



Article

Analysis of Geological Technology Development Trends in Natural Gas Exploration and Development

Zhang Xuancheng

Xi'an University of Petroleum, China, Shanxi 710065

Abstract: With the continuous advancement of exploration and development technology, the complex geological conditions of natural gas resources are gradually being revealed. This article introduces the current situation of natural gas exploration and development, analyzes the important role of geological technology in natural gas exploration and development, and finally explores the development trend of geological technology in future natural gas exploration and development.

Keywords: natural gas exploration, geological technology development trend

1. Geological technology status of natural gas exploration and development

With the rapid development of our country's economy, the demand for clean energy is increasing day by day. Natural gas, as a clean and efficient energy source, occupies an important position in China's energy structure. However, natural gas exploration and development face many challenges, such as complex geological conditions and high costs. Therefore, utilizing advanced geological technology to improve the efficiency of natural gas exploration and development is of great significance.

1.1 Seismic Exploration Technology

Seismic exploration technology is one of the most commonly used techniques in natural gas exploration and development. By analyzing the propagation characteristics of seismic waves underground, the location, thickness, and boundaries of natural gas reservoirs can be effectively identified. In recent years, seismic exploration technology has made significant progress, such as high-resolution seismic imaging and seismic attribute analysis, providing strong support for natural gas exploration.

1.2 Drilling Technology

Drilling technology is a key link in natural gas exploration and development. With the continuous advancement of drilling technology, such as the increase in drilling speed and the reduction of drilling costs, more possibilities have been provided for natural gas exploration. In addition, the environmental damage caused by drilling technology during the drilling process has also received widespread attention, and green drilling technology has gradually become a research hotspot.

1.3 Geophysical logging technology

Geophysical logging technology determines the distribution and characteristics of natural gas reservoirs by measuring the physical properties of underground rocks, such as density, porosity, permeability, etc. With the continuous development of geophysical logging technology, such as nuclear magnetic resonance logging, imaging logging, etc., more accurate reservoir information has been provided for natural gas exploration.

1.4 Exploration and development technology for natural gas hydrates

Natural gas hydrates are a new type of marine energy mineral with enormous potential for development. In recent years, significant progress has been made in the exploration and development technology of natural gas hydrates, such as deep-sea drilling technology and low-temperature drilling fluid technology. In addition, China has also achieved a series of results in the exploration and development of natural gas hydrates, providing new directions for the future development of natural gas resources.

2 Geological Technology Development Strategies for Natural Gas Exploration and Development

2.1 Increase research investment and improve technological level

Against the backdrop of the current global energy transition, the development trend of geological technology for natural gas exploration and development in China is becoming increasingly evident. In order to achieve more breakthroughs in this field, China should increase research investment and support research in areas such as seismic exploration, logging technology, and geological modeling. Firstly, in terms of seismic exploration, China should continue to deepen the theoretical research on seismic wave propagation and develop high-precision and high-resolution seismic exploration technologies. This helps to improve the accuracy of natural gas exploration and reduce the risk of blind drilling. At the same time, efforts should be made to increase research on non seismic exploration technologies, such as gravity, magnetic methods, electrical methods, etc., in order to achieve comprehensive exploration of multiple parameters, scales, and fields. Secondly, in terms of logging technology, China should focus on improving the level of logging data collection, processing, and interpretation. This includes developing new logging tools, improving the quality of logging data, and researching more accurate logging interpretation methods. In addition, research on unconventional natural gas logging technologies such as shale gas and coalbed

methane should be increased to provide technical support for the development of unconventional natural gas resources in China.

2.2 Optimize exploration and development strategies to improve resource utilization efficiency

Firstly, the application of geological big data analysis will change the way natural gas exploration and development are carried out. With the advancement of technology, the application of big data technology in geological exploration is becoming increasingly widespread. By collecting and analyzing various geological data, more accurate guidance can be provided for exploration and development. For example, through comprehensive analysis of seismic, logging, drilling and other data, the distribution, reservoir properties, fluid properties and other information of underground gas reservoirs can be revealed, thereby improving the success rate of exploration and development efficiency. Secondly, breakthroughs will continue to be made in unconventional natural gas exploration and development technologies. Unconventional natural gas resources are abundant, but the development difficulty is relatively high. With the continuous innovation of technology, such as fracturing technology, horizontal well technology, etc., significant achievements have been made in the development of unconventional natural gas. In the future, with the further development and optimization of these technologies, the exploration and development of unconventional natural gas will become more competitive, providing more choices for China's energy supply.

