

# 2023 ARMA East Asia Geomechanics Workshop

11<sup>th</sup>-12<sup>th</sup> August 2023

Hong Kong, China

## Workshop Programme

**Geomechanics and Geophysics for  
Sustainable Energy Development**



THE HONG KONG  
POLYTECHNIC UNIVERSITY  
香港理工大學



DEPARTMENT OF  
CIVIL AND ENVIRONMENTAL ENGINEERING  
土木及環境工程學系



# 2023 ARMA East Asia Geomechanics Workshop

## Program Overview

Workshop date: August 11-12, 2023

Venue: The Hong Kong Polytechnic University (PolyU)

Lim Por Yen Lecture Theatre (N001)

DATE	TIME	PROGRAM
Aug. 11 <sup>th</sup>	8:15-8:25	Reception
	8:25-8:35	Welcome Speech
	8:35-8:45	Opening Speech
	8:45-9:00	Group Photo
	9:00-9:40	Keynote (Prof. Manchao He)
	9:40-10:40	Invited Talks
	10:40-11:10	Coffee Break and Posters
	11:10-12:10	Invited Talks
	12:10-14: 00	Lunch & Coffee
	14:00-14:40	Keynote (Prof. Hyung-Mok Kim)
	14:40-15:40	Invited Talks
	15:40-16:10	Coffee Break and Posters
	16:10-17:30	Invited Talks
	18:30-20:30	Group Dinner
Aug. 12 <sup>th</sup>	9:00-9:40	Keynote (Prof. Derek Elsworth)
	9:40-10:40	Invited Talks
	10:40-11:10	Coffee Break and Posters
	11:10-12:10	Invited Talks
	12:10-14: 00	Lunch & Coffee
	14:00-14:40	Keynote (Prof. Kenji Furui)
	14:40-15:40	Invited Talks
	15:40-16:10	Coffee Break and Posters
	16:10-16:50	Invited Talks
	16:50-18:00	Closing Session

## 2023 ARMA East Asia Geomechanics Workshop

### 1. Basic Information

#### a. Title of workshop

2023 ARMA East Asia Geomechanics Workshop

b. **Theme:** Geomechanics and geophysics for sustainable energy development

c. **Date:** 11-12 Aug. 2023 (Friday and Saturday)

d. **Venue:** The Hong Kong Polytechnic University (PolyU) - N001

e. **Mode:** In-person (with online streaming)

### 2. Description

#### a. Workshop purpose

- This workshop is intended to be a small-scale and high-quality event organized by the ARMA East Asia Blue Ribbon Group.
- The long-term goal of the workshop is to connect ARMA and the geomechanics community in East Asia countries and regions and establish a platform for discussing frontier research and networking.
- This is the first workshop we organize. This event could be held annually or bi-annually, and the host institute could be rotating among universities and research institutes in East Asia countries/regions.
- Create an education platform for students to showcase their research work with posters and get to know each other.

#### b. Workshop topics

The topics of the workshop cover research areas of geomechanics, rock mechanics, and geophysics, focusing on the sustainable development of society. Interdisciplinary research that transcends traditional disciplinary boundaries and brings new insights into geomechanics/geophysics/rock mechanics fields are welcome. The topics of the workshop may include, but are not limited to, the following:

- Unconventional oil/gas
- Geothermal energy
- Advanced numerical approaches
- Big data and artificial intelligence
- Geo-hazard assessment and mitigation
- CCUS and hydrogen energy

## 2023 ARMA East Asia Geomechanics Workshop Committee

### ORGANIZING COMMITTEE

**Honorary Chair:** Dr. Gang Han – American Rock Mechanics Association

**Chair:** Dr. Qi Zhao – The Hong Kong Polytechnic University

**Co-Chairs:** Prof Mao Sheng – China University of Petroleum-Beijing

Prof Ki-Bok Min – Seoul National University

Prof Kenji Furui – Waseda University

### **Members** (In alphabetical order by last name)

<b>Name</b>	<b>Affiliation</b>
Yuedu Chen	Taiyuan University of Technology
Zhaowei Chen	PetroChina
Yongcun Feng	China University of Petroleum-Beijing
Bing Hou	China University of Petroleum-Beijing
Hyung-Mok Kim	Sejong University
Kiyoshi Kishida	Kyoto University
Fiona Kwok	The University of Hong Kong
Dae-Sung Lee	Dong-A University
Xiaorong Li	China University of Petroleum-Beijing
Tianshou Ma	Southwest Petroleum University
Xiaodong Ma	Chinese Academy of Sciences
Keh-Jian Shou	National Chung-Hsing University
Xianzhi Song	China University of Petroleum-Beijing
Jihoon Wang	Hanyang University
Bisheng Wu	Tsinghua University
Hui Wu	Peking University
Fengshou Zhang	Tongji University
Haiyan Zhu	Chengdu University of Technology



### Organizing Committee Honorary Chair

**Dr. Gang Han**

**Immediate Past President, American Rock Mechanics Association  
Founder and Chair, ARMA Hydraulic Fracturing Community**

Dr. Gang Han is the immediate past president of the American Rock Mechanics Association (ARMA). With 20-plus years of experience in Petroleum Engineering, he focuses on geomechanical technologies related to reservoir performance, well productivity, hydraulic fracturing, well planning, drilling, completion, sand control and management, and wellbore stability. He has over 50 technical publications and is a leading author of a multi-industry book *Drilling in Extreme Environments - Penetration and Sampling on Earth and Other Planets*. He has a Ph.D. in chemical engineering from the University of Waterloo, an M.Sc. in reservoir engineering from the Research Institute of Petroleum E&D, and a BSc in petroleum engineering from China University of Petroleum (East China).

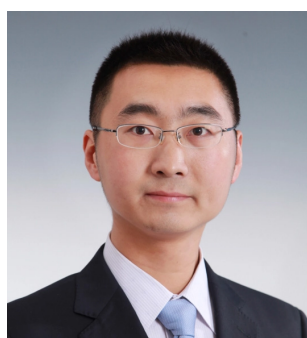


### Organizing Committee Chair

**Dr. Qi Zhao**

**Assistant Professor, The Hong Kong Polytechnic University**

Dr. Qi Zhao is an Assistant Professor at the Hong Kong Polytechnic University (PolyU) in the Department of Civil and Environmental Engineering. He obtained his Ph.D. degree at the University of Toronto and his Ph.D. dissertation was awarded the Leopold Müller Award by the Austrian Society for Geomechanics and the Dr. N.G.W. Cook Ph.D. Dissertation Award by the American Rock Mechanics Association (ARMA). He is an ARMA Future leader (class 2021). His research interests cover several aspects of geomechanics and geophysics, including in situ 4D rock physics experiments under X-ray micro-CT; the application of machine learning to rock mechanics and geophysics problems; and the shear behavior of rock discontinuities.



