PROCEEDINGS, 50th Workshop on Geothermal Reservoir Engineering
Stanford University, Stanford, California, February 10-12, 2025
SGP-TR-229

Simplified Fracture Model for Numerical Simulation of EGS: A Utah FORGE Case Study

Piyush Kumar Kumawat[1], Palash Panja[1, 2], Wencheng Jin[3], Lynn Brendon Munday[4], Robert Podgorney[4], Evan Earnest[5], Eric R. Upchurch[5], Mark Tozzi[5], Milind Deo[1, 2], John McLennan[1, 2], Joseph Moore[2]

[1]Chemical Eng. Dept., University of Utah, Salt Lake City, UT 84112

[2]Energy and Geoscience Institute, Salt Lake City, UT 84102

[3] Texas A&M University, College Station, TX 77843

[4]Idaho National Laboratory, Idaho Falls, ID 83415

[5] Chevron Corporation, Houston, TX 77002

piyush.kumawat@utah.edu

Keywords: Utah FORGE, Enhanced Geothermal System, Discrete Fracture Network, Circulation, Planar Modelling

ABSTRACT

The Utah FORGE (Frontier Observatory for Research in Geothermal Energy) project is a leading initiative to advance Enhanced Geothermal Systems (EGS) technology by using hydraulic fracturing. The project conducted a 10-stage stimulation, employing variable cluster spacing and diverse stimulation techniques. In a 30-day circulation test performed in August 2024, the results showed significant fracture connectivity and about 90% fluid recovery, emphasizing the effectiveness of the stimulation strategy. To understand reservoir behavior, numerical modeling with a representation of the fracture network is essential. One of the widely adopted approaches is the use of Discrete Fracture Network (DFN) models, which integrate microseismic event (MEQ) data, core samples, and well logs to provide detailed fracture characterization. DFN models are best suited for representing the system's geologic attributes. However, performing numerical simulations using these DFN models may require substantial computational resources. This study introduces a simplified planar fracture model, developed based on strain measurements during stimulation obtained from Distributed Strain Sensing (DSS). This computationally efficient method aims to replicate reservoir behavior using a uniform grid representation. This planar fracture modeling approach was first validated by comparing simulated inlet pressure data against DFN models. While field observations revealed transient operational variability and reservoir heterogeneities, the planar model effectively simulated thermal response in the history matching of the 30-day circulation test. This study shows the usefulness of simplified planar models for history matching and enabling EGS system simulations.

1. INTRODUCTION

The Utah FORGE project is a dedicated research initiative aimed at advancing EGS through the development and testing of stimulation technologies for geothermal energy. Located near Milford, Utah, the project targets a low-permeability granitic basement reservoir at temperatures exceeding 430°F (Allis et al. 2016). Utah FORGE has drilled eight wells, including two highly deviated wells, 16A(78)-32 and 16B(78)-32, which form a doublet system to evaluate EGS feasibility through hydraulic stimulation (Asai et al. 2018). These wells drilled between 2020 and 2023, span vertical depths of 6,000–8,000 ft and feature advanced monitoring systems, including fiber optics and geophones, for real-time data acquisition (Liu et al. 2025).

The project's stimulation program commenced in April 2022, with three fracture stages conducted in well 16A(78)-32. These initial stages used slickwater and crosslinked CMHPG fluids, incorporating proppants such as microproppant and silica sand to assess fracture initiation and propagation (McLennan et al. 2023). Data from these stimulations, monitored through MEQ and fiber optics, guided the drilling of the production well, 16B(78)-32, in 2023. This second well, located 300 ft above and parallel to 16A(78)-32, was designed to intersect the stimulated fracture network. Following its completion, multiple circulation tests demonstrated rapid pressure connectivity between the wells but highlighted challenges such as low outflow rates, attributed to fracture network recharge (Niemz et al. 2024). The project transitioned to a multistage stimulation program in well 16A(78)-32, comprising 10 stages with varying cluster spacing (45-75 ft), fluid viscosities, and proppant types. Ongoing analyses of MEQ and fiber optic data continue to refine fracture characterization, guiding future stimulation designs and enhancing EGS technology development (England et al. 2025)

The DFN model is a critical framework for representing complex fracture systems in geothermal reservoirs. At the Utah FORGE, the DFN integrates MEQ data, core samples, and fiber-optic measurements to provide a detailed depiction of natural and induced fractures. MEQs offer valuable insights into fracture geometry, orientation, and spatial distribution, while fiber-optic sensing captures high-resolution variations in temperature and acoustic signals, highlighting fracture connectivity and fluid flow pathways. This integration enables DFN models to simulate the behavior of fracture systems, including branching, termination, and flow dynamics. By leveraging both deterministic features such as large, well-characterized fractures and stochastic approaches for regions with limited data, DFNs are designed to capture the complexity and variability of fracture networks within the reservoir Cao and Sharma 2023; Finnila 2024; Finnila et al. 2021, 2023)

