SIMSG ISSMGE

# ISSMGE Bulletin

Volume 11, Issue 4
August 2017

International Society for Soil Mechanics and Geotechnical Engineering

If the quality of the distributed file is not satisfactory for you, please access the ISSMGE website and download an electronic version.

www.issmge.org

## TABLE OF CONTENTS



## EDITORIAL BOARD



# Research highlights

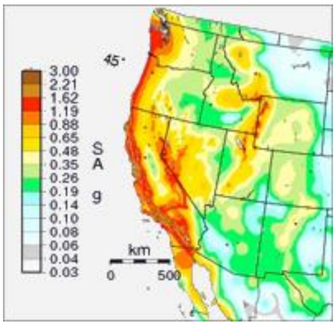
## University of California, Berkeley

Dr. Abrahamson has been involved in strong motion seismology for over two decades. He has extensive experience in the practical application of seismology to the development of deterministic & probabilistic seismic criteria (response spectra and time histories) for engineering design or analyses. He has been involved in developing design ground motions for hundreds of projects including dams, bridges, nuclear power plants, nuclear waste repositories, water and gas pipelines, rail lines, ports, landfills, hospitals, electric substations, and office buildings. About 3/4 of these projects have been in the Western US and the other 1/4 have been in the Eastern US or outside of the US.

Dr. Abrahamson has published over 100 papers on ground motion and seismic hazards. He has been a leader in the development of empirical ground motion models, including using advanced statistical methods for regression analyses. He was involved in the development of the first ground motion models that included hanging wall effects, directivity effects, and fling effects. His ground motion models have been widely used in practice. He was one of the leaders of the NGA project funded by the Pacific Engineering Research (PEER) Center http://peer.berkeley.edu
He was also the developer of one of the new NGA ground motion models. He is currently one of the leaders for an NGA-style project for the Eastern U.S. and is leading a project to develop new ground motion models for subduction earthquakes.

# Research highlights (Con't)

## University of California, Berkeley




Dr. Abrahamson developed the time-domain spectral matching method (RSPMATCH) that allows the engineer to modify time histories for matching the target response spectrum while preserving the key non-stationary character of the time history. This computer program is freely available and is a standard approach that is used in engineering practice. He has also developed models of the spatial variation of ground motion over short distances. These models have been used for seismic analyses of nuclear power plants and long-span bridges.

Dr. Abrahamson served as the technical leader for the PG&E/DOE program on extreme ground motions. This program integrated advanced numerical modeling of ground motions, empirical ground motion models, non-linear site response analyses, and observations of fragile geologic features to constrain the ground motions at very long return periods that are needed for critical facilities such as the proposed nuclear waste repository at Yucca Mountain.

At PG&E, Dr. Abrahamson is responsible for developing ground seismic evaluations of PG&E facilities including nuclear power plants, nuclear waste storage, dams, penstocks, electric substations, office buildings, and gas pipelines. He is also responsible for the technical management of the PG&E seismic research program.

As a consultant, Dr. Abrahamson has been involved in the ground motion studies for several major engineering projects in California. Projects include the Caltrans major toll bridge retrofit projects, the CalFed project for the Sacramento Delta levee system, the BART seismic retrofit project, and the SFO expansion. He has been involved in developing ground motion for nuclear plants and dams in the United States and in other countries.

---

Jonathan D. Bray, Ph.D., P.E., NAE is the Faculty Chair in Earthquake Engineering Excellence at Berkeley. He earned engineering degrees from West Point, Stanford, and Berkeley. Dr. Bray is a registered professional civil engineer and has served as a consultant on several important engineering projects and peer review panels. He has authored more than 350 research publications on topics that include liquefaction and its effects on structures, seismic performance of earth structures, earthquake ground motions, and earthquake fault rupture propagation. He leads the National Science Foundation (NSF) sponsored Geotechnical Extreme Events Reconnaissance (GEER) Association (geerassociation.org). Dr. Bray is a member of the US National Academy of Engineering and has received several honors, including the Ishihara Lecture, Peck Award, Joyner Lecture, Middlebrooks Award, Huber Research Prize, Packard Foundation Fellowship, and NSF Presidential Young Investigator Award. Additional information is available at: ce.berkeley.edu/people/faculty/bray

