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The Petroleum Engineering Department Presents

An Experimentally Coupled Dielectric and NMR Pore Combination Model

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Location: E124 Engr. Bldg. 9

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Abstract

The different physics and tools behind dielectric and NMR measurements have guided the use of these formation evaluation measurements to quantify and characterize different essential petrophysical parameters. While combinations of dielectric and NMR measurements frequently address challenging saturation determinations and wettability, the impact of the porous media structure is always distinctly separated. Petrophysical dielectric measurements and models have sought to describe the relative volumes of hydrocarbon and water in porous media referenced in some way with discrete structures for the conductive inclusions. The dielectric measurement response is attributed to the “texture” of the rock matrix. NMR measurements are frequently used to probe the solid structure by incorporating fluid saturations with the surface-to-volume ratio of the pore systems. The time decay of induced magnetization is correlated with relaxation times through an artificial and often ambiguous parameter, surface relaxivity.

The molecular motion descriptors and structure characteristics captured by the dielectric dispersion response in conventional carbonates have phenomenological matches to the molecular motions responsible for NMR relaxation. Correspondingly variations in the electromagnetic fields associated with NMR pulse sequences can be described in terms of the dielectric permittivity.

To improve the petrophysical use of dielectric and NMR measurements, we first incorporate previous work from magnetic resonance electrical properties tomography (MREPT), to establish an electro-magnetic surface-to-volume relationship. We then utilize dielectric spectroscopy relaxation time distributions to characterize the molecular dynamics in the restricted geometries of porous bimodal carbonates.

Using a pore combination model fit to the Havriliak-Negami dielectric relaxation time distribution, we formulate a model relating the dielectric constant to the surface-to-volume ratio of the pore system. This formalism as a differential effective medium model is used to evaluate and compare saturations, wettability, and relative displacement between macro-porous and micro-porous carbonate pore systems with conventional approaches.

Teams: https://teams.microsoft.com/l/meetup-join/19%3ameeting_NDRlOGUzYWEtNTliYy00NmM0LWIxMWYtYjY4YWUwMjc2MGQ2%40thread.v2/0?context=%7b%22Tid%22%3a%22170bbabd-a2f0-4c90-ad4b-0e8f0f0c4259%22%2c%22Oid%22%3a%22a2aa2430-0115-44a9-a9cf-223dc84fff61%22%7d