

48th Workshop on Geothermal Reservoir Engineering 2023

Stanford, California, USA
6 - 8 February 2023

Volume 1 of 3

ISBN: 978-1-7138-7111-8

Printed from e-media with permission by:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2023) by Stanford Geothermal Program
All rights reserved.

Printed with permission by Curran Associates, Inc. (2024)

For permission requests, please contact Stanford Geothermal Program
at the address below.

Stanford Geothermal Program
367 Panama Street
Green Earth Sciences 050
Stanford University
Stanford, CA 94305-2220
USA

Phone: (650) 725-9835

Fax: (650) 721-2415

pangea.stanford.edu/researchgroups/geothermal

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2633
Email: curran@proceedings.com
Web: www.proceedings.com

Table of Contents

[Introduction](#)

[Reservoir Engineering](#)

[Field Studies](#)

[Tracers](#)

[Modeling](#)

[Production Engineering](#)

[Injection](#)

[Enhanced Geothermal Systems](#)

[Geochemistry](#)

[Geophysics](#)

[Geology](#)

[Direct Use](#)

[Low Temperature](#)

[General](#)

[Emerging Technology](#)

[Drilling](#)

[EGS Collab](#)

Introduction

Introduction to the Stanford Geothermal Workshop
Roland HORNE

[27](#)

Reservoir Engineering

- Geologically Consistent Prior Parameter Distributions for Uncertainty Quantification of Geothermal Reservoirs** [44](#)
Alex DE BEER, Michael GRAVATT, Theo RENAUD, Andrew POWER, Joris POPINEAU, Ruanui NICHOLSON, Oliver MACLAREN, Ken DEKKERS, John O'SULLIVAN, Michael O'SULLIVAN
- Thermo-hydrodynamic Modelling in Silicoclastic Reservoirs: Case Study of the Albian Geothermal Reservoir at Saclay, Paris Basin, France** [56](#)
Codjo Thomas Florent ESSOU, Benjamin BRIGAUD, Miklos ANTICS, Pierre UNGEMACH, Perine MAS, Remy DESCHAMP, Eric LASSEUR, Yara EL BAYSSARI, Gillian BETHUNE
- Characterization of Fracture Aperture and Spacing Using Well Tests and Radon** [67](#)
T. KUO, T. C. CHEN
- Highly Hydrophobic Lightweight Cements for Underground Energy Storage and Recovery** [73](#)
Tatiana PYATINA, Toshifumi SUGAMA
- Low Pressure Wells Generation on Steam Dominated Field** [83](#)
Ibrahim Abdus SALAM, Gamal HASTRIANSYAH, Fernando PASARIBU
- Understanding of Naturally Fractured Geothermal Reservoirs Using Data Assimilation** [91](#)
Gabriel S. SEABRA, Stephan De HOOP, Denis VOSKOV, Femke C. VOSSEPOEL
- Self-Healing Cements for Low- and High-temperature Applications** [102](#)
Zihao Li, Chao ZENG, Lirong ZHONG, Susan PETTY, Geoffrey GARRISON, Hamid NAJAFI, Marc BRENNEN, Carlos A. FERNANDEZ

Field Studies

- Geothermal Field Management Strategies: Various Cases and Lesson Learn from Top Geothermal Producer Countries** [110](#)
M. Rizqi AL ASYARI, Daniel W. ADITYATAMA, Dorman PURBA
- Individual Feedzone Characterization in Two Phase Geothermal Reservoir for Preliminary Indication While Drilling: A Case Study Dieng Field, Indonesia** [133](#)
Rizkhy Ridoh ALAMSYAH, Siti Olivinia YUSRA, Iqbal MARATAMA, Max WILMARTH
- Analysis of Different Times Period for Achieving Thermal Recovery in Wells** [147](#)
Alfonso ARAGÓN-AGUILAR, Sara MOYA-ACOSTA, Ariel FRANCISCO-HERNANDEZ, Siomara LÓPEZ-BLANCO
- Serendipitous Petrothermal-Reservoir Development in a Hydrothermal Par-Excellence Play Setting** [158](#)
Horst BEHRENS, Julia GHERGUT, Martin SAUTER
- Fault Convection of Cold and Hot Waters in the Vicinity of Ittoqqortoormiit in East Greenland** [168](#)
Grimur BJORNSSON, Arni HJARTARSON, Finnbogi OSKARSSON, Kristian HAMMEKEN and Gunnar GRIMSSON
- Resource Evaluation Case Study for Surprise Valley, California** [181](#)
Richard HOLT, Lisa KUSCU, Curt ROSE, Roy MINK, Ismail KUSCU
- Geoscientific Studies of Geothermal Resources of Gunung Endut Area, Banten Province-West Jawa, Indonesia** [195](#)
Alanda IDRAL, Yuano REZKY, Dedi KUSNADI, Eddy SUMARDI
- Towards Subsurface Stress and Strain Monitoring at the Patua Geothermal Field** [210](#)
Nori NAKATA, Don W. VASCO, Michelle ROBERTSON, Chet HOPP, Hongrui QIU, Torquil SMITH, Eric SONNENTHAL, Trenton CLADOUHOS, Michael SWYER
- Mantle Helium in Cold Ground Water in the North Milford Valley and the Implications for Geothermal Resources at Roosevelt Hot Springs and the Utah FORGE EGS Field Site** [222](#)
Stuart SIMMONS, Stefan KIRBY
- Recent Soil Carbon Dioxide Flux Measurements at Kızıldere Geothermal Field** [229](#)
Ali Berkay TOKEL, Serhat AKIN, Taylan AKIN, Selçuk EROL, Doğuhan Barlas SEVİNDİK
- Added Value of Optimizing Single Liquid Ring Vacuum Pump (LRVP) in Lumut Balai Geothermal Power Plant** [236](#)
Erwandi YANTO, Asep Mamat Rohmat SOLIHAT, Miran AFRIANA, Dzuriat KHASANI, Priatna BUDIMAN, Hadi SURANTO

Tracers

How Precise Can Thermal Breakthrough Predictions Be That Are Derived from Adsorptive Tracer Tests? [244](#)

