Using Forward Modelling Geomechanics for Driving Generation of Reservoir Scale Discrete Fracture Network Models

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Abstract

This paper summarises an approach centred on the use of adaptive Finite Element (FE) forward modelling techniques combined with the Discrete Fracture Network (DFN) method to provide a geologically robust mechanism for the prediction of the pattern of natural fracturing away from well control. This workflow provides a powerful means of understanding the evolution of natural fracturing on the reservoir scale, which can then be used for understanding fluid migration mechanisms as well as helping guide field development strategies. The adopted forward modelling approach is full 3D and integrates the geometry, boundary kinematics, and constitutive descriptions of the reservoir rocks. The methodology is iteratively fitted to the present-day deformed configuration in terms of structural style and geomechanical conditions. The workflow combines the geomechanical restoration results with data from well fracture logs to provide foundation of the DFN description. Well scale fracture descriptions are uniquely combined with a mixture of geomechanical, geological and geophysical information derived using DFN data analytics techniques. The strategy provides reliable prediction of the primary DFN parameters (intensity, orientation, size) throughout structurally complex reservoir units. The framework permits construction of reservoir scale models, where upwards of 500 million natural fractures can be explicitly included in the description. Validation of the approach is afforded on multiple levels. Firstly, considering the prediction of geomechanical conditions, as well as blind prediction of fracturing patterns, such as those observed on well logs or on outcrops provides a means of verifying fracture geometry. Secondly, reservoir flow is

simulated on the forward model based DFN description to ensure that the hydraulic characterization of the fracture network fits with transient well test and production information. Using the described strategies permits geologically more accurate fractured reservoir descriptions, in structurally complex environments, to be efficiently developed ahead of upscaling to conventional continuum reservoir flow simulators.

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