NATIONAL ACADEMIES

Sciences
Engineering
Medicine

Frontiers in Geologic Hydrogen

Board on Earth Sciences and Resources and the Committee on Earth Resources Joint Spring Meeting 2025

https://events.nationalacademies.org/44520_05-2025_frontiers-in-geologic-hydrogen-board-on-earth-sciences-and-resources

May 22, 2025

11:00 AM EST

Division on Earth and Life Studies

Board on Earth Sciences and Resources

Committee on Earth Resources

HTTPS://EVENTS.NATIONALACADEMIES.ORG/44520_05-2025_FRONTIERS-IN-GEOLOGIC-HYDROGEN-BOARD-ON-EARTH-SCIENCES-AND-RESOURCES

MAY 22, 2025

Description

Meeting the energy demands of a modern and growing society requires consideration and development of all energy options. Geologic hydrogen has the potential to meaningfully supplement conventional resources. This meeting will consider the resource potential and methods of exploration for and production of geologic hydrogen, as well as economic and environmental considerations that need to be addressed before geologic hydrogen can contribute viably to the U.S. energy portfolio. The goal of this meeting is to better understand the technical and regulatory hurdles for making geologic hydrogen commercially viable and determine if there is a role for the NASEM in advancing the science and policy in this sector.

11:00 am ET **Introduction**
Michael Manga, BESR Chair

11:10 am **Keynote speaker: What is geologic hydrogen and what is its role in the future energy portfolio? (15 min presentation + 5 min questions)**
Mark Shuster, Texas Bureau of Economic Geologic

SESSION 1: CHARACTERIZATION AND PRODUCTION

Moderated by Jessica Moore

11:30 am **Resource potential for natural hydrogen**
Sarah Gelman, U.S. Geological Survey

11:45 am **Detection methods for natural hydrogen**
Mengli Zhang, Colorado School of Mines

12:00 pm **Key challenges in stimulated hydrogen production**
Alexis Templeton, University of Colorado

12:15 pm **Geologic hydrogen production: Geomechanics, reactive fluid transport, and induced seismicity**

Mengsu Hu, Lawrence Berkeley National Laboratory

12:30 pm **Panel Discussion**

- Where are there gaps in knowledge about assessments and characterization technologies?

1:00 pm **LUNCH**

SESSION 2: FUTURE OF R&D IN GEOLOGIC HYDROGEN

Moderated by Jolante W. van Wijk

1:20 pm **Keynote speaker: ARPA-E initiatives (15 min presentation + 5 min questions)**

Doug Wicks, ARPA-E

1:45 pm **Industry Panel (5 min presentation and panel discussion)**

Viacheslav Zgonnik, Hyreveal

Florian Osselin / Colin McCulley, Vema Hydrogen

Rafael Villamor-Lora, Eden Geopower

2:30 pm **SESSION 3: GROUP DISCUSSION (all previous panelists)**

Moderated by David Spears

- What are the issues agencies and industry are concerned about?
- How can the NASEM help further science and policy in this sector?

3:00 pm **Adjourn**

Sample Resources and Reading Materials

The USGS Central Energy Resources Science Center website on Geologic Hydrogen: https://www.usgs.gov/centers/central-energy-resources-science-center/science/geologic-hydrogen

This U.S. Geological Survey webpage provides an overview of ongoing research into geologic hydrogen, including its potential as a natural, low-carbon energy resource. Visitors will find links to current scientific studies, data products, and tools—such as the first publicly available prospectivity map for hydrogen in the U.S.—as well as explanations of key geologic processes and exploration methods relevant to subsurface hydrogen.

Ellis, G.S., & Gelman, S.E. (2024). **Model predictions of global geologic hydrogen resources.** *Science Advances*, 10(50), eado0955. https://www.science.org/doi/10.1126/sciadv.ado0955

This study presents a global model estimating natural hydrogen generation at 15–31 million metric tons per year. It highlights the potential of geologic hydrogen as a significant clean energy resource, emphasizing the need for further exploration to assess its viability.

Gelman, S.E., Hearon, J.S., and Ellis, G.S. (2025). **Prospectivity mapping for geologic hydrogen** (ver. 1.2, January 22, 2025): U.S. Geological Survey Professional Paper 1900, 43 p. https://pubs.usgs.gov/publication/pp1900

This report introduces the first publicly available map identifying regions in the conterminous United States with potential for naturally occurring, or "white," hydrogen accumulations. Readers will learn about the geologic criteria used to assess hydrogen prospectivity—source, reservoir, and seal—as well as key regions of interest and a flexible mapping methodology that can inform future exploration in the U.S. and globally.

Osselin, F., et al. (2022). **Reactive transport experiments of coupled carbonation and serpentinization in a natural serpentinite: Implications for hydrogen production and carbon geological storage.** *Geochimica et Cosmochimica Acta*, 318, 165-189. https://doi.org/10.1016/j.gca.2021.11.039

This paper presents laboratory experiments on natural serpentinite to investigate how CO_2-rich fluids interact with ultramafic rocks during serpentinization and carbonation at elevated temperatures. Readers will learn how these reactions impact permeability through carbonate precipitation, influence hydrogen generation, and inform both natural biogeochemical processes and engineered strategies for carbon sequestration and hydrogen production. The study combines experimental results with numerical modeling to highlight the dynamic interplay between fluid flow, reaction rates, and mineral transformations.

