Understanding Complex Fluid Contact Distribution in a Brown Carbonate Field-Mumbai High

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This paper presents a case study of an integrated and efficient methodology for establishment of complex fluid contacts in a large, heterogeneous, multi-layered carbonate brown field. The main producing reservoirs in this field exhibit unique behaviour in terms of fluid distribution. Whereas the gas-oil contacts appears to be consistent, the oil-water contacts encountered in different wells are found to be variable, in a stair-case pattern where it seems to be inclined down the structure. The case study focuses on the verification of fluid levels identified in different wells in the field with special emphasis on understanding the geological factors responsible for the variation of fluid levels. The study incorporates multi-scaled data analyzed and reviewed together to build a conceptual 'hydrocarbon accumulation model'. The study establishes that the hydrocarbon accumulation in this field is mainly controlled by the quality of the reservoir rock both vertically and laterally across the field and capillary forces above free water level, building the basis for a new saturation model. The good quality reservoir rock is characterized by the presence of secondary porosities in terms of vugs, moldic porosity etc., which is the result of intensive dissolution caused by freshwater meteoric invasion as suggested by core study results. This is also validated by the spatial distribution of reservoir quality from seismic inversion and fieldwise production distribution. The proposed conceptual model demonstrates the evolution of secondary porosity as a subtle interplay between sea level fluctuations and relief on the carbonate bank environment and how these, at a later stage, were filled with hydrocarbon. It explains the accumulation conditions within the framework of lithology, rock parameters, structure and fluid migration and is supported by reservoir data of the field.