



## 2019 ARMA-CUPB GEOTHERMAL INTERNATIONAL CONFERENCE



### From hydrothermal to enhanced geothermal systems: Technology sharing with the oil and gas industry

#### August 5

##### **13:00 – 17:00 Training with Fellows**

- Basic Geomechanics Considerations in Drilling Geothermal Wells, John McLennan, University of Utah
- Hydroshearing and Hydrofracking: Naturally Fractured Rock Mass Stimulation for EGS, Maurice Dusseault, University of Waterloo
- Controls on Permeability and Seismicity in EGS Reservoirs, Derek Elsworth, Pennsylvania State University

#### August 6

##### **8:00 – 8:30 Opening Mark: ARMA & CUPB Chairs**

##### **8:30 – 9:00 Opening Keynote**

- The Drilling, Stimulation and Extraction Technologies for Geothermal Resources, Gensheng Li, CUPB

##### **9:00 – 10:30 Session 1: Drilling and Completion**

Chairs: Jiang Shu, U of Utah; Yalong Wang, Petro-Geotech Canada

- 9:00 – 9:15 Inference of in-situ stress from thermoporoelastic borehole breakouts in Enhanced Geothermal Systems development, Hua Zhang, Shunde Yin, Maurice Dusseault
- 9:15 – 9:30 Support Vector Machine's Application in Estimation of the Drilling Rate of Penetration, Masoud Rashidi, Adel Asadi, Amin Abbasi
- 9:30 – 9:45 Three Dimensional DEM Simulation of Rock Indentation by Flat-joint Model, Zifan Zhang, Fengshou Zhang
- 9:45 – 10:00 Fully Coupled Thermo-Hydro-Mechanical Analysis of Wellbore Stability in Hot Dry Rock formation with Dual Porosity and Dual, Jiajia Gao, Jinsong Huang, Qian Li, Bisheng Wu
- 10:00 – 10:15 Impact of In-plane Perforations on Near-Wellbore Fracture Geometry in Horizontal Wells, Sun Feng, Xue Shifeng, Tang Meirong, Zhangxiang
- 10:15 – 10:30 A Phenomenological Model of Percussive Drilling: Review of Experimental Evidence, Xianfeng Song, Ole Morten Aamo, Pascal-Alexandre Kane, Emmanuel Detournay

##### **10:30 – 10:40 Coffee Break**

## **10:45 – 12:10 Session 2: Enhanced Geothermal System**

Chairs: Ahmad Ghassemi (Oklahoma U), River Chu (Itasca China)

- 10:45 – 11:05 Invited Talk: EGS Collab Project: Overview, Progress, and Invitation to a Rich, High-Quality Dataset for EGS Model Validation, Pengcheng Fu, Lawrence Livermore (Invited)
- 11:05 – 11:25 Invited Talk: The Challenge and Future Development of Hydraulic Fracturing in Deep Hot-Dry Rock in EGS, Jianchun Guo, Yong Xiao, Zhihong Zhao, Southwest Petroleum (Invited)
- 11:25 – 11:40 Bedretto Underground Laboratory (BUL), Switzerland, and the planned in situ hydraulic stimulation experiments for EGS, Xiaodong Ma
- 11:40 – 11:55 Experimental Investigation of Liquid Nitrogen Fracturing of Granite Under Triaxial-Confining stresses, Ruiyue Yang, Zhongwei Huang, Chunyang Hong, Zheqi Yang, Yang Che
- 11:55 – 12:10 Coupled Thermo-Hydro-Mechanical Modeling for Hydro-shearing Stimulation of an Enhanced Geothermal System in the Raft River, Yilong Yuan, Tianfu Xu, Zhenjiao Jiang, Bo Feng, Joseph Moore

## **12:10 – 13:00 Lunch**

- Keynote: FORGE in 2019, John McLennan, U of Utah

## **13:00 – 15:10 Session 3: Hydraulic Fracturing**

Chairs: Haiyan Zhu (Chengdu U of Tech); Xiandong Ma (ETH Switzerland)

- 13:00 – 13:20 Coupled Processes, Rock Deformation, and Fracture in EGS Development, Ahmad Ghassemi, Oklahoma University (Invited)
- 13:20 – 13:40 Research on the Method of Explosion-hydraulic Fracturing for Hot Dry Rock Used Downhole Robot, Qingyou Liu, Jianguo Zhao, Haiyan Zhu, Chengdu University of Technology (invited)
- 13:40 – 13:55 Thermal Cracking near a Hydraulic Fracture during EGS Processes : Finite Element Model and Implications, Yarloung wang
- 13:55 – 14:10 Investigating Wing Crack Propagation during Hydraulic Stimulation in an EGS Reservoir, Ayaka Abe, Roland N. Horne
- 14:10 – 14:25 Hydraulic Fracturing in High-Temperature Granite Characterized by Acoustic Emission, Guangqing Zhang, Yuekun Xing, Tianyu Luo, Yongwang Jiang, Shiwen Ning
- 14:25 – 14:40 A 3D Numerical Simulation of Hydraulic Fracturing in Orthogonal Joints Formation based on Block Discrete Elements, Yongxiang Zheng, Jianjun Liu
- 14:40 – 14:55 A Coupled Thermo-mechanical Model based on TOUGH-FEMM for Simulating Three-dimensional Cracking Processes, Xuhai Tang, Siji Tao
- 14:55 – 15:10 Effect of Solid Non-linearity on the Growth of a Radial Hydraulic Fracture Accounting for the Viscous Fluid Flow in a Rough Cohesive, Dong Liu, Brice Lecampion

