AAPG Datapages/Search and Discovery Article #90319 ©2018 GEO 2018 13th Middle East Geosciences Conference and Exhibition, Manama, Bahrain, March 5-8, 2018

Uncertainty Assessment in Fractured Reservoirs through an Iterative Approach in Fracture Modelling

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ABSTRACT

Fracture model is an integral part in developing a fractured reservoir. It allows for more rigorous analyses related to reservoir production. Discrete fracture network (DFN) modelling approach is often adopted as a tool to estimate the hydraulic properties of fracture networks in reservoir models. The inputs are typically acquired from well data, but many parameters are unconstrained and mere conceptual. As a result, fracture permeability and porosity in the reservoir model inherent large uncertainties. Efforts in addressing such uncertainties, however, are hindered due to the intense computing required for DFN, especially for a large-scale reservoir model. To overcome this challenge, we combined a rock typing approach and DFN into a coherent workflow. Implicit fracture modelling through rock typing offers a qualitative approach similar to facies model. The approach is efficient and effective to conduct hundreds of realizations for uncertainty assessments in large-scale reservoir models. In our approach DFN models are constructed to represent each identified rock type. The model size is set equal to the grid cell-size in reservoir model to allow direct implementation in the later stage. Furthermore, executing hundreds of DFN realizations at small scale is effective, especially to account for a stochastic-approach and other uncertainties related to fracture characteristics. In our findings, determination of intrinsic fracture permeability has the largest impact on fracture permeability, whilst fracture shape has less impact. The stochastic approach in DFN modelling introduced large variations in the permeability value, depending on the fracture intensity. To assess the uncertainties related to the fracture distribution, all identified rock types are then distributed within the larger sector model or full-field reservoir model. Geological concepts are implemented to base the fracture distribution. Cases from DFN results are then implemented in the reservoir grid to define the fractures hydraulic properties scenarios. Dynamic modelling is then used as a validation tool to iteratively select cases that are geologically robust with good history matching results. In our case study, the fracture distribution is mainly related to faults. Dynamic simulations suggest differences in fracture network characteristics for the up-thrown block compared to the down-thrown block. Several iterations were then conducted to fine tune the fracture model for production forecast.