



Hydrocarbon Geological Conditions and Exploration Prospects of Marine Strata in the Laoshan Uplift, South Yellow Sea Basin

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Abstract: Geological survey and exploration in recent years have shown that the marine strata in the Laoshan uplift in the South Yellow Sea Basin are generally well developed with large thickness, relatively stable and well preserved (Liang et al., 2017; Xu et al., 2018). However, no substantial breakthrough has been discovered in this basin. The lack of systematic understanding of hydrocarbon geological conditions has restricted its exploration (Zhang et al., 2019). The marine strata of the Laoshan uplift and its adjacent area have been taken as the object of this study. The latest seismic data, well log data and representative outcrops as well as drilling cores together with related laboratory analysis from wells are fully utilized. In-depth investigation of stratigraphy, sedimentology and geological structure has been carried out. The hydrocarbon geological conditions such as hydrocarbon generation, storage and accumulation in the Laoshan uplift are analyzed systematically and thoroughly. In addition, the differences of the hydrocarbon geological conditions within secondary structural units and source-reservoir-caprock assemblages are examined. It further points out the key target areas for marine hydrocarbon exploration, which lays a foundation for the exploration breakthrough in the South Yellow Sea Basin and also provides an important support for enriching the geological theory of marine hydrocarbon geological conditions in South China. The study shows that the Laoshan Uplift has undergone five tectonic evolution stages: stable cratonic deposition, strong Indosinian reversion, Yanshanian fault depression, early Himalayan uplift and sustained depression in mid-late Himalayan period. The tectonic strength of the Laoshan Uplift is obviously weaker than that of Qingdao Depression and Yantai Depression. The Laoshan Uplift can be further divided into two secondary structural units, the Qingfeng Deformation Zone on the north side and the Gaoshi Stability Zone in the middle and south. The marine strata of the Laoshan uplift consist of the Sinian, Cambrian, Ordovician, Silurian, Upper Devonian, Carboniferous, Permian and Lower Triassic from the bottom to the top. The Lower Cambrian Mufushan Formation, the Lower Silurian Gaojiabian Formation, the Lower Permian Qixia Formation, and the Upper Permian Longtan Formation-Dalong Formation are four sets of high-quality source

rocks in the Mesozoic and Paleozoic strata of the Laoshan Uplift (Zhang et al., 2017). For source rocks in the Lower Cambrian and Lower Silurian strata, the organic matter type is good (mainly type I), the maturity is high (high mature-over mature), and the organic matter abundance is relatively good (TOC is generally between 1.0% and 4.0%). Carbonate and clastic reservoirs are developed in the Mesozoic and Paleozoic strata in the Laoshan Uplift, and dolomite has been considered as the best reservoir. The relatively good reservoirs are mainly concentrated in the Upper Sinian Dengying Formation, the Middle Cambrian-Ordovician, the Middle Silurian-Lower Carboniferous, the Middle Carboniferous-Lower Permian, as well as the Upper Permian Longtan-Dalong Formation. The mudstones of the Lower Cambrian Mufushan Formation, the Lower Silurian Gaojiabian Formation and the Upper Permian Longtan-Dalong Formation are the most important three sets of caprocks in the Laoshan Uplift with relatively strong sealing ability. Therefore, the marine strata in the Laoshan uplift can be divided into two main sets of complete source-reservoir-caprock assemblages. The first set is the combination of the Sinian-Lower Silurian, and the second set corresponds to the combination of Lower Silurian-Upper Permian. The study of oil and gas inclusions in the Qingfeng Deformation Zone of the Laoshan Uplift indicates that hydrocarbon accumulation and multi-phase oil and gas filling processes have existed. The fault system of the Qingfeng Deformation Zone is developed, and the formation fold deformation is rather strong. Thus, it is difficult to preserve oil and gas in this zone. The Gaoshi Stability Zone is a weakly deformed zone where the early faults are not developed. The shallow faults are relatively developed, however, the deep and large faults are not developed. In such a case, the Gaoshi Stability Zone is more favorable to the formation and preservation of oil and gas in the marine strata. Geochemical exploration of oil and gas targets reveals that there may be primary gas reservoirs in the lower part and residual reservoirs in the upper part of the Laoshan Uplift. The Mesozoic-Paleozoic marine strata in the Gaoshi Stability Zone, especially the anticline structure in the southeastern part, is characterized by stable tectonics, complete source-reservoir-caprock preservation, large trap development, relatively weak magmatic activity,