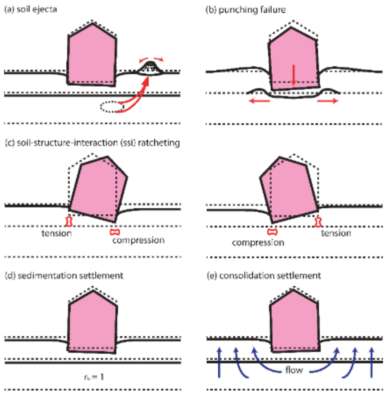
Dr. Bray has supervised the research of 32 Ph.D. students. Much of this research was in response to issues raised following major earthquakes. For example, the Bray and Sancio (2006) liquefaction of fine-grained soil criteria followed observations of silt liquefaction in the 1999 Kocaeli, Turkey earthquake (Bray et al. 2004). The simplified seismic slope displacement procedures of Bray and Travasarou (2007, 2009) were calibrated to provide results consistent with post-earthquake field measurements of earth dams and municipal solid waste (MSW) landfills. Damage observed during the 1994 Northridge earthquake motivated studies of the engineering properties of MSW with insights on its shear strength by Bray et al. (2009). The devastating effects of near-fault, pulse ground motions due to forward-directivity led to characterization schemes developed by Bray et al. (2009) and Hayden et al. (2014). Geotechnical mitigation measures proposed in Oettle and Bray (2013) are well-founded by observations of the effects of surface fault rupture following several important earthquakes. Lastly, recent studies documenting and

# Research highlights (Con't)

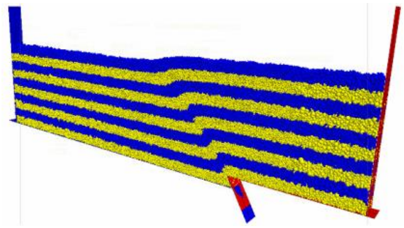
## University of California, Berkeley

discerning lessons from the effects of soil liquefaction on office buildings in Christchurch, New Zealand (e.g., Bray et al. 2014, 2017) have provided key insights on the important roles of the CPT and cyclic laboratory testing to characterize soil deposits and on the use of dynamic soil-structure-interaction (SSI) effective stress analyses to evaluate shear-induced liquefaction building settlement. A simplified procedure for evaluating liquefaction-induced building settlement is proposed in his 2017 Ishihara Lecture.

Tilted building due to liquefaction




Liquefaction-induced displacement mechanisms

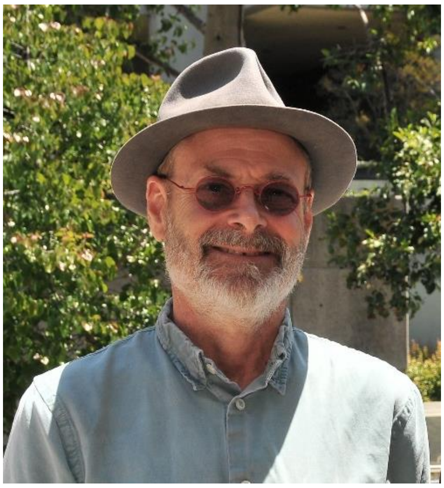


DEM fault rupture simulation

Significant research thrusts also utilize advanced geotechnical centrifuge modeling and advanced numerical tools such as discrete element modeling (DEM). The Dashti et al. (2010a,b) centrifuge experiments identified and evaluated the relative importance of key shear-induced and volumetric-induced liquefaction mechanisms. Mason et al. (2013), Trombetta et al. (2014), and Hayden et al. (2015) explored key dynamic SSI responses of structures founded on non-liquefiable and liquefiable ground. O'Sullivan et al. (2002, 2003a,b, 2004) emphasized the need to utilize realistic 3D sphere-cluster particles to capture the response of granular media. Further work is carried out with Ph.D. candidate Garcia who has developed a parallel-computing algorithm for evaluating fault rupture propagation through sand deposits.

