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Modeling Fracture Networks During Exploration Stages; A Case Study from West Kuwait

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ABSTRACT

The quest to have the ability to predict the location and orientation of highly fractured areas in reservoirs that produce mainly from fractures is at its climax, as oil companies develop the remaining hydrocarbon assets. Today discrete and continues fracture network models depend on mathematical equations to resolve complex fracture heterogeneities. These mathematical models are largely confined in being either stochastic or deterministic, each having its advantage and disadvantage. Geomodelers may combine these techniques to create a hybrid model to resolve complexities and overcome the disadvantages of each technique. The remaining challenge is, how good is the prediction. Normally this will take drilling a new well to know if the model is correct or not, this could be too late. This paper will introduce a novel fracture network modeling technique that takes advantage of the mathematical equations used today in modeling and guide fracture distribution based on structure kinematics and relative fracture aging. This may seem similar to the deterministic approach, but it is not. This technique focuses on building a conceptual geological model that runs through time, similar to structural restoration, and ages of fractures are noted and classified separately. The importance of having the age of the fracture system identified especially in carbonate reservoirs, is because of diagenesis. The model also takes into consideration the paleo-and-present day stress regime identifying areas of compression and extension. This novel approach was applied on a field in Kuwait before drilling a key well in a new exploration area. The model predicted that the new area has an extensional stress regime through its tectonic history increasing the chance of having open fractures. The general fracture trend of all six wells along with 3 dimensional seismic data shows a predominant NNE-SSW natural fracture trend, however the novel technique predicted that the new area has a predominate ENE-WSW. The key well was drilled in the analyzed area and fracture information obtained from borehole image logs showed an ENE-WSW orientation as predicted by the model. The fracture density over the target reservoir also matched the initial prediction. These results increased the confidence in this technique and demonstrates that fracture modeling needs to be done after structural and geological complexes are fully understood and analyzed.