Osselin, F., et al. (2023). **Water–rock interactions and self-remediation: Lessons from a hydraulic fracturing operation in the Vaca Muerta formation, Argentina.** *Geoenergy Science and Engineering*, 224, 211496. https://doi.org/10.1016/j.geoen.2023.211496

This study analyzes fluid samples from a hydraulic fracturing operation in Argentina's Vaca Muerta formation to assess the effects of a new gelling agent and long-term chemical evolution of flowback and produced waters. Readers will learn how sample composition changed over two years, with significant reductions in trace and heavy metal concentrations attributed to delayed barite precipitation. The findings suggest a potential pathway for naturally or intentionally remediating wastewater from hydraulic fracturing by promoting barite formation to sequester dissolved contaminants.

Templeton, A.S., et al. (2024). **Low-temperature hydrogen production and consumption in partially-hydrated peridotites in Oman: implications for stimulated geological hydrogen production.** *Frontiers in Geochemistry*, 2, 1366268. https://doi.org/10.3389/fgeoc.2024.1366268CU Experts+4Frontiers+4ePrints Soton+4

This study investigates hydrogen generation and consumption in partially serpentinized peridotites of the Samail Ophiolite in Oman. The authors assess the feasibility of enhancing hydrogen production through engineered stimulation, considering factors such as mineralogy, fluid flow, and microbial activity. The findings suggest that while natural

hydrogen fluxes are modest, strategic interventions could significantly boost production rates, informing future exploration and development of geologic hydrogen resources.

Viacheslav, Z. (2020). **The occurrence and geoscience of natural hydrogen: A comprehensive review**, *Earth-Science Reviews*, Volume 203, 2020. 103140, ISSN 0012-8252, https://doi.org/10.1016/j.earscirev.2020.103140.

This paper offers an interdisciplinary synthesis of global research on natural hydrogen, drawing from both Western and Eastern bloc literature, including rare sources. Readers will gain insight into the widespread occurrence of hydrogen across diverse geologic environments, proposed mechanisms for its formation (favoring a deep-seated origin), and its potential roles in Earth systems and energy exploration.

Zhang, M., & Li, Y. (2024). **The role of geophysics in geologic hydrogen resources.** *Journal of Geophysics and Engineering*, 21(4), 1242–1253. https://doi.org/10.1093/jge/gxae056

This article explores the application of geophysical methods in detecting and monitoring geologic hydrogen. It compares techniques used in hydrocarbon exploration and discusses adaptations necessary for hydrogen exploration.

Speaker and Panelist Biographies

Sarah Gelman is a geologist with the U.S. Geological Survey in the Central Energy Resources Science Center. Sarah works at the interface between quantitative modeling and geology, with specialties in both 3D subsurface modeling and resource evaluation. Prior to joining the Survey in 2020, she worked in frontier exploration and basin modeling at ExxonMobil for 6 years. Sarah has a Master's degree from the University of Washington where she studied supervolcanic magma systems and a Bachelor's degree from MIT where she focused on planetary geology and extrasolar planets. Most recently, Sarah's interests in geologic hydrogen include regional-scale evaluations of resource potential and subsurface characterization in the lower 48 contiguous U.S. and for the state of Alaska.

Mengsu Hu is a Staff Scientist at the Lawrence Berkeley National Laboratory. Her research focuses on multiscale numerical modeling and machine learning for analyzing coupled thermal-hydro-mechanical-chemical (THMC) processes from fundamental Earth science to subsurface engineering systems (e.g., geologic hydrogen, nuclear waste disposal). Currently, Dr. Hu is leading an ARPA-E project that focuses on developing novel technologies to use cyclic injection to achieve economic extraction of geologic hydrogen without inducing harmful seismicity. Dr. Hu is serving on the Board of Directors of American Rock Mechanics Association (ARMA). Since 2022, she has been invited to serve on the Editorial Board for Rock Mechanics and Rock Engineering (Associate Editor), PNAS Nexus of the National Academy of Sciences (NAS), International Journal of Rock Mechanics and Mining Sciences, and Geomechanics and Geophysics for Geo-Energy and Geo-Resources. In 2022, Dr. Hu was selected as a participant of National Academy of Engineering (NAE) U.S. Frontiers of Engineering (FOE) symposium.

Florian Osselin is the co-founder and CSO of Vema Hydrogen, a US company pioneering Stimulated Geologic hydrogen. Vema is launching the first stimulated geologic hydrogen projects in the United States and is a world leader in this technology. Dr. Osselin holds a PhD and is a former academic researcher with more than 10 years' experience in physical-chemistry and water-rock interactions for subsurface applications. He wrote the seminal paper on Stimulated Geologic Hydrogen in Nature Geosciences in 2022 before creating Vema in 2024 along with seasoned entrepreneur Pierre Levin and CEO.

