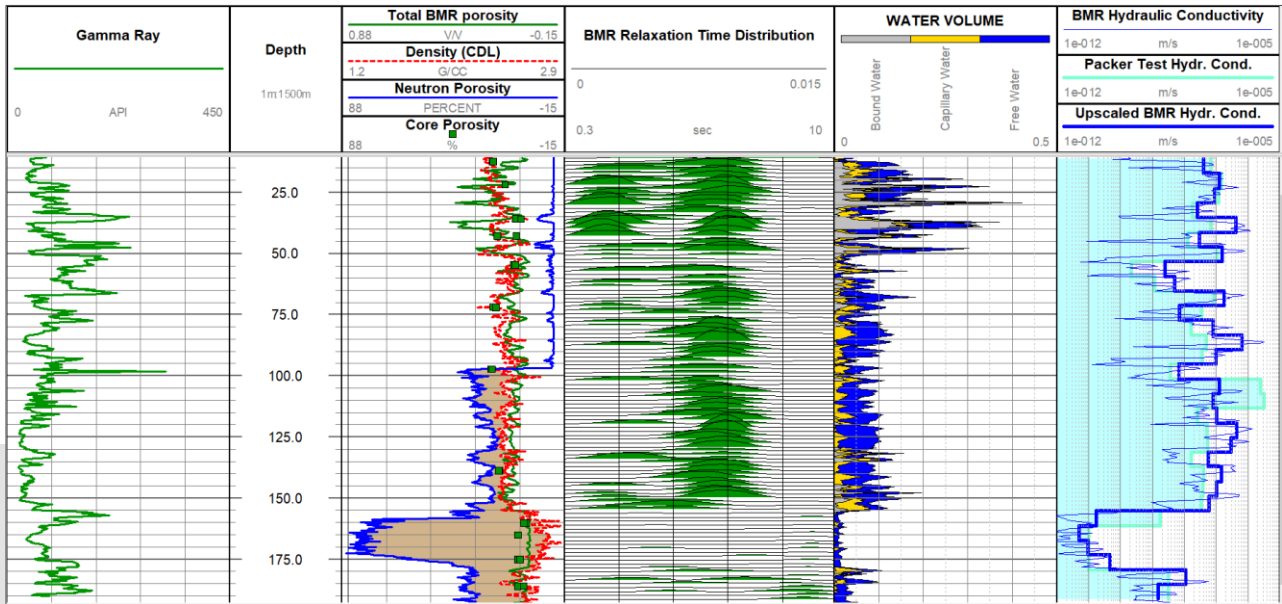
# Borehole Magnetic Resonance

(BMR)

## BMR Logging in Coal Overburden

Comparison of BMR data to packer testing and lab core results

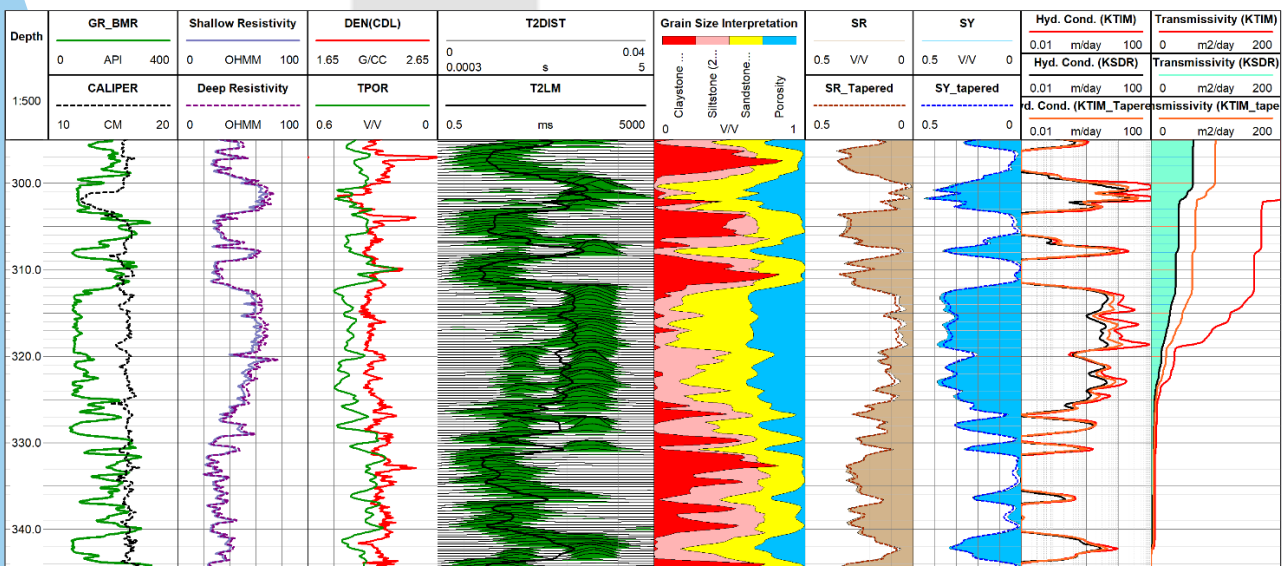
- Shaded blue (far right track) shows 6 m interval packer tests. They correlate well with thick blue BMR data over the same 6 m intervals. The thin blue line is full-resolution BMR data.
- Total BMR porosity (green, track 3) correlates well with lab results on cores (green dots).



