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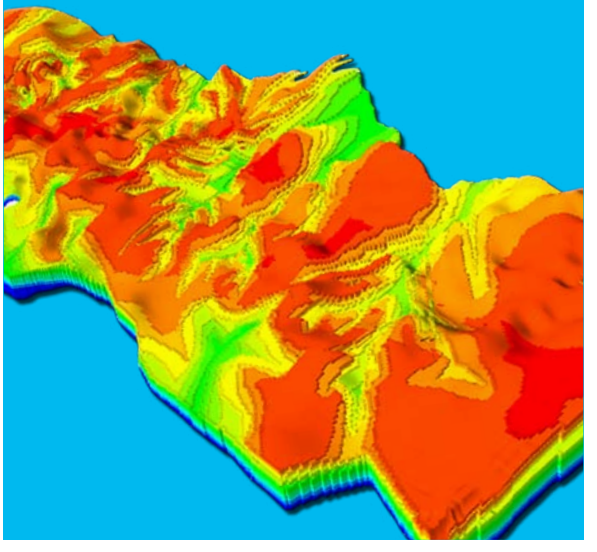


Water-bearing Carbonate Gas Reservoirs

Eastern Sichuan Basin

China National Petroleum Corporation

Water-bearing Carbonate Gas Reservoirs

Eastern Sichuan Basin

Several fractured porous carbonate gas fields, including Datianchi, Dachiganjing and Luojiazhai, have been proven in the eastern part of the Sichuan Basin since the 1980s. With cumulative proven gas in place of 504.87 billion cubic meters, these fields produce more than 9 billion cubic meters of gas a year, accounting for more than 60% of the gas output from the basin.

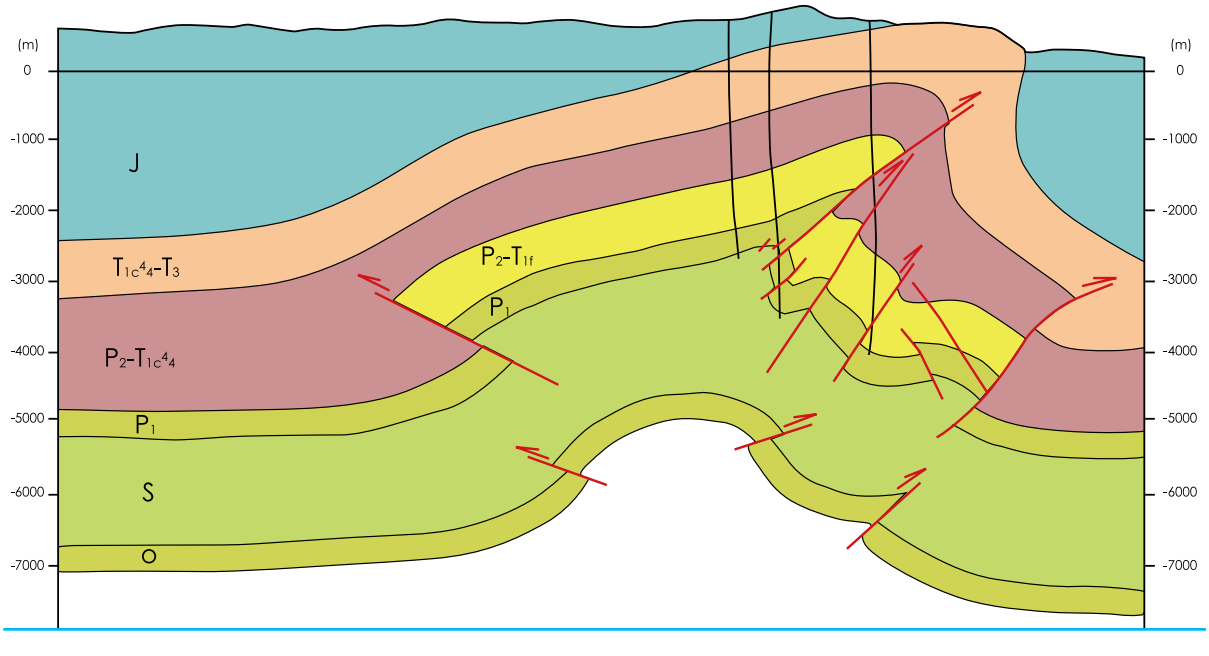
Cumulative proven gas in place **504.87**
billion cubic meters

Annual gas production **9**
billion cubic meters

Water-bearing carbonate gas reservoirs in the eastern part of the Sichuan Basin are deeply buried with high formation pressure. They are various types of small edge-water reservoirs entrapped in high-steep structures, commonly containing sour gases. In this context, great challenges have posed to gas field development, well drilling and completion, dewatering gas production from deep wells, EOR, and surface gathering and processing.

