An Integrated Formation Evaluation Approach to Characterize a Turbidite Fan Complex – A Case Study from the Falkland Islands

Graham Davis, Rob Newbould, and Aldo Lopez (Premier Oil)

Bob Engelman, Ron Balliet, Sandeep Ramakrishna, Andrew Imrie, Zunerge Guevara, and Hamid Hadibeik (Halliburton)

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The oil and gas potential of the basins surrounding the Falkland Islands has attracted exploration drilling which resulted in the discovery of the Sea Lion Field in the North Falkland basin in May 2010. More recent exploration drilling has resulted in new oil discoveries to the south of the Sea Lion Field which has not only confirmed the area as a significant hydrocarbon province but has also boosted the chance of commercializing the resources of the North Falkland Basin. The primary oil targets are stacked and amalgamated deep water lacustrine turbidite fans with each fan comprising multiple lobes. In exploration and appraisal wells, porosity characterization, permeability assessment, pressure measurements and hydrocarbon fluid identification, are essential input data for robust reservoir characterization and resource estimations.

A comprehensive suite of advanced logging measurements, in addition to conventional log measurements, have been used to facilitate data analysis and calibration to laboratory core measurements. The pressure gradients and fluid samples obtained from formation testing when combined with the wireline log measurements are critical in determining the thickness, quality, and connectivity of hydrocarbon zones, which in turn impacts the commercial evaluation of the well. In these remote offshore basins where rig costs are high, the ability to focus data acquisition in specific zones of interest, minimize the logging time whilst identifying and reacting early in real time to data points that lie off the expected trends can add significant value to the operating company.

Formation evaluation challenges include hydrocarbon identification, estimating oil viscosities, and resolving fluid contact uncertainties. In addition establishing whether there are any baffles or barriers in the system or significantly varying reservoir properties as a consequence of facies changes has the potential to complicate the evaluation in respect of permeability characterization and volume estimation.

A method of facies classification using a combination of resistivity-based borehole imaging data and nuclear magnetic resonance (NMR) data is outlined in this paper. This method, when combined with conventional log data, has shown encouraging results in terms of identifying lithofacies and determining a rock quality index. The mud logs and gamma ray logs were interpreted with the borehole image logs in these turbidite reservoirs which resulted in the identification of four distinct depositional lithofacies. These lithofacies were integrated with the Free Fluid Index (FFI) to Bulk Volume Irreducible (BVI) ratio determined from the NMR data. The FFI to BVI ratio was used as an index for rock quality index (RQI) classification. The RQI, was subsequently used to optimize formation pressure testing and sampling points.

The contribution and importance of lithofacies identification is typically ignored when optimizing formation pressure depths and interpreting the results. The methodology presented in this paper uses an integrated workflow jointly developed by the Operator and Service Company that allowed detailed reservoir evaluation in the zones of interest and real time adjustments to the data acquisition programme that enabled rig time savings and consequently reduced overall formation evaluation cost.