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Differential inheritance of strike slip faults and their relationship with oil and gas accumulation: A case study of the Xunyi area in the southern part of the Ordos Basin

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Summary

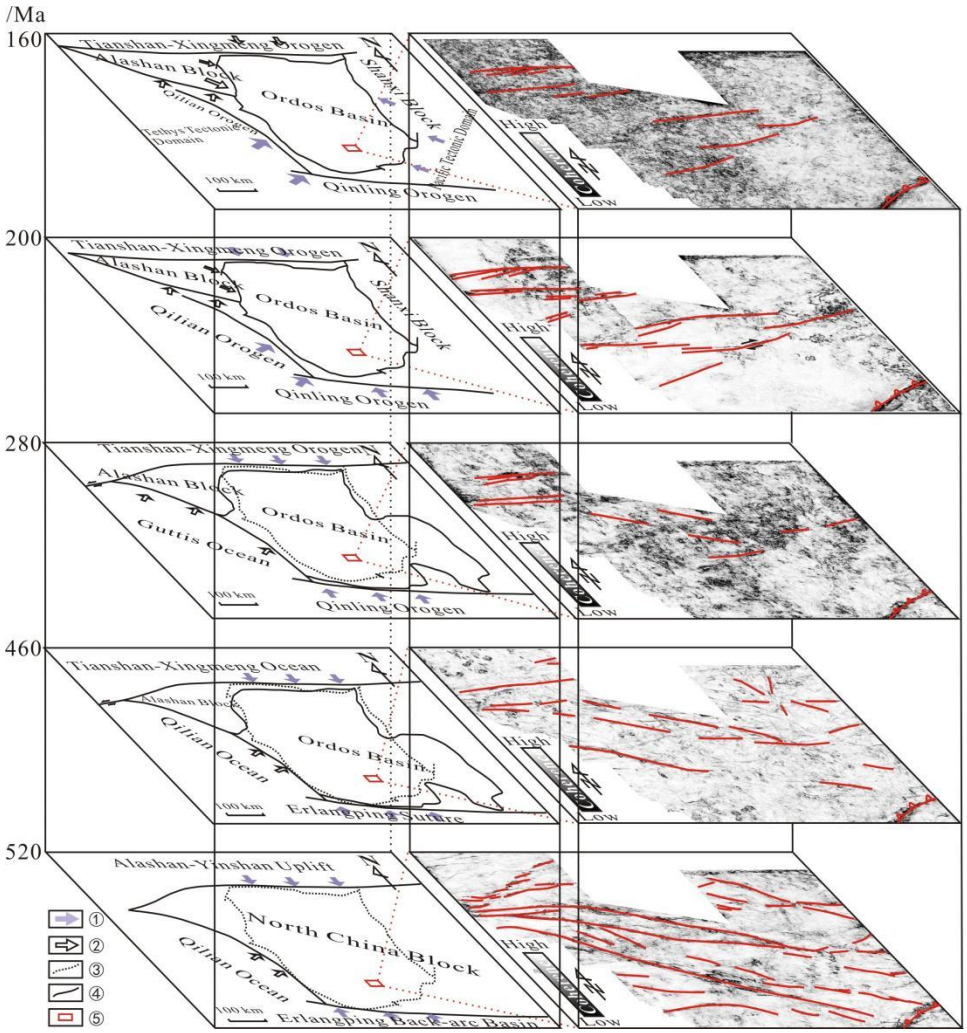
Strike-slip faults play a significant role in reservoir control, accumulation control and enrichment control, enabling the formation of large-scale high-quality reservoirs in tight formations through structural fracturing. In order to further investigate the relationship between strike-slip fault activity and hydrocarbon accumulation, detailed analysis of the strike-slip faults in the study area was conducted based on high-precision 3D seismic and drilling data. The geometric and kinematic characteristics of the fault activity and its phases were comprehensively analyzed using structural geometry and kinematic theories. The results indicate that the main active period of faulting occurred during the Yanshanian period, coupled with the hydrocarbon expulsion from the main source rocks in the study area. There are significant differences in the characteristics of strike-slip faulting between the Lower Paleozoic and Mesozoic in the Xunyi area. In the Lower Paleozoic, strike-slip faults predominantly trend northwestward, exhibiting segmented patterns and developing braided and overlapping structures. In contrast, Mesozoic faults trend predominantly northeastward or east-westward, developing en echelon and flower-like structures, with lower fault activity intensity and widespread occurrence of differential inheritance phenomena. Shallow faults mostly terminate in the Late Permian, with several hundred meters of separation from the Lower Paleozoic faults. This suggests that most of the Lower Paleozoic faults ceased activity during the accumulation period, with early fractures predominantly cemented by calcite and dolomite, resulting in significantly reduced transmissibility insufficient for the formation of reservoirs with good permeability. Conversely, late-stage, intensely active inherited faults continue to play a role in channeling fluids, sustaining fluid flow, and improving reservoir quality.

Theory / Method / Workflow

Based on high-precision 3D seismic data, employing geometric and kinematic principles of strike-slip faults, we comprehensively analyze the activity characteristics of faults at different stages. Concurrently, integrating thermal evolution of hydrocarbon source rocks and reservoir property test results, we investigate the impact of strike-slip fault activity on hydrocarbon accumulation.

Results, Observations, Conclusions

The strike-slip faults in the study area exhibit multi-stage activity, with most shallow faults not showing inheritable growth from early deep-seated faults, indicating that early faults ceased activity in later stages. The main hydrocarbon generation period of source rocks occurred during the Yanshanian period. During this time, as deep-seated faults generally ceased activity, early-formed fractures were predominantly filled with calcite, resulting in no improvement to the lower Paleozoic tight reservoirs. Therefore, subsequent exploration should focus more on inherited faults.



Stages of fault evolution.

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