In contrast, we define the planar fracture model as a simplified approach to fracture representation that does not explicitly account for a complex fracture network. For clarity, throughout this work, we refer to the complex fracture network as a DFN, whereas the simplified planar models are termed *planar fracture models*. Fractures are discrete and could be parameterized to represent a more complex system by choosing appropriate properties. The planar models do not disregard the presence of natural fractures but instead account for their effects indirectly by adjusting formation properties such as permeability within a matrix continuum framework. This approach assumes that the influence of natural fractures can be represented through bulk formation properties rather than explicitly modeling individual fractures. While planar models are computationally efficient and effective in scenarios where fractures are largely localized and align with planar hydraulic opening modes, they may fall short of capturing the true complexity of fracture systems in reservoirs with significant branching or interconnected fractures. Thus, the justification for using a DFN depends on the specific reservoir conditions, particularly whether the fractures are localized or highly interconnected (Mcclure 2023; Mcclure et al. 2024).

In the subsequent subsection, the focus will shift to a comparison of planar fracture and DFN modeling approaches, examining their respective strengths and limitations. It should be noted that the DFN approach is always geologically more representative. Parametrization as proposed here may be effective under the right conditions with the right set of parameters.

EGS modeling: DFN vs. Planar fracture models

The choice between DFN models and planar fracture models could be a critical consideration in EGS modeling. While DFN models offer a detailed representation of preexisting fractures and their interactions with hydraulic fractures, planar fracture models simplify fracture representation, assuming predominantly planar propagation (Mcclure et al. 2024) However, the planar model overlooks the reality that was observed in the reservoir during geologic study and well log analysis. These approaches differ significantly in terms of assumptions, computational approach, and applicability. Planar fracture models have emerged as simpler to DFN models, with minimal branching or termination. This approach accounts for the effects of natural fractures by adjusting matrix properties, such as permeability, rather than explicitly modeling individual fractures.

DFN models possess significant advantages, particularly in applications requiring a detailed and realistic representation of fracture networks. Their strength lies in accurately capturing the geometry, orientation, and connectivity of fractures. This level of detail makes DFN models highly effective for reservoirs characterized by extensive branching and termination, where the complex interactions between fractures play a critical role in governing fluid flow and heat transfer dynamics. However, in order to study long term circulation, DFN models requires high computational resources.

Planar fracture models provide a simpler and alternative to DFN models. Their ability to comply with simplified computational approach makes them less resource-intensive and suitable for large-scale simulations. By focusing on bulk properties such as permeability, planar fracture models offer a streamlined representation of fracture systems, eliminating the need for explicit modeling of individual preexisting fractures. This makes them an effective choice in scenarios where the fracture propagation is largely planar and where computational efficiency is a priority.

The Utah FORGE site is actively investigating the applicability of DFN and planar fracture models in crystalline basement lithologies. Recent studies include:

- **Dense DFN Models**: Incorporating hundreds of preexisting fractures (Xing et al. 2023).
- **Intermediate DFN Models**: Using tens of fractures to balance complexity and efficiency (Munday and Podgorney 2024; Podgorney et al. 2023).
- **Planar Models**: Assuming planar propagation without discrete preexisting fractures (Mcclure 2023; Mcclure et al. 2024).

Currently, two distinct approaches are common in geothermal reservoir modeling and are widely utilized in commercial applications. The first emphasizes the complexity of DFNs, attributing significant influence to natural fractures to capture intricate fracture interactions. This approach often uses explicit modeling of discrete fractures, requiring fine time steps and detailed computations, leading to higher computational demands. The second approach simplifies fracture representation by focusing on stimulated fractures that develop perpendicularly, often disregarding the role of natural fractures.

Since the first stimulation in 2023, simulations were conducted on the DFN model developed by (Finnila et al. 2023)., with Podgorney et al. 2023 performing thermo-hydro-mechanical simulations. These efforts focused on fluid flow and transport using FALCON (Fracturing And Liquid CONvection), a geothermal reservoir simulation code within the Multiphysics Object-Oriented Simulation Environment (MOOSE), developed by Idaho National Laboratory (Podgorney, R. et al. 2014.). Similar work was carried out by Munday and Podgorney 2024, where they used field circulation data from 2023, for numerically testing conceptual models using the finite element method. These simulations demonstrated the potential of MOOSE in capturing complex reservoir behaviors.

In order to expedite computational time with a different computational approach, the finite volume method, Mcclure 2023 introduced calibration parameters to match three-stage stimulations with a planar fracturing model. Building on this foundation, Mcclure et al. 2024 conducted numerical simulations of six-stage stimulations. These simulations made testable predictions regarding the number of fracture hits, the size and shape of fractures, flow rate uniformity, and the rate of thermal degradation during long-term circulation. However, DSS data from stimulation hits revealed a shared fracture corridor, emphasizing the importance of accounting for field-specific complexities.

