EVALUATION OF SURFACE-NMR SPIN ECHO MEASUREMENTS OF T2

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In order to improve estimation of hydrogeologic properties from NMR relaxation measurements, we must improve our ability to measure the NMR relaxation parameters that are most directly sensitive to the underlying properties of interest. While standard surface-NMR measurements of the free induction decay can yield accurate estimates of the relaxation time parameter T_2^*, it has been shown that this parameter exhibits limited sensitivity to pore-size and permeability. In this study, we evaluate a modified surface-NMR acquisition scheme that uses spin echo measurements to estimate the more robust and readily utilizable relaxation parameter T_2. We present a series of field experiments from the Central United States in which we have used surface-NMR to measure spin echo signals and estimate T_2 with variable echo times ranging from 100 ms to 400 ms. NMR logging measurements in a nearby borehole provide a unique opportunity to compare the T_2-values estimated by surface-NMR to ground-truth T_2-values determined from the logging data. We find very close agreement between these two forms of measurement; we note, however, that we cannot detect spin echo signals from depth intervals where T_2 is much shorter than the shortest echo time (100ms). Comparing the surface-NMR measurements of T_2 to measurements of T_2^* acquired at the same time, we find that T_2 is generally much longer than T_2^*. We explain the observed differences between these relaxation parameters by considering the effects of inhomogeneity in the background magnetic field. We find that T_2 exhibits greater variation and sensitivity to pore size than T_2^* in coarse-grained materials; however, T_2^* provides greater sensitivity in fine-grained materials where no echo signal is detected. Given these distinct advantages of the T_2 and T_2^* measurement, we propose a general framework for using both of these measurement types to enable more detailed characterization of groundwater aquifers.