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Original research paper

Controlling factors of volcanic hydrocarbon reservoirs in Bohai Bay Basin, China

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Abstract

Volcanic hydrocarbon reservoirs are developed in the Mesozoic and Cenozoic strata in Bohai Bay Basin in China. There is more than one hundred million tons of proven oil reserves in the said reservoir. They performed different actors for oil and gas accumulation in the basin. Faults controlled the distribution and accumulation of oil and gas related to volcanic rocks in Bohai Bay Basin. Not to mention, the zone near the faults is favorable for the development of good reservoirs. Volcanic rocks and volcanism can serve several roles during the course of hydrocarbon generation and accumulation. Volcanism can promote hydrocarbon generation from source rocks. Simultaneously, volcanic activity can damage petroleum reservoirs. Volcanic rocks can be both the reservoirs and the cap-rocks or obscured layer in the basin. The occurrence of volcanic rocks in source rocks can form fractures more easily compared to that in sandstones. Finally, volcanic rocks also control the distribution of mantle-derived CO_2 gas reservoirs in the basin.

Keywords: Volcanic hydrocarbon reservoir; Controlling factor; Accumulation; Bohai Bay Basin

1. Introduction

The history of volcanic reservoirs exploration has been going on for more than one hundred years. At the end of the 19th century, volcanic reservoirs were discovered in the San Joaquin Basin, California, United States. Unconsciously, Japan, Mexico, Indonesia, and other countries also drilled some small volcanic reservoirs. These explorations can be categorized as accidental [1]. In 1953, Venezuela carried out a drilling evaluation for volcanic rocks in Paz oilfield. The said assessment opened a prelude to human understanding of volcanic reservoirs. In the 1970s, a few countries began to conduct more detailed and systematic study and exploration about volcanic rock reservoirs. China has carried out research and exploration in Junggar, Sichuan, Bohai Bay, and Songliao basins, wherein and a large number of volcanic reservoirs with different scales have been discovered. In the last ten years, a group of volcanic rock reservoirs has been discovered in the Songliao, Junggar and Santanghu basins [2−6]. The high degree of exploration in the Bohai Bay Basin leads to the discovery of multiple small volcanic rock blocks with high-yield and enrichment.

Bohai Bay Basin is located in eastern China where the exploration and development of volcanic reservoirs have been over 40 years. Thirty volcanic reservoirs have been found (Table 1) with ten million tons reserves due to the exploration. Bohai Bay Basin consists of seven depressions, i.e., Liaohe, Bozhong, Jiyang, Huanghua, Jizhong, Linqing, and Changwei. Most of the reserves of the volcanic reservoirs were found in Jiyang and Liaohe depressions. Volcanic rocks are mainly distributed in the Mesozoic strata within the Cenozoic Shahejie Formation in the basin covering an area of about 11000 km^2 (Fig. 1). Major volcanic rock reservoirs were found in the 3rd

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Table 1
Characteristics of volcanic reservoirs and their petrophysics in Bohai Bay Basin.

Depression/Area	Reservoir name	Strata	Main lithology	Reservoir type	Porosity/%	Permeability/mD	Source
Liaohe	Huangshatuo	Shahejie	Trachyte	Pore-fracture	8.8	0.8	Ref. [7]
	Oulituozi	Shahejie	Trachyte	Fracture-pore	11.3	0.1	
	Rehetai	Shahejie	Trachyte, Basalt	Fracture-pore	13.3	16.4	
	Wa7	Fangshenpao	Basalt	Pore-fracture	21.7	15.2	
	Wa609	Mesozoic	Tuff	Pore-fracture	11.16	<9	
	Rong76	Mesozoic	Andesite	Fracture-pore			
	Tuo32	Mesozoic	Rhyolite	Fracture-pore			
Bozhong	Qinhuangdao36-1	Mesozoic	Andesite	Pore-fracture			
	Bozhong22-2	Mesozoic	Andesite				
Jiyang	Luo151	Dongying and Guantao	Diabase	Pore-fracture			
	Binnan	Shehejie	Basalt	Pore-fracture			
	Shang741	Shehejie	Pyroclastic rocks, Diabase	Pore-fracture			
	Lin41-14	Shahejie	Basalt	Pore-fracture			
	Gao42	Kongdian	Basalt	Pore-fracture	14.7	9.39	Ref. [8]
	Chunxi	Shahejie	Diabase	Pore-fracture			
	Xia38	Shahejie	Diabase	Pore-fracture	8.2	1.85	Ref. [8]
	Tong81	Shahejie	Diabase	Fracture-pore			
Huanghua	Zao35 fault block	Shahejie	Basalt, Pyroclastic rocks	Pore-fracture	27.08	1.46	Ref. [9]
	Wangguantun	Shahejie	Basalt	Pore-fracture			
	Beipu12-3	Shahejie	Basalt	Fracture-pore			
	Koucun	Shahejie and Mesozoic	Diabase, Trachyandesite	Fracture-pore			
	Fenghuadian	Mesozoic	Rhyolite	Pore-fracture			
Jizhong	Cao6	Shahejie	Diabase	Fracture-pore	4.39	0.29	Ref. [10]