Elvar K. BJARKASON

Model-Independent, and Model-Dependent Aspects of ‘Geothermal Solute’ Co-Production Forecast for Hydrothermal Vs. Petrothermal Reservoirs [253](#)

Julia GHERGUT, Bettina WIEGAND, Horst BEHRENS, Martin SAUTER

Nanoparticle-based Tracing Techniques in Geothermal Reservoirs: Advances, Challenges and Prospects [262](#)

Laura SPITZMUELLER, Fabian NITSCHKE, Jonathan BERSON, Annika MAERCKES, Bastian RUDOLPH, Thomas SCHIMMEL, Thomas KOHL

Modeling

- Multidisciplinary Collaboration to Create a New Numerical Model of the Lahendong Geothermal Field** [272](#)
John O'SULLIVAN, Fathan ABDURACHMAN, Greg BIGNALL, Chris BROMLEY, Ken DEKKERS, Muhammad GHASSAN, Michael GRAVATT, Pudy HASTUTI, Astri INDRA, Rony NUGRAHA, Fernando PASARIBU, Joris POPINEAU, Imam PRASETYO, Vicky RAI, Theo RENAUD, Jeremy RIFFAULT, Dhanie YUNIAR, Michael O'SULLIVAN
- A New Modelling Study of the Kamojang Geothermal Field** [287](#)
John O'SULLIVAN, Fathan ABDURACHMAN, Greg BIGNALL, Chris BROMLEY, Ken DEKKERS, Muhammad GHASSAN, Michael GRAVATT, Pudy HASTUTI, Astri INDRA, Rony NUGRAHA, Fernando PASARIBU, Joris POPINEAU, Imam PRASETYO, Vicky RAI, Theo RENAUD, Jeremy RIFFAULT, Dhanie YUNIAR, Michael O'SULLIVAN
- Modeling and Analysis of Hybrid Geothermal-Solar Energy Storage Systems in Arizona** [300](#)
Moones ALAMOOTTI, Olusegun Stanley TOMOMEWO, Ajan MEENAKSHISUNDARAM, Jerjes Porlles HURTADO, Etchukwu UZUEGBU, Emmanuel GYIMAH
- Tabulated Database of LCOE and LCOH for Hot-Dry-Rock Closed Loop Geothermal Systems** [326](#)
Koenraad BECKERS, Yaroslav VASYLIV, Gabriela A. BRAN-ANLEU, Mario MARTINEZ, Mark WHITE, Closed Loop Geothermal Working Group
- Modelling Borehole Thermal Energy Storage of Renewable Resources as a Fluctuating Source for Charge** [339](#)
Christopher S BROWN, Thibaut DESGUERS, Andrew LYDEN, Isa KOLO, Daniel FRIEDRICH, Gioia FALCONE
- Including the Topographic Profile of the Geothermal Field on Geothermal Numerical Reservoir Modeling: How Important Is it?** [352](#)
Nadya ERICHATAMA, Rizki Ratna AYUNINGTYAS, Jessica IVANA, Rony Prianto NUGRAHA
- Monte Carlo Model Simulations of Tracer Tests to Determine Fracture Aperture Size Range in an Anisotropic Geothermal Reservoir** [359](#)
Selçuk EROL, Taylan AKIN, Serhat AKIN
- Stochastic Fractality of the Gilondi Geothermal Reservoir** [366](#)
Mamadsho ILOLOV, Akhmadsho ILOLOV, Fumiaki INAGAKI, Jamshed RAHMATOV
- Thermal Power from a Notional 6km Deep Borehole Heat Exchanger in Glasgow** [379](#)
Isa KOLO, Christopher S BROWN, Gioia FALCONE
- Deploying Digital Twins for Geothermal Operations with the GOOML Framework** [389](#)
Iraklis KONSTANTOPOULOS, Paul SIRATOVICH, Grant BUSTER, Nicole TAVERNA, Jon WEERS, Andrea BLAIR, Jay HUGGINS, Christine SIEGA, Warren MANNINGTON, Alex URGEL, Johnathan CEN, Jaime QUINAO, Robbie WATT, John AKERLEY
- Closed Loop Geothermal Analysis Modeling and Simulation Using Idaho National** [396](#)

Laboratory' RELAP5-3D-FALCON Coupled Codes

Carlo PARISI, Paolo BALESTRA, Brian KYANJO, Theron D. MARSHALL, Travis L. MCLING, Mark WHITE

Improved Filtering for a New Resource Assessment Method

[405](#)

Andrew POWER, Michael GRAVATT, Ken DEKKERS, Oliver MACLAREN, Ruanui NICHOLSON, John O'SULLIVAN, Alex DE BEER, Theo RENAUD, Michael O'SULLIVAN

Modeling of Chloride and Carbon Dioxide Injection at Kizildere Geothermal Field

[417](#)

Doguhan Barlas SEVINDIK, Selçuk EROL, Taylan AKIN, Serhat AKIN

A Thermal-Hydrological-Mechanical Model of Patua Geothermal Field, Nevada

[424](#)

Torquil SMITH, Eric SONNENTHAL, Nori NAKATA, Trenton CLADOUHOS, Michael SWYER

Temperature Uncertainty Modeling with Proxy Structural Data as Geostatistical Constraints for Well Siting: Example from Granite Springs Valley

[433](#)

Whitney TRAINOR-GUITTON, Drew SILER, Bridget AYLING

Stochastic Inversion of Gravity and Magnetic Data to Build Subsurface Geological Fault Models Using Evolution and Swarm Intelligence-Inspired Optimization Algorithms

[452](#)

Divakar VASHISTH, Ahinoam POLLACK, Tapan MUKERJI, Drew SILER

Geostatistical Simulation of Reservoir Convection Indicators in Ďurkov Hydrogeothermal Structure (Slovakia)

[469](#)

Ladislav VIZI, Branislav FRIĀOVSKÝ

Closed-loop Geothermal Working Group Study - Understanding Thermal Performance and Economic Forecasts Via Numerical Simulation

[479](#)

Mark WHITE, Mario MARTINEZ, Yaroslav VASYLIV, Koenraad BECKERS, Gabriela BRAN-ANLEU, Carlo PARISI, Paolo BALESTRA, Roland HORNE, Chad AUGUSTINE, Laura PAULEY, Giorgia BETTIN, Theron MARSHALL, Closed Loop Geothermal Working Group

