Simulation and Experimental Measurements of Internal Magnetic Field Gradients and NMR Transverse Relaxation Times (T2) in Sandstone Rocks

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Abstract. NMR T2 measurements are widely used to determine various petrophysical properties of rock cores. Internal magnetic field gradients, which occur in rock cores during NMR measurements due to magnetic susceptibility differences between the rock matrix and the pore fluid, can however distort these T2 measurements. Here we implement a FEM simulation of these internal magnetic field gradients on 3D digital μCT images for five different sandstone rocks, coupled with a random walk simulation of the T2 NMR signal relaxation process. The FEM simulations required the magnetic susceptibility of each sandstone, this was directly measured using a SQUID magnetometer over a range of magnetic field strengths. The resultant probability distributions of internal magnetic field gradients were then compared against equivalent experimental measurements; they were generally in reasonable agreement, however the simulations failed to capture the larger magnetic field gradients that were observed experimentally. By consideration of various potential reasons for this, we identify the assumption of a single mean magnetic susceptibility as being the primary source of the variation between simulated and measured results. Simulations of 2 MHz T2 relaxation process are shown however to be in good agreement with experimental measurements across the five sandstones studied.