

Magazine



Abnormally High Pressure Gas Reservoirs

Efficient Development of Kela-2
Gas field



China National Petroleum Corporation

Abnormally High Pressure Gas Reservoirs

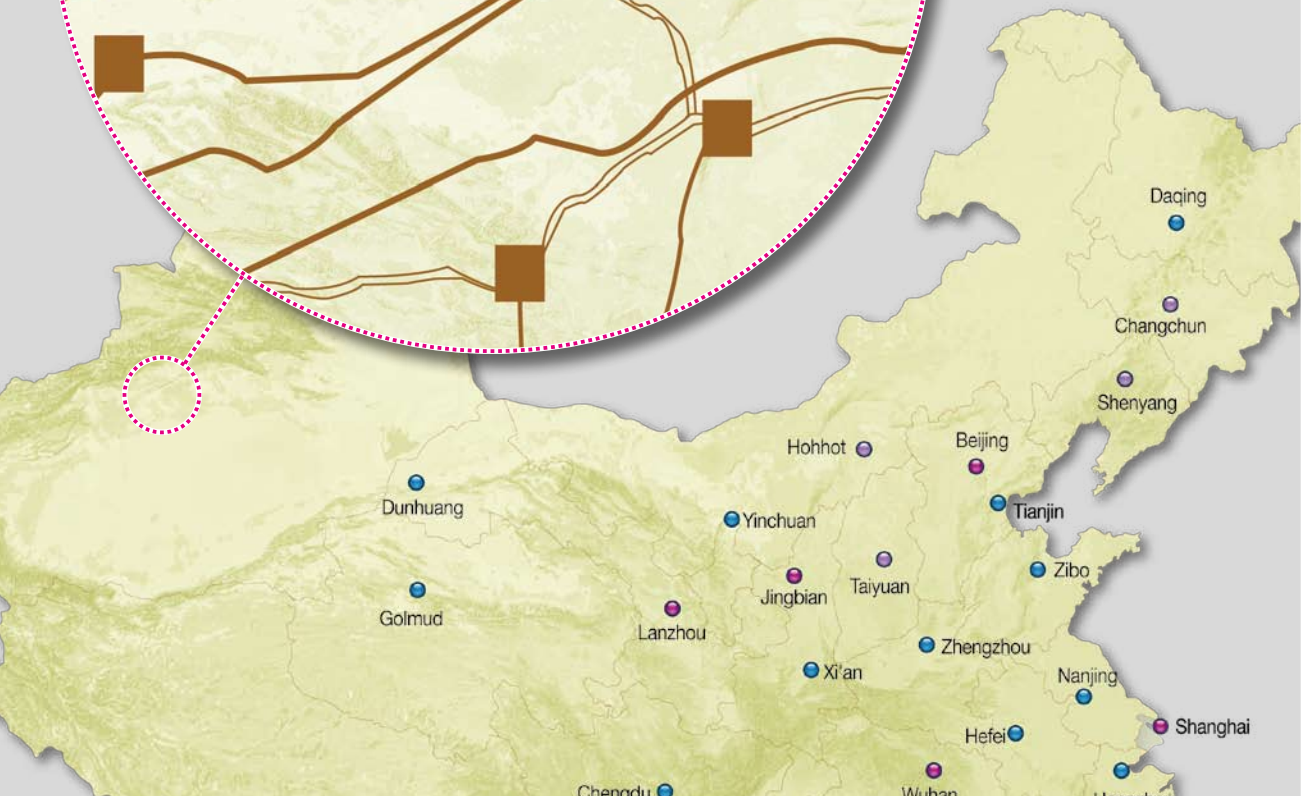
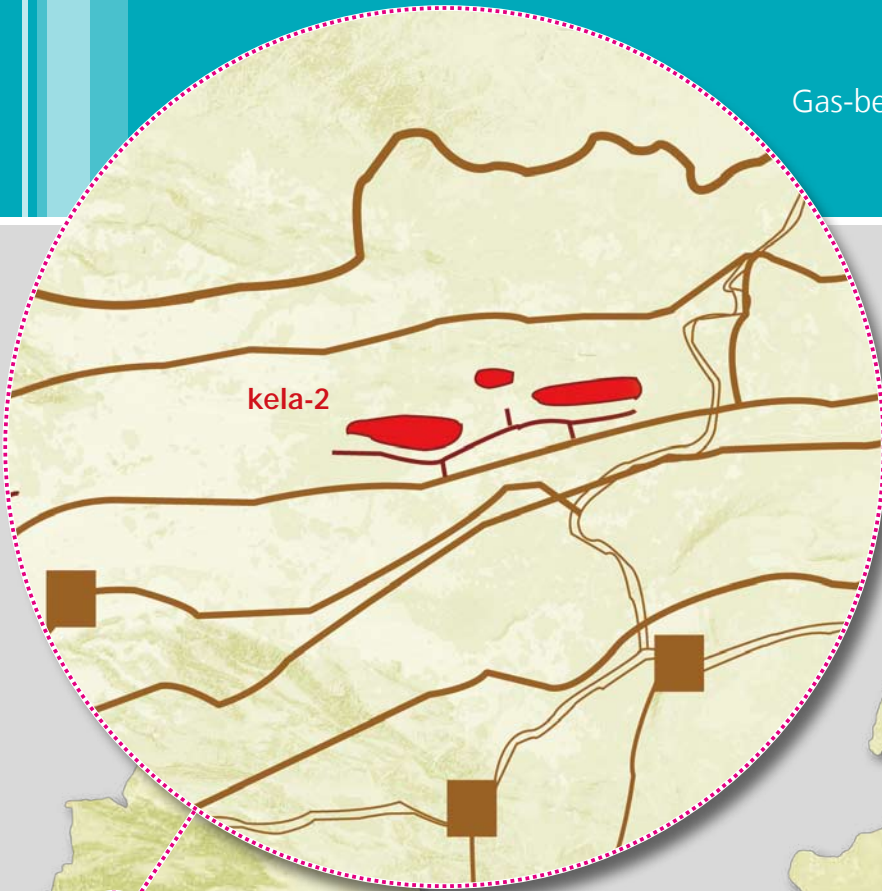
Efficient Development of Kela-2 Gas field

