Abstract

Economic Impacts of Fracture Patterns on Geothermal Productivity

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Geothermal heat has the potential to provide low-carbon, renewable electricity that could replace baseload generation historically provided by fossil fuels like natural gas or coal. Sandstones that have experienced protracted or deep burial offer widespread targets in the U.S. and worldwide for geothermal development, even where produced water is below 150 °C. Many sandstones produce gas or water with high effective well-test permeability. These responses likely reflect the effect of open fractures on permeability. Fractures are small or difficult to characterize in the subsurface. I used outcrop fractures that are analogs to those in the subsurface to provide insight into fracture network characteristics. I mapped fracture spacing in outcrops of Cambrian Potsdam sandstone, a unit in New York that is targeted for geothermal heat production. Guided by my outcrop data and other examples from the literature, I investigate the potential economic effects of pre-existing fracture networks by simulating production temperature for reservoirs with a range of fracture geometries using CMG STARS, a thermal compositional reservoir simulator. I used resultant temperature production profiles as input into techno-economic simulations to observe the magnitude of effects on annual electricity generation and levelized cost of electricity (LCOE). Results show that permeability is a key factor and that highly interconnected fractures can significantly delay thermal breakthrough, leading to improved reservoir economics compared with less interconnected fractures that might still sufficiently enhance permeability. In my field example, the connectivity of an initially favorable network was reduced by quartz cement deposits in narrow fracture connections, showing that protracted thermal exposure can degrade fracture permeability and limit geothermal production potential. While it is impossible to eliminate uncertainty regarding subsurface fracture

characteristics, site-specific core observations can partly discriminate favorable and unfavorable targets.

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