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Tectonic inversion of strike-slip fault system and its effects on hydrocarbon trap development in the southern Dezful Embayment, SW Iran

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A thorough understanding of structural inversion and the positive or negative impacts of inversion tectonics on hydrocarbon trap development is crucial in geological investigations and petroleum exploration. To characterize the occurrence of inversion tectonics and its controlling effects on the spatial distribution of oil and gas fields located in the southern Dezful Embayment (SW Iran), this study describes the structural characteristics and deformation history of the Rag-e-Sefid oil/gas field and its surrounding areas through the structural and tectono-sedimentary analyses. Based on the results obtained from the integration of aeromagnetic, seismic, and well data, the strike-slip basement faults with the Pan-African or Arabian trend (N-S to NE-SW) and the Najd trend (NW-SE) modified the evolutionary history of the sedimentary basin in the southern Dezful Embayment. The geological interpretation of seismic profiles and the investigation of the geometry and thickness changes of the sedimentary layers across the growth structures indicate that the minimum time of the strike-slip faults formation with the Najd and Pan-African trends is related to the Neoproterozoic-Cambrian rifting of the northern Gondwana margin. These faults experienced activity at least during seven different extensional and compressional deformation events that include Cambrian rifting, Hercynian compressional deformation in the Late Devonian-Carboniferous, Permo-Early Triassic rifting, and Zagros orogeny cycle in the Late Cretaceous and Cenozoic. Three-phase inversion tectonics along the strike-slip basement faults occurred at the Late Devonian-Carboniferous (positive inversion), Permian-Early Triassic (negative inversion), and Late Cenomanian-Early Turonian (positive inversion) boundaries. Inversion affected hydrocarbon trap development at the Late Cretaceous and controlled the final geometry and distribution of the oil and gas fields in the southern Dezful Embayment. Considering the hydrocarbon migration from the Miocene to the present day and the strong sealing of the Gachsaran Formation (Early-Middle Miocene) in the southern Dezful Embayment, the inversion tectonics event has a positive impact on hydrocarbon trap development. Also, the activity of the segmented strike-slip basement faults with the Pan Africa and Najd trends has an important effect on hydrocarbon migration and charging. These faults control the channel of hydrocarbon migration and the horizontal and vertical distribution of oil and gas in the region. The results of this study could add data to worldwide examples of the positive impact of tectonic inversion on hydrocarbon accumulation in the foreland of a collisional orogen.

Keywords: Inversion tectonics; Strike-slip fault; Tectono-sedimentary analysis; Hydrocarbon trap; SW Iran