Development Strategies of Fault-Controlled Fractured-Cavity Reservoirs in Tarim Fuman Oilfield

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Abstract

In China, a large number of fractured-cavity carbonate reservoirs controlled by several deep-seated faults have been discovered below 8,000-meter underground in the Fuman region of Tarim Basin, with original oil in place greater than 1.0 billion tons and daily oil production of high-yield wells larger than 100 tons per day. However, the relationship between faults, geological characteristics and fluid enrichment in this type of reservoir has not been well understood. The underlying mechanism of subsurface fluid flow is extremely complicated due to strong heterogeneity and coexistence of multiple reservoir types. The success rate of new producers is far below 75%. This results in significant variations in development outcomes and restricts the efficient exploitation of oil and gas in the area.

This paper proposes a new development method for fault-controlled carbonate reservoirs: Firstly, the accuracy of fault zone identification is improved by seismic attribute fusion and optimization. According to the geometric characteristics of the fault zone and the width of the control reservoir, the fault zone is segmented, and the section with large fracture zone width and strong fault activity is selected. The second step is to clarify the location of high-quality reservoirs. Through the coupling of multi-scale data such as core, imaging, conventional logging and seismic. This involves refining the characterization from outlining the contours of fault-controlled reservoirs to detailing the internal structure of the reservoirs, selecting high structural positions and reservoirs with 'beaded' seismic reflections, and then determining the well placement locations. Finally, based on the storage space type, connectivity relationship and seepage characteristics of fault-controlled reservoirs, volume development well patterns was constructed and developed using a combination of depletion development and water injection to replace oil, which increased the drilling success rate of Fuman Oilfield from 75% to 97%.

The study delineates the pivotal role of deep, substantial strike-slip faults in reservoir delineation, storage definition, and hydrocarbon enrichment, with NE- trending faults chiefly influencing storage. Analysis of drilling data uncovers pronounced segmentation of fault zones, both laterally and longitudinally, permeating vertically through strata with thicknesses exceeding 600 meters. The high-efficiency well position has the characteristics of main oil source strike-slip fracture, positive topography, multi-phase beaded reflection. The distribution of oil, gas and water in the reservoir space of fault-controlled fractured-vuggy carbonate reservoirs is mainly affected by gravity, and the capillary force can be ignored. Based on three different types of volume development well patterns designed for different types of fracture-cavity connected units, the development effect of this type of reservoir can be greatly improved by using depletion development assisted water injection huff and puff.The proportion of high-efficiency wells increased from 20% to 68%.

Field trials have proven that the adoption of new development methods in the Fuman Oilfield increased the annual production from 2.14 million tons in 2017 to 4.08 million tons in 2023. promotes the construction of China 's first zero-carbon desert highway, and providing valuable insights for the development of similar oil and gas reservoirs in the world.