Kela-2 Gas Field is located in Baicheng County of Akesu Prefecture in Xinjiang Uygur Autonomous Region. It is geologically at the east section of Kelasan structural belt, Kuche Depression, in the Tarim Basin, with a gas-bearing area of 48.1 square kilometers and 284.029 billion cubic meters of proven gas in place.



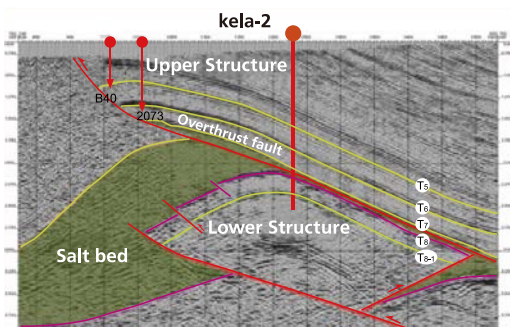
Proved gas in place **284.029**
billion cubic meters

Gas-bearing area **48.1**
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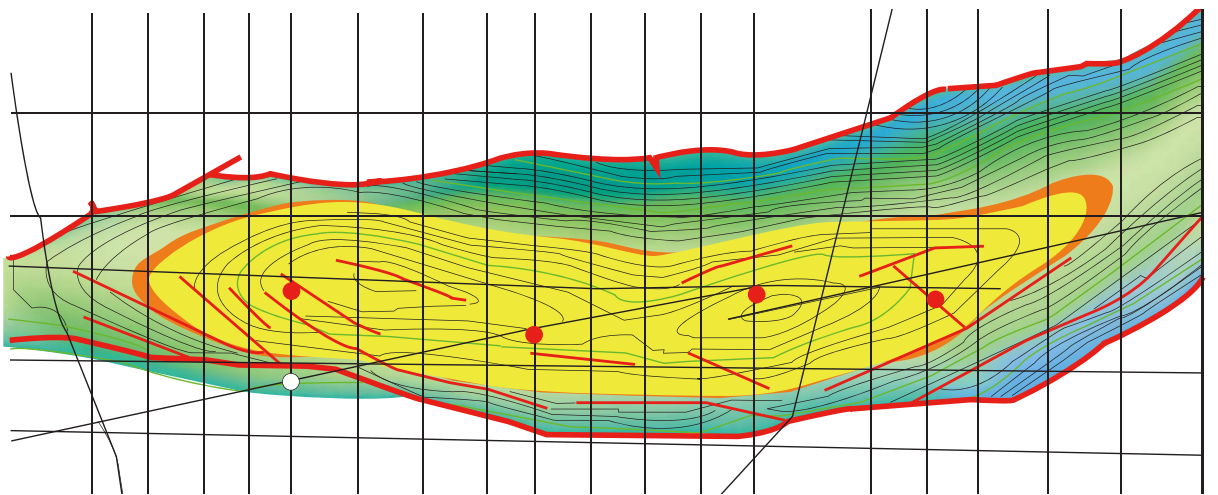


Kela-2 Gas Field is of high-step structure with its massive gas reservoirs buried at a depth of 3,500-4,100 meters. The gas is accumulated in Lower Tertiary dolomite, Lower Tertiary glutenite and Cretaceous sandstone formations. The gas field has a reservoir pressure of 74.35 MPa, a pressure coefficient of 2.02, methane content of more than 98%, and minimal H₂S and CO₂ contents.

Main Characteristics



- Large recoverable reserves : 213.02 billion m³
- High reserve abundance : 5.35 billion m³/km²
- High single-well production: 3-5 million m³/d
- Abnormally high pressure : 74.35 MPa
- High pressure coefficient: 1.9-2.02
- High gas quality: CH₄ 98%+ and minimal H₂S





Discovery

