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ARMA 2018:
52nd US Rock Mechanics/Geomechanics Symposium

Technical Program Committee: Richard Schultz (chair)

Organizing Committee: Bill Dershowitz (co-chair), Conrad Felice (co-chair)

Welcome

Seattle and the Pacific Northwest rock mechanics community welcome you to **ARMA 2018**, the 52nd US Rock Mechanics/Geomechanics Symposium. The Technical Program Committee and Organizing Committee of ARMA 2018 are delighted to present an outstanding program of technical papers, keynotes, short courses, and social activities.

Although our program hotel sits on over 2 km of glacial till, there are many exciting rock mechanics features in the Pacific Northwest, including active volcanoes, numerous seismically active faults, critical rock slopes, and old mine workings, all within a few hours from downtown Seattle. Beyond the interests of Rock Mechanics, the Seattle area is famous for Pike Place Market, local seafood, ferry's crisscrossing Puget Sound, and beautiful parks and forests. We particularly recommend the Kubota Japanese Gardens, which are not far from SeaTac Airport, and the Water Tower climb in Volunteer Park, which is just a few miles from downtown.

We hope that you will have a stimulating, educational, and enjoyable time at ARMA 2018, and that you will take the opportunity to experience everything that our beautiful Pacific Northwest has to offer.

The symposium organization acknowledges the authors, reviewers, and participants of ARMA 2018 for their efforts to make a successful, enjoyable, quality technical conference.

Our thanks go to the members of the Technical Program Committee and the Organizing Committee for their volunteer support. We also would like to acknowledge the generous contributions of our sponsors, exhibitors and our sponsor, the American Rock Mechanics Association (ARMA).



Richard Schultz,
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General Information

Registration and Speaker Ready Room

Registration (pre-registration pickup and online registration) is open during the following hours:

Sunday, 17 June, 7:30 am – 9:00 pm

Monday, 18 June, 7:00 am -6:45 pm

Tuesday, 19 June, 7:00 am – 6:30 pm

Wednesday, 20 June, 7:00 am – 2:00 pm

The speaker ready room is located in the registration area. A laptop and projector will be available

Technical Tours

There are two technical tours offered:

- Friday, 15 June, 9:00 am – 6:00 pm – (1) Snoqualmie Powerhouse and I-90 Rock Slope Stability
- Saturday, 16 June, 9:00 am – 6:00 pm, (2) Whidbey Island Land slides, Lahara, Tsunamis, and Earthquakes

Short Courses

Two short courses are offered:

- Sunday, 17 June, 8:30 am – 4:30 pm. (1) Microstructural Modeling of Rock Fracture: Bonded–Particle Modeling with PFC and Bonded-Block Modeling with 3DEC
- Sunday, 17 June, 8:30 am -4:30 pm. (2) 2D and 3D Modeling of Rock Fracturing Processes in Geomechanics

Workshop

There is one workshop offered:

- Sunday, 17 June, 8:00 am – 5:00 pm. Characterizing Induced Seismogenic Potential

Author's Breakfast

Please bring the appropriate ticket.

Podium speakers and session chairs are required to attend the speaker's breakfast on the day of the speaker's presentation, beginning at 7:00 am. Poster presenters are invited to attend the breakfast on the day of their presentation. Prior to breakfast, podium speakers should load their presentations via a portable USB storage device to the session laptop. In addition to uploading the presentation, podium speakers will be able to meet with session chair(s). Tables will be identified by session number. Speakers should bring 1 or 2 biographical sentences, so that the session chair can prepare an introduction.

Exhibit Hall

Sunday, 17 June, 2:00 – 5:00 pm Exhibits setup/Posters mounted on display boards— All posters will be displayed for the duration of the Symposium.

Sunday, 17 June, 7:15 – 8:30 pm Opening reception and Exhibits

Monday, 18 June, 8:30 am – 4:30 pm Exhibits open (Coffee breaks, 9:30 -10:00 am, 3:30 -4:30 pm)

Tuesday, 19 June, 8:30 am -4:30 pm Exhibits open (Coffee breaks, 9:30 -10:00 am, 3:30 - 4:30 pm)

Wednesday, 20 June, 8:30 am – 4:30 pm Exhibits open.

Special Activities

There are two special activities offered:

Monday, 18 June, 9:30 am -12:30 pm —Seattle Sights Bus Tour

Tuesday, 19 June, 10:30 am – 1:30 pm – Guided Food and Historic Walking Tour of Pike Place Market

Other Scheduled Meetings

Sunday, 17 June, 9:00 am – 4:00 pm: ARMA Board of Directors Meeting

Monday, 18 June, 12:30 – 1:30 pm: ARMA Publications Committee (lunch)

Monday, 18 June, 7:00 – 9:00 pm: ARMA Fellows Dinner

Tuesday, 19 June, 12:30 – 2:00 pm: ARMA Future Leaders (lunch)

Wednesday, 20 June, 12:30 – 2:00 pm: Seattle/2018 and New York/2019 Symposia Organizing Committees (lunch)

Sponsors

The 52nd U.S. Rock Mechanics/Geomechanics Symposium is pleased to acknowledge the following corporate sponsors.
To all our sponsors, our sincere thanks.



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Across the globe, companies and governments are creating the world of tomorrow. They are building vital infrastructure, developing projects, restoring landscapes and renewing their economies with sustainability in mind.

Golder is an employee-owned, global organization providing consulting, design, and construction services in our specialist areas of earth, environment, and energy through technical excellence, innovative solutions and award winning client service. Today, our clients represent the world's major industries and drivers of development: Oil and Gas, Mining, Manufacturing, Power, and Infrastructure.

Employee owned since being founded in 1960, our more than 6,500 people operating from 165 offices worldwide deliver deep technical understanding, cross-disciplinary thinking and a passion to help our clients succeed.

Golder is recognized as one of the world leaders in rock slope engineering within the civil and mining engineering communities. Our experience covers all phases of a project from initial risk assessment, concept development, and detailed design through to construction. Our major rock engineering clients include oil and gas, radioactive waste management, mining, infrastructure companies, and government agencies. Our experience and reputation has allowed us to work on some of the most technically challenging projects in the world, including mountainous regions and volcanic islands.



MTS Systems Corporation (Platinum Sponsor)

The U.S. Rock Mechanics/Geomechanics Symposium presents an exceptional opportunity to discover the full extent of MTS testing technology and expertise. Integrating high-performance MTS servohydraulic technologies, durable test accessories, versatile digital controllers and fully-featured test application software, MTS solutions deliver years of reliable geomaterials testing in all types of lab environments. MTS testing solutions can be configured to accommodate a wide range of tests, enabling standardization of test procedures worldwide on the same types of equipment and with the same test methods.

MTS standard geomaterials testing systems include the high-capacity Model 815 Rock Mechanics Test System and the compact lower capacity Model 816 Rock Mechanics Test System. Both systems integrate high response MTS servohydraulics, controls, test application software, and a host of accessory options to accurately determine the characteristics of a variety of rock specimens.

MTS also designs new industry-leading solutions. Working in conjunction with Norwegian independent research organization, SINTEF, MTS completed the design and construction of a large-scale polyaxial rock testing system that can emulate the complex, high-pressure environments found "down-hole" in oil wells. This system will be of great value in ensuring supply continuity and wellbore integrity as drilling goes to even greater depths. The new test system replicates the stress profiles present in different rock formations, as well as simulates fluid flow patterns and other factors that impact well integrity.

Due to innovations such as the polyaxial rock testing system, researchers worldwide turn to MTS for the technology and expertise they need to accurately and efficiently determine the physical characteristics of rock and concrete materials, components and structures for research for wide range of industrial and commercial applications. We invite you to discover how MTS technology and decades of testing expertise can work to improve your testing processes and enhance overall lab productivity.

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Schlumberger Reservoir Laboratories provide comprehensive rock and fluid analysis. Our complete range of services integrates advanced technologies, petrotechnical expertise, and a state-of-the-art equipment portfolio to efficiently deliver accurate, precise results for making timely informed decisions. Whether you need to find the most profitable zones, ensure completion quality, or understand phase behavior under simulated or real operating conditions, the physical and digital analysis services we provide across our global reservoir laboratory network help you leverage the dynamic properties of your reservoir to mitigate risk and maximize production.

For geomechanics measurements and special core analysis, Schlumberger manufactures industry-leading analytical equipment to measure the rock properties necessary for understanding reservoirs—whether conventional or unconventional shale. The same specialized apparatus we use in our laboratories is also available for customer purchase, including triaxial and polyaxial load frames, TerraTek[®] scratch index (TSI), isotherm, gamma logger, desorption, goniometer fracture measurement, pressure and pulse decay, 1,300-degF-rated retort oven, continuous flow, porosity-permeability, and core flood systems. We also customize rock geomechanics equipment such as the load frames systems as per customer requirements.

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several pressure vessels for Section II and IV testing and the industry's largest polyaxial stress frame for quantifying the response of saturated large-scale rock samples subjected to perforation shock, dynamic underbalance, perforation cleanup, perforation flow efficiency, sand production, acidizing, and hydraulic and dynamic fracturing.

Other Sponsors



Agapito Associates, Inc., Sponsor of the 19 June Awards Banquet



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Itasca International, Inc., Sponsor of the Symposium Delegate Bags

Exhibitors



FLOXLAB

FloXlab is an engineering firm specialized in the design and manufacture of an ample range of products encompassing advanced geotechnical testing equipment, high precision syringe pumps and compression frames. Our philosophy is continuous improvement through constant market demand monitoring, higher quality material prospection, and meticulous customer feedback collection and analyses.

FracTech Laboratories

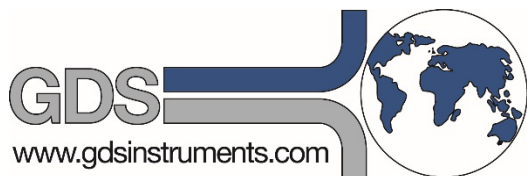
FracTech Laboratories

FracTech Laboratories is a 25 year established provider of world class Geomechanics and Hydraulic Fracturing testing solutions to the international oil and gas industries. FracTech Laboratories operates out of a purpose built high technology facility in London, UK. FracTech Engineering manufactures and installs testing equipment globally.



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GCTS Testing Systems provides complete testing solutions for the advanced material characterization of rocks, soils, and pavements. Since 1994, we have designed and manufactured a complete line of pneumatic and hydraulic testing equipment to meet all of our customer's needs.



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GDS Instruments designs, develops and manufactures materials testing machines and software used for the computer-controlled testing of soils and rocks. This technology is used to evaluate the mechanical properties that are key in geotechnical and earthquake engineering design.



GEOMECHANICA

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Geomechanica develops innovative geomechanical simulation software (Irazu), provides simulation-aided consulting services for rock engineering applications, and offers rock mechanics laboratory testing services. Irazu is a general-purpose simulation package to model deformation and fracturing of geomaterials in petroleum, mining and civil engineering applications.



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Since 1977, GEOSLOPE International Ltd. has developed, marketed and supported the most popular geotechnical modelling software worldwide. Our geo-engineering software is used in over 150 countries for the last 40 years.



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IDS GeoRadar is a world leading developer of slope monitoring radars designed for real-time evaluation and characterization of slopes and structures. Based on microwave interferometry, submillimeter displacement can be measured up to four kilometers distance to identify areas of risk and hazard. What can be measured can be managed with IDS GeoRadar.



Itasca Consulting Group, Inc.

Since 1981 Itasca has provided engineering consulting services, developed simulation software, and conducted research in geomechanics, hydrogeology, and microseismics. With 16 offices worldwide, our consultants solve complex problems for the mining, civil, environmental, energy, and materials industries. Itasca's software is among the most widely used and respected analyses tools available.



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A unique, diversely skilled company, MetaRock Laboratories provides a range of consulting services in areas of Rock Mechanics and Core Analysis, Custom Software Development and Automation, Automated Integration Solutions, Testing Systems and Services. Our custom-designed products service a high-value segment in the Oil & Gas, Mining, Geotechnical & Medical Industry. Our commitment to staying ahead of the technology and innovation curve, and meeting clients' needs has allowed us to extend our portfolio to a wide array of technology and automation solutions.



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MTS delivers a full range of high-performance hardware, software, and accessories to meet challenging rock testing requirements. Find rock mechanics test systems for today's critical applications like ultrasonic velocity, fracture toughness and polyaxial testing.



