



## Motivation

Two major civil infrastructure projects in the United Kingdom required accurate and precise mapping of subsurface porosity and permeability to ensure that underlying sediment formations were suitable for the intended construction. In the city of Ipswich, a new crossing over the River Orwell faced engineering risks associated with unmapped soft sediments and zones of dissolution in chalk formations. In the city of London, a new

tunnel construction project required information on permeability and likely infiltration rates in the London Clay formation, through which the tunnel is to be built.

Fugro, the geotechnical/geophysical services contractor on both projects, used the Javelin® NMR logging tool to provide direct, high-resolution measurements of porosity and lithology-independent estimates of pore size distribution and permeability.



## Technical Approach

NMR logging measurements were acquired using a 4-frequency 2.38 inch diameter Javelin® NMR logging tool in 6.5 inch diameter open hole geotechnical borings, with temporary 3-inch diameter PVC casings installed to prevent borehole collapse. Most of the NMR logs were run from a jack-up platform over open water. The multi-frequency logging capability of the Javelin® tool, with its 4 independent diameters of investigation, enabled the geologists to ensure that the

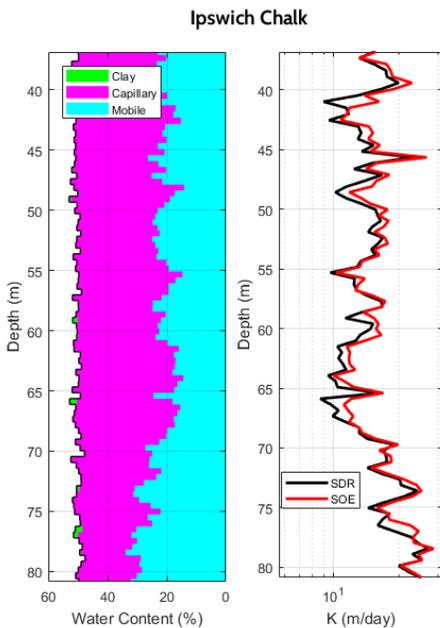
NMR measurements were entirely within the undisturbed native formation, and were not impacted by drilling disturbance or well construction features.



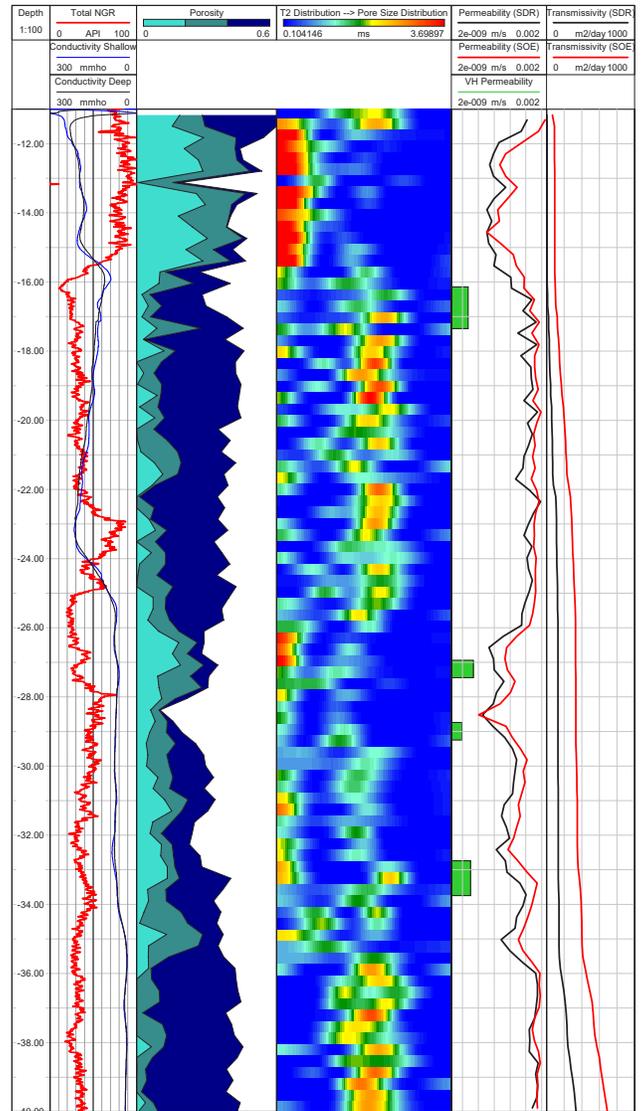
Javelin® NMR Logging Tool

# Results

The Javelin® NMR logging in Ipswich (below) detected zones with partial dissolution of chalk, interbedded soft clay, and clear differences in the water-bearing pore structure among different layers in the chalk formations. These significant features impacting mechanical stability would not have been observed in neutron logging, which estimates only total porosity—a quantity which had little variability in this area.



The Javelin® NMR logging results for the London Clays (right) likewise provided clear, high-resolution characterization of sediment pore size distributions and variations in permeability, as required by the project.



## “Takeaway”

These two successful applications of NMR logging by the international geo-services provider Fugro have paved the way for NMR logging to be used more broadly in the construction and engineering sectors. Several unique features of the Javelin® logging tool, including multi-frequency logging, a wide range of tool sizes, and

largest depths of investigation for any tool size, are critical to the successful use of NMR logging in geotechnical investigations.

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References: Rigler, B., “Porosity and permeability values: Filling the gaps with NMR (Nuclear Magnetic Resonance)”, AGS Magazine, May/June 2018, p. 20-25.  
<https://www.ags.org.uk/magazine/ags-magazine-may-june-2018/>