Remining as a Domestic Critical Mineral Resource

Fall 2022 BESR Meeting

November 3, 2022

NATIONAL ACADEMIES *Sciences Engineering Medicine*

Previously mined and abandoned mine sites can host reserves of critical minerals essential for the energy transition and our modern technological society. Unextracted resources from tailings at these sites often reflect technological limitations of the era in which the site was mined. As the demand for critical minerals has risen and the technology for mineral extraction has improved, the potential for redeveloping old mine sites is becoming increasingly attractive for mining companies. However, a major roadblock for remining is the liability incurred by new owners if the abandoned mine site has a legacy of contamination. Additionally, remining could remobilize pollutants and add to the environmental damage. This meeting will discuss the role that remining might play in the supply of critical minerals, the potential environmental impacts of remining, and the policies related to Good Samaritan Laws and permitting that might accelerate responsible remining of critical minerals.

Agenda (all times EDT)

10:30 AM – 12:00 PM	**Welcome and introductions |** *Isabel P. Montañez (BESR chair) & James Slutz* **Panel I: Demand and supply potential |** *James Slutz, moderator* Frank Hoffman, S&P Global Nedal Nassar, U.S. Geological Survey Jennifer Dunn, Northwestern University Abby Seadler Wulf, Securing America's Future Energy
12:00 PM – 1:00 PM	Break for lunch
1:00 PM – 2:30 PM	**Panel II: Remining and associated impacts |** *Deborah Peacock, moderator* Warren Day, U.S. Geological Survey Edouard Asselin, University of British Columbia Mckinsey Lyon, Perpetua Resources Greyson Buckingham, DISA Technologies
2:30 PM – 2:45 PM	Break
2:45 PM – 4:15 PM	**Panel III: Policy issues associated with remining |** *Jeffrey N. Rubin, moderator* Kyle Danish, Van Ness Feldman LLP Steve Feldgus, U.S. Department of the Interior Debra Struhsacker, Women's Mining Coalition Corey Fisher, Trout Unlimited
4:15 PM – 4:30 PM	**Summary, outlook, and concluding remarks |** *James Slutz*

Board on Earth Sciences and Resources
2022 Membership

Isabel P. Montañez, NAS (Chair)
University Distinguished Professor and Chancellor's Leadership Professor
Department of Earth and Planetary Sciences
University of California, Davis

Thorsten W. Becker
Shell Foundation Distinguished Chair in Geophysics
Institute for Geophysics and Department of Jackson School of Geosciences
The University of Texas at Austin

Brenda B. Bowen
Professor, Geology and Geophysics
Director, Global Change and Sustainability Center
Department of Geology and Geophysics
University of Utah

Nelia W. Dunbar
Director and State Geologist
New Mexico Bureau of Geology and Mineral Resources

Rodney C. Ewing, NAE
Frank Stanton Professor in Nuclear Security and Professor of Geological Sciences
Freeman Spogli Institute for International Studies and Stanford University

Mary (Missy) Feeley

Zelma Maine-Jackson
Hydrologist (retired)
Washington State Department of Ecology

Michael Manga, NAS
Professor and Chair
Department of Earth and Planetary Science
University of California, Berkeley

Allen Marr, NAE
Founder and Chief Executive Officer
Geocomp Corporation

Patricia McDowell
Professor Emeritus
Department of Geography
University of Oregon

Harvey J. Miller
Reuche Chair in Geographic Information Science
Department of Geography
The Ohio State University

Jeffrey N. Rubin

James (Jim) A. Slutz
Senior Study Coordinator, National Petroleum Council

Elizabeth J. Wilson
Professor, Environmental Studies and
Inaugural Director of the Arthur L. Irving Institute for Energy and Society
Dartmouth College

Panelists

Edouard Asselin is a Professor and Tier II Canada Research Chair in Aqueous Processing of Metals at the University of British Columbia, Department of Materials Engineering. He is also co-Director of UBC's Pipeline Integrity Institute. Dr. Asselin is an applied electrochemist: he teaches and conducts research in aqueous metal extraction (metal leaching from minerals), electro-metallurgy (making metal from aqueous solutions of metals), corrosion and protective coatings. He was President of the Metallurgical Society of Canada in 2019 and he was a member of its Board of Directors from 2009 to 2021. Dr. Asselin has published over 130 peer-reviewed journal articles and over 40 conference publications. He is a co-inventor of the licensed and commercial Jetti copper leaching process, for which he holds several patents.

