

# CBBG

## Center for Bio-mediated & Bio-inspired Geotechnics

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### As I See It: View from Director's Chair

#### Shifting Gears

As we proceed through Year 3 of CBBG operations, it is time for CBBG to shift gears and accelerate our efforts in advancing our more promising biogeotechnologies and more fruitful education and outreach efforts. The Leadership Team has now initiated a strategic planning exercise to do just that (well, maybe not "just"). Starting with a comprehensive review of our portfolio of research projects and education and outreach activities, we intend to narrow the broad spectrum of activities we have pursued over the past two and a half years to focus our efforts on those research technologies and education and outreach programs that have the greatest potential for a transformative impact.

Since the inception of the Center, CBBG has pursued a diverse group of activities in which we covered a broad spectrum of research topics within the realm of biogeotechnics, accompanied by a variety of education and outreach activities. I think our approach can be reasonably described as sowing many seeds to see which ones would take root and flourish within the ERC (Engineering Research Center) environment. By "taking root and flourish," I mean which research projects have

shown the potential to transform geotechnical practice, in both the short and long term, and which education and outreach activities have shown the greatest potential for long term impact.

While, in general, CBBG got high marks for our second year of operations from the NSF Site Visit Team, they did express concern that "the large number of research projects and lack of prioritization may impede the ability of the CBBG to make significant impacts in key areas." In the same vein, they also expressed concern that "The large number of workforce development/ education activities and lack of prioritization may impede the ability of the students/faculty to make significant impacts in key areas." In response to these comments, in the strategic planning exercise currently underway, we plan to sharpen the focus of our research programs, concentrating on those projects that have shown the greatest potential for commercialization, with an eye towards large scale testing of those technologies that are approaching readiness for field deployment and continue investment in the technologies with longer term prospects that are needed to sustain CBBG beyond the initial 5-year funding allocation and even beyond the 10 year horizon of NSF support. Similarly, we intend to sharpen the focus of our education and outreach activities based upon the lessons we have learned to date regarding what activities are most effective and provide the greatest return on CBBG investment in both human capital and financial resources. As part of this exercise, we are soliciting input from our Science Advisory Board and Industry Advisory Board on prioritization of our existing projects.

An important emphasis in our strategic planning will be on identifying opportunities to leverage the NSF ERC program's investment in the Center with supplemental funding from other sources, including other NSF programs, other government agencies, foundations, and industrial support. It has become abundantly clear that while our annual allotment of NSF funding is certainly not insignificant, it is not sufficient to fund the broad array of research, education, and outreach activities we would like to pursue. The sharpening of our focus on those activities that

offer the greatest potential impact (both short and long term) and our movement towards large scale field testing, which will be expensive, will only exacerbate the demands on Center resources. This will inevitably result in some projects being asked to wrap up their work by the end of Year 4 unless we can secure additional funding for them from sources other than our core NSF funds. So, as we shift gears and accelerate development of those projects that offer the greatest potential return on investment, we need to secure supplemental resources to not just maintain our momentum but to accelerate it. If we are successful, it will be a fun ride!

## Important Dates

**April 11-13, 2018**

CBBG Mid-Year Meeting  
Georgia Institute of Technology  
Atlanta, Georgia

**July 31, 2018**

Last Day to Enter Information into  
ERC 360

**September 2018**

Annual Report Due to NSF

**October 2018**

NSF Site Visit to CBBG  
Tempe, Arizona

# Research Highlights

## Woolley Mentors Summer Program Participants



Reading measurement of cone penetration from fall cone apparatus on fugitive dust mitigation project

Photos above show Michael Edgar, Jameson Moulis, and other summer mentees of Miriam Woolley, CBBG Graduate Student, doing a fall cone test for measurement of EICP crust strength. This project under Fugitive Dust Mitigation aims to provide more information about EICP crust for fugitive dust mitigation.

## Science and Engineering Experience (SCENE) for High School Students

Ayesha Raman, a sophomore in high school, who worked alongside CBBG Young Scholars last summer, has returned with her lab partner, Sonakshi Sharma, to work on their project for the Hamilton High School Science Fair. CBBG Senior Investigator, Dr. Narayanan Neithalath, invited the pair to join the research team from the Science and Engineering Experience (SCENE) Program at ASU working in his lab. These high school students have caught the 'research bug,' as you can tell in the following quote:

"We love science research because it lets us delve into endless research papers and projects about specific fields of science that we are interested in. Science research lets us release our inner nerdy selves and get a head start on knowing what we want to do in the future. ASU has allowed us to progress and grow by offering whatever resources available, furthering our project beyond its initial capabilities. I have learned so much from this experience and I would love to continue this for the rest of high school, and hopefully in the future!"