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Schlumberger is the world's leading provider of technology for reservoir characterization, drilling, production, and processing to the oil and gas industry. Working in more than 85 countries and employing approximately 100,000 people who represent over 140 nationalities, Schlumberger supplies the industry's most comprehensive range of products and services, from exploration through production and integrated pore-to-pipeline solutions for hydrocarbon recovery that optimize reservoir performance.



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TRE Altamira is a globally recognized leader in InSAR data interpretation. Using the proprietary SqueeSAR™ algorithm, ground deformation is measured to millimetric accuracy; without the need to install Artificial Corner Reflectors. Working closely with clients, TRE designs ongoing and historic deformation monitoring programs.

Keynote Presentations

Tenth Annual MTS Lecture

Sunday, 17 June, 6:15 pm – 7:15 pm

Reliability-based hazard analysis and risk assessment for rock slopes

H. Sebnam Duzgun, Professor and Fred Banfield Distinguished Endowed Chair in Mining Engineering, Colorado School of Mines

Quantification of risks due to failure of natural and engineered rock slopes is essential for supporting objective decision-making in rock engineering. Although risk assessment is well-developed in structural engineering, its adoption in rock engineering still involves various challenges. These challenges involve modeling and quantification of uncertainties, implementation of analytical and numerical approaches in probabilistic modeling frameworks for hazard assessment, prediction of losses in relation to potential instability, and evaluation of the assessed risk in terms of established acceptability/tolerability criteria. Such challenges also impact the development of engineering standards and, hence, engineering practice.

This talk will provide an overview of probabilistic approaches for rock slope stability analysis with emphasis on the first-order reliability method (FORM) in hazard assessment. Various case study examples will be discussed for the adoption of FROM in numerical and analytical frameworks. The methods for quantification of uncertainties will be explained. Then, quantitative prediction of losses due to rock slope instabilities and associated risk assessment approaches will be outlined considering acceptability and tolerability criteria. Demonstration of implications related to the risk assessment concepts will be performed by using case studies from large natural slopes. Finally, the talk will highlight future research directions and necessary standardization and adaptation strategies in rock engineering practice.

Keynote Address

Monday, 18 June, 10:00 am – 10:50 am

Rock Mechanics Aspects of the John Hart Generating Replacement Project

Tony Dell, Engineering Specialist-Geotechnical, SNC Lavalin

This presentation will discuss several rock mechanics aspects of the design and construction of the John Hart Generating Station Replacement Project. The project provides for the replacement of the furthest downstream station in the Strathcona-Ladore-John Hart cascading hydroelectric development on the Campbell River on Vancouver Island in British Columbia. The John Hart facility has been in operation since 1947 and is being replaced for a number of reasons, including age related deterioration. The current project will provide an underground power house and gate chamber with headrace and tailrace tunnels, service tunnels and construction adits, and two shafts -- one as the inlet to the headrace tunnel and the other to cater for the upstream surge.

The rock mechanics issues discussed will include:

- The investigations carried out prior to and during construction;
- The geological and rock mechanics properties of the intact rock and rock mass;
- The analysis and design of the coffer dam behind the existing concrete dam using 900 mm dia. pipe piles socketed into the rock;
- The stress/strain analyses for the tunnel under the existing concrete dam. This includes the provision of temporary support to cater for the 1:2,500 AEF earthquake and permanent support for the 1:10,000 AEF earthquake of the combined dam block, intake and tunnel system;
- The limit equilibrium and stress analyses for design of the shotcrete and rockbolt support for the 93 m long, 23 m wide and 40 m deep underground power house;
- The 3D stress analyses of the interaction between the tunnel, the powerhouse and the gate chamber. This includes the seepage analyses and the calculation of hydraulic fracture, which decided the location of the powerhouse and the distance of the power tunnel from the powerhouse;

- The seepage analyses for the pressurized power tunnel that passes under a 40 high earthfill dam to ensure that the increased seepage pressures do not affect the stability of the existing earthfill dam;
- Discussion of several of the construction activities; and
- The investigation of an alternative route for the main access adit after a buried channel, containing sand and gravel was encountered during construction. This will include a discussion of the rock stresses in the narrow rock pillar between the access tunnel and the gate chamber.

Early Career Keynote Address

Monday, 18 June, 1:30 pm – 2:00 pm

Hydraulic Fracturing in Naturally Fractured Reservoirs: Aspects from Multi-Scale Numerical Modeling

*Fengshou (Frank) Zhang, Department of Geotechnical Engineering,
Tongji University*

Naturally fractured reservoir rock in-situ is one of the most complex geomaterials. Uncertainties such as material inhomogeneity and discontinuities at various length scales make the propagation of hydraulic fracture in such a medium “enigmatic”. Advanced numerical modeling provides a powerful tool to analyze the complex fracturing process, assess the extent of various uncertainties and provide advice to practical fracturing designs. This talk aims to give a comprehensive review of multi-scale numerical modeling of hydraulic fracturing in naturally fractured reservoir based on distinct element method, particle flow codes, lattice method and finite difference method. Some key aspects of unconventional hydraulic fracturing, such as near wellbore fracture initiation, hydraulic fracture/natural fracture interaction, complex fracturing and micro-seismic geomechanics, refracturing and in-fill well fracturing, injection induced seismicity and fault activation, and hydraulic fracturing in unconsolidated rocks will be covered and discussed.

Second ARMA Distinguished Lecture

Tuesday, 19 June, 10:00 am – 10:50 am

Rock Engineering —Where is the Laboratory?

*Charles Fairhurst, Professor Emeritus, University of Minnesota;
Co-Founder, Itasca Consulting Group; and ARMA Fellow*

The International Society for Rock Mechanics (ISRM) was established by Dr Leopold Müller in 1962 to emphasize that rock mechanics was distinct from soil mechanics. Soil could be considered as a plastic continuum -- its isotropic constitutive behavior could be determined in classical 'bench scale' laboratory tests.

Although not stated explicitly, the term 'rock', as used by Dr. Müller, referred to rock in situ on a scale large enough to include major discontinuities, usually aligned in several sets of orientations. Such large scale features are a primary factor in rock engineering. Their constitutive behavior cannot be determined in a classical laboratory. This concern for engineering was underlined by the recent decision of ISRM to change its name to the International Society for Rock Mechanics and Rock Engineering, although retaining the acronym ISRM .

Rock Mechanics/Engineering is a central component of sub-surface Earth Resources Engineering, relevant to issues of major national and global importance -- with relevance also to extra-terrestrial developments. How can the influence of large scale discontinuities be addressed in rock engineering? The presentation will examine several options that have been used, and will offer suggestions. The lecture will conclude with recommendations concerning future development of engineering-scale Rock Mechanics.

Keynote Address

Wednesday, 20 June, 10:00 am – 10:50 am

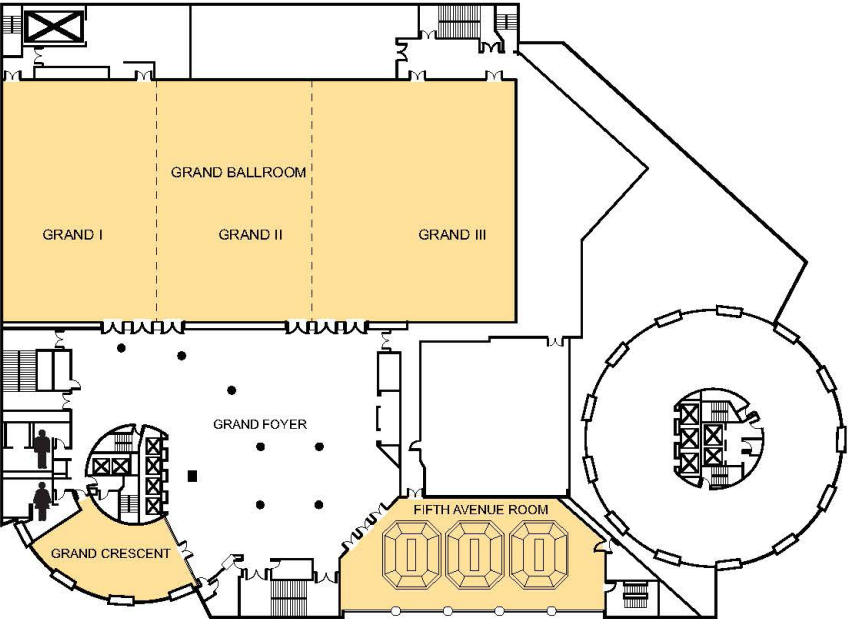
The Making of a Hydraulic Fracture Swarm

Andrew Bunger, Assistant Professor, Department of Civil and Environmental Engineering, University of Pittsburgh

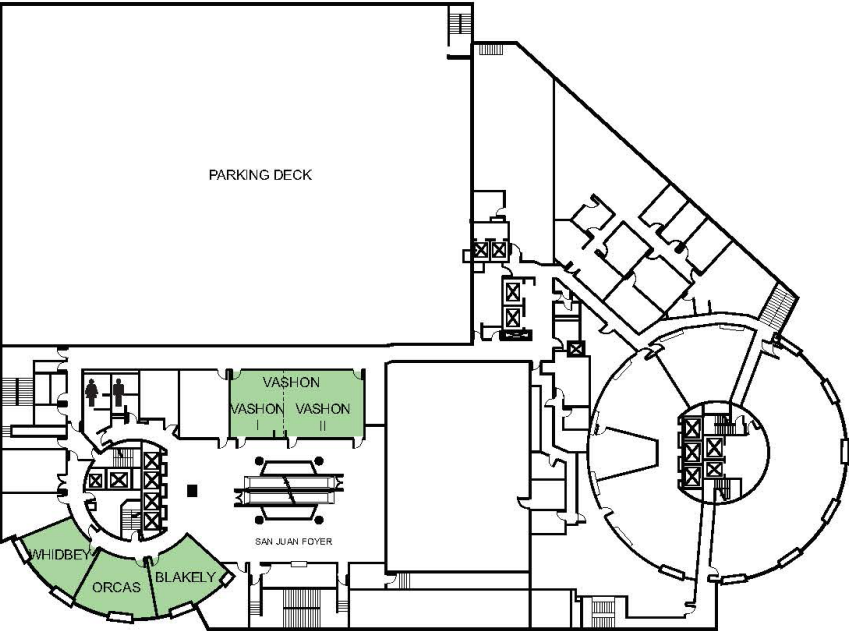
This talk will tell of a pursuit to identify the ingredients required for swarming behavior to occur in systems of hydraulic fractures. It will show that key missing elements have included: 1) a basic understanding of the attractive force in these systems -- that is, why fluid-driven cracks would have any mechanical impetus to grow near one another in the first place, and 2) a model capable of predicting conditions in which subsequent hydraulic fractures can initiate even when fluid pressure is limited by flow in previously-initiated hydraulic fractures.

A combination of theory, laboratory experiments, and numerical simulation shows that the ability to initiate and sustain propagation of multiple hydraulic fractures stems from the dependence of these key ingredients on geometry, the relative importance of viscous energy dissipation in the context of the energy balance of the system, and time-dependent failure of rocks rooted in subcritical crack growth. Finally, looking to the future, the talk will discuss how this research provides a story of both success and caution, emphasizing the need to hold reductionism and complexity in tension with one another as we seek models that are more representative of observed reality while pursuing this goal in systematic manner that allows us understand what is driving the behavior generated by the models we are developing.

