Volcanic Rocks and Its Related Oil-Gas Reservoir in 58 Shang Block of Huimin Sag, China

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1 Geological setting

The recognition and prediction of high quality reservoir is a key link in the process of exploration and development of volcanic rock reservoir. The oil-gas reservoir in volcanic rock is disproportional. Based on the core features and microscopic CT data, it can be general understood the different periods of the volcanic reservoir features, such as effective pore throat present of cores, energy storage abundance and so on. It has a great significance to oil-gas migration and accumulation.

Huimin sag with area of 7000 km2 cover a large area in west Jiyang depression of Bohai Bay basin, east China, and is Cenozoic faulted basin extending in NNE direction (Liu et al., 1988). Huimin sag in which volcanic rocks is up to 5000m thick has developed a complex faults system. Associated with frequent volcanic activity, it was controlled by the contemporaneous faults. Multiple reservoirs have been discovered to be lacustrine deposition in Tertiary strata, and tectonic activities are very strong during deposition period. The central uplift is mainly the oil-gas enrichment zone in Huimin sag. The 58 Shanghe block located in northeastern central uplift belt of Huimin sag. It faces Linnan sub-sag in the north and is close to Shanghe ancient uplift in the east. Tectonically, the block lain at the end of the Linyi brush fault system. The lithologies of volcanic rock are mainly basalt, diabase and volcanic pyroclastic rocks etc (Cao et al., 1999).

2 Volcanic Period and Lithofacies Distribution

The volcanic rocks in 58 Shang block are mainly formed under eruption face. According to the detailed field observations and the microscopic identification, the volcanic rocks were erupted at three periods. All those rocks had developed three different lithofacies for each period. During the first period, the volcanic rocks are mainly brecciated tuff in which the fragments are only 0.1~0.8cm in diameter. During the second and third period, the lithologies consist of breccia tuff and volcanic breccia, and the fragments range in 0.2~3cm and 0.2~1cm respectively.

The volcanic rocks can be divided into three intra-faces, including of proximal crater, distal crater and volcanogenic sedimentation. Proximal crater has a few normal sediment and thin layer of volcanic breccia in which the fragments are only 0.1~0.8cm. Primary pore, solution pore, shrinkage joint, and structural fracture widely developed in the proximal crater. The rocks in distal crater faces are composed of mainly mud and few volcanic debris. The volcanogenic sedimentation has thin volcanic breccias and a small amount of porosity.

3 Physical Property of Volcanic Rock Oil-Gas Reservoir

The diagenesis for three periods of volcanic rocks has played a key role in the formation of oil-gas reservoir. It can determine the distribution of oil-gas reservoir, including deposit scope and space (Wang et al., 2005). The storing space characteristics in volcanic rocks are directly affected the quality of oil-gas reservoir.

Based on our sample porosity test data, volcanic rocks from the first to the third phases have average porosity of 25.29%, 21.54%, 24.83% respectively. All the rocks show average permeability of 60.67 mD, 12.91 mD, 43.01 mD respectively. The permeability of the third period volcanic rocks gives three peak data which are all about 6000mD.

The microscopic CT scan image for volcanic rock can be able to show the fracture density and width. It can be seen the dissolved holes and pore network. The fractures in the hole samples from 1700m~1706m are very steep and reflect greatly influenced by posterior tectonic movement in the study area. Big fractures improve obviously permeability of the rocks. It makes two
independent narrow throat connected each other so that the oil-gas and water can easily circulate. Dissolve pores with irregular shapes are the effective oil-gas reservoir space in the study area, and it can promote the fluid flow.

4 Discussion

The pore and throat of volcanic rock reservoir is not well connected. The third period volcanic rock permeability is better than other two periods’. It has three high permeability values, which reflects the existence of the tectonic fracture. But the porosity is very uneven. So the condition for oil-gas storage is not well developed.

The volcanic rock has high porosity during second period, but the permeability are as low as less than 20 mD. The reservoir pores are poorly connected. Therefore the volcanic rocks belong to low permeability reservoir.

The reservoir in volcanic rock during first period is near the crater subfacies with good porosity and permeability. So it is the favorable stratigraphic position. The storing spaces are different, such as primary pore, tectonic fracture, dissolution etc. thus, the reservoir is well enough for the oil-gas storage.

We can conclude the favorable lithology is brecciated tuff by analyzing the physical property data and well-measueing data comprehensively. Thus, the first period of volcanic rocks’ porosity and permeability conditions are better than the other two periods’.

5 Conclusion

The pore and throat connection during diagenesis become complicated in the reservoir of the volcanic rock. By the way, compaction and cementation press pore of volcanic rock reservoir small. Therefore, the reservoir quality and effectiveness is reduced. Dissolve pores and fractures make volcanic reservoir pore and throat connect together so that it improves the efficiency of oil-gas transportation (Wang et al., 2011). In this research area, the oil-gas reservoir connected among small pore throat and pore throat connectivity is not effective. Most pores are full of zeolite minerals in the volcanic rocks. The area with conditions of high porosity and permeability were due to large scale fault.

Volcanic rocks in 58 Shanghe block main lithology is volcanic breccia and volcanic tuff which have good permeability and property. The first period near the crater has better oil-gas reservoir performance than other two periods. It contains a large number of primary pore, tectonic fracture, dissolution, and has less sediments. So the first period of volcanic rock reservoir exploration has a big potential.

Acknowledgements

This study was jointly supported by “Program for Changjiang Scholars and Innovative Research Team in University (IRT1083), the Talent Award project to M.Santosh through the 1000 Talents Plan of the Chinese Government and 111 Project (B07011).” We would like to thank Yumin Du, Ruifu He, Zhijun Yang of institute of geology in Linpan oil production plant, Shengli Oilfield. We are very grateful for Jie Wu for the micro-CT measurement.

References