## Figure in Research Paper Nabs Journal Cover



A figure from a paper published in the journal, *Materials*, by CBBG researchers Mahdi Roozbahani, Rodrigo Borela and David Frost entitled, "Pore Size Distribution in Granular Material Microstructure" was reproduced on the cover of the journal and has been chosen as one of the Featured papers of 2017.

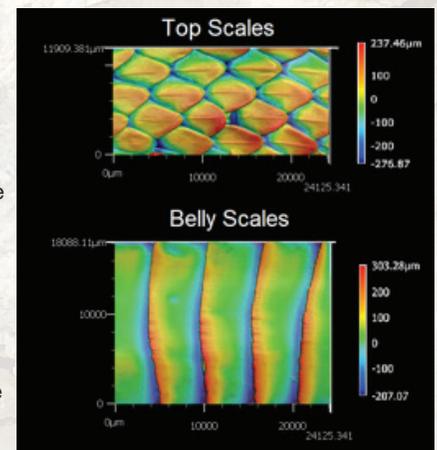
## Roozbahani Wins Poster Award at Geotechnical Symposium



A poster presented by CBBG researcher Mahdi Roozbahani, at the inaugural Fall Geotechnical Graduate Student Poster Symposium, sponsored at Georgia Tech by the ASCE Georgia Section Geo-Institute Chapter, was selected as the overall research poster winner by a judging panel consisting of G-I practitioners. The poster was entitled, "Geotechnics of Bio-locomotion and Self-Excavating Systems (Numerical Simulations)."

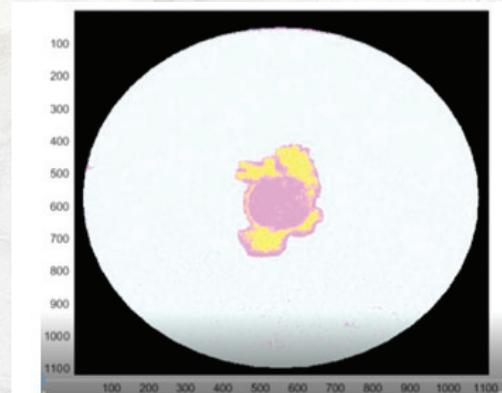
## Snakeskin Research at University of California, Davis

CBBG research on snake-skin inspired interfaces, led by CBBG Senior Investigator, Professor Alejandro Martinez, welcomed Kyle O'Hara as a new graduate student on the project. Recent results by Sophia Palumbo on scanned snake skin surfaces (shown in picture) exhibit significant differences in structure and form. Some of their results to date were recently selected for presentation and publication at the International Foundations Congress and Equipment Expo (IFCEE) 2018 that will be held in Orlando, Florida. The title of the paper is "Anisotropic shear behavior of soil-structure interfaces: bio-inspiration from snake skin."



## Slime Mold Inspired Supply Networks

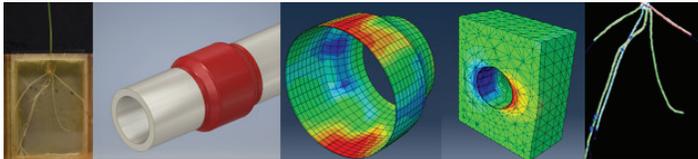
Fernando Patino and Dr. Chloé Arson started a collaboration with Dr. Audrey Dussutour from Toulouse University in France, to study the adaptation of slime mold networks to a variety of stresses such as food deprivation or high salt concentration. The topological characterization of slime mold network is based on the analysis of time-lapse images taken during slime mold growth experiments. Different contrast enhancement strategies were used distinguish the shows an attempt to retrieve slime mold in a pink petri dish.



