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Quantitative characterization of pore structure and analysis of seepage characteristics of tight reservoir based on digital core and NMR

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Quantitative characterization of pore structure and analysis of seepage characteristics of tight reservoir based on digital core and NMR
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Abstract: The pore-fracture structure characterization and seepage characteristics analysis are the keys to the effective development of tight reservoirs. However, it is difficult to accurately characterize the pore and fracture structures of different scales by conventional methods, which makes it difficult to analyze the seepage characteristics. In this study, combined with CT scanning technology and advanced mathematical algorithms of AVIZO visualization software, a three-dimensional digital core of tight reservoirs was constructed, and the comprehensively quantitative characterization of microscopic pore-fracture structure from multiple dimensions was carried out. On this basis, nuclear magnetic resonance (NMR) centrifugation experiments were conducted to monitor the fluid migration dynamics in tight reservoirs, and mobile fluid migration characteristics were analyzed based on NMR T2 spectra. The results show that the average porosity of the reservoir in this area was 11.2%, and the average permeability was 1.573mD, which belongs to low porosity and low permeability tight reservoirs. The distribution of pore throats was mainly contiguous and isolated. The connected pores were mainly distributed in enriched bands, which was due to the interconnection of gas pores, intergranular pores, and dissolution sheet fractures, while the disconnected pores were mainly distributed in isolated form, which was related to the development of inter-gravel dissolved pores and matrix dissolved pores, and the contribution of pore connectivity to seepage was greater than that of pore scale. The pore radius in this area was mainly 4.31-32.17 μm, the throat radius was mainly 3.42-13.29 μm, and the pore and throat cross-sectional shapes were mostly triangular, meanwhile, the fracture types could be divided into 3 types according to the occurrence and opening, which were mainly high-angle structural fractures and vertical fractures, indicating that pore-fracture structure had strong heterogeneity and fractures could play a better role in the infiltration of oil and gas. The connectivity of pore throats in the tight matrix was poor, which made the imbibition exchange effect weak and prone to water sensitivity. Subsequently, the movable fluid saturation increases with the increase of permeability, and the fractures and micropores had less flow resistance and were more conducive to water flow compared with small pores. This case study provides new insights into the exploitation of similar tight reservoirs.
Key works: NMR; dual porous medium; CT scanning; cross scale; digital core; quantitative characterization of pores fractures; fluid mobility

Participation

In-Person

References

References

[1] Yuan S, Wang Q, Li J, et al. Technology progress and prospects of enhanced oil recovery by gas injection [J]. Acta Petrolei Sinica, 2020, 41(12): 1623-1632.

[2] Jiang Q, You H, Pan J, et al. Preliminary discussion on current status and development direction of heavy oil recovery technologies [J]. Lithologic Reservoirs, 2020, 27(6): 30-39.

[3] Zou C, Zhai G, Zhang G, et al. Formation, distribution, potential and prediction of global conventional and unconventional hydrocarbon resources[J]. Petroleum Exploration and Development, 2015, 42(1): 13-25.

[4] Liu, P.; Zhang, X.; Wu, Y.; Li, X. Enhanced oil recovery by air-foam flooding system in tight oil reservoirs: Study on the profile-controlling mechanisms. J. Pet. Sci. Eng. 2017, 150, 208–216.

[5] Zhang X, Gao W, Li J, et al. Facies Evolution Pattern of Volcanic Fractured R eservoir in Zhongguai Bulge[J]. Special Oil & Gas Reservoirs, 2019, 26(2): 52-58.

[6] Ren, L.; Wang, W.; Su, Y.; Chen, M.; Jing, C.; Zhang, N. Multiporosity and Multiscale Flow Characteristics of a Stimulated Reservoir Volume (SRV)-Fractured Horizontal Well in a Tight Oil Reservoir. Energies 2018, 11, 2724.

[7] Fan C, Li Y, Li H, et al. Development characteristics, stages and seepage characteristics of structural fractures in Carboniferous volcanic rocks in Zhongguai area, Xinjiang[J]. Geological Science and Technology Information, 2018, 37(3): 38-42.

[8] Zhang X, Zhang B, Zhou J, et al. Characteristics and controlling factors of Carboniferous volcanic rock reservoirs in Jinlong 10 well area of Zhongguai uplift[J]. Geological Review, 2017, 63(5): 136-138.

[9] Yang L， Zhang X， Zhou T， et al. The effects of ion diffusion on imbibition oil recovery in salt-rich shale oil resevoirs[J]. Journal of Geophysics and Engineering, 2019, 16(3): 525-540.

[10] Zheng, S.; Yao, Y.; Liu, D.; Cai, Y.; Liu, Y. Characterizations of full-scale pore size distribution, porosity and permeability of coals: A novel methodology by nuclear magnetic resonance and fractal analysis theory. Int. J. Coal Geol. 2018, 196, 148–158.

[11] Li Y, Di Q, Hua S, et al. Visualization of foam migration characteristics and displacement mechanism in heterogeneous cores[J]. Colloids and Surfaces A, 2020, 607(1): 1-8.