Well Kela-2 was drilled on March 25, 1997, and produced 270,000 cubic meters of natural gas on January 20, 1998 during a drillstem test in the Lower Tertiary formations.

Evaluation

From 2000 to 2003, 3D seismic exploration, well appraisal, drilling and production technology R&D and the preparation of a development program took place for this gas field. In addition, cooperation was conducted with Shell, Schlumberger and Gazprom.

Production capacity construction

In October 2003, construction was launched at Kela-2 Gas Field. On December 1, 2004, the Central Natural Gas Processing Plant was put into operation to formally supply gas to the West-East Gas Pipeline. On November 26, 2006, the Second Processing Plant became operational with a processing capacity of 20 million m³/d.

Gas production and supply

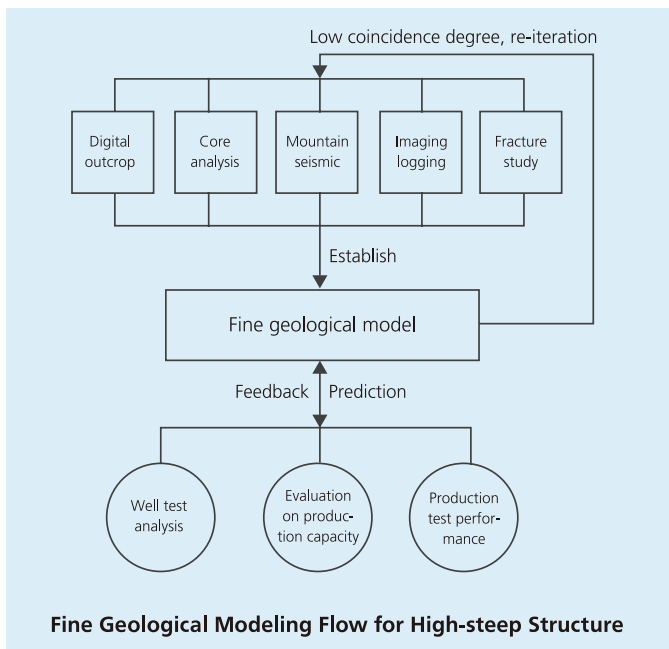
Kela-2 Gas Field is a major gas source for the West-East Gas Pipeline, supplying 63% of the gas delivered by the pipeline. Kela-2 has produced over 34 billion cubic meters of gas since becoming operational. In 2007, the gas field reached its designed production capacity, and produced 10.9 billion cubic meters of natural gas. It achieved an output of 11.7 billion cubic meters in 2008.



