NSF DISTINGUISHED LECTURE SERIES BIOECONOMY COORDINATING COMMITTEE 2021

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GEOSCIENCES DIRECTORATE | GEO

BIOECONOMIC APPLICATIONS OF EXTREME EARTH ENVIRONMENTS

DATE
June 10

TIME
11 am - 1 pm

LOCATION
Register

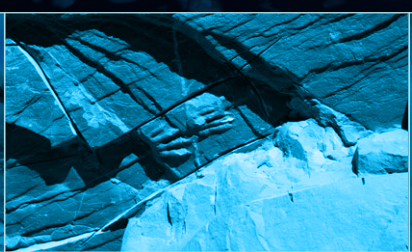
SPEAKERS

Dr. Tullis C. Onstott

Dr. Paula Welander

Dr. Kristin O'Brien

Dr. Andrew Thurber



National Science Foundation
WHERE DISCOVERIES BEGIN

ABSTRACT

The vast majority of microbial capabilities remains unknown, as they primarily reside in extreme habitats such as the deep subsurface. By promoting our understanding of how these microbes adapt to extreme environments, we can utilize this biodiversity to further contribute to the bioeconomy. In this presentation, Dr. Onstott will shed light regarding the innovative approaches currently being harnessed by microorganisms to bioremediate groundwater that has been contaminated by toxic metals. He will also expand upon how methods such as metagenomics and single cell genomics can be combined with metadata to help identify potential new enzymes to facilitate the growth of subsurface bacteria. Lastly, he will address how metagenomics and synthetic biology can be used to identify novel enzymes for methane uptake to address the issue of climate change.

ABOUT DR. TULLIS C. ONSTOTT

TULLIS C. ONSTOTT, PHD

PROFESSOR EMERITUS
IN THE GEOSCIENCES DEPARTMENT

PRINCETON UNIVERSITY

Dr. Tullis C. Onstott is a Professor Emeritus in the Geosciences Department at Princeton University where he taught Astrobiology, Geomicrobiology, Mineralogy and Petrology, Geochronology, Isotope Geochemistry and Methods in Environmental Geochemistry. Dr. Onstott earned a B.S. in Geophysics from the California Institute of Technology in 1976 and completed his PhD from Princeton University in Geology in 1980. Since 1994 his research group has focused on exploring terrestrial subsurface microbiology and its implications for life on Mars. Most of their field studies occurred in the ultradeep mines of South Africa where they found that radiolysis could support subsurface chemolithotrophic bacteria such as Cand. Desulforudis audaxviator and the discovered the thermally adapted nematode, Halicephalobus mephisto. The South African deep mine project has led to over 100 publications in peer-reviewed journals on geomicrobiology, biochemistry and isotope chemistry, many authored by South African faculty and students. His research group also carried out studies on a wide range of topics including combined metatranscriptome/metaproteome/geochemical analyses of subsurface samples, impact of global warming on permafrost greenhouse gas emissions, development of a high sensitivity CRDS for C and H isotopic analyses of CH_4, genomes of high affinity atmospheric CH_4 oxidizing bacteria in the Arctic and Antarctica, genomic analyses of Dinosaur “soft tissue”, analyses of trace gas oxidizing bacteria in early Mars analog environments and recovery of microbial genomes from ancient DNA. He has received several awards including the NSF Presidential Young Investigator Award in 1985, the Jubilee Medal from the Geological Society of South Africa in 1988, the TIME’s 100 Most Influential People in the World in 2007 and recently appeared on CBS 60 Minutes. In 2016 he authored the book, Deep Life: The Hunt for the Hidden Biology of Earth, Mars and Beyond, (Princeton University Press).

