CBBG

Center for Bio-mediated & Bio-inspired Geotechnics

Newsletter ▪ Summer 2020 ▪ Volume 16

As I See It: View from Director's Chair

Keeping the Band Together

Now that the second (and last) 5-year core funding increment from NSF is secure, there may be a tendency to take a deep breath and relax. Our raison d'être for the first five years was, frankly, to obtain a second five years of funding, and we have done that. But, rather than sit back and bask in our success at having demonstrated to NSF that we deserve 5 years of additional core funding, we really need to ask what does CBBG need to do in the next 5 years so that we can continue to maintain our position as leaders in the sub-discipline of biogeotechnics we have worked so hard to establish, or to put it more succinctly, "What do we need to do to keep the band together?" The answer to this question depends to some extent upon the context in which it is asked: are we looking at this question from a technology and education development point of view or from a Center sustainability perspective. But, perhaps not unexpectedly, the answer from these two different perspectives is surprisingly similar.

From a technology perspective, we certainly are not going to deviate from our focus on bio-mediated and bio-inspired geotechnics. However, in the proposal for the second 5 year increment of funding we did state an intent to broaden our purview to include abiotic nature-inspired processes (e.g., abiotic mineral precipitation, abiotic soil remediation). Considering the time lag between initiation of a new project and maturation of the associated technology, if we are going to undertake some new initiatives in nature-inspired geotechnics, or in bio-mediated and bio-inspired design, that needs to happen this year or next, providing time for the technology to develop before our core NSF funding winds down.

However, our capacity to take on new projects is limited, as our annual allocation from NSF is fixed for the next three years and then declines for the last two years and, despite a fixed allocation, our "buying power" for the next three years declines as costs (salaries, tuition, other expenses, overhead) tend to increase annually. Therefore, to make room for new projects we will need to critically examine our current portfolio of projects, many of which date back to the formation of CBBG, to identify projects that have not been able to attract industrial support and thus may need to be terminated to make room for new initiatives. New projects will have to move CBBG in a new direction and new and continuing projects will have to attract significant support from beyond the CBBG coffers, whether it be from an industry partner, a government agency, or some other funding source for the Center to be sustainable.

As well as being a major factor in continued funding of current projects and funding of new projects, the ability to attract support from beyond the CBBG core funds is the key to the sustainability of CBBG after the end of the NSF core funding period. By Year 11 (after the end of NSF core funding), we will need to be self-sufficient. Self-sufficiency will require over $3 million in support annually to sustain our current level of research. Sustaining our IDEA (innovation, diversity, and education activities) program will require another several hundred thousand dollars annually in order to continue at our current level. While we have started to develop the relationships necessary to secure the necesary levels of funding for both our research and education endeavors, much work remains to be done.

In short, while our focus for the first five years of CBBG's existence was development of a body of work in both research and education that was sufficient to convince NSF we deserved a second five years of funding, our focus for the second five years must be development of relationships and funding sources that will sustain CBBG beyond the end of the NSF core funding period. This is necessary to both continue developing the discipline of biogeotechnics in both technology and education directions and to continue doing so under the auspices of the CBBG, i.e., this is what we need to do to keep the band together.

Important Dates

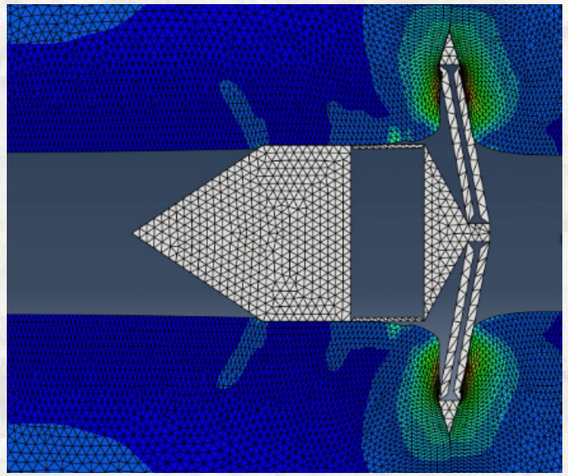
YR5 Annual Meeting/NSF Site Visit
October 26-28, 2020
Arizona State University

2021 Mid-Year Meeting
April 11, 2021 - Student Retreat
April 12-13, 2021 - YR6 Mid-Year Meeting
Georgia Institute of Technology
Atlanta, GA

Research Highlights

New Projects for Year 6

In late July, the CBBG leadership team approved three new projects for Year 6: one in the Subsurface Excavation and Exploration (SEE) thrust and two in the Environmental Protection and Restoration (EPR) thrust. Chloe Arson, Professor of Civil and Environmental Engineering at Georgia Tech, returns as a CBBG Senior Investigator in the SEE thrust with her project on *Mole rat - inspired bidirectional propeller for self-excavating probes.* Professor Arson will be working with a new member of the CBBG team, Dr. Frank L. Hammond III, Assistant Professor of Mechanical Engineering at Georgia Tech. Taking inspiration from the mole rat, this project aims to design a system of coupled anchors that can propel a burrowing probe forward and backward, with the immediate goal of facilitating retrieval of self-burrowing probes deployed from a shallow tunnel or borehole. Haley and Aldrich, Inc., a CBBG Industry Partner, is a collaborator on this project.



Numerical simulation of propulsion assisted by back anchors for backward motion in a previously excavated boring (Arson)

In the EPR thrust, CBBG is pleased to welcome two new Senior Investigators from UC Davis to the CBBG research team, Jasquelin Peña, Associate Professor, and Veronica Morales, Assistant Professor of the Civil and Environmental Engineering Department. Their project on *In situ manganese biomineralization in granular media for contaminant removal* aims to develop a low-cost and low-impact pathway for sorption and oxidation processes in systems impacted by metal and metalloid contamination (e.g., Mn, Pb, Cu, Co, Ni, As, Sb). Also in the EPR thrust, Anca Delgado, Assistant Professor of Environmental Engineering at ASU, is resuming her active engagement in CBBG research. Professor Delgado is the Senior Investigator for *Enhanced control of microbial activity and substrate delivery via inhibitors for in-situ contaminant treatment*. The over-arching goal of this project is to control microbial processes in space and time through the use of inhibitors that temporarily deter microbial growth and activity near a substrate injection point to allow for a larger or a more uniform treatment zone farther down gradient. CBBG Industry Partner Haley and Aldrich will also be collaborating with Professor Delgado on this project.

