Particle Filtration in Sandstone Cores: Application of a Chemical Shift Imaging Technique

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Abstract

Recent developments have led to increased interest in the application of borehole nuclear magnetic resonance (NMR) as a probe of petrophysical properties. Of particular importance in this connection is the measurement of the longitudinal relaxation time, T_1. As T_1 is, to a large extent, controlled by the effective pore surface area, its value may be strongly influenced by the invasion of submicron-sized clay particles found in drilling muds. We have undertaken a quantitative study of this effect by the application of novel magnetic resonance imaging (MRI) techniques. The resolution of conventional readout gradient MRI is limited in sandstone cores by the presence of internal field gradients associated with either paramagnetic impurities or the natural susceptibility contrast between the predominantly quartz matrix and the pore fluid. This problem can be overcome by the application of a phase encode (i.e. chemical shift) imaging sequence. The utility of this technique will be illustrated by a study of the effect of bentonite invasion on T_1 values in Berea sandstones. Our experimental results indicate that the extent to which T_1 values are affected by particulate invasion depends on several characteristics of the drilling mud. In the case of spud muds (i.e. simple bentonite slurries) we see a region deep within the core where T_1 values are significantly reduced due to an initial *spurt* of clay particles. In better formulated muds this effect is greatly reduced. Our imaging studies are supported by measurements made using a laboratory "inside-out" NMR spectrometer which measures a T_1 value at single depth (roughly 2 cm) below the inflow core end.