Role of Geomechanics and Integrated Reservoir Characterization in Production Enhancement from a Heterogeneous Carbonate Reservoir: A Success Story from Kuwait.

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ABSTRACT

The subject upper Cretaceous carbonate formation has been characterized as a heterogeneous reservoir with varying facies and petrophysical properties. Distribution of facies strongly varied not only with depth, but also laterally across the field. Upper part of the reservoir is dominated by natural fractures whereas lower part is predominantly argillaceous with mud enrichment. In addition, presence of laminations and vugs enhanced the heterogeneity of the reservoir. Very few wells were drilled and some of them were fractured. This paper demonstrates how geomechanical and integrated reservoir characterization has shown value in well placement strategy and achieved record hydrocarbon production. 1-D models quantified the distribution of rock mechanical properties and pore-pressure as well as present day principle stresses. In addition, these models were integrated with geological model as well as seismic data to generate a 3D geomechanical model. Finally, the 3D geomechanical model combined present day in-situ stress and pore pressure magnitudes, mechanical properties of all rock facies and natural fracture occurrences at field scale. A thorough well production analysis was also performed to validate the role of natural fractures during production. Some natural fracture subsets were identified that are optimally oriented to become critically stressed at present day stress regime. Upon further analysis, a new parameter “Index of Critically Stressed Fractures (iCSF)” was created that captured the spatial distribution of networked fracture sets in 3D model that are geomechanically favorable for fluid flow. Number of geomechanical sweetspots were identified at field scale and correlated these areas with other data. It was also recommended to stimulate wells with certain practices. After this analysis, a new horizontal well was drilled with geomechanical preferences across iCSF rich locations in the field. Integration of geomechanical models with production analysis and natural fracture indicators delivered value in identifying geomechanical sweetspots that have potential to flow. Distribution of these sweet spots provided a strategy for well placement as well as stimulation. In addition, this paper also exhibits logical integration of findings from geosciences and engineering disciplines to make informed decisions on well planning in order to maximize the production from challenging reservoirs.