

Research article

Discovery and reservoir-forming geological characteristics of the Shenmu Gas Field in the Ordos Basin

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Abstract

By the end of 2014, the giant Shenmu Gas Field had been found in the Ordos Basin with an explored gas-bearing area of 4069 km² and the proved geological gas reserves of 333.4 billion m³. This paper aims to review the exploration history of this field and discusses its reservoir-forming mechanism and geological characteristics, which may guide the further discovery and exploration of such similar gas fields in this basin and other basins. The following research findings were concluded. (1) There are typical tight sand gas reservoirs in this field primarily with the pay zones of the Upper Paleozoic Taiyuan Fm, and secondly with those of the Shanxi and Shihezi Fms. (2) Gas types are dominated by coal gas with an average methane content of 88% and no H₂S content. (3) The gas reservoirs were buried 1700–2800 m deep underneath with multiple pressure systems and an average pressure coefficient of 0.87. (4) The reservoir strata are composed of fluvial delta facies sandstones with an average porosity of 7.8% and permeability of 0.63 mD, having high pressure sensibility and a strong water-locking effect because the pore throat radius are mostly less than 1 μm. (5) There are different dynamics at various stages in the gas reservoir-forming process. The abnormal well-developed strata pressure was the main reservoir-forming force at the Early Cretaceous setting stage while the fluid expansibility became the main gas-migrating force at the uplift and denudation stage after the Early Cretaceous period. (6) Gas reservoirs with ultra-low water saturation are mainly controlled by many factors such as changes of high temperature and high pressure fields in the Late Jurassic and Early Cretaceous periods, the charging of dry gas at the highly-mature stage, and the gas escape and dissipation at the post-reservoir-forming periods. (7) Natural gas migrated and accumulated vertically in a shortcutting path to form gas reservoirs. At such areas near the source rocks, large-scale gas reservoirs were easily found with plenty of gas sources and high gas saturation; but at those far from the source rocks, relatively small-scale and mostly secondary gas reservoirs were discovered.

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Keywords: Ordos Basin; Shenmu Gas Field; Late Paleozoic; Tight sand gas reservoir; Coal gas; Gas reservoir characteristic; Reservoir-forming mechanism

According to the *China Energy* published on April 20, 2015, the proved oil and gas reserves of China kept rapid increase in 2014 to a new record, with newly increased oil reserves of 10.61×10^8 t and newly increased gas reserves of 1.1×10^{12} m³. The proved gas reserves have maintained the growth momentum since the “10th Five-year Plan”, with newly increased gas reserves of 9437.72×10^8 m³, an

increase of 53% year on year, and newly increased proved recoverable gas reserves of 4749.56×10^8 m³. There are five giant gas fields with newly increased reserves of over 1000×10^8 m³, among which, the Shenmu Gas Field in the Ordos Basin is the largest, with newly increased gas reserves of over 2000×10^8 m³. In this paper, the exploration history, gas reservoir geological characteristics and gas reservoir-forming mechanism of Shenmu Gas Field are systematically summarized, in the hope to provide guidance for the exploration of gas in this basin and similar gas reservoirs in other basins.

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1. Discovery and exploration history of the Shenmu Gas Field

Located in Yuyang District and Shenmu Country, Yunlin City, Shaanxi Province, the Shenmu Gas Field borders Yulin, Daniudi, Zizhou and Mizhi Gas Fields (Fig. 1), with an exploration area of $2.5 \times 10^4 \text{ km}^2$. Structurally, this gas field is located in the secondary structural unit, northeastern Yishan Slope, in the Ordos Basin, and its structural form is a gentle

west-dipping slope, with a gradient of 6–10 m/km and dip angle of less than 1° . On the monoclinic background, there are multiple rows of low and gentle nose uplifts of NE-trending, with an amplitude of about 10 m, width of 4–5 km and length of 25–30 km. The Upper Paleozoic Carboniferous – Permian system, a set of marine-terrigeneous coal-bearing strata, includes Benxi Fm (C_2b), Taiyuan Fm (P_1t), Shanxi Fm (P_1s), Shihezi Fm (P_2sh) and Shiqianfeng Fm (P_3q) (Fig. 1) from bottom to top.

