PALEOCENE PETROLEUM SYSTEM AND ITS SIGNIFICANCE FOR EXPLORATION IN THE SOUTHWEST LOWER INDUS BASIN AND NEARBY OFFSHORE OF PAKISTAN

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Overall exploration failure in the southwest Lower Indus Basin and near-shore area has generally been attributed to the absence of a working petroleum system. This paper is an attempt to show within a sequence stratigraphic framework that a Late Paleocene shelf margin systems tract (SMST) possesses organic, paleoenvironmental, maturity and sequence stratigraphic attributes characteristic of an effective source rock. Deep burial of Paleocene strata into the oil window and below has probably led to the generation of hydrocarbons as evident from oil/gas shows, 0.5-2.5% TOC and 0.5- 1.7 % VR in the near-shore wells.

Sedimentologic and regional stratigraphic observations from outcrop, coal-fields and well logs correlation show that the shelf margin built out by the Middle Paleocene Ranikot-1 to -4 highstands was extended basinward (westward) to form a regionally extensive ramp from Thar in the east to the Indus Offshore in the southwest, possibly under the combined effect of sea-level fall and subsidence. Subsequently, Ranikot SMST developed and contained marginal-marine lagoonal, marshy, fluviodeltaic and paralic siliciclastic systems. The organic richness of Ranikot SMST is probably related to the peat-forming environments in the east and overall increase in accommodation space towards top that led to the subsequent burial of extensive marshlands. From Thar in the east to Lakhra in the west, these Ranikot intervals exhibit, fair to good HI, perhydrous vitrinite and considerable proportion of liptinite macerals which qualify them for a potential hydrocarbon source. TOC, Tmax and VR of dirty coal and calcareous shales range between 1.5-18%, 379-433ºC, and 0.33-0.40% respectively.

Thermal maturity modeling of Karachi South -1A indicates that Ranikot sequences started oil generation in middle Oilgocene and reached the main generation phase in the Early Miocene. This section entered into the dry gas zone in the Middle Miocene and subsequently led to the thermal cracking of oil as evident from the presence of solid bitumen in siltstone-sandstone pore network of Ranikot in Karachi South-1A. A dummy well is modeled near Eocene carbonate shelf margin and these sequences again turn out to be in the main oil generation phase in Middle Oligocene. The section was pushed into the gas window in Early Miocene.

Stratigraphic correlation shows that within this hydrocarbon source-generation-charging system, the potential reservoirs can be provided by the Ranikot-3 & -4 paralic and turbidite sandstone bodies, shelf margin carbonate buildups (reefs) of the Ypresian Laki Sequence, and the slope fans (channel-levee complexes) and shelf edge deltaic topsets of the Nari-1 lowstand systems tract. We conclude that for any successful exploration program in this region, the timing of hydrocarbon expulsion relative to the time of structuration of the Paleocene-Eocene strata needs to be understood on a regional and prospect-scale in order to address reservoir charge and preservation of ‘paleo’ accumulations in Paleocene-Eocene stratigraphic and structural plays.