
102-1 - Booth No. 55: MODELING THERMAL FLUX THROUGH A NORMAL FAULT DAMAGE ZONE WITH ENHANCED PERMEABILITY: IMPLICATIONS FOR GEOTHERMAL ENERGY PRODUCTION



Monday, September 23, 2024



8:00 AM - 5:30 PM



Hall D (Anaheim Convention Center)

Booth No. 55

Abstract

Geothermal energy supplies less than 2% of the renewable energy produced in the US. Geothermal resources have been limited because traditional systems require natural fluids, high permeability, a seal, and high heat flow. Most such systems are located near tectonic boundaries or magmatic bodies and consist of fractured hot wet rock. However, most non-magmatic heat sources are concentrated in deeper hot dry rock (HDR) systems that lack sufficient fluids and permeability. Fault damage zones, volumes of fractured rock adjacent to faults, may have sufficient heat flow but lack sufficient permeability. To address this limitation, energy can be extracted from HDR thermal reservoirs by an Enhanced Geothermal System (EGS). EGS greatly reduces geographical limitations on geothermal energy in the US, especially because so many normal faults in the Basin and Range Province are associated with high heat flows.

EGS uses directional drilling and hydraulic fracturing (HF) to create a cylindrical channel of high permeability. Cold fluid is pumped into the channel by an injection well, gains thermal energy in the channel, and is drawn out by an extraction well to be used to generate energy. The channel has a fluid flux that is highest in the center and decreases radially because just as permeability in a damage zone decreases with distance from the fault, permeability in the channel decreases with distance from the borehole.

We investigate fluid flow and thermal flux within a simplified EGS by modeling the system as an hydraulic fractured cylindrical channel. The model consists of nested cylinders with radially decreasing permeability and radially increasing thermal conductivity (rock is more conductive than water). We use Matlab and Simulink to solve the coupled partial differential equations governing thermal and fluid flow. We use Darcy's law to determine the fluid flux as a function of distance from the borehole and the heat equation to determine the thermal flux as a function of the distance from the borehole. These results allow us to determine the total thermal flux flowing out of the system at the extraction well.

This allows us to investigate the impacts of differing permeability and radii ranges on the productivity of the theoretical system.

Geological Society of America Abstracts with Programs. Vol. 56, No. 5, 2024
doi: 10.1130/abs/2024AM-401014

© Copyright 2024 The Geological Society of America (GSA), all rights reserved.

Author



Isabel Garcia
Trinity University



Benjamin Surpless
Trinity University

View Related