Enhanced Control of Microbial Activity and Substrate Activity via Inhibitors for In-Situ Contaminant Treatment

Promoting microbial reactions to occur either at desired locations or more uniformly during in situ contaminant treatment has been a long-standing goal in the field of bioremediation. This project will investigate methods to control microbial processes in space and time through the use of microbial inhibitors that temporarily deter microbial growth and activity near a substrate injection point. Cometabolic aerobic biodegradation of trichloroethene (TCE) will be used as the model microbial process during Year 1 of the project. Several microbial inhibitors (acetylene, propylene, hydrogen peroxide, low pH) wil be tested under various conditions. The project is expected to generate fundamental knowledge on the use of inhibitors to minimize bio-clogging and maximize contaminant biodegradation downstream of substrate injection points during in situ treatment. The project brings together experts in microbiology, biogeotechnics, and bioremediation and has financial and in-kind support from the Industry Partner, Haley & Aldrich.

Mole Rat-Inspired Bidirectional Propeller for Self-Excavating Probes

This project focuses on probe retrieval and aims to design a system of coupled anchors that can propel a burrowing probe forward and backward. We take inspiration from mole rats, which are known for their ability to burrow long tunnels with very short limbs, and to move forward and backward on steep slopes. Contrary to terrestrial rats, mole rats do not change their body weight distribution when they move, which makes their gait easier to replicate with a small-size rigid cylindrical robot. We will design an excavating robot that will propel itself with a system of coupled front- and back- anchors. The prototype will be 5-8 centimeters in diameter, smaller than a cone penetrometer, to reduce anchoring forces during laboratory tests. Due to the limited space inside the robot body, we will seek to deploy the same anchors during forward and backward motion. We will first optimize the number, shape and angle of the anchors. We will then simulate different robot gaits and compare the force needed to move forward or backward with different anchor deployment sequences. We will prototype a bidirectional propeller, collaborate with geotechnical practitioners to assess use cases for shallow tunneling projects, and develop a commercializable device in conjunction with industry partners.

CBBG Research Featured in ASU Engineering School Newsletter

The ASU Ira A. Fulton School of Engineering recentrly featured CBBG's work on the large outdoor rainfall and infiltration simulator (LORIS), which is installed at the Polytechnic campus in Mesa, AZ. More information about the LORIS project can be found in the article here: https://bit.ly/33HjuBZ

Rainfall simulator at the ASU Polytechnic campus.

Biocemented Columns Research Moves Forward

CBBG research on biocementation took a major step forward in early August with the excavation of the CBBG test pit testbed on the ASU polytechnic campus, exposing the seven biocemented columns that we created within the pit several months ago. Under the direction of ASU PhD student Kimberly Martin, seven columns up to 8 ft long were created using CBBG's patented Enzyme Induced Carbonate Precipitation (EICP) process and a conventional "tube a manchette" (TAM) penetration grouting approach. The cementation solution of urease, calcium chloride, urea, and powdered milk was introduced through slotted PVC TAM pipes using a packer system to isolate one set of slots at a time, from the bottom-up. Three cycles of cementation solution were injected through the TAM, with 24 hours between each cycle. Different columns were subjected to different volumes of cementation solution depending upon the target diameter of the column and the injection rate was varied among the columns to study its influence on the process.

The 200 sq. ft, 12 ft-deep pit was loosely filled with dumped sand from a local quarry. Prior to excavation of the pit, a load test was conducted on one of the columns and CBBG industry partner ConeTec conducted cone penetrometer soundings and downhole shear wave velocity measurements in one of the biocemented columns. During excavation, penetrometer tests were conducted on the columns as they were exposed, compressional and shear wave velocity measurements were made on the exposed columns, and samples were recovered from every column for laboratory testing (e.g., carbonate content, unconfined compression strength, scanning electron microscope imaging). Monitoring and sampling was a collaborative effort among CBBG students and staff, including Professor's Leon van Paassen and Ed Kavazanjian, Reserch Professor Hamid Khodadaditirkolaei, PhD students Vinay Krishnam, Miriam Woolley, Farideh Ehsasi, Lei Hang and CBBG support engineer Robin Cheng. The work was conducted with appropriate health and safety precautions, including gas monitoring within the test pit, face coverings at all times, maintaining social distancing as much as practical, and limiting shifts and hydrating between shifts as the temperature approached 110 degrees F during the day.

CBBG PhD student Kimberly Martin surveys the exposed biocemented columns

Professor Ed Kavazanjian, CBBG Director and the CBBG Senior Investigator on this project, described this work as a major step towards commercialization of CBBG's EICP technology. Results of this test pit testbed work on biocemented columns will be reported in Ms. Martin's PhD thesis, expected to be completed this fall, as well as in appropriate professional publications. The test pit testbed is now being readied for the next experiment, testing of NMSU's innovative bio-inspired deep foundation system.

Georgia Tech Summer Highlights

Georgia Tech CBBG researchers have been continuing to make progress in their projects albeit with greater emphasis on numerical rather than experimental activities over the Summer. While many have remained close to campus in Atlanta, a few ventured a little further away for a period during the summer to take advantage of family cooking and larger space to work than a small apartment in Atlanta. Notable travelers included Karie Yamamoto who continued her ant tunnel modeling studies in Seattle and Nimisha Roy who ventured to Memphis but remained tethered to her Dell HPC in the lab in Atlanta. The Geo-Society at Georgia Tech remained very connected also through Friday afternoon Geo-coffee sessions that included a lot of on-line games and activities. We probably know more about each other now than if we had actually been together on campus. Thanks to SLC President and GT CBBG researcher Boyoung Jeong who coordinated these critical weekly events and helped us all keep our sanity.