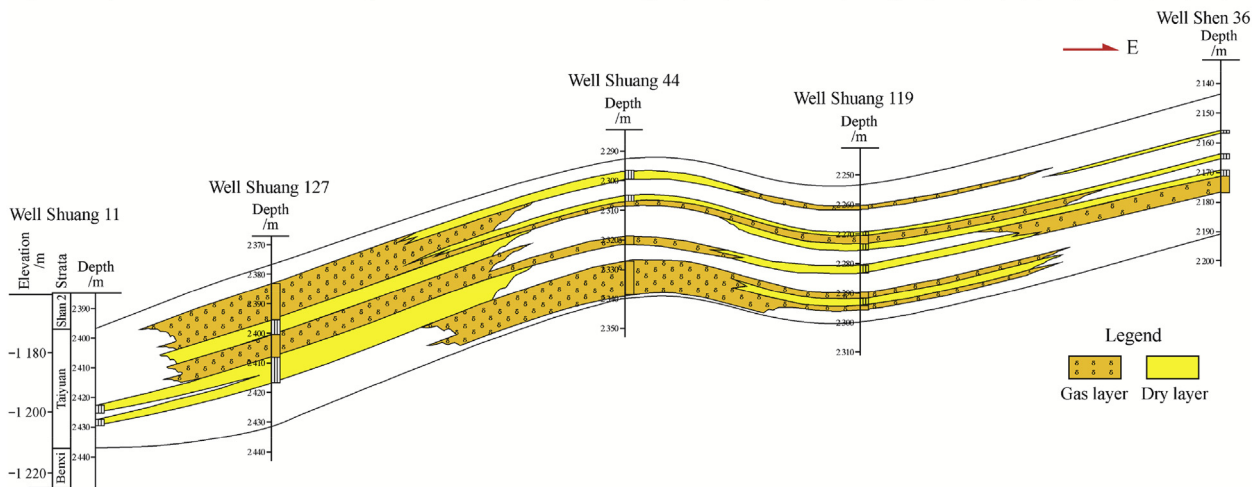
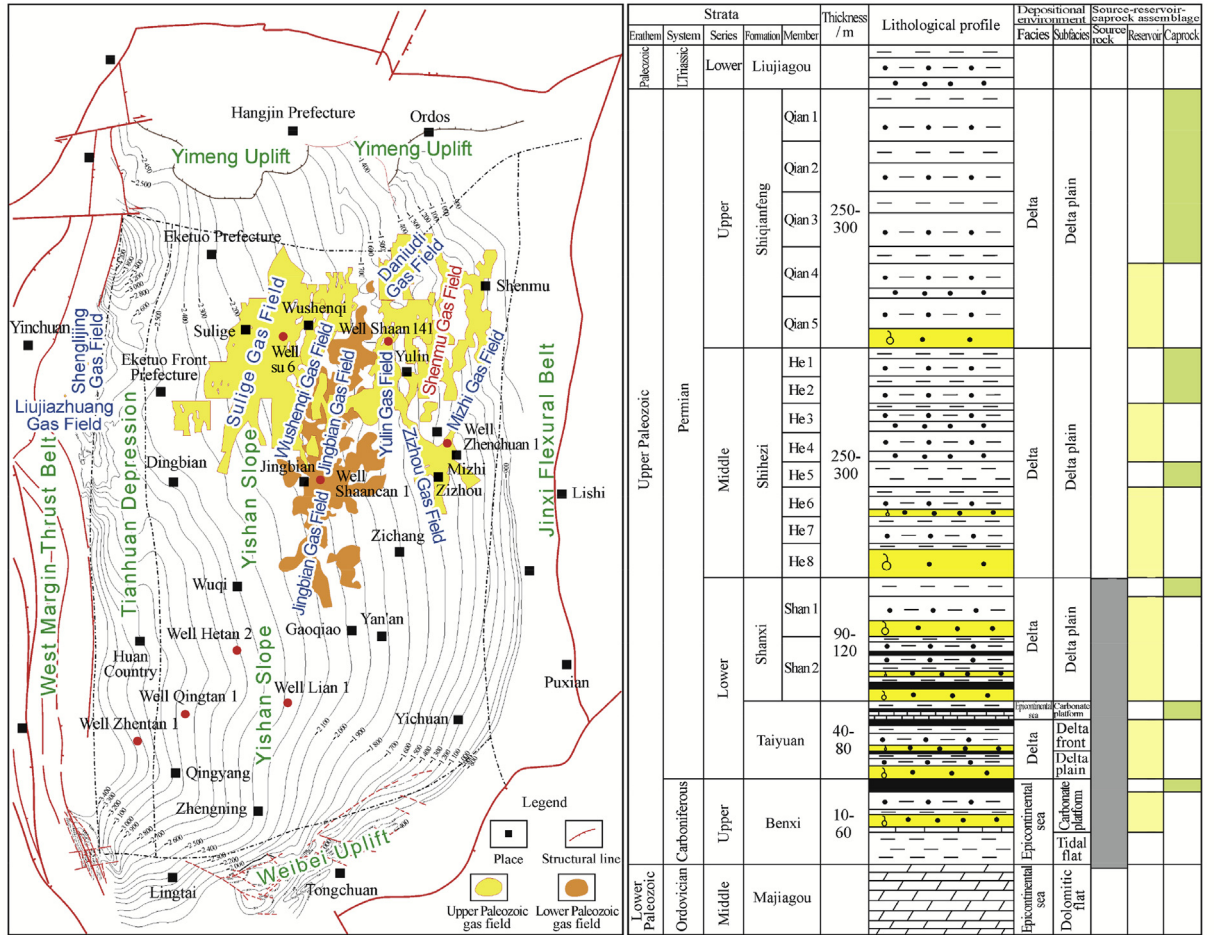


Fig. 1. Geographic location, gas reservoir profile and composite stratigraphic column of the Shenmu Gas Field.

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