---

Steven D. Glaser is a professor in the Dept. of Civil and Environmental Engineering, University of California, Berkeley, distinguished affiliate professor at the Technical University of Munich, and a research scientist at the Lawrence Berkeley National Laboratory. Glaser's engineering training was at The University of Texas at Austin. He also has a B.A. in philosophy from Clark University, 1975. He completed the apprentice program of Local 77 of the International Union of Operating Engineers, following which Glaser worked eight years as a driller, including one year in Iraq.

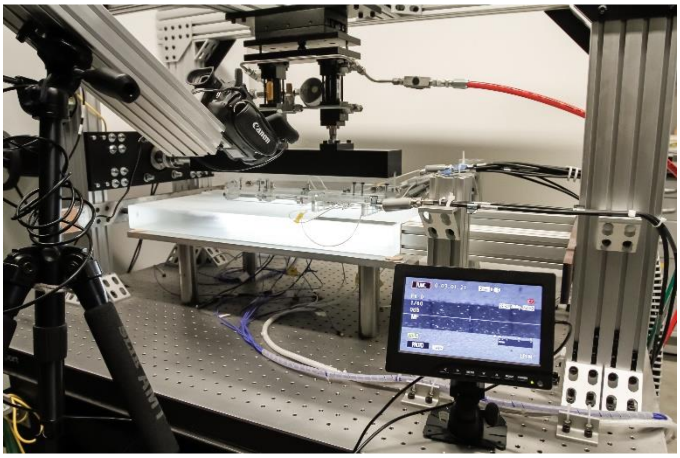


Glaser has worked on many aspects of rock mechanics and rock physics, most often by applying principles from geophysics. His work in this field has been published in Nature, Journal of Geophysical Research and other significant journals. Glaser currently operates the largest wireless network in the world, monitoring forest hydrology of snow melt and water balance in the Sierra Nevada (arho.org; https://vimeo.com/162487136).

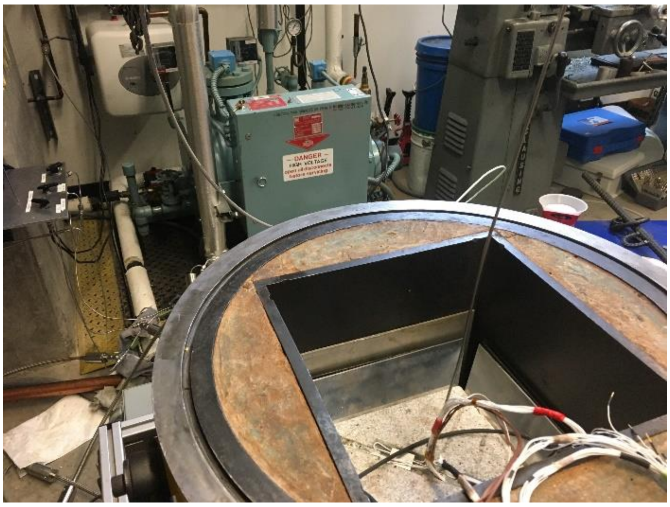
# Research highlights (Con't)

## University of California, Berkeley

The Glaser lab has a laboratory earthquake device that is now being used by the third Ph.D. student. The device can duplicate virtually any fault behavior leading up to gross rupture using lightly loaded PMMA. We are beginning to use extended fault source models to interpret the nanoseismic signals recorded during tests. We make use of the absolutely calibrated Glaser-type displacement sensor, which has a noise floor of 0.2 fm. We have examined asperity mechanics, effects of fault healing time, preslip mechanisms, slow-slip, and the mechanics of foreshock swarms. (https://www.youtube.com/watch?v=AMw490jPDlA&feature=youtu.be)