NMSU EE Undergraduate Contributes to Interdisciplinary Project

Salvador (Sal) Ibarra is a senior Electrical Engineering student at NMSU and CBBG undergraduate research assistant mentored by Dr. Douglas Cortes. During the last two years, Sal has been instrumental in the development of control systems for the earthworm-inspired self-excavating devices being developed by Cortes' team at NMSU. Sal's expertise in Arduino microcontrollers and the peripheral electronics that support this open source architecture has been essential to the rapid development of prototypes necessary to identify and overcome emerging barriers. Sal will graduate with B.S. (EE) this Fall 2020 and plans to work in the industry. Sal is a New Mexico native and first generation to attend college. In his free time, Sal likes to play soccer and enjoys spending time with his family.

NMSU senior (EE) Salvador Ibarra

Mitchell and Bandini Co-PIs of New NSF S-STEM Grant

Drs. Martha Mitchell and Paola Bandini are Co-Principal Investigators of a recently awarded National Science Foundation (NSF) $5 million S-STEM grant titled "Pathways for the Successful Transfer and Retention (STAR) of Engineering Students from Two- to Four-Year Colleges in New Mexico" (2020-2025). This project is a partnership of New Mexico State University (NMSU) and the Dona Ana Community College, both Hispanic-serving Institutions, to support through degree completion three cohorts of 30 students who will transfer from the community college to engineering programs at NMSU. The project will contribute to the national need for well-educated engineers.

Over its five-year duration, this project will enhance the existing Community College-University transfer pathway; provide need-based financial assistance to academically talented engineering students (scholarships of up to $10,000/year per student); enhance transfer engineering students' math proficiency through a Summer Math Boot Camp; enhance students self-efficacy, growth mindset, and engineering identity through metacognition- and cohort-based activities; assess students' academic performance using data analytics; and utilize near-peer mentors and tutors for academic interventions. The project team is composed of faculty and researchers from the two institutions. The NSF abstract is found in this link: https://bit.ly/3hPkB6N

Bandini and Mitchell are currently the PI and co-PI of an NSF S-STEM project (2016-2021) in the NMSU College of Engineering that has provided support, professional development and one-on-one faculty mentorship to a cohort of twenty-eight engineering students.

(From left) Paola Bandini and Martha Mitchell of NMSU

Student Initiatives

SLC Connects, Informs CBBG Students

As the Fall 2020 semester approaches the CBBG Student Leadership Council has capitalized on student strengths to help keep students across universities connected and informed. The 2020 CBBG mid-year meeting included a student brainstorming session where teams identified skills and technologies they found useful for working in the field of biogeotechnics, as well as strategies for educating the CBBG on these topics. The SLC is working to push these ideas forward by working with each team to publish a series of professionally produced, peer-reviewed training videos on their topics that will be used across all CBBG campuses. These training videos are a great opportunity for building connections between students at different universities and the end product will be a valuable resource for the CBBG for years to come. The SLC is also working to maintain connections between students, industry partners, and other ERCs. The SLC has maintained close connections with industry partners and there are plans in the near future for both online webinars or mixers as well as potential field or office tours for interested students. The CBBG SLC has also been in contact with SLCs from other Engineering Research Centers across the US and have many fun plans for collaboration and outreach. The SLC is looking forward to another productive year and has some exciting plans for everyone, so keep an eye out!

CBBG Students Develop Online Training Sessions

As a result of student breakout sessions during the 2020 mid-year meeting, it was suggested that online resources be created for CBBG students to aid in their development of valuable research skills and tools. The Student Leadership Council (SLC) has taken the lead on developing online training sessions that incorporate and realize the ideas from the student breakout sessions.

The SLC has drawn up guidelines and a template for creating these videos to ensure the consistency and level of professionalism in all training sessions, and student group leaders meet with the SLC regularly for progress checks. CBBG students are proactively engaged in this process, with each breakout group being responsible for the content, visual aids, recording, and editing of their video.

This process facilitates collaboration among students across all campuses and provides an opportunity to improve communications skills. In addition, the training videos will be posted on the CBBG website and given a DOI so that the students involved can cite them on their resume as a published peer-reviewed online lesson. The development of these videos will foster center-wide communication and provide current and future students easy access to information they need to be successful.

Education & Outreach

New Hybrid Research Experience for Teachers (RET)

In response to COVID-19, the 2020 CBBG RET Program was modified and delivered in a hybrid format to better provide support for teachers adapting STEM-focused and lab-based engineering lessons for online and remote delivery. The program included a mentored five-week virtual portion with both synchronous and asynchronous components delivered via Zoom and Canvas. Eight K-12 STEM teachers participated with four at ASU, three at Georgia Tech, and one at CBBG PUI partner, Lafayette College. With the support of CBBG faculty and graduate student mentors, these six middle school teachers and two high school teachers developed biogeotechnical engineering lesson plans to be implemented during the 2020-2021 school year as part of their programs. In some instances, teachers also completed a lab experience simultaneously, while others will complete the lab component as campus labs are available (after the school day or weekend).

CBBG RET Program Reaches Out to Young Scholars

Brianne Loya's first experience with CBBG was at the Educate to Innovate conference where 100+ teachers attended to learn about best science teaching practices and to take some fun science activities back to their classrooms. She believed the research and educational outreach that CBBG was doing was incredibly important and wanted to be a part of it in some way. CBBG inspired the topic for the semester long, after school teen program called CREATE U at Arizona Science Center. Seventeen high school students from a variety of high schools worked for a semester developing ways to help their communities adapt to the impacts of climate change with solutions inspired by nature. Students got an opportunity to hear a presentation and demo from Dr. Edward Kavazanjian and PhD Student Miriam Woolley about their research and then attended ASU open door to further interact and learn with CBBG demonstrations and interactivities as well as taking a private tour of a CBBG lab with Dr. Tao. Students began designing solutions that would be built with equipment found at CREATE makerspace. Through the experience with CBBG students, many who will be first generation college students, got to learn about the process in which science is done. They came out of their experiences with CBBG better understanding how science is used to solve important and relevant problems and through the exposure many expressed interest in participating in the CBBG Young Scholars Program.