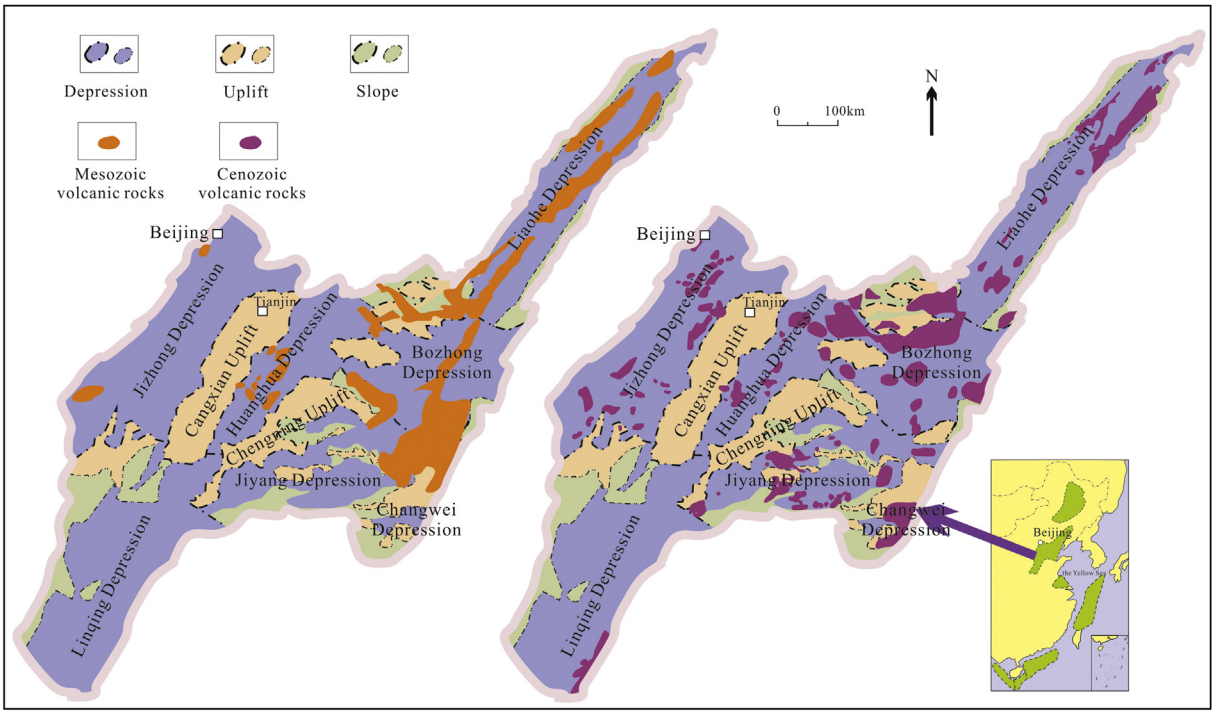

Fig. 1. Distribution of Mesozoic and Cenozoic volcanic rocks in Bohai Bay Basin (modified after Refs. [11−13]).

member of Shahejie Formation in the eastern Liaohe Depression, such as Huangshatuo, Oulituozi, Rehetai, and Qinglongtai volcanic reservoirs. For the western Liaohe Depression, Dawa, Niuxintuo, Huanxiling, and Shuguang volcanic reservoirs were found in the Mesozoic volcanic rocks. The Fenghuadian volcanic reservoir was found in the Mesozoic volcanic rocks in Huanghua Depression, whereas Zaoyuan and Wangguantun volcanic reservoirs were found in Mesozoic Kongdian Formation and the 3rd member of Shahejie Formation. Meanwhile, Caojiawu volcanic reservoir was found in Jizhong Depression in the 3rd member of Shahejie Formation. Luojia and Shang741 volcanic reservoirs were found in Shahejie Formation in Jiyang Depression. All these findings opened a prelude to volcanic reservoir exploration in Bohai Bay Basin.

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