Production Engineering

- Novel Approach to Co-Produce Geothermal Energy from Oil and Gas Wells** [500](#)
Ismail CEYHAN, John BOWLING, Sharat CHANDRASEKHAR, P. V. SURYANARAYANA
- Significance of Pressure Let Down Station in Mitigating Effects of Silica Precipitation in Steam Pipelines. A Case Study of Olkaria** [511](#)
Joseph CHUMARI, Daniel ODONGO
- GeoLingo: Defining Optimal Data Collection Requirements for Geothermal Operations and Advanced Analytics** [518](#)
Andrew MARSH, Paul SIRATOVICH, Nicole TAVERNA, Grant BUSTER, Jon WEERS
- Numerical Simulation of Periodic Wellbore Flow Due to the Inflow of Low-Enthalpy Fluid** [530](#)
Mitsuo MATSUMOTO, Haruki OKADA, Ryuichi ITOI, Yasuhiro FUJIMITSU
- Well Output Measurement Using the Dual Differential Pressure Method** [536](#)
Richard STEVEN and Egill JULIUSSON
- Development of Corrosion Risk Evaluation System in Acidic Geothermal System** [555](#)
Norio YANAGISAWA, Masatake SATO, Koji SAKURA

Injection

The Effects of Soft Stimulation on Reservoir Growth and Injectivity at the United Downs Geothermal Project, Cornwall

[563](#)

Hazel FARNDALE, Ryan LAW

Enhanced Geothermal Systems

- A FORGE Datathon Case Study to Optimize Well Spacing and Flow Rate for Power Generation** [576](#)
Bulbul AHMMED, Luke FRASH
- A Systematic Review of Enhanced Geothermal System** [585](#)
Keyur AJWALIA
- Enhanced Geothermal Shot Analysis for the Geothermal Technologies Office** [594](#)
Chad AUGUSTINE, Jonathan HO, Sarah FISHER, Ian WARREN, and Erik WITTER
- WHOLESCALE - Calibration and Simulation of hydro-mechanical Behavior at San Emidio, Nevada During Operational Changes** [608](#)
Michael CARDIFF, Chris SHERMAN, Hao GUO, Erin CUNNINGHAM, Matt FOLSOM, John MURPHY, Ian WARREN, Hiroki SONE, Cliff THURBER, Herbert F. WANG and Kurt L. FEIGL
- Building the Fracture Network Model for Okuaizu Geothermal Field Based on Microseismic Data Analysis** [616](#)
Dian DARISMA, Yusuke MUKUHIRA, Naoki AOYAGI, Kyosuke OKAMOTO, Takuya ISHIBASHI, Hiroshi ASANUMA, Takatoshi ITO
- Experimental and Numerical Study of Hydraulic Fracturing in Enhanced Geothermal Systems (EGS)** [624](#)
Fan FEI, Yunxing LU, Andrew P. BUNGER, Matteo CUSINI
- The 2022 WHOLESCALE Deployment at San Emidio, Nevada, U.S** [634](#)
Kurt L. FEIGL, Hao GUO, Erin CUNNINGHAM, Jesse HAMPTON, Matthew FOLSOM, John AKERLEY, Matteo CUSINI, Chris SHERMAN, Ian WARREN, Corné KREEMER, Hiroki SONE, Michael A. CARDIFF, Neal E. LORD, Peter E. SOBOL, Clifford H. THURBER, and Herbert F. WANG
- Geology, State of Stress, and Heat in Place for a Horizontal Well Geothermal Development Project at Blue Mountain, Nevada** [650](#)
Steven FERCHO, Jack NORBECK, Emma MCCONVILLE, Nick HINZ, Irene WALLIS, Aleksei TITOV, Saurabh AGARWAL, Sireesh DADI, Christian GRADL, Hank BACA, Eric EDDY, Camden LANG, Katharine VOLLER, and Timothy LATIMER
- Development of a Discrete Fracture Network Model for Utah FORGE Using Microseismic Data Collected During Stimulation of Well 16A(78)-32** [666](#)
Aleta FINNILA, Branko DAMJANAC, Robert PODGORNEY
- Utilizing Downhole Drilling Dynamic Data to Characterize Geomechanics of Enhanced Geothermal Reservoirs at FORGE** [672](#)
Emilie GENTRY, Joseph BATIR, Hamed SOROUSH, Olivier HOFFMAN, Andrew MADYAROV
- Hydraulic Fracturing in Petroleum and Geothermal Reservoirs with Reference to the Utah** [683](#)

FORGE Stimulation

Ahmad GHASSEMI, Dharmendra KUMAR

Stimulation, Tracers and Geochemistry at Utah FORGE

[692](#)

Clay G. JONES, Kevin ENGLAND, Stuart SIMMONS, Peter ROSE, Michael MELLA, Benjamin BARKER, John MCLENNAN, Joseph MOORE

Development Update on Chloride-based Inflow Measurement in Fractured Enhanced Geothermal Systems (EGS) Wells

[701](#)

Luthfan Hafizha JUDAWISASTRA, Sarah SAUSAN, Jiann-cherng SU, Roland HORNE,

Generating Heat from Unused and Abandoned Wells with the Advanced/Enhanced Geothermal System Technology

[715](#)

Murat KARADAS, Mansur MUSTAFAOGLU, Seymour GULIYEV, Selim TUNA, Alptug GUR, Ilker KIRCA, Mustafa AKKOYUN, Ahmet KARABIYIK, Gulcan KARADAS

The EGS Collab – Discoveries and Lessons from an Underground Experiment Series

[724](#)

Tim KNEAFSEY, Doug BLANKENSHIP, Jeff BURGHARDT, Tim JOHNSON, Pat DOBSON, Paul C. SCHWERING, Chet HOPP, Mark WHITE, Joseph P. MORRIS, Chris STRICKLAND

Selection and Testing of Proppants for EGS

[751](#)

Sunghyun KO, Ahmad GHASSEMI, Matt UDDENBERG

The Large-Scale Helmholtz Research Infrastructure GeoLaB

[763](#)

Thomas KOHL, Ingo SASS, Olaf KOLDITZ, Judith BREMER, Bastian RUDOLPH, Eva SCHILL

Permeability-specific Spatial Correlation Systematics for UtahForge EGS Stimulation Meqs