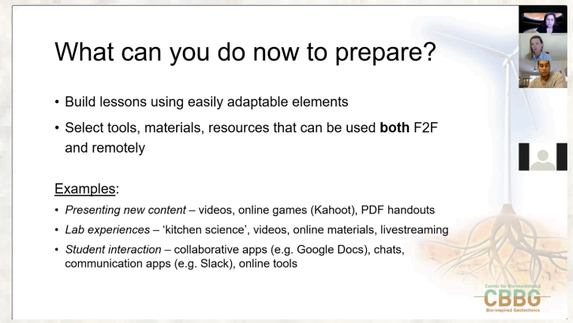
NSF ERCs Unite to Enhance Overall Education Program Evaluation

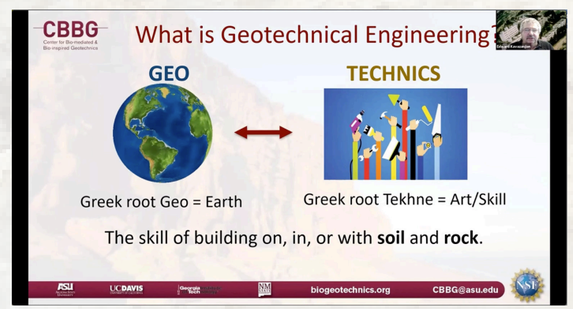
The education and evaluation leads from the CBBG, NEWT, and QESST ERCs that make up the ASU Tri-ERC Education Consortium (TEEC) continued their work to develop and test instruments and protocols that appropriately measure ERC education and diversity program impacts. The team has continued to meet each week to work on revising the quantitative Multi-ERC Instrument (MERCI) survey, which was distributed during Spring and Summer 2020 to all three Centers to collect evidence that will inform a finalized version of the instrument. Since the completion of the CBBG supplement last year, the group has worked on complementary qualitative tools to supplement the quantitative findings of the study and address categories that are not easily assessed using a survey. These additional qualitative measures will allow each ERC to collect supplementary information based on their special interests, unique setting, or from a specific participant group. These qualitative tools, including interview and observation protocols, will also allow evaluation teams to examine specific and detailed nuances of each individual program. (Continued on page 7)

In August, the team was awarded an NSF Research in the Formation of Engineers (RFE) Design and Development proposal titled: NSF Engineering Research Centers Unite: Developing and Testing a Suite of Instruments to Enhance Overall Education Program Evaluation. CBBG IDEA members involved are Dr. Jean Larson (Co-PI), Drs. Megan O'Donnell and Wendy Barnard (Evaluators), Dr. Willi Savenye (Senior Advisor), and Kim Farnsworth (PERL Programmer). This greater effort will enhance overall understanding of ERC educational and diversity programming and provide the necessary data to support changes throughout the ERC program.

Virtual Outreach Activities

To adapt to the COVID-19 shutdown, the Education Team at CBBG developed and presented several virtual outreach activities. Dr. Jean Larson and Kim Farnsworth provided the Roosevelt School District K-8 teachers with virtual professional development on lab-based STEM activities in a crisis teaching situation.





We also had the opportunity to provide two ASU virtual summer camps (SEE@ASU and Grand Scholars Challenge Program) with CBBG videos including a presentation by Director Dr. Ed Kavazanjian introducing CBBG and our research, two videos on bio-inspired and bio-mediated geotechnics, as well as videos of kitchen lab activities. Due to these efforts, we are leveraging our webinar recordings of prior presentations as well as developing new videos in order to provide continued virtual outreach presentations and activities throughout the coming school year in K-12 classrooms and for K-12 teacher professional development.

CBBG Community Updates

Van Paassen to Lead Environmental Thrust

Associate Professor Leon van Paassen of ASU has assumed leadership of the Environmental Protection and Restoration thrust at the start of Year 6. Professor van Paassen takes over from Professor Rosa Krajmalnik-Brown, who led this thrust since the inception of CBBG. While Professor Krajmalnik-Brown will continue to serve as a CBBG Senior Investigator, she stepped aside as thrust leader so she could focus on her role as Director of a new ASU research center, the Biodesign Center for Health Through Microbiomes (see the next article on this page).

Professor van Paassen came to ASU and joined CBBG in 2017 from Delft University of Technology, where he had already established himself as a leader in the area of microbially induced carbonate precipitation (MICP). At Delft, he participated in some of the first field scale experiments and field trials of MICP for ground improvement. At CBBG, Professor van Paassen has worked on MICP, microbially induced desaturation and precipitation (MIDP), and Enzyme Induced Carbonate Precipitation (EICP) for liquefaction hazard mitigation, various ground improvement applications (e.g., scour protection), and environmental protection. He has continued his work on field scale trials of biogeotechnologies in collaboration with CBBG industrial and academic partners, including field testing of MICP and MIDP in Toronto and field testing of the desaturation component of MIDP in Portland, Oregon. On these projects, he has continued to refine protocols for process monitoring and quality assessment. He is also engaged in CBBG research on investigation of alternative microbial pathways to precipitate minerals in soil, including co-precipitation of iron and calcium carbonate to create subsurface barriers, biogeotechnical mitigation of seepage through embankments, and using minerals or polymers to mitigate fugitive dust from mine tailings.

Krajmalnik-Brown to Lead New ASU Biodesign Center for Health Through Microbiomes (BCTHM)

Professor Rosa Krajmalnik-Brown, CBBG Senior Investigator and former head of the CBBG Environmental Protection and Restoration thrust, has been tapped to lead a new research center at ASU, the Biodesign Center for Health Through Microbiomes (BCTHM). The goal of BCTHM is to engineer the human microbiome to transform human health in a positive way. The Center aims to build on Professor Krajmalnik-Brown's ground breaking work on the microbiome and metabolism, autism-microbiome, and microbiome interventions to develop a range of interventions involving nutrition, and some of them harnessing the contribution of microbes in gut-brain connections. Knowledge gained will lead to better management of obesity, autism, and neurodegenerative diseases including Alzheimer's and Parkinson's. BCHTM will use knowledge gathered by examining microbiomes and performing microbial interventions to enhance fundamental knowledge and translate that fundamental knowledge into clinical applications.