Glaser is currently working on an experiment looking at injection-induced seismicity from injecting cold water into hot rock. We are investigating the effects of thermal contraction, and injected water flashing to steam, as proximate causes of fault weakening. In particular we are modeling the Geysers geothermal field in N. California. The experiments take place in our true-triaxial geothermal reservoir simulator. Integral to this device is a high-pressure boiler that floods 250 mm cubes of rock with 2 MPa steam, duplicating the Geysers. The dynamic junction-level displacement 'seeds' that lead to macro-rupture will be studied through nano-seismic imaging using high temperature increased sensitivity Glaser-type sensors. We have just finished an experiment looking at the efficiency of using supercritical $CO_2$ as the circulating fluid in an enhanced geothermal reservoir.



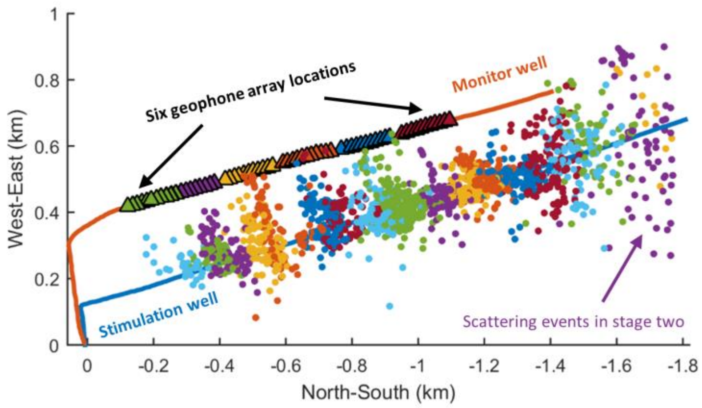
---

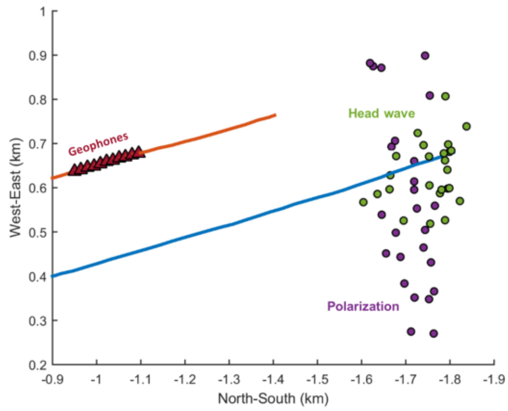
Professor Rector has been a member of the Berkeley Faculty since 1992. He is an expert in applied seismology with a focus on both near surface seismology and deep oil and gas reservoir imaging and has been a seminal contributor to seismic while drilling, crosswell seismic, near surface imaging, interferometry, anisotropic imaging, passive seismic, fracture mapping, and machine learning in seismology. He has supervised over 40 Ph.D. and Masters' students and holds a faculty appointment in the Department of Earth and Planetary Science and the Lawrence Berkeley National Laboratory. In addition to his work at Berkeley, he founded several successful commercial seismic technology companies, works with many of the major oil companies, and has patented a number of innovative technologies. He has won several major awards in the Society of Exploration Geophysicists, and has served as Editor in Chief of the Journal of Applied Seismology.

