Multi-stage hydrocarbon migration and accumulation of Permian petroleum system in the Zaysan Basin, NE Kazakhstan

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Abstract:

The Zaysan Basin in northeastern of Kazakhstan is a petroliferous basin and one important tectonic unit of Central Asian Orogenic Belt (CAOB). The hydrocarbon accumulations are characterized by multi-stage migration and accumulation, however, the detailed processes have not been well constrained. Based on the regional tectonic evolution, combining the geochemistry, geophysics data and basin model result, with the analysis of traps forming time and hydrocarbon history simulation, the hydrocarbon accumulation processes are discussed and a model is established. Oil and gas geochemistry data indicates the source rocks were deposited under anoxic brackish-saline environment, the organic matter of source rock are mainly type I and type II kerogen, and the Paleogene gas is the biodegradation product of the Jurassic oil. The oil and extracted bitumen in the Permian and Jurassic reservoirs both originated from the same Permian source rocks, the oils are in early maturity, but the biodegradation level between the Permian and Jurassic reservoirs is different, indicating that they underwent different alteration history. Two fluorescence colors of intergranular oils were identified with strong brown yellow in deep Permian reservoirs and yellow in Jurassic reservoirs. Two stages of oil charging and one stage of gas charging in the study area were deduced. The first oil charging started at about 207 Ma (Late Triassic) when the source went into the oil window. The oils were stored in the Permian reservoirs and suffered from biodegradation. The second oil charging took place at about 70~100Ma controlled by the cooling and exhumation events occurred at Late Cretaceous. The Jurassic oils accumulation was the result of the Permian oils remigration. The gas charging occurred during late Cenozoic. The gas was sourced from the Jurassic oils which suffered from biodegradation and traveled vertically along the faults and accumulated in the Paleogene reservoirs.

Keywords: hydrocarbon migration, hydrocarbon accumulation, geochemistry, Permian, petroleum system, the Zaysan Basin, Kazakhstan