While serving as Director of BCTHM, Professor Krajmalnik-Brown plans to continue her work as a CBBG Senior Investigator in the Environmental Protection and Restoration Thrust on Microbial Metabolic Exploration to provide bio-mediated, ecologically friendly, sustainable (green) and cost-effective technology for remediation and restoration of contaminated subsurface environments. Accomplishments under this project to date include development of techniques to enrich and analyze microbial communities and find novel microbial processes, enrichment and isolation of microorganisms that metabolize Carbon Monoxide, demonstration of rapid Cr (VI) reduction in soil microcosms and enrichment of a new Cr (VI)-reducing microbial culture, and demonstration of simultaneous detoxification of Arsenic (III) and Chromium (VI).

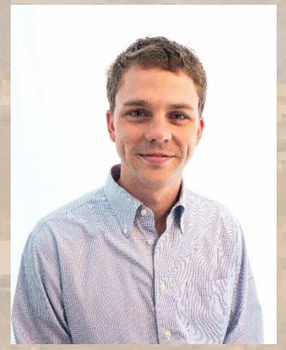
CBBG Welcomes New Administrative Director

Charlotte Bowens, Administrative Director, started at CBBG in July 2020 and brings years of sponsored research administration experience, including grant and financial management, human resources oversight, proposal and budget development, operational support, and strategic planning. Prior to joining CBBG, she was the Research Advancement Manager for the School of Life Sciences at Arizona State University. During her tenure at the University of Michigan she served as the Administrator for the Automotive Research Center and the Senior Research Process Manager for the College of Pharmacy. Her entrepreneurial endeavors include providing financial, marketing and strategic planning consulting services to tech startups, food entrepreneurs and various emerging small to mid-sized businesses.

Liu Joins University of Alberta

Former CBBG researcher and GT graduate student, Fangzhou Albert Liu, will be joining the faculty as an Assistant Professor in the Department of Civil and Environmental Engineering at the University of Alberta in Edmonton, Canada. He obtained his M.S. in Computational Science and Engineering and Ph.D. in Civil Engineering from the Georgia Institute of Technology. Originally scheduled to join the faculty at Edmonton in Spring of this year, Albert had been in Covid-19 isolation in Shanghai since January and is anxious to begin his academic responsibilities this Fall. His research interests include soil behavior, natural and human induced hazards, remote sensing, AR/VR and resilient bio-inspired infrastructure.

Mallet Joins Metropolitan State University



Former CBBG researcher and GT graduate student, Seth Mallett, has joined the faculty at Metropolitan State University of Denver as an Assistant Professor in the Department of Engineering and Engineering Technology. He obtained his B.S., M.S., and Ph.D. degrees all from the Georgia Institute of Technology in Civil Engineering. His research interests include soil particle behavior and biologically inspired geotechnics. He employs tools such as x-ray computed tomography, 3D printing, computer vision techniques, and machine learning to probe deeper into soil processes.

Out & About

Katerina Ziotopoulou Participates as Panelist in ASCE Geo-Institute Webinar on Online Learning

On July 27th, the Geo-Institute of the American Society of Civil Engineers' hosted a discussion panel about teaching during the COVID-19 pandemic. Katerina Ziotopoulou (UC Davis) was invited to participate as one of the 6 panelists during this live discussion. A recording of the webinar can be found here: https://bit.ly/3gEJ3qX.

CBBG Director Ed Kavazanjian Makes Contribution to Geo-Institute's Student Fund

In honor of the Geo-Institute's 25th anniversary, G-I Past President Ed Kavazanjian, Jr, Ph.D., P.E., NAE, D.GE, Dist.M.ASCE has generously donated $125,000 to the Geo-Institute for student programs . In addition, Ed has agreed to match up to another $125,000 in contributions from ASCE/G-I members to the Student Participation Fund.

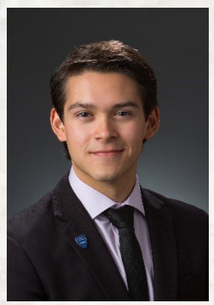
The Student Participation Fund helps geotechnical engineering students attend Geo-Congress every year, supports regional and national student competitions, and more!

(Photo courtesy of Jason Dixson Photography)

Graduating Students

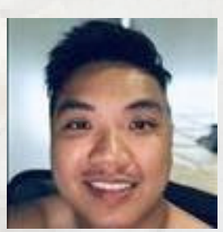
Tamar Baumer
Institution: University of California, Davis
Degree: BS, Civil Engineering (June 2020)
CBBG Research Project: PR36 - MICP Physical Modeling to Assess Liquefaction Mitigation
Post-graduation plans: Employed in industry.

Patricia Borunda
Institution: New Mexico State University
Degree: B.S., Civil Engineering (May 2020)
CBBG Research Project: Bio-inspired Resilient Earthen Construction (Thrust 3: Infrastructure Construction)
Post-graduation plans: Master's in construction management at the University of Concordia, Montreal.



Pascual Camacho
Institution: New Mexico State University
Degree: B.S., Civil Engineering (May 2020)
CBBG Research Project: Prototype Testing of Laterally Expansive Piles (Thrust 3: Infrastructure Construction)
Post-graduation plans: Master's in structural engineering at Stanford University and entrepreneurship activities (Prototype development and commercialization of patented invention)

Paul Chavez
Institution: New Mexico State University
Degree: B.S., Civil Engineering (May 2020)
CBBG Research Project: Bio-inspired Resilient Earthen Construction (Thrust 3: Infrastructure Construction)
Post-graduation plans: Work as a civil engineer for a private firm or government agency. Currently applying for jobs.

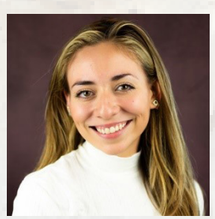


Robin Cheng Ng
Institution: Arizona State University
Degree: MS, Civil, Environmental and Sustainable Engineering
CBBG Research Project: (PR60) Construction of a Rainfall Simulator Testbed
Currently working for CBBG as a Field Tech

John F. Cooper
Institution: Las Cruces High School (2018-2020 Young Scholar at New Mexico State University)
Degree: H.S. Diploma (May 2020), Salutatorian
CBBG Research Project: Utilitarian Subterranean Annelid Inspired Geoprobe (Thrust 4: Subsurface Exploration and Excavation)
Post-graduation plans: B.S. in Computer Science and B.S. in Computational Mathematics at the University of New Mexico in Albuquerque.

