Differential Hydrocarbon Accumulation Mechanisms and Exploration Zones Optimization in the Deep-Water Areas of South China Sea

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Abstract

The deep-water area of Qiongdongnan and Nam con son basins in South China Sea is different from the shallow-water area in sedimentary filling, thermal evolution, hydrocarbon migration and accumulation. A poor understanding of the differential reservoir-forming mechanisms has hindered petroleum exploration in the deep-water area. This study aims to identify the hydrocarbon origin and their dominant migration pathways and accumulation zones on the basis of paleo-morphological reconstruction, integrated description of source rock-reservoir-cap rock assemblages and quantitative characterization on hydrocarbon migration. The results of this study show that during the Early to Middle Oligocene, alternate sags and uplifts were widely developed and distributed in this semi-closed neritic environment which was conducive to the flourishing and preservation of terrestrial plants and marine algae, forming high-quality source rocks (TOC ≥1.0%, present Ro ≥1.3%) with type IIb-III kerogens in sags. Coeval widespread coastal and delta sandstones were well developed both on the slopes and uplifts. The thermal evolution and hydrocarbon generation potential of the source rocks as well as the porosity of Oligocene sandstones display significant change from shallow-water to deep-water to ultra deep-water area due to the varying depositional rates since the Middle Miocene, and the thermal maturity of source rocks has thus been significantly promoted by the accumulation of the huge thick Miocene-Pliocene sediments, favorable for strong hydrocarbon generation and expulsion. Meanwhile,

large-scale sandstones with approximate porosities of 10%~30% on the slope and uplift in the deep-water area could serve as carriers for highly-efficient hydrocarbon migration. Therefore, the coupling distribution of high-quality neritic Oligocene source rocks, large reservoirs, discrepant fluid potential and structural ridge throughout Oligocene times would eventually determine the hydrocarbon migrating direction and migration-accumulation coefficient. Quantitative assessment shows that the deep-water area yields a three to fourfold greater resource potential than the shallow-water area, which has also been evidenced by several discoveries of medium-large-sized gas fields in deep-water area, including the Y8 granite and clasolite gas fields with high production on the Songnan uplift. Based upon the above analysis, hydrocarbon migration and accumulation zones were divided into four levels (I to IV), and the Level I was the overriding zones in which the resource potential was considerable and hydrocarbon charge risk was lower.

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