Summary of GR Steering Technology While Drilling in Carbonate Horizontal Wells

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Abstract

Horizontal wells are the key well type for the development of carbonate oil and gas fields, but the drilling of horizontal wells often faces technical problems such as low drilling rate of reservoirs and unreasonable borehole trajectory, which is not conducive to the later stage of reservoir reconstruction, seriously restricting the high and stable production of single wells and the development of oil and gas scale benefits. The traditional steering string while drilling is optimized, and the gamma steering combination design is innovated. By processing and analyzing the real-time gamma data obtained in drilling, the azimuth of well deviation is adjusted in time, to minimize the dogleg degree and ensure that the trajectory is stable and smooth in the designed target box. Improve the drilling rate of reservoirs, provide a good borehole environment for staged reconstruction, and play the role of horizontal wells in increasing production.

Keywords

Carbonate rock, Horizontal well, Gamma guidance, Reservoir drilling rate

Introduction

The seismic reflection characteristics of carbonate reservoirs are mainly four types: beaded, flaky, chaotic and weak reflection. The reservoirs with beaded reflection characteristics are mainly karst caves, fractures and cavities, and the porosity is generally more than 4%. During drilling, the leakage is serious and venting often occurs, and the reservoir space is mainly large caves. The reservoir with flaky reflection characteristics is mainly of fracture-cavity type, followed by fracture-cavity type, and the porosity is generally 2-8%.

The reservoir space is nearly layered fracture and cavity layer. The reservoir with chaotic seismic reflection characteristics is mainly fracture type and fracture-cavity type, followed by cavity type, with porosity of 2 ~ 6% in general, and the reservoir space is a complex of fracture and cavity; The reservoirs with weak reflection characteristics are mainly fractured and vuggy, with porosity generally less than 2%, and the reservoir space is discontinuous bugs and a few fractures [1-3]. With the deepening of exploration and development, flaky, disordered and weakly reflective reservoirs have become the key targets for tackling key problems. For the development of these three types of reflective reservoirs, the effect of horizontal wells is better than that of vertical wells [4].

The heterogeneity of carbonate reservoir is strong, and it is difficult to determine the development position of reservoir on seismic profile.

Applying GR technology while drilling to continuously correct the trajectory according to the formation changes not only improves the target entry accuracy but also improves the reservoir drilling rate and maximizes the oil drainage area, thus improving the single well production and realizing less wells and high efficiency.

GR steering technology system while drilling

Based on GR steering technology while drilling, the study of geological characteristics, seismic reflection, drilling engineering, logging response and other disciplines is comprehensively applied. By analyzing the development characteristics of carbonate reservoirs, fine stratigraphic correlation, accurately locating the reservoir development position, taking the optimal design of horizontal well trajectory as the premise and

dynamic tracking while drilling as the means, to improve the single well production, the efficient development of horizontal wells is finally realized [5-7].

Trajectory optimization design

Two sets of high GR members are generally developed in Yingshan Formation in the second area of Tazhong. Member GR of Gaoyi layered argillaceous belt; In GR section of the second year of high school, the cave is (semi-) filled with mud. Gaoyi GR section, located near Eagle Peak, has been drilled in 14 wells, accounting for 17.7%, with an average GR value of 30 ~ 60 API. Gao Er GR section is located inside Yingshan Formation, and 18 wells have developed Gao Er GR section, accounting for 22.8%, with an average GR value of 90 ~ 120 API. Based on the analysis of the distribution law of regional high GR section of carbonate rocks in Tazhong and the corresponding relationship between reservoir development position and high GR section, the lower part of high GR section is determined to be a high-quality reservoir development section, and the reservoir development position is determined to accurately locate the target, thus ensuring the accuracy and rationality of horizontal well trajectory design.

Dynamic research while drilling

According to the actual drilling experience, combined with GR curve while drilling, four key nodes of trajectory adjustment in the process of horizontal well drilling are explored, and the design trajectory is optimized in time, reasonably and finely, so as to ensure the accurate target entry of horizontal wells, improve the reservoir drilling rate, increase the oil drainage area, effectively improve the single well production, and innovate a set of horizontal well tracking technology while drilling [8,9].

Node 1, according to the actually drilled top of Lianglitage Formation, determine the depth of target layer according to the macroscopic seismic calibration, steering technology was piloted in 2012 and fully popularized in 2013.

The dynamic tracking effect of horizontal wells while drilling was remarkable, and the drilling rate of horizontal wells increased significantly. In 2012, the average drilling rate of carbonate horizontal wells was 37.4%, which was 70.1% higher than that in 2011(21.9%). In 2013, it is currently 41%, which is 9.7% higher than that in 2012 (37.4%).

GR steering technology while drilling has matured, and and make preliminary adjustment, with the adjustment range of > 20m; Node 2, the well deviation is 60 ~ 70, the bottom hole position is determined according to GR curve while drilling, and the target layer is optimized and adjusted by 10-20m; by fine comparison with adjacent wells; Node 3, before entering the target, accurately determine the target position according to the GR characteristics at the top of the regional reservoir and the change of GR curve while drilling, and adjust the range by 5-10m; Node 4, drilling in the horizontal section of the target layer, and making accurate adjustment according to GR characteristics while drilling, logging display and seismic response form, with the adjustment range less than 5m [10].

Dynamic research while drilling

Combined with the technical difficulties of horizontal well drilling, the quantitative adjustment of horizontal well trajectory is realized. Systematic analysis of the corresponding relationship between the target entry angle and the rationalization of trajectory adjustment, determination of the optimal target entry angle range, consideration of exploration potential while avoiding engineering risks, increase the rationality and practicability of trajectory adjustment, and basically form the optimization technology of horizontal well drilling trajectory adjustment angle [11,12].

GR steering technology while drilling application effect

In 2013, GR while drilling has been successfully applied to 23 wells in the study area, and the effect of “flaky and disorderly” seismic reflection reservoir is good. At present, 20 carbonate development wells have been tested and completed, and 18 wells have been successfully drilled, with a drilling success rate of 90%. This GR-while-drilling

the construction technical scheme and research method while drilling have basically formed.

Conclusion

Through the analysis and study of reservoir development position characteristics, the drilling trajectory is optimized reasonably by using the tracking while drilling technology of four key nodes of horizontal well dynamic tracking, combined with the optimization technology of horizontal well trajectory adjustment angle, so as to ensure the accurate target entry of horizontal wells,

improve the drilling rate of reservoirs, and effectively improve the oil and gas production of carbonate single wells.

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Conflicts of Interest

The authors declare no conflict of interest.

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