Kristina Coppinger
Institution: Arizona State University
Degree: BS, Civil Engineering (August 2020)
CBBG Research Project: (PR4) Liquefaction Mitigation via Microbial Denitrification – Thrust 2: Hazard Mitigation
Currently working as an Assistant Civil Engineer with Burns & McDonnell

Tory Howells
Institution: New Mexico State University
Degree: B.S., Civil Engineering (May 2020)
CBBG Research Project: Microbially Enhanced Iron-Modified Zeolite Permeable Reactive Barrier (Thrust 2: Environmental Protection)
Post-graduation plans: Civil engineer at MolzenCorbin in Albuquerque and Master's in environmental engineering at NMSU.



Priscyla Marquez
Institution: New Mexico State University
Degree: B.S., Civil Engineering (May 2020)
CBBG Research Project: Microbially Enhanced Iron-Modified Zeolite Permeable Reactive Barrier (Thrust 2: Environmental Protection)
Post-graduation plans: Graduate studies (MS, PhD) in environmental engineering at the University of Texas at Austin, NSF GRFP award.

Graduating Students Cont'd.

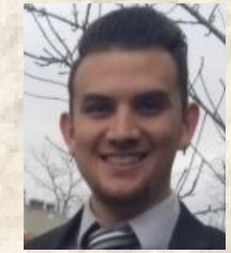
Regina Marquez
Institution: New Mexico State University
Degree: B.S., Chemical Engineering (May 2020)
CBBG Research Project: EICP for Erosion Control in Sloping Ground (Thrust 3: Infrastructure Construction)
Post-graduation plans: Chemical engineer at Eagle Moon Hemp.

Magdaleno Meza
Institution: Arizona State University
Degree: BS, Civil Engineering (May 2020)
CBBG Research Project: (PR4) Liquefaction Mitigation via Microbial Denitrification – Thrust 2: Hazard Mitigation
Currently working as a Civil Engineering Intern with Speedie & Associates

Casey Phradichith
Institution: University of California, Davis
Degree: MSCE, March 2020
CBBG Research Project: PR 30 Biofilm Enabled Permeability Reduction in Sands
Post-graduation plans: Working at GEI consultants, in Oakland, CA

Chris Purdy
Institution: University of California, Davis
Degree: MS, Civil Engineering (June 2020)
CBBG Research Project: PF 19: A Life Cycle Sustainability Assessment Framework for Geotechnical Engineering
Post-graduation plans: Working at USACE in Sacramento, CA office.

Joel Ramirez
Institution: Arizona State University
Degree: MS, Environmental Engineering (May 2020)
CBBG Research Project: (PR65) Bio-based Scour Protection for Underwater Foundation Systems – Thrust 3: Infrastructure Construction



Derrick Rivera
Institution: New Mexico State University
Degree: MS, Civil Engineering (May 2020)
CBBG Research Project: Bio-inspired Resilient Earthen Construction (Thrust 3: Infrastructure Construction)
Post-graduation plans: Work as electrical engineer for a private firm or government agency. Currently applying for jobs.

Shirly Tam
Institution: Arizona State University
Degree: BS, Industrial Design (May 2020)

Xi (Lucas) Yu
Institution: Arizona State University
Degree: BS, Civil Engineering (May 2020)
CBBG Research Project: (PR56) EICP Biocemented Soil Columns for Ground Improvement – Thrust 3:Infrastructure Construction Methods and Materials

Atefeh Zamani
Institution: University of California, Davis
Degree: Post-doctoral scholar, until June 2020
CBBG Research Project: PR36 - MICP Physical Modeling to Assess Liquefaction Mitigation
Post-graduation plans: Working at California Department of Water Resources - Soil Testing Facility

Honors & Awards

Colleen Bronner Receives Chancellor's Fellowship for Diversity, Equity and Inclusion

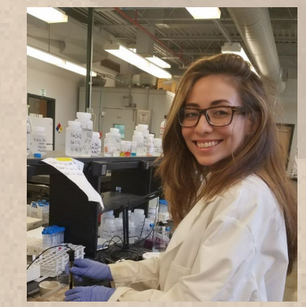
Congratulations to Colleen Bronner (Department of Civil and Environmental Engineering, University of California, Davis), who has been recognized as one of the inaugural recipients of the Chancellor's Fellowships for Diversity, Equity, and Inclusion! This fellowship recognizes faculty who demonstrate notable work in diversity, equity and inclusion. Fellowship recipients are given $5,000 to support their continued efforts. More information about this fellowship and its 2019-2020 recipients can be found here: https://bit.ly/3ikCJp7.

CBBG Student Wins Geosyntec 2020 Groundwater Student Paper Competition

On behalf of Geosyntec Consultants, we are pleased to announce that ASU graduate student Aide Robles is the winner of the 2020 Geosyntec Groundwater Student Paper Competition. Geosyntec would like to send their sincere thanks to all participants. Geosyntec also wishes to acknowledge their appreciation of the support and encouragement from the professors who help reach out to their top students each year.

Ms. Robles received the award for her paper titled, "Microbial Chain Elongation Drives complete Reductive Dechlorination of Trichloroethene". This was a CBBG project led by Aide's advisor, Professor Anca Delgado. Aide receives a cash prize of $1,000 USD. Congratulations, Aide!