# Research highlights (Con't)

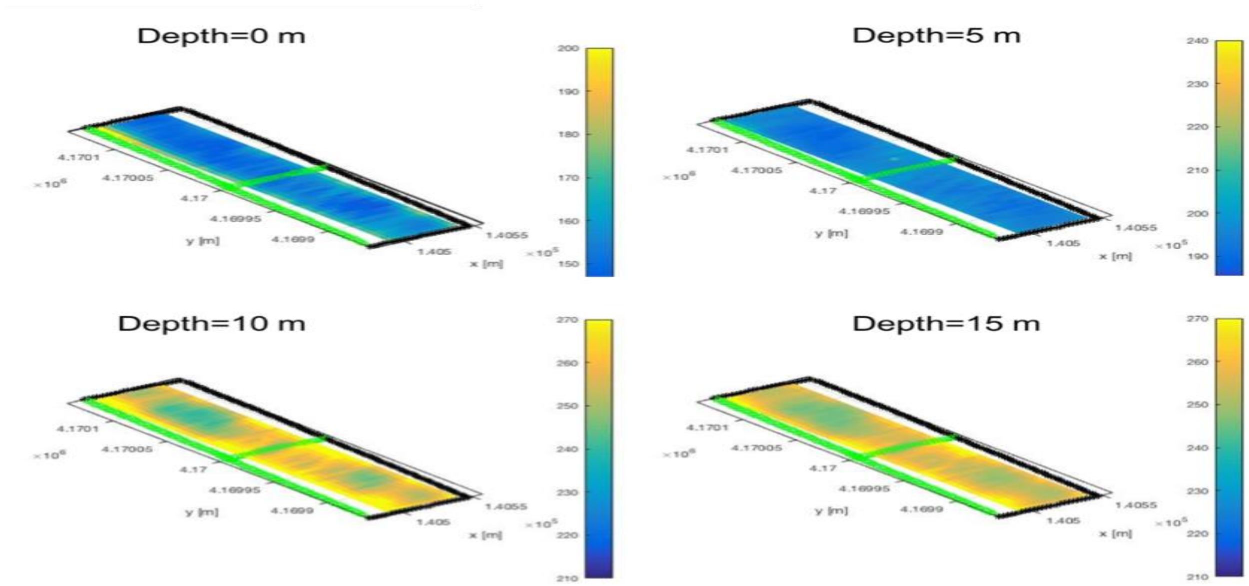
## University of California, Berkeley

Rector's work in oil and gas is focused on fracking and he has been a keynote speaker recently with a talk entitled "Fact and Fiction in Fracking". His research has been focused on improving the quality of microseismic data analysis. Compared to conventional event locations, event locations in real world situations have been dramatically improved through the development of Bayesian machine learning algorithms and the incorporation of other arrivals such as head waves.




He is also applying his expertise in seismic imaging to environmental and near surface geophysics. This work is aimed at understanding the mechanical properties of the soil and rock in the first 100 m of the earth. He developed and patented a new technique that uses tomographic techniques to analyze surface waves which provides a cost-effective 3-D extension of conventional 2-D analysis in MASW. This information can be used to characterize near surface soil profiles (for example to design building parameters), to detect voids, and to find near surface objects (bunkers, buried pipes, etc.), and to characterize fluids and flow such as contaminant transport and groundwater.



# Research highlights (Con't)

## University of California, Berkeley

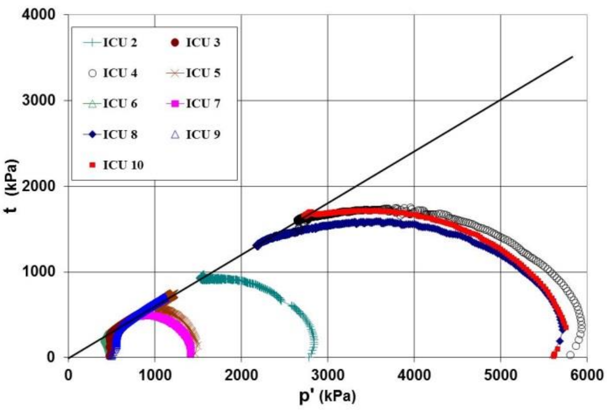
Michael Riemer is an Adjunct Professor in Civil and Environmental Engineering, as well as having been the manager of the geotechnical laboratories at UC Berkeley since 1992. He completed his undergraduate studies at Virginia Tech in Civil Engineering, and focused on Geotechnical engineering for his Masters and Doctoral studies at UC Berkeley. From 2000 through 2003, he also served as Manager of the Lifelines Research Program within the Pacific Earthquake Engineering Research (PEER) Center, coordinating a $1.3 million program of user-directed research ranging from ground motions through soil and structure response, to network risk and emergency response.

