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A new method of evaluating tight gas sands pore structure from nuclear magnetic resonance (NMR) logs

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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 methods are invalid. Many effective gas bearing formations are considered as dry zones or water saturated layers, and cannot be identified and exploited. To improve tight gas sands evaluation, the best method is quantitative characterizing rock pore structure. The mercury injection capillary pressure (MICP) curves are advantageous in predicting formation pore structure. However, the MICP experimental measurements are limited due to the environment and economy factors, this leads formation pore structure cannot be consecutively evaluated. 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 sandstone reservoirs of Sichuan basin, and simultaneously applied for lab MICP and NMR measurements, the relationships of piecewise power function between nuclear magnetic resonance (NMR) transverse relaxation T2 time and pore-throat radius Rc 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 radius distribution, and pore structure evaluation parameters, such as the average pore throat radius (Rm), the threshold pressure (Pd), the maximum pore throat radius (Rmax) and so on, can also be precisely extracted. After this method is extended into 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. Comparing with the previous methods, this presented model is much more theoretical, and the applicability is much improved. Combining with the evaluated results, our target tight gas sands are well evaluated, and many potential gas-bearing layers are effectively identified.