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Research Article

Theoretical innovation and technical progress will usher in a production period of gas fields with an annual capacity of ten billion cubic meters☆

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Abstract

Challenged by the increasing complexity of targets and the tense situation of turning losses into profits during the 12th Five-Year Plan, by virtue of technological innovation, Sinopec Southwest Oil & Gas Company proposed the theories of gas exploration in continental clastic rock and marine carbonate rock, and developed the development technologies for reef, channel sandstone and tight sandstone reservoirs. Moreover, it innovatively formed a series of engineering technologies, including intelligent sliding sleeve staged fracturing, blasting−packing−fracturing stimulation, impulse fracturing, and drilling, completion and production technologies for ultra-deep horizontal wells with high sulfur contents. With these innovated theories and improved technologies, great discoveries have been made in the continental clastic rocks and marine carbonate rocks in West Sichuan Basin, the marine shale in South Sichuan Basin, and the marine carbonate rocks in Yuanba area of NE Sichuan Basin, and three 100 billion-m^3 class commercial gas reserves zones were discovered. Moreover, two medium- and large-sized gas fields were proved, and three medium- and large-sized gas fields were completely constructed. Both reserves and production reached a new record in history. During the 13th Five-Year Plan, Sinopec Southwest Oil & Gas Company will focus on the exploration and development of deep marine carbonate reservoirs, commercial development of deep shale gas, safe development of gas fields with high sulfur, and enhancement of recovery in mature gas fields. By the end of the 13th Five-Year Plan, it is expected that the annual gas production of $(10-12) \times 10^9$ m^3 will be achieved.

Keywords: Sichuan Basin; Sinopec Southwest Oil & Gas Company; Natural gas; Exploration; Development; 12th Five-Year Plan; 13th Five-Year Plan; Commercial reserves zone; Annual gas production

1. Overview

Sinopec Southwest Oil & Gas Company (hereinafter referred to as SWOGC) has many exploration and production license blocks that distribute widely in Sichuan, Chongqing, Guizhou, Guangxi, Hunan, Tibet and other provinces/municipalities, covering an acreage of 13.42×10^4 km^2. The blocks (5.69×10^4 km^2) (Fig. 1) within the Sichuan Basin are mainly located in some depression zones, such as West Sichuan depression and North Sichuan depression, where reservoirs are deeply buried and tight. Thus exploration and development in these blocks are challenging and advanced engineering techniques are required. During the 12th Five-Year Plan, SWOGC successfully promoted the strategy of gas development by advanced technologies, contributing greatly to the significant breakthroughs in exploration and development of continental, marine and shale reservoirs in the Sichuan Basin, and thereby laying a solid foundation for the 100×10^8 m^3 gas field construction during the 13th Five-Year Plan.