Mark Shuster is Deputy Director of the Bureau of Economic Geology at the University of Texas at Austin overseeing the Bureau's Energy Research Division. Mark also leads the GeoH2 consortium at the University of Texas at Austin. The GeoH2 consortium conducts research on geological and in situ generation of hydrogen, geological storage of hydrogen, and techno-economic and value chain analysis. In addition to leading GeoH2, Mark was a co-author of the U.S. National Petroleum Council's study on the deployment of low carbon intensity hydrogen. Mark joined the Bureau in 2016 after retiring from Shell. In Mark's 30 year career at Shell, he worked in upstream research and exploration as a Geologist, Manager, Vice President, and

Executive Vice President in the US, The Netherlands, Australia, Oman, and the U.A.E. on projects around the globe. Mark is a member of Society of Petroleum Engineers, American Association of Petroleum Geologists, and the Geological Society of America. He is past president of the Gulf Coast Association of Geological Societies, former Vice-Chair of the American Geosciences Institute Foundation, and Trustee of the AAPG Foundation. Mark has a PhD in Geology from the University of Wyoming.

Alexis Templeton received her PhD from Stanford University in Environmental Geochemistry, and a M.S. and A.B in Earth Sciences from Dartmouth College. During her career, Alexis has built field-based and laboratory-based research programs in Geochemistry and Geobiology at the University of Colorado, where she is a Professor in the Department of Geological Sciences. Her research utilizes spectroscopic, mineralogical, and isotopic tools, as well as environmental microbiology, to characterize the chemical and biological states of subsurface systems undergoing active water/rock interaction, and to quantify controls on the production and consumption of energy sources such as hydrogen. She has traveled to Oman, Hawaii, Samoa, New Zealand, and the High Arctic to conduct investigations of the integrated geochemical, hydrological and microbiological processes occurring in subsurface aquifers and hydrothermal systems. Her work has been recognized by awards from the Mineralogical Society of America, the Geological Society of America, the Advanced Photon Source, and the Geochemical Society. Dr. Templeton is now focusing her research efforts on how to increase the production of geological hydrogen as a clean energy source in several locations globally.

Rafael Villamor-Lora is the Vice President of Research and Development in Eden GeoPower Inc. He received his PhD from MIT in Geomechanics. He holds a BS and M.Eng. in Civil and Environmental Engineering, and a BS in Environmental Sciences from Alfonso X University (Spain). He also holds an MS in Geotechnical Engineering from University of Vermont. During his doctoral work, he studied different physical processes in stressed rough fractures, including rock deformation, fluid flow, and mass transport. He has extensive experience in digital fabrication, and in the development of new laboratory apparatus and experimental protocols. He joined Eden in 2022 and leads the R&D experimental program.

Douglas Wicks currently serves as a Program Director at the Advanced Research Projects Agency-Energy (ARPA E). His focus at ARPA-E is on waste-to-energy, critical mineral mining and geologic hydrogen technologies. Wicks joined ARPA-E from Imerys a French industrial minerals production and processing company, where he was most recently the Director of Transformational and External Innovation. At Imerys he developed an innovation network comprised of academic, contract research organizations, start-ups and strategic partners. Before joining Imerys Wicks worked in a variety of roles at several start-up companies focused on innovative materials. Dr. Wicks began his career at Bayer Corporation, where he ultimately became Vice President of Research for the Coatings and Colorants division. Wicks earned a B.S. in Chemistry from North Dakota State University and a Ph.D. in Polymer Science and Engineering from the University of Massachusetts Amherst. Technical Focus: Critical Materials; Industrial Decarbonization

Viacheslav Zgonnick is the world's first serial entrepreneur in natural hydrogen. He has over a decade of experience leading natural hydrogen exploration project including the world's first successful deep-drilling project using a new paradigm. The well confirmed that hydrogen is a major underground gas in this first drilled borehole. Today, Dr. Zgonnik is leading a deeptech startup HyReveal, which is developing tools for natural hydrogen exploration. He is a French-Ukrainian scientist, with a PhD in Chemistry & post-doctoral research in geochemistry, and has authored some groundbreaking publications on natural hydrogen, including the most

comprehensive scholarly review on natural hydrogen's global occurrence and geoscience. He is TEDx speaker on natural hydrogen.

Mengli Zhang is a Research Assistant Professor of Geophysics at the Colorado School of Mines, Co-Director of the Center for Gravity, Electrical, and Magnetic Studies (CGEM), and Principal Investigator of the Geo-Multiphysics Research Consortium. Her research centers on innovative geophysical data acquisition, multiphysics integration, and AI-enhanced interpretation to advance critical mineral and geologic hydrogen exploration. She leads several federally funded projects, including one supported by ARPA-E, and co-leads the world’s first joint industry program on geologic hydrogen in collaboration with the U.S. Geological Survey. Dr. Zhang serves as an Associate Editor for the Journal of Applied Geophysics and is a frequent invited speaker at international conferences. Her work on geologic hydrogen has been featured in Financial Times, Bloomberg, New Scientist, and other global media. She is a member of AGU, GSA, and SEG.