### Organizing Committee Co-Chair

**Dr. Mao Sheng**

**Professor, China University of Petroleum-Beijing**

Dr. Mao Sheng is a professor at the China University of Petroleum-Beijing (CUPB). He was selected as the National Distinguished Young Scholar of China and the Future Leader of America Rock Mechanics Association in 2021 and 2020. He obtained his Ph.D. degree from CUPB in 2014 and was a visiting scholar at the University of Oklahoma from 2011 to 2012. His research interests involve unconventional oil and gas well completion and AI application in hydraulic fracturing. He has published 36 first/corresponding-authored papers, authorized 6 registered patents, and received 2 R&D awards in this field.





## Organizing Committee Co-Chair

**Dr. Ki-Bok Min**

**Professor, Seoul National University**

Dr. Ki-Bok Min is currently a Professor at the department of energy resources engineering at Seoul National University (SNU). He obtained his BSc in Mineral & Petroleum Engineering and MSc in Rock Mechanics at SNU and his PhD in Engineering Geology at the Royal Institute of Technology in Sweden. His primary area of research is anisotropic rock mechanics and coupled processes in fractured rock with main applications in geological repository of nuclear waste and enhanced geothermal systems (EGS). His research focus on coupled processes includes stress-dependent permeability in fractured rock, thermally induced fracture shearing (thermoshearing) both at near- and far-field repository, and understanding the key mechanism of hydraulic stimulation in EGS in terms of role of hydraulic shearing and hydraulic jacking. He is a recipient of American Rock Mechanics Association (ARMA) applied rock mechanics research award (2009) and case history award (2010). He was a guest scientist at German Research Center for Geosciences (GFZ) and Lawrence Berkeley National Laboratory in 2015 and 2022, respectively. He is also serving as an associate editor of the International Journal of Rock Mechanics and Mining Sciences.



## Organizing Committee Co-Chair

**Dr. Kenji Furui**

**Professor, Waseda University**

Dr. Kenji Furui is professor in the department of resources and environmental engineering at Waseda University, Tokyo, Japan. Furui is a subject matter expert in geomechanics, well stimulation, and well performance analysis. Prior to joining Waseda University, he worked as a completion engineer in Global Completion Engineering team in ConocoPhillips based in Houston, Texas. Also, Dr. Furui worked as applications engineer for Baker Oil Tools' Cased-Hole Completion Systems in Houston. He holds a BS degree in mineral resources and environmental engineering from Waseda University in Japan (1999) and MS and PhD degrees in petroleum engineering from the University of Texas at Austin in 2001 and 2004, respectively. He was the recipient of the SPE Young Engineer of the Year Awards in Gulf Coast Section in 2012 and also received Cedric K. Ferguson Medal in 2013. Furui has authored and co-authored more than fifty technical papers on geomechanics, drilling and completion related topics.

## Keynote Presentations (Sort by talk order)



### Possible Earthquake Prediction Strategies

**Manchao He**  
**CSRME President;**  
**Academician in Chinese Academy of Sciences;**  
**Professor, China University of Mining and Technology,**  
**Beijing**

Professor Manchao He is currently an Academician of the Chinese Academy of Sciences (CAS), a foreign Academician of the Argentine National Academy of Engineering (ANI) and Russian Academy of Mining Sciences (AGN), the Director of the State Key Laboratory for Geomechanics and Deep Underground Engineering (SKLGDUE) in Beijing, and Professor of China University of Mining and Technology-Beijing (CUMTB). He is the President of the Chinese Society for Rock Mechanics and Engineering (CSRME). He is also the Vice President and honorary fellow of the International Consortium on Geo-disaster Reduction (ICGdR). Dr. Manchao mainly engaged in the research of Rock Mechanics and Engineering, including landslide, active fault stability analysis, monitoring and control, soft rock large deformation mechanism and control, mining technologies, rock burst mechanism, etc. He successfully invented the novel energy-absorbing NPR (Negative Poisson's Ratio) bolt/anchor. The bolt called "HE-bolt" in the world can exhibit extraordinarily large elongation at very high working resistance to the external load and also have an ideal elastic-plastic behavior. It has been applied successfully in many practical projects, which makes a significant contribution to disaster control.



### The essential elements for implementing underground storage of compressed air and hydrogen energies in excavated and lined hard rock caverns

**Hyung-Mok Kim**  
**Professor, Sejong University, Seoul, Korea**

Dr. Hyung-Mok Kim is a professor at the Department of Energy Resources and Geosystems Engineering, at Sejong University, Seoul Korea since 2012. He earned his Ph.D from the University of Tokyo, Japan in 2002 and prior to this, he completed his M.S.c and B.Sc degrees at Seoul National University, Korea. His primary research interest is the modelling of coupled Thermal-Mechanical-Hydraulic (THM) processes in geological media. His major research achievements include the modelling of internal stability of granular geomaterials with fluid flow, cement grout injection and coupled HM behavior of rock joints, underground fluid injection-induced geomechanical instability, hydrate-bearing sediments mechanics during gas production, and geomechanics associated with compressed air energy storage (CAES) in underground excavated rock caverns. Before academia, he held a position at the Korea Institute of Geoscience and Mineral Resources (2006-2012) and at Obayashi Corporation in Japan (2003-2006), and as a visiting scholar at Lawrence Berkeley National Laboratory (2018-2019) in the United States. Presently, he serves as an associate editor of the Geosystem Engineering journal.



