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Constraints of multiple detachment layers on structural deformation patterns in the basin: insight from 3D geological structure model in the Puguang area, China

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Based on outcrop investigations, 3D seismic interpretations, drilling data and results from physical simulation experiment, the structural deformation characteristics of the Puguang area in the Sichuan Basin were studied. Our results show that there are three main detachment layers at different depths in the Puguang area. The lower detachment layer, which is composed of middle Cambrian gypsum-salt rock, controlled the deep structural deformation system (\square_{2-3} -S). The mudstone at the bottom of the Silurian acts as the central detachment layer, separated while influencing both the bottom and the central structural deformation system (S-T_{1j}). The Triassic Jialingjiang Formation gypsum-salt rock forms the upper detachment layer, which mainly controls the shallow structural deformation system (T₂l-K). Different structural deformation systems have different degrees of structural deformation and relatively independent deformation styles. The deformation degree of the deep structural deformation system is relatively high, faults of this system cut through the Cambrian to the Silurian strata, forming a series of low amplitude thrust anticline; the central structural deformation system, which is sandwiched by two gypsum-salt rock layers, mainly brittle ductile shear zone, is characterized by high dipping thrust faulted anticlines with relatively larger amplitudes; the deformation degree of the shallow structural deformation system is relatively low, with narrow detachment anticlines and wide synclines developed, while a series of small pop-up structures superimposing on the overlying Jurassic sequences, and asymmetric highs and steep anticlines formed in local areas. Balanced cross section and physical simulation experiments show that the Puguang area suffered from superimposed compressional deformations originated from two directions, northeast and southeast. They represent the compressive stresses transmitted from the Dabashan orogenic belt in the northern margin of the Sichuan Basin and the compressive stresses transmitted from the Xuefengshan orogenic belt in the eastern margin, respectively. In addition, the rheological properties and the thickness of the detachment layer have important influence on the structural style.