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Technology Applications in Unconventional Resources: A Case Study on Use of Microseismic and Supplementary Surveillance for Hydraulic Fracture Monitoring in the Jafurah Basin of Saudi Arabia

Clay Kurison[1], Huseyin Sadi Kuleli[1], Ali Al-Sultan[1], Saad Al-Shehri[1], and Ahmed Mubarak[1]

[1]Saudi Aramco

ABSTRACT

An optimized field development plan in any unconventional reservoir requires understanding several parameters such as hydraulic fracture half-length, stage contribution, lateral well spacing and effective drainage area. The Jurassic Tuwaiq Mountain formation in the Jafurah Basin of Saudi Arabia has been actively appraised. Today, Saudi Aramco's unconventional program in Jafurah Basin is progressing towards pilot/development.

One of the challenges is estimation of the resultant hydraulic fracturing stimulation geometries, and fracture propagation behavior. To address this challenge, a multi-well pad was planned and drilled with three 5,000 feet horizontal lateral wells in the Tuwaiq Mountain formation. The wells were placed at varying lateral spacing and targeted different stratigraphic interest zones within the TQMN. All wells underwent multi-stage plug-n-perforating completions with hydraulically fracturing involving two stimulation designs with distinct slurry volumes but same amount of proppant.

Different hydraulic fracturing stimulation design parameters were validated through the microseismic (MS) monitoring with some showing clear correlations between the fracturing treatment job size and resulting microseismic fracture geometry. While microseismic fracture mapping was the primary focus of this study, other diagnostic/surveillance techniques such as chemical and oil tracers, inter-well pressure interference during fracturing, and downhole pressure gauge measurements during production were utilized to assess the hydraulic fracturing treatments. Chemicals tracers were used to provide a measure of stage contribution and also inter-well hydraulic fluid communication to validate micro seismicity; recorded pressure interference was used to provide possible fracture communication and validate microseismic geometries. The integration of different and independent surveillance technologies allowed for a more comprehensive understanding of fracture propagation and geometry in this complex environment.

This study showed how microseismic monitoring can be used for evaluation of the efficiency of effective stage isolation, upper ends of hydraulic fracture geometries, and how the targeted reservoir was accessed during the stimulation operation. These results have proven valuable in completion design optimization and provision of insights for field development planning.