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A Multi-Scale Approach for Assessing Shale Oil Accessibility: Digital Core, Molecular Simulation and Machine Learning Analysis

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This study presents a novel multi-scale approach for assessing the accessibility of shale oil in cores. By using FIB-SEM equipment to build digital core, watershed and maximum ball method to extract pore size and shape factor. Then molecular simulation is used to study the availability of shale oil in individual pores with different shapes and radii. Finally, combining the results of the above two scales, machine learning is used to predict shale oil availability across the entire core. On the core scale, the watershed and maximum ball method is used to extract the core pore network model, and it is found that square pores occupy the highest proportion among the three pore types, and most of the radii are distributed in the range of 2-3 nm. The molecular scale dynamic simulation results show that the adsorption forms of shale oil are different in different pores, and the adsorption of shale oil in circular pores is less than that in flat pores. The proportion of shale oil adsorption in square pores is the highest, followed by triangle pores, and the proportion of shale oil adsorption in circular pores is the lowest. The Random Forest machine learning algorithm is used to predict the availability of shale oil with different pore shapes and obtain the shale oil availability ratio of the whole core. The results show that the pores with a more obvious angular structure show a lower shale oil availability ratio. In general, the impact of pore shapes on shale oil availability is not significant, and the difference between different pore shapes is only 10%. The multi-scale evaluation method for shale oil availability proposed in this study is helpful to better understand the availability of shale oil in reservoirs and to optimize recovery strategies.

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References

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