

Multiscale Analysis of Shale Heterogeneity in Silurian Longmaxi Formation from South China

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Abstract : Characterization of shale multi scale heterogeneity is an important part to evaluate size and space distribution of shale gas reservoirs in sedimentary basins. The origin of shale heterogeneity has always been a hot research topic for it determines shale micro characteristics description and macro quality reservoir prediction. Shale multi scale heterogeneity was discussed based on thin section observation, FIB-SEM, QEMSCAN, TOC, XRD, mercury intrusion porosimetry (MIP), and nitrogen adsorption analysis from 30 core samples in Silurian Longmaxi formation. Results show that shale heterogeneity can be characterized by pore structure and mineral composition. The heterogeneity of shale pore is showed by different size pores at nm- μ m scale. Macropores (pore diameter > 50 nm) have a large percentage of pore volume than mesopores (pore diameter between 2~ 50 nm) and micropores (pore diameter < 2nm). However, they have a low specific surface area than mesopores and micropores. Fractal dimensions of the pores from nitrogen adsorption data are higher than 2.7, what are higher than 2.8 from MIP data, showing extremely complex pore structure. This complexity in pore structure is mainly due to the organic matter and clay minerals with complex pore network structures, and diagenesis makes it more complicated. The heterogeneity of shale minerals is showed by mineral grains, lamina, and different lithology at nm-km scale under the continuous changing horizon. Through analyzing the change of mineral composition at each scale, random arrangement of mineral equal proportion, seasonal climate changes, large changes of sedimentary environment, and provenance supply are considered to be the main reasons that cause shale minerals heterogeneity from microcosmic to macroscopic. Due to scale effect, the change of shale multi scale heterogeneity is a discontinuous process, and there is a transformation boundary between homogeneous and in homogeneous. Therefore, a shale multi scale heterogeneity changing model is established by defining four types of homogeneous unit at different scales, which can be used to guide the prediction of shale gas distribution from micro scale to macro scale.

Keywords : heterogeneity, homogeneous unit, multiscale, shale

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