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Some Effects of Petrophysics and Geomechanics in Unconventional Reservoir Stimulation, New Zealand

J. Salazar* (Baker Hughes), C. Rabe (Baker Hughes), R. Filho (Victoria University of Wellington)

Summary

This work compare different methodologies in order to select the best sweet spot for hydraulic fracturing and stimulation. After analyzing the results, a hydraulic fracture design, zonation selection and perforation modeling were performed. The geomechanical model indicated a strike slip fault regime with high pore pressure (using Undercompaction), high fracture gradient and high tectonic stress.

Introduction

Geomechanics and petrophysics have important roles in the selection of the technique that is most appropriate for oil and gas well stimulation in unconventional reservoirs in order to reach the maximum productivity of a hydraulic fracture. They are responsible for the selection of the optimum reservoir stimulation zone, fracture design (geometry, conductivity, spacing), fracture containment (length vs. height, depletion) and critical stress (breakdown, fault reactivation), once the mineralogy, TOC, reservoir pressure, elastic properties, stresses (magnitude and direction), directly affect the stimulation design.

Method

In this work, a hydraulic fracture design, zonation selection and perforation modeling were performed. The results indicate that the Whangai formation is a clay of non-calcareous origin composed by around 20% sand, 10% limestone and 70% clay with a content of organic matter between 0.5% and 2% (Figure 1).

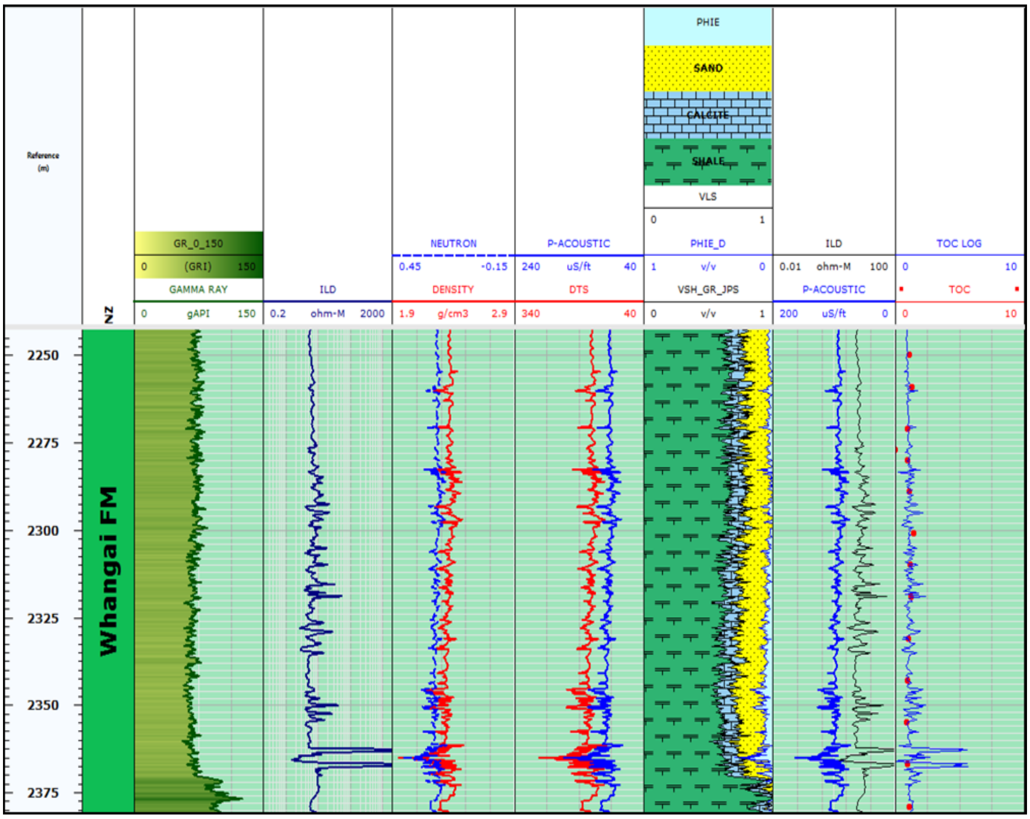

Figure 1 *Petrophysical evaluation of the Whangai Formation. Red dots in the seventh column represent the side cores used to calculated the TOC in the lab.*

