Novel Approach for Improved Formation Evaluation and Saturation Estimate Behind Casing for Gotnia Formation Using New Advanced Inelastic and Capture Nuclear Spectroscopy Technique

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ABSTRACT

Gotnia Formation comprises of alternating halite and anhydrite with limestone intercalations, is traditionally considered as regional seals for lower Jurassic hydrocarbon bearing reservoirs. Sharp contrast in lithology of halite-anhydrite and high pressure in interbedded limestone layers make this formation extremely challenging to drill and evaluate. Casing is set immediately after drilling, limiting open hole data acquisition. Due to complex lithology and low porosity, a comprehensive acquisition and interpretation methodology was required to further characterize and assess the potential of this formation. Recent hydrocarbon discovery over these formations has opened up new limits for explorations and enabled new characterization techniques for the evaluation behind casing. The technique provides a robust and accurate total organic carbon (TOC) estimate taking advantage of the recent advances on the inelastic and capture gamma ray spectroscopy measurements of the pulsed neutron logging tool. It differs from the well-known approach of using carbon-to-oxygen ratios that is most often applied in cased-hole evaluation. The main advantages of this new method are that it does not require knowledge of formation water resistivity, it does not rely on a resistivity model, it does not require an extensive calibration database, and it is largely independent of the lithology effects. The petrophysical interpretation consists of first computing element dry-weight fractions from which the lithology of the Gotnia units and their alternating Halite and Anhydrite layers are derived. The novel approach uses the directly measured TOC to estimate Hydrocarbon saturation. The inorganic carbon in limestone within Gotnia units is estimated by using the elements from this logging tool (Ca, Mg, Mn, Fe) and the value is subtracted from the measured total carbon to give TOC from which the Hydrocarbon saturation is derived. The logging parameters applied to the logged Gotnia interval are optimized to minimize uncertainties and the precisions on the TOC which is around 0.5 - 1.0 wt%. The saturation derived using this method was compared to the offset wells' evaluation with a very good agreement. The technique has provided a safe and practical solution for a comprehensive evaluation and saturation estimate of the Gotnia formation, shedding the light on its reservoir potential.