Superhot Geothermal Energy with Gravity-assisted Geothermal Systems

Luke P. Frash[1], Zhenghua Li[1], Artches Migdissov[1], Mauricio A. Rivas[2], Douglas Simpkins[2], Mike Eros,[2]
Lev Ring[2], Jesse C. Hampton[3], Usuru R. Okoroafor[4], Jingjing Yang[5], Tim Lines[6], Fan Fei[7], Kayla Kroll[7]
[1]Los Alamos National Laboratory, [2]Sage Geosystems Inc., [3]University of Wisconsin – Madison,
[4]Texas A&M University, [5]GE Vernova Inc., [6]Geothermal Wells LLC, [7]Lawrence Livermore National Laboratory

Innovation: The gravity-assisted pressure geothermal system leverages three independent technologies for superhot geothermal resources to achieve LCOE<$30/MWh with reduced risk of seismicity: (i) patterned well designs, (ii) hydraulic pressure propping, (iii) densified fluids.

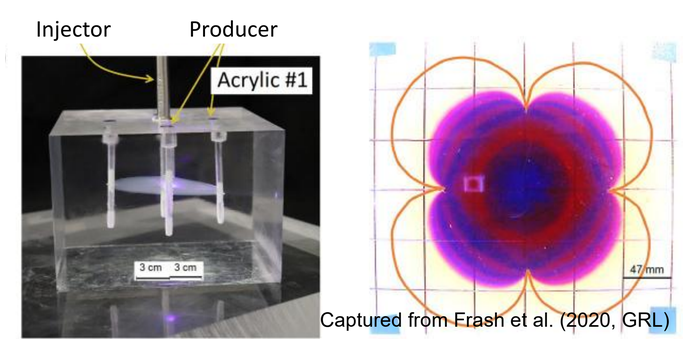
Final Deliverable(s): (i) Identification of a cost-effective densified fluid for superhot systems; (ii) Optimization of well patterns for economics and reduced seismic risk; (3) Prediction of GGS, EGS, and AGS production and economics; (4) Field-validation of gravity-assisted fracture growth; (5) A risk-matrix for project development.

Impact: Geopressured geothermal surpasses existing EGS or AGS (closed-loop) concepts by reducing costs and risks from high pumping pressure, extended well drilling, and proppant injection, with a target LCOE<$30/MWh and economic lifespan of 15-30 years.

Risks: (i) Densified fluids can require expensive ingredients (e.g., LiBr) so we need a lower cost option; (ii) Numerical models currently lack the equations of state for supercritical water, so these will need to be added; (iii) Super high-temperature high-pressure laboratory equipment is not available and multiple systems need to be developed.

ENGAGED

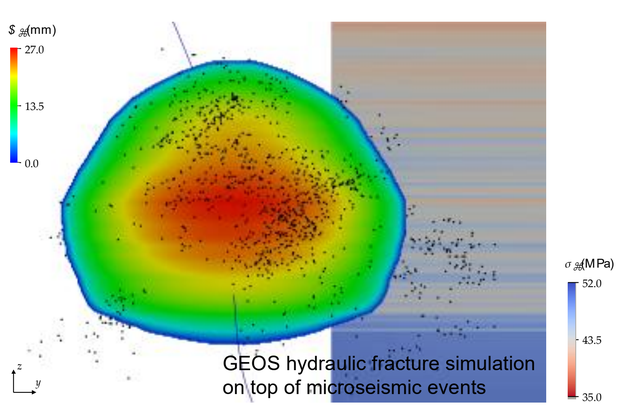
Advanced Lab Work | **High-fidelity Modeling** | **Field Testing**



Captured from Frash et al. (2020, GRL)

Task 1
Lab measurements of **densified fluids** & rock samples for GGS

Task 2
Lab testing of **patterned well arrangements** in GGS



GEOS hydraulic fracture simulation on top of microseismic events

Task 3
Modeling of coupled **multiphysics processes**, **gravity assisted fracturing processes**, **induced seismicity** for GGS and its **economics**


Captured from sagegeosystems.com

Task 4
Field tests to **validate the model** with Sage's existing test wells

Task 5
Integration & technoeconomic analysis

- ✓ Accurate estimate of LCOE for GGS
- ✓ Long-term productivity prediction
- ✓ Risk assessment for induced seismicity

Metric	Current EGS (< 8 km)	GGS (> 10 km)
15 yr average reservoir flow temperature	150 to 325 ℃	375 to 500 ℃
15 yr average flow pressure at reservoir	15 to 70 MPa	40 to 250 MPa
15 yr average flow rate at wellhead	40 to 150 l/s	100 to 300 l/s
15 yr average estimated net power output	>10 MW/site	>50 MW/site
Levelized Cost of Electricity (LCOE)	<$45/MWh	<$30/MWh

Acknowledgements

This work is supported by Department of Energy DOE Basic Energy Sciences LANLE3W1. Additional support was provided by LANL's Technology Evaluations and Demonstrations (TED) for program development. The views expressed herein do not necessarily represent the views of the U.S. Government.