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Geologic-tectonic Evolution and Associated Hydrocarbon Accumulation in Arabian Plate

CHEN Xifeng*, CHEN Xiufa and YE Jinhua

Development and Research Center，China Geological Survey, Beijing 100037, China

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1 Introduction

This introductory paper provides a summary of the history of geologic-tectonic evolution and associated hydrocarbon accumulation from Precambrian to now, major petroliferous basin and the hydrocarbon potential areas for exploration in Arabian Plate. This paper aims at resolving some of the major outstanding tectonic and hydrocarbon accumulation problems in Arabian Plate, particularly regarding the timing and processes concerning the geologic-tectonic evolution, as well as how these processes and their temporal supermposition led to hydrocarbon accumulation.

2 Regional Geologial and Tectonic Setting

The Arabian plate had gone through three times of largescale tectonic movements in Precambrian-Late Paleozoic (Moujahed, 1989; Martin, 2001; Alsharhan et al., 2003). The first largescale tectonic movement is Hercynian movement in Newproterozoic-Early Paleozoic. The second and third largescale tectonic movement are the Caledonian movement and the Hercynian movement in Paleozoic, which led to the conjunction of Gondwana and Laurasia with Pangea formed. Furthermore these three tectonic movements controlled holistic tectonic sedimentary pattern of major petroliferous basin in Arabian plate. The main tectonic units of the Arabian plate include Arabian shied, Arabian Basin, Zagros Basin in the northwestern margin and Oman Basin in the eastern margin of Arabian plate (Alsharhan et al., 2003). The tectonic evolution of Arabian plate can be mainly divided into five stages: the matching stage of old basement in Precambrian, the development stage of the passive continental margin in Late Precambrian-Late Devonian, the development stage of the active continental margin in Late Devonian-Middle Permian, the development stage of the passive continental margin of Neo-Tethys in Late Permian-Late Cretaceous and the development stage of the active continental margin from Late Cretaceous to now.

3 Geologic-tectonics Evolution and Hydrocarbon Accumulation

The tectonic and sedimentary evolution of the Arabian plate provided favorable petroleum conditions for hydrocarbon accumulation in Arabian areas. Therefore, the geologic-tectonics evolution and associated hydrocarbon accumulation process of Arabian plate from Precambrian to now can be divided into the following five stages.

3.1 The matching of old basement and rift basin formation stage

During the Precambrian period (about 715-610Ma), a series basement in the Arabian Shield were converged and formed the present-day Arabian plate (Stoeser et al.,1985; Liu, 2007). In this process, a number of uplift zones were formed which are the most important oil and gas accumulation areas in the current Arabian plate, such as the Gaywal Uplift and the Qatar Uplift which hosted Ghawar oil field and the North oil field.

3.2 The development of passive continental margins and source rock formation stage

At this stage, the Arabian plate is located in the craton and bounded by the passive continental margins of Paleo-Tethys Ocean to the north. This tectonic evolution process can be divided into three stages. The first stage is the rift stage in Late Precambrian - Late Ordovician. Some salt basins were formed in the rift stage, such as Oman Basin, which provided favorable petroleum conditions for hydrocarbon accumulation in Arabian areas. The second stage is the depression stage of cratonic marginal of Paleo-Tethys Ocean and is the source rock formation stage in Early Cambrian - Late Ordovician. After the Najd fault activity and the Precambrian rift activity in Early Cambrian-Late Devonian (520-364Ma), the Arabian plate eventually stabilized and entered a long craton-marginal depression stage with the marine clastic sediments was formed and the continental deposition only distributed in the southwestern part of the plate near the Arabian Shield area. In Early Silurian, with the Arabian plate moved to towards north, the Sharawra formation and the Qusaiba formation were formed which are the most important source rocks of the Qatar northern gas field and the Paleozoic oil and gas reservoirs in central Saudi Arabia. The third stage is postglacial depression stage in Early Ordovician-Late Devonian.

