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Effects of mineral-organic matter interaction on the interfacial features of shale and its significance to shale oil accumulation

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Minerals, especially clay minerals, always form organo-complexes with OM, which show significant effect on the interface properties of pure minerals. Therefore, based on N2 adsorption, dielectric property, atomic force microscope (AFM) and contact angle test as the main methods, the controlling factors of interfacial properties (specific surface area, dielectric constant, surface potential and wettability) of pure minerals, mineral-organic matter complexes and natural shale samples were analyzed. Then, the control of interfacial properties on hydrocarbon occurrence were further discussed. The followings are the main achievements and understandings:

(1) Minerals different significantly in their specific surface area, dielectric properties and surface potential, they are always hydrophilic. OM adsorption could change the interfacial properties greatly. Although the hydrophobicity of mineral-OM complex always increases after OM adsorption, the complexes formed by different types of minerals and OM show great differences.

(2) The change of interfacial properties of solid residues after thermal simulation at different temperatures of smectite-Lys and illite-Lys complexes show obvious stage characteristics, and coincide with mineral transformation, OM transformation and element composition. The hydrophobicity of original smectite complexes are weak, but some stage of evolution may be conducive to the enrichment of shale oil, while the pores composed of illite may be more conducive to the seepage of shale oil.

(3) The research on the controlling factors of shale interfacial properties indicates that the surface area is mainly contributed by clay minerals and significantly modified by the occurrence of organic matter, while the wettability (contact angle) is significantly controlled by organic components. Generally speaking, the higher the abundance of OM and HI, the greater the contact angle. Further discussion on the controlling factors of hydrocarbon with different occurrence states shows that the interface attribute plays an important role in controlling the occurrence form and amount of hydrocarbons. The stronger the lipophilicity of the interface, the higher the content of various hydrocarbons, especially free and physically adsorbed hydrocarbons, and more adsorbed hydrocarbons will in turn promote the retention of hydrocarbons further.