Unravelling the Qara Dagh Anticline, Zagros Mountains, Southeastern Kurdistan Region of Iraq

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ABSTRACT

Qara Dagh is a very large and rugged surface anticline within the High Fold Belt of the Zagros Mountains of southeastern Kurdistan Region of Iraq. The anticline is long, linear and narrow, 60 km in length and 6-8 km in width. Elevation ranges from 700 m amsl in the adjacent valleys to 1700 m amsl along the ridges. Knowledge of the subsurface at Qara Dagh is limited. The rugged topography and a strong 3D aspect to the anticline have challenged 2D-seismic acquisition efforts and have led to generally poor imaging of the structural core. Two 2D-seismic datasets were acquired: 356 km in 2009 and 202 km in 2015. Although substantially improved, the more recent data did not fully resolve the ambiguity of the core. Cross-sections based on model-based structural interpretation of the seismic datasets, assisted by remote sensing and conventional field geologic methods are the primary interpretation techniques to understand Qara Dagh geometry and structural evolution. Its prospective area is over 70,000 acres and includes three stacked targets. Fractured carbonates of the Cretaceous Shiranish, Kometan and Balambo Formations are the objectives beneath a thickened shale top seal. Light oil was recovered from the Shiranish in the QD-1 well. Small amounts of geochemically similar oil flowed to surface in one of the 2015 seismic upholes. The anticline exposes rocks ranging in age from Early Paleogene to Late Neogene. In the eroded core of the structure, the oldest rock unit that crops out is the Paleocene to lower Eocene Kolosh Shale. Overlying and exposed on the interior rims surrounding the core are the Eocene Sinjar Limestone, Gercüs Shale and the high-ridge-forming Pila Spi carbonates. On the outer flanks of Qara Dagh are outcrops of: Oligocene Kirkuk carbonates; Miocene mixed clastic rocks, limestones and anhydrites of the Lower Fars Formation; and finally clastic rocks of the Mio-Pliocene Upper Fars and Bakhtiari Formations. The well and seismic data show that Tertiary units exposed at the surface are detached from those at depth by a series of intra layer décollement. Field geology shows that the anticline changes vergence along trend, from SW vergent in the south to NE vergent in the north part of Qara Dagh block. This change in vergence suggests potential compartmentalization at depth. The anticline can be interpreted alternately as a fault-related anticline or as a detachment structure. A hybrid wedge structure and detachment fold model best explains all datasets.