GeoInfo

Robertson Geo and **OEM Vista Clara Inc.** have collaborated to bring their **Javelin JPY238 NMR Probe** into the UK market for application in geotechnical/hydrogeology investigations.

Borehole Nuclear Magnetic Resonance (NMR) for Geotechnical and Hydrogeological Applications

What is Borehole NMR?

Borehole NMR is a technique that measures fluid volumes and the distribution of those fluids as a function of pore geometry enabling detailed characterisation of the storage and flow capacity of subsurface formations.

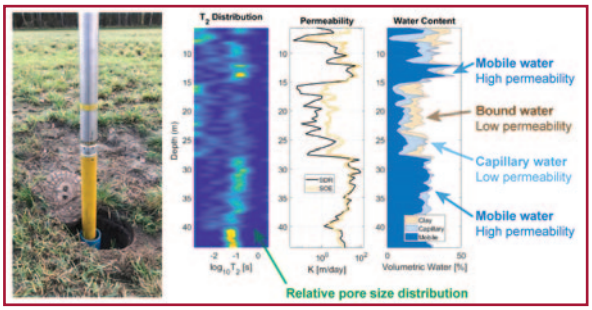
The History of NMR

The phenomenon of nuclear magnetic resonance, discovered in the 1930's, is the ability of atomic nuclei to absorb RF energy of specific frequencies when placed in a strong magnetic field. After many years of development work, earning Nobel Prize awards, technology was developed using this principle for many applications including the MRI scanner used today in medical imaging. The technology was also developed as a downhole wireline probe for use in the oil and gas industry. Finally, with reduced costs, borehole NMR has found its place in groundwater investigations for geotechnical and hydrogeological purposes.

How Borehole NMR Works

Using RF frequencies selected to influence only Hydrogen nuclei, a powerful permanent magnet and a sophisticated RF transmitter/receiver are used to align, precess and then measure an induced RF signal from the nuclei. The nuclei are thus "excited" and the rate of decay measured.

Hydrogen nuclei in water are naturally randomly aligned magnetically. By applying a strong magnetic field for a period the nuclei can be aligned (longitudinal). The RF transmitter then tilts the nuclei through 90° (transverse) and nudges them at a specific frequency such that they wobble or precess in phase. This precession generates an oscillating RF signal which decays as the nuclei de-phase and can be detected by the receiver. In practice a precise sequence of electromagnetic pulses (CPMG) are used: 90°, then a series of 180° pulses to reverse and realign the precessing nuclei producing new peaks or spin echoes. Several precession decay processes influence the resulting signals, most notably from surface interactions within the formation where the signal decays faster in smaller pore spaces.



Data Outputs

T1 is the longitudinal relaxation time derived from the decay rate following polarisation by the permanent magnet, describing the rate of polarisation. T2 is the transverse relaxation time describing the rate of decay, influenced by pore size. The peak amplitude of the RF signal following polarisation is used to determine the total porosity. The total porosity can be further split into clay based, capillary and mobile components using the T2 decay information whereby permeability (K) can be reliably estimated.

Vista Clara's advanced Javelin family of borehole NMR magnetic resonance logging tools provide direct, low-cost, high-resolution measurements of hydrogeological properties including: Volumetric water content; Pore size distribution; Bound and mobile porosity; Hydraulic conductivity and Transmissivity.

In Practice

Effects from washout and drilling disturbance and also RF interference are effectively eliminated as the Javelin JPY238 uses multiple frequencies giving different depths of investigation. The system is deployed using a conventional wireline setup making it a cost effective means of providing a unique set of data invaluable for geotechnical and hydrogeological investigations.