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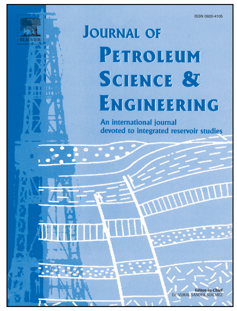

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Combining pressure-controlled porosimetry and rate-controlled porosimetry to investigate the fractal characteristics of full-range pores in tight oil reservoirs

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Abstract

Tight oil reservoirs have the characteristics of wide pore size range and complex pore system. The understanding of pore characteristics is the basis for studying the accumulation and migration of oil and gas. To better study the fractal characteristics of full-range pores in Lucaogou tight oil reservoir, scanning electron microscopy (SEM) and mercury intrusion porosimetry (MIP) were used to obtain the pore size. XRD was used to obtain the mineral composition. In addition, fractal analysis was performed on the samples based on MIP data. The results show fracture pore (FP), residual interparticle pore (RIP), dissolution pore (DP) and clay dominated pore (CDP) are the main pore types. The interparticle pores is commonly largest in size, followed by dissolution pores. Quartz and feldspar play dominant roles in the composition in Lucaogou tight oil reservoir. The full-range pore size distribution (PSD) curves ranged from 3.6 nm to 400 μm with two main distribution intervals. The fractal dimensions (D_1, D_2 and D_3) reflect the complexity of CDPs, DPs and RIPs, respectively. The average values of fractal dimensions were 2.88, 2.8 and 2.56, the smaller pores have more complex pore system. The pore structure of clay dominated pores is most complex. The more complex the pore structure, the worse the reservoir performance. Quartz shows negative correlation with D_3, Clay shows positive correlation with D_1, and feldspar is positively correlated with D_2. D_1, D_2 and D_3 are negatively correlated to porosity, D_1 shows a strong negative correlation with permeability.

Key words: Tight oil reservoir; Pore size distributions; Fractal characteristics; Mineral composition; Mercury intrusion porosimetry.

1. Introduction

Fractal theory, which was first proposed by Mandelbrot (1975), is a very popular and active new theory and new discipline. The mathematical basis of fractal theory is fractal geometry, from which fractal information, fractal design, fractal art, and so on are derived (Mandelbrot, 1975). As a mathematical tool, fractal theory has been applied in many fields at present (Cutler, 1993; Cai et al., 2017). The fractal theory is one of the most commonly used methods to describe the natural objects with non-Euclidean shapes (Liu et al., 2018). In the field of geology, it is difficult to describe the pore heterogeneity of underground rocks because of the complexity of the pore system (Wang et al, 2017). Fractal theory can quantificationally characterize