Main Characteristics

- Multiple gas-bearing formations: from Carboniferous to Triassic
- Burial depth: 3,000- 5,000 m
- Formation pressure: 40-60MPa, with pressure coefficient of 1.2-2.0
- Hydrogen sulfide content: medium to high
- Water yield: 100-1,000 m^3/d



October 1977
A Carboniferous gas reservoir was discovered by well Xiang-18 in eastern Sichuan Basin.

May 1980
Xiangguosi Gas Field became operational.

1985
A ring-shaped gas transportation trunk was built in the Sichuan Basin.

2000
The Chuandongbei high sour gas field was discovered by well Luojia-1.

2004
The Southwest Oil and Gas Field became the first in China to produce more than 10 billion cubic meters of natural gas a year.

Technology and Innovation

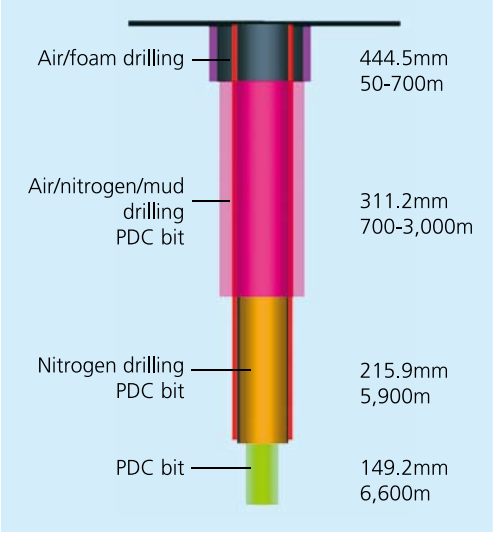
We have made breakthroughs in key technologies, gained rich experiences, and developed packages of advanced and practical technologies during more than three decades of the development of water-bearing carbonate gas reservoirs in eastern Sichuan.

Seismic Acquisition and Processing for Complex Mountainous Area

Full 3D seismic acquisition considerably improves the signal-to-noise ratio and the resolution of data in complex mountainous areas. The seismic wave fields of complex surface and subsurface high-steep structures in the mountainous area can be accurately offset through static calibration, speed analysis and migration imaging. In addition, we have integrated a technology package for the prediction of carbonate reservoirs, represented by the "bright spot" technology.

Underbalanced Fast (Gas) Drilling and Completion

The application of full-process underbalanced drilling and gas drilling ensures a success rate of more than 90% for development wells.

