Measurement of GOR and Compositional Gradients by Downhole Fluid Analysis for Reservoir Characterization and Connectivity Assessment: Case Studies from Offshore West Africa

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Presence of GOR gradients, compositional grading and depth dependent fluid property variations in hydrocarbon reservoirs has long been recognized. There are many published studies on theoretical and field aspects of compositional grading in hydrocarbon reservoirs - including several cases from offshore West Africa.

To use fluid gradients and compositional variation for reservoir connectivity assessment it is necessary to measure and map them during exploration and appraisal - so this knowledge can be incorporated in commercial decisions and development planning. A variety of data can be used to reveal presence of fluid property variations: GOR, CGR, saturation pressure, and fluid density at reservoir conditions. Traditionally this data came from PVT analysis of samples from DST's and formation testing in wells across a reservoir and sometimes multiple depths in individual wells. A new technology, downhole fluid analysis (DFA) has enabled determination of GOR and reservoir fluid gradients in the reservoir. DFA consists of conveying optical spectrometers and other sensors into wells, extracting reservoir fluids at known depths under controlled conditions and performing analysis of live reservoir hydrocarbons.
A significant part of formation evaluation in offshore West Africa reservoirs has required increasing application of downhole fluid analysis (DFA) using a pumpout wireline formation tester. The primary objectives being to obtain measurements of formation pressures, identification of the formation fluids, and capture of samples at multiple depths. Significant advances have been made which allow in-situ characterization of reservoir fluid type and composition, gas-oil-ratio (GOR), and the use and application of fluorescence measurements.

In this contribution we compare and demonstrate the utilization of measurements from wireline downhole fluid analysis and formation tests from offshore West Africa and other deepwater petroleum systems. Depth dependent fluid property variation from fluid gradients, GOR, PVT properties, asphaltene science and fluid models are compared and discussed. Guidelines are presented on how to interpret wireline pressure and DFA measurements in multilayered systems, and perform reservoir connectivity and compositional gradient assessment. We describe how to improve on these interpretations by performing more advanced formation testing procedures; some of which are based upon new and emerging technology.