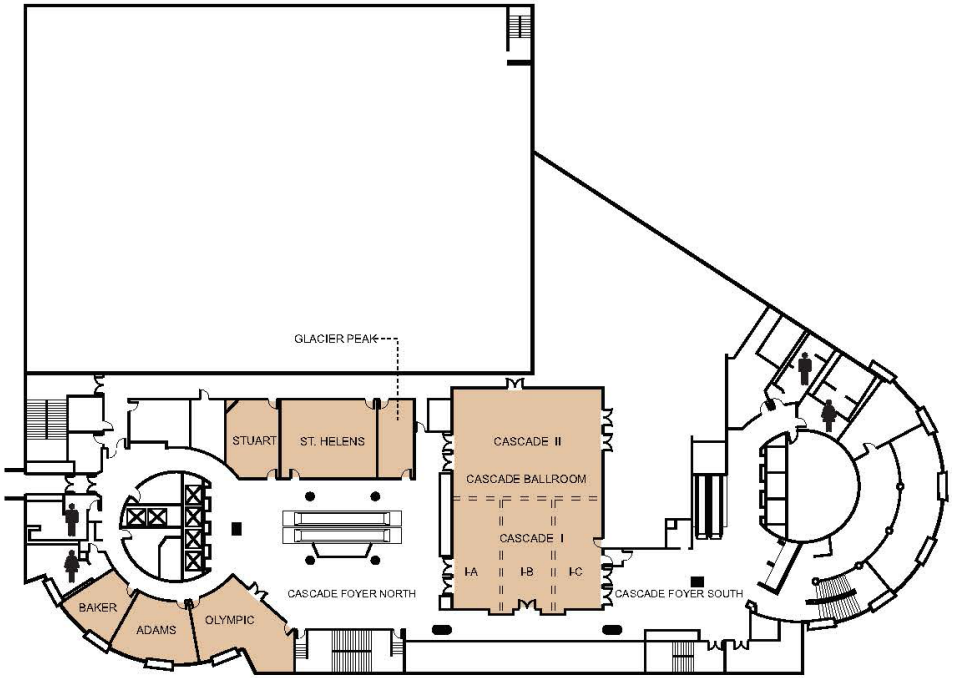
Floor Plans



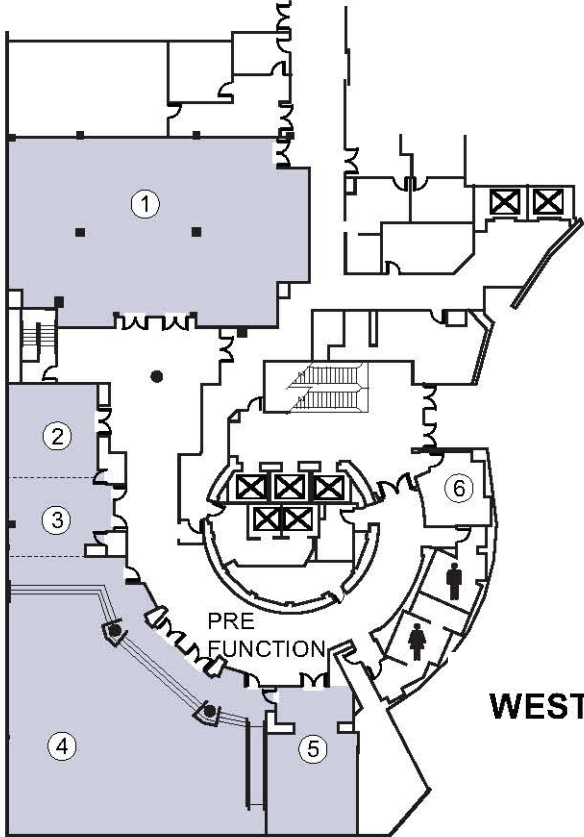
GRAND LEVEL



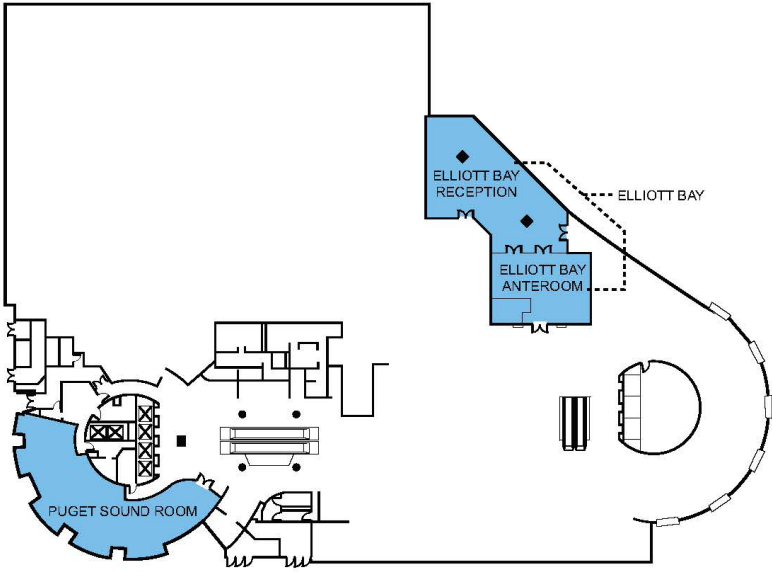
SAN JUAN LEVEL



MEZZANINE LEVEL



WESTLAKE LEVEL



LOBBY LEVEL

Monday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 1	Technical Session 5	Technical Session 9	Technical Session 13	Technical Session 9	Technical Session 13	Technical Session 9	Technical Session 13
	Geomechanics of Unconventionals	Geotechnical Laboratory and Field Testing	Experimental Studies	Geomechanics in Geothermal Processes				
	<i>Session Chair(s): Vahid Mostafaei, Hiroki Sone</i>	<i>Session Chair(s): Dan Seely, Bruno da Silva</i>	<i>Session Chair(s): Kathy Kalenchuk</i>	<i>Session Chair(s): Zach Frone, Elisabeth Metcalfe</i>				
8:00 am – 8:15 am	1230 T. Garipov Simulation of Coupled Geomechanics and Multiphase Flow in Naturally Fractured Reservoirs	22 F. Ricos Bayona Comparison between shear strength based on Barton's roughness profiles and equivalent synthetic profiles based on fractal theory	745 E. Schmidt Experimental investigation of fault surface asperities and slip response to hydraulic injection as a fault slip risk mitigation technique in deep mines	1345 T. Kneafsey The EGS Collab Project: Stimulation and Simulation				
8:15 am – 8:30 am	100 Y. Wang Rebound hardness and its relation to facies, mineralogy, natural fractures, reservoir quality, and rock mechanical properties, the "Mississippian Limestone" play, North-Central Oklahoma, USA	27 M. Nasser-Behrestaghi CT imaging and petrofabric analysis of Olkikuto rock specimens tested under true-triaxial stresses: a comparison to damages observed at a repository site	977 K. Condon Controls on the Ductile Deformation of Thermally-Fractured Granite Rocks	7 J. Morris Experimental Design for Hydrofracturing and Fluid Flow at the DOE Collab Testbed				
8:30 am – 8:45 am	55 M. Ante Nano- and Micro-Scale Deformation Behavior of Sandstone and Shale	416 M. Stigsson Finally, an objective approach to infer JRC from digitised fracture traces	735 R. Weyher Energy Analysis of Roof Sag and Fracture in Stratified Ground using Beam Theory: Dynamic Loading	1190 W. Roggenthen Natural Fractures and Their Relationship to the EGS Collab Project in the Underground of the Sanford Underground Research Facility (SURF)				
8:45 am – 9:00 am	881 V. Lavoie A method to assess potential induced seismicity hazard with application to the Duvernay	1107 L. Wong Experimental study on two semi-circular bend methods for mode I fracture toughness determination in granite	892 S. Dehkhoda Rock Cutting with an Actuated Disc: An Experimental Study	843 S. Nadimi Hydraulic Fracturing and Shear Stimulation of the Utah FORGE Enhanced Geothermal System Reservoir				
9:00 am – 9:15 am	207 H. Wang Microcrack Segmentation of Middle Bakken Shale Rock Sample with High-resolution SEM – The Application of Self-adaptive Image Enhancement Technique	1436 B. Collins Thermally-induced fracture of macro-scale surficial granite sheets	713 F. Gao Experiment study on strain softening behavior after post-peak of rock	981 A. Kamali 3D Analysis of Natural Fracture Propagation during Circulation in Geothermal Systems				
9:15 am – 9:30 am	856 S. Cuervo Integration of 1D and 3D Mechanical Earth Models in oil shale plays. An example from the Vaca Muerta Formation (Argentina)	1177 A. Ghebi Ultrasonic investigation of micro-processes occurring during sliding of fault gouge material	410 H. Lin Experimental Investigation on Borehole Breakout and its Implication on Stress Magnitudes	888 L. Hu Flow Pathway Characterization and Production Capacity of Hydraulically-induced Fracture in EGS				

Monday Technical Sessions

Track A		Track B		Track C		Track D	
Technical Session 2		Technical Session 6		Technical Session 10		Technical Session 14	
Hydraulic Fracturing Modeling		General Geomechanics		Advances in the Simulation of Damage and Fracturing Processes in Rocks and Rock Masses I		Seismicity in Mining	
Session Chair(s): Ivan Gil, Ahmad Ghassemi		Session Chair(s): Matthew Ingraham, Steve Sobolik		Session Chair(s): Andrea Lisjak, Zhou Lei		Session Chair(s): Erik Westman, Darryl Rebulli	
11:00 am – 11:15 am	Parallel Finite Element Simulations of 3D Hydraulic Fracture Propagation Using a Coupled Hydro-mechanical Interface Element	615 E. Araujo Constraining In Situ Stresses in Southern Saskatchewan, Canada	491 A. Paluszny Finite element-based simulation of the growth of dense three-dimensional fracture networks	493 S. Boltz Evaluating Seismicity at Underground Coal Mines using Temporary Surface Geophone Deployments	864 D. Rebulli Seismic calibration of in situ stress at Williams mine		
11:15 am – 11:30 am	Simulation and Analysis of Laboratory Scale Hydraulic Fracturing Using a 3D Virtual Multidimensional Internal Bonds Model	1188 J. Nopola Advancements in Laboratory and Field Testing of the Rock Melt Borehole Sealing System	267 I. Vazalos A Multidisciplinary Approach in Modelling Hard Rocks with Natural Discontinuities: From Data Collection to Numerical Simulation.	674 T. Zvarivadza Common rockburst damage mechanisms associated with mechanized deep to ultra-deep gold mining in South Africa			
11:30 am – 11:45 am	Numerical and Experimental Studies on the Hydraulic Fracture Propagation Behavior Influenced by pre-existing production and injection wells	557 Q. Lei Effects of far-field stress state on local stress perturbation in heterogeneous fractured rocks	790 M. Heidari Enhancing Modified Cam Clay Model for large stress range				
11:45 am – 12:00 pm	Coupled simulation of the interaction of a hydraulic fracture with a natural fracture	1122 A. Tripathy An investigation on the influence of thermal treatment on the mechanical, physical and acoustic characteristics of shales	79 G. Shams Optimizing the DEM calibration process by applying a series of empirical equations	863 L. Brown Observed Variations in Seismic Response During a Mine Shutdown			
12:00 pm – 12:15 pm	Investigation of Kerogen's Effects on Hydraulic Fracturing using a Micromechanical HF Simulator	218 P. Azhdari Bonded particle-finite element simulation of rock in Split Hopkinson Pressure Bar test	106 N. Dubinya Nonlinear model for reversible deformation of rock containing critically stressed fractures	1012 J. Tuleau Multivariate statistical analysis to investigate the seismic response to production blasting at Goldcorp Eleonore.			
12:15 pm – 12:30 pm	Investigation of the fracture propagation in fractured-vuggy reservoirs	307 F. Gao A numerical study on the effect of loading system stiffness on strainbursts	1100 P. Clarke Random field realization and fracture simulation of rocks with angular bias for fracture strength	1027 K. Den Using the Energy Index Method to Evaluate Seismic Hazards in an Underground Narrow Vein Metal Mine			