ABSTRACT

The research in Dr. Welander's lab has focused on using molecular approaches to understand how microbes produce and utilize specific membrane lipids. Many of the lipids we study – sterols, hopanoids, carotenoids, tetraethers – are of interest to geobiologist as they can be preserved in ancient sedimentary rocks and can be used as molecular fossils or biomarkers indicative of certain microbial taxa, metabolisms, or environmental conditions deep in time. However, an understanding of the biosynthesis, expression, and physiological roles of these lipid in modern microbes is needed to better constrain biomarker interpretations. Through our studies, we have discovered novel proteins and biochemical pathways for generating these geologically relevant lipids in a variety of marine and terrestrial microbes including methane consuming bacteria and thermoacidophilic archaea. These studies have not only expanded our knowledge of the utility of microbial lipids as geological biomarkers but have also revealed the many ways microbes can alter their lipid profiles to withstand stressors encountered in extreme environments. These studies provide unique insight into the biochemistry that microbes invent to adapt to extreme environments as well as expand our understanding of membrane biology that can be informative for drug discovery, vaccine development, and applications yet to be discovered.

ABOUT DR. PAULA WELANDER

PAULA WELANDER, PHD

ASSOCIATE PROFESSOR

EARTH SYSTEM SCIENCE AND MEMBER, BIO-X

STANFORD UNIVERSITY

Dr. Paula Welander is a microbiologist who received her undergraduate degree from Occidental College in Los Angeles. She pursued her PhD studies in microbiology at the University of Illinois at Urbana-Champaign and completed her postdoctoral studies at MIT in the Departments of Biology and of Earth, Atmospheric, and Planetary Sciences. In 2013, Paula joined the Earth System Science faculty at Stanford, where her current research focuses on understanding the biosynthesis and physiological function of lipid biomarkers, or "molecular fossils," in extant bacteria. Dr. Welander has received numerous research and teaching awards including a Stanford University Excellence in Teaching Award, an NSF Early Career Development Award (CAREER), and the GSA Geobiology and Geomicrobiology Division Award for Outstanding Research. Dr. Welander is the proud daughter of Mexican immigrants and first-generation student herself. She is an advocate for justice, equity, diversity, and inclusion through her work as Associate Chair of Diversity and Inclusion for her department and mentoring through various programs at Stanford and beyond. Beyond science, Dr. Welander enjoys running, reading, spending time with her family, and spoiling her dog, Tommy.

ABSTRACT

Evolution in extreme environments has equipped organisms with novel solutions to basic biological problems that when queried, may enhance our understanding of human biology. Often however, the innovative designs that permit animals to thrive in extreme environments render them vulnerable in a rapidly changing environment. In this presentation, Dr. O'Brien will focus on the unique adaptations of members of the Antarctic Channichthyidae family of icefishes to discuss (**1**) how the lack of the oxygen-binding hemoglobin in icefishes provides a natural genetic knockout for understanding how organisms cope with low oxygen conditions, (**2**) how evolution in the frigid waters of the Southern Ocean may constrain the ability of Antarctic fishes to withstand a warming environment and (**3**) how the brilliance and wonder of the Antarctic environment may be utilized to ignite interest among youth in pursuing careers in STEM fields to create a more inclusive and diverse scientific workforce.

