Automated Determination of Formation Porosity from Drill Cuttings using Nuclear Magnetic Resonance

Joel BILLIOTTE*, Mahdi* Ammar*, Karim* Bondabou and *Jerome* Breviere

Abstract. Surface measurements of drill cuttings enable early-stage and low-cost access to petrophysical parameters compared with core-based laboratory measurements. Porosity measurements on cuttings using an accurate porosity measurement technique such as nuclear magnetic resonance (NMR), could be considered for petrophysical reservoir characterization, assuming a limited effect of drilling tools on effective cuttings porosity.

The recent development of rare-earth magnets and high frequency electronics technologies leads to the availability of low-cost, compact NMR spectrometers that can be used on the well site. A compact, 20-MHz NMR spectrometer can provide a signal that characterizes the fluid located inside a rock sample including weakly bound water molecules to clay particles. A typical NMR measurement is achieved in less than three minutes providing an accurate porosity measurement (with less than 0.5 point of error) by using an approximately 2-g rock sample.

Cuttings sample preparation to remove excess fluid outside the cuttings without affecting the rock texture was the main challenge. Numerous sample preparation protocols were proposed, including wiping, controlled drying, and capillary drainage. However, these methods are time-consuming and require a highly skilled operator to obtain consistent results.

In this paper, we present a new procedure based on automated analysis of the relaxation time distribution (T2) to remove contributions of the external fluid. This approach provides a first order correction of the porosity evaluation. Furthermore, we propose to perform plurality of NMR measurements during the sample preparation process of the cuttings fluid. This method enables a direct estimation of the fluid mass saturating the porous space.

To get controlled conditions, large block of cores (limestones) with different textures were used. Cuttings are produced from drilling bench experiments using real in-situ conditions and various drilling parameters. The error of porosity estimation on 25 cuttings samples with porosity ranging from 8 to 24% was less than 1 point compared to reference measurements.

The proposed workflow renders the porosity estimations on cuttings independent of the sample preparation process. Finally, the paper discusses automation of repetitive NMR measurements with a custom NMR instrument.