NMSU undergraduate receives NSF Graduate Research Fellowship Program (GRFP) Award



NMSU senior Priscyla Marquez was awarded a 2020 Graduate Research Fellowship (GRFP) from the National Science Foundation (NSF). Priscyla graduated with a B.S. in Civil Engineering in May 2020 and started her graduate studies in environmental engineering at the University of Texas at Austin this fall semester. At NMSU, Priscyla was a CBBG undergraduate research assistant for three years working on the experimental and numerical simulations for the development of a microbially enhanced iron-modified zeolite permeable reactive barrier, mentored by Prof. Lambis Papelis. Based on this research, Priscyla received the first-place award for her technical paper and presentation at the ASCE Regional Student Conference in spring 2019. In addition, Priscyla presented this work at the 2020 National Meeting of the American Chemical Society (ACS). During her undergraduate studies, Priscyla participated in the Undergraduate Research Scholars (URS) Program at NMSU and the Research Experiences for Undergraduates (REU) program at North Caroline State University. She served as Vice President and President of the NMSU Student Chapter of the American Society of Civil Engineers (ASCE) as well as an officer of Chi Epsilon Civil Engineering Honor Society. She was also an S-STEM Scholar at NMSU and was recognized in the Dean's List and Crimson Scholar List every year.

ADSC Announces Scholarship to NMSU Graduate Student

Peter Zelkowski was awarded the 2020-2021 ADSC's Johnie Stephens Memorial Scholarship. Peter is a Ph.D. student in the Department of Civil Engineering at New Mexico State University. His doctoral research is sponsored by CBBG and develops a deep foundation system with bioinspired features that enhance the shaft resistance. Peter currently works on designing, constructing and testing a series of instrumented mid-scale prototype piles to be tested at the ASU Polytechnic Campus test pit this fall.

Peter served as the 2018-2019 President of the CBBG Student Leadership Council (SLC) and the lead graduate mentor for the CBBG 2019 summer program participants at NMSU. His academic achievements include merit scholarships, Crimson Scholar List, and member and officer of Chi Epsilon Civil Engineering Honor Society. Peter has worked as a summer intern for URENCO USA and Wood Group in New Mexico, and Palo Verde Nuclear Generating Station and Granite Construction in Arizona.

ADSC and the Industry Advancement Fund provide Civil Engineering Graduate Study Scholarships to well deserving students from schools in the U.S. and Canada. Peter and the other scholarship recipients are invited to attend the 2020 ADSC Annual Meeting in Amelia Island, Florida in January. ADSC is the International Association of Foundation Drilling.

Recent Publications

Barciela-Rial, M., van Paassen, L.A., Griffioen, J., van Kessel, T., Winterwerp, J.C. (2020), The effect of solid-phase composition on the drying behavior of Markermeer sediment, Vadose Zone Journal, 19/1, https://doi.org/10.1002/vzj2.20028

Bronner, C.E., Raymond, A.J. Integrating geotechnical engineering research into K-12 education through a graduate course in engineering education. Geo-Congress 2020.

Burdalski, R., Gomez, M.G. (2020). "Investigating the Effects of Biogeochemical Conditions During Microbially Induced Calcite Precipitation (MICP) Soil Improvement", ASCE GeoCongress 2020, Minneapolis, MN.

Burrall, M., DeJong, J.T., Martinez, A., Wilson, D., Huang, L. "Bio-inspiration through tree root pullout tests for innovative anchorage design", GeoCongress 2020, Minneapolis, MN, March 2020.

Cao, J., Roy, N. and Frost, J.D. (2020). "Relating Shear-Induced Evolution in Topology of Pore Networks to Sand Specimen Response",Geotechnique Letters.

Y. Chen, A. Khosravi, A. Martinez, J. DeJong, and D. Wilson (2020). "Analysis of the self-penetration process of a bio-inspired in-situ testing probe." GeoCongress 2020.

Y. Chen, A. Khosravi, A. Martinez, J.T. DeJong, and D. Wilson. 2020. "DEM analysis of an in situ reaction module for penetration in-situ testing." 6th International Conference on Geotechnical and Geophysical Site Characterization.

Edgar, M., Ray, H., Grubb, D. G., van Paassen, L. A., Hamdan, N., & Boyer, T. H. (2020). Removal of Phosphate and Nitrate from Impacted Waters via Slag-Driven Precipitation and Microbial Transformation. Journal of Sustainable Water in the Built Environment, 6(2), 04020007.

Giraldo-Silva, A., Fernandes, V., Bethany, J., & Garcia-Pichel, F. (2020). Niche Partitioning with Temperature among Heterocystous Cyanobacteria (Scytonema spp., Nostoc spp., and Tolypothrix spp.) from Biological Soil Crusts. Microorganisms, 8(3), 396.

Hall, Caitlyn A. (2020). My career earthquake. Science, 368 (648), 330. doi: 10.1126/science.368.6488.

Hall, Caitlyn A, McCutcheon, Griffin, Morton, Evvan V., Tindell, R. Kevin, and Weller, Nicholas. (2020). Strategies to curtail Valley Fever in Arizona: A policy memorandum to Congressman Greg Stanton. Journal of Science Policy and Governance, 16(1): 1-9.

Hall, C., Rittmann, B., van Paassen, L., and Kavazanjian, E.: Out of the Lab, Into the Frying Pan: Understanding the Effect of Natural Groundwater Conditions on Bio-Based Ground Improvement Strategies, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-11378, https://doi.org/10.5194/egusphere-egu2020-11378

Huang, S. and Tao, J. (2020) Bio-inspired dual-anchor burrowing: Effect of Vertical Curvature of the Shell, GeoCongress 2020 DOI: 10.1061/9780784482834.031

Lo, C. Y., Tirkolaei, H. K., Hua, M., De Rosa, I. M., Carlson, L., Kavazanjian Jr, E., & He, X. (2020). Durable and ductile double-network material for dust control. Geoderma, 361, 114090

Ma, Y., Evans, T.M. & Cortes, D.D. 2D DEM analysis of the interactions between bio-inspired geo-probe and soil during inflation–deflation cycles. Granular Matter 22, 11 (2020).

