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Pore-Type-Dependent microstructures of Shales and Implications on Permeability

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Pore structure features govern the capacity of gas storage and migration in shales and are highly dependent on the types of pores, i.e., interparticle (InterP) pores, intraparticle (IntraP) pores and organic matter (OM)-hosted pores. However, microstructures and fractal features regarding pore types and their respective contributions to permeability have been rarely addressed. Based on SEM and FIB-SEM imaging, fractal dimensions (Ds) have been determined from both pore size distributions and digital rock to quantify the heterogeneity in pore morphology and spatial textures. Overall, OM-hosted pores are smaller in size and more abundant in quantity, corresponding to a relatively high D, while IntraP pores are mainly isolated and scarce, translating into lower D values. Additionally, crack-like InterP pores with a moderate level of porosity and the D can play a pivotal role in shale seepage potential. A comparison of the estimated permeability among different pore types highlights that the contribution of interconnected OM pores to the overall permeability remains constrained unless they can link neighboring pore clusters, as commonly observed in organo-clay composites. Furthermore, pore morphology and fractal features of shale rocks can exhibit noteworthy variations subjected to sedimentology, mineralogy, diagenesis and OM maturation.

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