Monday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 3		Technical Session 7		Technical Session 11		Technical Session 15	
	Heavy Oil Geomechanics		New Developments in Geomechanics		Advances in the Simulation of Damage and Fracturing Processes in Rocks and Rock Masses II		Ground Control in Coal Mining	
	<i>Session Chair(s): Ahmad Ghassemi, Reza Safari</i>		<i>Session Chair(s): Eric Poek</i>		<i>Session Chair(s): Andrea Lisjak, Doug Stead</i>		<i>Session Chair(s): Peter Zhang, Brijes Mishra</i>	
2:00 pm – 2:15 pm	1351. A. Settari Use of thermal geomechanics for improving vertical communication in oil sands reservoirs with interbedded shales	494. A. Drienzo Development of a video-based real-time hazard monitoring system for underground mining	498. R. Bewick A Proposed Methodology for Rock Mass Strength Characterization in Weak Veined Rock Masses	40. M. Ghasemi Development of a laboratory testing apparatus and numerical simulation of three-hinge buckling	508. R. Turner Geotechnical Characterization of Underground Mine Excavations from UAV-Generated Photogrammetric and FLIR Imagery	516. E. Russel UAV-based Geotechnical Characterization of Inaccessible Underground Sites	587. G. Manthei Comparison of Moment Tensors and Cluster Formation of Acoustic Emission Events with Macroscopic Failure Process of Salt Rock Specimen under Triaxial Extension	26. M. Sears The Effect of Floor Strength and Horizontal Stress Orientation on Floor Heave in a Deep US Longwall Mine
2:15 pm – 2:30 pm	1324. D. Walters Permeability Enhancement of Oil Sands for optimized thermal recovery	1324. D. Walters Permeability Enhancement of Oil Sands for optimized thermal recovery	1349. A. Settari Modeling of thermal geomechanical effects in the SAGDOX recovery process in oil sands	642. M. Roostaei How the design criteria for slotted liners in SAGD are affected by stress build up around the liner	31. Y. Gao Modeling of reservoir deformation upon preheating in SAGD wells considering phase change of bitumen	99. H. Pang A new methodology for the preparation of synthetic oil sand cores	62. D. Adhikary Height of longwall mining induced connective fracturing and estimation of permeability enhancement	68. T. Minoski Comparison of Longwall-induced Subsurface Deformations on Shale Gas Well Casing Stability under Medium and Deep Covers
2:30 pm – 2:45 pm								214. M. Van Dyke Significant Floor Failure at a Deep US Longwall Mine
2:45 pm – 3:00 pm								956. P. Zhang Roof Failure in Longwall Headgate – Causes, Risks, and Prevention
3:00 pm – 3:15 pm								958. K. Andrews Assessment of Sequenced Room and Pillar Retreat Coal Mine Subsidence Using the Surface Deformation Prediction System (SDPS)

Monday Technical Sessions

	Track A	Track B	Track C	Track D
Time	Technical Session 4 <i>Sanding</i>	Technical Session 8 <i>Reservoir Geomechanics</i>	Technical Session 12 <i>Developments in Backfilling Mining Stopes</i>	Technical Session 16 <i>Induced Seismicity and Microseismic Monitoring</i>
	<i>Session Chair(s): Reza Safari, James Otoo</i>	<i>Session Chair(s): James Otoo, Ahmad Ghassemi</i>	<i>Session Chair(s): Brad Seymour, Dave Stone</i>	<i>Session Chair(s): Shawn Maxwell, Fengshou Zhang</i>
4:30 pm – 4:45 pm	915 W. He The Application of Element Concentration on Tensile Failure Prediction of Sandstone Formations Using Digital Imaging Correlation and Microscope Observation	554 P. Schutjens Compaction- and shear-induced well deformation in Tyra: Geomechanics for impact on production	815 M. Raffaldi Geomechanics of Cemented Paste Backfill at the Lucky Friday Mine	478 F. Zhang Co-evolution of Friction and Permeability in a Propped Fracture under Constant Shear and Implication to Induced Seismicity
4:45 pm – 5:00 pm	961 E. Papamichos Sand production in isotropic and anisotropic stress tests	785 M. Hettrema A predictive model for the seismicity rate of the Groningen gas reservoir	873 S. Warren Estimating the in situ material properties of cemented rockfill in underhand cut and fill mines	604 L. Jin Modeling Induced Seismicity: Co-Seismic Fully Dynamic-Spontaneous Rupture Considering Fault Poroelastic Stress
5:00 pm – 5:15 pm	966 X. Wu Experimental study on the physical and mechanical properties of high-temperature sandstone after liquid nitrogen cooling	610 R. Yuan Fault slip or bed-parallel shear? – A multi-scenario modeling approach to investigating well deformation in the deep overburden of a compacting reservoir in the North Sea	1008 B. Seymore Long-term stability of a large undercut span beneath cemented rockfill at the Turquoise Ridge Mine	661 S. Lui Investigating the effect of induced stress perturbation on the slip behavior of faults through numerical simulations
5:15 pm – 5:30 pm	462 C. Morales - Monsalve Effect of temperature and confining stress on petrophysical behavior of unconsolidated Colombian sands	262 P. Jeanne Changes in fault hydro-mechanical properties associated with a series of small ruptures in a claystone formation: field experiments and numerical simulations	1031 K. Dehn An Alternative Method for Utilizing Cemented Hydraulic Sand Backfill in Underhand Cut-and-Fill Mining for Large Span Excavations in a Deep Metal Mine	882 B. Hemami A Study of Basement Structures in Central Oklahoma with Reference to Seismicity
5:30 pm – 5:45 pm	269 X. Liu 3D Finite Element Analysis and Experimental Study of Stability of Slotted Liners	502 C. Ozan Assessment of Creep Potential of Gearle Formation for Griffin Field PP&A Planning and Field Observations	1198 J. Oke Backfill Barricade Design: Practical Experiences and Recommendations	1239 A. Amini A Numerical Investigation of the Effects of Geological Heterogeneity and Formation Stiffness on Induced Seismicity Magnitudes
5:45 pm – 6:00 pm	221 O. Kolawole Geomechanical modeling of wellbore stability and sand production in the Hadjuoszoboszló field, Pannonian Basin: Hungary	905 F. Hadi Shear Wave Prediction in Carbonate Reservoirs: Can Artificial Neural Network Outperform Regression Analysis?	825 W. Li Transport-Controlled Dissolution in Underground Cavities: an Experimental Validation of the Extended Graetz Solution	552 D. Zbinden Modeling the effects of in-situ conditions on induced seismicity

Tuesday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 17	Technical Session 21	Technical Session 21	Technical Session 21	Technical Session 25	Technical Session 25	Technical Session 29	Technical Session 29
	<i>Casing/Cement/Formation Interactions</i>	<i>Hydraulic Fracturing Experimental</i>	<i>Hydraulic Fracturing Experimental</i>	<i>Slope Stability in Mines</i>	<i>Slope Stability in Mines</i>	<i>Slope Stability in Mines</i>	<i>Rock Physics and Geophysics for Integrated Geomechanical Characterization</i>	<i>Rock Physics and Geophysics for Integrated Geomechanical Characterization</i>
	<i>Session Chair(s): Mohammed Azeemuddin, Chao Liu</i>	<i>Session Chair(s): Ruijing Wu, Abhijit Mitra</i>	<i>Session Chair(s): Ruijing Wu, Abhijit Mitra</i>	<i>Session Chair(s): Cristobal Herrero, Rennie Kaunda</i>	<i>Session Chair(s): Cristobal Herrero, Rennie Kaunda</i>	<i>Session Chair(s): Cristobal Herrero, Rennie Kaunda</i>	<i>Session Chair(s): Doug Schmitt, Luyi Shen</i>	<i>Session Chair(s): Doug Schmitt, Luyi Shen</i>
8:00 am – 8:15 am	35 J. Kao A method evaluating cement-sheath integrity evaluated by damage mechanics	430 B. Crawford Evaluating Mechanical Damage and Closure Stress Effects On Hydraulic Fracture Treatments Using Novel Geomechanics Laboratory Testing: Application to Julia Field, GOM	430 B. Crawford Evaluating Mechanical Damage and Closure Stress Effects On Hydraulic Fracture Treatments Using Novel Geomechanics Laboratory Testing: Application to Julia Field, GOM	1366 K. Moffitt Back-analysis of the Bingham Canyon South Wall—a quasi-static complex slope movement mechanism	1366 K. Moffitt Back-analysis of the Bingham Canyon South Wall—a quasi-static complex slope movement mechanism	1366 K. Moffitt Back-analysis of the Bingham Canyon South Wall—a quasi-static complex slope movement mechanism	151 P. Bhournick Mapping hydraulic fracture in Pyrophyllite using Shear Wave	151 P. Bhournick Mapping hydraulic fracture in Pyrophyllite using Shear Wave
8:15 am – 8:30 am	953 N. Agofack Effect of loading history on mechanical properties of hardened oil/gas well-cement	1221 O. Al Dajani Hydraulic Fracture of Opalinus Shale under Uniaxial Stress: Experiment Design and Preliminary Results	1221 O. Al Dajani Hydraulic Fracture of Opalinus Shale under Uniaxial Stress: Experiment Design and Preliminary Results	531 A. Perry A methodology to delineate hydrothermally altered and fractured material as a geomechanical domain	531 A. Perry A methodology to delineate hydrothermally altered and fractured material as a geomechanical domain	531 A. Perry A methodology to delineate hydrothermally altered and fractured material as a geomechanical domain	256 N. Dutler Observations of fracture propagation during decameter-scale hydraulic fracturing experiments	256 N. Dutler Observations of fracture propagation during decameter-scale hydraulic fracturing experiments
8:30 am – 8:45 am	1026 D. Crain Numerical Simulation of Micro-annuli Attributes Imposed by Stress Regime and Elastic Contrast	1119 B. Fan Laboratory Study on Hydraulic Fracturing in Poorly Consolidated Sandstones	1119 B. Fan Laboratory Study on Hydraulic Fracturing in Poorly Consolidated Sandstones	A Comparison of the Shear Strength Reduction Technique and Limit Equilibrium Method for Slope Stability	A Comparison of the Shear Strength Reduction Technique and Limit Equilibrium Method for Slope Stability	A Comparison of the Shear Strength Reduction Technique and Limit Equilibrium Method for Slope Stability	257 S. Lozovyi Static vs. dynamic stiffness of shales: frequency and stress magnitude effects	257 S. Lozovyi Static vs. dynamic stiffness of shales: frequency and stress magnitude effects
8:45 am – 9:00 am	224 W. Zhang Numerical investigation of the influence of Cement Failure to Micro-annuli Generation	442 R. Feng Experimental Investigation in the Effect of Rock Brittleness on Hydraulic Fracture Parameters	442 R. Feng Experimental Investigation in the Effect of Rock Brittleness on Hydraulic Fracture Parameters	1155 D. Gao Random field data analysis of rock specimens with laboratory scales	1155 D. Gao Random field data analysis of rock specimens with laboratory scales	1155 D. Gao Random field data analysis of rock specimens with laboratory scales	1204 L. Jiang Elastic wave conversion from fractures with oriented voids	1204 L. Jiang Elastic wave conversion from fractures with oriented voids
9:00 am – 9:15 am	1298 B. Orlic Numerical investigations of cement interface debonding for assessment of well integrity risks	1189 D. Fjaestad Experimental Investigation of Proppant Flow and Transport in Narrow Fractures	1189 D. Fjaestad Experimental Investigation of Proppant Flow and Transport in Narrow Fractures	1419 C. Chen Three calculation methods for stability analysis of footwall slopes	1419 C. Chen Three calculation methods for stability analysis of footwall slopes	1419 C. Chen Three calculation methods for stability analysis of footwall slopes	389 T. Ishibashi Concurrent monitoring of hydraulic-mechanical-seismic properties of granite fracture during hydraulic shearing in laboratory	389 T. Ishibashi Concurrent monitoring of hydraulic-mechanical-seismic properties of granite fracture during hydraulic shearing in laboratory
9:15 am – 9:30 am	324 D. Gao Non-uniform In-Situ Stress Applied on Casing due to Plastic Deformation of Rock	140 L. Tan Experimental and numerical 3D analysis of hydraulic fracturing in Shaly Unconsolidated Sandstone Reservoir	140 L. Tan Experimental and numerical 3D analysis of hydraulic fracturing in Shaly Unconsolidated Sandstone Reservoir	80 B. Azarfar A Discussion on Numerical Modeling of Fault for Large Open Pit Mines	80 B. Azarfar A Discussion on Numerical Modeling of Fault for Large Open Pit Mines	80 B. Azarfar A Discussion on Numerical Modeling of Fault for Large Open Pit Mines	1170 J. Parker Understanding Micro-Asperity Rupture through Finite Source Inversion	1170 J. Parker Understanding Micro-Asperity Rupture through Finite Source Inversion