## BMR in Hydrogeology

Generate complete hydraulic characterisation of the lithology

- BMR has been extensively used to obtain hydraulic characterization of formations.
- A range of answers can be gained from BMR Logs including porosity (3), specific retention (6), specific yield (7), hydraulic conductivity (7) and borehole integrated transmissivity (8).
- A grain size distribution log can be generated from the T2 Distribution (5).
- In combination with resistivity, formation water salinity can be quickly calculated.



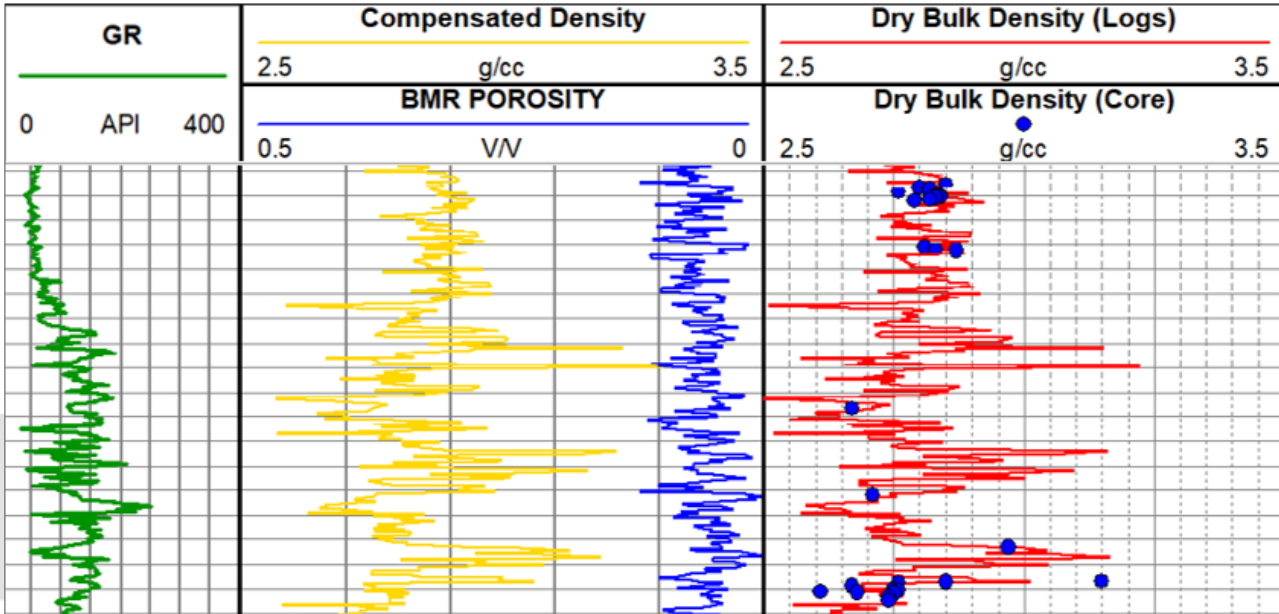
# Borehole Magnetic Resonance

(BMR)

