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Opinion

Efficient Development of Offshore Fractured Granite Buried-Hill Oil and Gas Fields in China

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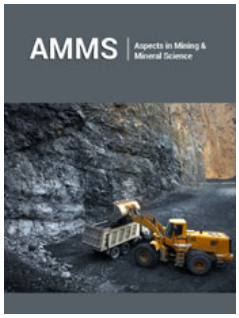
ISSN: 2578-0255



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Submission: December 01, 2022

Published: December 08, 2022

Volume 10 - Issue 3

How to cite this article: Laiming Song, Zupeng Ding, Shuo Yang*, Xu Liang, Yu Hu. Efficient Development of Offshore Fractured Granite Buried-Hill Oil and Gas Fields in China. Aspects Min Miner Sci. 10(3). AMMS. 000737. 2022.
DOI: 10.31031/AMMS.2022.10.000737

Opinion

The resource evaluation shows that the resource of offshore granite buried-hill reservoirs is huge, which plays an important role in increasing reserves and production of oil and gas. However, the existing theories and techniques of oil and gas field development around the world are difficult to guide the efficient development of granite buried-hill oil and gas fields, mainly facing three major challenges: (1) it is difficult to evaluate the reserves reasonably, and the uncertainty of the layered or massive mode of granite buried-hill reservoirs leads to difficulties in reserve-scale evaluation and production of the reservoirs; (2) fracture characterization is challenging, in which the spatial distribution of fractures, the effective evaluation of three-dimensional connectivity of fractures, and the quantitative characterization of fracture anisotropy, are unclear; (3) the deployment of the development plan of the granite buried-hill reservoirs is hard, since the establishment of fluid flow mechanisms and the efficient development mode of the fractured granite buried-hill reservoirs is still lacked. Hence, it is difficult to achieve high production with fewer offshore wells. In response to the technical problems above, three major breakthroughs have been made in three aspects -- reservoir modelling, fracture characterization, and the deployment of field development plan, after 15 years of scientific and technical research. A number of granites buried-hill reservoirs have been benefited from the breakthroughs and are developed successfully, and made important contributions to the achieving the strategic goals of the national oil and gas energy.

a. This research work pioneers in proposing that the massive-bottom fluid distribution is the dominant fluid distribution mode in granite buried-hill reservoirs. Also, the existence of the corresponding relationship between the ridge landform, and the scale and the development degree of fractures was discovered. The fracture distribution mode controlled by ridges and ridge fractures were established, revealing the law of the control of fracture direction on the development effect of the well patterns. The innovative theories above have guided intelligent deformation of well deployment, increasing the average drilling rate of fractured reservoirs from 70% to 83%.

b. This research work innovated the spatial characterization method of the granite buried-hill reservoir, including fracture distribution prediction, identification and comparison of time-space coupled physical interface, and evaluation of three-dimensional connectivity of fractures. The fluid flow and development of techniques of fractured reservoirs was invented, including evaluation of the effectiveness of fluid flow in fractures and testing of anisotropic permeability tensor of the fractures. The innovative techniques above have determined the limit of fracture aperture for heavy oil flow, which significantly increased the proportion of reserves in fractures of offshore granite buried-hill reservoirs, increasing the recoverable reserves of fractures in PL Oilfield from 11.55 million m^3 to 34.81 million m^3.

c. A large-scale physical model of heterogeneous fractured reservoir was developed to investigate through the oilfield development laws in advance. The detailed three-dimensional development mode of "horizontal well+trench slope injection ridge production+bottom injection top production+intelligent deformation of well pattern" for granite buried-hill massive reservoirs has been invented, optimizing the development deployment plan, and pioneering "artificial bottom water, uniform advancing and three-dimensional development" for less wells and higher production in offshore oilfields. These techniques have extended the stable production life of JZ Oilfield from one to more than six years.

Overall, this research work established granite buried-hill reservoir mode clarified the spatial distribution law of fractures, revealed the fluid flow mechanisms of fractured reservoirs, and formed a series of efficient development techniques. Relevant theoretical and technical achievements have been applied to more than 10 oil and gas fields in the major oil and gas bearing basins of the Bohai Sea, the East China Sea and the South China Sea, and have obtained significant economic and social benefits.