Therefore, this study adopts a novel strategy to develop planar fracture networks by integrating DSS data obtained from stimulation. By focusing on a simplified planar modeling approach, the proposed work aims to achieve efficient history matching without compromising the essential characteristics of the fracture system. The methodology begins with a hypothesis to evaluate two distinct fracture network representations within the same finite element simulation environment in MOOSE. Following the hypothesis, DSS data were subsequently incorporated to construct a full-scale fracture network with planar fractures, which was further utilized for numerical simulations using the commercially available thermal reservoir simulator CMG STARS, developed by the Computer Modeling Group (CMG) in Calgary, Canada.

2. NUMERICAL MODELING

To highlight the comparison between the DFN and planar fracture models, we conducted a series of simulations. The DFN used for this comparison was developed by Finnila et al. (2023) based on MEQ data, employing a methodology that fitted 2D hexagonal features to the microseismic point cloud. The DFN (Fig. 1, left) was compared against a planar fracture model (Fig. 1, right). For the planar fracture model, four planes were defined based on the projection of the production well intersecting four points within the DFN. The simplicity of the planar fracture representation facilitated the comparison. Detailed model specifications can be found in Podgorney et al. (2023). Under consistent conditions, including matrix and fracture properties, fluid flow simulations were performed to evaluate the inlet pressure response. It should be noted that planar models do not disregard the presence of natural fractures but instead account for their effects indirectly by adjusting formation properties, in this case, it is surface area.

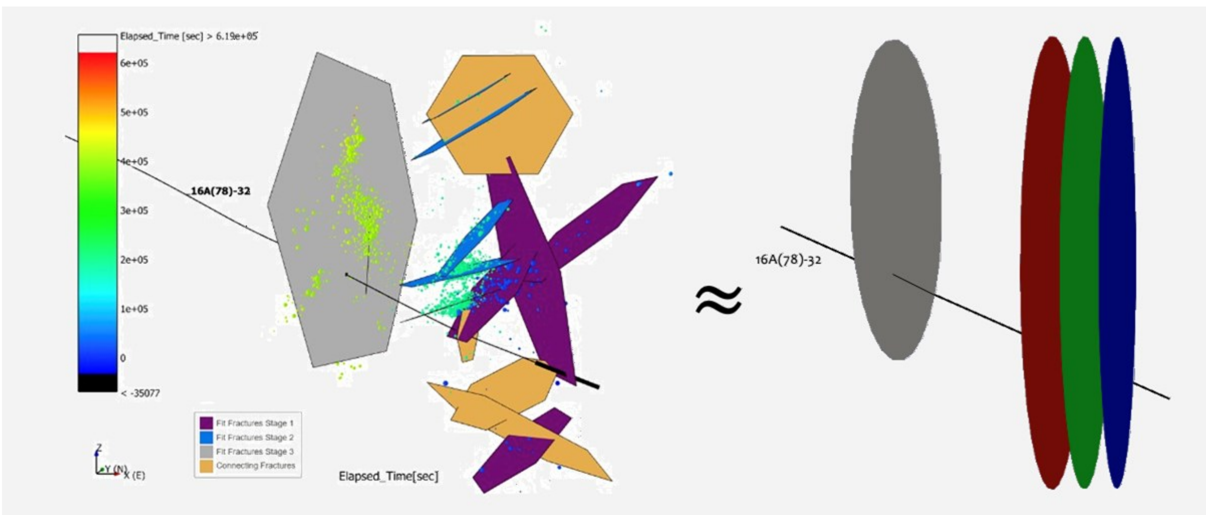

Figure 1. (Left) DFN model for well 16A(78)-32, derived from MEQ data. Points represent MEQs, and the planes are fitted among those and categorized within three fracture stages

The results presented in Fig. 2 (right) create a hypothesis that planar fracture has ability to represent DFN. It should be noted that mechanical coupling is not considered in this case. This hypothesis was based on the premise that planar fractures, mapped using perforation and hit data, could effectively capture the dominant pressure responses of the reservoir without explicitly modeling complex fracture interactions. For the initial 3-stage model, we utilized MOOSE due to its flexibility of creating geometry and examine them using the finite element method suited for DFN and planar fracture modeling .