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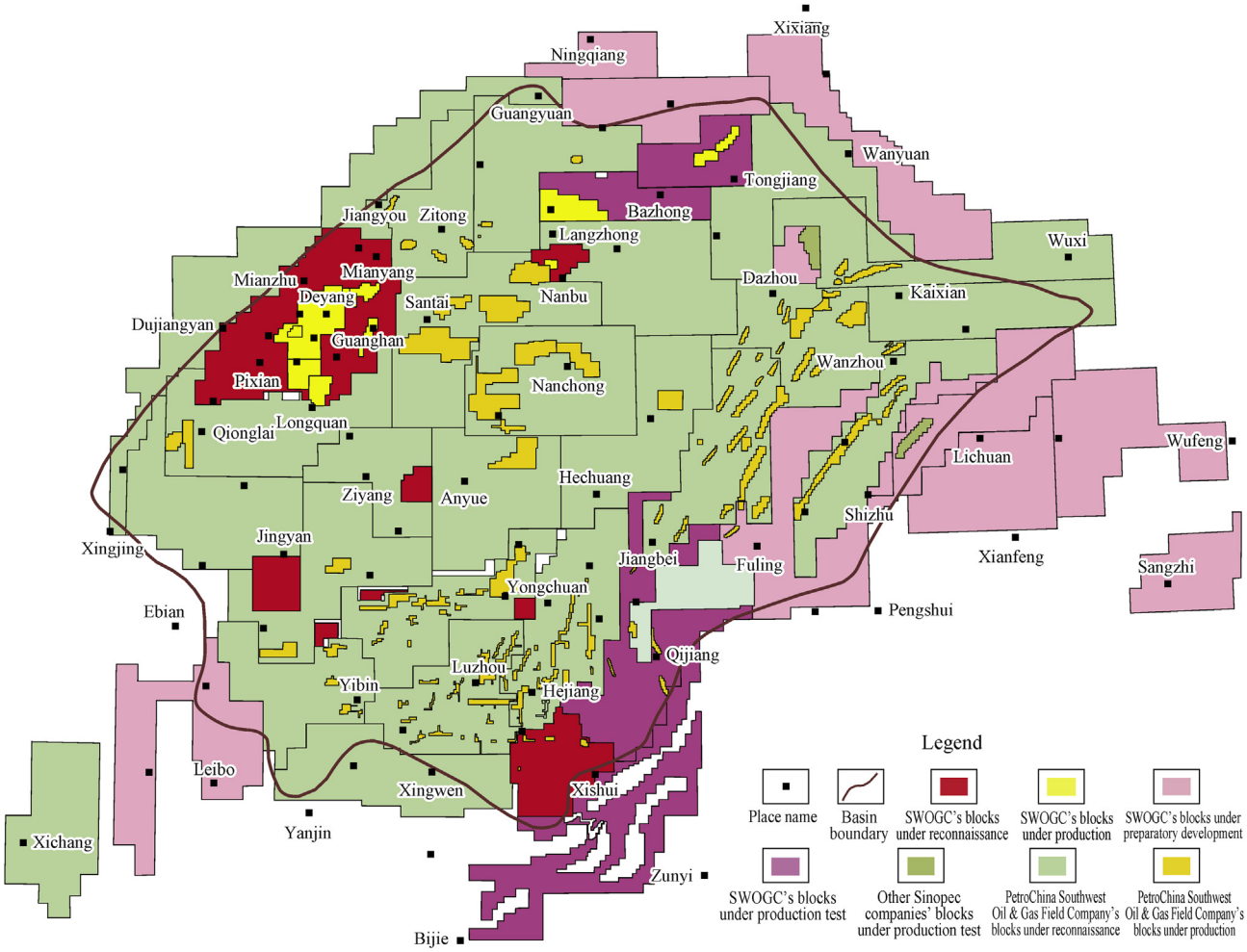

Fig. 1. Distribution of SWOGC's license blocks.

2. Natural gas exploration and development achievements during the 12th Five-Year Plan

In terms of exploration, SWOGC vigorously implemented the strategy of resource development. With great efforts in expanding continental resources, stressing on marine resources, searching new areas, and making breakthroughs in unconventional reservoirs, SWOGC finally discovered three scale commercial reserve zones with 100 billion cubic meters of gas, including the shallow-medium lithologic gas reservoir in Chengdu sag, the shallow-medium lithologic gas reservoir on the eastern slope of West Sichuan depression, and the marine gas reservoir in Longmenshan piedmont zone. During the 12th Five-Year Plan, the newly-added gas in place totaled 1.77×10^{12} m^3 (proved: 2661.2×10^8 m^3; probable: 6497.8×10^8 m^3) (Fig. 2). Exploration was carried out with a relatively high commercial success rate, with two large/medium gas fields (Chengdu and Zhongjiang) ascertained. Scale reserve increase and high-efficient exploration were realized.

In terms of development, SWOGC followed the principles of producing hard-to-be-recovered reserves, working out a development scheme for Yuanba area, and accelerating the appraisal on shallow-medium new areas in the West Sichuan Basin. In practices, SWOGC strengthened the productivity construction for shallow-medium reservoirs in the West Sichuan Basin, carried out the productivity construction for upper Permian Changxing Fm. in Yuanba area, and promoted the application of horizontal well drilling techniques and the refined management of gas reservoir development. As a result, natural gas production grew at peak. During the 12th Five-Year Plan, the cumulative gas reserves produced amounted to 2267×10^8 m^3, increased by 1175×10^8 m^3 from the level at the end of 11th Five-Year Plan. Annual gas production grew from 27×10^8 m^3 at the end of 11th Five-Year Plan to 50×10^8 m^3 in 2015 (Fig. 2), recording an almost double increase. Meanwhile, reserve/production ratio rose steadily. Three medium/large gas fields were completely constructed, including the large-sized Yuanba reef ultra-deep high sulfur gas field, the large-sized Zhongjiang gas field on the eastern

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