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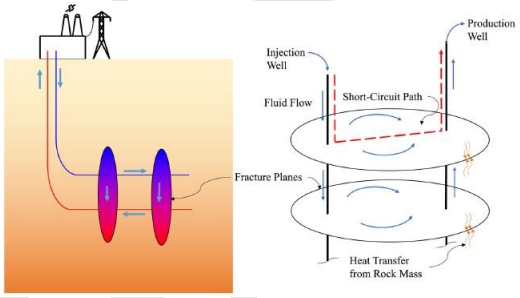
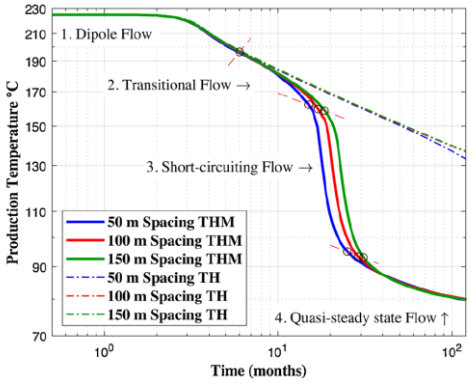


UNPACKING PERFORMANCE PROBLEMS IN GEOTHERMAL SYSTEMS

Robert Gracie and Maurice Dusseault

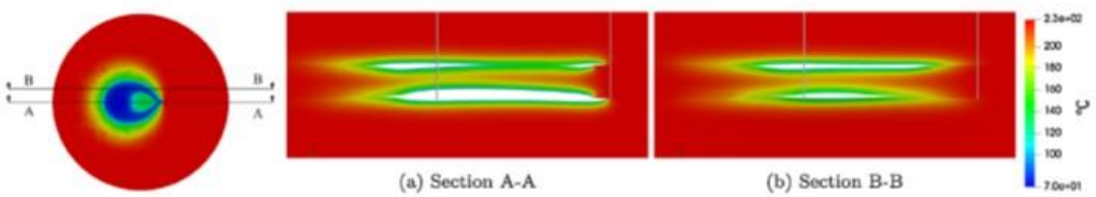
Enhanced geothermal systems (EGSs) take advantage of heat deep beneath the Earth's surface, forcing water through an engineered set of fractures at high pressure. The resulting steam can then be used to generate electricity or to heat buildings. However, this complex process is vulnerable to short-circuiting— a positive feedback loop in which the thermal contraction of cooled regions of the reservoir leads to increased fluid flow through these regions and diversion of fluid away from warmer regions – which can drastically reduce the efficiency of an EGS.



Bruce Gee, Robert Gracie and Maurice Dusseault set out to understand how this happens. The WISE researchers started by creating a custom Thermo-Hydro-Mechanical (THM) mathematical model and Finite Element Analysis software for both single-facture and multi-fracture EGSs.

Next, they ran their models through simulations that examined fluid temperature, fluid velocity and the evaluation of fracture aperture over time. They also considered the effects of spacing between fractures and the diameter of well casings. According to their results, short-circuiting appeared within 36 months in single-fracture systems and within 12–24 months for multi-fracture systems.

The modelling revealed important insights. For example, it demonstrated how the effects of flow channelling — a common cause of short-circuiting — are worse in multi-fracture systems. Meanwhile, the researchers identified



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two new short-circuiting mechanisms: plane channeling, where flow is increasingly directed through a single path, and bifurcation, where short-circuiting pathways are split in two.

EGSs have the potential to efficiently harness geothermal energy; however, improving their performance requires addressing short-circuiting. This research will help engineers and operators design systems that mitigate that risk and enhance overall production.

Researchers: Bruce Gee, Robert Gracie, & Maurice Dusseault

Partners: Natural Sciences and Engineering Research Council of Canada, Ontario Ministry of Research and Innovation

Source: Gee, B., Gracie, R., & Dusseault, M. (2021). Multiscale short-circuiting mechanisms in multiple fracture enhanced geothermal systems. Geothermics, 94, 102094.

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