# Out & About

## Root-Inspired Tunneling

Burrowing organisms, such as plant roots and worms, sense their surroundings, adapt their shape to local stress conditions in the soil, dig, and invade cavities accordingly. We are building a device that will integrate root-inspired processes of excavation and soil characterization. The prototype resembles a pressure meter, but it is designed to work in drained conditions and under biaxial far field stress. The probe will be installed on excavation machines to continuously adapt tunnel alignment with in situ conditions, like roots do. A series of 2D root growth experiments are being conducted in partnership with Oak Ridge National Laboratory to understand root topological adaptation to obstacles.



Root-inspired geo-probe design (Patino Ramirez, Jin, Arson, unpublished): 2D root growth experiment in collaboration with Oak Ridge National Laboratory; sketch of a root-inspired pressure-controlled vessel; FEM model of the membrane; FEM model of the soil; root time lapse photo analysis.

## Root-Inspired Soil Characterization



The seeds planted at L3SR in Grenoble, France, gave some roots! Floriana Anselmucci started growing chickpea roots in real soil, and monitored the experiments by X-ray CT-scan. By observing the rearrangement of soil grains around the roots, we will better understand the effects of root growth on soil structure and mechanical properties. The micro-mechanical processes initiated by root growth will be modeled to improve the design of the root-inspired geo-probes.

## ASU Open Door - February 24, 2018

CBBG will participate in the ASU Open Door on Saturday, February 24, 2018 from 1 p.m. to 6 p.m.

It is ASU's opportunity to welcome families, students, and the community to explore the innovation spaces, so people can explore their wildest imagination.



## Savenye Presents Keynote Address at ICoME in Hawaii



Dr. Wilhelmina Savenye gave the Keynote Address at the annual international meeting of ICoME, International Conference on Media in Education, first time held in the U.S. – at University of Hawaii at Manoa, August 2, 2017.

The presentation was entitled, "STEM Engineering Education for All Learners: The Education and Outreach Program for a National Science Foundation Engineering Research Center, CBBG. Contributors included: J. Larson, C. Zapata, E. Kavazanjian, D. Saenz, M. Mitchell, C. Bronner S. Brown, W. Newstetter, P. Bandini, D. Frost, J. DeJong, R. Krajalnik-Brown, M. O'Donnell, W. Barnard, K. Elwood, M. Dalal, E. Stallings.

## Paper Accepted for ICEG in China

The abstract title, "Durability for Hydrogel-Assisted EICP for Fugitive Dust Mitigation" has been accepted as a conference paper for ICEG in China 2018. The contributors are Miriam Woolley, Nasser Hamdan, and Edward Kavazajian Jr.

## Invited Lectures at TRB, 2018



CBBG Cross-Cutting Thrust Leader and Co-PI David Frost delivered two invited lectures at the 97th Annual TRB meeting in Washington DC in January. One lecture was entitled, "New Environmentally-Friendly Ground Improvement Technologies," which was given in a Workshop on Design and Construction Using Environmentally Friendly Technologies. The second lecture was entitled, "Bio-inspired Ground Improvement for Transportation Infrastructure: At the Intersection of Biology and Geotechnics," which was given in a podium session on Innovations and Advances in Transportation Geotechnics.

## Watson Forum Interview



Dr. Chloe Arson gave an interview on modeling careers for the Watson Forum, an initiative launched at Imperial College London to promote the participation of women in STEM, and in modeling in particular. The YouTube channel is: <https://www.youtube.com/channel/UCpUMVgjSe0hvw3eMvc6mkEw>

# Honors & Awards

## Elizondo Successfully Defends Dissertation



Sofia Esquivel Elizondo, former CBBG Ph.D. student, successfully defended her dissertation, *Microbial Communities Involved in Carbon Monoxide and Syngas Conversion to Biofuels and Chemicals*, on Monday, November 6, 2017. Her dissertation aimed to contribute to the understanding of CO and syngas fermentation by uncovering key microorganisms and understanding their metabolism. Congratulations Dr. Elizondo!

## CBBG Undergraduate Research Assistants at NMSU Advance to Master's Programs



Cori Cromwell, B.S. Civil Engineering in Fall 2017 (left), Judit Garcia, B.S. Civil Engineering in Fall 2017 (right)

Cori Cromwell and Judit Garcia graduated with B.S. degrees in civil engineering at New Mexico State University in Fall 2017. They were undergraduate research assistants for the project "Bio-inspired Resilient Earthen Construction," mentored by Dr. Paola Bandini and Dr. Brad Weldon. This January, Cori started her Masters

with geotechnical emphasis at the University of Colorado - Denver and works for Kumar & Associates in Denver. Judit started her M.S. at NMSU and continues her CBBG research as a graduate research assistant. Congratulations!