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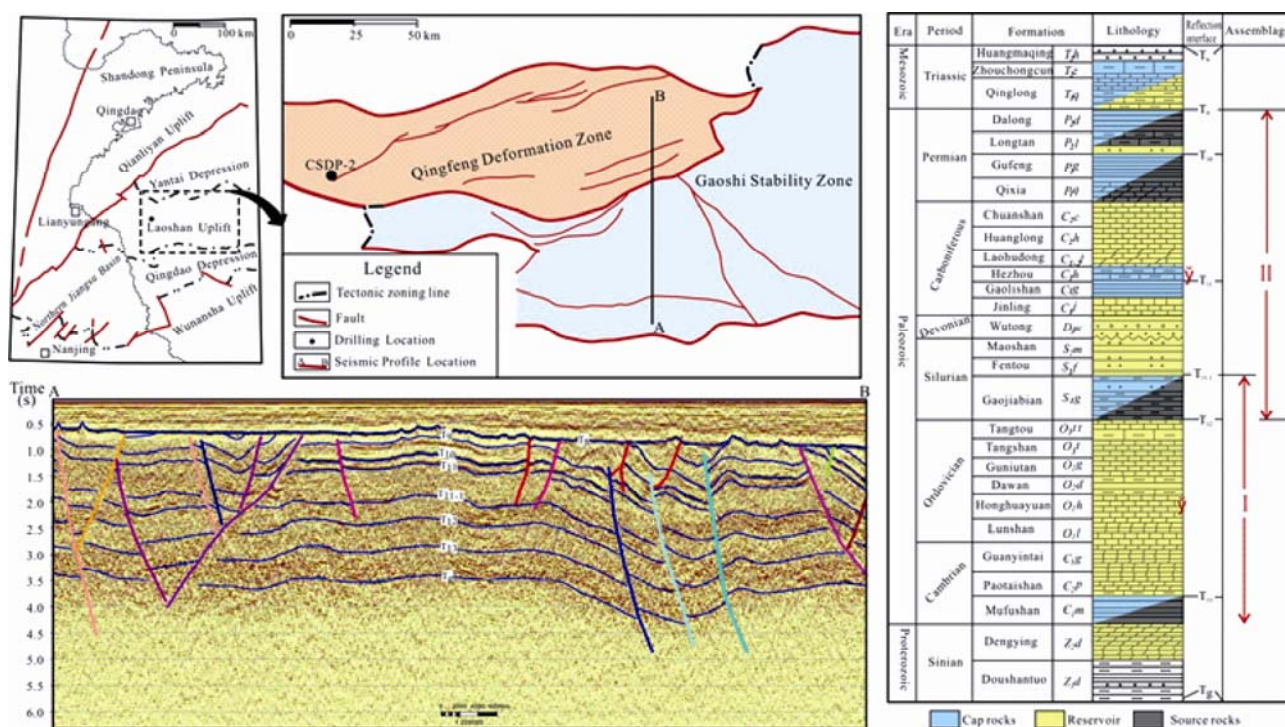


Fig.1. Tectonic districts and seismic interpretation profile in the Laoshan uplift

superior hydrocarbon preservation characteristics and a shallow burial condition. Therefore, it has been regarded as a favorable zone for deep oil and gas exploration of the lower assemblage of marine strata in the South Yellow Sea Basin.

Keywords: Laoshan Uplift, South Yellow Sea Basin, marine strata, hydrocarbon geological condition, exploration prospect

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