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Integrated Well Logging Technologies to Identify Viscous Hydrocarbons: Shallow Carbonate Reservoir Case Study, West Kuwait

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ABSTRACT

The objective of this paper is to demonstrate advanced petrophysical technology integration for identification and characterization of viscous hydrocarbon leading to discovery and production of heavy oil from a new carbonate reservoir in West Kuwait. The Tayarat Formation of Cretaceous age is a 1000ft thick unit forming a north dipping gentle homocline at depth of 3000ft in Abduliya field. Presence of hydrocarbons was indicated in old well logs recorded in the wells targeting deeper reservoirs. In order to fulfil West Kuwait's strategic objective of appraising its heavy oil resource base, a vertical well was drilled in Abduliya for the production appraisal of Tayarat reservoir. The drilling plans incorporated comprehensive well logging, conventional coring and wireline formation pressure testing and sampling. Advanced suite of well logs included acquisition of Nuclear Magnetic Resonance (NMR), Elemental Spectroscopy, Cross Dipole Sonic, in addition to resistivity and acoustic images. The NMR data indicated presence of 85 feet thick oil zone in Tayarat with an equally large transition zone. The oil type was identified as viscous heavy oil using NMR cross plot between diffusivity and T2 measurements. The comparison between NMR and conventional logs porosities demonstrated NMR porosity under-call, which supported the identification of viscous oil. Based on the log interpretation, the heavy oil and water samples were successfully acquired using dual packers' wireline tool along with reservoir pressure measurements. The Mineral Spectroscopy log identified lithology to be mainly limestone and minor clay with the exception of lowest part of Tayarat, which included some dolomite, anhydrite and quartz. Excess carbon identified using this technique further confirmed the presence of heavy hydrocarbons. The stonely wave permeability showed reasonable match with the permeability derived from NMR as well as with the mobility measured during wireline formation testing. The Dipole Acoustic data identified porous zones where the stonely reflectivity shows significant separation between high and low reflectance demarcating the vuggy zones. Direct observations on core and image logs confirmed these petrophysical analysis and interpretations. Combining well logging results with core observations helped in developing assurance to carry out prolonged production testing leading to successful production appraisal of the new heavy oil reservoir.