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Petrophysical characterization of reservoir sandstone through NMR and electrical measurements

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Introduction

Petrophysics measurements are essential for characterizing hydrocarbon reservoirs, mainly because the capacity to maintain fluids is a function of the physical properties of rocks. Obtaining petrophysical data through laboratory measurements is a less costly and less destructive way to define the quality of a reservoir. These measurements involve various techniques that can deliver information and precision. The most common strategies for obtaining petrophysical parameters are based on the association of pore space, electrical, elastic, and mechanical properties. However, some methods fail to deliver high standards of accuracy because of the reflection of the aspects inherent to the technique used, the environmental conditions, and the interference caused by the composition of the rock. Combining physics measurements can improve the confidence of the reservoir's estimates. We use nuclear magnetic resonance (NMR), resistivity, and phase angle vs frequency data to estimate the petrophysical properties of the Maracangalha Formation, one of the main hydrocarbon reservoirs of the Recôncavo Basin in Bahia.

Method

NMR refers to the response of atomic nuclei to magnetic fields. When a spinning magnetic nucleus interacts with the external magnetic fields, longitudinal (T1) and transverse (T2) relaxations are caused between protons. The T2 distributing data offers reasonable estimates of pore space properties. The electrical behavior of the rock will depend on factors such as the intrinsic resistivity of the matrix, the porosity, the texture and distribution of the pores, the resistivity of the interstitial liquid, and the processes that occur on the contact surfaces between the matrix and the fluid phases. For electrical measurements obtained using the multiple salinity method, the ARS-300 equipment manufactured by CoreLab Instruments uses four electrodes, one for current injection and another for measuring potential in contact with the saturated sample to derive electrical impedance values for each sample used. The petrophysical parameters analyzed using Nuclear Magnetic Resonance (NMR) and electrical measurement techniques in this research were: resistivity, porosity, free fluid index (FFI), bound fluid index (BVI), irreducible saturation, and permeability.

Results and Conclusions

The sandstones of the Ponta de Nossa Senhora group of the studied formation present low permeability, probably due to their more clayey nature in relation to the other groups of the formation. The porosity values obtained through the combination of methods are between 18% and 31%, however the T2 relaxation time of the NMR measurements showed that most of the pores of the samples are not interconnected, that is, the fluid is trapped in the pores.