Caspian Night
Petroleum Systems Dynamics of the South Caspian Basin

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The South Caspian Basin represents an extremely young petroleum system in which more than 26,000 ft (8 km) of sediment has been deposited in the past 6–10 million years, with up to 10,000 ft (3 km) in the last 1–2 million years. The high rates of deposition have pushed the sedimentary section into significant disequilibrium with respect to temperature and pore-pressure evolution. The basin dynamics are expressed in

1. rapid vertical and lateral pressure changes that challenge the capacity of seals to build and preserve petroleum columns; and
2. low temperature gradients, which delay petroleum generation and reservoir diagenetic processes.

Basin modeling has proved to be the key technology for understanding the South Caspian Basin dynamics and quantifying their impact on petroleum generation, migration and seal capacity evolution, as well as in assessing prospect drillability and field development options.

The Miocene Maykop source rock series is overlain by a group of world-class reservoir systems and extensive lacustrine shales, which are folded into extremely large anticlines. Depending on the regional extent of the sandstone "sheets," high pressure is transferred both regionally from the overpressured basin to the basin margins and semi-regionally from synclines to crests. This pressure transfer results in reduced seal capacity for petroleum accumulations and stacked pays. The complex regional aquifer pressure distribution can explain variations in fluid contacts observed in structures. The resultant low effective stress in the shallow section also creates substantial drilling and field development challenges.

From our early studies we learned that the sedimentation rate, aquifer extent and nature of the fine-grained sediments exert fundamental controls on pressure distribution. The complex interaction between the 3D connectivity of the high-permeability sediments (aquifers) and the 3D architecture of the low-permeability sediments (aquitards) can be best understood using integrated basin modeling simulation techniques. Our methodology is strongly based on the calibration of models to the observed pressures and temperatures in a number of exploration and appraisal wells across the Azerbaijan sector of the South Caspian Basin. ■