BOARD ON EARTH SCIENCES AND RESOURCES

Statement of Task

The Board on Earth Sciences and Resources coordinates National Academies' activities on solid Earth science issues and organizes and oversees studies of important national issues in the earth sciences. The Board oversees the following standing committees:

- Committee on Earth Resources
- Committee on Geological and Geotechnical Engineering
- Committee on Solid Earth Geophysics
- Geographical and Geospatial Sciences Committee

The Board and its standing committees serve as the focus for interaction with agencies. As a consequence of this interaction, multidisciplinary ad hoc study committees are established under the auspices of the Board or its standing committees to provide advice as identified by statements of task.

Through its activities, the Board identifies opportunities for advancing basic research and understanding of earth science information for policy decisions, reports on the applications of Earth sciences to important societal issues and addresses the overall health of research and education programs related to earth sciences and resources issues. The Board and its committees also serve as fora for discussions and exchange of information among scientists, engineers, and policy makers from government, universities, and industry.

NATIONAL ACADEMIES Sciences Engineering Medicine

BOARD ON EARTH SCIENCES AND RESOURCES

2025 MEMBERSHIP BIOGRAPHIES

MICHAEL MANGA, is professor and chair in the Department of Earth and Planetary Science at the University of California, Berkeley (UCB). His research focuses on the processes that control the storage, ascent, and eruption of magmas and the impacts of those eruptions on surface environments. Current projects also include studies of geysers, the interactions between hydrological processes and earthquakes including the origin of induced seismicity, the evolution of hydrological systems on Mars, and the tectonics of Jupiter's moon Europa. He chaired the National Academies of Sciences, Engineering, and Medicine's 2017 report "Volcanic Eruptions and Their Repose, Unrest, Precursors, and Timing." He is the recipient of several awards including a MacArthur fellowship in 2005, The Geological Society of America's Donath Medal, the American Geophysical Union's Macelwane Medal, the European Geoscience Union's Bunsen Medal for research in geochemistry, mineralogy, and petrology, and UCB's campus Distinguished Teaching Award in 2017 – the first to be issued from the Department of Earth and Planetary Science. In 2018, he was elected to the National Academy of Sciences for internationally recognized work including elegant experimental and theoretical work and creative field studies. Dr. Manga received a B.Sc. in solid Earth geophysics from McGill University and a M.Sc. in engineering sciences and a Ph.D. in Earth and planetary sciences from Harvard University.

MICHELE L. COOKE is a Professor of Geosciences at the University of Massachusetts Amherst. She is a fellow of the Geological Society of America. Dr. Cooke has served in leadership roles for the Southern California Earthquake Center, the Geological Society of America's Structural Geology and Tectonics division, the international analog modeling community and the Subduction Zones in 4D research collaboration network. Dr. Cooke was awarded the UMass Amherst Distinguished Academic Outreach Teaching Award in 2010, earned the UMass Amherst College of Natural Sciences Outstanding Research Award in 2018, and was awarded the International Association for Geoscience Diversity Inclusive Geoscience Education and Research Award in 2020. She holds a PhD in Earth Sciences from Stanford University.

BRADLEY CRAMER is a professor of stratigraphy and geochemistry with the School of Earth, Environment, and Sustainability at the University of Iowa. His interests include Earth system science, stable and radiogenic isotope geochemistry, chemostratigraphy, biostratigraphy, geochronology, and the Geologic Time Scale. In his words, "I try to understand the major biological, chemical, and physical events that punctuate the history of our planet by integrating as many tools and proxies as I can into a system science framework to investigate the problem." He is currently the Chair of the U.S. National Committee for Geological Sciences as well as the Chair of the International Subcommission on Timescale Calibration. His current NSF EPSCoR grant, Critical Resource Availability for the Future of the Renewable Energy Industry, focuses on critical mineral and ground water resources in Iowa and Kansas.

MARY (MISSY) FEELEY retired as chief geoscientist from ExxonMobil Exploration Company in 2014. Her responsibilities included advising senior ExxonMobil Upstream management on strategic geoscience matters and identifying global geoscience opportunities for ExxonMobil. Dr. Feeley's graduate work was focused on understanding depositional patterns in upper slope salt basins and the Mississippi Fan using seismic stratigraphy techniques. She also spent many years working on lease sales, prospect maturation, and energy development in the Gulf of Mexico. Dr. Feeley's National Academies of Sciences, Engineering, and Medicine experience includes membership on the Ocean Studies Board from 2005 to 2010 and serving on several committees, including the 2015 Committee on Guidance for NSF on National Ocean Science Research Priorities: Decadal Survey of Ocean Sciences and most recently on the Committee on Offshore Science and Assessment for BOEM. Dr. Feeley earned her Ph.D. in oceanography from Texas A&M University.

YOUSSEF M. HASHASH is the Grainger Distinguished Chair in Engineering and Professor of Civil and Environmental Engineering at the University of Illinois Urbana-Champaign. Professor Hashash's expertise includes underground structures, deep excavations, numerical modeling, earthquake engineering, and static and dynamic soil-structure interaction analysis, visualization and application of information technology, deep learning and artificial intelligence to geotechnical engineering. Professor Hashash's experience encompasses geotechnical design for tunnels and excavations, seismic soil-structure interaction analysis, and construction monitoring, and the use of advanced computational tools for geotechnical practice. Prof. Hashash was elected to the National Academy of Engineering in 2022, is the recipient of the 2014 Peck Medal, and the 2000 Presidential Early Career Award for Scientists and Engineers amongst many honors and recognitions. Professor Hashash received his Ph.D. (1992), M.S. (1998) and B.S. (1997) in Civil Engineering from the Massachusetts Institute of Technology.