Tuesday Technical Sessions

	Track A Technical Session 18	Track B Technical Session 22	Track C Technical Session 26	Track D Technical Session 30
Time	Salt and Injection Geomechanics <i>Session Chair(s): Ruiting Wu, Neal Nagel</i>	Hydraulic Fracturing Geomechanics I <i>Session Chair(s): Ivan Gil, Katelyn Huffman</i>	Slope Stability, Dams and Foundations <i>Session Chair(s): Ingrid Tomac, Hossein Masoumi</i>	Imaging Technologies for Geomechanics <i>Session Chair(s): Laurent Louis, Giovanni Grasselli</i>
11:00 am – 11:15 am	647 F. Pereira A methodology for the assessment of casing integrity in scenarios of salt rock dissolution	261 H. Fu Experimental Study and Field Application of Fiber Dynamic Diversion in West China Ultra-deep Fractured Gas Reservoir	115 A. Schmitt Increasing the Stability of aged solid hydraulic structures on weathered rock - Examination and rehabilitation of a rolling-weir gate	300 C. Davy Three scale analysis of a natural shale
11:15 am – 11:30 am	637 M. Nikolinkou Geomechanical modeling of stress and deformation associated with salt-sheet advance	1124 H. Lin Experimental and Numerical Investigations of Hydraulic Fracture Propagation in Weakly Consolidated Sandstone Reservoir	180 T. Nguyen Overview of Carbonate-Rocks and IGM Supporting Florida Bridges	999 L. Frash Fracturing, fluid flowing, and x-ray imaging through anhydrite at stressed conditions
11:30 am – 11:45 am	984 S. Orozco Orozco Managing Creep Closure in Salt Uncertainty While Drilling	201 T. Almubarak Reducing Polymer Loading in Fracturing Fluids Through Mixed Polymer Synergy	755 D. Elmo A finite-discrete element numerical analysis to study the instability of the Passo della Morte slopes (Carnian Alps, Italy)	1167 Q. Zhao Rotary shear test under X-ray micro-computed tomography
11:45 am – 12:00 pm	266 B. Park A Risk of Loss in Integrity of the Sidewall of a Cavern Located Near the Edge of the Salt Dome	238 Z. Chen Analysis of mechanical conditions and affecting factors for forming micro-annuli during hydraulic fracturing	788 D. Martin The factor of safety for slopes in strain-weakening material	1199 M. Schindler Micro CT Imaging of Pore-Scale Changes in Unconsolidated Sediment under Confining Pressure
12:00 pm – 12:15 pm	423 D. Zhang Is salt a poromechanical material?	189 X. Shi Fracture propagation in multi-lateral horizontal wells with zipper fracturing of non-uniform spacing	434 M.-C. Weng Dynamic behavior of a dip slope using shaking table tests	1233 J. Carey Experimental Investigation of Shear Fracture Development and Fluid Flow in Dolomite
12:15 pm – 12:30 pm	409 B. Zhao The effects of long-term waterflooding on the physical and mechanical properties of tight sandstones	841 M. Chen Numerical Investigation on the Effect of Horizontal Frictional Interfaces on Hydraulic Fracture Growth based on 2D BEM with a Complementarity Algorithm	852 B. Avar Tectonic fault rupture hazard and impact on structures?	1320 L. Louis Integration of rock images and laboratory data through the lens of a new discipline

Tuesday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 19	Technical Session 23	Technical Session 27	Technical Session 31	Technical Session 27	Technical Session 31	Technical Session 27	Technical Session 31
	Hydraulic Fracturing Geomechanics II <i>Session Chair(s): Katelyn Huffman, Ruiting Wu</i>	Experimental, Hydrothermal and Biological Rock Mechanics <i>Session Chair(s): Xiaodong Ma, Mathew Ingraham</i>	Mining Case Histories <i>Session Chair(s): Tom Vandergrift, Tawanda Zvarivadza</i>	AE and NDE Techniques for Material and Microcrack Characterization <i>Session Chair(s): Jesse Hampton, Andy Rathbun</i>				
2:00 pm – 2:15 pm	879 J. Ramos Development and Testing of Advanced Inter-Well Pressure Pulse Analysis for Fracture Diagnostics in Tight Gas Reservoirs	282 P. Gardiner Release of geogenic gases as a signal of deformation in rock	126 G. Walton Rock Mechanics Challenges for the Excavation of a Deep Shaft in Anisotropic Ground	86 M. Khandelwal Prediction of index properties of different rocks using non-destructive testing				
2:15 pm – 2:30 pm	377 S. Tong Mechanical Principle of Hydraulic Pressure Vibration Method for Increasing Production-A New Approach	830 H. Roshan Newly Designed Cell for Triaxial Testing	363 G. Esterhuizen A case study of pillar collapse at a limestone mine in Pennsylvania	133 S. Vialle Prediction of the macroscopic mechanical properties of carbonate from nano-indentation tests				
2:30 pm – 2:45 pm	382 S. Tong Study on Mechanism of Improving Horizontal Wellbore Carrying Sand Flow based on Archimedes Double Helix Tubing Strings and its Application in Changqing Oilfield	1017 S. Zhi Hydraulic Fracturing of MECBM reservoirs for nutrient delivery and gas production	434 K. Kalensuk Estimation of in-situ stress from borehole breakout at KGHM's Victoria Project, Canada	129 G. Bolnott High resolution geomechanical profiling in heterogeneous source rock from the Vaca Muerta Fm, Neuquén Basin, Argentina				
2:45 pm – 3:00 pm	917 H. Dong Influence of Natural Fracture dimensions on Hydraulic Fractures	1169 H. Zhou Dilation of rock joints based on quantified surface description	680 T. Zvarivadza Support design for large chamber excavations: case study of mechanized deep to ultra-deep gold mining in South Africa	772 M. Petruzaiek Shear tensile crack as an AE source model				
3:00 pm – 3:15 pm	901 S. Mighani Role of Fault Gouge during Interaction between Hydraulic Fracture and a Preexisting Fracture	1228 E. Davis Temperature-Dependent Elasticity of Common Reservoir Rocks	655 K. Kalensuk Geomechanical aspects of risk evaluation, design and implementation of crown pillar extraction at Pino Altos Mine.	1234 A. Vacharampill Insight into True Triaxial Failure Mechanisms in Berea Sandstone Using Acoustic Emission Monitoring				
3:15 pm – 3:30 pm	567 S. Green Effect of Cluster Spacing on Propped Fracture Net	1437 M. Epps Linking subcritical cracking to long-term rock erosion.	498 J. Riedel Network Monitoring with a Leveling Subsurface: A Case Study in Measuring Small Changes in Elevation	1422 N. Zakharova Formation strength and acoustic velocity in rift basin mudstones: effects of in situ stress, frequency, and lithology				

Tuesday Technical Sessions

	Track A Technical Session 20	Track B Technical Session 24	Track C Technical Session 28	Track D Technical Session 32
Time	Hydraulic Fracturing Special: Acid and Refrac <i>Session Chair(s): Yongcun Feng, Katelyn Huffman</i>	Lab Studies: Unconventionals <i>Session Chair(s): Hiroki Sone, Yahid Mostafaei</i>	Case Histories-Civil Engineering Projects <i>Session Chair(s): Chi Park, Nick Hudyma</i>	AE for Lab Scale Fracturing Monitoring and Microcrack Detection <i>Session Chair(s): Jesse Hampton, Luke Frash</i>
4:30 pm – 4:45 pm	545 L. Zhang An Experimental investigation of long-term acid propped fracturing conductivity in deep carbonate reservoirs	1146 E. Fjær Laboratory test for studies on shale barrier formation	712 M. Karami Technical and Practical Analysis of Contact grouting in mechanized Tunneling Case Study: Konjancham Water Conveyance Tunnel (in Iran)	1160 M. Diaz Acoustic emission monitoring and analysis of laboratory cyclic hydraulic fracturing on granite under differential stresses
4:45 pm – 5:00 pm	909 R. Safari Near Wellbore Carbonate Rock Failure Model with Acid-Weakening Effects	78 A. Abbas Laboratory Determination of the Mechanical Properties of Shale	1021 E. Friedman Rock Mapping, Characterization, and Stabilization in the Anton Anderson Memorial Tunnel, Whittier, Alaska	629 Z. Ye Injection-driven Fracture Propagation and Coalescence under Triaxial Loading
5:00 pm – 5:15 pm	1260 Y. Wang Combined influences of acid solution and geo stress on fracture geometry during acid fracturing in laboratory	342 Y. Peng Impact of Fluid Adsorption on Geomechanics Properties of Shale Gas Reservoir and Shale Gas Recovery Rate	244 A. Al-Ostaz Devising Sustainable but Cost-Effective Retrofitting Techniques for Levees and Floodwalls in New Orleans	69 J. Hampton Extended-term monitoring of acoustic emission post-laboratory hydraulic fracturing
5:15 pm – 5:30 pm	1048 J. Lai Pore Structure and Mechanical Property Change on the Surface of the Tight Limestone After Acid-Rock Reaction	805 H. Du Mechanical Properties Mapping by Indentation on Shale Rocks	1050 P. Woodmansey Road tunnel excavations beneath existing metro lines: Tseung Kwan O – Lam Tin tunnel	795 D. Shirole A Non-Linear Ultrasonic Method for Damage Characterization in Brittle Sandstone
5:30 pm – 5:45 pm	729 D. Kumar A 3D Geomechanical Analysis of Horizontal Wells Refracturing and “Frac-hits”	1220 J. Goral Macro- and Micro-Scale Uniaxial Compression Testing of Woodford Shale	1286 P. Shi Mixed face tunneling using earth pressure balanced TBM in Suzhou China	798 I. Onsel Applications of virtual and mixed reality in rock engineering
5:45 pm – 6:00 pm	859 X. Wan Potential Thermoelastic Stresses Effects during the Fracture Propagation of Refracture Treatments in Horizontal Bakken Wells	127 Q. Chen Mode I and Mode II fracture toughness of Montney shale	521 Y. Zhang Research on the limit operating pressure of bedded salt cavern gas storage	174 J. Shan Investigation of the Acoustic Emission and Heat production properties on Joint surfaces due to the wave-induced friction

Wednesday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 33		Technical Session 37		Technical Session 41		Technical Session 45	
	<i>Formation Laboratory Evaluations I</i>		<i>Tunnels and Underground Structures</i>		<i>Wellbore Stability I</i>		<i>Coupled Processes, Fluid-driven Fracture, Caprock Integrity</i>	
	<i>Session Chair(s): Abhijit Mitra, Shuyang Wang</i>		<i>Session Chair(s): Eva Ieronymaki, Gabi Walton</i>		<i>Session Chair(s): Gang Li, Mohammed Azeemuddin</i>		<i>Session Chair(s): Parth Newell, Mehرداد Shabanzadeh</i>	
8:00 am – 8:15 am	1230 S. Hoi	Simplified method to determine the uniaxial-strain compressibility of cohesive sandstone	253 A. Hedayat	Analysis of stresses and deformations in crozier tunnels in strain-softening rock masses	686 F. Xindong	A Stable Explicit Solution for Borehole Stress Calculation in Arbitrary Transversely isotropic Formations	268 A. Rasmehnykh	Aspect ratio of an elliptic hydraulic fracture in a transversely isotropic material
8:15 am – 8:30 am	1245 S. Mighani	Can we use nanoindentation to derive the Poroelastic Parameters of Microporous rocks? experimental evidence	749 H. Liu	A Markovian rock mass quality prediction model for tunneling	11 K. Seydabreza	A Method to Find Optimum Mud Weight in Negative Safe Mud Weight Windows	230 J. Protasov	Modeling constant height parallel hydraulic fractures with Elliptic Displacement Discontinuity Method (EDDM)
8:30 am – 8:45 am	897 Y. Li	Rock Behavior and Brittleness under the Confined Brazilian Test	756 B. Forbes	Spile support performance monitored in a shallow urban tunnel using distributed optical strain sensing	329 T. Ma	Wellbore stability analysis by using a risk-controlled method	651 J. Rueda Cordero	Discrete and smeared fracture model to simulate fluid flow in naturally fractured reservoirs
8:45 am – 9:00 am	1163 S. Ali	Effect of Various Unloading Criteria on Rock Failure Parameters from Multi-Stage Triaxial Test – A Comprehensive Study	884 M. Moridzadeh	Creep Analysis of Pump Station Cavern in Thinly Bedded Shale	105 Z. Lu	Study on Intelligent Prediction for Risk Level of Lost Circulation While Drilling Based on Machine Learning	656 J. Huang	Applicability of Virtual Crack Closure Technique for Simulating Hydraulic Fractures Breaking Through Stress and Stiffness Barriers
9:00 am – 9:15 am	98 T. Pryhovaoka	Effect of rock heterogeneity on rock reaction force oscillation	1104 L. Eriksson	Comparison between Blasting and Wire Sawing regarding Hydraulic Properties of the Excavated Damaged Zone in a Tunnel – Experiences from Crystalline Rock at the Aspö Hard Rock Laboratory, Sweden	806 B. Valley	Temporal borehole breakout evolution and its impact on stress estimation	899 H. Yu	The effect of CO ₂ on the Mechanical Properties of Reservoir Sandstones under Low Differential Pressure
9:15 am – 9:30 am	512 Y. Peng	Experimental study on energy dissipation of rock crushing under impact load	255 T. Wang	Numerical investigation of the supporting system of Qionghong underground powerhouse cavern	134 R. Rahimi	Experimental Evaluation of Using Fine-Grained Coal Combustion Residuals for Controlling Fluid Invasion in Shales	297 L. Zhuang	Experimental study on permeability enhancement of granite during cyclic hydraulic fracturing under differential stresses