Mahabadi, N., van Paassen, L.A., Battiato, I., Yun, T.S., Choo, H. & Jang, J. (2020) Impact of Pore-Scale Characteristics on Immiscible Fluid Displacement, GeoFluids, Article ID 5759023, https://doi.org/10.1155/2020/5759023

Martin, K.K., Khodadadi Tirkolaei, H., and Kavazanjian, E., Jr. (2020) "Enzyme-Induced Carbonate Precipitation: Scale-up of Bio-cemented Soil Columns," Proceedings of Geo-Congress 2020, ASCE Geotechnical Special Publication 320, Biogeotechnics, pp. 96-103, https://doi.org/10.1061/9780784482834.011

Martin, K.K., Khodadadi Tirkolaei, H., Chester, M., and Kavazanjian, E., Jr. (2020) "Hot Spot Life Cycle Assessment for Enzyme-Induced Carbonate Precipitation as a Ground Improvement Technology," Proceedings of Geo-Congress 2020, ASCE Geotechnical Special Publication 320, Biogeotechnics, pp. 321-329, https://doi.org/10.1061/9780784482834.035

Martinez, A., Huang, L. Study of Interface Frictional Anisotropy at Bioinspired Soil-Structure Interfaces. GeoCongress 2020.

Nelson, C., Giraldo-Silva, A., & Garcia-Pichel, F. (2020). A fog-irrigated soil substrate (FISS) system unifies and optimizes cyanobacterial biocrust inoculum production. Applied and Environmental Microbiology (doi:10.1128/AEM.00624-20)

Oathes, T, Bronner, C.E., and DeJong, J. (2020). Developing Authentic Design Experiences Using Case Studies in a Senior Design Course. Proceedings of Geo-congress 2020: Geotechnical Earthquake Engineering and Special Topics, Minneapolis, Minnesota, February 25 to 28, 2020. pp. 669-675.

K.B. O'Hara and A. Martinez (2020). "Effects of Asperity Height on Monotonic and Cyclic Interface Behavior of Bioinspired Surfaces under Constant Normal Stiffness Conditions." GeoCongress 2020.

Ohan, J., Saneiyan, S., Lee, J., Bartlow, A., Ntarlagiannis, D., Burns, SE, Colwell, F. (2020). Microbial and Geochemical Dynamics of an Aquifer Stimulated for Microbial Induced Calcite Precipitation (MICP), Frontiers in Microbiology, section Microbiotechnology, Vol. 11, pp 1327, DOI: 10.3389/fmicb.2020.01327 .

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Ross W. Boulanger, Daniel W. Wilson, Bruce L. Kutter, Jason T. DeJong and Colleen E. Bronner. 2020. "NHERI Centrifuge Facility: Large-Scale Centrifuge Modeling in Geotechnical Research." Frontiers for Built Environment, Vol 6, Article 121.

San Pablo, A.C., Lee, M.1, Graddy, C.M.R., Kolbus, C.M.2, Zamani, A., Khan, M., Acuff, C., Martin, N., Gomez, M.G., DeJong, J.T., Nelson, D.N. (2020). "Meter-scale Soil Column Experiments to Examine Spatial Control of Bio-cementation Soil Improvement", GeoCongress 2020 Technical Papers, 11 pp.

Tang, Y., Huang, S. and Tao, J. (2020) Effect of rotation on seed's self-burial process: insights from DEM simulations, GeoCongress 2020 DOI: 10.1061/9780784482834.032

Tao, J., S. Huang, and Y., Tang. 2020. "SBOR: A Minimalistic Soft Self-Burrowing-out Robot Inspired by Razor Clams." Bioinspiration & Biomimetics, April. https://doi.org/10.1088/1748-3190/ab8754.

Wang, L. , van Paassen, L.A., and Kavazanjian, E., Jr. (2020) "Feasibility Study on Liquefaction Mitigation of Fraser River Sediments by Microbial Induced Desaturation and Precipitation (MIDP)" Proceedings of Geo-Congress 2020, ASCE Geotechnical Special Publication 320, Biogeotechnics, pp. 121-131 https://doi.org/10.1061/9780784482834.014

Weaver, W.C., T.C.G. Kibbey, and C. Papelis (2020). "Dissolution-desorption dynamics of strontium during elution following evaporation: pH and ionic strength effects." Water, 12, 1461; doi:10.3390/w12051461

Won, J., Jeong, B., Lee, J., Dai, S. and Burns, S.E., 2020. Facilitation of microbially induced calcite precipitation with kaolinite nucleation. Géotechnique, pp.1-7.

A. Zamani, Ph.D.; C. Phradichith; J. DeJong, Ph.D.; D. Nelson, Ph.D. (2020) "Effect of biofilm treatment strategy on the permeability reduction of sands". GeoCongress 2020.

Ziotopoulou, K., Bronner, C.E., and Moug, D. (2020). Graduate Student Perceptions of Mentoring: A Pilot Case Study in the Geotechnical Graduate Student Society at UC Davis. Proceedings of the International Conference on Geotechnical Engineering Education, June 23-25, 2020, streamed from Athens, Greece.

Industry & Innovation

ADEQ Arizona Department of Environmental Quality
ADOT
AERO AGGREGATES
ARCADIS Design & Consultancy for natural and built assets
ArcelorMittal
BioCement TECHNOLOGIES
City of Phoenix
CONETEC
United States Environmental Protection Agency
Freeport McMoRan Copper & Gold
Geo-Logic Associates
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GOLDER
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HALEY ALDRICH
HAYWARD BAKER Geotechnical Construction KELLER
NICHOLSON
REPUBLIC SERVICES
SALT RIVER LANDFILL An Enterprise of the Salt River Pima-Maricopa Indian Community
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How does nature do it?

Nature has developed elegant, efficient and sustainable biologically-based solutions to many challenges that vex geotechnical infrastructure systems. Examples include ant excavation processes that are 1000 times more energy efficient than man-made tunneling machines, carbonate cemented sand that is exceptionally resistant to erosion and earthquakes, and self-sensing and self-healing tree root structures that are 10 times more efficient than any mechanical soil reinforcing/foundation system yet devised.

The NSF Engineering Center for Bio-mediated and Bio-inspired Geotechnics (CBBG) will focus on ecologically friendly, cost-effective solutions, inspired by nature, for development and rehabilitation of resilient and sustainable civil infrastructure systems. It will serve as a nexus for two transformative trends in engineering: biologically-based design and sustainability.

CBBG is a National Science Foundation (NSF) Engineering Research Center funded in 2015 under cooperative agreement EEC-1449501, and headquartered at Arizona State University.

biogeotechnics.org

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