[769](#)

Peter LEARY and Peter MALIN

Modeling and Analysis of Stimulation and Fluid Flow in the Utah FORGE Reservoir

[781](#)

Sang H. LEE and Ahmad GHASSEMI

Haskell Waveform Modeling of EGS Stimulation Meqs as Slow Ruptures Within Ambient Crust Permeability Structures

[791](#)

Peter MALIN and Peter LEARY

Simulation Study on Heat Extraction Efficiency and CO₂ Recovery Rate for CO₂-EGS in Hydrothermal Reservoirs

[804](#)

Kentaro MASUOKA, Hajime YAMAMOTO, Sou KUMAMOTO

Calibration Parameters Required to Match the Utah FORGE 16A(78)-32 Stage 3 Stimulation with a Planar Fracturing Model

[815](#)

Mark MCCLURE

Findings and Lessons Learnt from Hydraulic Stimulations for Pohang Enhanced Geothermal Systems Project

[832](#)

Ki-Bok MIN, Sehyeok PARK, Kwang-Il KIM, Hwajung YOO, Saeha KWON, Juhyi YIM, Jonny RUTQVIST

Deep Learning for Modeling Enhanced Geothermal Systems	<u>844</u>
<i>Maruti MUDUNURU, Bulbul AHMMED, Luke FRASH, Rene FRIJHOFF</i>	
Permeability Enhancement Process by Shear Slip on Existing Fractures from the Microseismic Perspective	<u>852</u>
<i>Yusuke MUKUHIRA, Takuya ISHIBASHI, Takatoshi ITO, Hiroshi ASANUMA</i>	
Stability and Breakdown of Acid-Induced Hydrated Silicate Gels and Metal Silicates Under Geothermal Conditions: A Preliminary Laboratory Study	<u>858</u>
<i>Seiji NAKAGAWA, William KIBIKAS, Chun CHANG, Timothy KNEAFSEY, Patrick DOBSON, Abraham SAMUEL, Michael OTTO, Stephen BRUCE, Nils KAARGESON-LOE, Stephen BAUER</i>	
A Review of Drilling, Completion, and Stimulation of a Horizontal Geothermal Well System in North-Central Nevada	<u>869</u>
<i>Jack NORBECK, Timothy LATIMER, Christian GRADL, Saurabh AGARWAL, Sireesh DADI, Eric EDDY, Steven FERCHO, Camden LANG, Emma MCCONVILLE, Aleksei TITOV, Katharine VOLLER, and Mark WOITT</i>	
DGS High-Capacity, Single Well, Full Hydraulic Circuit Technology Refinements for EGS	<u>894</u>
<i>William K OTT and Jeffery A SPRAY</i>	
Preliminary Determination of in-situ Stress Orientation and Magnitude at the Cornell University Borehole Observatory (CUBO) Geothermal Well, Ithaca NY	<u>903</u>
<i>Daniela PINILLA, Patrick FULTON, Teresa JORDAN</i>	
Thermal-Hydraulic-Mechanical (THM) Modeling of Fluid Flow and Heat/Tracer Transport Between Injection and Production Wells at the Utah FORGE Site	<u>912</u>
<i>Robert PODGORNEY, Lynn MUNDAY, Jerry LIU, Wen JIANG, Aleta FINNILA, Branko DAMJANAC, Pengyu XING, Zorica RADAKOVIC-GUZINA</i>	
Comparison and Analysis of Multiple Scenarios for Enhanced Geothermal Systems Designing Hydraulic Fracturing	<u>928</u>
<i>Jerjes PORLLES, Moones ALAMOOTI, Ajan MEENAKSHISUNDARAM, Etochukwu UZUEGBU, Emmanuel GYIMAH, Olusegun TOMOMEWO</i>	
Modeling of Distributed Strain Sensing (DSS) in Utah FORGE Stimulations	<u>939</u>
<i>Ruwantha RATNAYAKE, Ahmad GHASSEMI</i>	
Shut-In Testing on the 4100L - Implications on the State of Stress, Fractures, and Wellbores in the Second EGS Collab Testbed	<u>948</u>
<i>Paul SCHWERING, Mathew INGRAHAM, Vince VERMEUL, Jeff BURGHARDT, Tim JOHNSON, Chris STRICKLAND, Mark WHITE, Chet HOPP, Veronica RODRIGUEZ TRIBALDOS, Tim KNEAFSEY, Tyler ARTZ, Earl MATTSON, Thomas DOE, and The EGS Collab Team</i>	
WHOLESCALE - Characterization of Conductive Fractured Zones Based on Borehole Data at San Emidio Geothermal Field, Nevada	<u>965</u>
<i>Hiroki SONE, Oddy MUDATSIR, Zirou JIN, Matt FOLSOM, Gabrielle RAMIREZ, and Kurt L. FEIGL</i>	

Evaluation of Ultra-high Temperature Resistant Hydrogels for the Preferential Fluid Flow Control	<u>979</u>
<i>SONG Tao, BAI Baojun, SCHUMAN Thomas</i>	
Amplify EGS Project: Seismic Monitoring for In-field and Near-field Enhanced Geothermal Systems Stimulation at Wells of Opportunity (WOO) Sites in Nevada	<u>984</u>
<i>Jiann SU, Chet HOPP, Michelle ROBERTSON, Paul C. SCHWERING, Nori NAKATA, and The Amplify Monitoring Team</i>	
Microcapsule Transport in Transparent Rough Fractures for EGS Fracture Modification	<u>992</u>
<i>Pearl A. TETTEH, Brittney SEABURN, David GOERING, John C. STORMONT</i>	
Distributed Acoustic Sensing Strain Signatures as an Indicator of Fracture Connectivity in Enhanced Geothermal Systems	<u>1000</u>
<i>Megan WARD-BARANYAY, Matthew BECKER, Ahmad GHASSEMI, Jonathan AJO-FRANKLIN, and The FOGMORE Team</i>	
Seismic Monitoring of the 2022 Utah FORGE Stimulation: the View from the Surface	<u>1009</u>
<i>Katherine WHIDDEN, Gesa PETERSEN, Kristine PANKOW</i>	
Thermal Hydraulics Evaluation of Fluid Flow Distribution in a Multi-Stage Stimulated Enhanced Geothermal System Wellbore at the Utah FORGE Site	<u>1015</u>
<i>Benjamin WILLIS and Robert PODGORNEY</i>	
Comparison of Modeling Results with Data Recorded During Field Stimulations at Utah FORGE Site	<u>1024</u>
<i>Pengju XING, Branko DAMJANAC, Zorica RADA KOVIC-GUZINA, Maurilio TORRES, Aleta FINNILA, Robert PODGORNEY, Joseph MOORE, John MCLENNAN</i>	
Reexamining In-situ Stress Interpretation Using Laboratory Hydraulic Fracturing Experiments	<u>1036</u>
<i>Zhi YE, Ahmad GHASSEMI</i>	
On Tunable Fracture Conductivity to Enhance Heat Extraction from Fractured Geothermal Systems	<u>1043</u>
<i>Qitao ZHANG, Arash DAHI TALEGHANI</i>	
Modeling Thermal Fracturing During Operation of Enhanced Geothermal Systems: Improved Heat-Transfer Area and Reservoir Sustainability	<u>1050</u>
<i>Quanlin ZHOU, Bin CHEN</i>	