## **15:10 – 15:20 Coffee Break**

## **15:20 – 17:30 Session 4: CO<sub>2</sub> and Environment**

Chairs: Jeoung Seok Yoon (GFZ Germany); Shifeng Xue (UPC)

- 15:20 – 15:40 CCUUUS: Utilizing CO<sub>2</sub> Capture and Storage for 1) geothermal power generation, 2) subsurface energy storage, and 3) direct-air CO<sub>2</sub>, Martin O. Saar, ETH Switzerland (Invited)
- 15:40 – 16:00 Geothermal Drilling Process, Zhongwei Huang, CUPB (Invited)

- 16:00 – 16:15 Study on the Influence of CO<sub>2</sub> Finger-Channeling Flooding on Oil Displacement Efficiency and Anti-channeling Method, Jie Wang, Fujian Zhou, Lufeng Zhang, Erdong Yao
- 16:15 – 16:30 Thermal and Fluid Processes in Closed-Loop Geothermal System Using CO<sub>2</sub> as Heat Transmission Fluid, Zixu Hu, Tianfu Xu, Bo Feng, Guan hong Feng, Yilong Yuan, Fengyu Li
- 16:30 – 16:45 Efficient Geothermal Extraction with CO<sub>2</sub> Sequestration by Cyclic Alternation of Injection and Production Pressures, Kelvin Bongole, Zhixue SUN, James Mboje, Tong Wang, Chuanyin Jiang
- 16:45 – 17:00 Numerical Analysis of Fluid Injection Induced Fault Activation - Effect of Fault Hydraulic Properties on Activation Magnitudes and its Mechanisms, Jeoung Seok Yoon, Arno Zang, Ove Stephansson, Hannes Hofmann, Günter Zimmermann, Kwang-Yeom Kim, Yong-Bok Jung
- 17:00 – 17:15 Fluid Pressure Heterogeneity in Rock Fractures and Associated Frictional Slip, Yunzhong Jia, Yinlin Ji, Wei Wu
- 17:15 – 17:30 Influences of Reinjection by Lake Water and Geothermal Tail Water into the Dolomite Thermal Reservoir of the Wumishan Formation, Bo Feng, Dan Song, Donglin Liu, Jianan Xu

### **18:30 – 20:30 Welcome Reception**

- 19:30 – 20:00 Keynote: Optimizing Liquids- and Gas-Fracturing for Permeability Evolution in Naturally- and Artificially-Fractured Reservoirs, Derek Elsworth, Penn State University
- 20:00 – 20:30 Keynote: Can We Model Stimulation Processes in Naturally Fractured Geothermal Reservoirs? Maurice Dusseault, U of Waterloo

## **August 7**

### **8:00 – 8:30 Morning Keynote**

- The Frontier Observatory for Research on Geothermal Energy (FORGE): A Laboratory for Enhanced Geothermal System Development, Joseph Moore, U of Utah

### **8:30 – 10:05 Session 5: Field Development**

Chairs: Jian Zhou (SINOPEC); Sheng Mao (CUPB)

- 8:30 – 8:50 Geological Conditions for the Development of China's Enhanced Geothermal System, Zhonghe Pang, CAS Institute of G&G (invited)
- 8:50 – 9:10 From Steaming Ground to Power Plant -- A Review on the Yangyi 16-MW Geothermal Project, Haibing Shao, UFZ, Germany (Invited)
- 9:10 – 9:25 Current Status of Geothermal Developments in Taiwan, Sheng-Rong Song
- 9:25 – 9:40 New Opportunities and Challenges to Discover and Develop Unconventional Plays in The Middle East and North Africa: Critical, Mohammed Ba Geri
- 9:40 – 9:55 Present Geothermal Fields and Geothermal Resource Potentials in the Dongpu Depression, Shu Jiang, Yinhui Zuo
- 9:55 – 10:10 Benchmark Testing of Zonal Isolation Borehole Completions for Multi-stage EGS Stimulation in the Bedretto Underground Rock, Peter Meier, Frédéric Guinot, Roland Faschingbauer, Falko Bethmann, Xiaodong Ma, Marian Hertrich

## **10:10 – 10:25 Coffee Break**

## **10:25 – 12:00 Session 6: Case Studies**

Chairs: Zhaowei Chen (CNPC); Kaibin Qiu (Schlumberger)

