

Distribution Characteristics of Paleo-Karst Zones and Reservoirs in the Fourth Member of Dengying Formation in Gaoshiti Block, Central Sichuan Basin, China

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Abstract

This paper divides the vertical paleo-karst zone of the intended interval in the study area, establishes the quantitative relationship between the thickness of the paleo-karst zone and the relative elevation of the paleo-karst landform, subdivides the underflow zone into sub-zones, analyzes the development characteristics of high-quality reservoirs in different sub-zones, and selects the favorable paleo-karst sub-zone for each region.

In this paper, the paleo-karst zone is divided by using core, conventional logging and imaging logging data, and the quantitative relationship between the thickness of the paleo-karst zone and the relative elevation of the paleo-karst landform is established by statistics of the single well. On this basis, according to the development characteristics of vugs and fractures, logging response and reservoir physical properties, multi-period sub-zones are identified in the underflow zone. We refine the underflow zone in 41 wells with imaging logging data, and the distribution characteristics of different underflow sub-zones are defined. The recognition and seismic prediction of high-quality reservoirs are conducted. Thus, the distribution characteristics of high-quality reservoirs in each underflow sub-zone are characterized. We analyze the distribution differences of high-quality reservoirs and reasons in different sub-zones.

Research shows that the epigenetic paleo-karst zone of the intended interval in the study area includes the vadose zone, underflow zone and slow flow zone from top to bottom. The higher the paleo-karst landform is, the thicker the vadose zone is and the thinner the underflow zone is. The underflow zone comprises three stages of subzones, among which the development of high-quality reservoirs in sub-zone 1 and sub-zone 2 are better than that in sub-zone 3. We divide the study area into three regions. High-quality reservoirs in region-1 exist in the vadose zone and each underflow subzone. High-quality reservoirs in region-2 mainly exist in the vadose zone and underflow subzone-1. However, high-quality reservoirs in region-3 only exist in the vadose zone.

Paleo-karst landforms control the development of paleo-karst zones to some extent. Because of the tectonic uplift, the ancient water table declined continuously. The multi-period decline of the ancient water table, which forms the underflow zone currently, reformed the earlier karst zone. Sedimentary facies and paleo-karst landforms mainly control the development characteristics of high-quality reservoirs. The novelty of this paper lies in clarifying the distribution of high-quality reservoirs in the paleo-karst zone under the influence of multiple changes on the ancient water table, and optimizing the favorable underflow sub-zone. This research provides a reference for the fine characterization of the weathered karst carbonate reservoir and guides the optimization of the development technology policy in the research area.