## NMSU's M.S. Graduate Employed at Los Alamos National Lab



At NMSU commencement, Audrey Smith (left) with fiancé Jerome Sanchez, also M.S. (geotechnical) employed by LANL as design engineer.

CBBG student Audrey Smith graduated from NMSU with a M.S. in Environmental Engineering degree in Fall 2017. Audrey successfully defended her Master's thesis entitled, "Arsenic Removal from Water using Zeolites: Effects of Zeolite Treatment and Geochemical Conditions" under

the advising of Dr. Lambis Papelis. Audrey works as an Environmental Professional for the Environmental Stewardship Group at Los Alamos National Laboratory (LANL), where she also worked as an intern during the last three summers. Audrey mentored three CBBG REU students and served in the Student Leadership Council (SLC) during her graduate studies at NMSU.

## NMSU Graduate Student Receives Eisenhower Transportation Fellowship

CBBG Master's student, Jason Alcantar, was awarded a Dwight David Eisenhower Transportation Fellowship (DDEF) from the Federal Highway Administration (FHWA) this semester. The fellowship included his attendance to the Transportation Research Board (TRB) 2018 Annual Meeting. As a DDEF Program Fellow, Jason participated in TRB technical and student networking sessions and was accompanied by CBBG faculty Dr. Brad Weldon and five other NMSU DDEF fellows.



Jason Alcantar (first from right) at 2018 TRB Annual Meeting with Dr. Weldon (first from left) and other DDEF Program Fellows from NMSU

Jason started his CBBG research experience as an undergraduate at NMSU and currently is a graduate research assistant for the CBBG project on bio-inspired foundations with faculty advisors Dr. Paola Bandini and Prof. Craig Newton. Jason is the graduate mentor of an undergraduate research assistant in his CBBG project.

## Students and Faculty Celebrate End of Semester at NMSU



CBBG team at NMSU

CBBG students and faculty at NMSU gathered in December to celebrate a successful fall semester and the graduation of team members. During final exams week, SLC provided this opportunity to introduce new faculty and student members and as farewell to those completing degree programs this fall.

## School of Civil and Environmental Engineering Inter-disciplinary Research Award



In Fall 2017, Dr. Chloe Arson received the Inter-Disciplinary Research Award from the School of Civil and Environmental Engineering at Georgia Tech, in recognition of her work in bio-inspired network dynamics and damage and healing mechanics in crystalline and porous media, which applies to rock engineering, concrete design, geomorphology, biomechanics, environmental ethics and sociology.

# Diversity & Inclusion

## CBBG Faculty Participate in NSF INCLUDES Summit



Dr. Claudia Zapata, CBBG Deputy Director, Dr. Delia Saenz, CBBG Diversity Director, and Dr. Jennifer Chandler, member of the CBBG IDEA Working Group, participated in the INCLUDES Summit, which was hosted by the National Science Foundation (NSF) in early January. This Conference provided NSF Centers and other large NSF grantees a space to: (a) share information about their diversity activities, strategies and outcomes; (b) identify ways in which the community might use collaborative change strategies in their broadening participation initiatives; and (c) identify opportunities to mobilize and act together through intentional team activities. In addition, Centers were engaged with information about NSF INCLUDES as a Big Idea and were asked to generate ideas for the program's vision, partnerships, shared goals and common metrics, leadership and communication, and expansion, sustainability and scale.

## CBBG Team Members Participate in AccessERC Capacity Building Institute



Colleen Bronner (UCD), Rodrigo Borela (GT), Jean Larson (ASU), Devajani Borah (ASU), Diego Garcia Vera (NMSU), and Jennifer Chandler (ASU)

Representatives from all four CBBG partner universities (see photo above) participated in the ACCESS ERC Capacity Building Institute provided by the DO-IT (Disabilities, Opportunities, Internetworking, and Technology) Center at the University of Washington, in Seattle in early December. This institute was a forum for sharing interventions and strategies that promote the full inclusion of people with disabilities in ERCs. Attendees came from ERCs across the United States.