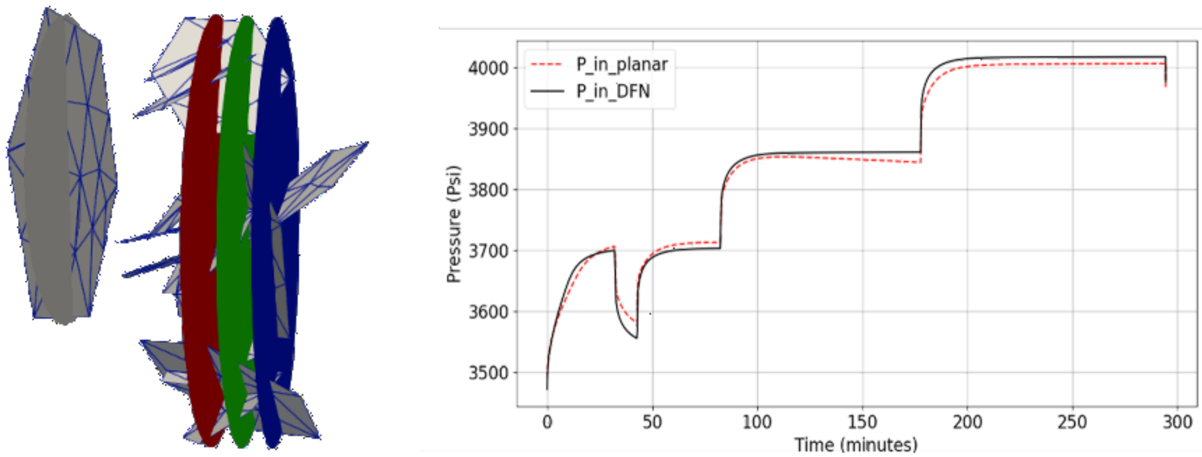

Figure 2. (Left) A juxtaposition of the DFN model (meshed) and planar fracture model (colored), illustrates their structural differences. It is important to note that the models were not simultaneously used during simulations. (Right) A comparison of inlet pressure results from simulations using the planar and DFN models, with arbitrarily varying flow rates applied in both cases.

2.1. Overview of Utah FORGE circulation test, connectivity, and interaction between wells

To model the circulation test, we use only the fracture corridors identified using DSS. Thermal simulations were performed using a thermal simulator from the Computer Modeling Group. Using CMG, we implemented a uniform grid and integrated planar fracture representations derived from field data. This allowed for direct comparisons of pressure and temperature responses under equivalent reservoir conditions.

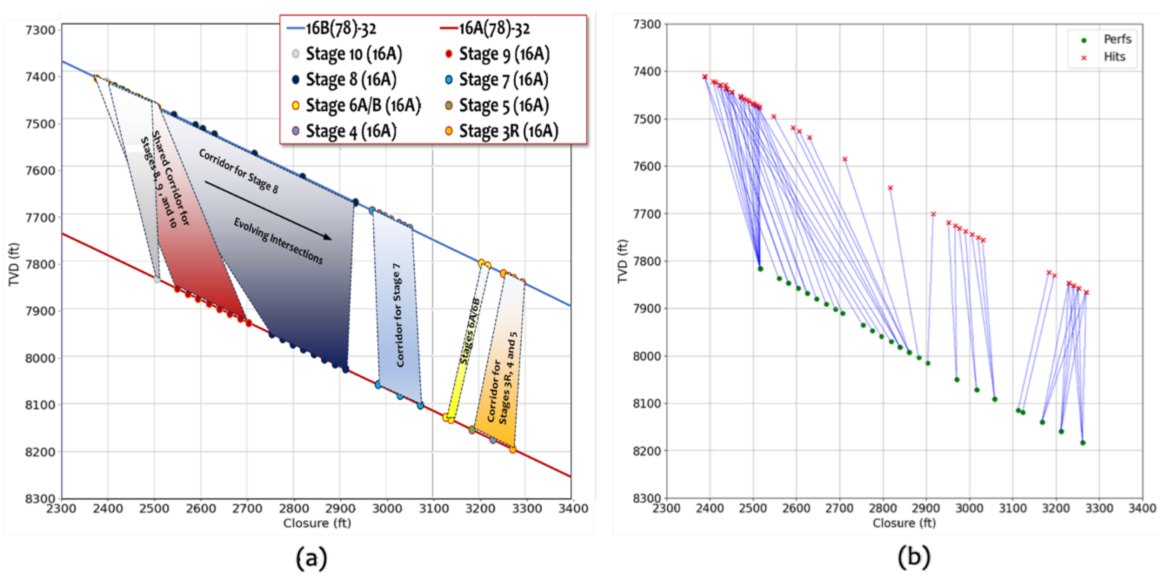

Figure 3. Fracture corridor between 16A (lower line) and 16B (upper line); (a) Schematic representation of fracture corridors for various stages, indicating evolving intersections and stage-specific corridors. (b) Set of 57 planar fractures obtained from matching perf to hits.