2.3 Strengthen talent cultivation and cooperation

In terms of strengthening talent cultivation in the field of natural gas exploration and development, China should focus on the following aspects: firstly, increase investment in higher education, establish relevant majors, and cultivate professional talents with basic knowledge and practical abilities in natural gas exploration and development. Secondly, strengthen practical teaching by combining industry, academia, and research to enable students to accumulate experience in practical projects and improve their hands-on abilities. In addition, attention should be paid to the continuing education of talents, continuously updating the theoretical knowledge and technical level of existing talents through training courses, seminars, and other forms. In terms of strengthening domestic and international technological exchanges and cooperation, China should do the following: firstly, actively participate in international technological exchange activities, introduce advanced foreign technology and management experience, and promote the improvement of domestic natural gas exploration and development technology. Secondly, domestic enterprises are encouraged to cooperate with internationally renowned oil companies to jointly carry out natural gas exploration and development projects, and learn from international advanced technologies. In addition, establish international cooperation mechanisms, strengthen information exchange and technical cooperation in the field of natural gas exploration and development, and achieve resource sharing.

3 Development Trends

3.1 Three dimensional seismic technology

Three dimensional seismic technology plays an important role in natural gas exploration and development. By obtaining information on underground structures, sedimentary facies, faults, etc., it provides a basis for drilling and production decisions. In the future, 3D seismic technology will be further developed, such as high-resolution seismic imaging, full waveform inversion, etc., to improve exploration and development efficiency.

3.2 Geophysical logging technology

Geophysical logging technology provides key data for natural gas exploration and development by measuring the physical properties of formation rocks. With the continuous advancement of logging technology, such as nuclear magnetic resonance logging, imaging logging, etc., it is possible to more accurately identify gas reservoirs, evaluate reservoir properties, and improve drilling success rates and recovery rates.

3.3 Geological modeling and numerical simulation

Geological modeling and numerical simulation technology have important application value in natural gas exploration and development. By modeling and simulating underground gas reservoirs, dynamic changes in gas reservoirs can be predicted and production strategies can be optimized. In the future, geological modeling and numerical simulation technologies will become more mature, such as intelligent modeling based on artificial intelligence and multi-scale simulation, providing more accurate predictions for natural gas development.

3.4 Deep sea natural gas exploration and development technology

With the gradual reduction of terrestrial natural gas resources, deep-sea natural gas exploration and development have become a new direction of development. The exploration and development technology of deep-sea natural gas faces many challenges, such as complex deep-sea environments and high technical requirements. In the future, breakthroughs will be made in deep-sea natural gas exploration and development technologies, such as deep-sea drilling and deep-sea oil and gas field development.

In short, the geological technology development trend of natural gas exploration and development presents the characteristics of diversification, high precision, intelligence, and greenness. In the future development, geological technology will continue to promote the prosperity of the natural gas industry and provide strong support for global energy supply. However, the application of geological technology in natural gas exploration and development also faces many challenges, such as complex underground conditions and rapid technological updates. Therefore, strengthening geological technology research, innovation, and application, and cultivating high-quality geological technology talents are important tasks in the field of natural gas exploration and development.

Funding: This section is required for all papers. Please add: “This research received no external funding.” or “This research was funded by Name of Funder, grant number XXX.”

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References:

1. Wang Guoshun. Progress and Prospects of Natural Gas Development Technology in China. *Natural Gas Industry*, 2019 (11): 78-79
2. Li Shenghe. A Preliminary Discussion on the Current Status and Future Development Trends of Natural Gas Reservoir Exploration and Development in China. *Geological Science*, 2019 (7)
3. Yu J ,Wang S ,Wang F , et al. Triacylglycerols in human milk and their association with edible oils in maternal diet: A study of five regions in China. *Journal of Food Composition and Analysis*,2024,136106777-106777.
4. Feng Y ,Yang Z ,Jiang W , et al. The influence of mudstone lithofacies sedimentation on the development of shale oil “sweet-spot intervals” within large down-warped lacustrine basins in China.*Marine and Petroleum Geology*,2024,169107063-107063.