### **Understanding Triggered Seismicity and Permeability Evolution in the Subsurface – Key Needs in Pursuit of the Energy Transition**

**Derek Elsworth**  
ARMA Fellow;  
Member of the U.S. National Academy of Engineering;  
G. Albert Shoemaker Chair and professor of Energy and Mineral Engineering and Geosciences, Departments of Energy and Mineral Engineering and Geosciences, G3 Center and EMS Energy Institute, Pennsylvania State University

Professor Derek Elsworth is G. Albert Shoemaker Chair and Professor of Energy and Mineral Engineering and Geosciences at Penn State. He is a co-founder of the Center for Geomechanics, Geofluids, and Geohazards. His interests are in the areas of computational mechanics, rock mechanics, and the mechanical and transport characteristics of fractured rocks, with application to geothermal energy, the deep geological sequestration of radioactive wastes and of CO<sub>2</sub>, unconventional hydrocarbons including coal-gas, tight-gas-shales and hydrates, and instability and eruption dynamics of volcanoes.



### **Perspectives of Oil and Natural Gas Development and Geomechanics-Related Issues in Geological CO<sub>2</sub> Storage**

**Kenji Furui**  
Professor, Waseda University

Dr. Kenji Furui is professor in the department of resources and environmental engineering at Waseda University, Tokyo, Japan. Furui is a subject matter expert in geomechanics, well stimulation, and well performance analysis. Prior to joining Waseda University, he worked as a completion engineer in Global Completion Engineering team in ConocoPhillips based in Houston, Texas. Also, Dr. Furui worked as applications engineer for Baker Oil Tools' Cased-Hole Completion Systems in Houston. He holds a BS degree in mineral resources and environmental engineering from Waseda University in Japan (1999) and MS and PhD degrees in petroleum engineering from the University of Texas at Austin in 2001 and 2004, respectively. He was the recipient of the SPE Young Engineer of the Year Awards in Gulf Coast Section in 2012 and also received Cedric K. Ferguson Medal in 2013. Furui has authored and co-authored more than fifty technical papers on geomechanics, drilling and completion related topics.



## Invited Talks (Sort by talk order)



### **Frictional properties of faults for engineering in the extreme environment**

Prof. Fengshou Zhang is a Changjiang Distinguished professor in the Department of Geotechnical Engineering, Tongji University. He got his PhD from the Georgia Institute of Technology in 2012, and MS, BS from Tongji University in 2007, 2004, respectively. His research areas focus on multi-field coupling of rock mechanics and its application in unconventional resource exploitation. He published more than 180 papers in PRL, GRL, JGR etc., and won the ARMA Early Career Award in 2018, the first Qian Qihu Award in 2020, the China Youth Science and Technology Award in 2022, and the ARMA Rock Mechanics Research Award in 2023. He also served as the first Executive Editor-in-Chief of Rock Mechanics Bulletin, an official flagship journal of CSRME.



### **Layer-penetration fracturing technology in deep coal-bearing strata**

Prof. Bing Hou is a professor and Ph.D. advisor at the School of Petroleum Engineering, China University of Petroleum (Beijing). Prof. Hou mainly engaged in the research of deep rock mechanics and hydraulic fracturing mechanics in petroleum engineering. He has led a Sino-US international cooperation project of the National Key Research and Development Program in the past five years. He has been awarded the Future Leader of Rock Mechanics by the American Rock Mechanics Association and has been selected in the 2022 Elsevier global top 2% of highly cited scientists.



### **Multiphase Flow in Cohesive Granular Material**

Dr Fiona Kwok is an Assistant Professor at the Department of Civil Engineering at the University of Hong Kong. She obtained her BEng degree (first class) from University of Sheffield, MEng degree from MIT and a PhD degree from University of Cambridge. She registered as a Geotechnical Engineer in Hong Kong and Professional Engineer (PE) in California, USA. She previously worked in the industry as a Geotechnical Engineer at Itasca Consulting Group in Minneapolis and CDM in Los Angeles in the USA. She was selected as the Future Leader by American Rock Mechanics Association (ARMA) in 2015. She is a grant assessor for the Research Projects Vetting Subcommittee of Environmental Conservation Fund (ECF). She is a committee member of the Hong Kong Institution of Engineers (HKIE) Civil Division and a nominated member of technical committee TC307 Sustainability in Geotechnical Engineering of International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). She has published more than 100 journal and conference papers.



### **The digital twins of grain-based rocks with micro-RME and AGBM**

Prof. Xuhai Tang is a professor at Wuhan University and an editorial board member of the *International Journal of Rock Mechanics and Mining Sciences*. He holds a Ph.D. degree from Imperial College London and was a postdoc at Princeton University. His group developed the Accurate Grain-Based Model (AGBM) with Microscale Rock Mechanics Experiment (Micro-RME) and Aifrac-TOUGH software.

The AGBM and Micro-RME have been successfully used to generate the accurate digital twin of geomaterials at grain-scale, to investigate the mechanical behavior of Earth and planetary geomaterials. The Aifrac-TOUGH software is developed to generate the digital twin of discontinuous reservoirs with multi-source information fusion. His achievement contributes to smarter energy exploitation and space exploration.



### **How energy dissipation controls the evolution of multiple hydraulic fractures**

Dr. Bisheng Wu is currently an Associate Professor at the Department of Hydraulic Engineering, Tsinghua University, China. Prior to joining Tsinghua in 2018, he was one research scientist (indefinite) from 2012 to 2018 at CSIRO Australia (Melbourne) where he worked as a Postdoctoral Research Fellow from 2009 to 2012. His research focuses

on geomechanics related to efficient exploration of unconventional energy resources, such as shale gas, natural gas hydrate and CCUS. He has published more than 100 papers including journal articles, book chapters and papers in conference proceedings. He was one member of ARMA (American Rock Mechanics Association) Future Leadership Program in 2018 and was awarded "ARMA Distinguished Service Award" in 2022. He has been one member of editorial board in international journals such as *International Journal of Rock Mechanics and Mining Sciences*, *Geofluids*, *International Journal of Coal Science & Technology* and *Energies*, and has been lead/guest editors seven times in international journals such as *Lithosphere*, *Geomechanics* and *Geophysics for Geo-Energy and Geo-Resources* and *Geofluids*.



### **Physics-constrained distributed neural network model for 3D in-situ stress prediction**

Dr. Tianshou Ma is currently a professor in the Petroleum Engineering School at Southwest Petroleum University (SWPU). He received his M.S. and Ph.D. degrees in oil and gas well engineering from SWPU in 2012 and 2015, respectively. His research interests include petroleum-related rock mechanics, measurement while drilling, and advanced drilling

technology for safe and efficient drilling of complex hydrocarbon reservoirs. He has published 70+ peer-reviewed journal articles. He has been elected as an ARMA Future Leader in 2019. He is currently an associate editor of the *Journal of Petroleum Exploration and Production Technology* and *Frontiers in Earth Science* on Geohazards and Georisks section.