[12] Fan C, Qian Q, Zhi D, et al. Carboniferous volcanic rocks in the Zhongguai uplift in the northwestern margin of the Junggar Basin Reservoir characteristics and main controlling factors[J]. Natural Gas Geoscience, 2012, 23(01): 81-87.

[13] Dai C , Cheng R, Sun X, et al. Oil migration in nanometer to micrometer sized pores of tight oil sandstone during dynamic surfactant imbibition with online NMR[J]. Fuel, 2019, 245(17): 544-553.

[14] Peng J, Han H, Xia Q, et al. Fractal characteristic of microscopic pore structure of tight sandstone reservoirs in Kalpintag Formation in Shuntuoguole area, Tarim Basin[J]. Petroleum Research, 2020, 5(1): 1-17.

[15] Wang C, Shen J, Chu X, et al. Characterization and analysis of pores and fissures of high-rank coal based on CT three dimensional reconstruction[J]. Journal of China Coal Society, 2017, 42(08): 2074-2080.

[16] Li W, Sun W, Tang P, et al. A method for rock fracture network characterization based on topological structure[J]. Natural Gas Industry, 2017, 37(06): 22-27.

[17] Golab A, Ward C R, Permana A, et al. High-resolution three-dimensional imaging of coal using microfocus X-ray computed tomography, with special reference to modes of mineral occurrence[J]. International Journal of Coal Geology, 2013, 113(Complete): 97-108.

[18] Bijoyendra b, k. M S, Douglas V. Understanding the micro structure of Berea Sandstone by the simultaneous use of micro-computed tomography (micro-CT) and focused ion beam-scanning electron microscopy (FIB-SEM)[J]. Micron, 2010, 42(5): 412-418.

[19] Lv W, Chen S, Gao Y, et al. Evaluating seepage radius of tight oil reservoir using digital core modeling approach[J]. Journal of Petroleum Science and Engineering, 2019, 178(3): 609-615.

[20] Luo Y, Zhen T, Xiao H, et al. Identification of distinctions of immiscible CO2 huff and puff performance in Chang-7 tight sandstone oil reservoir by applying NMR, microscope and reservoir simulation [J]. Journal of Petroleum Science and Engineering, 2022, 109(2): 47-58.

[21] Zhu C, Sheng J, Ettehadtavakkol A, et al. Numerical and Experimental Study of Enhanced Shale-Oil Recovery by CO2 Miscible Displacement with NMR [J]. Energy & Fuels, 2020, 34(15): 1524-1536.

[22] Gao, H.; Li, H. Determination of movable fluid percentage and movable fluid porosity in ultra-low permeability sandstone using NMR (NMR) technique. J. Pet. Sci. Eng. 2015, 133, 258–267.

[23] Yang Z, Li R, Li Hi, et al. Experimental evaluation of the salt dissolution in inter-salt shale oil reservoirs[J]. Petroleum Exploration and Development, 2020, 47(4): 750-755.

[24] LI J, CHEN B, KONG M, et al. Digital core reconstruction and research on microscale flow characteristics of shale oilreservoir: A case of the shale oil in Permian Lucaogou Formation, Jimsar Sag[J]. Xingjiang Petroleum Geology, 2019, 40(3): 319-327.

[25] Bai B, Zhu R, Wu S, et al. Multi-scale method of nano (micro) CT study on microscopic pore structure of

tight sandstone of Yanchang Formation, Ordos Basin[J]. Petroleum Exploration and Development, 2013, 40(3): 329-333.
[26] Liu X, Zhu H, Liang L. Digital rock physics of sandstone based on micro-CT technology[J]. Chinese Journal of Geophysics, 2014, 57(4): 1133-1140.
[27] Xu, J.; Sun, B.; Chen, B. A hybrid embedded discrete fracture model for simulating tight porous media with complex fracture systems[J]. Journal of Petroleum Science and Engineering, 2019, 174(3): 131-143.
[28] Yin, T.; Liu, D.; Cai, Y.; Zhou, Y.; Yao, Y. Size distribution and fractal characteristics of coal pores through NMR cryoporometry[J]. Energy Fuels, 2017, 31, 7746−7757.
[29] Wang G, Shen J, Chu X, et al. Characterization and analysis of pores and fissures of high-rank coal based on CT three-dimensional reconstruction[J]. Journal of Petroleum Science and Engineering, 2017, 42(8): 2074-2080.
[30] Yang Z, Liu X, Li H, et al. Analysis on the influencing factors of imbibition and the effect evaluation of imbibition in tight reservoirs[J]. Petroleum Exploration and Development, 2019, 46(4): 739-745.
[31] Dehghanpour, H.; Lan, Q.; Saeed, Y.; Fei, H.; Qi, Z. Spontaneous imbibition of brine and oil in gas shales: Effect of water adsorption and resulting micro fractures[J]. Energy Fuels, 2013, 27, 3039−3049.

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