2.2 Full scale modelling

In modeling a full 10-scale model for the Utah FORGE reservoir using CMG STARS, a uniform grid size was employed across the entire simulation domain to simplify computational requirements while maintaining consistency in fracture characterization. Fig 3 (b) fractures were mapped using perforation (perf) locations and their corresponding hits, as derived from field data, mainly DSS. Each perforation location was used as the initiation point for fractures, and the hits, representing the fracture intersections or stimulated zones, were mapped spatially to define the fracture path. This mapping process involved creating a direct correlation between the perf locations and hits by assigning specific grid cells along the fracture path with enhanced permeability and porosity values. These properties were calibrated to replicate the observed pressure and temperature data from the field. The use of a uniform grid allowed for consistent modeling of fluid flow and heat transfer while ensuring that the planar fractures derived from the data were seamlessly integrated into the reservoir model.

In the CMG model, fractures are represented with a simplified planar approach, where the aperture is approximated by the block size of 1 ft. To match the observed reservoir pressure responses, the permeability in the CMG model is tuned to varying conductivity of fracture. This tuning ensures that the transmissivity aligns with the hydraulic behavior observed in the DFN characterization by EGI, data is available on GDR (https://dx.doi.org/10.15121/2440870.), allowing the CMG model to replicate the fluid flow dynamics of the reservoir accurately. providing a simplified yet reliable representation of fractures for the simulation of the Utah FORGE reservoir.

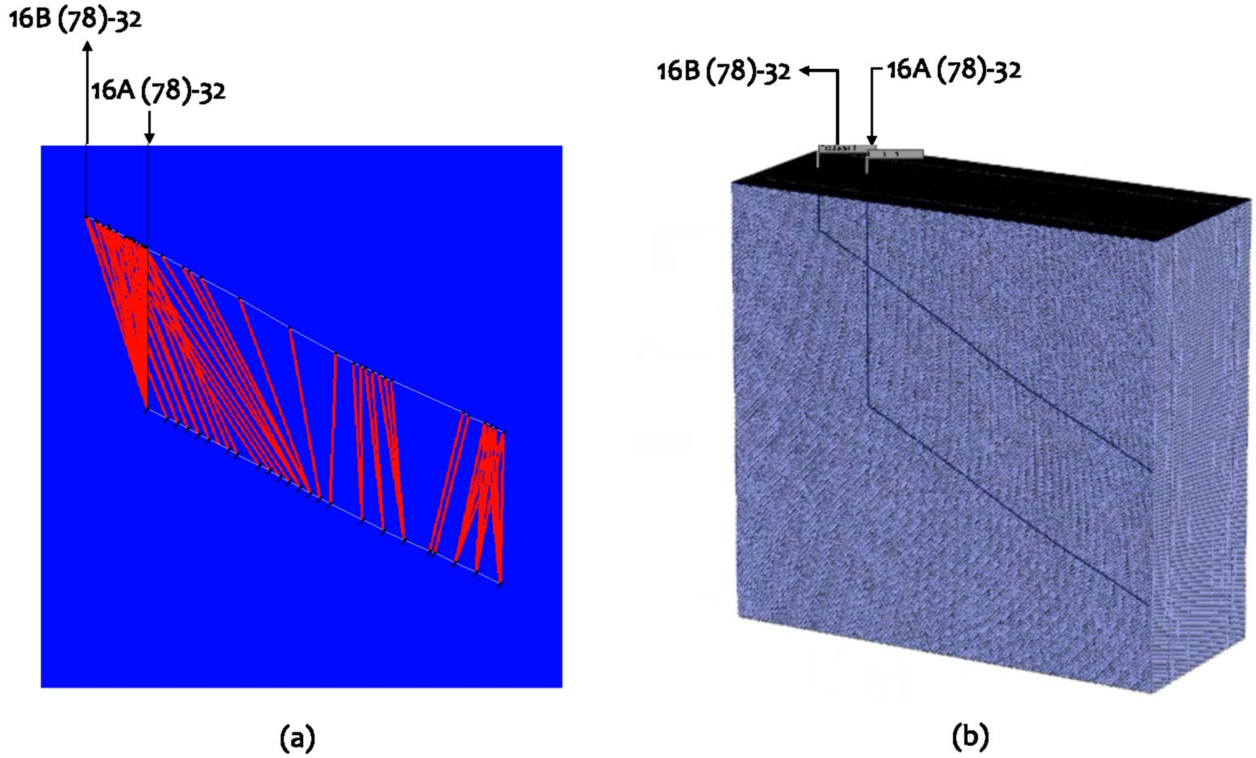

Figure 4. Visualization of FORGE reservoir. (a) 2D- view of fracture permeability connections, highlighting the interaction between producer and injector wells. (b) Full 3D model domain illustrating the spatial extent of the reservoir

The simulation model in Fig 4, represents a geothermal heat recovery system with pre-defined permeability distribution within the reservoir. The cross-sectional view in Fig 4(a) highlights the spatial distribution of fractures in a sliced 2D view, where fractures are shown in red as high-permeability zones embedded within a low-permeability matrix represented in blue. These fractures, mapped based on perforation and hit data, are explicitly defined in the model and have enhanced permeability to achieve pressure matching and to approximately simulate fluid flow behavior. The producer and injector wells are positioned to interact with the high-permeability fractures, enabling efficient geothermal heat recovery.