Technology and Innovation

A series of major difficulties have been tackled, and a sophisticated development technology package for gas fields with abnormally high pressure and high productivity evolved during the development of Kela-2 Gas Field.

Fine Geological Modeling of Abnormally High Pressure Gas Fields

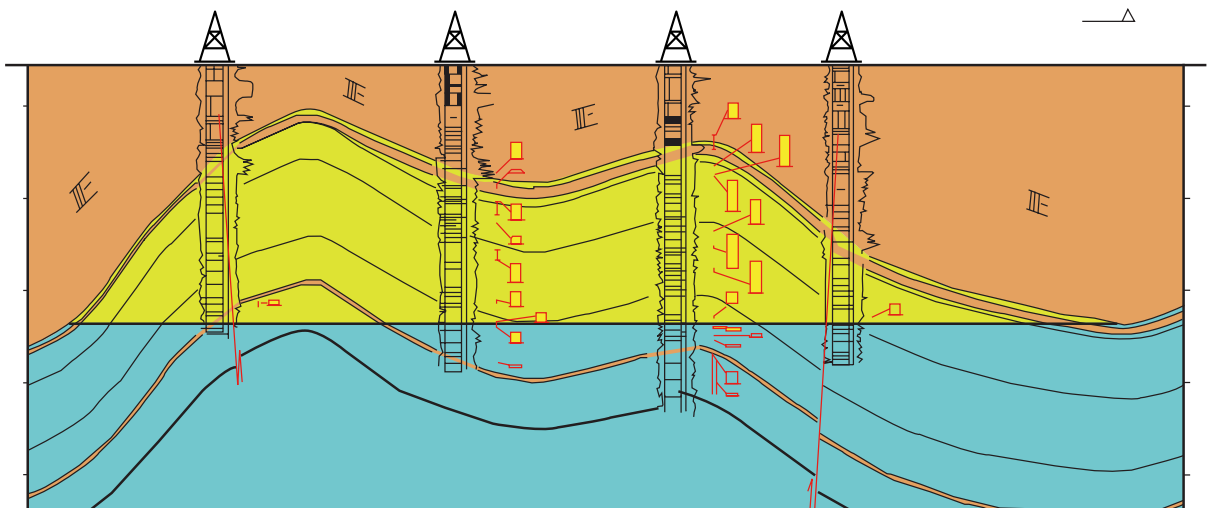


Based on seismic, well logging, well testing and surface outcrop data and combined with modeling method optimization, a 3D geological model in conformity with 90% of the geological characteristics of Kela-2 Gas Field was established when there were only five exploration and appraisal wells with a well space of 3-6km. The model provides a basis for development program planning and optimization. In addition, fine modeling technology in the case of wide spacing has been formed.

3D geological model in conformity with
90% of the geological characteristics

Development Program Design — High Productivity with Few Wells

07



Based on a study of how the gas deviation factor varies with formation pressure under abnormally high pressure, the quantitative correlation of rock porosity & permeability with formation pressure was determined, and the production capacity evaluation method for abnormally high pressure stress sensitive gas reservoirs and the well testing data processing method for abnormally high pressure and ultrahigh yield wells were established. A gas field development mode for ultrahigh productivity with few wells was planned to allocate the wells along the major axis of the upper part of the structure and complete it with a large pipe diameter. The 17 production wells have a production capacity of 10.7 billion cubic meters, and been 100% fulfilled.

Production capacity

10.7 billion cubic meters,
100% fulfilled.

