

Facies Analysis and Permeability Estimation In late Cretaceous Giant Carbonate Reservoir Using LWD Technology: A Case Study in Sabriyah Field, North Kuwait

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Abstract

Sabriya Mauddud original development plan was based on an inverted 9 spot pattern to produce oil from multi carbonate reservoir layers. Recently, Kuwait Oil Company (KOC) implemented a paradigm shift to an intensive campaign for drilling horizontal wells in the Mauddud Formation in North Kuwait. The lateral section extended for a long interval penetrating different facies of the Maudud carbonate reservoir. The need for advanced formation evaluation was highlighted as critical where the complex pore structure will play a big role in fluid mobility.

Formation mobility in carbonate reservoirs has been always a challenge in any formation evaluation. The Sabriya Mauddud Formation is a ramp system, ranging from shallow restricted and barrier shoal / rudist buildup to outer ramp sedimentation. Mauddud carbonate is divided into two parts, a lower (Maj-MaG/F), belongs to outer to middle ramp dominated with intermittent influxes of Burgan delta shoreface sandstone sediments. The upper Mauddud (MaF to MaA) is inner ramp, barrier shoal / rudist build up and shallow restricted Packstone/Grainstone facies. The best reservoir quality is in the inner / middle ramp and barrier shoal / rudist build-up facies of MaE, MaD, MaC and MaB. The current strategy in Mauddud development plans is to produce high (MaB/MaC) and inject low (MaE/MaD).

The LWD resistivity was used in this field to measure resistivity (Laterolog type) to calculate water saturation. In addition, due to the fact that LWD tools measure while rotating, several resistivity images with different depths of investigation were also available in real time and recorded mode.

In this case, the LWD resistivity imaging was used to study azimuthal formation porosity distribution in order to quantify the different porosity portions (Primary / Secondary). Following that, an empirical equation was used to determine formation permeability profile. This qualitative profile is calibrated to the formation pressure / mobility with high vertical resolution to enhance permeability calculations compared to derived permeability from standard open-hole logs.

Facies determination were obtained based on porosity spectrum, amount of secondary porosity combined with relevant logging results using neural network technique. This is significant to optimize well placement in the best reservoir rock types (grainstones, rudist build up and packstones). This has been proved as successful technique for horizontal well ICD completion compartmentalization design.