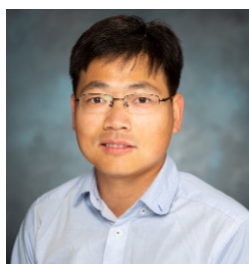
### **Four-dimensional geo stress prediction and its application in shale gas fracturing**

Prof. Haiyan Zhu is currently a full professor and the vice director of the National Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, Chengdu University of Technology, Chengdu, China. He is also the director of the Sichuan Provincial Key Engineering Laboratory of Shale Gas Exploration and Exploitation. His research interests are petroleum-related geomechanics, including hydraulic fracturing, drilling geomechanics, and geology-engineering integration. He has been the PI for over 40 projects from the government and Chinese major oil companies. Most of his research results have been applied in the hydraulic fracturing of shale gas reservoirs in the Sichuan Basin, tight sand oil and shale oil reservoirs in the Bohai Bay Basin, tight sandstone gas reservoirs in the Eastern Ordos Basin, etc.



### **GeoCloud - a multiscale and multiphysics data-driven modeling platform for subsurface energy system**

Dr. Bo Zhang is an assistant professor in the Department of Civil and Environmental Engineering at the University of Alberta, where he obtained his MSc degree in petroleum engineering and a Ph.D. degree in geotechnical engineering. He is a registered professional engineer and has been involved in a variety of projects in subsurface energy geomechanics. Dr. Zhang is the founder and PI of the GeoCloud Research Group at the University of Alberta, focusing on building a cloud-based modeling, simulation, and data-driven decision-making platform for the energy sector. The research area of his group encompasses oil sands, shale gas/oil, carbon storage and utilization, geothermal, and natural gas hydrates. Dr. Zhang is also the PI of the Future Energy Systems project "Uncertainty quantification and optimization for the scale-up of geological carbon storage" and NSERC Discovery project "Multi-physical and data-driven modeling for subsurface energy geotechnics".



### **Investigation of the effect of matrix on tracer transport processes in subsurface fractured reservoirs**

Dr. Hui Wu currently works as an assistant professor at the School of Earth and Space Sciences at Peking University. His main research interests include (1) Deep-learning assisted fracture network characterization, and (2) High-performance computing platforms for subsurface reservoirs. (3) Enhanced geothermal system. He obtained his bachelor's and doctor's degree from the Department of Hydraulic Engineering at Tsinghua University and then worked at Lawrence Livermore National Laboratory in the United States to engage in research on unconventional energy exploitation. He has published 30 papers in TOP international journals. He is an associate editor of Geoenergy Science and Engineering and served as a reviewer for more than 20 academic journals such as Applied Energy, Water Resources Research, and Geothermics.



### **Balanced hydraulic fracturing technology for controlling fault activation of shale formations: Concept and strategy**

Dr. Peng Tan, Ph.D., Senior engineer, works at CNPC Research Institute of Engineering Technology Co., Ltd. He is mainly engaged in hydraulic fracturing and casing deformation prevention and control technology of unconventional shale oil and gas reservoirs. He participated in more than 10 national science and technology major projects, including CNPC science and technology major projects. He has published more than 20 papers as the first/corresponding author, 3 papers with high ESI citations, and more than 1200 times cited in total. He has been granted 12 patents and won 4 provincial and ministerial science and technology awards. In 2021, he won the Excellent Doctoral Dissertation Award of the Chinese Society of Rock Mechanics and Engineering. In 2022, he was selected into the "Young Elite Scientists Sponsorship Program" of the China Association for Science and Technology.



### **THM coupled behaviors of hydro-shear stimulation and heat extraction in hot fractured reservoirs: experiment and modeling.**

Dr. Yuedu Chen is presently working as an associate Professor at Taiyuan University of Technology, China. He obtained his MSc degree and Ph.D. degree from Taiyuan University of Technology, China under the supervision of Prof. Weiguo Liang. He has vast research interests in multi-physics coupling processes in fractured geological media in Geo-Energy and Environmental engineering. He has practical experience in advancing fundamental research and developing predictive modeling capability. He won the excellent paper award at the China-Rock Conference in 2020 and also is the youth editor of the Journal of Rock Mechanics Bulletin and the International Journal of Mining Science and Technology. Additionally, he won the 2022 Distinguished Reviewer of the International Journal of Mining Science and Technology.



### **Failure mechanism of cement sheath integrity considering the coupled thermo-hydro-mechanical-chemical effects**

Dr. Xiaorong Li, Associate Professor at China University of Petroleum (Beijing). She received her Ph.D. degree from the University of Texas at Austin. Her research topics include wellbore stability, wellbore integrity, sand production, and sand control. She has published more than 30 technical papers and holds 10 patents. Additionally, she received the 2019 Petroleum Science Most Influential Paper Award. In 2021, she was selected into the "ARMA Future Leader" program, and was also honored to be part of the 7th China Association for Science and Technology Young Talent Support Project.



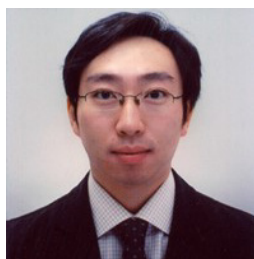
### **Integrated Technology of Natural Gas Hydrate Reservoir Stimulation and Carbon Storage by Radial Well Cavitation Jet**

Dr. Yiqun Zhang, professor, and deputy dean of the Department of offshore oil and gas engineering at China University of Petroleum-Beijing (CUP). His research interest focuses on drilling and completion engineering, applied fluid mechanics, and well testing, including the development of natural gas hydrate and geothermal resources. He was awarded the ARMA Future Leader in 2023 and the Outstanding Scholar of CUP in 2021. Prof. Zhang has undertaken one National Key Research and Development Program and two NSFC projects, won 6 science and technology awards, published 38 first/corresponding-authored papers, co-authored 3 monographs, and authorized 10 patents. He serves on the editorial board for three petroleum-related journals, as a reviewer for over 10 renowned journals



### **Findings and lessons learned from geomechanical studies at Enhanced Geothermal Systems Project in Pohang, Korea**

Dr. Ki-Bok Min is currently a Professor at the department of energy resources engineering at Seoul National University (SNU). He obtained his BSc in Mineral & Petroleum Engineering and MSc in Rock Mechanics at SNU and his PhD in Engineering Geology at the Royal Institute of Technology in Sweden. His primary area of research is anisotropic rock mechanics and coupled processes in fractured rock with main applications in geological repository of nuclear waste and enhanced geothermal systems (EGS). His research focus on coupled processes includes stress-dependent permeability in fractured rock, thermally induced fracture shearing (thermoshearing) both at near- and far-field repository, and understanding the key mechanism of hydraulic stimulation in EGS in terms of role of hydraulic shearing and hydraulic jacking. He is a recipient of American Rock Mechanics Association (ARMA) applied rock mechanics research award (2009) and case history award (2010). He was a guest scientist at German Research Center for Geosciences (GFZ) and Lawrence Berkeley National Laboratory in 2015 and 2022, respectively. He is also serving as an associate editor of the International Journal of Rock Mechanics and Mining Sciences.



