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Pore Structure Evaluation and Fluid Assessment for Permian Carynginia Shale

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Pore structure characterization and pore fluid assessment play an essential role in unconventional shale gas evaluation. However, the determination of petrophysical parameters, especially effective porosity for shale is challenging due to the impact of clay bound water (CBW), the tight texture and the complicated pore structure. In particular, no such porosimetric technique is able to appropriately cover the wide range of pore size distribution (PSD), ranging from <2nm micropores to >50nm macropores, up to the micrometer-sized pores or micro-fractures.
In this study, a novel method of thermal treatment in combination with multi-PSD interpretation is applied to determine the effective porosity by cutting CBW off total porosity in shale. Thermal dehydration process makes it possible to maximally extract free and capillary water that are hosting in highly complex nanopore structure, while keeping the sensitive clay mineral and clay bound water well-preserved for accurate pore structure interpretation. Characterization techniques using different penetration fluids are conducted for the access into different pore sizes. Low-pressure CO2 gas adsorption is applied for the detection of 0.35-2nm pore sizes, while low-pressure N2 gas adsorption is applied for pore range of 2-100nm and nuclear magnetic resonance (NMR) using water probe is available for pores >3nm. Fluid extraction behavior and pore structure are further evaluated based on the comparison between multi-PSD interpretations. The results can be further applied in formation evaluation practice to establish gas originally in place for shale.

References

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