ABOUT DR. KRISTIN O'BRIEN

KRISTIN O'BRIEN, PHD

PROFESSOR OF BIOLOGY

UNIVERSITY OF ALASKA FAIRBANKS

Dr. O'Brien is a Professor of Biology at the University of Alaska Fairbanks located on the Troth Yeddha' campus, ancestral land of the Dena people of the lower Tanana River. Research in her laboratory seeks to understand how the environment shapes the physiology and biochemistry of fishes, potentially constraining their ability to withstand a changing environment. Dr. O'Brien received her Ph.D. degree in Zoology from the University of Maine, where she first began her studies of the unique adaptations of Antarctic notothenioid fishes to life in the frigid waters of the Southern Ocean. To expand her molecular toolbox, Dr. O'Brien pursued her interest in bioenergetics and mitochondrial biology as an NIH NSRA postdoctoral fellow in the Department of Molecular, Cellular and Developmental Biology at the University of Colorado in Boulder. Throughout her career, Dr. O'Brien has sought to leverage her research program to engage a diversity of students in science in an effort to create a more inclusive scientific process that values all perspectives. A CAREER award supported a collaboration with high school teachers and students in the rural Alaskan community of Utqiaġvik, which was followed by collaborations with PolarTREC, and most recently, with the Aquarium of the Pacific, which will host a year-long seminar series featuring female scientists who conduct research in Antarctica to inspire and mentor middle and high school students towards careers in STEM fields. Dr. O'Brien also serves as the Co-Chair of the Research Experience Core for the Alaska IDeA Network of Biomedical Research Excellence program, supporting undergraduate and graduate students pursuing careers in biomedical science with an emphasis on expanding opportunities for underrepresented students.

ABSTRACT

While often viewed as remote and rare, 'extreme' environments are an integral part of a functioning planet and among those that may be deterministic in our future. An example of this are methane seeps, areas where a greenhouse gas is emitted from vast and deep reservoirs. Seeps are epicenters of unique and dense communities that harness the leaking gas for energy while mitigating the potential impact of that gas on our climate. Integrating interdisciplinary research at these habitats has allowed us to translate scientific understanding into ecosystem service frameworks, current, and future societal benefits gained from the functions that occur in these environments. However, warming climate and ocean temperatures will perturb the underlying drivers of methane seepage with unknown ramifications to the benefits gained from 'functioning' seep habitats. In this talk, Thurber will present a synoptic view of the societal benefits gained from seep habitats including novel directions that may stimulate future novel bioeconomic research. He will also present a case study that provides an example of how a changing climate can, through shifting methane cycles and lethargic microbiological response as elucidated, impact the rate and trajectory of our changing planet.

ABOUT DR. ANDREW THURBER

ANDREW THURBER, PHD

ASSOCIATE PROFESSOR

OF OCEANOGRAPHY AND MICROBIOLOGY

OREGON STATE UNIVERSITY

Dr. Andrew Thurber is an Assistant Professor of Oceanography and Microbiology at Oregon State University. His research focuses on understanding ecosystem function of marine habitats inclusive of microbial, biogeochemical, and animal ecology. His research has spanned from the tropics to the poles and from shallow to deep-sea habitats. Integral to his field-forward research program are extreme habitats, including methane seeps and polar marine regions, that he uses as windows into marine processes that translate into ecosystem services. Central to his research is a portfolio of engagement and using his research of mesmerizing habitats as a gateway to greater scientific interest and literacy by the public. He was a NSF Postdoctoral Fellow in Polar Regions Research focusing on ecosystem persistence in highly seasonal habitats and received his PhD from Scripps Institution of Oceanography studying deep-sea and methane-fueled habitats.

Please visit

http://colddarkbenthos.ceoas.oregonstate.edu/

for more information.

UPCOMING LECTURES | 2021

NSF Bioeconomy Coordinating Committee Distinguished Lecture Series

NSF invests in fundamental research to support biotechnology and advance the U.S. bioeconomy across all fields of science and engineering. Presented by NSF's Bioeconomy Coordinating Committee and NSF Directorates, this distinguished lecture series will bring in individual speakers and panels representing the science and technology funded by a Directorate every month. Speakers will present on research and broader impacts in areas associated with biotechnology and the bioeconomy that are of interest broadly across the foundation.

All sessions will be conducted virtually.

THURSDAY, SEPTEMBER 9, 2021

11:00 a.m. – 1:00 p.m.

PANEL PRESENTATION:

TOM MUIR, PHD
Princeton University

BEN GARCIA, PHD
Washington University School of Medicine

LISSA ANDERSON, PHD
National High Magnetic Field Laboratory

PING MA, PHD
University of Georgia

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For more information, refer to the NSF Bioeconomy Distinguished Lecture Series **website** or contact **Jared Dashoff at jdashoff@nsf.gov**.

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