Geochemistry

- Thermodynamic and Transport Properties of Geothermal Fluids from South Russia Geothermal Field** [1057](#)
ABDULAGATOV Ilmutdin, ALIEV Rasul, BADAVOV Gasan
- Use of Arsenic as a Complementary Tool in Geothermal System Exploration** [1077](#)
Hermas DAVILA
- Distribution, Isotopic Composition and Origin of Lithium in the Salton Sea Geothermal Field** [1086](#)
J. HUMPHREYS, M. BROUNCE, M. A. MCKIBBEN, P. DOBSON, N. PLANAVSKY, H.R. HOOVER, B. WENZEL
- Geochemical Reservoir Damage Due to Fluid-Mineral Interactions Induced by Drilling Fluid: an Inevitable Problem During Geothermal Drilling** [1096](#)
JIANG Ou, CHU Baozheng, GONG Qingjie, ZHU Wenxi, Zheng Xiuhua
- Integrate Monitoring Data and Geochemical Modeling Construct Carbonate Precipitation of Tuchang Geothermal Area, Taiwan** [1105](#)
Chia-Mei LIU, Shih-Ting CHOU, Chun-Fa HUANG, Ke-Han SONG
- Geochemical Constraints on the Operations of High Temperature Aquifer Energy Storage (HT ATES) in Abandoned Oil Reservoirs** [1109](#)
Fabian NITSCHKE, Lars YSTROEM, Florian BAUER and Thomas KOHL
- An Improved Reactive Transport Model for Supercritical Geothermal Systems** [1119](#)
Tianfu XU, Ye GONG, Guanhong FENG

Geophysics

- Deep Borehole EM Deployment for Fracture Mapping at the FORGE Site** [1127](#)
David ALUMBAUGH, Evan UM, Michael WILT, Ed NICHOLS, and Kasumi OSATO
- Zero Impact Seismic in Support of Geothermal Exploration** [1134](#)
Allan CHATENAY, Krystal MACDONALD, Megan EYRE, Fred HEIKKINEN, Michael SAUNDERS, Tim THOMPSON, Alison THOMPSON
- Delineating Faults Beneath Basalt at the Soda Lake Geothermal Field** [1142](#)
Lianjie HUANG, Kai GAO, David LI, Yingcai ZHENG, and Trenton CLADOUHOS
- Seismic Study at the Mori Geothermal Power Plant, Japan Using DAS and DTS in a Geothermal Well** [1150](#)
Junzo KASAHARA, Yoko HASADA, Hitoshi MIKADA, Haruyasu KUZUME, Hiroshi OHNUMA and Yoshihiro FUJISE
- Elastic Characterization at FORGE ~P-wave Tomography and VSP Subsurface Imaging~** [1159](#)
Nori NAKATA, Don W. VASCO, Hongrui QIU, Peidong SHI, Federica LANZA, Ben DYER, Tong BAI, and Coral CHEN
- Exploring for Superhot Geothermal Targets in Magmatic Settings: 2022 Field Campaign at Newberry Volcano** [1171](#)
Hannah PAULING, Adam SCHULTZ, Esteban BOWLES-MARTINEZ, Xiaolei TU, Chet HOPP, Alain BONNEVILLE, Amanda KOLKER
- Repeated Magnetotelluric Measurements at the Geysers, California** [1179](#)
Jared PEACOCK, David ALUMBAUGH, Mike MITCHELL, Craig HARTLINE
- Geothermal Potential of a Passive Margin in the Baja California Peninsula, México** [1184](#)
Rosa Maria PROL-LEDESMA
- Fracture Structure of the Kakkonda Geothermal Field, Analyzed Microearthquake Data of the Nation-wide Seismic Network** [1190](#)
Mituhiko SUGIHARA
- Comparing Large Scale Geothermally Related Topographic and Bathymetric Features and the Mantle Convection Rolls Model** [1196](#)
Steingrimur THORBJARNARSON
- Characterizing Steam-Filled Fracture Zones at the Soda Lake Geothermal Field Using Seismic Double-Beam Neural Network (DBNN)** [1208](#)
Yingcai ZHENG, Hao HU, Muhammad Nawaz BUGTI, Jake PARSONS, Lianjie HUANG, Kai GAO, Trenton CLADOUHOS

Geology

High-Resolution Structure-from-Motion Models of Hydrothermal Sites in the Central Nevada Seismic Belt: Applications in Hydrothermal, Paleoclimate, and Neotectonic Investigations [1215](#)

Owen A. CALLAHAN, Cassandra BRIGHAM, Emma HEITMANN, Emma SULLIVAN, Amanda JACKSON, Siti R. MAT, Jay MUDAMBI, Jennifer OSAKO, Mattathias NEEDLE, Katharine HUNTINGTON, and Juliet G. CRIDER

Palaeothermometry of an Enigmatic Travertine Deposit: Cottonwood Travertine, Stillwater Range, NV [1228](#)

