Comparison of Pore Size Distribution on Crushed and Whole-Rock Shale Samples Using Nuclear Magnetic Resonance (Nmr)

Mercy Achang[1]
[1]Oklahoma State University, Stillwater Oklahoma, Petrophysics, Stillwater, OK USA
achang_mercy@yahoo.co.uk

Contributors: Jack C. Pashin (Oklahoma State University), Parameswar Hari (University of Tulsa)

ABSTRACT

To estimate oil and gas resources, reserves and reservoir flow models, it is important to accurately characterize the porosity, pore size distribution, permeability, and saturation of shale. Nuclear Magnetic Resonance (NMR) has become a tool of choice for the estimation of porosity, pore size distribution because it is independent of conductive minerals in reservoir pore fluids. Whole-rocks in shale are challenging to saturate because pore space and permeability are in the nano-scale range compared to conventional reservoirs in the micro to macro scale. Additionally, porosity and fluid saturation estimation in unconventional rocks are regularly carried out on crushed samples as crushing increases the surface area, making the samples easier to clean and also reduces the turnaround time for sample analysis. The objective of this study is to compare porosity to pore size distribution in crushed and whole-rock shale samples, estimate pores shapes and geometry, and determine if crushed or whole-rock samples are suited for NMR investigations in shale. The results show that both crushed rocks and whole-rocks have unimodal and bimodal T2 distributions; translating to dominantly nanopores and mesopores in the samples. The area under the T2 distribution increases with decreasing particles size in the crushed shale and remains constant for the whole-rock. The increase in NMR porosity is suggested to result from the presence of coupling between crushed shale particles. Coupling of particles of crushed rock skews porosity estimates but may be used for the development of more accurate reservoir flow models in hydraulically fractured reservoirs as well as in the estimation of the amount of damage-related porosity resulting from crushing. Therefore crushed samples will not be ideal for the determination of porosity thus, pore size distribution using NMR. From low-pressure nitrogen sorption, pore size distribution indicates mostly mesopores with slit-like pore shapes.

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