Fig 4 (b) provides a 3D representation of the entire reservoir model, with the uniform grid used for the simulation. The uniform grid simplifies the geometric complexity of the fractures while preserving their hydraulic properties, balancing computational efficiency and physical accuracy. The low-permeability matrix, represented by blue zones, restricts fluid flow to the fracture network, which governs the dominant transport pathways in the system. This combined representation captures the key hydraulic behavior of the fractures and surrounding matrix.

The numerical model applies boundary conditions to simulate the reservoir. Lateral boundaries are treated as infinite boundaries, allowing unrestricted heat and mass transfer beyond the model domain, and preventing artificial thermal confinement. Vertical boundaries permit conductive heat transfer based on the thermal conductivity of the rock matrix. The injection well serves as a source term, supplying a constant mass flow rate of 10 barrels/min at an injection temperature of 50°F from the wellhead of 16A (78)-32. To simplify fluid distribution, we assume uniform flow across all fractures in the injection well, ensuring even fluid allocation to the reservoir. In future, this can be modified based on production logging tool results. The 8 million grid size of the reservoir takes less than approximately 2 hours to compute with system specifications of Intel core i7 and 128GB memory.

3. RESULTS AND DISCUSSION

Fig. 5 compares the pressure and temperature responses from field measurements and numerical simulations over a 30-day period, highlighting key discrepancies between real-world observations and model predictions. The model was calibrated and finalized with the conductivity of 100 mD-ft of fractures to closely represent the field data.

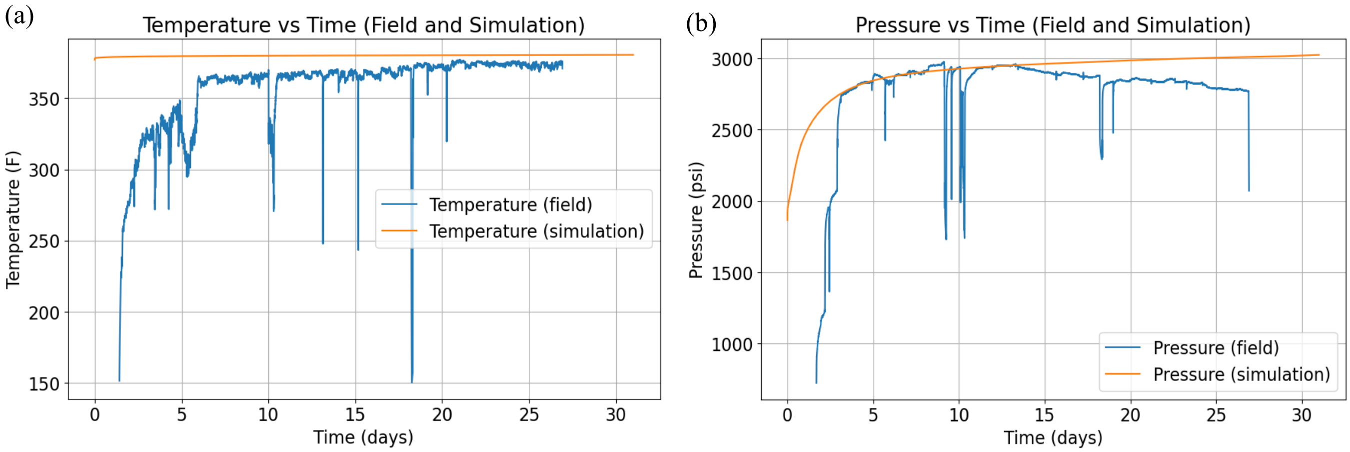

Figure 5. Comparison of field and simulation results. (a) temperature vs. time plot (b) pressure vs. time plot

Figure 5 (a) shows that the field data (blue line) exhibits dynamic fluctuations and transient behavior. The field pressure rises rapidly in the initial phase and stabilizes around 2500–3000 psi, with occasional sharp drops due to operational or reservoir factors. In contrast, the simulated pressure (orange line) follows a smooth curve, steadily increasing to a stable value of approximately 3000 psi without the variability seen in the field. This is because the simulation represents an idealized system, missing the complexities of operational changes, reservoir heterogeneities, or equipment-related influences observed in the field.

Similarly, Figure 5 (b) illustrates that the field temperature (blue line) rises rapidly in the first 5–10 days, stabilizing near 350°F at the surface, but exhibiting significant fluctuations, including sharp drops, particularly around days 10 and 15–20. These variations could be caused by transient operational effects, wellbore dynamics, or reservoir interactions. The simulated temperature (orange line), however, presents a smooth and steady rise to approximately 360°F, stabilizing early in the timeline, with no evidence of the fluctuations observed in the field.

