Improvement of NMR T_1 Log Processing and Interpretation

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NMR longitudinal relaxation time, T_1, is a critical petrophysical parameter for hydrocarbon typing, volumetrics estimation, and in-situ fluid characterization (e.g., viscosity, *GOR*). Although T_1 interpretation is simpler than T_2 interpretation, estimation of T_1 is very challenging. A new technique, which takes advantage of the high signal-to-noise ratio of the sum of echoes (*SE*) from individual echo trains, is presented for estimating hydrocarbon T_1. The irreducible water contribution is removed from *SE* so that the T_1 analysis is based on the slowly relaxing components.

The new technique requires acquisition of two echo trains with long and short wait time, *TWL* and *TWS*, respectively, in order to take advantage of the T_1 contrast between light oil and water. However, the new approach does not require the two echo trains being acquired in the same pass. Further, previous approaches for estimating T_1 from dual wait time logs required ample vertical averaging to reduce noise, which hindered the identification of thin hydrocarbon beds. In contrast, the new approach achieves noise reduction by summing the echoes *within* each sample, thus, keeping the vertical resolution intact. Several case studies of oil-gas and oil-water reservoirs are presented to demonstrate the utility of estimated T_1 logs.

The reduction of noise in *SE* makes depth marching NMR logs acquired in different passes and different sampling rates much easier because *SE* approximates the product of $<T_2>$ and ϕ, and thus is more sensitive to variations in either or both. The product of $<T_2>$ and ϕ also enhances the *SE* difference between *TWL* and *TWS* data making it more reliable for identification of low hydrocarbon porosity reservoirs. Applications of the *SE* technique for log quality control are also presented.