Wednesday Technical Sessions

Track A		Track B		Track C		Track D	
Technical Session 34		Technical Session 38		Technical Session 42		Technical Session 46	
Formation Laboratory Evaluations II		Numerical Modeling of Civil Engineering Projects		Wellbore Stability II		Pore-scale, Micro, and Nano Rock Mechanics	
Session Chair(s): Shuping Wang, James Otoo		Session Chair(s): Yida Zhang, Seunghee Kim		Session Chair(s): Gang Li, Chao Liu		Session Chair(s): Mehرداد Soltanmehdi, Paul Young	
63 A. Givelli	Effects of Microfractures Properties on Stress-dependent Permeability in Tight Oil Reservoirs	220 H. Li	Experimental and numerical investigations on nonlinear shear behavior of rough joints	1059 W. Liu	Numerical modeling of wellbore stability in naturally fractured shale formation	52 M. Mashhadini	A probabilistic multiscale approach for modeling poromechanical properties of shales
11:15 am – 11:15 am		388 H. Ji	Generation of the polycrystalline rock microstructure by a novel Voronoi grain-based model with particle growth	175 W. U	A Model of Open-hole Extended-reach Limit Of Wells In Hydrate-bearing Sediments Of Permafrost Regions	54 V. Dubey	Multiscale modeling of microcrack-induced mechanical and transport properties in shales
202 L. Yang	Effects of Microfractures Properties on Stress-dependent Permeability in Tight Oil Reservoirs	876 J. Ha	Three-dimensional FDEM modeling of laboratory tests and tunnels	846 X. Li	The Maximum Measured Depth of Extended-Reach Well Based on Mud Weight Window for Different Drilling-Operating Conditions in Horizontal Drilling	76 M. Liu	A Poroelastic Solution of Rigid Sphere Indentation into a Compressible Half-Space
11:30 am – 11:45 am		980 M. Gardner	Modeling Rock Scour using Coupled 3-D Discrete Element and Lattice Boltzmann Methods	851 E. Arriago	Applied Wellbore Stability Analysis to Pyrenees Development Area: A Field Case	501 S. Ilyamodin	Micro-mechanical modeling of dynamic shear on rough fracture surfaces
739 J. Favero	Constitutive elastoplastic model applied for representation of the geomechanical behavior of Travertine carbonate rock	1294 Y. Ma	Effect of Shear Band Failure on the Strength Ratio in DEM Modeling	328 S. Wei	An analytical method to study the influence of impact loads on the pore pressure during drilling	877 Y. Qu	Micro-mechanical characterization of Montney Shale
11:45 am – 12:00 pm		1049 H. Zhu	Nonlinear constitutive model and discrete-element-method modeling of synthetic Methane Hydrate sand	1120 R. Kifan	Wellbore Strengthening Characteristics: Evaluation of Situations using Experimental and Analytical Studies	219 P. Kabir	Fluid-Rock Interactions in Mt. Simon Sandstone at the Microscopic Length-Scale
12:00 pm – 12:15 pm		1273 B. U	Experimental Investigation on the Fracture Conductivity of Tight Oil Reservoirs: Especially focus on the Unrapped Fractures.				
12:15 pm – 12:30 pm							

Wednesday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 35	Technical Session 39	Technical Session 43	Technical Session 47	Technical Session 43	Technical Session 47	Technical Session 43	Technical Session 47
	Formation Stress Evaluations	Numerical Modelling in Geomechanics I	Drilling General and Bit Geomechanics	CO₂ and CBM Geomechanics				
	<i>Session Chair(s): Neal Nagel, Yongcun Feng</i>	<i>Session Chair(s): Joe Carvalho, Stephan Arndt</i>	<i>Session Chair(s): Chao Liu, Gang Li</i>	<i>Session Chair(s): Yongcun Feng, Neal Nagel</i>				
2:00 pm – 2:15 pm	949 R. Holt Stress-induced pore pressure change during undrained loading	44 B. Kim Experimental and Numerical Investigation of the Engineering Properties of a Utah Coal considering the Effect of Anisotropy due to Cleats	1237 O. Rzaevi A Fully-Coupled Geomechanical Model for Solid Plugging of Drilling Induced Fractures	432 Y. Li Numerical simulation of disturbed stress field of orthotropic coal rock in pulse fracturing				
2:15 pm – 2:30 pm	286 S. Sarath Dependence of Blot's Coefficient on Depletion Stress Path	184 D. Li Modelling of Load-Displacement Behaviour of Fully Grouted Cable Bolts under Constant Normal Stiffness	75 B. Bai A Coupled Geomechanical and Fluid Flow Model for Evaluating Impact of Drilling Fluid Imbibition in Reservoir Shale Formations	277 B. Yildirim The effect of natural fracture heterogeneity on hydraulic fracture performance and seismic response in shale and coal formations				
2:30 pm – 2:45 pm	1130 J. Hampton The misnomer of "Effective Stress", and its relation to Blot coefficients	251 Z. Zhang DEM analysis on the cracking behavior of jointed rock masses pre and post-excavation	110 G. Chen Geomechanical Study for a Modern Drilling Testing Facility in Grimes County, Texas	1066 Y. Zhao Calculation of the Stress-dependent permeability in coal fracture networks by Lattice Boltzmann Method				
2:45 pm – 3:00 pm	1006 G. Gunaratna Finite element study of the stress field near resurcised and non-pressurised flaws in rock specimens subject to uniaxial and biaxial loads	264 S. Bastola Experimental Study on the Features of Hydraulic Fracture Created by Slickwater, Liquid Carbon Dioxide, and Supercritical Carbon Dioxide in Tight Sandstone Reservoirs	458 B. Zhang Prediction model of shallow geological hazards in deepwater drilling based on a hybrid computational approach	767 S. Li Experimental Study on the Features of Hydraulic Fracture Created by Slickwater, Liquid Carbon Dioxide, and Supercritical Carbon Dioxide in Tight Sandstone Reservoirs				
3:00 pm – 3:15 pm	1272 M. Myers Calculating the Frame Modulus in Gasams Equation	1109 H. Wang Effect of Supercritical Carbon Dioxide Treatment Time, Pressure and Temperature on Mechanical Properties of Sandstone	895 Q. Liu Influence of Weakness plane on Radial Drilling with Hydraulic Fracturing Initiation	1200 H. Wang Effect of Supercritical Carbon Dioxide Treatment Time, Pressure and Temperature on Mechanical Properties of Sandstone				
3:15 pm – 3:30 pm	171 A. Chan An Integrated In-Situ Stress Measurement Program for Deepwater Brown Field Developments	50 Z. Sun CO ₂ Injection Induced Fracture Initiation Based on a Resolved CFD-DEM Approach	344 Q. Deng A Model for Estimating Penetration Length under Different Performance Conditions	51 Z. Sun CO ₂ Injection Induced Fracture Initiation Based on a Resolved CFD-DEM Approach				

Wednesday Technical Sessions

Time	Track A		Track B		Track C		Track D	
	Technical Session 36		Technical Session 40		Technical Session 44		Technical Session 48	
	<i>Hydraulic Fracturing Stress Evaluations</i>		<i>Numerical Modelling in Geomechanics II</i>		<i>Ground Control in Hard Rock Mining</i>		<i>Injection Geomechanics</i>	
	<i>Session Chair(s): Abhijit Mitra, Ivan Gil</i>		<i>Session Chair(s): Berk Tulu, Zach Aguilantis</i>		<i>Session Chair(s): Eske Esterhuizer, Kevin Andrews</i>		<i>Session Chair(s): Reza Safari, Shugang Wang</i>	
4:30 pm – 4:45 pm	225 H. Wang	Estimating Fracture Closure Stress in Naturally Fractured Reservoirs with Diagnostic Fracture Injection Tests	1158 T. Garza-Cruz	Effect of shear stresses on pillar stability – A back-analysis of the Ivray Mine experience to forward predict pillar performance at Nordanoire.	307 M. Pierce	Conceptual Models of Rock Reinforcement Behavior as an Aid to Advanced Analysis	803 J. Hwang	Wellbore Integrity and Sand Failure Mechanisms of Frac-Packed Wells in Unconsolidated Sand Formations
4:45 pm – 5:00 pm	572 J. Homburg	Evaluating the Mechanism of Mechanical Damage and Closure Stress Effects on Fracture Treatments Using Textural and Chemical Characterization: Application to Julia Field, GDM	613 P. Fokker	On the use of Influence Functions in Subsidence Estimation	566 M. Raffaldi	Ground Support System Installation Sequencing and Surface Support Performance	165 A. Chan	From Wellbore Instability, Grain Mixing to Injectivity Reduction: A New Damage Mechanism for Water Injectors
5:00 pm – 5:15 pm	924 Z. Liu	Effect of low pore pressure zone at crack front on rock fracture toughness	655 C. Hume	Numerical Assessment of Roof Buckling in Mining due to High Horizontal Stress at Shallow Depths	688 T. Zornvitz	Evaluation of the ability of an Electronic Load Indicator to indicate load loss in a cable anchor	1339 L. Louis	Experimental study on the hydromechanical behavior of a GoM reservoir sand analogue at in situ conditions of pressure and temperature
5:15 pm – 5:30 pm	1176 S. Agrawal	Medianistic Explanation of the Impact of Pore Pressure on Hydraulic Fracture Propagation	945Z. Guolong	Numerical Analysis of the stability of a gob-side entry retaining in non-pillar coal mining using discrete Fracture Network Modelling	750 S. Warren	Ground Support Design Curve - Squeezing Ground in Nevada	691 H. Hofmann	Comparison of cyclic and constant fluid injection in granitic rock at different scales
5:30 pm – 5:45 pm	X367XX M. Jammoul	Effect of Reservoir Characteristics on Interval Stress Interference	525 X. Dong	Extended finite element modelling of fracture propagation during in-situ rock mass alteration	1172 J. Chow	Improved prediction of back stability in large unsupported stops at the Doe Run Mines	1321 M. Haddad	Poroelastic models for fault reactivation in response to injection and production
5:45 pm – 6:00 pm	389 J. Qe	Semi-Analytical Modelling on 3D Stress Redistribution during Hydraulic Fracturing Stimulation and Its Effects on Fault Reactivation	514 E. Azad	A Numerical simulation of Thermo-Hydro-Mechanical behavior of a single fracture in porous rock	1205 R. Calvezas	Brittle behavior and brittleness indicators around hard rock excavations	47 L. Tienheng	Laboratory Study of Hydraulic Fracturing in Cyclic Injection

