

LÜ Baofeng, CAI Zhourong, YIN Zhengxin and WANG Xue, 2014. An Analysis of Cenozoic Petroleum Structural Mineralization in Kunbei Oil-Gas Pool, Southwestern Qaidam Basin, China. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 1648-1650.

An Analysis of Cenozoic Petroleum Structural Mineralization in Kunbei Oil-Gas Pool, Southwestern Qaidam Basin, China

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1 Introduction

The Qaidam basin is a plateau basin inside the Tibetan plateau with very rich oil-gas resources. It has had a history of some forty years of exploration and geological research (Fu Suotang, et al., 2013; Chen Shijia, et al., 2012), despite the production of oil and gas inside the basin and extensive exploration since the late 1980s, but the proven rate is very low because of the complex accumulation conditions. For quite a long period the main exploration objectives were in the Cenozoic sedimentary sub-sag, and less attention has been paid to the thrust structure belt of basin margin. Recently, the discovery of a large oil-gas pool termed the Kunbei oil-gas pools made a great breakthrough in Qinghai oil field, this large oil-gas pool located in the Kunbei thrust structure belt of southwest margin of Qaidam basin, and characterized by shallow buried, big storage and high single well production, buried hill, anticline, fault block, structure-lithology and other types oil and gas reservoirs have been found. Preliminary studies results made it clear that the oil-gas pools formed with the collocation of long distance stepwise migration, continue filling and dynamic accumulation, it presents absolutely as a new special type of petroleum structural mineralization in China. However, there have not been reports or publications discussing the formation of oil-gas accumulation and the process of petroleum system crossing and superimposing. The purpose of this paper is to present the characteristics and formation mechanism of this oil-gas pool using an integrated geological, geophysical and geochemical approach based on data from relatively recently published papers and current research.

2 Structural Mineralization model

There are on plenty of sources rocks in this region, oil and gas came from Cenozoic salt-lake facies strata in the north side of the belt involved in E_{1+2} , E_3^1 , E_3^2 , N_1 , N_2^1 and N_2^2 , especially involved in E_3^2 and the bottom of N_1 (Chen Shijia, et al., 2012) (fig.1-A).

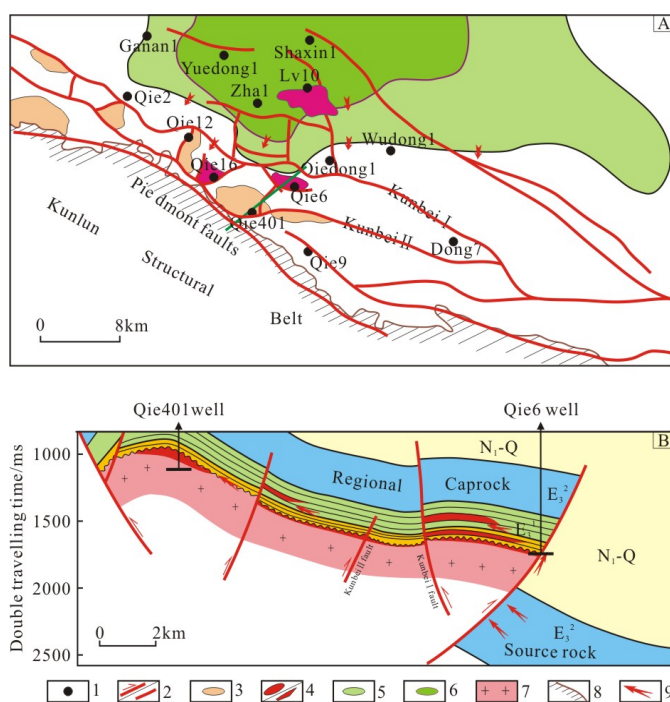


Fig. 1. Conceptual model of Kunbei Oil-gas Pools formation mechanism.

A. The plan of Kunbei thrust structure belt and the distribution of oil-gas Pools, showing that the pool of Qie6 and Qie16 locates outside the scope of effective source rock. B. The profile of Kunbei thrust belt, showing the model of oil-gas stepwise migration and pools formation mechanism. 1. Drilling. 2. Regional fault. 3. Trap. 4. Oil-gas pool. 5. The scope of E_{1-2} - N_1 effective source rock. 6. The scope of E_{1-2} - N_1 high-quality source rock. 7. Basement. 8. Basin edge. 9. Direction of oil-gas migration.

