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A New Method of Evaluating Tight Gas Sands Pore Structure from Nuclear Magnetic Resonance (NMR) Logs

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ABSTRACT

Tight gas sands always display such characteristics of ultra-low porosity, permeability, high irreducible water, low resistivity contrast, complicated pore structure and strong heterogeneity, these make that the conventional formation evaluation methods are invalid. Many effective gas bearing formations are considered as dry zones or water saturated layers. To improve tight gas sands evaluation, the best method is quantitative characterizing rock pore structure. Nuclear magnetic resonance (NMR) logs are considered to be promising in evaluating rock pore structure. Generally, to consecutively quantitatively evaluate tight gas sands pore structure, the best method is constructing pseudo Pc curves from NMR logs. In this paper, Based on the analysis of lab experimental results for 20 core samples, which were drilled from tight gas sands of Sichuan basin, and simultaneously applied for mercury injection capillary pressure (MICP) and NMR measurements, the relationships of piecewise power function between NMR transverse relaxation T2 time and capillary pressure (Pc) are established. A novel method, which is used to transform NMR reverse cumulative curve as pseudo capillary pressure (Pc) curve is proposed, and the corresponding model is established based on formation classification. By using this model, formation pseudo Pc curves can be consecutively synthesized. The pore throat size distribution, and pore structure evaluation parameters, such as the average pore throat radius (Rm), the threshold pressure (Pd), and so on, can also be precisely extracted. After this method is extended to field applications, several tight gas sandstone reservoirs are processed, and the predicted results are compared with core derived results. Good consistency between evaluated results with core derived results illustrates the dependability of the proposed method. By using this method, several potential gas bearing formations in central Sichuan Basin, which were considered as invalid and eliminated formations, are accurately identified.