Monday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session MA1	Poster Session MB1	Poster Session MC1	Poster Session MD1
<i>Heavy Oil, CO₂ and CBM Geomechanics</i>	<i>New Developments in Mining Geomechanics</i>	<i>Lab and Field Testing</i>	<i>Unconventionals</i>
<i>Session Chair(s): Neal Nagel</i>	<i>Session Chair(s): Brent Slater, Mark van Dyke</i>	<i>Session Chair(s): Kathryn Dehn</i>	<i>Session Chair(s): Vahid Mostafaei</i>
12 L. Tan Coalbed Methane Development in Liulin Block, Ordos Basin: A Study on the Complexity of Fracture Morphology in High-rank Coal Rock Fracturing	45 W. Handspiker Preliminary development of discontinuous artificial rock joints	628 Y. Chugh Time-Dependent Field Measurements of Immediate Roof Deformations at Coal Mine Intersections	34 X. Wang Decreasing water invasion into shale using hydrophilic sulfonated silica nanoparticles
252 X. Shen Coupled Transient Thermo-Hydro-Mechanical Model with Strain-dependent Hydraulic Conductivity for Heavy Oil Formation under Steam Injection	246 G. Manekar Conservation of valuable mineral by rock mechanics investigations in Musnar underground manganese mine of MOIL Limited, India	15 E. Isleyen Evaluation of 3D printing utilization in obtaining discontinuity roughness profiles	273 H. Songail Experimental study of the effect of liquid nitrogen on physical/mechanical properties of shale
488 Q. Wang Numerical Simulation on SAGD Recovery in Terrestrial Heavy Oil Reservoirs Considering the Influence of Mudstone Stringers	865 L. Brown Mining-Induced Seismicity in Canada: A 2017 Update	39 A. Corkum Evaluation of 3D printing utilization in obtaining discontinuity roughness profiles	446 X. Fan Brittleness Evaluation of the Inter-salt Shale Oil Reservoir in Jiangnan Basin in China
609 P. Cerasi Simple simulation of fracturing as a result of CO ₂ mineral dissolution and precipitation	978 Z. Cheng Spatial-temporal evolution of mining-induced fracture fields in a gas burst-prone coal seams	227 N. Zhang Triaxial compression test of the mudstone interlayers in bedded rock salt	869 M. Vishkai Geomechanical characterization of naturally fractured formation, Montney, Alberta
641 S. Wang Properties Evaluation of the Middle Bakken Formation Due to the CO ₂ Injection	1002 J. Li An investigation of the engineering rock characterization of altered granite: a case study of the Fengliushan polymetallic deposit Gejiu mineral district, China	318 G. Sang Nano-pore characterization of mine shales by small angle neutron scattering and its implication on moisture induced strength reduction	692 K. Liu Characterizing the creep behavior of shale in nanoscale
942 Z. Chang Experimental investigation on hydraulic fracture initiation and propagation for vertical well fracturing in coal-bearing multilayers	1069 A. Adoko A Bayesian Approach for Predicting Rockburst	338 J. Heo Developing and Application of Laboratory-Scale Convergence Measuring Device in Monitoring Borehole Stability	1020 O. Adekunle Influence of Osmotic Behavior on Geomechanical Property Alteration in Shales from Stress and Fluid Salinity Induced Structural Changes
1023 C. Li Effects of CO ₂ injection on elastic properties of Carbonate Rocks—A laboratory case study of Middle Bakken rocks	1166 Y. Zhang The nanoscale rockmechanical properties for low to high rank coal	447 Z. Chaojie Lab measurement and analysis of coal failure characteristics under different drilling fluids effects	1024 D. Cannon Reactivation of critically stressed fractures during well completions, Midland Basin, Texas
972 Y. Zhang Geomechanical properties change in carbonate rock during carbon geosequestration	325 H. Kang Application of hydraulic fracturing to distress abutment pressures in longwall coal mining practice- a case study	461 N. Gupta Analysis of Crack Propagation in Shale Using Microscopic Imaging Techniques	
1121 J. Xu A Fully Coupled Thermo-Hydro-Mechanical Model for Simulating Cyclic Steam Stimulation of Heavy Oil Reservoir		526 K. Kaklis A multi-stage triaxial test for cemented paste backfill	
		530 H. Zhai A validation of current rock mass property determination methods for coal measure rocks	
		551 H. Tang Experimental investigation on the stress relaxation behavior induced by subcritical crack growth of granite	
		713 F. Gao Experiment study on strain softening behavior after post-peak of rock	
		1072 Y. Chen A new experimental method for investigating the coupled shear flow behavior of rough jointed rock samples	
		1278 P. Garg Investigation of the failure mode of intact rock in biaxial and triaxial compression tests	
		786 Y. Yang Gas sorption and diffusion characteristics of tectonically deformed coals and their implications on gas drainage and outburst control	

Monday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session MA2	Poster Session MB2	Poster Session MC2	Poster Session MD2
<i>Sanding and Injection Geomechanics</i>	<i>Reservoir Geomechanics</i>	<i>General Geomechanics</i>	<i>Induced Seismicity and Microseismic Monitoring</i>
<i>Session Chair(s): Richard Schultz</i>	<i>Session Chair(s): James Otton</i>	<i>Session Chair(s): Matthew Ingraham, R. Charles Choens</i>	<i>Session Chair(s): Shawn Maxwell, Fengzhou Zhang</i>
336 C. Ma Development of a New Pre-Packaged Sand Retaining Media (Evaluating Cell)	143 M. Tran Effect of Coupled Flow and Geomechanics on Transport of a Fluid Slug in a Stress-sensitive Reservoir	116 Z. Xie The build-up of contact pressure behind casing due to formation creep	991 S. Maxwell Monitoring of Induced Seismicity Associated with Hydraulic Fracturing in the Montney Shale
85 I. Mohamed Formation Damage Induced Hydraulic Fracture during Slurry Injection into High permeability Sandstone. Is it a Good Practice?	243 A. Abbas Integrated Laboratory Measurements of Petrophysical and Geomechanical Properties for Zubair Sandstone Reservoir in Southern Iraq	811 D. Boyd Improving Geological Models through Geostatistics using Bonehole Data and an A-Priori Model	1114 K. Chang Coupled multiphase flow and geomechanical modeling of injection-induced seismicity on the basement fault
164 E. Golovin Observations of injectivity Reduction from a Near-Wellbore Mixing under Cyclic Injection into Unconsolidated Sand	247 A. Asadi Correlation between Static and Dynamic Elastic Modulus of Limestone Formations using Artificial Neural Networks	1047 S. Li A sensitivity study on internal structure in salt tectonics with compressive environment	
492 Z. Li Study on Mechanism of Dynamic Fracture Propagation Induced by Long-term Water Injection of Low Permeability reservoir	620 E. Edelman Experimental and Numerical Investigation of Time-Dependent Deformation of Low-Permeability Formations	1269 E. Bullock Sampling bias of fracture orientation: Tests using data from the Kimama borehole, Western Snake River Plain, Idaho, USA	
720 P. Quen Development of a new model to better understand and interpret underdamped slug test responses observed in straddle packer tests in fractured sandstone	472 T. no A New Method of Stress Measurement Based on Elastic Deformation of Sidewall Core with Stress Relief during Coring	786 Y. Tang Gas sorption and diffusion characteristics of tectonically deformed coals and their implications on gas drainage and outburst control	
1256 Y. Nie The Influence of Water-oil Content on the Strength of Sandstone with Weakness Plane	870 S. Goodarzi Geostatistical modeling accounting for variation of reservoir and geomechanical properties in Montney formation, Alberta	952 K. Alkhuwaili Validation of Stimulation Treatments Depends on Wellbore Mechanical Responses During Drilling	
463 C. Morales - Monsalve Evaluation of the Mechanical Behaviour of Non-Consolidated Sands at Different Stress Path	885 E. Akmal Collapse Volume Log Estimation Using Image Processing Approach	1008 A. Hedayat Direct and Quantitative Evaluation of Frictional Contacts and Processes in Goodford Sandstone Rock Joints	
	927 R. Yang Laboratory Experiment of using Liquid Nitrogen as a Temporary Blocking Agent for Coalbed Methane Fractured Wells	1219 M. Galvão Fault zones control on permeability of poorly lithified sandstone	
	1154 T. Epp Geomechanical Properties of a Porous Carbonate Saturated with a Highly Viscous Fluid from Laboratory Testing	381 M. Wierig A failure criterion for foliation of Slate	
	1214 J. Hasbani On the characterization of the viscoelastic response of the Vista Muerta Formation		
	1300 R. Makhoezi Anisotropy in the undrained pore pressure response of rock		
	1308 S. Hof Proxies for quantifying depletion-induced reservoir compaction in the Groeningen field		
	160 C. Gerny An objective review of non-destructive methods for the direct testing of strength on rock cores		
	216 B. Yusuf Basis Pressure Method for Subsurface Properties Estimation – A Case Study		
	319 S. Borglum A viable alternative: tensile strength determination of the Trezona Sandstone and Salem Limestone by pore-overpressurization		
	323 S. Khatibi Geomechanical and geochemical characterization of organic matter by Raman spectroscopy		
	535 P. Huang Effects of High Temperature and Liquid Nitrogen Cooling on Model Fracture Toughness of Hot Dry Rocks		
	744 Z. Tariq A Rigorous Empirical Approach to Predict Poisson's Ratio of Carbonate Rocks from Wireline Logs using Artificial Intelligence Tools		
	831 Y. Kovalyuchen Measurement of rock strain using Fiber Bragg Grating sensors		

Monday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session MA3	Poster Session MB3
<i>Geomechanics in Geothermal Processes</i>	<i>Advances in the Simulation of Damage and Fracturing Processes in Rocks and Rock Masses I</i>
<i>Session Chair(s): Laurent Louis, Giovanni Grasselli</i>	<i>Session Chair(s): Andrea Lisjak, Zhou Lei</i>
1197 A. Riahi Numerical Modeling of Discrete Fractures in Field-Scale EGS Reservoirs	292 L. Wong Investigating the influence of microstructural fabric on fracturing behavior of the crystalline rock: an insight from the discrete fracture network simulation
464 M. Swyer Simulating Local Sources of Crustal Deformation at Depth for Washington State Geothermal Play Fairway Prospects using the Geomechanical Models of Faults and Magma Chambers and Remote Tectonic Stress Derived from Geodetic Strain-Rate Tensors	326 G. Liu Modeling Time-dependent Failure of Brittle Rock using Grain-Based Model
777 Y. Wang Hydraulic Fracturing Initiation and the thermal cracking near a horizontal Well: Model, Analytical solution and Applications to Enhanced Geothermal System	658 B. Euser 3-D finite-discrete element simulation of a triaxial direct-shear experiment
787 J. Yoon Discrete element simulation of fault dynamic rupture and slip distribution: effect of off-fault damage and fault extension	770 M. Starmoni Three-dimensional finite volume discretization of a simple capped Drucker-Prager model for poro-elasto-plastic geomaterials
1360 E. Yildirim Laboratory Observations of Fracture Permeability and Friction Evolution in Rocks from the SIGMA-V Site	832 S. Ma Coupled damage and plasticity model for shear behavior of shales
1252 C. Ulrich The distribution, orientation, and characteristics of natural fractures for Experiment 1 of the EGS Collab Project, Sanford Underground Research Facility	1210 Y. Alzayer Numerical Modeling of Early-Formed Natural Fractures in Modern and Ancient Carbonate Systems
791 J. TerHeege The geomechanical response of naturally fractured carbonate reservoirs to operation of a geothermal doublet	499 C. Zeng The effect of radial cracking on the integrity of asperity under thermal unloading process
130 M. Ingraham Design of a long term hydraulic fracture and flow system	943 W. Yan Subcritical Crack Propagation Tests on Tight Oil Sandstone under Different Fluid Conditions
148 Z. Zhou Experimental study of hydraulic fracturing in enhanced geothermal system	1178 P. Lollino FDEM analysis of fracturing processes affecting vertical cliffs in soft calcarenites
813 N. Islam Determining Geothermal ultra-hard rock properties from Mechanical Specific Energy and bit measurements	
1143 A. Ahmadi Feasibility Study and Simulation of Deep Solar Energy Geo-Storage	
1001 L. Frash Laboratory validation of fracture caging for hydraulic fracture control	
862 K. Kurtun Hydraulic Fracture Modling in Support of EGS Collab Treatment Designs	