DOUG HOLLETT is President of MH Technology Partners, working with national labs, academia, industry partners and federal agencies on earth resource challenges and innovation. His academic background is in structural geology and rock mechanics. He currently consults with Idaho National Laboratory, Colorado School of Mines, DARPA, and with startups in the geothermal, critical minerals, carbon sequestration, biotech and geologic hydrogen sectors. He had 29 years executive experience with Marathon Oil, including as Manager International New Ventures, Director Global Unconventional New Ventures, and GM/VP Atlantic Canada. More recently he worked at the U.S. Department of Energy from 2011-2017, including as Director Geothermal Technologies, Deputy Assistant Secretary Renewable Power and Acting Assistant Secretary Fossil Energy, and Special Advisor to the Under Secretary for Science and Technology from 2021-23. He is currently a trustee at Wellesley College. He received a B.A. in geology from Williams College and an M.S. from the University of Utah. His recent National Academies activity includes 4 years on the Committee on Earth Resources (CER) and as a reviewer for the Future Directions USGS Energy Resources Program report, and the Accelerating Decarbonization in the United States report. He was also a member on the 2020 National Academies Committee on Catalyzing Opportunities for Research in the Earth Sciences (CORES), A Decadal Survey for NSF's Division of Earth Sciences, and he is a member of the current National Academies Committee on Optimizing the USGS Mineral Resources Program Science Portfolio.

KATHARINE (Kate) W. HUNTINGTON is a professor in the Department of Earth and Space Sciences at the University of Washington, where she holds the Endowed Professorship in Earth Systems, College of the Environment. Her research focuses on the interactions of tectonics, erosion and climate in shaping Earth's surface and crust over million-year to human timescales. Huntington's

work has made contributions to understanding the dynamic interactions of surface and deep-Earth processes; paleoclimate and paleotopography; soil processes and geochemistry; and the role of extreme floods in landscape evolution. She has also developed new approaches using geochronology and isotope geochemistry to quantify erosion patterns, basin thermal histories, and fluid movement through fault zones. She is a fellow of the Geological Society of America (GSA) and a recipient of the National Science Foundation CAREER Award and the Donath Medal of the GSA. Recently she served on the GSA Council, where she Chaired the Society's Diversity Working Group. Huntington received a B.S. in geology and economics from the University of North Carolina at Chapel Hill and a Ph.D. in geology from the Massachusetts Institute of Technology. She previously served on the National Academies Committee on Catalyzing Opportunities for Research in the Earth Sciences: A Decadal Survey for NSF's Division of Earth Sciences.

KRISTEN KURLAND is a Teaching Professor of Architecture, Information Systems, and Public Policy at Carnegie Mellon University's Heinz College of Information Systems and Public Policy and School of Architecture. She is also the president of a local consulting firm that has implemented computer technology programs in numerous organizations. She is a Past President of CMU's Andrew Carnegie Society and recently served as a Trustee of Carnegie Mellon University. Ms. Kurland's research focuses on interdisciplinary collaborations in health, the built environment, geospatial analysis, and 3D data visualization. Projects focus on addressing equity, health, urban design, economic development, sustainability, big data, and smart cities issues. She actively collaborates with healthcare, non-profit, and industry organizations in Pittsburgh and worldwide. Ms. Kurland is the co-author of a series of best-selling GIS workbooks that are used by universities, colleges, and self-learners. Her accomplishments were the focus of chapter in a recent book by Esri Press highlighting twenty-two global women of influence in GIS. She is the recipient of numerous awards, including the 2020 Carlow University Women of Spirit award; the 2012 Esri Health Communications Award; and the 2004 Esri Special Achievement in GIS Award. Ms. Kurland received a B.A. in architectural studies from the University of Pittsburgh.

JESSICA MOORE is the West Virginia State Geologist and Director of the West Virginia Geological and Economic Survey (WVGES). Prior to her appointment in 2021, she managed the agency's Oil and Gas program for ten years and worked as a geologist for the North Carolina Geological Survey from 2003 to 2007. Moore's primary professional expertise is subsurface geology, with emphasis on sequence stratigraphic analysis, conventional and unconventional petroleum systems, and geologic storage. Her research is included in several regional cooperative projects, including the North Carolina Coastal Cooperative, the Utica Shale Play Book, the Appalachian Storage Hub for Natural Gas Liquids, and the Midwest Regional Carbon Sequestration Partnership. Her current research focuses on carbon sequestration, geothermal energy, hydrogen production and storage, and critical minerals in coal and coal waste. She has been recognized for achievement by a USGS S.T.A.R award and an Imperial Barrel award from the American Association of Petroleum Geologists as well as fellowships from the National Science Foundation and West Virginia University's Distinguished Doctoral program. Moore currently serves as President-Elect of the Association of American State Geologists and East Region Vice President of the U.S. Potential Gas Committee. A first-generation college student, she received a B.S. in geology from West Virginia University, an M.S. in geology from the University of North Carolina at Wilmington, and was a Ph.D. candidate in geology at West Virginia University before joining WVGES.

