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The Impact of Geophysical Well Log Analysis (GWLA) on a Clastic Rock Physics Analysis

Omar H.Afif[1], Muhammad Ashfaq[1]

[1]Saudi Aramco, Dhaharan, SAUDI ARABIA

ABSTRACT

Geophysical well log analysis differs from conventional log analysis in many aspects. In the seismic world, the zone of interest is always much larger than just the hydrocarbon producing zones. The seismic data is based on the acoustic impedance (density*sonic velocity) contrast between different subsurface layers. Therefore, it is vital to quality control and condition the density and sonic logs data before using them to generate the synthetic seismograms for well-to-seismic calibration. The log conditioning exercise becomes even more challenging when logs are acquired using different tool vintages from different service companies.

The density and sonic logs are usually affected by borehole washouts and mud filtrate invasion. Sonic cycle skipping due to borehole rugosity is quite common. In these cases, the tool records velocities that appear too low, so the subsequent velocity interpretation is misleading. Before any analysis, density spikes due to borehole washouts need to be checked and edited appropriately. Sometimes, in old wells the density and shear sonic data are limited to a particular zone and therefore require the logs to be estimated over the missing intervals. To estimate missing logs, a robust tailored workflow is needed for each zone due to the varying elastic properties within the zones. The main goal of log conditioning is to prepare optimum quality data to use successfully in quantitative seismic reservoir characterization.

Different cross-plots and histograms were used in this study to quality control the density and sonic data for four wells over multiple reservoirs. Badhole flags were generated to identify erroneous readings. Using appropriate transforms with calibrated local coefficients, different approaches were adopted to predict sonic and density log values over the missing zones. The estimated logs were then spliced with original logs to produce continuous log data from surface to the total depth. A petrophysical model was developed and used to compute porosity, fluid saturations and lithologies. Eventually, different rock physics models were implemented to establish a relationship with the predicted logs. The rock physics bounds, which define the physical limits of different minerals and fluid mixtures, were used to quality control and validate the measured and corrected/estimated logs over the zone of interest in all wells. The workflows developed in this study can also be used for future projects of a similar nature.