Tuesday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session TA1	Poster Session TB1	Poster Session TC1	Poster Session TD1
Hydraulic Fracturing	Experimental, Hydrothermal and Biological Rock Mechanics + AE and NDE techniques for material and microcrack characterization	Slope, Tunnel, and Underground Structure	Rock Physics and Geophysics for Integrated Geomechanical Characterization
Session Chair(s):	Session Chair(s): Xiaodong Ma, Jesse Hampton	Session Chair(s): Reza Hedayat	Session Chair(s): Layl Shen, Doug Schmitt
32 T. Wang Experimental Study on Improving Complexity of Hydraulic Fracture Geometry in Reservoirs with Large Horizontal Stress Difference	395 E. Lindenbach Comparison of results from constant normal stiffness and constant normal load testing on rock and concrete	371 G. Liu Influence of air temperature on the stability of slope based on thermo-hydraulic-mechanical coupling	217 L. Shen Determination of the Anisotropic Mechanical Properties of A Calcareous Shale from Duvernay Unconventional Reservoir Rock
357 M. Fan Investigating the Impact of Proppant Embedment and Compaction on Fracture Conductivity using Continuum Mechanics, DEM and LBM Coupling Approach	1127 S. Akutagawa Experimental observation of hardening process of engineering materials by optic fiber sensor	1101 D. Elmo Analysis of foundation problems in fractured rock masses using an equivalent continuum approach with embedded discrete fractures	317 T. Lokajick Elastic anisotropy of layered rocks: Texture-based theoretical predictions (effective media modeling) versus ultrasonic measurements of gneiss
659 T. Hoenk Stress around pressurized and propped fractures	538 D. Barrick Lateral Loading Parameters for Monopoles (Drilled Piers) in Anisotropic Precambrian Rock	918 A. Huang The action law of geometry and structure characteristic parameters of homogeneous anti-dumping layered rock slope toppling deformation	800 H. Krietsch A comparison of FBG- and Brillouin-strain sensing in the framework of a decimeter scale hydraulic stimulation experiment
29 A. Michael Analysis of Hydraulic Fracture Initiation from Perforated Horizontal Wellbores	1375 H. Wang AE Space-time evolution study for precision damage law of marble based on the change of P-wave velocity under loading	71 S. Utsuki Construction of a geological information management system using AI, CIM and image processing technology	
57 R. Zhang Experimental Study on Hydraulic Fracture Non-Planar Propagation from Perforated Horizontal Well in Tight Formations		361 S. Aki Application of Undrained Strength Analysis to Deep Excavation Design	
58 K. Zhang Investigation on Hydraulic Fracture Initiation and Propagation from Perforated Horizontal Well in the Deep Tight Reservoir		667 X. Li Dac cutoff wear prediction model of hard rock TBM based on dynamic Bayesian networks	
111 J. Wang A model for conductivity evolution of proppant-filled hydraulic fractures		822 Z. Zhang A new method to identify the translational removability of blocks during underground excavation	
136 A. Mendez The Complexity of Hydraulic Fracturing Designs Offshore United Arab Emirates		929 Z. Ren Three-dimensional engineering-geological model of the soil mass: the case study of the base of a hydrotechnical building	
187 M. Samraejad A novel approach for studying hydraulic fracturing access factors using a numerical coupled model of flow and continuum damage mechanics		983 A. Mitalwan A Proposed Probabilistic Analysis Methodology for Tunnel Support Cost Estimation Depending on the Construction Method	
278 R. Zhang Investigate on Fracture Propagation with Acid Fracturing in Fracture-vuggy Limestone Formation based on True Tri-axial Laboratory Experiments			
287 J. Ge Sensitivity Study on the Poroelastic and Thermoelastic Effects on the Stress Reversal nearby an Existing Hydraulic Fracture			
337 D. Wang The Influence of Pore Pressure on Crack Propagation in Diverting Fracturing			
437 M. Wigwe Actual Hydraulic Fracture Length Determination Using a new Technique for Shale Fracturing Data Analysis in Real Time			
495 S. Hirose Numerical Modelling of Fractures in Multilayered Rock Formations Using a Displacement Discontinuity Method			
591 H. Meier Modeling of fluid-driven fractures using multi-physics simulation capabilities			
695 P. Seth Hydraulic Fracture Closure in a Poroelastic Medium and its Implications on Productivity			
792 M. Oyarhossein Fracture Geometry with Non-Uniform Boundary Stresses			

Tuesday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session TA2	Poster Session TB2	Poster Session TC2
<i>Imaging Technologies for Geomechanics</i>	<i>Experimental, Hydrothermal and Biological Rock Mechanics</i>	<i>AE and NDE Techniques for Material and Microcrack Characterization</i>
<i>Session Chair(s): Laurent Louis, Giovanni Grasselli</i>	<i>Session Chair(s): Xiaodong Ma, Mathew Ingraham</i>	<i>Session Chair(s): Jesse Hampton, Andy Rathbun</i>
90 L. Kong Anisotropy analysis of 3D printed gypsum rocks integrating ultrasonic pulse-transmission, nanoindentation and micro-CT techniques.	156 P. Cacciari The pull-off test for obtaining the tensile strength of rock materials	271 I. Gupta New applications of nano-indentation for Reservoir Characterization in Shales
284 P. Zhang Automated and digital geological surveying, mapping and analysis based on 3D photogrammetry	385 J. Woodman Thermal effects on discontinuity behaviour: a laboratory scale study	365 I. Gupta Water Weakening: Case study from Marcellus, Woodford, Eagle Ford and Wolfcamp
306 A. Kozhagulova Bond Characteristics of Artificial Sandstones with Sodium Silicate Cement	893 Y. Feng Investigating the effect of sample size on uncertainty in stress measurement	619 R. Choens Acoustic Emission during Borehole Breakout
1090 X. Li Experimental Investigation on the Progressive Failure Characteristics of Longmaxi Shale Using an In-situ Micro X-ray CT Scanner	976 N. Hudyma Microbiologically Induced Calcite Precipitation for the Improvement of Porous Building Stone	176 S. Jia Investigating Fracture Growth and Source Mechanisms in Shale using Acoustic Emission Technique
1093 S. Li Investigation on Fracture Intervention in Rock Hydraulic Fracturing Test through CT Scanning	1025 M. Serati Some novel aspects on the diametral point load testing	473 N. Li Experimental Investigation into Dynamic of Laboratory Hydraulic Fracturing Based on Acoustic Emission Monitoring
1211 R. Becker Digital Photogrammetry Software Comparison for Rock Mass Characterization	1357 F. Wang Effect of Joint Geometric Parameters on Mechanical Behavior of Jointed rock mass under Compression Shear	131 T. Scott Multi-Stage Triaxial Failure Testing Utilizing Acoustic Emission
1253 R. Yoshida Co-registration of CT images by SIFT method and observation of temporal change in granite fracture aperture under long term loading	1103 U. Waqas Effect of loading frequencies on the dynamic properties of thermally treated selected rock samples	1223 S. Prakash Analysis of damage induced during a multi-stage triaxial test using acoustic emissions
1414 B. Liu Pore Changes of Mesozoic Water-rich Medium Sandstone during One Freeze-thaw Cycle Test under Different Confining Stress Using CT Scanning	607 S. Wang Influence of confining pressure on failure mechanical behavior of mudstone specimens containing a single joint by discrete element modeling	1195 C. Hammerquist 3D Anisotropic Damage Mechanics Model in Material Point Method - Validations
771 M. Soldal Imaging of rock deformation using micro-CT scanner and X-ray transparent triaxial apparatus		

Wednesday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session WA1	Poster Session WB1	Poster Session WC1	Poster Session WD1
<i>Pore-scale, Micro, and Nano Rock Mechanics</i>	<i>Constitutive models and numerical modeling</i>	<i>Ground Control</i>	<i>Drilling</i>
<i>Session Chair(s): Mehrooz Salazaradeh, Paul Young</i>	<i>Session Chair(s): Cheng Zhu</i>	<i>Session Chair(s):</i>	<i>Session Chair(s):</i>
1010 D. Seely Full-Scale Permeability, Porosity, & Particle Size Distribution of an Oil Shale Rockfill	104 J. Deng A creep damage constitutive model of salt rock and its properties	147 A. Goulet Development of an integrated geotechnical database and associated analysis tools for excavation design in seismically active underground mines.	544 C. Ezeakacha Pore-Scale Mud Invasion in Different Rock Samples and Wellbore Conditions: Implications for Lithology Dependent Wellbore Strengthening
1235 C. Mitchell Microstructural controls on the macroscopic behavior of geo-architected rocks	969 Y. Ohnishi Solid and Water Interaction Analysis by DDA and MPS (Moving Particle Semi-implicit) Methods applied to Rock Engineering	183 D. Zhang The economic performance of different support systems for a tunnel in weak rock and high stress environment	274 H. Wen Poroelastodynamic solution for an incline borehole subjected to non-hydrostatic stress field
933 K. Sharma Micro-pores and fluid flow - a numerical study	1373 J. Cavalho Pillar field and far-field thermal-mechanical modelling of a two-level deep geological repository for the used nuclear fuel in crystalline rock	194 B. Sliker Seismic and Stress Response to Development Loading in a Dipping Limestone Pillar	304 J. Zeng Research on the effect of casing deformation on sustained casing pressure
1115 H. Yoon Impact of multiscale pore structure and mineralogy on mechanical properties of geomaterials	1215 H.-M. Kim Estimation of grout penetration using a coupled hydraulic-deformation analysis of rock joints	320 W. Cao Gas-driven rapid fracture propagation and gas outbursts under unloading conditions in coal seams	916 H. Mohammed Wellbore Instability Analysis for Nahr Umr Formation in Southern Iraq
	684 J. Ibañez Friction degradation in rapid sliding: Back analysis of the catastrophic Vajont landslide using DDA	481 T. Le A review of roof strata instability associated with Longwall Top Coal Caving	1164 W. Li The poroelastodynamic response of a casing-cement-stratum system
	1178 P. Lollino FDEM analysis of fracturing processes affecting vertical cliffs in soft calcarenites	673 F. Sengani The impact of wet drilling on mine seismicity: mechanized deep to ultra-deep level gold mining experience	1242 A. Didler The Wellbore Cement Additive, Gilsonite, a Solution to Leaky Gas Wells?
		676 T. Chikande Review of pillar design and cutting practices in geotechnically challenging ground conditions	198 A. Alrabiah Optimization of the tripping parameters to prevent the swab pressure-related wellbore instability
		677 T. Chikande Evaluation of tendon support in anisotropic jointed rockmass	351 P. Kowalchuk Improving Drilling Efficiency by Using Event-Time Analysis to Better Understand Wellbore Stability
		679 T. Zvarivadza In situ performance of split sets in deep to ultra-deep level gold mining	740 Z. Liu Calculation of Drilling Mud Density Window and Open-Hole Wellbore Extension Limit for Extended Reach Well
		681 T. Zvarivadza Evaluation of the impact of production rate on mine seismicity: mechanized deep to ultra-deep level gold mining case study	895 B. Heideri Advanced Real Time Drilling Geomechanics
		1331 J. Aubertin Investigation on the influence of the selected creep constitutive model for the design of a ground control monitoring program in an underground room and pillar salt mine	1057 K. Gillis Comparison of Field and Laboratory Vibration Assisted Rotary Drilling
		1364 Y. Chen Analytical study of loading and displacing angles of rock bolt subjected shear condition	1098 M. Rashidi An Artificial Intelligence Approach in Estimation of Formation Pore Pressure by Critical Drilling Data
			1280 H. Zhao Cuttings Carrying Capacity in A New Efficient Rock Breaking Technique

Wednesday Technical Poster Presentations • 3:30 -4:30 pm

Poster Session WA2	Poster Session WB2
<i>Coupled Processes, Fluid-driven Fracture, Caprock Integrity</i>	<i>Numerical Modeling in Mining Geomechanics</i>
<i>Session Chair(s): Pania Newell, Mehrdad Soltanzadeh</i>	<i>Session Chair(s):</i>
101 S. Kadinappuli Hewage Evaluation of superiority of liquid CO ₂ as a non-aqueous fracturing fluid for coal seam gas extraction	1005 Y. Xue Stochastic simulation of rock size effect with correlation length
168 M. Siddiqui Digital rock mechanics using Xurography: A new approach to study Multiphysics interactions in shales	1064 A. Adoko Modeling Rock Mass Deformation Modulus using Adaptive Techniques
650 C. Wang The Influence of Grain Coating on the Shear Strength, Slip Stability, and Permeability of CO ₂ -altered Reservoir Rocks and Caprocks	730 C. Newman Numerical Application of Interface Elements for Stability Analysis of Stress Distributions in Stope-and-Fill Mining Operations
654 Z. Li Friction-permeability response of Marcellus shale caprock	99 Y. Akbarzadeh Numerical Study of Effect of Pressurization and Temperature on the Stability of the Cavity Created by Borehole Mining
875 C. Wong Effective stress law and criterion for crack initiation in brittle rock under pore pressure elevation	280 D. Shacker Prediction of hanging wall instability using the Strain Effective Radius Method
889 H. Jung Local stress changes near CO ₂ injector wells due to coupled thermo-poro-mechanical processes: impact of formation heterogeneity	568 X. Wang A grain-based model considering inter- and intra-grain contact strength heterogeneity of brittle rock
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