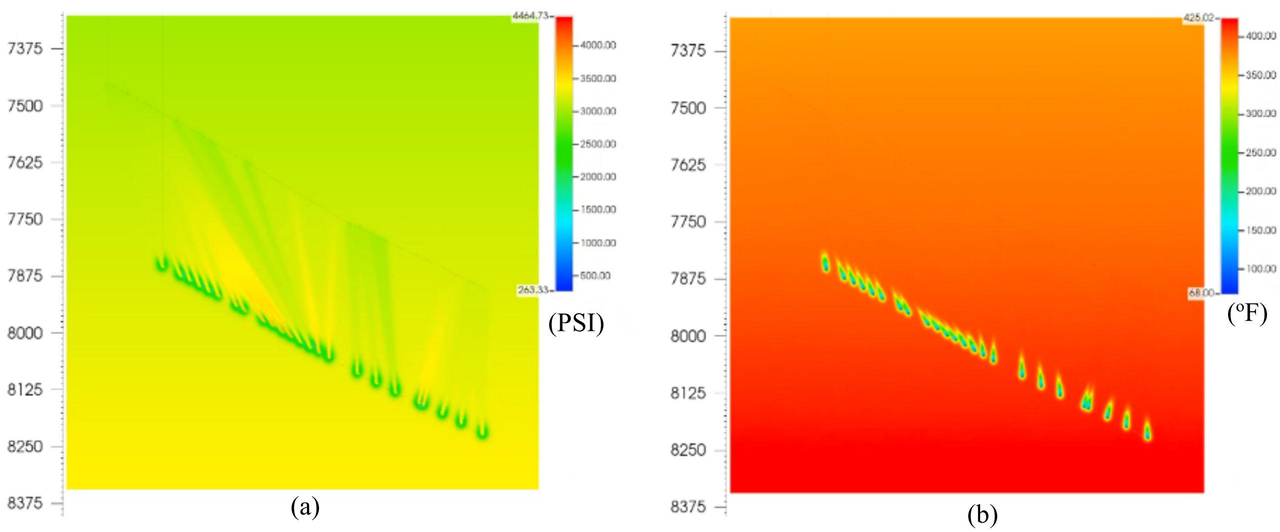

Figure 6. Contour visualization reservoir along the well trajectory. (a) Pressure distribution shows the impact of injection and production on reservoir zones. (b) Temperature distribution highlighting thermal gradients around fractures and injection well paths.

These comparisons emphasize a critical discrepancy between field measurements and simulations for both pressure and temperature. While simulations provide smooth, idealized responses, the field data reflect the dynamic and transient nature of real-world reservoir behavior.

Fig 5 (a) shows the simulation results after 30 days of the circulation test in the Utah FORGE reservoir, focusing on how the fracture network influences pressure and temperature distributions. The left image represents the pressure distribution within the reservoir. High-pressure zones are shown in red, while low-pressure zones are in blue. The gradual pressure gradients extending toward the production wells demonstrate the movement of the fluid through the fracture network, confirming the hydraulic connectivity of the fractures. This pressure profile reflects the effectiveness of fluid flow within the fractures, as the low-permeability matrix has minimal influence on fluid movement.

Fig 5 (b) illustrates the temperature distribution in the reservoir. The blue zones near the injector indicate cooler temperatures, corresponding to the colder injected fluid. As the fluid moves through the fracture network toward the producer, it exchanges heat with the surrounding rock, resulting in progressive warming, as shown by the transition from blue to red. The thermal gradients align with the fracture pathways, emphasizing that most heat transfer occurs along the fractures rather than through the matrix. This behavior demonstrates the dominant role of fractures in controlling both fluid flow and heat transfer during the circulation test. Together, these images validate the role of the modeled fracture network in capturing the essential hydraulic and thermal processes within the reservoir. The pressure and temperature patterns reflect how fractures facilitate fluid movement and enhance heat recovery, providing critical insights for optimizing geothermal reservoir performance.

4. CONCLUSIONS

The Utah FORGE project represents a transformative initiative in advancing EGS through hydraulic stimulation and innovative modeling approaches. The results of the 2024 10-stage stimulation and subsequent 30-day circulation test highlight significant fracture connectivity and approximately 90% fluid recovery, showcasing the effectiveness of the stimulation strategies. Numerical modeling played a pivotal role in understanding reservoir behavior, with DFN models providing detailed fracture characterizations based on MEQ data.

This study introduced a planar fracture modeling approach as a computationally efficient method for history matching and simulating reservoir behavior. By leveraging DSS data and a uniform grid representation, the planar model effectively captured the hydraulic and thermal responses observed during the circulation test. Despite its simplicity, the planar model demonstrated the ability to replicate reservoir behavior.

This study introduced a planar fracture modeling approach as a computationally efficient method for parameterizing, history matching and simulating reservoir behavior. By leveraging Distributed Strain Sensing (DSS) data and a uniform grid representation, the planar model effectively captured the hydraulic and temperature responses observed during the circulation test. Despite its simplicity, the planar model demonstrated the ability to replicate reservoir behavior.

