Case History of Automated Evaluation of Mineralogy and Porosity in Complex Carbonates

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Significant oil and gas reserves in the U.A.E., Qatar, and elsewhere occur in carbonate formations containing anhydrite and quartz disseminated within calcite and dolomite reservoirs. Accurate evaluation of mineralogy in these complex carbonates, while critical to computing porosity, hydrocarbon density and well-to-well correlation, is challenging when a conventional logging suite is used. The problem is that the number of unknowns in the formation exceeds the number of available independent measurements.

Mineralogy evaluation of a complex carbonate in the well studied was greatly improved when nuclear spectroscopy logs were incorporated into the evaluation. These logs measure calcium, sulfur and silicon which directly map to the key mineralogical components – carbonates, sulfates (anhydrite) and quartz / chert. The resulting evaluation was far more accurate when compared to mineralogy evidence from core samples obtained on the same well.

Many such carbonate reservoirs have formation waters with salinity in excess of 200,000 ppm. Drilling fluids used to drill the well also have high salinity. In order to reduce the environmental effects on the neutron porosity log, an epithermal neutron porosity tool was run in the subject well. We demonstrate through comparison to core data the improvement in the accuracy of porosity evaluation through the use of epithermal neutron data.

We show that the combination of nuclear spectroscopy and epithermal neutron porosity improves both the accuracy and the precision of porosity and mineralogy evaluation. Detailed uncertainty analysis further substantiates the accuracy and precision improvement in lithology and porosity through the use of these measurements.