Amanda JACKSON, Owen A. CALLAHAN, Siti R. MAT, Emma HEITMANN, Andrew SCHAUER, Cassandra BRIGHAM, Jay MUDAMBI, Jennifer OSAKO, Emma SULLIVAN, Katharine HUNTINGTON, and Juliet G. CRIDER

Effect of Thermal and Mechanical Processes on Hydraulic Transmissivity Evolution [1239](#)

Tamara JEPPSON, David LOCKNER, Joshua TARON, Diane MOORE, Brian KILGORE, Nicholas BEELER, and Stephen HICKMAN

Identification of Geothermal Surface Manifestation Using ASTER Satellite Imagery. Case Study: Nakuru County, Kenya [1248](#)

Mathew KAMAU

Tectonic and Structural Setting of Geothermal System in Southern Thailand [1257](#)

Pitsanupong KANJANAPAYONT, Panupong KONGPET, Nicole LAUTZE, Erin WALLIN

Preliminary Play Fairway Analysis of Geothermal Resources in Southern Thailand [1264](#)

Panupong KONGPET, Pitsanupong KANJANAPAYONT, Nicole LAUTZE, Erin WALLIN

Structural Assessment for Well Targeting in the Dieng Geothermal Field, Eastern Part of North Serayu Gea-Anticline [1274](#)

Iqbal MARATAMA, Taufik Al AMIN, Siti Olivinia YUSRA, Rizkhy Ridoh ALAMSYAH, ALFIADY, Randy Wijaya ATMAJA, Maxwell WILMARTH

Petrology and Hydrothermal Alteration Mineral Distribution of Wells LA-9D and LA-10D in Aluto Geothermal Field, Ethiopia Geothermal Field [1284](#)

Dereje MOGES

Geothermal Mapping and Remote Sensing of Thermal Anomalies at Grændalur Area, Hveragerði, SW Iceland [1298](#)

Patrick MUANZA, Ingibjörg JÓNSDÓTTIR, Sigurður KRISTINSSON, Gunnlaugur EINARSSON, Grímur BJÖRNSSON

Direct Use

- Exploring New Ideas to Improve Geothermal Direct Use in Indonesia** [1317](#)
Adika BAGASKARA, M. Rizqi AL ASYARI, Daniel W. ADITYATAMA, Dorman PURBA, A. Haykal AHMAD, A. Rizky PRATAMA, Nursanty E. BANJARNAHOR, Agung W. MUKTI
- Preliminary Hydrogeologic Characterization of the Cornell University Borehole Observatory (CUBO), Ithaca NY** [1332](#)
Roberto D. CLAIRMONT, Patrick M. FULTON, Teresa E. JORDAN
- Fracture Network Characterization and Permeability for Direct-Use Geothermal Energy – Cornell University Borehole Observatory ESH No. 1** [1345](#)
Sean A. FULCHER, Daniela PINILLA, Teresa E. JORDAN, Patrick M. FULTON, Pedro Henrique Vieira DE LUCA
- Preliminary Constraints on Thermal Conditions Within the Cornell University Borehole Observatory (CUBO) in Ithaca, New York** [1358](#)
Ivanakbar PURWAMASKA, Patrick M. FULTON
- Geothermal Direct Use for Decarbonization - Progress Towards Demonstrating Earth Source Heat at Cornell** [1366](#)
Jeff TESTER, Olaf GUSTAFSON, Steve BEYERS, Terry JORDAN, Patrick FULTON
- Another Way to Alleviate Europe’s Energy Crisis** [1384](#)
Aniko N. TOTH, David K. FENERTY, Gusztav SZTERMEN Jr

Low Temperature

- Long-term Monitoring of a District-Scale Geothermal Exchange Field Using Fiber-Optic Distributed Temperature Sensing** [1392](#)
Shubham ATTRI, James TINJUM, Mehmet YILMAZ, Evan HEEG, Dante FRATTA, David HART
- Mapping Techno-Economic Feasibility of Geothermal Energy Resources in Alberta, Canada** [1402](#)
Gordon BRASNETT, Catherine HICKSON, Roman SHOR
- Low-Temperature Geothermal Geospatial Datasets: an Example from Alaska** [1425](#)
Estefanny DAVALOS ELIZONDO, Amanda KOLKER, and Ian WARREN
- City-Scale Geothermal Energy Everywhere to Support Renewable Resilience – a Transcontinental Cooperation** [1443](#)
Gregor GOETZL, Erick BURNS, Andrew J. STUMPF, Yu-Feng LIN, Amanda KOLKER, Maciej R. KŁONOWSKI, Cornelia STEINER, Jeff D. PEPIN, Ryan C. CAHALAN
- Geospatial Characterization of Low-Temperature Heating and Cooling Demand in the United States** [1454](#)
Hyunjun OH, Koenraad BECKERS
- Webinformation Systems for Shallow Geothermal Energy – an Example from Austria** [1467](#)
Cornelia STEINER, Gregor GOETZL, Martin FUCHSLUGER
- Energy Efficiency and Life Cycle Assessment of a District-Scale Geothermal Exchange Field** [1481](#)
James TINJUM, Mehmet YILMAZ, Evan HEEG, Shubham ATTRI, Dante FRATTA, David HART