ANN S. OJEDA is an Assistant Professor in the Geosciences Department at Auburn University. Her research focus is water resources, and she studies geology, environmental science, and health

science to cumulatively understand ways in which the geosphere and humans are connected through groundwater. Dr. Ojeda leads the Auburn Contaminants Group, where she focuses on integrating geochemistry and public health to address questions related to water quality and water contamination from organic compounds. Two of her research foci are potential contamination of drinking water aquifers that contain low-rank coal and the transformation of toxic organic compounds in groundwater and soils. She earned a Ph.D. from the University of Oklahoma in 2017.

DAVID SPEARS retired as the State Geologist of Virginia in December of 2022. David began his professional career as a petroleum geologist for Chevron USA in 1983. In 1993, he joined Virginia's geological survey as an economic geologist. From 2005 to 2009, David served as the Policy Manager for Virginia's Department of Mines, Minerals and Energy, where he facilitated revisions to Virginia's regulations covering mining, drilling, and energy. He was named State Geologist in 2009, a role in which he was called upon to provide a scientific perspective in developing Virginia's policies on offshore drilling, mining, hydraulic fracturing, earthquake response, landslide preparedness, and groundwater management. David is a member of the Geological Society of America, the American Association of Petroleum Geologists, and is a past President of the Association of American State Geologists. He served as a member of the Committee on Earth Resources at the National Academies of Sciences, Engineering, and Medicine from 2015 to 2021. David holds a B.S. in Geology from Lafayette College and an M.S. in Geology from Virginia Tech. He has been a certified Professional Geologist since 2002 and was named a Fellow of the Geological Society of America in 2020.

DAVE SZYMANSKI is Professor of Geology at Bentley University. His work as a scientist spans igneous petrology, elemental cycling in watersheds, forensic chemistry, and climate and sustainability policy. His current research is in transdisciplinary sustainability curriculum development, leading a multi-institutional NSF-funded project, BASICS, or Business and Science: Integrated Curriculum for Sustainability. Before starting at Bentley, he served as environmental and energy policy adviser to U.S. Senator Jon Tester (D-MT) as the 2008-09 AAAS/USGS/GSA Congressional Science Fellow. He served as a contract trace evidence analyst for the Michigan State Police (2004-2008) and continues to practice as a consulting forensic geologist for Forensic Science Consultants, Inc. He is an elected Fellow of the American Association for the Advancement of Science (AAAS), as well as the Geological Society of America (GSA). Szymanski received an M.S. and Ph.D. in geological sciences, as well as an M.S. in forensic chemistry, from Michigan State University.

JOLANTE VAN WIJK serves as Group Leader for the Energy and Natural Resources Security group at Los Alamos National Laboratory and as the Laboratory's Program Manager for the Department of Energy's Office of Fossil Energy and Carbon Management and Geothermal Technologies Office. She holds a joint appointment at New Mexico Institute of Mining and Technology as Professor of Geophysics. Prior to joining the Laboratory in 2021, her academic career included positions at University of Houston and New Mexico Institute of Mining and Technology. She founded and was co-PI of an industry consortium, and spent a sabbatical at a natural resources company. Van Wijk's research areas include geodynamics, sedimentary basins and petroleum systems, carbon capture, utilization, and storage, energy transition, and natural hazards. She is a Fellow of the Geological Society of America. Van Wijk received a combined B.S./M.S. in geophysics from Utrecht University, Netherlands and a Ph.D. in geophysics from Vrije University Amsterdam, Netherlands.

JESSICA M. WARREN is a Professor of Geochemistry and Geophysics in the Department of Earth Sciences at the University of Delaware. Her research focuses on the rheology and geochemistry of

the Earth's mantle through a combination of field and laboratory analyses. Dr. Warren has participated in 14 field expeditions, including on-land expeditions to the western United States and Oman Ophiolite and seagoing expeditions in the Pacific, Atlantic, and Indian Oceans. In 2019, she served as chief scientist on the R/V Atlantis for an interdisciplinary experiment on the Gofar transform fault in the equatorial Pacific. Outreach by Dr. Warren includes work to improve the quality and accessibility of Earth Science education with a focus on field learning and the graduate experience. Dr. Warren is a recipient of a NSF CAREER award, Stanford Terman Fellowship, and Carnegie Postdoctoral Fellowship. She holds a B.A. First Class, M.A., and M.Sci. from the University of Cambridge and a Ph.D. from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program.

Committee on

EARTH RESOURCES

Statement of Task

Division on Earth and Life Studies
Board on Earth Sciences and Resources
500 5th Street, NW
Washington, DC 20001
Phone: (202) 334-3409

The Committee on Earth Resources serves as the focal point within the Board on Earth Sciences and Resources for activities relevant to mineral and energy resources. The committee is responsible for organizing and overseeing studies on issues relevant to the supply, delivery, and associated impacts of hydrocarbon, metallic, and nonmetallic mineral resources, and mineral and nonmineral energy resource systems. The committee:

1. monitors the status of mineral and energy resource issues;
2. identifies study opportunities and responds to requests from federal agencies; and
3. provides a unique forum for discussion and exchange of information among scientists, engineers, and policy makers from government, universities, and industry.