His research interests center on static and dynamic property evaluation for a broad range of geomaterials, from naturally occurring silty sands and deep clay deposits through mine tailings, rubble fills and municipal solid waste.

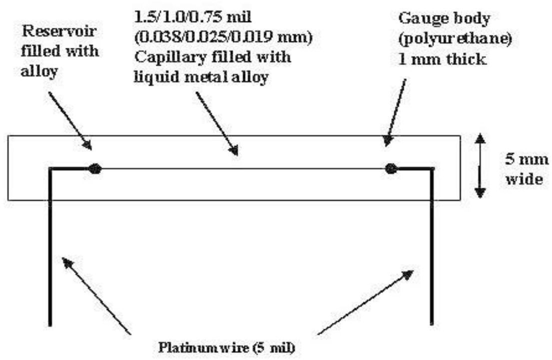
The testing conditions necessary for such measurements range in scale from conventional lab samples to triaxial testing at 12" diameter; confining pressures range from a few psi to over 60 atm. and deformations range from a few microns to nearly a foot. As such, an important part of the research is the development, refinement and upgrading of equipment across multiple scales and the incorporation of newer technologies within existing facilities.

One such example is the implementation of the Elastomer Strain Gauge (Safaqah & Riemer, 2007), a deformable elastic strip containing a metallic-filled capillary that can be attached to conventional latex or other membranes and deployed as a local strain sensor. Depending on the signal conditioning, these are capable of measuring strains as low as 0.001% up to 25%, and have been utilized both in extension and torsional shear.

In addition to his own research, Prof. Riemer often collaborates with other faculty in the program, training research students in advanced laboratory testing techniques, modifying existing research equipment to enhance particular capabilities for a specific project, or developing specialized procedures for given research goals.




Evaluating effects of grain breakage on steady state for tailings




Elastomer Strain Gauge for local measurement

# Research highlights (Con't)

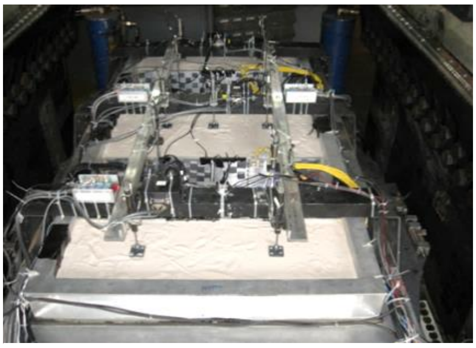
## University of California, Berkeley

Nicholas Sitar holds the Edward G. Cahill and John R. Cahill Chair in Civil and Environmental Engineering. His undergraduate training was in Geological Engineering at the University of Windsor in Ontario, Canada, and he completed both his M.S. in Hydrogeology and Ph.D. in Geotechnical Engineering from Stanford University. His research activities encompass a broad range of areas in engineering geology, geological engineering, groundwater hydrology, and risk and reliability, with an overarching interest in natural hazard evaluation, modeling, and mitigation. His research is driven by coupling field observations with experimental and numerical analyses.

Early mote prototype for wildfire monitoring

His experience with the challenges in field data acquisition in landslide monitoring led to his involvement in the early development of sensor boards and applications for wireless sensor systems, motes, capable of ad-hoc networking, remote data acquisition, and position tracking. Among the prototype demonstrations was an environmental sensor demonstration network for tracking of wildfires in Northern California. The basic sensor boards demonstrated in these experiments and their derivatives are now used by researchers worldwide and are starting to be implemented in engineering practice.

His involvement in geotechnical earthquake engineering started with post-earthquake investigation of seismically induced landslides in Guatemala in 1976. Since then his focus has been the seismic response of underground space, seismic earth pressures on retaining structures, and seismic slope stability. His most recent research with his graduate students (L. Al-Atik, R.G. Mikola, G. Candia and N. Wagner) focused on the seismic response of retaining walls and basements. This effort combined field observations with extensive experimental work using geotechnical centrifuge and numerical modeling to develop new guidance for analysis and design of these structures in high seismicity regions (for more information see: 10.21418/G8WC7H).