General

- Thermodynamic and Economic Comparison of Organic Rankine Cycle and Kalina Cycle as Bottoming Unit to Utilize Exhaust Steam from Back Pressure Turbine Geothermal Power Plant** [1493](#)
Azaria Haykal AHMAD, Prihadi Setyo DARMANTO, Firman Bagja JUANGSA, M. Rizqi AL ASY'ARI, Daniel W. ADITYATAMA, Dorman PURBA
- Techno-Economic Modeling and Optimization of Flexible Geothermal Operations Coupled with Energy Storage** [1502](#)
Mohammad ALJUBRAN, Oleg VOLKOV, Roland HORNE
- New Maps of Conductive Heat Flow in the Great Basin, USA: Separating Conductive and Convective Influences** [1515](#)
Jacob DEANGELO, Erick R. BURNS, Emilie GENTRY, Joseph F. BATIR, Cary R. LINDSEY, Stanley P. MORDENSKY
- U.S. DOE Clean Energy Demonstration Program on Current and Former Mine Land – A Review of Geothermal Energy Case Studies and Opportunities** [1528](#)
Patrick DOBSON, Erika GASPERIKOVA, Sharon BORGLIN, Yingqi ZHANG, Gail MOSEY, Amanda KOLKER, Xiaobing LIU, Yarom POLSKY
- The Social Issue on Indonesia Geothermal Project** [1538](#)
Ferdino R FADHILLAH, M. Rizqi Al ASYARI, Adika BAGASKARA, Dies Valley Vie VANDA, Daniel W. ADITYATAMA, Dorman PURBA, Respati KATMOYO, Ajarani DJANDAM, Linda GURNING
- Probabilistic Models of Booking the Geothermal Reserves (McKelvey Scheme) in Construction of Geothermal Potential Catalog for Slovakia – Case Studies for the Levoča Basin, S and W Part** [1553](#)
Branislav FRIČOVSKÝ, Ladislav VIZI, Klement FORDINÁL, Radovan ČERNÁK, Katarína BENKOVÁ, Daniel MARCIN
- Why Geothermal Energy? A Questionnaire-analysis of Community Acceptance to Promote Energy Justice and Sustainable Development Strategies in Rural Argentina** [1566](#)
Jackson Marshall GRIMES
- Geothermal Business Outlook in Indonesia** [1601](#)
HABIBI Al Husni, Tito Satria Putra PERDANA, Eko Hari PURWANTO, Herlambang SETIAWAN
- Critical Problems in the Development of Basin-Hosted Geothermal Resources – Considerations from the Western Canada Sedimentary Basin** [1613](#)
Nicholas B. HARRIS
- Spatial Prediction for Bottom Hole Temperature and Geothermal Gradient in Colombia** [1620](#)
Jhon Camilo MATIZ-LEON
- Discovering the Potential of Unconventional Geothermal Systems in Indonesia** [1636](#)

Astri I. MUSTIKA, Galih B. PERMADI, Muhammad G.J. SALIHIN, Rony P. NUGRAHA, Aulia R. PRATAMA, Eko H. PURWANTO, Havidh NAZIF

Thermodynamics and Economics Analysis of Utilization of Ionic Liquids in Kalina Cycle System 34 [1647](#)

Deny Fajar RIANSYAH, Tubagus Ahmad Fauzi SOELAIMAN, Firman Bagsa JUANGSA, Azaria Haykal AHMAD

Observations of Thermal Cracking Propagation in Geopolymer Curing [1664](#)

Miguel ROMERO, Cameron DEVERS, Catalin TEODORIU

Role of Earth Scientists in the Geothermal Energy and Volcanic Hazard Education in a Geothermal Field, East Java, Indonesia [1675](#)

M. Ghassan Jazmi SHALIHIN, Sukir MARYANTO, Adi SUSILO, Dwiandaru DARMAWAN, Rony P. NUGRAHA

Geothermal Project De-risking: Discussion on Various Schemes [1681](#)

Maria SIAHAAN, Gitta SEPTIANI, Dorman PURBA, Adyaksa PARIPURNA

Preparing Technical and Commercial Documents for Geothermal Exploration Project Financing in Indonesia [1693](#)

Maria SIAHAAN, Dorman PURBA, Gitta SEPTIANI, Adyaksa PARIPURNA

Improving the Quality of Geothermal Data Through Data Standards and Pipelines Within the Geothermal Data Repository [1709](#)

Nicole TAVERNA, Jon WEERS, Jay HUGGINS, Sean PORSE, Arlene ANDERSON, Zachary FRONE, RJ SCAVO

Evaluation of Geothermal Resources Potential in China [1716](#)

WANG Guiling, ZHANG Wei, LIANG Jiyun, LIN Wenjing, LIU Zhiming, WANG Wanli

Seismotectonic Evolution and Geothermal Energy Production in the Salton Sea Geothermal Field [1726](#)

Malcolm C. A. WHITE, Nori NAKATA, Verónica RODRÍGUEZ TRIBALDOS, Avinash NAYAK, and Patrick DOBSON

Emerging Technology

- Do We Need a New Standard for Geothermal Downhole Tools?** [1736](#)
Khizar ABID, Aditya SHARMA, Catalin TEODORIU
- Potential Closed-loop Geothermal Power Generation Application for Non-commercial Well in Indonesia: A Preliminary Study** [1744](#)
Daniel ADITYATAMA, M. Rizqi Al ASYARI, Azaria Haykal AHMAD, Dorman PURBA, Vicky Rai CHANDRA, Nadya ERICHATAMA
- A Progress Report on GeoThermalCloud Framework: an Open-Source Machine Learning Based Tool for Discovery, Exploration, and Development of Hidden Geothermal Resources** [1753](#)
Bulbul AHMMED, Maruti K. MUDUNURU, Luke FRASH, and Velimir V. VESSELINOV
- Comparison of Water, sCO₂, and Organic Hydrocarbons as Working Fluids for the GreenLoop System and ORC Unit** [1760](#)
Harish CHANDRASEKAR, Alvaro AMAYA, Saul MOLINA, Ray ALVARADO, Joseph SCHERER, Glenn GOLLA
- A Proposal for Safe and Profitable Enhanced Geothermal Systems in Hot Dry Rock** [1771](#)
Luke P. FRASH, J. William CAREY, Bulbul AHMMED, Matthew SWEENEY, Meng MENG, Wenfeng LI, Bijay K C, Uwaila IYARE
- GFITM: Deep Closed-Loop GeoHeat™ Feasibility Assessment Workflow** [1782](#)
Maria F. GONZALEZ, Ghazal IZADI, Hani IBRAHIM
- Active Tracers for Hydraulic Control of Cooled Short Circuits** [1794](#)
Adam J. HAWKINS, Danni TANG, Ritwick SINHA, Sean A. FULCHER, Sarah HORMOZI, Patrick M. FULTON, Christopher A. ALABI, Uli B. WIESNER, Jefferson W. TESTER
- Quench-spallation Drilling: A Novel Drilling Head Design for Routine Heat Mining Above the Brittle-ductile Transition** [1799](#)
Ben HOLTZMAN, Nate GROEBNER, Tushar MITTAL, Rob SKARBEEK
- Advancing CO₂ Plume Geothermal: A Preliminary Investigation of Key Success Factors** [1809](#)
Yuezhou KANG, Ahmed MERZOUG, Axel INDRO, Oluwakemi OLOFINNIKA, Esuru Rita OKOROAFOR
- Harnessing Energy and Water in the Salton Sea** [1817](#)
Nikola LAKIC
- Harnessing Geothermal Energy with the Self-Contained In-Ground Geothermal Generator and Self-Contained In-Ground Geothermal Heat Exchanger** [1842](#)
Nikola LAKIC
- System for Drilling Deeper and Wider Wellbores** [1863](#)
Nikola LAKIC