The geomechanical model indicated a strike slip fault regime with high pore pressure (using Undercompaction), high fracture gradient and high tectonic stress. The Whangai fm. presents in some intervals (selected to navigate the horizontal section) an excellent brittleness index (BI) using both Petrophysical and geomechanical parameters. The BI estimations indicate that the best interval for reservoir stimulation is in the middle of the Whangai Formation between 2224 mMD and 2365 mMD in Rere-1 well. These conclusions are derived from the higher Young's Modulus, Lower Value of Poisson's Ratio, High Pore Pressure, High Internal Friction Coefficient, Higher content of siltstone, lower content of mudstone and good quantity of TOC in certain intervals (Figure 2). The BI methodologies using geomechanical parameters give higher values than the methods using mineralogy and TOC, with very low discrepancy of P_{10} and P_{90}.

Conclusions

The design shows an increase in the drainage area due to reduction of the tortuosity with perforations with azimuth of 800 when comparing with azimuth of 100 due to a reduction in the stress contrast in the area around the perforations. Fracture dimensions using DFN modelling reaches 300 fts of length with 110 fts of height (one wing). Perforating with high azimuth (close of SHmax) presented lower tortuosity, lower fracture initiation (breakdown pressure) and fracture link-up, with higher fracture length, with lower effects on fracture height.

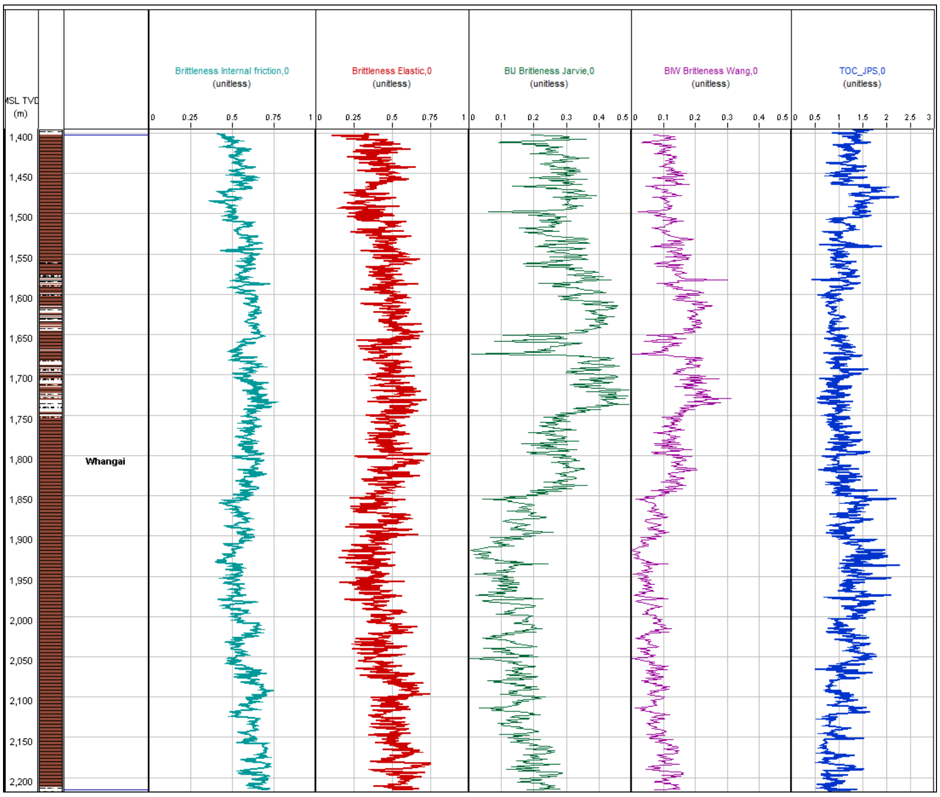

Figure 2 *BI comparison and best interval (1497-1750 mMD) for Hydraulic Fracturing Stimulation – Rere-1 well.*

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