5.2 POTENTIAL USE OF SONIC DATA FOR ROCK TYPING AND GEOSTEERING IN BIOTURBATED CARBONATE STRATA

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ABSTRACT

Earlier work showed that bioturbation can impact the reservoir quality of the Upper Jurassic Hanifa Formation in central Saudi Arabia which consists of burrowed and non-burrowed carbonate strata. While permeability varies drastically between the bioturbated and non-bioturbated strata, their porosity and minerology are very similar. This introduces a challenge in differentiating between the different rock types based on conventional well logs. This study investigated the impact of bioturbation attributes (intensity, expressed here as burrow percentage, BP and burrow-fills) on the sonic velocity of these carbonate strata. The ultimate goal is to find an sonic-derived approach to perform rock typing in such bioturbated rocks. Burrowed units were classified as highly bioturbated rocks (UB unit with BP > 15%) and rocks with low BP (LB unit with BP range of 2–15%). On the other hand, the non-burrowed strata were classified as NB unit. Seventy-seven core plugs were extracted from these three units and were characterized using different laboratory techniques including petrography, petrophysical measurements of porosity, permeability, and velocity, as well as computed tomography scanning to estimate BP. The laboratory analysis results were complemented by rock-physics modeling. Examining the permeability–porosity and velocity–porosity relationships of the combined dataset, we observed a noticeable scatter which could be explained largely by variations in BP: samples characterized by BP of > 15% (UB samples) have higher permeability and compressional velocity at any given porosity compared to LB and NB samples. These observations are explained by two factors. First, bioturbation created pathways for diagenetic fluids which resulted in the stronger cementation within the host microporous matrix (in UB samples) compared to the weakly cemented microporous matrix (LB and NB samples). Second, burrows are filled with grainy sediments characterized by dominant macro interparticle, moldic, and vuggy pores, which result in higher velocity in UB samples compared to microporosity dominated samples of LB and NB. The experimental velocity–porosity data and the pore type observations were consistent with rock-physics modeling which was also utilized for rock typing. This work shows an example where sonic data can be used to perform rock typing and assist the geo-steering by differentiating between good reservoir quality rocks (UB unit) and other non-reservoir zones (LB and NB units). This is particularly important given the similarities between all three units in terms of mineralogy and porosity.

KEY WORDS : Rock-physics, Carbonates, Rock-Typing, reservoir quality, bioturbation.