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Integrated Upscaling and History Matching of Fractured Reservoirs

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Small-scale fractures, either induced or naturally occurring, are of great importance in geothermal reservoirs. A common way of handling small-scale (or diffuse) fracture networks, is to upscale the fracture network properties to a dual-continuum model, where the rock and the fluid-filled fracture network behave as separate, interacting continua.

Simulation models of fractured reservoirs are commonly adjusted after some time of production, to match observed field data. This is done either through Bayesian methods or residual minimization methods. Traditionally, the history matching procedure makes adjustments to the upscaled parameters, i.e. the permeability, porosity and heat transfer coefficient. By doing this, one may generate model parameters that are inconsistent with the underlying fracture description of the reservoir. The same problem may occur in two-phase, dual-continuum reservoirs.

In this work, we show in which situations inconsistent model parameters may be created, and what the consequences are. Our proposed remedy is to use fracture parameters as primary variables during history matching, and include fracture upscaling as an integral part of the history matching workflow. For this purpose, we demonstrate the effectiveness of analytical upscaling methods.

We compare our proposed methodology with the traditional approach using both simple synthetic models and a more complicated dual-continuum synthetic field case. Our proposed method is seen to give a consistently better history match, while also preserving consistency with the underlying fracture model.