

Folding history of shale-cored anticlines in the South Caspian Basin

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The Caspian Sea is a Neogene basin associated with the Alpine-Himalayan collision and has one of the major sedimentary accumulations in the world. The South Caspian Basin in particular, comprises a thick (~ 10 km), fluvio-deltaic sequence, the Productive Series, deposited during the late Miocene to middle Pliocene (~6-3 Ma) over a rapidly subsiding crust of probable oceanic nature. The uppermost sedimentary cover is affected by numerous detachment folds cored by overpressured, organic-rich muds derived from the marine source rock of the Maykop Series; of Oligocene to Early Miocene age. The tectonic evolution of the South Caspian Basin triggered mud migration of the Maykop Series trapping oil and gas in anticlines structures. Major reservoirs are concentrated there in the Productive Series and the stratigraphic seal is a late Pliocene unconformity (~3 Ma) overlaid by the Akchagyl, Apsheron and Gelasian series.

Our study focused on the geometrical analysis of the folding history in offshore Azerbaijan. We use a post-stack 3D seismic cube tied with data from two exploration wells. The overall geometry of the Productive Series reflects low-dipping sequences of different delta systems propagating basinward, and sedimentary thickness is approximately constant. Fold geometries evolve along strike from symmetrical, gentle anticlines, to close, box-like folds that can host double-vergence reverse faults. Anticline culmination coincides commonly with an hour glass-like mud diapir, where mud ascent and extrusion in the upper tear created vertical welds.

Folding occurred simultaneously to mud diapir perforation and extrusion, with tilting and differential subsidence toward basin centre, whilst shortening rates vary along fold axis. Maximum shortening estimates are inferred in regions pierced by the overpressured mud and folding structures indicate a single, low-dipping detachment level at 9.5-11 km depth. A first major folding pulse occurred during the middle Pliocene (~3.5-3.1 Ma), toward the end of the deposition of the Upper Productive Series (Surakhany Suite). Folding rates decreased afterwards during the Late Pliocene, although a second, syn-growth folding episode occurred during the sedimentation of the Akchagyl Series (~1.5-1 Ma).

We implement also the algorithms to analyze in 3D this detachment folding-type that departs from the classic examples since punctuated deformation is accompanied by progressive tilting and differential subsidence between fold flanks.