Geophysical Research Abstracts
Vol. 19, EGU2017-14395, 2017
EGU General Assembly 2017

Efficiency and accuracy of equivalent fracture models for predicting fractured geothermal reservoirs: the influence of fracture network patterns

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Frequently, flow and transport in fractured geothermal reservoirs are modeled using discrete and continuum fracture models. In discrete fracture models, each fracture is represented explicitly based on unstructured grids, which increases greatly the computational effort. In continuum models, e.g., equivalent fracture models, the hydraulic properties of fractures are averaged on coarse grids, which are often applied for the field-scale modeling.

We use and compare both discrete and equivalent fracture models for predicting the field-scale temperature distribution in fractured geothermal reservoirs. We assess the efficiency and the accuracy of the equivalent fracture models regarding the influence of fracture network pattern: In one model fractures are parallel to the axes of the model, another one contains also non-parallel fractures. We use the OpenGeoSys and SHEMAT-Suite codes for discrete fracture modeling and for equivalent fracture modeling, respectively. For equivalent fracture modeling, both the classical finite volume scheme and the mimetic finite difference scheme are used for solving the flow equation. The Oda method is used for computing permeability for equivalent fracture models. For the non-parallel fracture network, the equivalent permeability tensor contains off-diagonal components.

Our simulations show that the equivalent fracture models remain computationally efficient with changing fracture pattern. The temperature at the production well turns out to be less sensitive to fracture pattern variations compared to the discrete fracture model. And the equivalent fracture model yields efficient and accurate results in case of dominating parallel fractures.