Microstructures of Organic Matters from Shale Gas/Oil Reservoirs in China

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Unconventional Resources including shale gas and shale oil have been proved highly promising, especially in Sichuan basin, Ordos basin, and Junggar basin in China. Organic matters (OM) in shale, mostly kerogen, play a key role in both generation and rentation of hydrocarbons, which are both related to the microstructure. The routine geochemistry analyses of OM mainly focus on marcoscopic paramters such as the level of maturity, the type of kerogen, etc. They can barely elucidate the microstructure difference or microstructure change of OM. Focused ion beam – scanning electron micrscope (FIB-SEM) with scanning transmission electron microscopy (STEM) detector and Energy Dispersive Spectrometer (EDS) makes it possible to directly analysis the microstructure and element distribution of the OM down to nano-scale. Two shale gas samples from Longmaxi formation and Qiongzhusi formation in Sichuan basin, two shale oil samples from Yanchang formation in Sichuan basin, Lucaogou formation in Junggar basin, are systemetically analysised by conventional geochemistry analyses and STEM-EDS analyses. It shows that the microstructure of OM in Longmaxi shale (kerogen Ro~2.33%) is highly porous and aboundant of well-connected nano pores with pore size in the range of 5~20 nm, providing an excellent storage space for shale gas. The over matured OM of Qiongzhusi shale (kerogen Ro~3.67%) shows a granular morphology, with sporadic pores in the range of 50~100 nm. Qiongzhusi shale was once considered a potential shale gas reservoir, however it revealed far less productive than Longmaxi shale, these STEM-EDS results may give a novel microscopic point of view by comparasion of these two distinct microstructures. For the Yanchang shale oil sample (kerogen Ro~0.73%), the appeared black OM in SEM backscattered image actually contains a large quantity of nano-sized filamentous mineral particles, which may act as catalysts during the hydrocarbon formation process, and few micro cracks along the edge of the particles were observed. For the Lucaogou shale oil sample (kerogen Ro~0.61%), the OM exhibits a uniform amorphous structure, no visible pores exist, indicating a good oil generation potential. In conclusion, the STEM-EDS method is a feasible method in identifying the mico structure of OM in shale, and it may provide much more information than normal SEM imaging and higher resolution. Combined with conventional geochemistry analyses, it will provide a novel perspective in evaluating shale rocks.