## Devajani Borah Reports on Participation on ACCESS ERC Capacity Building Institute

The AccessERC Capacity Building Institute was organized by the University of Washington in Seattle on December 6-8, 2017. It was a great learning experience for me as a student. As part of an Engineering Research Center (ERC), often our sole focus is on the research that we do. But amidst all the scientific work we do, it is also necessary for us to realize that societal

aspects such as inclusivity is one of the fundamental facets of growth for society as a whole.

The main focus of the workshop was to educate students, faculty, and staff about the various ways of diversifying and including people from all walks of life, irrespective of gender, race, ethnicity and, above all, physical ability, into the ERCs. We were given tours of the engineering block of the University of Washington to review and learn how to make a building more accessible to people with disabilities and were shown existing facilities in the classrooms and laboratories.

There was also a student panel with high achieving students with disabilities giving us an inside view of their day to day lives, the physical and social challenges they face, and how they overcome these to become the achievers they are now. There was also a group discussion with people not only from the ERCs, but faculty from science and engineering and members of the department of psychology, who elucidated and discussed various perspectives in which disability is both a physical and psychological issue in current times, and how we can try and improve things for the better.

Overall, it was a very eye opening experience for me. As an added bonus, it is always a pleasure to meet people from various ERCs and learn about their research. Also, the city of Seattle is absolutely lovely and the University of Washington did not hold back on their hospitality. I would specially like to thank Scott Bellman and Sheryl E. Burgstahler for the wonderful coordination of this three day event.

## Publications

Gebremariam, T., Weldon, B., and Bandini, P. (2017). Experimental evaluation of two small-scale adobe walls under lateral loading. *Earth USA 2017, 9th Int. Conf. on Architecture and Construction with Earthen Materials*, Santa Fe, New Mexico, September 29–October 1.

Cates, W., Glazewski, G., Akili, G., K., Lockee, B., Peck, K., Reiser, R., **Savenye, W.**, Smaldino, S., Young, P., Leary, H., & Draper, D. (2017). Presidential Session – Propelling into the Future: Educational Technology Scholarship Fueled by Core Philosophy and Emerging Trends. Presentation at the annual meeting of the Association for Educational Communications and Technology, Jacksonville, FL, November 6-11, 2017.

**Savenye, W.**, and multiple other book chapter authors (2017). Presidential Session – Contemporary Dialogues in ID, Technology, Learning & Leading. Presentation at the annual meeting of the Association for Educational Communications and Technology, Jacksonville, FL, November 6-11, 2017.

Elwood, K., **Savenye, W.**, Larson, J., Jordan, M., & Zapata, C. and multiple other book chapter authors (2017). *Wicked Instructional Problems: Exploring How STEM Teachers Use Design Thinking*. Presentation at the annual meeting of the Association for Educational Communications and Technology, Jacksonville, FL, November 6-11, 2017.

Reiser, R., and Hannafin, M., Hannafin, R., Klein, J., Ozogul, G., Ross, S. M., & **Savenye, W.** (in alphabetical order) (2017). Presidential Session – Leadership by Example: The Legacy of Howard Sullivan. Presentation at the annual meeting of the Association for Educational Communications and Technology, Jacksonville, FL, November 6-11, 2017.

# Education & Outreach

## CBBG Visits Capitol Girl Scout Troop

On November 16, 2017, the ASU outreach team performed an activity with Capital Elementary School, a CBBG educational partner. CBBG graduate student, Miriam Woolley, along with Dr. Jean Larson, CBBG Education Coordinator, and Dr. Wilhelmina Savenye, CBBG Education Director, visited the STEM-focused Girl Scout Troop and did an activity on Earthquake-Induced Liquefaction. The demonstration began with an introduction to the field of geotechnical engineering and led into a discussion about earthquakes. Several troop members shared details of when they personally experienced an earthquake.

Next, a scenario was set up - each of the girls becomes a successful engineer and decides to purchase their own island and build a house. Unfortunately, their island is in an earthquake-prone area. What will happen to the island? What will happen to the house? Using a cylinder of saturated sand, a Lego house, and a rubber mallet, Miriam demonstrated and explained liquefaction to the scouts. Then the demonstration was turned into a hands-on activity where the scouts were challenged to create a method to prevent liquefaction in their own smaller-scale islands. Given their very own "island" and "house," smaller groups experimented with provided materials to create the most effective method to prevent their houses from sinking.

