INTERPRETATION METHODOLOGY OF RESISTIVITY LOGS IN GRONINGEN CONDITION

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Introduction

Proper calculation of water/hydrocarbon saturation from the apparent resistivity recorded by electrical logs is still a problem in reservoir formations drilled by boreholes filled with very conductive mud, where in the vicinity of reservoir exists highly resistive bed. The problem arose when records of different types resistivity logs were analyzed in the Groningen hydrocarbon deposits, Netherland (Andersen, 2001). Many constructional, modelling and interpretational solutions were tested in the long time period between 60 to now (Król, 2002; Yang et al., 2007; Drahos and Galsa, 2015; Szijártó et al., 2017, Xiao-Wei et al., 2017). In the paper there are presented various outcomes obtained by Geofizyka Toruń S.A. for proper hydrocarbon saturation determination in the Main Dolomite deposits in Polish Lowland. There is illustrated the long history of efforts directed to make proper exploitation decisions in wells where Groningen effect was observed, starting with standard measurement and interpretational approach, through modified construction of reference electrode in the laterolog device and ending on examination of HRLA (High Resolution Laterolog Array) results.

Geological setting and data sets

The examples are from the Polish Lowland (Fore-Sudetic Monocline) Permian formations where the sequence of high resistivity salts and anhydrites are present over and under the Main Dolomite, Zechstein Limestone and Rotliegendes hydrocarbon productive formations (Mamczur et al., 1997; Piesik-Buś, 2018) Thickness of salts ranges between 30 - 600 m, anhydrites between few meters to 300 m, and productive beds between 13–85 m (Górski et al., 1996). There were considered sedimentological conditions (facies) of the Main Dolomite, thickness of reservoir, porosity and permeability of the selected parts of the productive bed as regards relation to resistivity values. The depth of casing bottom over the porous/permeable formation was also checked to analyze the possibility of current flow in the borehole (salty mud) and formation and consider the shape of current lines beam mainly influencing the recorded resistivity values.

Resistivity logs and porosity-lithology-saturation solutions from 42 boreholes on BMB reservoir were available for technical analyses, qualitative description of resistivity anomalies and interpretation results checking.

Results

Recorded apparent resistivity and interpreted water/hydrocarbon saturation on the basis of true resistivity from different probes measurements were examined. Selected solution illustrating the positive interpretation result being the basis for decision about production is presented in Fig. 1.

Conclusions

Differences observed in the examined geological structures and various combinations of technical and geological conditions met in the wells are the reasons that the obtained results are not repeatable. It is very difficult to present an unique methodology for measurement and processing of resistivity logs in the Groningen effect case. Description of technological efforts together with geological structural analysis paid for obtaining the positive result as regards hydrocarbon potential determination is the basis for establishing proper acquisition and interpretation rules in difficult environment condition. Applying the newest records (HRAL curves) into known laterolog resistivity correction procedures is testing the ability of improving the water/hydrocarbon saturation determination in the Groningen effect case on the basis of available solutions.

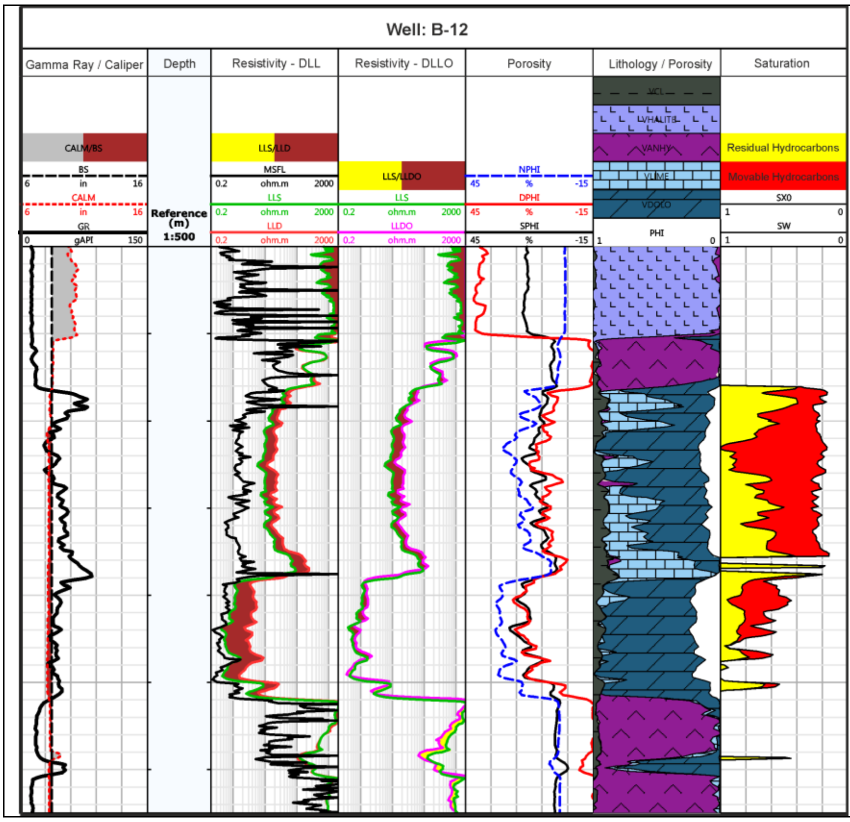

Figure 1. *Sample of positive recognition of the hydrocarbon saturated Main Dolomite deposit, standard dual laterolog (LLD and LLS) and MSFL (microresistivity) curves and laterolog with the modified construction (LLDO); visible curve separation as indicator of pay zone; VCL, VHALITE, VANH, VLIME, VDOLO - volumes of clay minerals, halite, anhydrite, limestone and dolomite, respectively.*

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