A LABORATORY STUDY OF ESTIMATING PERMEABILITY FROM NMR DATA FOR UNCONSOLIDATED MATERIALS

Katherine Dlubac, Stanford University
Rosemary Knight, Stanford University

There is growing interest in the use of proton nuclear magnetic resonance (NMR) for near-surface aquifer characterization due to its sensitivity to hydrogen atoms in the pore-water saturating geological materials. Two equations containing empirically-determined constants, the Schlumberger Doll Research (SDR) and the Timur-Coates (T-C) equations, have been widely used for petroleum applications to obtain permeability, k, from NMR data and have been found to yield good estimates of k in consolidated reservoir rocks. However, in unconsolidated materials there have been problems in obtaining reliable estimates of k from NMR data. In this laboratory study we made NMR and k measurements on samples collected from the High Plains aquifer to evaluate the use of the SDR equation for estimating k from NMR data.

A continuous core was obtained from the top 60 feet of the Alluvium section of the aquifer. The core was contained in 12, 5-ft long, plastic tubes. The top 40 feet of the core consists of silts and clays and the lower 40 to 60 feet consists mostly of gravels. The 5-ft sections of core were slowly saturated from the bottom up allowing any trapped air to escape through the top. NMR transverse relaxation time measurements were acquired approximately every 6 inches by lowering the 5-foot sections into a 2 MHz Maran Ultra NMR core analyzer. A constant head permeameter was used to measure k over each 5-ft section of the core.

We first used the standard form of the SDR equation, and found that NMR-derived k followed the trends observed in the permeameter data, but underestimated k by an order of magnitude. We found excellent agreement between the measured and NMR-derived values of k if we reduced the exponent on the porosity term in the SDR equation. The decrease in this exponent better represents the contribution of porosity to permeability in these unconsolidated materials.