Structural style of the Kashan-Ardestan syn-tectonic sedimentary basin in Central Iran, Arabian-Eurasian collision zone

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The Kashan-Ardestan sedimentary basin in Central Iran was initially formed by back-arc extension due to the subduction of Neo-Tethys oceanic lithosphere beneath the Iranian Plate during Eocene time. Following rifting and the onset of the Arabian-Central Iranian continental collision in the Oligocene, the basin was infilled by a sequence of continental clastic and evaporitic sediments referred to as the Lower Red Formation. Post-rift cooling and thermal subsidence led to the development of a shallow marine environment for the accumulation of Qom Formation carbonates and shales in the late Oligocene–early Miocene. The Qom Formation is the most significant hydrocarbon target in Central Iran, containing both source and reservoir rocks. The continental collision triggered the reactivation of pre-existing normal and strike-slip fault systems. The basin was subjected to compressional tectonism during the deposition of the Miocene Upper Red Formation and overlying Plio-Quaternary sediments. This long-lasting and multi-episodic tectono-sedimentary evolution of the Kashan-Ardestan Basin has led to the formation of a complex structural style, which must be resolved before petroleum system modeling and drilling of prospects can take place.

In this study, several transverse and longitudinal 2D seismic lines were converted to depth and interpreted to define the deep-seated geometry of structures in the basin. The seismic lines were tied to the data from three exploration wells, reaching depths of ~ 4 km. In addition, ~ 15000 gravity and magnetic stations, covering the entire Kashan-Ardestan Basin, were integrated into our model.

The results of our study indicate that two major strike-slip fault systems, including the Qom-Zefreh and Ardestan faults in the south and the Gazu fault zone in the north, control the geometry and evolution of the Kashan-Ardestan Basin. In this basin, the rheological profiles of the sedimentary sequences control the folding style and deformation mechanisms. Both basement-involved and thin-skinned faults developed in the basin and formed different types of fault-related anticlines. The reactivation of pre-existing strike-slip faults has produced positive flower structures during compression. There is some evidence that the Navab Anticline in the SW developed as a forced fold, with basement involvement. In addition, several thin-skinned detachment folds are observed.
above the evaporites of the Lower Red Formation at the base of the sedimentary cover. The Lower Red Formation thins and pinches out toward the eastern limit of the basin, where the Qom carbonates directly overlie the Eocene volcanic basement. Meanwhile, the Upper Red Formation thins toward the north and northeastern limits of the basin, and towards the crests of anticlines. These syntectonic thickness variations allow us to define the geometric evolution of the Kashan-Ardestan Basin through geologic times, allowing for the burial history of the source rock and timing of trap formation at the reservoir level to be described.