



Geology of coalbed methane reservoirs in the Southeast Qinshui Basin of China

Xianbo Su^{a,*}, Xiaoying Lin^a, Shaobo Liu^b, Mengjun Zhao^b, Yan Song^b

^aHenan Polytechnic University, Jiaozuo, Henan 454000, China

^bResearch Institute of Petroleum Exploration and Development, PetroChina, Beijing 10083, China

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Abstract

The No. 15 coal seam of the Pennsylvanian Taiyuan Formation and the No. 3 coal seam of the Permian Shanxi Formation in the Southeast Qinshui Basin are relatively thick (>3 m), laterally continuous, and are of anthracite rank ($R_o=2.2-4.5\%$). The depth of these coal seams is generally between 200 and 700 m. A tectonic-thermal event during the Jurassic to Cretaceous Yanshanian Orogeny controlled coalification and thermogenic hydrocarbon generation. Because the generation of late-stage bacterial gas, coalbed methane in the Southeast Qinshui Basin occupies two zones, which are the mixed thermogenic and late-stage bacterial gas zone near the basin margins, and the dominantly thermogenic gas zone in the structurally deep part of the basin. Basin hydrodynamics causes low gas content in the shallow subsurface (<20 m³/t) and high gas content at the deep part of basin (>20 m³/t). Because cleats are rare and are mostly filled with calcite, the permeability of the coalbed methane reservoir is controlled by shear fractures. The recharge and flow of groundwater not only control gas content, but also control reservoir pressure. Abnormally high pressure reservoir in the deep stagnant zone is a favorable area for coalbed methane exploration and development. The current coalbed methane wells are generally completed in the deep stagnant zone.

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1. Introduction

During the last three decades, the characteristics of coalbed methane reservoirs were investigated from six

sets of variables: tectonics and structure, stratigraphy and sedimentology, coal rank, permeability, gas content, and hydrodynamics by many researchers (Pashin et al., 1991; Pashin, 1998; Ayers and Kaiser, 1994; Kaiser et al., 1994; Ayers, 2002; Liu et al., 1998; Zhang et al., 2000; Scott, 2002).

The coalbed methane resource is extremely large (3.28×10^{12} m³) in the Qinshui Basin of Shanxi province, China. Because of this large resource, the

* Corresponding author. Tel.: +86 391 3987981; fax: +86 391 3987961.

E-mail address: suxianbo@263.net (X. Su).

Southeast Qinshui Basin is a favorable district for coalbed methane exploration and development. More than 70 coalbed methane wells have been drilled by China United Coalbed Methane Co. Ltd. and China National Petroleum Corporation in this district. The highest coalbed methane production is 16,000 m³/d per well, and the average is 2000–4000 m³/d per well. Exploration confirms that coalbed methane reservoirs with high permeability exist in the Southeast Qinshui Basin, which is the first basin to be developed commercially in China.

The data obtained from the exploration and development of petroleum, coal, and coalbed methane, form the foundation for this investigation, many investigations have been published on the geology of coalbed methane reservoirs in the Qinshui Basin (Chen, 1998; Shan, 1998; Sun et al., 1998; Wang et al., 1998; 2001; Li et al., 2000; Hu et al., 2001; Wei et al., 2002; Ye et al., 2002, Qin et al., 1997; Su and Zhang, 2002). These investigations treat specific aspects of coalbed methane potential, and few broad, multidisciplinary investigations have been conducted in this area. The geological characteristics of coalbed methane reservoirs in the Southeast Qinshui Basin are discussed comprehensively in this paper. It is hoped that the investigation will be a guide to the further exploration and development of coalbed methane in South East Asian coal basins.

2. Results and analyses

2.1. Tectonic and structural setting

In the Shanxi Province, the Qinshui Basin is bounded by the uplifts of Taihang Mountain, Huo Mountain, Wutai Mountain, and Zhongtiao Mountain. It is one of the Mesozoic basins evolved from the Late Paleozoic North China Craton Basin. Uplift and erosion during the Triassic Indosinian Orogeny and the Jurassic to Cretaceous Yanshanian Orogeny separated the Qinshui Basin from the North China Craton Basin. The Qinshui Basin is a complex syncline striking NNE–SSW. The study area in this paper is the Southeast Qinshui Basin, which is bounded by a groundwater divide at north latitude 36° in the north, the Sitou normal fault in the west, and coal outcrop in the east and south, and covers 660 km² (Fig. 1). The Southeast Qinshui Basin is the southeastern limb of the syncline. The dip of the coal-bearing strata is about 5°NW. Structure within the study area is relatively simple; faults are few, and folds with axial traces striking NNE–SSW and near N–S are common (Fig. 1). Previous investigations have shown that the folds in Southeast Qinshui Basin were due to NW–SE compressional stresses during the Jurassic–Cretaceous Yanshanian

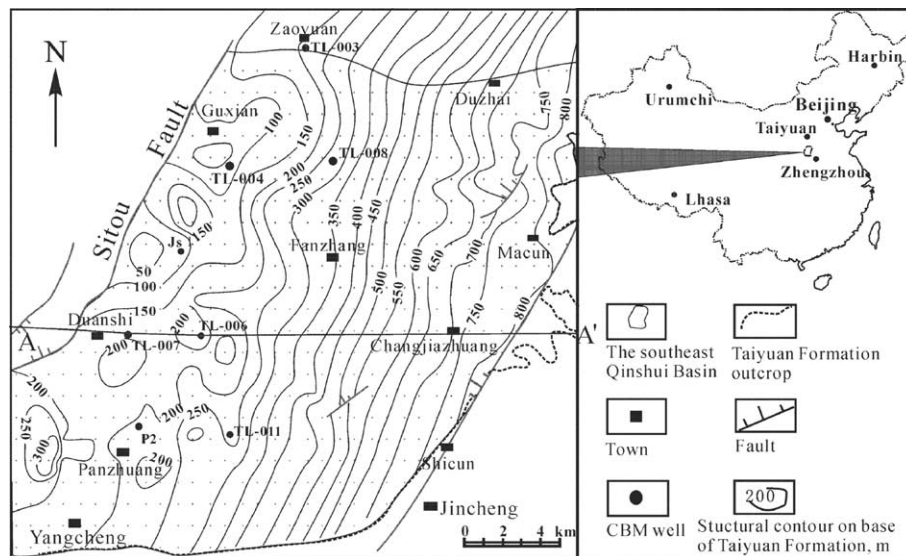


Fig. 1. Location map of the Southeast Qinshui Basin and structural contour map of the base of the Pennsylvanian Taiyuan Formation.

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