Committee on Earth Resources

Committee biographies

David B. Spears (Chair) received a B.S. in geology from Lafayette College in 1981 and an M.S. in geology from Virginia Tech in 1983. He began his professional career on the Gulf Coast as a petroleum geologist for Chevron USA, where he worked from 1983 to 1991. In 1993, David began working for Virginia's Department of Mines, Minerals and Energy, serving as senior geologist, economic geology manager, and policy analyst. His work involved resource analysis of coal, natural gas, and gold deposits as well as policy development for several Virginia governors on offshore drilling, shale gas, geologic hazards, and mining. David became State Geologist of Virginia in 2009 and served in that role until his retirement in 2022. He is a Fellow of the Geological Society of America, a member of the American Association of Petroleum Geologists, and is a past president of the Association of American State Geologists. David served as a member of the Committee on Earth Resources of the National Academies of Sciences, Engineering, and Medicine from 2015 to 2021. He has been a certified professional geologist since 2002.

Christopher D. Barton is a Professor of Forest Hydrology and Watershed Management in the Department of Forestry and Natural Resources at the University of Kentucky. He is currently working in the areas of ecosystem restoration, reforestation and remediation of streams, wetlands and mined lands. Best management practices for protecting water resources are also being examined. Dr. Barton is an Associate Editor for the International Journal of Phytoremediation and the International Journal of Mining, Reclamation and Environment. Dr. Barton is also the founder and President of Green Forests Work, an NGO that aims to improve the environment and economy of mined landscapes. Through this program, over 4 million trees have been planted on mined lands in Appalachia and Australia and over 22,000 volunteers have participated. Dr. Barton was the recipient of several State and National awards including: the American Society of Mining and Reclamation's 2020 William T. Plass Award; the Kentucky Department of Environmental Protection's 2018 Environmental Excellence Award for Resource Caretaker; and the 2011 United States Department of Interior - Presidential Migratory Bird Federal Stewardship Award. Recently, Dr. Barton was named a Fulbright Distinguished Chair and will work with CSIRO in Australia in 2023. Dr. Barton received his Ph.D. in soil science from the University of Kentucky.

Erin A. Campbell is the Wyoming State Geologist and Director of the Wyoming State Geological Survey, where she serves as a cabinet member for the governor of Wyoming, and as a commissioner for the Wyoming Oil and Gas Conservation Commission and the Enhanced Oil Recovery Commission. Dr. Campbell is also a member of Wyoming Board of Professional Geologists, State Groundwater Coordination Committee, the State GIS Advisory Board, and the Yellowstone Volcano Observatory. Additionally she worked as a geologist for Chevron in Louisiana and California and taught at the University of Wyoming, where she directed the Geology Field Camp and conducted research in structural geology and geomechanics. She

was manager of Energy and Mineral Resources at the Wyoming State Geological Survey before being appointed as state geologist. She has served on executive committees and as president of the Association of American State Geologists, and the Rocky Mountain Section of GSA. Erin has received awards for excellence in research, teaching and service from AGU, GSA, the University of Wyoming, the Association for Wyoming Geoscientists, and Wyoming Women of Influence. Dr. Campbell holds a bachelor's degree in geology from Occidental College and a Ph.D. in geology from the University of Wyoming.

Harry "Red" Conger retired in 2024 after 47 years in the mining industry and now serves on the Board of Directors for Newmont. He previously served as President, Chief Operating Officer (COO), and Director of Teck Resources Ltd. from 2020 to 2023 and President and COO of Americas for Freeport-McMoRan from 2015 to 2020. Throughout his career, he has been recognized for his leadership in safety and is considered a leader in change management and production efficiency. Conger served as chairman of the National Mining Association 2014-2015, where he has been a member of the Executive Committee since 2007. He was elected to the National Academy of Engineering in 2019 and has received multiple awards for his efforts in safety and leadership, including the Ankh Award by the Copper Club and the Charles F. Rand Memorial Gold Medal. He has also received multiple awards in academia, including being selected as the William N. Poundstone Lecturer by the Benjamin M. Statler College of Engineering and Mineral Resources at West Virginia University, the Daniel C. Jackling Award, and the Colorado School of Mines Distinguished Achievement Medal. He additionally has served as the Commissioner on the New Mexico mining commission and served on an Arizona water review commission. Conger received a B.S. in mining engineering from Colorado School of Mines. He has completed post-graduate executive management studies at Duke University Fuqua School of Business, and Whitmore School of Business and Economics at the University of New Hampshire.