For the future, the reduced computational efforts associated with planar models hold significant potential for enabling more frequent and detailed long-term predictions of reservoir behavior. This capability will enhance the design and optimization of EGS systems, supporting their scalability and contributing to the broader development of geothermal energy technology. Future work will focus on integrating additional field data and enhancing model fidelity to optimize EGS performance and contribute to the broader development of geothermal energy technology.

REFERENCES

Allis, R., J. Moore, N. Davatzes, M. Gwynn, C. Hardwick, S. Kirby, J. McLennan, K. Pankow, S. Potter, and S. Simmons 2016. 'EGS Concept Testing and Development at the Milford, Utah FORGE Site', in *Proceedings, 41st Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2016).

Asai, P., P. Panja, R. Velasco, J. McLennan, and J. Moore 2018. 'Fluid flow distribution in fractures for a doublet system in Enhanced Geothermal Systems (EGS)', *Geothermics*, 75 (2018), 171–179.

Cao, M. and M. M. Sharma 2023. 'Creation of a Data-Calibrated Discrete Fracture Network of the Utah FORGE Site', in *57th U.S. Rock Mechanics/Geomechanics Symposium, Atlanta, Georgia* (2023).

England, K., P. Li, P. Xing, J. Moore, and J. McLennan 2025. '2024 Enhanced Geothermal System Hydraulic Fracturing Campaign at Utah FORGE', in *SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas* (2025).

Finnila, A. 2024. 'Updated Reference Discrete Fracture Network Model at Utah FORGE', in *49th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2024).

Finnila, A., B. Damjanac, and R. Podgorney 2023. ‘Development of a Discrete Fracture Network Model for Utah FORGE Using Microseismic Data Collected During Stimulation of Well 16A(78)-32’, in *48th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2023).

Finnila, A., T. Doe, R. Podgorney, B. Damjanac, and P. Xing 2021. ‘Revisions to the discrete fracture network model at Utah FORGE site: 2021 Geothermal Rising Conference: Using the Earth to Save the Earth, GRC 2021’, *Using the Earth to Save the Earth - 2021 Geothermal Rising Conference, GRC 2021*, Transactions - Geothermal Resources Council, (2021), 757–766.

Liu, Q., M. Cao, Y. Ou, and M. Sharma 2025. ‘Hydraulic Fracturing Design in Geothermal Wells: A Utah FORGE Case Study’, in *SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas* (2025).

Mcclure, M. 2023. ‘Calibration Parameters Required to Match the Utah FORGE 16A(78)-32 Stage 3 Stimulation with a Planar Fracturing Model’, presented at the *Proceedings, 48th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2023).

Mcclure, M. W., R. Irvin, K. England, and J. Mclennan 2024. ‘Numerical Modeling of Hydraulic Stimulation and Long-Term Fluid Circulation at the Utah FORGE Project’, in *Proceedings, 49th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2024).

McLennan, J., K. England, P. Rose, J. Moore, and B. Barker 2023. ‘Stimulation of a High-Temperature Granitic Reservoir at the Utah FORGE Site’, in *SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas* (2023).

Munday, L. and R. Podgorney 2024. ‘Numerically Testing Conceptual Models of the Utah FORGE Reservoir Using July 2024 Circulation Test Data’, in *Proceedings, 49th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2024).

Niemz, P., J. McLennan, K. L. Pankow, J. Rutledge, and K. England 2024. ‘Circulation experiments at Utah FORGE: Near-surface seismic monitoring reveals fracture growth after shut-in’, *Geothermics*, 119 (2024), 102947.

Podgorney, R., Huang, H., Lu, C., Gaston, D, Permann, C, Guo, L, and Andrs, D n.d. ‘Falcon: A Physics-Based and Massively Parallel and Fully-Coupled, Finite Element Model for Simultaneously Solving Multiphase Fluid Flow, Heat Transport, and Rock Deformation for Geothermal Reservoir Simulation’, (Technical Report INL/EXT-11e23351 Idaho National Laboratory: Idaho Falls, ID,).

Podgorney, R., L. Munday, J. Liu, W. Jiang, A. Finnila, B. Damjanac, P. Xing, and Z. Radakovic-Guzina 2023. ‘Thermal-Hydraulic-Mechanical (THM) Modeling of Fluid Flow and Heat/Tracer Transport Between Injection and Production Wells at the Utah FORGE Site’, in *Proceedings, 48th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2023).

Xing, P., B. Damjanac, Z. Radakovic-Guzina, M. Torres, A. Finnila, R. Podgorney, J. Moore, and J. Mclennan 2023. ‘Comparison of Modeling Results with Data Recorded During Field Stimulations at Utah FORGE Site’, in *Proceedings, 48th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California* (2023).