## University of California, Davis Instructs Middle Schoolers on Earthquake Engineering Research

A 7th and 8th grade class of 25 students from Knights Ferry School visited the UC, Davis' Center for Geotechnical Modeling. CBBG students Maya El Kortbawi, Kyle O'hara, Sophia Palumbo, and other geotechnical engineering graduate students hosted the group. The students first learned about how data from research on earthquake engineering research is used to influence and change infrastructure design. After a tour of the geotechnical centrifuge, students designed their own earthquake-resilient structures out of K'nex, which were then subjected to earthquake motions on the UC, Davis small mechanical shake table.

## Martin Presents Information about Engineering Research Centers

Kimberly Martin, CBBG graduate student, made a presentation to a Delta Kappa Gamma chapter in Casa Grande, Arizona on January 11, 2017. Delta Kappa Gamma is a professional honor society for female educators. Eighteen K-12 teachers, administrators, and counselors were in attendance for the presentation entitled, "National Science Foundation Engineering Research Centers: What can they do for you?" The members were excited to learn about the CBBG's RET and YS programs, and many took information about the summer program application process and handouts with ideas for STEM activities in the classroom.



Capitol Girl Scout Troop



Capitol Girl Scout Troop



Students from Knights Ferry School



Delta Kappa Gamma Chapter

## Nelson Presents Road to Research Seminar to Undergraduates



On November 8, 2017, CBBG Senior Investigator, Dr. Douglas Nelson, gave a "Road to Research" seminar aimed at lower division biology undergraduates seeking information on research in various labs in the College of Biological Sciences at the University of California, Davis. The 45 minutes presentation encouraged students to ask a lot of good questions. Nelson reports that he almost certainly will be taking two additional undergraduate researchers into his lab based on interest shown in the talk.



## CBBG Researchers at Georgia Tech Judge Charter School Science Fair

Prashanth Vangla, a CBBG post-doc at Georgia Tech, excitedly reported on CBBG's participation in the Charles R. Drew Charter School Science Fair in early December. It was great experience for all GT CBBG members, and the STEM coordinators at Drew were extremely appreciative. GT got a great lead for future CBBG events like developing problem-based learning program with Drew charter school students.



**CBBG Researchers Judging at Dew Charter School**

# Industry & Innovation

## Grubb New IAB Chair



Dr. Dennis Grubb has accepted the position of IAB Chair for 2018. Dr. Grubb is the Vice President for Research, Development and Technical Sales at Phoenix Services, LLC. He has more than 25 years combined academic, research and engineering consulting experience in environmental

remediation, beneficial use, stabilization/solidification, environmental forensics and litigation support. In his current role, Dennis is responsible for research and development of various beneficial use applications for slag and other mill products on a worldwide basis. In 2015, his team was responsible for the beneficial use of >2.6 million tons of slag materials into various applications in the U.S.

## Special Thank You to Chris Hunt



CBBG wants to thank 2017 IAB Chair, Dr. Chris Hunt, from Geosyntec Consultants for his service and various CBBG activities. During his tenure, Chris helped improve delivery of content to the IAB through the "IAB Members Only" website and has driven efforts for greater Industry-Researcher

collaboration through direct engagement (think "voluntary project assignments"). Of course, Chris continues to be involved in the CBBG and Geosyntec remains one of the CBBG's Founding Members. Thank you, Chris.

## Industrial Engagement

Companies are welcome to join the CBBG ERC industrial consortium. The membership program provides benefits, including access to the Center's researchers and facilities, a seat on the Industry Advisory Board, advanced access to technology, and early access to intellectual property. For more information about this program, please contact Nasser Hamdan, CBBG Industry Collaboration and Innovation Director, at [nasser.hamdan@asu.edu](mailto:nasser.hamdan@asu.edu) or (480) 965-2277.

## CBBG Industry Partners



WSP | Parsons Brinckerhoff is now WSP USA

# Partner Universities

**UC DAVIS**  
UNIVERSITY OF CALIFORNIA

**ASU** ARIZONA STATE  
UNIVERSITY

**NM**  
STATE  
UNIVERSITY

 **Georgia Institute  
of Technology**



# 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](http://biogeotechnics.org)

**ASU** Ira A. Fulton Schools of  
**Engineering**  
Arizona State University