- 10:25-10:40 Case study: Casing Deformation and Fault Slip Induced by Hydraulic Fracturing in Sichuan Basin, Zhaowei Chen, Rui Huang, Yi Song, CNPC & PetroChina
- 10:40-10:55 Classification Ability of Machine Learning Algorithms for Optimum Drilling Bit Type Selection A Case Study using Comprehensive Drilling and Logging Data, Masoud Rashidi, Adel Asadi, Erfan Asadi
- 10:55-11:10 Study on a New Cement Slurry System with High Temperature Resistance for the Hot-dry Rock Formation, Peiqing Lu, Yijin Zeng, Shiming Zhou, Yuan Gao, Qian Tao, Rengguang Liu
- 11:10-11:25 Influence of Mineral Composition on Thermal Conductivity and Productivity of Carbonate Geothermal Reservoir, Zhengbin Wu, Congjiao Xie, Zhenliang Guan, Shu Jiang
- 11:25-11:40 Heat Extraction Potential Evaluation of Supercritical Water --Based on IDDP-2 Well of Reykjanes Geothermal Field, Iceland, Yu Wang
- 11:40-11:55 Outlook of Geothermal Exploration Potentials in Taiwan Through Play Fairway Analysis, Chyi Wang, Wei Lo, Sheng-Rong Song, Ming-Yu Wu

## **12:00 – 13:00 Lunch**

- Keynote: The Impact of Stress and Fracture Roughness on Flow and Heat Transfer in Geothermal Rocks, Roland Horne, Stanford University

## **13:00 – 15:10 Session 7: Reservoir Simulation and Engineering**

Chairs: Fujian Zhou (CUPB); Christopher Pain (Imperial College London)

- 13:00 – 13:20: New methods for reservoir and inertia dominated fluid dynamics modelling in geothermal energy extraction and Oil & Gas, Chrisopher Pain, Imperial College London (Invited)
- 13:20 – 13:40: Modeling Thermal-Hydraulic-Mechanical Processes in Enhanced or Engineered Geothermal Systems, Yushu Wu, Colorado School of Mines (Invited)
- 13:40 – 13:55 Informed Design of EGS Operations using Numerical Modeling Tools, Azadeh Riahi, River Chu, Branko Damjanac
- 13:55 – 14:10 Optimization of geothermal injection and production using coupled thermal-hydraulic modeling, Fengyu Li, Tianfu Xu, Bo Feng, Guanhong Feng, Zixu Hu, Zhenjiao Jiang
- 14:10 – 14:25 A Flow Diagnostic Method for Geothermal Reservoirs, Zhao Zhang, Jianchun Guo, Yiqun Zhang
- 14:25 – 14:40 Study on a Dual Embedded Discrete Fracture Model Based on Local Upscaling, Heng Zhang, Dongxu Han, Jingfa Li, Dongliang Sun, Tingyu Li
- 14:40 – 14:55 Numerical Modeling of Reactive Chemical Species Transport in Reservoir Fluids, Shiyuan Li, Gabriele Marquart, Mao Sheng
- 14:55 – 15:10 Applications of Carbon Dots as Sensitive Tracers in Reservoir Engineering, Junfei Ma, Panpan Zhang, Mao Sheng, Shouceng Tian, Quan Xu

## **15:10 – 15:25 Coffee Break**

## **15:25 – 17:15 Session 8: Experiments and Models**

Chairs: Yiqun Zhang (CUPB); Bisheng Wu (Tsinghua University)

- 15:25 – 15:45 New Technology for Coproduction of Oil-heat-electricity in Oil Fields, Kewen Li, Stanford University (Invited)
- 15:45 – 16:00 Experimental Study on the Mechanical Properties of the Pre-treated Granite with High Temperature, Gongsheng Zhu, Tianshou Ma, Yang Liu, Nian Peng
- 16:00 – 16:15 The Study of Tight Gas Reservoirs Imbibition by Nuclear Magnetic Resonance, Mianmo Meng, Hongkui Ge, Yinghao Shen, Qinyu Li, Jiayao Yu
- 16:15 – 16:30 Evolution of Seepage in Microfracture Structure of Coal subject to 3D Stress Environment, Gang Wang, Zhiyuan Liu, Weimin Cheng
- 16:30 – 16:45 Experimentally Exploring Permeability Evolution Induced by THMC-coupled Processes, Xiang-Zhao Kong, Jin Ma, Marina Grimm Lima, Martin O. Saar
- 16:45 – 17:00 Influence of Fracture Treatment Parameters on Hydraulic Fracturing Optimization in Unconventional Formations, Marshal Wigwe, Oladoyin Kolawole, Marshall Watson, Ion Ispas
- 17:00 – 17:15 A Novel 3D Numerical Model to Simulate the Induced Seismicity by Hydraulic Fracturing in HDR Geothermal Reservoir, Lei Zhou, Yiyu Lu, Honglian Li

## **17:15 Closing Remark: ARMA and CUPB**