New Insights of the Cenozoic Transtensional Fault System in the Sichuan Basin and its Petroleum Significance

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Abstract

In previous studies, many scholars believed that the Sichuan basin is dominated by thrust faulting deformation in its surrounding rims. There has been very limited investigation on the fault systems in the internal basin where the recent key targets of deep carbonates are primarily addressed. In this research, by integrating the basin scale seismic modelling and 3D seismic coherence cube analysis, a set of transtensional fault system in the deep to ultra-deep basin was developed in Cenozoic. It indicates that the internal Sichuan basin was dominated by transtensional deformation and presents high level of heterogeneity of stress distribution, although the Cenozoic Sichuan basin was dominated by contraction at the surrounding rims. This set of transtensional fault system, primarily E-W striking, was broadly developed in the internal Sichuan basin rather than the foreland system in the northwest or the steeply dipping structural domains in the east. In section view, this set of fault system is characterized by flower structures, high angle faults and small vertical offsets, which suggests its close relationship with strike-slip deformation. The transtensional faults are primarily developed from the Sinian sediments, being terminated upward by Permian or Ordovician strata. However, some of these faults can penetrate upward until upper Triassic strata. The deformation timing was determined to be Cenozoic by integrating the characteristics of high angle faults, penetrating Triassic strata and being lack of syn-sedimentation. The analogue physical modelling also suggests that this set of fault system is controlled by transtensional stress field, presenting distinct differences with pure extension. The development of the

transtensional faults may provide very important significance on petroleum exploration. Firstly, this set of transtensional fault system vertically linked multiple source rocks (e.g., Qiongzhusi Formation) with high quality reservoir rocks (e.g., Longwangmiao Formation, Xixiangchi Formation, Qixia-Maokou Formation). The development of efficient linkage between source rocks and reservoir rocks is benefiting from the transtensional stress field. For example, there have been 6 high capacity gas wells in the internal Sichuan basin, with 5 of them are located near these faults. Secondly, the efficient domains for petroleum accumulation are formed by integrating the structural highs and fault linkages derived from flower structures. The cores of positive flower structures and rims of negative flower structures can be high capacity traps. Thirdly, the development of faults also potentially improves the petrophysical properties of reservoir rocks. For example, the reefs of the Longwangmiao Formation neighboring the transtensional faults present better permeability than that are far away from the fault system.