### **Experimental and numerical analysis of coupled HMC processes in single rock fractures**

Dr. Bo Li is presently working as a professor at Tongji University, Shanghai, China. He obtained his MSc degree and Ph.D. degree from Nagasaki University, Japan under the supervision of Prof. Yujing Jiang. He has broad interests and experiences in rock testing and associated numerical modeling. He designed and developed a series of testing apparatuses related to coupled Thermal-Hydraulic-Mechanical-Chemical (THMC) processes in fractured rocks. He is the principal investigator of five national-level grants and is involved in multiple industrial research projects regarding deep-seated rock behavior assessment, stability analysis of rock slopes, etc. He is a member of the International Society for Rock Mechanics and Rock Engineering (ISRM) and the Chinese Society for Rock Mechanics and Engineering (CSRME).





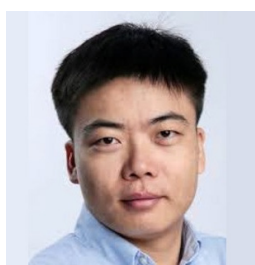
### **A practical application of elastic full-waveform inversion: Gulf of Mexico ocean-bottom node case study**

Yongchae Cho received a B.S. (2011) and an M.S. (2013) in geophysics from Seoul National University. He received a Ph.D. (2019) in geophysics from Texas A&M University as a member of the Crisman/Berg-Hughes consortium for petroleum research. From 2013 to 2015 and 2019 he served as a geophysicist at Schlumberger. Since 2020 he has been a research geophysicist at Shell International Exploration and Production Inc. conducting research about earth model-building algorithms. His research interests include computational seismology fracture modeling seismic imaging and waveform inversion. Yongchae Cho is presently serving as an assistant professor in Department of Energy Systems Engineering at Seoul National University.



### **Earthquakes during shale gas development in the Sichuan basin**

Dr. Hongfeng Yang is an associate professor in the Earth and Environmental Sciences Programme at The Chinese University of Hong Kong (CUHK). His research interests include earthquake source physics, subduction zone dynamics, fault zone structure and evolution, and induced earthquakes. He was awarded the 2018 Chinese Geophysical Society Fuchengyi Young Scientist Award, the 2016 Geophysical Research Letters Editors Citation for Excellence in Refereeing, and the 2021 Faculty Exemplary Teaching Award, CUHK. He is now an associate editor for Earthquake Sciences, Earthquake Research Advances, and Seismological Research Letters.



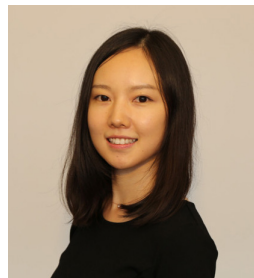
### **Investigating geothermal energy potential in Singapore using adjoint-state seismic imaging techniques**

Dr. Ping Tong is an associate professor holding a joint position with the Division of Mathematical Sciences and the Asian School of the Environment at Nanyang Technological University (NTU) Singapore. He is also a principal investigator at the Earth Observatory of Singapore. Ping got his Ph.D. degree in computational mathematics from Tsinghua University in 2012. Before joining NTU in September 2016, he was a postdoctoral fellow at the University of Toronto (2012-2014) and Stanford University (2014-2016). His research primarily focuses on seismic imaging, numerical modeling, inverse problems, and optimization.



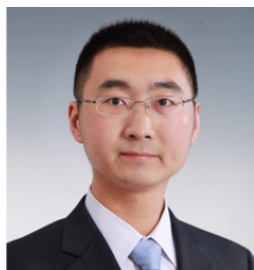
### **Water Effects on Elastic Wave Propagation and Attenuation across Single Clay-rich Rock Fractures**

Dr. Hui Yang is a postdoctoral researcher in the Grasselli Geomechanics Group at the University of Toronto. Before that, she served as a postdoctoral fellow in the group of Dr. Qi ZHAO at the Hong Kong Polytechnic University. She obtained her Ph.D. degree from the Hong Kong Polytechnic University in 2021 and her BSc. Degree from Central South University in 2015. Her research interests mainly include (1) fluid effects on rock mechanics and physics, (2) mechanical and seismic characteristics of rock fractures, (3) high-strain-rate rock behaviors and fragmentation, and (4) rock physics with acoustic emission and computerized tomography.



### **Environmental Geomechanics for Sustainable Energy Resources Engineering**

Dr. M.M. Hu is currently an Assistant Professor in the Department of Civil Engineering at the University of Hong Kong (HKU). She holds a Ph.D degree from Duke University (USA) and a B.Eng degree from Zhejiang University (China). Prior to joining HKU, Dr. Hu worked as Vice Chancellor's Research Fellow at the University of New South Wales, Sydney (Australia). Dr. Hu's research work has been focusing on the interdisciplinary field of environmental geomechanics driven by modern-day geo-engineering activities and fundamental understandings of geomaterial behavior in response to environmental perturbations of all sorts. Her current research group focuses on tackling the fundamental Multi-scale Multiphysics problems in geomaterials and geo-processes that play an essential role in a wide context of geoenvironmental circumstances concerning carbon neutrality, clean energy and adaptation to Climate Change, including enhanced geothermal systems (EGS), Carbon Capture Utilisation and Storage (CCUS), unconventional resources recovery, sediment aging, geochemical inception of land motion, effect of ocean acidification, emerging geomaterials for sustainability and resilience, etc.



