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Depositional and diagenetic controls on hydrocarbon generation of mudstones through clay-organic matter interactions

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Mudstones are mainly composed of organic matter (OM) and minerals, of which interaction run through deposition and late diagenesis. The mineral-OM plays crucial roles in affecting hydrocarbon generation of OM and interaction mechanisms vary with respect to types and properties of minerals and OM, which are determined by deposition environment and diagenetic conditions. Therefore, the hydrocarbon generation of mudstones is a joint result of deposition and diagenesis.

The northern and southern Dongpu Depression represent two endmembers of depositional environment and diagenetic conditions. Mudstones from northern Depression were developed in stable deep lacustrine environment and underwent saline diagenetic condition, while those of southern Depression formed in shallow lacustrine environment with abundant terrigenous input and experienced fresh-water diagenetic condition. To investigate the depositional and diagenetic controls on hydrocarbon generation, mudstones from northern and southern Dongpu Depression were collected to analyze the formation and evolution of mudstones based on clay organic matter interactions.

Results showed that the lithofacies of northern Depression mudstones were dominated by laminated mudstones, in which clay-rich and organic rich laminae were interbedded. Meanwhile, TOC, S1, and S2 of the bulk rocks were lower than those of corresponding <2μm clay-sized fractions, indicating the enrichment of high-quality OM in the clay-sized fractions. The association between clay and OM determined the OM could be well preserved and contributed to the better hydrocarbon generation potential of northern Depression mudstones. In addition, the saline diagenetic condition promoted the smectite illitization, during which the variations of mineral properties led to desorption of interlayer OM and accelerated the subsequent hydrocarbon generation process. By contrast, OM in southern Depression mudstones was scattered distributed as particles among detrital minerals or above argillaceous matrix. The enrichment of TOC, S1, and S2 in the clay-sized fractions was inapparent, demonstrating that clay minerals were weakly associated with OM during the formation of southern Depression mudstones, which coincided with lower hydrocarbon generation potential. Moreover, the slower illitization in the fresh-water diagenetic condition contributed slightly to converting the OM to hydrocarbon. In general, deposition controls the material prerequisite and diagenesis determines the hydrocarbon generation impetus.