

## **FIELD DEMONSTRATION OF NUCLEAR MAGNETIC RESONANCE (NMR) LOGGING TOOLS FOR GROUNDWATER AND ENVIRONMENTAL INVESTIGATIONS**

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Nuclear magnetic resonance (NMR) measurements provide direct sensitivity to pore fluids enabling estimation of key petrophysical properties including porosity, bound/free fluid content, and permeability. NMR logging instruments have been used for decades in the oil and gas applications, but until recently, the size and high cost of oil-field tools have limited the availability of this powerful technology for groundwater and environmental investigations. We present results from field tests of a newly-developed suite of economical, small-diameter NMR logging tools, specifically designed to meet the unique needs of near-surface investigations. Principal field tests of two NMR probes were conducted at the Geohydrologic Experimental and Monitoring Site near Lawrence Kansas. One of the probes, is optimized for logging measurements in very small-diameter holes that are commonly available for environmental studies. With an outer diameter of 43 mm, this probe operates in small PVC or open-cased holes ranging from 50 to 100 mm. The second probe has a diameter of 64 mm and is designed for dynamic and minimally-invasive operation with a Geoprobe® direct push machine. Both probes were operated with a minimum echo time spacing of 2.0 ms; the depth resolution is 1.0 m for the 45 mm probe and 0.5 m for the direct-push probe. The NMR logs provide continuous distributions of the transverse (T<sub>2</sub>) relaxation time versus water content at each depth interval, which are used to derive estimates of porosity, bound/free water content, and hydraulic conductivity. Results from the two tools were found to be consistent with one another and with auxiliary subsurface information available at the extensively characterized site. The availability of these newly-developed and unique tools open vast opportunities for utilizing NMR to enhance groundwater and environmental investigations.