### **Mechanical Characteristics of Shale bedding and impacts on hydraulic fracture propagation**

Dr. Mao Sheng, Professor at China University of Petroleum-Beijing (CUPB). He was selected as the National Distinguished Young Scholar of China and the Future Leader of the America Rock Mechanics Association in 2021 and 2020. He obtained his Ph.D. degree from CUPB in 2014 and was a visiting scholar at the University of Oklahoma from 2011 to 2012. His research interests involve Unconventional Oil and Gas Wells Completion and AI application on Hydraulic Fracturing. He has published 36 first/corresponding-authored papers, authorized 6 registered patents, and received 2 R&D awards in this field.



### **An ABAQUS VUEL subroutine of pore-pressure cohesive elements for simulation of 3D dynamic meso-scale fracking in quasi-brittle materials**

Dr. Feng-Chen An is an associate professor in the Department of Offshore Petroleum Engineering at the China University of Petroleum in Beijing. He obtained his Ph.D. degree at the University of Edinburgh in UK. His research interests mainly focus on the development and application of FE model in the simulation of the mechanical behavior of the reservoir under hydraulic fracturing, casing failure in the multi-stage hydraulic fracturing and the subsea pipeline under complex environments.



### **Investigating the propagation of multiple hydraulic fractures in shale oil rocks using acoustic emission**

Dr. Shan Wu is a Lecturer at Hefei University of Technology in the School of Resources and Environmental Engineering. She obtained her Ph.D. degree at the China University of Petroleum, Beijing, focusing on Petroleum Engineering. Additionally, she spent a year in a joint Ph.D. program at the University of Toronto's Department of Physics from 2017 to 2018. Before her current role, she was a Postdoctoral Fellow at the Southern University of Science and Technology and a Research Assistant at the Hong Kong Polytechnic University. Her research concentrates on hydraulic fracturing technology, dynamic fracture propagation, fracture type classification, and initiation and termination mechanisms of tensile-type fractures. She employs diverse methodologies, including the finite-discrete element method (FDEM), acoustic emission monitoring systems, spectral element method (SEM), and unsupervised machine learning.



### **Numerical simulation of injection-induced seismicity in the fractured rock mass**

Dr. Qi Zhao is an assistant professor at the Hong Kong Polytechnic University (PolyU) at the Department of Civil and Environmental Engineering. He obtained his Ph.D. degree at the University of Toronto and his Ph.D. dissertation was awarded the Leopold Müller Award by the Austrian Society for Geomechanics and the Dr. N.G.W. Cook Ph.D. Dissertation Award by the American Rock Mechanics Association (ARMA). He is an ARMA Future leader (class 2021). His research interests cover several aspects of geomechanics and geophysics, including in situ 4D rock physics experiments under X-ray micro-CT, the application of machine learning to rock mechanics and geophysics problems, and the shear behavior of rock discontinuities.

## Conference Agenda

### Plenary Session Day 1

#### Sustainable energy development of unconventional resources

Time	Speaker	Topic
8:15-8:25	Reception	
8:25-8:35	Dr. Andy Leung	Welcome from PolyU CEE
8:35-8:45	Dr. Han Gang	Opening Speech
8:45-9:00	Group photo of all attendees	
SECTION 1	CHAIR: Dr. Gang Han	
9:00-9:40	Prof. Manchao He (China University of Mining and Technology, Beijing, China)	Possible Earthquake Prediction Strategies (Keynote)
SECTION 1	CHAIR: Prof. Mao Sheng	
9:40-10:00	Dr. Fengshou Zhang (Tongji University)	Frictional properties of faults for engineering in the extreme environment (Invited)
10:00-10:20	Dr. Bing Hou (China University of Petroleum-Beijing, China)	Layer-penetration fracturing technology in deep coal-bearing strata (Invited)
10:20-10:40	Dr. Fiona Kowk (The University of Hong Kong, China)	Multiphase Flow in Cohesive Granular Material (Invited)
10:40-11:10	Coffee Break and Posters	
SECTION 2	CHAIR: Prof. Fengshou Zhang	
11:10-11:30	Dr. Xuhai Tang (Wuhan University, China)	The digital twins of grain-based rocks with micro-RME and AGBM (Invited)
11:30-11:50	Dr. Bisheng Wu (Tsinghua University, China)	How energy dissipation controls the evolution of multiple hydraulic fractures (Invited)
11:50-12:10	Dr. Tianshou Ma (Southwest Petroleum University, China)	Physics-constrained distributed neural network model for 3D in-situ stress prediction (Invited)
12:10-14:00	Lunch at U. Green	

SECTION 3 CHAIR: Prof. Ki-Bok Min		
14:00-14:40	Prof. Hyung-Mok Kim (Sejong University, South Korea)	The essential elements for implementing underground storage of compressed air and hydrogen energies in excavated and lined hard rock caverns (Keynote)
14:40-15:00	Dr. Haiyan Zhu (Chengdu University of Technology, China)	Four-dimensional geo stress prediction and its application in shale gas fracturing (Invited)
15:00-15:20	Dr. Bo Zhang (University of Alberta, Canada)	GeoCloud - a multiscale and multiphysics data-driven modeling platform for subsurface energy systems (Invited)
15:20-15:40	Dr. Hui Wu (Peking University, China)	Investigation of the effect of matrix on tracer transport processes in subsurface fractured reservoirs (Invited)
15:40-16:10	Coffee Break and Posters	
SECTION 4 CHAIR: Prof. Bing Hou		
16:10-16:30	Dr. Peng Tan (CNPC Engineering Technology Research and Development Company Limited, Beijing, China)	Balanced hydraulic fracturing technology for controlling fault activation of shale formations: Concept and strategy (Invited)
16:30-16:50	Dr. Yuedu Chen (Taiyuan University of Technology, China)	THM coupled behaviors of hydro-shear stimulation and heat extraction in hot fractured reservoirs: experiment and modeling (Invited)
SECTION 5 CHAIR: Prof. Haiyan Zhu		
16:50-17:10	Dr. Xiaorong Li (China University of Petroleum-Beijing, China)	The failure mechanism of cement sheath integrity considering the coupled thermo-hydro-mechanical-chemical effects (Invited)
17:10-17:30	Dr. Yiqun Zhang (China University of Petroleum-Beijing, China)	Integrated Technology of Natural Gas Hydrate Reservoir Stimulation and Carbon Storage by Radial Well Cavitation Jet (Invited)
18:30-20:30	Group dinner at U. Green	



