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NMR characterization of critical boundary of pore fluid in shale

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Pore fluids are generally classified into movable fluid and irreducible fluid by one or two NMR T2 cut-offs (T2C). Fluid movability in shale may not be accurately characterized by pore size-based classification methods solely because of the complex pore structure and heterogeneity in pore size. In this study, we propose a nine-grid dual T2C model to characterize critical boundary of fluid and calculate the percentages of free fluid (FF), capillary-bound fluid (CAF), and clay-bound fluid (CBF). The pore size distributions and capillarity boundaries are converted from T2 and mercury injection capillary pressure (MICP). Three T2 spectra (TFF, TCAF, and TCBF) under water saturation, centrifugation, and heat-treatments are measured to classify pore fluids as FF, CAF, and CBF according to the pore capillary force needed to displace them. T2C1 and T2C2 are calculated to classify pores into three size categories. Finally, the nine-grid dual T2C model that is composed of the three T2 distributions and two T2C is applied to explain results of a N2 displacement test and evaluate fluid movability in shale samples. The results suggest that the conventional classification method based on fixed T2C results in the underestimation of CAF and overestimation of CBF. The macro-pores range in size of T2 > T2C1 and have lower pore capillary pressures. Micro-pores (T2 < T2C2) are smaller, and have high capillary pressures. Compared with conventional methods, the introduced model interprets the pore capacity-related displacement process well, especially for the remarkable displacement ratio of medium pores. The co-effect of fluid types and pore sizes in gas-displacing-water tests indicates that the process is primarily governed by fluid-matrix interaction and the connections among pores, rather than a simple sequential displacement of larger-to-smaller pores.

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Time Block Preference

Time Block A (09:00-12:00 CET)

Participation

Online

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