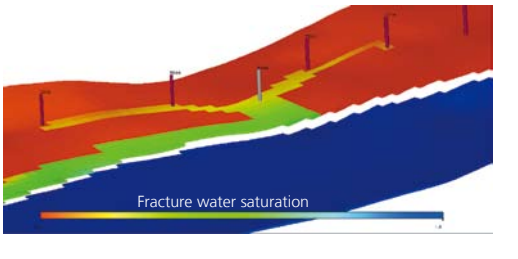


Fine Description of Gas Reservoir

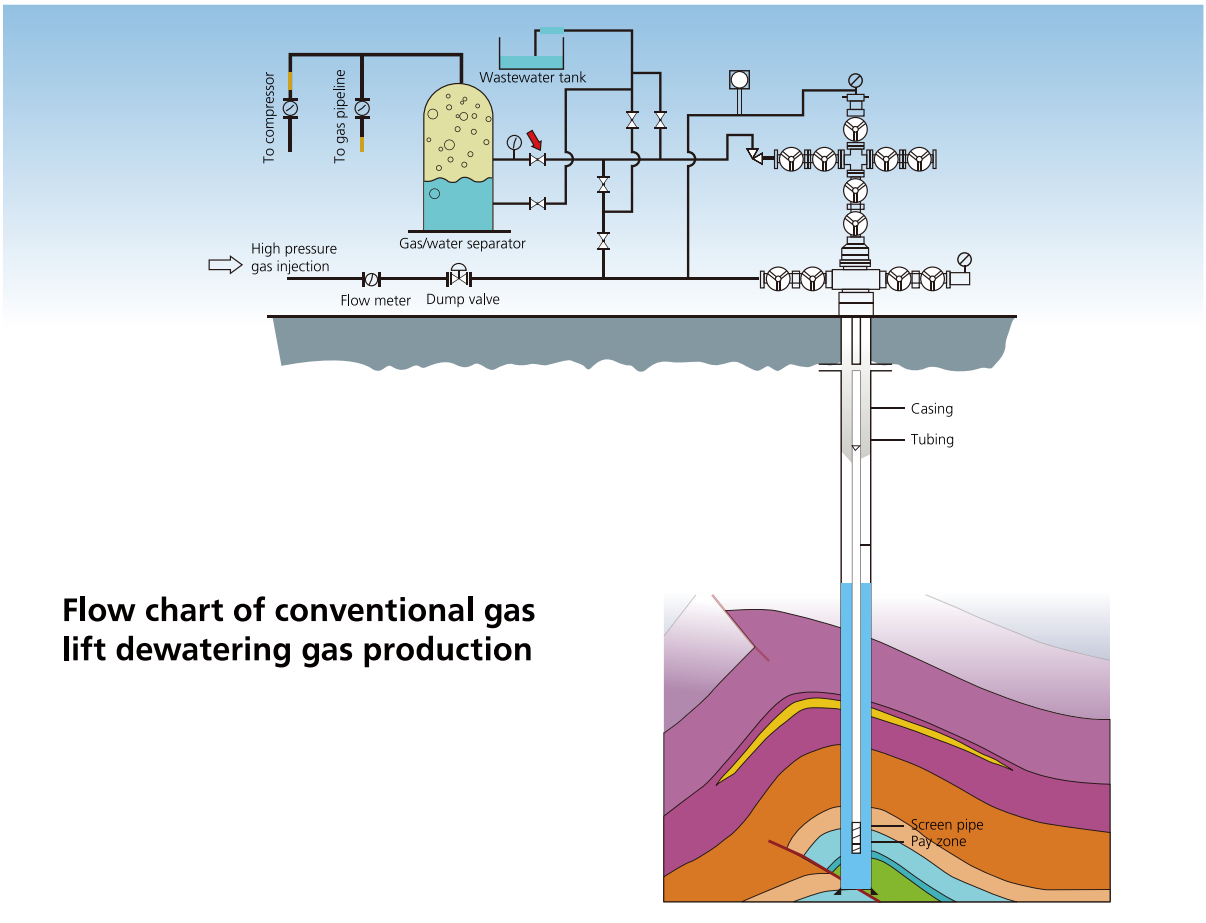
The integrated application of fine reservoir description, well test analysis and numerical simulation has led to an improved understanding of reservoir characteristics and the distribution of remaining reserves and aquifer. This has helped us to optimize well locations, increase producible reserves, and enhance recovery efficiency of gas reservoirs.

Prediction of Water Invasion Performance and Integral Water Control

With innovative analysis technologies, we can diagnose different types of water invasion performance and make early prediction of water yield from gas wells, so as to realize the optimization and balance in integral water control during the development of gas reservoirs. As a result, the actual recovery of some water-bearing gas reservoirs in eastern Sichuan has been enhanced to over 90%.



Dewatering Gas Production for Deep Wells



Flow chart of conventional gas lift dewatering gas production

Using high-back-pressure gas-lift dewatering and high-temperature foam dewatering technologies for deep wells, dewatering gas production can be carried out in wells with a depth of 5,000 meters and a temperature of 120°C. A maximum of 850 cubic meters of water can be drained out from individual well per day.

Gathering and Transportation of High Sour Gas

Key technologies for hydrate suppression, line pipe materials, pipeline anticorrosion, and enclosed wastewater transportation and treatment have been developed to ensure the safe gathering and transportation of high sour gas.

Anticorrosion in Sour Gas Fields

Based on experimental evaluation on fluid corrosiveness and corrosion resistance of various materials, we have developed advanced and applicable corrosion inhibitors and anticorrosion techniques, so that we can tap sour gas reservoirs in a safe, environmentally friendly, and cost-effective manner.

Gas Puriþcation and Processing

Gas purification means to remove hydrogen sulfide, carbon dioxide, water and other impurities from natural gas to make it qualified product gas. The purifying process mainly includes gas desulfuration, dehydration, decarbonization, sulfur recovery, tail gas processing and degasification of liquid sulfur.

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