## Dry Bulk Density

Calculate dry bulk density at the wellsite

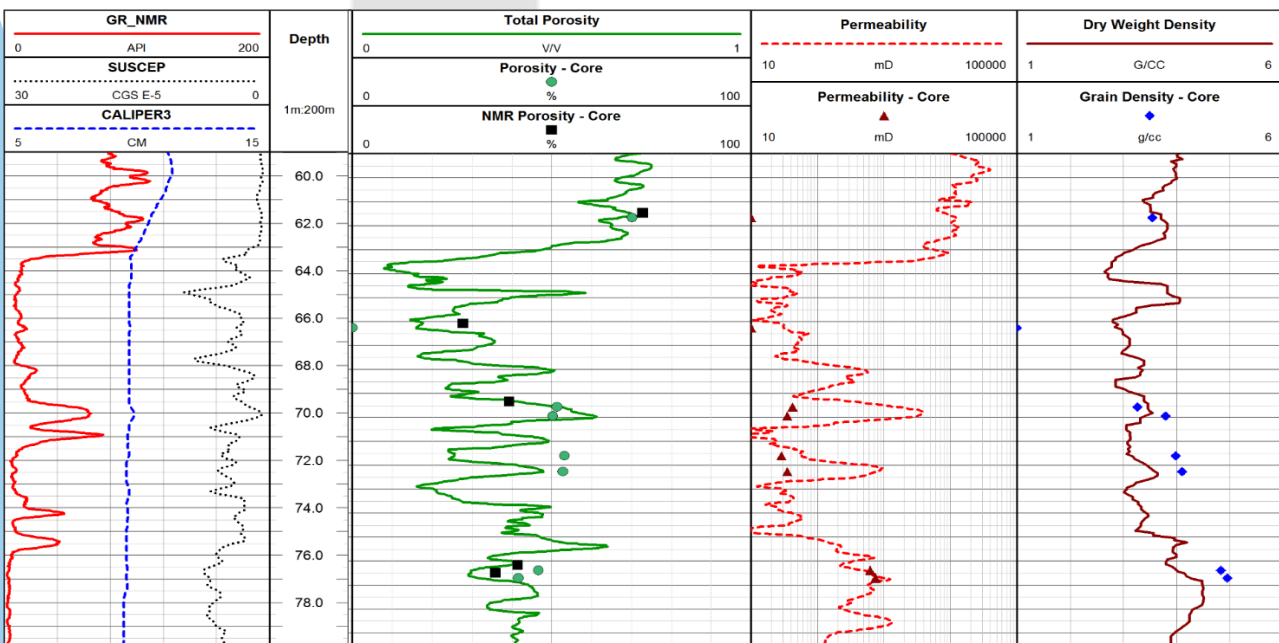
- Combining density and total porosity from BMR allows for the calculation of matrix grain density and dry bulk density.
- Matrix density is used for lithology determination.
- Dry bulk density is a key parameter in resource estimation, mine and process planning.



## 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.



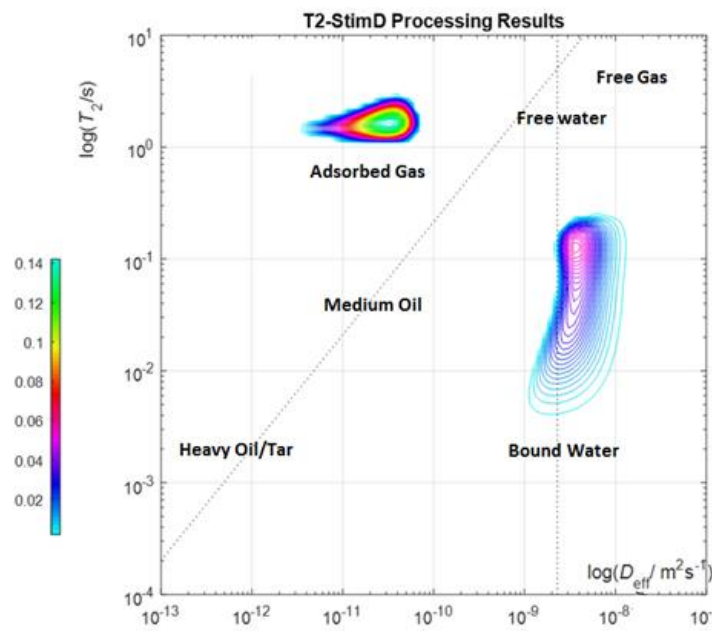
# Borehole Magnetic Resonance (BMR)



