Deep South Caspian Petroleum System

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Abstract

The South Caspian and Trinidad and Tobago hydrocarbon basins are among the earliest developed petroleum provinces in the world, having >100 years of petroleum production. Some likeness between the young Oligocene-Pliocene petroleum systems of the South Caspian and Trinidad –Tobago basins came from similarity in tectonic evolution.

The South Caspian basin (SCB) is situated on the southern margin of Euarasia, in the central part of the Mediterranean-Himalayan folded zone. Its present geological setting and petroleum system formed from the Triassic-Recent interaction of the Eurasian, Indian and Arabian plates. The oblique collision (Oligocene-Present) between the Caribbean and northern South America plates resulted in folding and thrusting of rocks with accompanying basin uplift. Further sedimentation in the Trinidad Southern basin was governed by the progradation of the Orinoco delta associated with subsequent building of thick deltaic successions restricted by a series of trust faults.

Similarly, the main hydrocarbon production unit in the South Caspian basin is the Lower Pliocene Productive Series (PS) that was accumulated in a small, rapidly subsiding basin, and consists of a 8 km thick fluviodeltaic succession deposited at very high sedimentation rate (3 km/Ma). The burial history of the SCB central part is characterized by continuous sedimentation and stable subsidence from the Late Jurassic to present. Avalanche sedimentation during the Pliocene-Pleistocene (3mm/year) resulted in deposition of from 5 km on the flanks to 10 km of sediment in the central part Pliocene-Quaternary succession. The thickness of the sedimentary cover in the studied area is > 20 km.

Studies of superdeep wells and mud volcano ejecta allow understanding of the geological and thermal conditions down to 14 km, and testify to a good generation potential of the Oligocene-Lower Miocene and Middle-Upper Miocene sediments (Maycop and Diatom Series). For example, TOC is 12,39% and HI is 588 mg HC/gCorg in mud volcanic breccia. Kerogen type varies from II to III.

Being one of the “coolest” basins in the world with the very thick sedimentary cover, the South Caspian basin is characterized by the abnormally low recorded values of geothermal gradient ($1,3^0$C–$1,35^0$C /100 m). From T and R0 predicted values, oil and gas windows on the western shelf and continental slope are located in intervals 10-13 km and 13-14 km correspondingly; in the deep water zone, 10-16 km and 16-18 km; in the eastern shelf 10.5-12.5 and 12.5- 13.5 km. These intervals correspond to source rocks in the South Caspian basin (the Maycop and Diatom Series). Isotopic compositions of fluids testify to a wide temperature - pressure diapason of hydrocarbon generation and migration. Subvertical migration of hydrocarbon fluids along mud volcanoes channels and subvertical decompacted bodies traced to the basement, and lateral migration along porous and permeable laterally-connected sand bodies in some PS intervals are typical features of the South Caspian petroleum system basin.

Interplay of large river systems, rapid sea level and sediment supply changes in the Early Pliocene played an important role in the accumulation of reservoir rocks. Some stages of PS accumulation were characterized by considerable Caspian Sea level fall and basinwards progression of the PaleoVolga river system, providing good reservoir potential for these sediments in the distal part of the basin. Besides numerous large structural traps, the results of 3D modeling suggest the occurrence of lithological traps as a result of lithofacies heterogeneity of PS sediments in this part of the SCB. Existence of overpressure zones in the studied area enables preservation of reservoir quality in the deeply subsided horizons.

The well explored South Caspian basin could serve as a suitable analogue for less studied petroleum systems in Trinidad and Tobago petroleum province, for instance, ultra deep water Atlantic margin, where expected sedimentation of young Plio-Pleistocene sandstone reservoirs originated from the Orinoco river (K. Persad, 2008).