APPLICATIONS AND ADVANTAGES OF A SHORT DEAD-TIME FOR SURFACE NUCLEAR MAGNETIC RESONANCE (SNMR) MEASUREMENTS

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Surface nuclear magnetic resonance (SNMR) measurements provide non-invasive detection and characterization of groundwater by measuring the relaxation decay of hydrogen nuclei following excitation by a surface loop. A key factor controlling the sensitivity of the SNMR measurement to groundwater is the so-called dead-time, which describes the delay between the end of the excitation pulse and the first reliable recording of the NMR signal. The dead-time will fundamentally limit the shortest signals that can be detected and thus effectively controls the range of environments in which SNMR can be successfully used. We describe the recent development of very short dead-time SNMR instrumentation and application of these measurements in a series of case studies. We demonstrate the achievement of dramatically reduced dead-times, as short as 4 milliseconds, which enable detection of groundwater in environments previously considered inaccessible by SNMR. Specifically, we illustrate detection of very short NMR decay signals associated with water in magnetic geology, bound water in silts and clays, and capillary water in the vadose zone. The availability of a new small diameter NMR logging tool provides an opportunity to ground-truth the surface NMR data and confirms that these short signals are reliably detected using short dead-time surface NMR capabilities. Based on our field results, we discuss the advantages and implications of a short-dead time SNMR instrument for quantifying short signals, improving signal to noise ratios, and characterizing aquifer properties.