Models of retaining walls for testing

DEM model of disintegration of a jointed rock mass

The overall focus of his research in rock mechanics has been the influence of kinematics on the response of fractured rock masses. His current research is focusing on the behavior of jointed rock masses under different environmental conditions, including rock fall hazard identification using acoustic emission monitoring, evaluation of conditions leading to rock erosion in unlined spillways, and kinematics of large rock slides. With student M. Gardner he is currently leading an effort to develop a new generation of numerical codes for modeling dynamic response of jointed rock masses and rock fluid interaction. This effort aims to combine 3-D DEM rock mass model with LBM fluid model while taking advantage of new developments in parallel computing in order to make analyses of realistic field-scale problems achievable and suitable for wide application in research and practice.

# Research highlights (Con't)

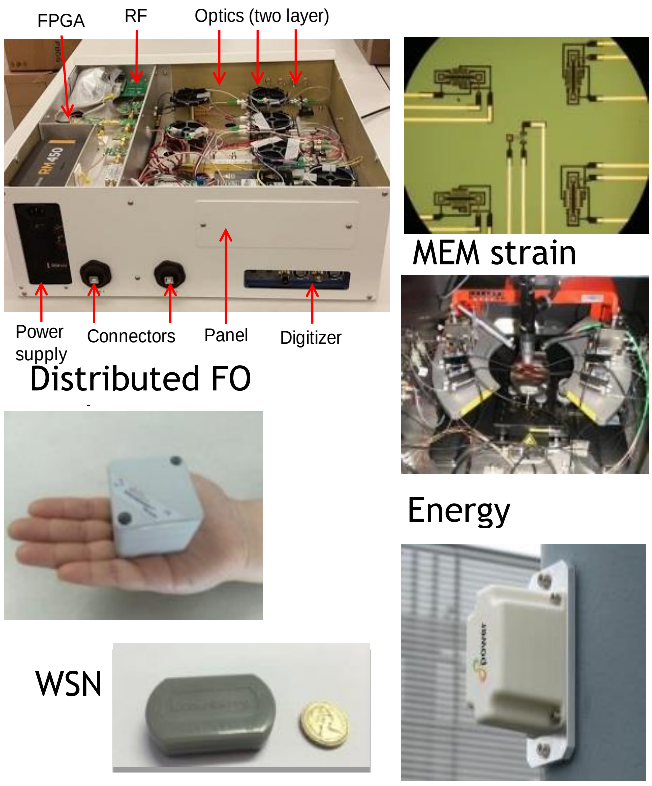
## University of California, Berkeley

The overarching element in his research, starting with his Ph.D. dissertation, has been the influence of geologic environment on the properties of sedimentary deposits. He and his students have performed extensive studies of the influence of depositional fabric on the stability of steep slopes in sands and gravels. He is currently embarking on the exploration of the influence of depositional fabric on the strength characteristics of fluvial sediments from micro- to macro-scale.

---

Kenichi Soga is Chancellor's Professor in Civil and Environmental Engineering. He received his B.Eng. and M.Eng. from Kyoto University, Japan, and Ph.D. from the University of California, Berkeley, US. Prior to his move to UC-Berkeley in 2016, he was Professor of Civil Engineering at the University of Cambridge, UK. He is currently the secretary of ISSMGE's Technical Oversight committee. He is also the vice chair of TC308 Energy Geotechnics and the secretary of TC105 Macro and Micro Geomechanics. He is co-author of "Fundamentals of soil behavior, 3rd edition" with Professor James Mitchell. His research interests are fundamental soil behavior, computational geomechanics and infrastructure sensing. His current research at Berkeley continues from his research at Cambridge, which was reported in ISSMGE Bulletin: Volume 8, Issue 4.

