AAPG Datapages/Search and Discovery Article #90315 ©2017 Asia Pacific Region GTW, Oil and Gas Resources of India: Exploration and Production Opportunities and Challenges, Mumbai, India, 6-7 December, 2017

Electrical Characterization Of Low Resistivity Fresh Water Fluvial Reservoirs Of Krishna Godavari Basin, East Coast, India

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ABSTRACT

The Electrical characterization is essential for the application of appropriate conduction model for precise estimation of water saturation in reservoir evaluation. Determination of hydrocarbon saturation in fresh water fluvial reservoirs has long been a challenge because of the complexities of the electrical conductance mechanism varying in the range from Archie, non-Archie to a severely non-Archie behavior of electrical conduction where conventional shaly sand equation breaks down. This is mainly due to the small grains/pores with large surface areas exhibiting excess surface conduction in low salinity similar to clay/shale.

Model presented in this paper, incorporates two different formation factors to represent bound water associated with micro-pores in very fine/silty beds and free water in clean sands representing the extreme ends of a fining or coarsening upwards cycles of the deposition. Pseudo-Archie method has been used for precise computation of water saturation in these reservoirs where reduction of cementation ‘m‘ and saturation ‘n‘ exponents are allowed to find their own levels to take care of anomalous reduction of formation resistivity factor. Severely non Archie reservoirs are indicating linear relationship of cementation exponent with excess conductivity on core measurements, which in turn related with the shale/silt volumes. For the compensation of excess conductivity related with surface conductance phenomenon a relation has been developed, which allow ‘m‘ to change from ‘m‘ clean-sand to ‘m‘ shale, as a function of shale volume. As shale concept is based on fining of constituents grain size itself, it represents extreme facie exhibiting highest surface conductance phenomenon with ‘m’ close to unity (or less than one, in presence of clay) on lower salinity as derived from the boundary conditions of electrical core measurements.

In this paper, experimental basis has been evolved for the additional conduction with respect to Archie through a large number of geological and electrical core measurements of a completely cored low resistive reservoir section. The bulk conductivity of the fluvial reservoirs does not correlate to a significant degree with either the amount or the type of clay minerals in the rocks. Excess surface conductance phenomenon is identified on formation factor ratio with brine conductivity plot derived from these measurements. Same procedure has been extended to confirm the evidence of the surface conductance phenomenon on log motifs. Once evidence of surface conductance is established, co-variances of core measurements and log motifs has been evolved to establish possible inter relationship between different Archie parameters. Archie‘s cementation factor _m ‘decreases with shaliness/ grain size index. A linear regression of the data points in water bearing zone of the reservoir indicate volumetric average relationship, where cementation factor varies between the respective values of clean sand and shale beds. This relationship has been extended for the computation of water filled resistivity of the rock in hydrocarbon zone to compute water saturation. The results of extensive laboratory experiments, described in this paper, show that the use of two cementation exponents approach to characterize

electrical behaviour of fluvial reservoirs is substantially better than the conventional use of an average cementation exponent value and corroborates well with core derived water saturation.