Paper 10

High resolution facies description from vintage dipmeter logs, a case-study from the Betty Field, offshore Sarawak

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The upper cycle V sediments of Betty Field comprise of clastic reservoirs that are primarily homogeneous shoreface deposits. However, there are heterogeneities primarily related to biogenic structures and rip up clasts in a few poor quality sandstones. High-resolution log data and borehole azimuthal coverage from dip meters and image logs facilitates identification of small-scale depositional heterogeneity and is essential for a precise three-dimensional geological model that predicts true reservoir behaviour. This study illustrates an approach to improve the reservoir characterization of the field by quantifying small-scale heterogeneities using dip meter data. Old dipmeter data such as High Resolution Dipmeter (HDT) and Stratigraphic high Resolution Dipmeter (SHDT) commonly logged prior to the introduction of image logs namely FMS, FMI or OBMI have the potential to provide in-depth textural and fabric information. Textural analyses derived from micro-resistivity variations have been used for one well in the Betty field to demonstrate the methodology and to emphasize the optimized use of the dipmeter data in extracting detailed sedimentary information in a quantified way. Fine scale heterogeneities in some of the clastic lithofacies of Betty reservoirs generated by the presence of intense bioturbation, rip up clasts, heterolithic bedding, or massive/homogeneous characters could be detected from these dipmeter logs without any associated images. This valuable information could be obtained through the application of a new suite of Geology software developed for the exploration and production industry which comprises of the fabric/texture analysis module BorTex*.

In a field-wide perspective calibration with cores, however, is essential to validate the dipmeter signatures with actually observed sedimentary features. This was done as a case-study in the Betty Field where vintage dipmeter logs were digitized, and analyzed to detect fine textural heterogeneity, which was later calibrated with the core-description.

The formation heterogeneities are extracted quantitatively based on conductivity variations using BorTex where the dense features are detected as resistive anomalies, and argillaceous features are detected as conductive anomalies. Based on the high resolution dip meter micro-resistivity channels from the key well, Betty-5, the proportion of conductive and resistive heterogeneities was mapped around the borehole wall which when compared to the core image and description correlated very well with observed sedimentary characteristics. The lack of any heterogeneity, i.e., intervals with least active HDT logs matched very well with homogeneous structure-less to very poorly stratified amalgamated sandstone lithofacies representing shoreface deposits. Intervals with high proportion of conductive anomalies with highly active HDT logs, relates to intensely bioturbated sandstone as seen in the core. Higher proportion of conductive heterogeneity as calculated by the textural analysis also correlated well with storm related event beds, which has clay rip-up clasts at the base of the units. The last two lithofacies represent deposition in lower shoreface to an offshore transitional environment. Conductive heterogeneity proportions are also high in bioturbated mud dominated heterolithics, which represents deposition in open marine inner neritic/shelfal environment. Positive resistive anomalies from the textural analysis, on the other hand, correlated well with open-marine massive shales with siderite nodules, which mark flooding events or end of deposition of individual parasequences.

This novel technique has great potential to bring added value from old dipmeter logs which otherwise are nearly forgotten. Fine-scale near wellbore geological heterogeneity is reflected as electrical heterogeneity and is recognizable in these dipmeter and image logs. The specific domain to benefit would be the asset-teams looking for additional data to constrain their facies models and facies geometries. The insights gained from similar dipmeter analysis has the potential for providing quantitative information that can directly be used in property or facies modeling in a fieldwide context. The dipmeter based log motifs have to be calibrated, however, with core observations before populating the information fieldwide. Because of the large vertical resolution contrast between cores and conventional logs, extrapolation of fine depositional heterogeneity into uncored wells using a traditional approach would be unconstrained. The availability of textural analyses in a multi-well scenario and their subsequent use in lithofacies estimation would reduce model uncertainties before up-scaling. The degree of improvement in the ability to identify and quantify geological heterogeneity will have significant implications for future coring, logging programs, and reservoir characterization efforts especially in marginal fields.

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