## Plenary Session Day 2

### Geophysics and Rock Physics for sustainable energy development

Time	Speaker	Topic
SECTION 6 CHAIR: Dr. Qi Zhao		
9:00-9:40	Prof. Derek Elsworth (The Pennsylvania State University, USA)	Understanding Triggered Seismicity and Permeability Evolution in the Subsurface – Key Needs in Pursuit of the Energy Transition (Keynote)
9:40-10:00	Dr. Ki-Bok Min (Seoul National University, South Korea)	Findings and lessons learned from geomechanical studies at Enhanced Geothermal Systems Project in Pohang, Korea (Invited)
10:00-10:20	Dr. Bo Li (Tongji University, China)	Experimental and numerical analysis of coupled HMC processes in single rock fractures (Invited)
10:20-10:40	Dr. Yongchae Cho (Seoul National University, South Korea)	A practical application of elastic full-waveform inversion: Gulf of Mexico ocean-bottom node case study (Invited)
10:40-11:10	Coffee Break and Posters	
SECTION 7 CHAIR: Prof. Yongchae Cho		
11:10-11:30	Dr. Hongfeng Yang (Chinese University of Hong Kong, China)	Earthquakes during shale gas development in the Sichuan basin (Invited)
11:30-11:50	Dr. Ping Tong (Nanyang Technological University, Country)	Investigating geothermal energy potential in Singapore using adjoint-state seismic imaging techniques (Invited)
11:50-12:10	Dr. Hui Yang (University of Toronto, Canada)	Water Effects on Elastic Wave Propagation and Attenuation across Single Clay-rich Rock Fractures (Invited)
12:10-14:00	Lunch at U. Green	

SECTION 8CHAIR: Prof. Bo Li		
14:00-14:40	Prof. Kenji Furui (Waseda University, Japan)	Perspectives of Oil and Natural Gas Development and Geomechanics-Related Issues in Geological CO2 Storage (Keynote)
14:40-15:00	Dr. Manman Hu (The University of Hong Kong, China)	Environmental Geomechanics for Sustainable Energy Resources Engineering (Invited)
15:00-15:20	Dr. Mao Sheng (China University of Petroleum-Beijing, China)	Mechanical Characteristics of Shale bedding and impacts on hydraulic fracture propagation (Invited)
15:20-15:40	Dr. Fengchen An (China University of Petroleum-Beijing, China)	An ABAQUS VUEL the subroutine of pore-pressure cohesive elements for simulation of 3D dynamic meso-scale fracking in quasi-brittle materials (Invited)
15:40-16:10	Coffee Break	
SECTION 9CHAIR: Prof. Xuhai Tang		
16:10-16:30	Dr. Shan Wu (Hefei University of Technology, China)	Investigating the propagation of multiple hydraulic fractures in shale oil rocks using acoustic emission (Invited)
16:30-16:50	Dr. Qi Zhao (The Hong Kong Polytechnic University, China)	Numerical simulation of injection-induced seismicity in the fractured rock mass (Invited)
Closing Session		

## Transportation and Event Venue – PolyU N001

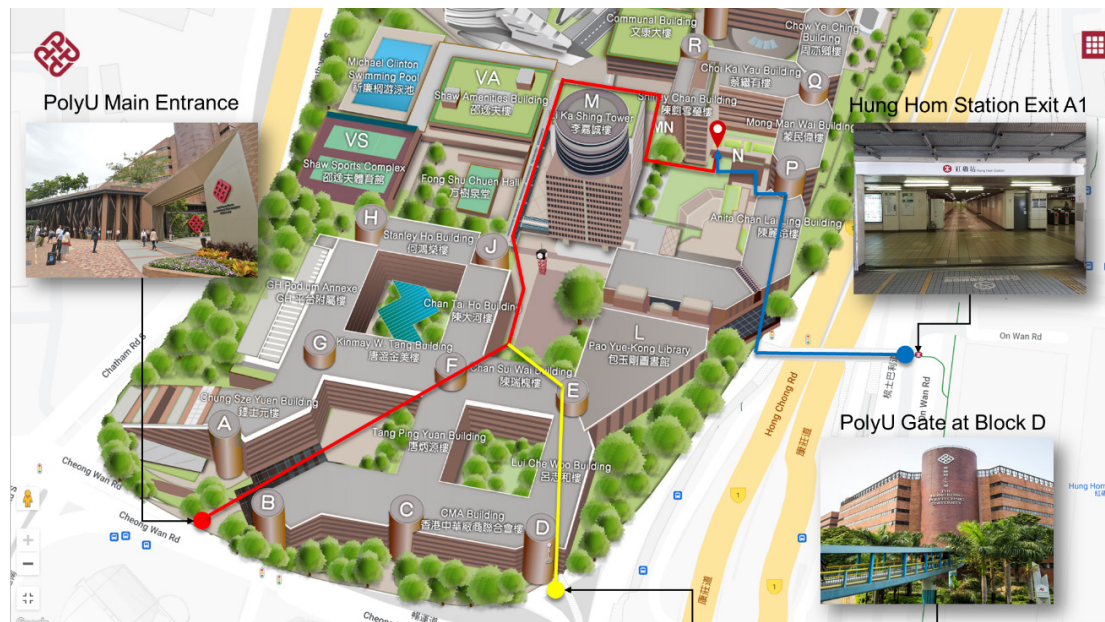
The workshop will be hosted in the Lim Por Yen Lecture Theatre (N001), located in Block N at the Hong Kong Polytechnic University.

Meals, including lunch and dinner on August 11 and lunch on August 12, will be provided at U. Green, which is situated on the 5th floor of the Communal Building.