3.3 The extrusion-back-arc tectonic movement and oil and gas storage space formation stage

In Late Devonian -Late Carboniferous （364-295Ma）, the tectonic environment of Arabian plate was compression environment. The passive continental margins located in northern margin of Gondwana changed into active continental margins, which caused the uplift and the strata suffered from erosion of Arabian plate. The Ghawar Salient, Burgan Salient

* Corresponding author. E-mail: chen6100117@126.com

and Qatar uplift were formed during the Hercynian movement in Late Devonian-Late Carboniferous. The tectonic environment of Arabian plate was tensional tectonic environment in Late Carboniferous-Middle Permian. At this stage, the Arabian plate has undergone the second chasmic stage. As Hercynian movement, some large Paleozoic structures in Arabian platform area were formed, which provide spatial for oil and gas accumulation.

3.4 Passive continental margin depression stage

After the Hercynian movement, in Late Permian, the Zagros rift was formed during the rifting which happened in northeastern margin of Arabian plate, and then the Zagros rift was submerged and the Neo-Tethys Ocean was formed. In Middle Permian- Middle Cretaceous, Arabian plate was the passive continental margin of Neo-Tethys Ocean, and another important source rock named Unayzah Formation was formed in the Paleozoic.0

3.5 The development stage of the active continental margins

In Late Cretaceous the margins of Arabian plate changed into active continental margins, and the Neo-Tethys Ocean was closed .

4 The Major Hydrocarbon Potential Areas for Exploration in Arabian plate

Based on the analysis of the conditions for hydrocarbon accumulation, there are some major hydrocarbon potential areas in Qatar and United Arab Emirates. The main favorable hydrocarbon potential areas for exploration are the flanks of Qatar Uplift and Southern Gulf Salta Basin in the eastern part of the country (Rao et al.,2015). There are eight reservoir combinations of hydrocarbon potential areas for exploration in United Arab Emirates, including the Thamama group of the Lower Cretaceous, the western part of Arab formation of the Lower Jurassic, the eastern part of Arab formation of the Upper Jurassic, the eastern part and western part of the Thamama group of the Lower Cretaceous, Araej formation of the Middle Jurassic, the Khuff formation of the Upper Permian, the Thamama group of the Lower Cretaceous in the eastern part of the country (Gao, 2016).

Key words: geologic-tectonic evolution**,** hydrocarbon accumulation, Arabian Plate

References

Alsharhan, A.S., Nairn, A.E.M., 2003. Sedimentary basin and petroleum geology of the Middle East. 2. Amsterdam: The Netherlands, Elservier Science, 559–574.

Gao, L., 2016.The Hydrocarbon Potential in UAE. Beijing: China University of Petroleum, 97 (in Chinese with English abstract).

Liu, W., 2007. Characteristics of depositional system and petroleum geology in Paleozoic Period of Rub'Al Khali Basin. *Chengdu: Chengdu University of Technology,* 1–10(in Chinese with English abstract).

Martin, A.Z., 2001.Late Permian to Holocene paleofacies evolution of Arabian Plate and its hydrocarbon occurrences. *GeoArabia,* 6(3): 445–450.

Moujahed, I.H., 1989.Tectonic and depositional model of Late Precambrian-Cambrian Arabian and adjoining plate. *AAPG Bulletin,* 73(9): 1117–1131.

Rao, Y., Du, X.D., Yu, S., 2015. Petroleum geological chearacteristics and exploration potential of Paleozoic clastic rock stratum in Qatar. *China Petroleum Exploration,* 20(1): 84 –94 (in Chinese with English abstract).

Stoeser, D.B., Cam, P.V.E, 1985. Pan-Afrian micro-plate accretion of the Arabian shield. *Geological Society of America Bulletin,* 96: 817–826.

About the first author

CHEN Xifeng, male, born in 1979 in Liaocheng City, Shandong Province; PhD; graduated from China University of Geosciences, Beijing; senior engineer of Development and Research Center, China Geological Survey; He is now interested in hydrocarbon accumulation. Email: chen6100117@126.com; phone:010-56315772, 13693308853.

About the corresponding author

CHEN Xiufa, male, born in 1976 in Rizhao City, Shandong Province; PhD; graduated from Institute of Geographical Sciences and Natural Resources, Chinese Academy of Sciences; professor of Development and Research Center, China Geological Survey; He is now interested in the study on mineral resources strategy. Email: cxiufa@mail.cgs.gov.cn; phone:010-56315751, 18910897928.