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Geological time	E ₁₊₂	E ₃ ¹	E ₃ ²	N ₁	N ₂ -Q
Source rocks					
The first time injection	Beginning of N ₁				
The second time injection	N ₂ ¹ -Q				
The main stage of reservoiring					
The retention period					

Fig. 2. Oil-gas accumulation events. showing the configuration of hydrocarbon accumulation elements in Kunbei area in the Southwest of Qaidam Basin and on a large scale injection took place with two relatively fast phase(beginning of N₁ and N₂¹-Q)

The identified reservoirs include sandstone, algal limestone and structure microfracture(Fu Suotang, et al., 2013; Zhang Changhao, et al., 2013; Wu Chan, et al., 2013). Among them, the fluvial delta sandstones are better reservoirs bodies. The algal limestone have more strata with better physical property and thin single layer thickness. Structure microfracture reservoirs bodies controlled by fault fracture degree, the promising parts for petroleum accumulation always occur in the zones composed by level 2 faults and level 3 faults, they controlled the distribution characteristics of oil and gas in longitudinal and transverse space.

The main regional caprocks are three sets of mudstone contained in the middle of E₃², the upper of E₃¹ and the top of E₁₊₂, they have optimistic thickness of 500~700m and made a solid foundation for the reservoir preservation and excellent reservoir-seal combinations for petroleum accumulations.

Determined traps including buried hills, anticlines, fault blocks, structure- lithologies and other types, they are controlled by faults, palaeohighs and the lithofacies.

The oil and gas migration channel is the transport system including faults, unconformity, permeable sand bodies and their consortium(Fu Suotang, et al., 2013). Unconformities occurred on the top of basal weathered layre and Cenozoic basal conglomerate, they are advantage channels for oil and gas migration. Faults play important roles on petroleum transfer and longitudinal migration, accumulation took place after oil-gas through long distance and stepwise migration (fig.1-B).

Controlled by Cenozoic Himalayan movement, faults in the Southwestern Qaidam Basin keep continuous activity with two relatively fast phase(Zhou Jianxun, et al., 2006; Yin An, et al., 2008; Weilin Zhang, et al., 2008; Wu Chan, et al., 2013), the first phase tookplace during 15-8Ma and the second one was during 4Ma-present, this caused structure amplitude increasing not only, but also led to oil-gas migrated through long distance and continuous injection into reservoirs and accumulation, accordingly, two main accumulation period occurred during 15-8Ma and

4Ma-present.

Such a petroleum structural mineralization process result in oil and gas of Kunbei oil-gas pools which came from the two main hydrocarbon source layer of the three hydrocarbon-generation sag in the north side of the Kunbei thrust belt sharing caprocks, reservoir space, migration channels and accumulation zones together, two key accumulation crucial moment performed with the process of faults activity. By the excellent configuration of accumulation elements and the dynamic process, the composite petroleum system characteristed crossing, superimposing and through-going each other formed, and multiple source oil-gas accumulation zone appeared as a result. In this composite petroleum system, sealing system mainly formed in Neotectonic movement, transport system and reservoir-seal combinations controlled the location of oil and gas and their distribution form in three-dimensional space, with such a condition, oil-gas pools formed possibly anywhere if there are suitable combination of sealing system and channel system, and oil-gas composite hydrocarbon accumulation zone appeared naturally.

These research achievement not only improved the understanding of petroleum mineralization mechanism, but also greatly expanded the Oil-gas exploration area in Qaidam basin, even in Chinese Cenozoic continental basins, it is said that: ① the xcellent petroleum geological condition and the unique basin evolution history made the foundation of “sag wide oil-gas bearing”, the promising exploration targets could be distributed in any area of the basin, no longer limited to the secondary structural belt. ② all kinds of trap (as anticlines, fault blocks, stratigraphic pinch-out traps, lithologic traps and their alliances) possessing the possibility to become the oil-gas accumulation bodies. ③the amount of the oil-gas pools may be great many, but the possibility of large-scale reservoirs appear is not too big, and the difficulty of identifying oil-gas pool will increase greatly.

Acknowledgments

The author wishes to thank Prof. Lin Ge and Prof. Xu Deru from Guangzhou institute of geochemistry Chinese academy of sciences for their helpful discussions that led to the improvement of the manuscript. We also appreciate the research institute of exploration & development of Qinghai oilfield company of PetroChina for providing information and structural data. This study was supported by the Open fund (Granted No. TPR-2013-24) of Key Laboratory of Tectonics and Petroleum Resources (China University of Geosciences) , Ministry of Education

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