NMR-MICP INTEGRATION & PERMEABILITY: A NEW FREE PETROPHYSICS SOFTWARE

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ABSTRACT: In hydrocarbon exploration, accurate mapping of the formations' permeability is crucial to assess the reservoir's productivity. NMR logging has long been used for estimating permeability of reservoir oil wells through semi-empirical models, where lithological parameters are calibrated with core data. The KSDR model is one of the most used to this end, where the main assumption is that the surface relaxivity parameter (ρ) - which scales the relation between the NMR relaxation times and the surface-to-volume ratio (S/V) of the pore system - is homogeneous for each formation. However, variations of ρ in complex lithologies can result in poor accuracy of the permeability estimation. Several authors developed techniques for obtaining ρ, in order to enhance the predictability of the KSDR equation. These techniques often use the matching between the NMR transverse relaxation time (T2) and MICP pore-throat distributions, derived from laboratory experiments in rock cores. In all of these studies, the authors showed significant improvements on permeability estimation when adding ρ as a pre-multiplier in the KSDR equation, even when dealing with complex lithologies such as carbonates. Each technique generates similar values for ρ, but in cases were the pore system is too heterogeneous, these values can differ considerably, leading into different performances when estimating permeability. This fact raises the question of which techniques works better for certain lithologies, and how to compare them. However, the workflow for calculating ρ and evaluating permeability for different models is somewhat laborious and time-consuming, involving interpolation and optimization of several parameters in big datasets. This creates difficulties for other specialists to reproduce these workflows and optimize the NMR permeability models in their own studies. In this work, we developed a software with graphical user interface (GUI), called NMR-MICP Integration and Permeability (NMIP), to calculate ρ from sample or log data using several approaches and different permeability models. The main goal is to speed up and facilitate the evaluation of these NMR permeability models, so that other specialists can also test their own theories. NMIP can read NMR, MICP and other petrophysical data directly from Excel files and organizes it in a simple way so the user can handle and combine samples subsets for testing particular models. Furthermore, we developed interactive visualization and data processing tools to help the user to perform the quality control of the data and to interpret the results. NMIP's code was written in Python 2.7 and uses most of the python's main free scientific packages for performing numerical calculations, creating plot features and dealing with data. NMIP is on its beta version and is being tested by experts in the area for feedback and bug checking. This project is currently open for ideas and implementations, and NMIP final version will be registered and released free of charge to academic users. Acknowledgements to ANP – Compromisso com Investimentos em Pesqusa e Desenvolvimento - for the support and data required to develop this work.

PALAVRAS-CHAVE: PETROPHYSICS, NMR, MICP, SOFTWARE