During the past 15 years, he and his research team have been developing innovative sensor technologies for geotechnical engineering applications. The technologies include distributed fiber optics (FO) sensing, wireless sensor network (WSN), low power micro-electro-mechanical sensors, energy harvesting and computer vision. They have been deployed in tunnels, deep excavations, piles and slopes, leading to industry adoption and commercial spin offs. These activities resulted in the establishment of the Cambridge Centre for Smart Infrastructure and Construction (smartinfrastructure.eng.cam.ac.uk) at Cambridge. Even after his move to the US, he continues to be an active member of the centre, leading their international activities. He is co-author of "Distributed Fibre Optic Strain Sensing for Monitoring Civil Infrastructure" and "Wireless Sensor Networks for Civil Infrastructure Monitoring", which are available from ICE publishing. At Berkeley, he initiated research projects to test these technologies for monitoring large shafts, cutoff walls for river levees and pipelines. The main goal of these projects is to promote the concept of performance based design, construction and maintenance of our geotechnical structures by actively monitoring them throughout their lifetime.

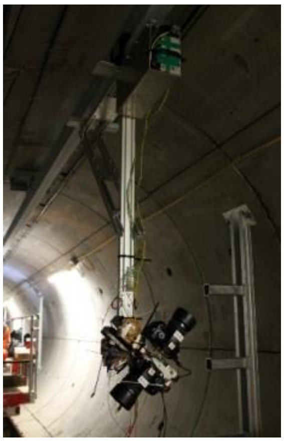



Developing new sensors

# Research highlights (Con't)

## University of California, Berkeley

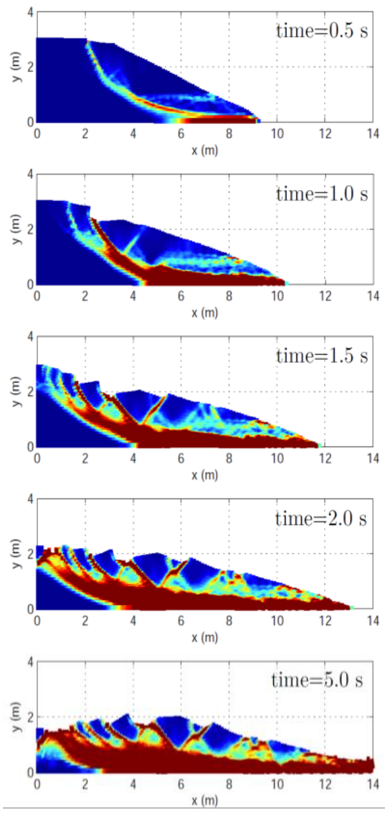
His interest in computational geotechnics started when he was working on UC Berkeley's finite element code FEAP for his Ph.D. research 25 years ago. Over the years, his research team has developed new codes for geotechnical engineering applications. These include: (i) Coupled fluid flow-deformation Material Point Method code for large deformation landslide analysis, (ii) Lattice Boltzmann Method-Discrete Element Method code for particle-scale solid-fluid interaction analysis, (iii) Coupled Lattice Element Method code for hydraulic fracturing simulations, and (iv) Thermo-Hydro-Mechanical code to solve energy geostructures and methane hydrate problems. The research also investigates the role of various constitutive models in understanding the fundamental deformation mechanisms of various geotechnical problems. The current research activities utilize high performance computing facility and techniques to conduct large scale simulations.



Computer vision for tunnel inspection

Fiber optics installation in energy piles

The overall arching theme of his research is investigation of fundamental soil behavior in geotechnical engineering using the research tools described above. The current research topics include: (i) thermo-hydro-mechanical interactions for geothermal and deep geomechanics problems, (ii) large deformation for landslides and sand production, (iii) soil fabric and micro-macro relationships for developing models for microbial induced-cementing and soil erosion, and (iv) long term performance of underground structures.




Fluid-soil coupled MPM simulations

Long-term performance of CERN tunnels, Switzerland