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Comparative Analysis and Hydrocarbon Exploration on South Yellow Sea Basin

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Based on the geological-geophysical data such as satellite gravity, airborne gravity, aeromagnetic survey, seismic exploration, drilling and stratigraphic (rock) physical property in South Yellow Sea, and using the method of comparative analysis, this paper discusses the common features and the differences among the south depression, north depression and central uplift of the South Yellow Sea basin, and proposes the hydrocarbon exploration targets in the future.

The common features among the south depression, north depression and central uplift of the South Yellow Sea basin are as follows. (1) In Paleozoic and early-middle Triassic, the three all belonged to the same marine sedimentary basin with the different sedimentary thickness. (2) In Neogene, the three all belonged to the same sedimentary basin with the stable sedimentary thickness. The differences among the south depression, north depression and central uplift of the South Yellow Sea basin are as follows. (1) In Paleozoic and early-middle Triassic, the south depression and north depression weren't the sedimentary centers, and the sedimentary thicknesses were small (1500–4500m); while the central uplift was the sedimentary center, and the sedimentary thickness was stable and large (4000–7500m). (2) In Jurassic-Cretaceous and Paleogene, there was a significant change in the sedimentary pattern. During this period, the south depression and north depression were two sedimentary centers, and the sedimentary thicknesses were large (0–9000m); while the central uplift was a uplift, and there was only local and sporadic deposition (0–1600m).

The common features between the south depression and north depression of the South Yellow Sea basin are mainly as the following three aspects. (1) Both displayed the five-layer stacking structure from vertical stratigraphic succession, namely the basement tectonolayer (Pre-Sinian metamorphic rock series), the lower tectonolayer (Sinian, Paleozoic to early-middle Triassic marine strata), the middle tectonolayer (Mesozoic terrestrial strata), the upper tectonolayer (Paleogene strata), and the top tectonolayer (Neogene to Quaternary strata). (2) Both underwent the development stages such as the marine deposit ($Pz–T_2$), the terrestrial fault-depression deposit ($T_3–J–K–E$), and the depression deposit (N–Q). (3) Both had the three petroleum system, namely the Paleozoic to middle–lower Triassic petroleum system ($Pz–T_2$), the upper Triassic to Jurassic–Cretaceous petroleum system ($T_3–J–K$), and the Cenozoic petroleum system (Kz). The differences between the south depression and north depression of the South Yellow Sea basin are as follows. (1) The geotectonic positions of the two depressions were different from each other. The north depression was situated in the northern margin of the lower Yangtze platform, while the south depression was situated in the interior of the lower Yangtze platform. (2) The gravity fields corresponding to the two depressions are different from each other. The gravity field corresponding to the north depression mainly displays a series of ribbon-shaped positive gravity anomalies with NEE–SWW trend; while the gravity field corresponding to the south depression mainly shows both the positive and negative gravity anomalies with near E–W and NW–SE trends. (3) The magnetic fields corresponding to the two depressions are different from each other. The magnetic field corresponding to the north depression displays a negative magnetic anomaly zone with NEE–SWW trend, mingled with local positive magnetic anomalies; while the magnetic field corresponding to the south depression shows a series of the positive and negative massive magnetic anomalies. (4) The depression trends, structures and depression-controlling faults to the two depressions are different. The north depression is NEE–SWW trend, faulted in northern edge and overlapped in southern edge in Paleogene; the majority of depression-controlling faults are NEE–SWW trend, and the next are NW–SE trend. The south depression is near E–W trend, faulted in southern edge and overlapped in northern edge in Paleogene; the majority of depression-controlling faults are near E–W trend, the next are NE–SW and NW–SE trends. (5) The tectonic

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evolution and stress field to the two depressions in Mesozoic are different. The north depression belonged to a foreland basin formed by the compressional stress field, while the south depression belonged to a strike-slip pull-apart basin or an extensional basin formed by the extensional-shear stress field. (6) The stratigraphic fold deformation and its strength to the two depressions are different. The fold deformation of the north depression was strong, while the south depression was relatively weak. (7) The total thicknesses of the Meso–Cenozoic terrestrial deposits (T_3–J–K–E) to the two depressions are different. The north depression is thicker than the south depression, and the former is 1000–10000m, the latter is 1000–6000m. Besides the thickness of the Neogene–Quaternary (N–Q) in the south depression is larger than that of the north depression, the thicknesses of the upper Triassic to Jurassic–Cretaceous (T_3–J–K) and the Paleogene (E) in the south depression are all smaller than that of the north depression, which shows the plenty of provenance supply in the north depression and the relative shortage of provenance supply in the south depression from late Triassic to Paleogene. (8) The sedimentary facies (Permian to Cretaceous) to the two depressions are different from each other. In Permian, the north depression was the neritic facies area, while the south depression was the littoral facies and swamp facies area. In early–middle Triassic, the north depression was mainly the neritic marly facies area, while the south depression was the neritic platform limestone facies area. In Jurassic–Cretaceous, the north depression was the alluvial fan facies and (littoral–shallow–half-deep) lacustrine facies area, while the south depression was the fluvial facies and shallow lacustrine and swamp facies area. (9) The structural reversion to the two depressions are different from each other. There occurred the obvious positive reversion in the north depression in the late Paleogene, while there wasn′t any obvious structural reversion in the south depression.

Analysis shows that there may be different hydrocarbon reservoirs in different structural elements in the South Yellow Sea basin. For the south depression, there were the medium-thickness terrestrial Mesozoic–Paleogene strata and the certain marine Meso–Paleozoic strata, but suffering from the tensional faulting in Yanshanian and early Himalayan period, the formations were cutted seriously, and the sags were small. Therefore it was disadvantageous to the preservation of large hydrocarbon reservoirs, but there may be some small terrestrial Mesozoic and Paleogene faulted-block reservoirs and marine Meso–Paleozoic buried-hill regenerated reservoirs. For the north depression, both the terrestrial Mesozoic–Paleogene and the marine Meso–Paleozoic were developed, and the sags were relativelylarge. On the one hand, the Indosinian compressional fold deformation was advantageous to the marine Meso–Paleozoic hydrocarbon accumulation except too-deep burying. On the other hand, the tensional faulting in Yanshanian and early Himalayan period had a destructive effect on the Meso–Paleozoic hydrocarbon accumulation, but some terrestrial Mesozoic and Paleogene faulted-block or (faulted) anticline reservoirs and marine Meso–Paleozoic buried-hill or faulted-block regenerated reservoirs may be formed. For the central uplift, the thick marine Meso–Paleozoic were developed. Although the formations suffered from the Indosinian compression and a long-term uplift and erosion, the tectonic deformation was relatively weak, and formed a series of open folds which were advantageous to the preservation of large primary reservoirs. To sum up, the terrestrial Mesozoic and Paleogene small faulted-block structures and the marine Meso–Paleozoic buried-hill structures in the south depression, the terrestrial Mesozoic and Paleogene faulted-block and (faulted) anticline structures and the marine Meso–Paleozoic buried-hill or faulted-block structures in the north depression, and the anticline structures in the central uplift, should be the important targets for the future hydrocarbon exploration.

Key words: South Yellow Sea basin, structural element, terrestrial strata, marine strata, hydrocarbon exploration

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