- **Campus map** (<https://www.polyu.edu.hk/campus-map/>)

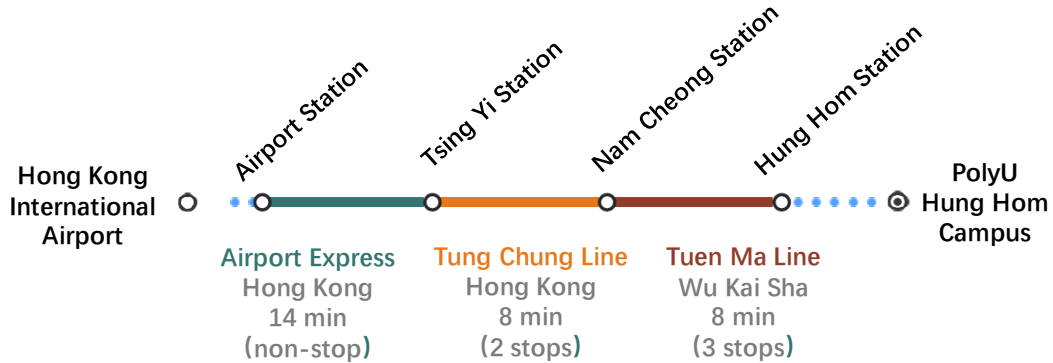


- **Directions to the Venue**

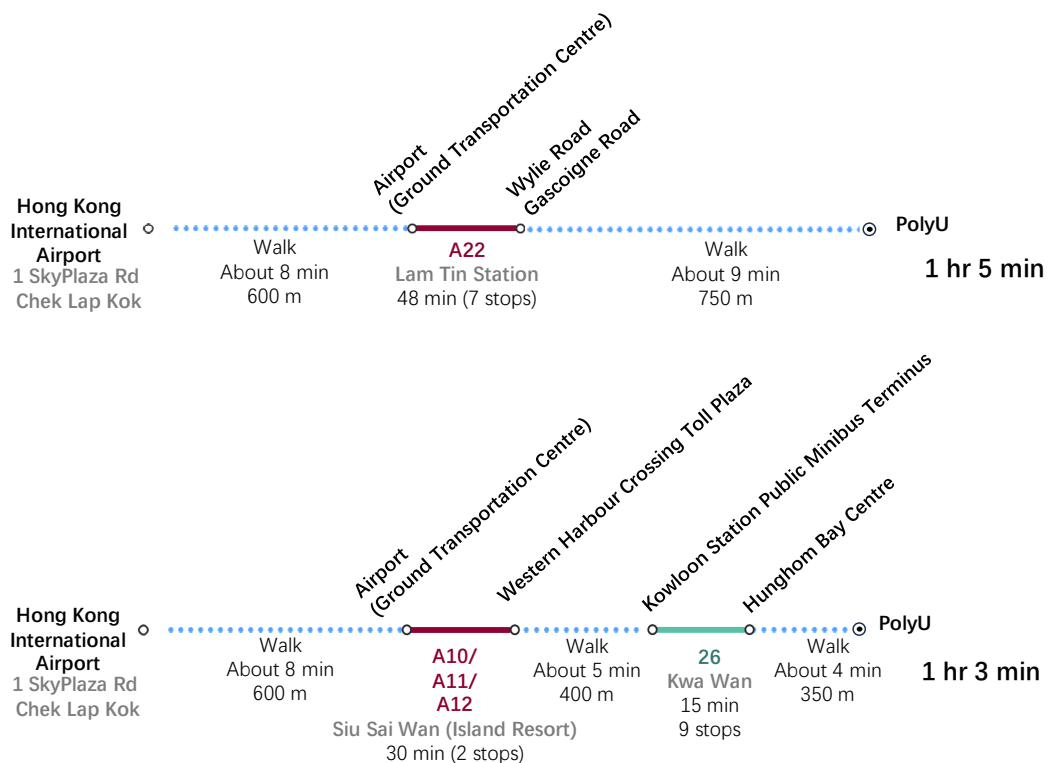


- Transportation from Hong Kong International Airport to the workshop**

**By Metro (MTR):** Using the Metro (MTR) in Hong Kong, you have multiple payment options available: you can use cash, the Octopus card, or Alipay for MTR fares.



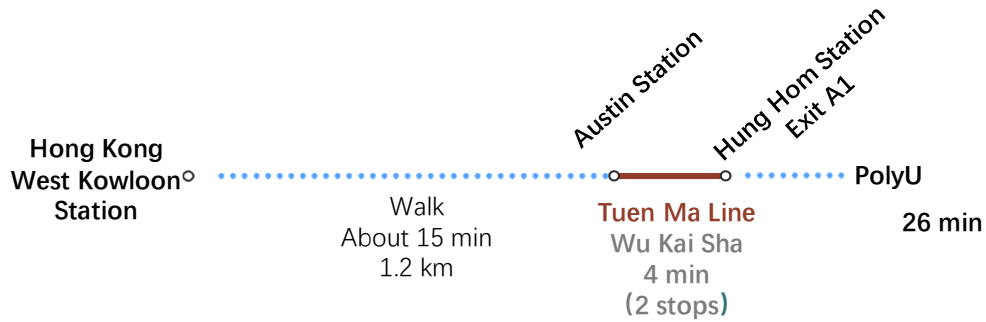
**By Bus:** When taking the bus in Hong Kong, you can use either cash or the Octopus card as a payment method.



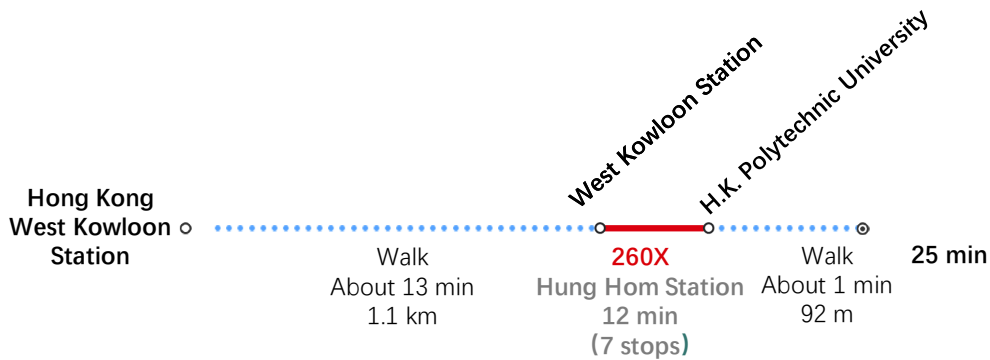
**By Taxi:** Cash is the preferred payment method, and Octopus is sometimes accepted. One-way fare from the airport to PolyU is approximately 265 HKD.

- **Transportation from Hong Kong West Kowloon Station**

**By Metro (MTR):** Cash, Octopus, and Alipay can be used for MTR



**By Bus:** Cash or Octopus is needed for taking the bus



**By Taxi:** Cash is the preferred payment method, and Octopus is sometimes accepted. One-way fare from the HK West Kowloon Station to PolyU is approximately 35 HKD.





## Notes

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