- Conductive Proppants to Improve Heat Extraction** 1878
Sai LIU, Faras AL BALUSHI, Arash DAHI TALEGHANI
- Need for the Development of a Facility to Study the Behavior of Rocks, Proppants, Diverters, Cements, Instrumentation and Equipment at Greater Than Supercritical Conditions** [1885](#)
Susan PETTY, Matthew UDDENBERG, Geoffrey GARRISON, Jill WATZ, Sriram VASANTHARAJAN
- CO₂ Plume Geothermal (CPG) Systems for Combined Heat and Power: Opportunities and Challenges** [1891](#)
Christopher SCHIFFLECHNER, Christoph WIELAND, Hartmut SPLIETHOFF, Martin O. SAAR
- Harnessing the Waste Heat from Radioactive Waste in a Notional UK Geological Disposal Facility Using a Closed-Loop Geothermal System** [1899](#)
Muhammad U. TAHIR, Hannah R. DORAN, Gioia FALCONE, David C.W. SANDERSON

Drilling

- Applications of Radial Jet Drilling Techniques in Geothermal Wells** [1912](#)
Ramadan AHMED, Catalin TEODORIU
- Towards Less Carbon Future: Integrated Strategy for Abating Carbon Emissions in Geothermal Drilling Project** [1923](#)
M. Rizqi AL ASYARI, Daniel W. ADITYATAMA, Jerry TOBING, Yohanes Ronny Costamte SIREGAR, Dorman PURBA
- Geothermal Drilling Waste Management in Indonesia: Regulation, Practices, and Utilization** [1940](#)
Rizki R AYUNINGTYAS, Dorman PURBA, Daniel ADITYATAMA, Nadya ERICHATAMA, M Rizqi AL ASY'ARI
- Enablement of High-Temperature Well Drilling for Multilateral Closed-Loop Geothermal Systems** [1943](#)
Michael HOLMES, Colin BROWN, Vlad ZATONSKI, Matt TOEWS
- Thermal Degradation and Mixture Properties of Materials Used for Lost Circulation Management** [1977](#)
William KIBIKAS, Chun CHANG, Stephen J. BAUER, Seiji NAKAGAWA, Patrick DOBSON, Timothy KNEAFSEY, Abraham SAMUEL
- Laboratory Evaluation of the Short-Term Clogging Behavior of Various Materials and Their Combined Use for Lost Circulation Management** [1988](#)
Seiji NAKAGAWA, Chun CHANG, Willam KIBIKAS, Timothy KNEAFSEY, Patrick DOBSON, Abraham SAMUEL, Stephen BAUER
- Geothermal Drilling Center of Excellence: A Way to Closing Knowledge and Skill Gap in Indonesia Drilling Community** [1998](#)
Dorman PURBA, M. Rizqi Al ASYARI, Medhat KEMAL, Ahmad AFZARURROHMANSYAH, Dafiq AL-MADANI, Amrullah F. SUNARYO, Indira Z. ZAFIRA, Daniel ADITYATAMA
- Drill-well-on-paper (DWOP) Practice in Geothermal Exploration Drilling Project in Indonesia: Have We Done It the Right Way?** [2010](#)
Dorman PURBA, Daniel ADITYATAMA, Vicky CHANDRA, Ronny SIREGAR, Jerry TOBING, Rony NUGRAHA, Nadya ERICHATAMA, M. Rizqi Al ASYARI
- Improvement in ROP with Real Time MSE Monitoring in the Salton Sea** [2029](#)
Ernesto RIVAS, Bill RICKARD, Sam ABRAHAM, Sami ATALAY, Nathan SILVA
- Novel Coiled Tubing Operations in A Hostile Thermo-Chemical Environment** [2036](#)
Santiago ROCHA, Louis CAPUANO III, Louis CAPUANO Jr., David FAULDER, Patrick WALSH
- Design and Experimental Validation of a Machine Learning Estimation System for Down-hole Drilling Performance** [2045](#)
Jacob SACKS, Kevin CHOI, Kathryn GREENHILL, Jiann-Cherng SU, Stephen P. BUERGER, Byron BOOTS, Anirban MAZUMDAR

Drilling the Perfect Geothermal Well: an International Research Coordination Network for Geothermal Drilling Optimization Supported by Deep ML and Cloud Based Data Aggregation [2056](#)

Adam SCHULTZ, Pradeep ASHOK, Alain BONNEVILLE, Daniel BOUR, Rolando CARBONARI, Trenton CLADOUHOS, Geoffrey GARRISON, Roland HORNE, Gunnar Kaldal, Susan PETTY, Robert RALLO, Carsten SORLIE, Dang TON, Matt UDDENBURG, Eric VAN OORT, Leandra WEYDT

Numerical Investigations of Tensile Induced Debonding Due Temperature Variation in Geothermal Wells [2063](#)

Catalin TEODORIU, Ionut LAMBRESCU

Thermal Expansion Investigations of Oilwell Cements Using a Novel Apparatus [2072](#)

Alberto TOLEDO VELAZCO, Khizar ABID, Catalin TEODORIU

Colloidal Gas Aphron (CGA) Drilling Fluid: A Drilling Technique to Protect EGS Geothermal Reservoir [2082](#)

ZHU Wenxi; JIANG Ou; ZHENG Xiuhua

EGS Collab

Fluorescein Tracer Testing on the 4100L – A Preliminary Examination of Initial Arrival in Wells and the Drift at the Second EGS Collab Testbed

[2086](#)

Hari NEUPANE, Earl MATTSON, Vince VERMEUL, Mitchell PLUMMER, Dana SIROTA, MaThew INGRHAM, Tim KNEAFSEY and The EGS Collab Team