Elizabeth Holley is an Associate Professor of mineral exploration and mining geology at Colorado School of Mines, where she studies the processes responsible for ore deposit genesis, as well as the geologic characteristics that determine how ore bodies are developed, mined, and reclaimed. Her interdisciplinary work examines the intersections between technical and social risks in mining. She is a fellow of the Payne Institute for Public Policy at Colorado School of Mines, as well as the Site Director for a mining and mineral exploration-focused National Science Foundation Industry-University Collaborative Research Center. Dr. Holley is a National Science Foundation Career Awardee, as well as the lead investigator for a National Science Foundation Growing Convergence Research project on responsible approaches to critical mineral supply. Her Mining Geology Research Group has been supported by federal agencies, private foundations, and the mining industry. Dr. Holley has worked in the industry on five continents. She is also a fellow of the Society of Economic Geologists and served as the society's 2022 Distinguished Lecturer. Dr. Holley received a B.A. in geology from Pomona College, an M.Sc. in geochemistry from the University of Otago, New Zealand, and a Ph.D. in geology from Colorado School Mines. She previously served on the National Academy committee on the Potential Impacts of Gold Mining in Virginia.

Sarah Jewett is Fervo's Vice President of Strategy. In this role, she runs multiple corporate functions including corporate strategy, policy and regulatory engagement, external affairs, people operations, and future business lines. Prior to joining Fervo, she worked in corporate development and strategic initiatives for Select Energy Services. She started her career in the oilfield, running hydraulic fracturing crews across the Western United States and Alaska for

Schlumberger. As a result of her widespread work on behalf of the geothermal industry, she also serves as the chair of the policy committee and an active board member for Geothermal Rising. Ms. Jewett has a M.BA. from Harvard Business School and a B.E. from Dartmouth College.

Alexandra B. Klass is the James G. Degnan Professor of Law at the University of Michigan Law School. She teaches and writes in the areas of energy law, environmental law, natural resources law, tort law, and property law. In 2022 and 2023, she served as deputy general counsel for energy efficiency and clean energy demonstrations at the U.S. Department of Energy. Before joining the Michigan Law faculty in 2022, Professor Klass was a Distinguished McKnight University Professor at the University of Minnesota Law School, where she was a member of the faculty from 2006 to 2022. She has been a visiting professor at Harvard Law School, Uppsala University (Sweden), and the University of Arizona Rogers College of Law. Prior to her academic career, Professor Klass was a partner at Dorsey & Whitney LLP in Minneapolis, where she specialized in environmental law and land use litigation. Professor Klass's recent scholarly work, published in many of the nation's leading law journals, addresses regulatory and permitting challenges to integrating more renewable energy into the nation's electric transmission grid, siting and eminent domain issues surrounding interstate electric transmission lines and oil and gas pipelines, and applications of the public trust doctrine to modern environmental law challenges. Professor Klass received a B.A. from the University of Michigan and a J.D. from the University of Wisconsin-Madison.

Ryan Mathur is a professor and chair of geology at Juniata College. He has worked on a large variety of ore deposits on five continents with the focus of geochronology of sulfide minerals (Re-Os and several other chronometers) and transition metal (Ti, Fe, Cu, Zn, Mo, Ag and Cd) and metal (Sn) isotope geochemistry. He also is interested in creating a research program to analyze the water quality of the Susquehanna River Basin. Dr. Mathur's research has been published in Earth and Planetary Science Letters, Journal of South American Earth Sciences, Mineralium Deposita, Geology and Economic Geology. Mathur has also served as a geochemical consultant for mining, government, and academia for over 20 years. Mathur received a B.A. in history and geology from Juniata College and a Ph.D. in economic geology and isotope geochemistry from the University of Arizona.

Esuru Rita Okoroafor is an Assistant Professor at Texas A&M University and previously served as a Principal Reservoir Engineer at SLB, an organization she worked with for 13 years. Her research focuses on subsurface engineering for sustainable energy, including geothermal energy, geological carbon dioxide storage, and underground energy storage. Dr. Okoroafor has held various technical committee roles especially for the Society of Petroleum Engineers (SPE) Annual Technical Conference and Exhibition. She also has been a technical committee member for the Carbon Capture Utilization and Storage (CCUS) Conference and Geothermal Rising Conference. She serves as an Associate Editor for the Petroleum Science and Technology Journal and Editor for the Journal of Petroleum Technology. She is honored as an SPE Distinguished Lecturer (2023 – 2024) and is a 2021 GRIT Award Recipient. Dr. Okoroafor received a Ph.D. in energy resources engineering from Stanford University.

Jacqueline Wong is the Senior Vice President for Climate and Energy at the Natural Resources Defense Council (NRDC). In that capacity, she advances NRDC's goals related to climate change mitigation and clean energy. Before assuming this role, Wong led NRDC's Industrial division and focused on decarbonization of the industrial sector, responsible deployment of green hydrogen in targeted applications, mitigation of non-CO2 greenhouse gases, and development

and commercialization of emerging technologies. Previously, she was a senior advisor for energy and climate change at the White House, where her portfolio included the Kigali Amendment to the Montreal Protocol to address hydrofluorocarbons, and policy related to the federal coal program and the Outer Continental Shelf. She also has experience working on international clean energy cooperation at the U.S. Department of Energy and in the private sector at Bain Capital and McKinsey & Company. Wong received a bachelor's degree in economics and English from Yale University and an MPA with a concentration in economics and public policy from Princeton University.