## BMR for Adsorbed Gas

Qteq has developed a propriety BMR acquisition method that enables the accurate measurement of adsorbed gas in-situ

- This acquisition sequence is designed to be sensitive to the high T1/T2 ratio of adsorbed gas as well as delineate other fluid types in the hole.
- It requires a station measurement to ensure a high SNR.



## 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
- In combination with other logs
  - Matrix density
  - Dry bulk density
  - Formation water salinity

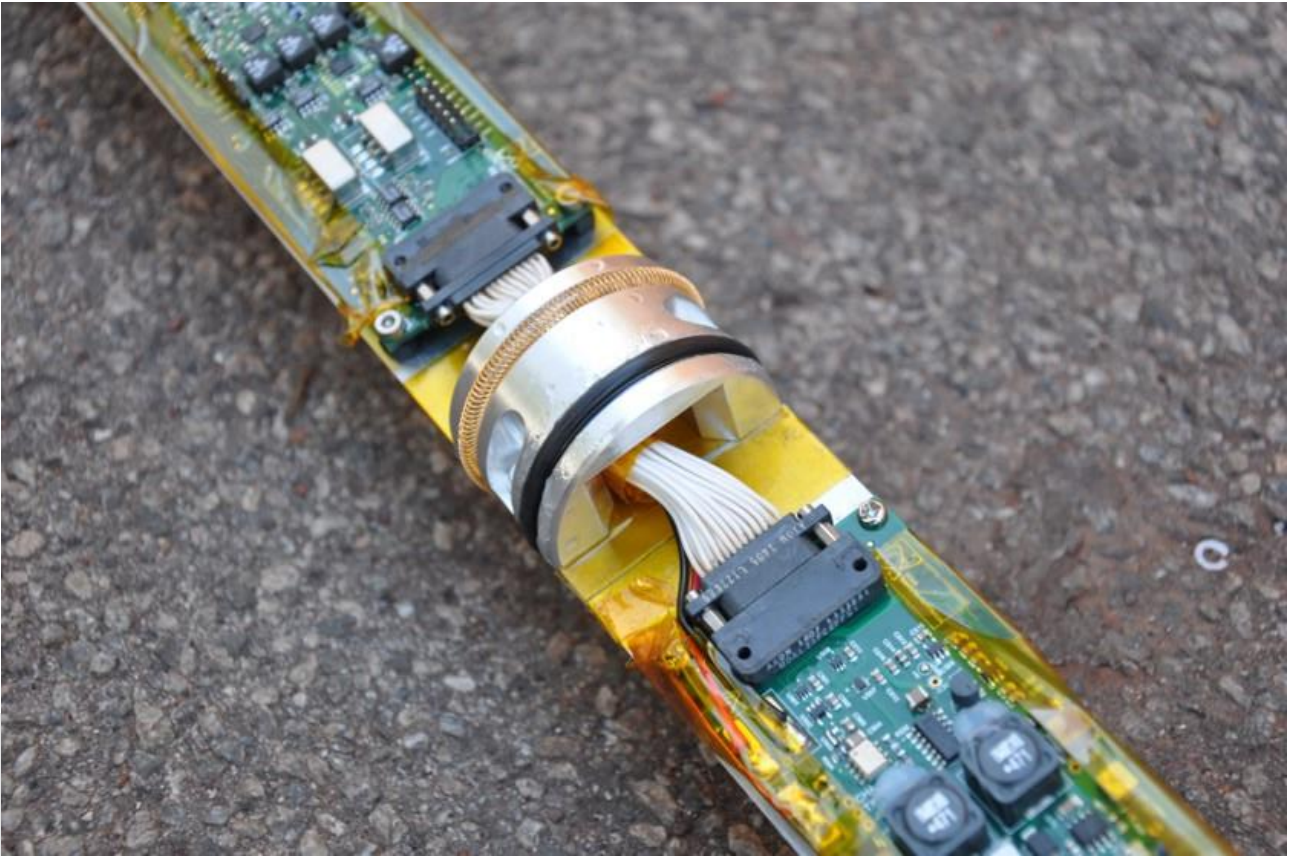
### Cost Savings

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

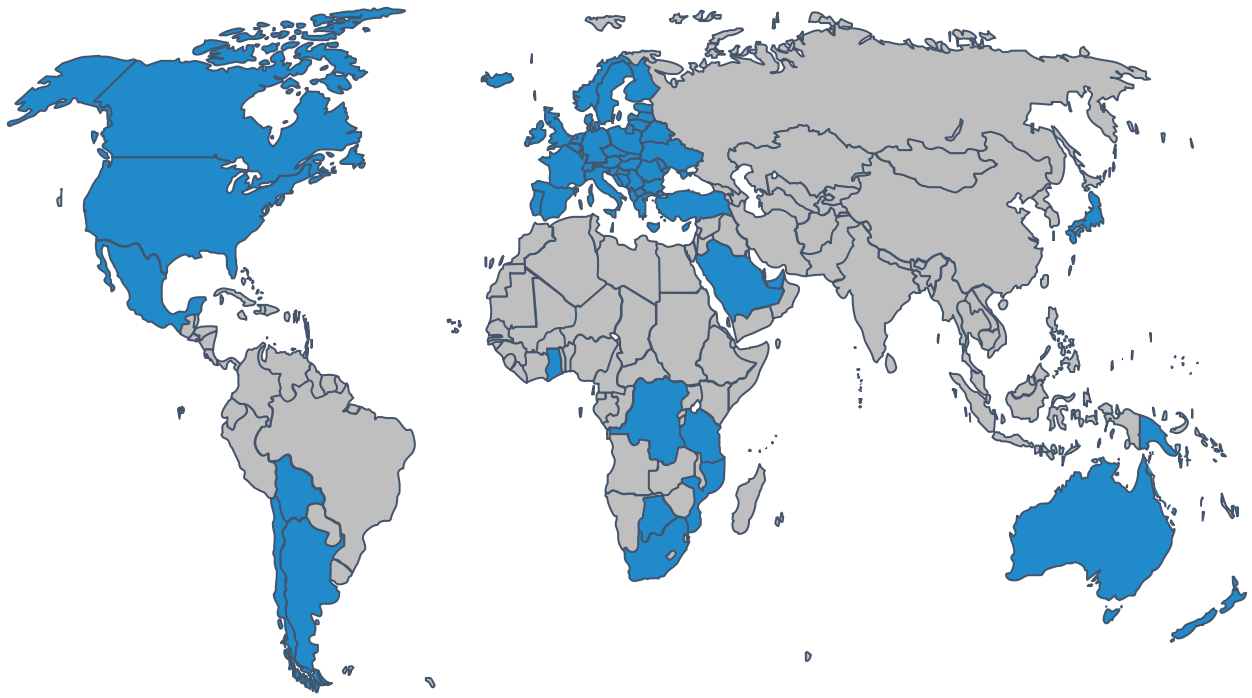
**Completely safe – no chemical sources, no radiation, no worries...**

# Borehole Magnetic Resonance

(BMR)



MEASURE MONITOR MANAGE MITIGATE



# Economic Innovations



[qteq.com.au](http://qteq.com.au)  
1800 WIRELINE

[sales@qteq.com.au](mailto:sales@qteq.com.au)  
[info@qteq.com.au](mailto:info@qteq.com.au)

Registered Address  
**Brisbane (QHQ)**  
Level 3, 340 Adelaide Street  
Brisbane, 4000 QLD, Australia  
T +61 (0)7 3834 9100

Centre of Excellence (east)  
**Toowoomba**  
179 Stephen Street  
Harristown, 4350 QLD, Australia  
T +61 (0)7 4659 0537

Centre of Excellence (west)  
**Wangara**  
56 Paramount Drive  
Wangara, 6065 WA, Australia  
T +61 (0)8 9303 4616