Reducing Sample Heating During NMR Measurements

M. J. Dick*, D.* Veselinovic*,* and *D.* Green

Abstract. NMR-measurements (T2-distributions, T1-T2 and T2-diffusion maps) are employed to derive porosity, wettability, fluid type and other properties. These measurements are derived using the Carr Purcell Meiboom Gill (CPMG) NMR pulse sequence. This pulse sequence employs a train of radio-frequency pulses which probe the exponential decay of the NMR-signal. The rate of this decay directly leads to petrophysical information such as pore size. In order to probe the smallest pores, the pulses at the beginning of the CPMG-pulse train must be close together to properly quantify the fast-exponential decay. For larger pores, the pulse train must be long enough to fully probe the entire exponential decay.

In a typical CPMG-sequence, the pulses in the train are linearly spaced. This results in trains with a large number of pulses at high duty cycle leading to heating of the sample. Heating is an issue because as the sample's temperature increases its NMR-signal decreases. This can lead to inaccuracies in the porosity derived from the NMR-data. In addition, the petrophysical property being measured may be temperature dependent and thus there is no control of an important property. For porosity, we have explored the degree of inaccuracy and have found that heating can lead to changes in retrieved NMR-porosity of approximately 10% in both bulk fluid and core samples. We have also explored the effect of salinity of the sample fluid and strength of NMR-field on sample heating.

The processing of the CPMG-train of data is usually decimated into a much lower number of echo data. One common method reduces the echo train by logarithmically decimating the data into approximately 500 data points. These points are then processed further into the distributions and maps. One method to eliminate the unwanted heating of samples by CPMG sequences is to replace the linearly spaced pulse train with a train where the pulses are logarithmically spaced. This logarithmically spaced train will maintain the closely spaced pulses at the beginning of the sequence necessary to probe the smallest pores, while decreasing the density of the pulses as the train gets longer. This leads to a reduction in the total number of pulses and therefore a reduction in the heating of the sample. We have implemented this logarithmically spaced CPMG sequences and will show that these sequences still accurately reproduce the NMR-measurements for all samples while eliminating sample heating.