Fast Drilling with High-steep Structure and Narrow Pressure Window

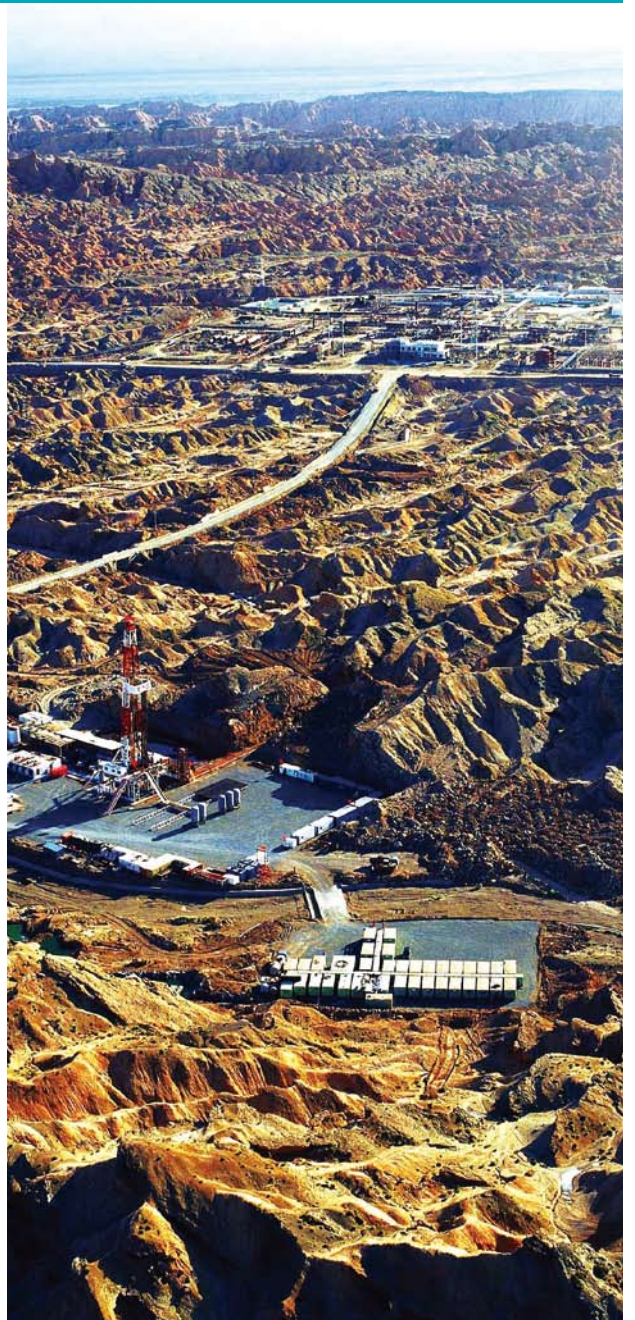
High-quality fast drilling technologies mainly based on top drive drilling, deviation measurement while drilling and optimization of drilling parameters have been developed. Vertical drilling standards and operating procedures for high-steep structures have also been developed. Major problems such as a steep dip angle, sharp changes in lithology and multiple pressure systems have been solved to realize the safe and quick penetration of gas wells and increase the bit speed sixfold.



Bit speed increased **6**-fold

Safe Completion of Gas Wells with Abnormally High Pressure and Ultrahigh Productivity

New types of 9 $\frac{5}{8}$ " packer, 7" down-hole safety valve, large diameter (7 $\frac{1}{16}$ ") Y-type integrated Christmas tree and modular perforating gun were designed for the safe completion of gas wells with ultrahigh productivity at a pressure of 70MPa. Single-well production of 5 million m³/d has been achieved.



Daily output per individual well **5** million cubic meters

Surface High Pressure Gas Gathering and Processing



One-stage station high pressure (16MPa) gas gathering and processing flow has been developed, as well as large-scale application technology of SAF 2205 duplex stainless steel. The completed high pressure gas gathering, transportation and processing system fully utilizes formation energy to significantly decrease investment and energy consumption. A “three-in-one” automated safe control system integrating wellhead, gathering and transportation pipeline and processing station has been established. The automatic control technology can realize down-hole and wellhead three-stage shutoff, remote control emergency shutdown and unattended operations.