Greyson Buckingham serves as the CEO & President of Disa Technologies, Inc. Disa provides efficient, cost-effective and sustainable solutions for mineral processing and remediation. Disa's novel High-Pressure Slurry Ablation (HPSA) technology liberates/treats a variety of materials including metallic and industrial minerals, hydrocarbons and abandoned uranium mines. Greyson previously served as the Director of Policy for Mesa Natural Gas Solutions, a T. Boone Pickens owned company. Prior to that, he worked on Capitol Hill for several years and helped run a U.S. senate campaign. Greyson is a licensed attorney and a Field Artillery officer in the Wyoming Army National Guard (recipient of the Theodore Roosevelt Leadership Award which recognizes the top officers in the U.S. military). He has deployed to Kuwait (Operation Spartan Shield) and Iraq (Operation Inherent Resolve). Greyson received both his B.A. in History and Government and M.A. in American Government from Georgetown University. He received his J.D. and MBA in Energy Management from the University of Wyoming, where he graduated with honors. He is a Board Member for the Wyoming Federalist Society, a Board Member for Advance Casper, and serves on the Georgetown Alumni Admission Interview Committee.

Kyle W. Danish is a partner at Van Ness Feldman LLP. He is a nationally recognized expert on energy projects, the energy transition, sustainability, government relations, and environmental regulation. He has decades of experience assisting his clients, including energy companies, manufacturers, financial institutions, think tanks, NGOs and coalitions, on navigating complex issues at the intersection of business and government policy. Examples of his work include providing counsel on the permitting of major energy and infrastructure projects, advising on corporate climate strategies, drafting agreements for carbon market transactions throughout the world, building policy coalitions, drafting legislation, analyzing regulations, drafting rule-making comments, developing compliance plans, providing advocacy services, representing clients in litigation, and defending enforcement actions. Kyle has been recognized by Chambers USA, Chambers Global, the International Who's Who of Environmental Lawyers, and Best Lawyers in America. He is a Senior Associate (Non-Resident) in the Center for Strategic and International Studies' Energy and National Security Program. He is on the Editorial Board of the Carbon & Climate Law Review. Kyle is a Member of the Board of the Montgomery County Green Bank.

Warren Day is a research geologist serving as the Science Coordinator for the USGS Earth Mapping Resources Initiative (commonly known as Earth MRI). Earth MRI is charged to map the Nation's nonfuel critical mineral resources both below the ground and those above the ground in mine waste materials. Earth MRI focuses on acquiring and interpretation modern framework geologic, geophysical, and topographic data for areas across the Nation that may host critical mineral resources. The goal of the effort is to help meet the Nation's shortfalls in the upstream parts of the critical minerals supply chains. As well, Earth MRI data and interpretative efforts have applications beyond mineral resources, including helping define groundwater, geothermal, energy resources as well as natural geohazards. Warren Day received his undergraduate degree in Earth and Planetary Sciences from Washington University, St. Louis, Missouri and doctorate in geology and geophysics from the University of Minnesota.

Jennifer Dunn is an Associate Professor of Chemical and Biological Engineering at Northwestern University. She studies emerging technologies, their energy and environmental impacts, and their potential to influence air pollutant and greenhouse gas emissions, water consumption, and energy consumption at the economy-wide level. Particular technologies of interest include biofuels and bioproducts, automotive lithium-ion batteries, fuels and chemicals made from carbon capture and utilization technologies and from natural gas liquids, and resource recovery from wastewater. She applies life cycle analysis as a key tool to evaluate emerging technologies. Jennifer earned her PhD in Chemical Engineering from the University of Michigan. Her B.S. degree in Chemical Engineering is from Purdue University. Jennifer directs the Center for Engineering Sustainability and Resilience and is the co-chair of the Northwestern Sustainability Council.

Steve Feldgus is the Deputy Assistant Secretary for Land and Minerals Management at the Department of the Interior. Prior to joining DOI in the Biden administration he was the Deputy Staff Director for the House Natural Resources Committee, and has also previously worked for the Bureau of Land Management, the Bureau of Safety and Environmental Enforcement, and has held various other positions during 16 years of working for Congress. He has a Bachelor's degree in Chemistry from the University of Massachusetts and a Ph.D. in Chemistry from the University of Wisconsin.

Corey Fisher lives in Missoula, MT where he is the Public Land Policy Director for Trout Unlimited's Angler Conservation Program. His portfolio includes engaging policy makers and Trout Unlimited's nationwide grassroots network to advance conservation-focused legislation, as well as administrative polices that provide for healthy fish and wildlife habitat and resilient public lands. This work includes mining and abandoned mine land polices that support responsible land use and restoration initiatives. He is a graduate of Northland College with BA in writing and outdoor education and spends his free time in the mountains and on the water hunting, fishing and trail running.

Frank Hoffman is a consulting principal on the Economics and Country Risk team at S&P Global Market Intelligence with a focus on market planning and supply chain. He brings expertise in econometric modeling and analytics, market analysis, and price forecasting to both market planning and supply chain-related engagements. He also has extensive data visualization experience and specializes in using data, modeling,

and forecasting to drive strategy and operations and help clients make more informed data-driven decisions. Frank's projects include sizing and forecasting the paint and home improvement product markets, building a dashboard used to develop global sourcing strategies, and developing a framework for a diversified manufacturer to track their key end markets and efficiently allocate marketing resources between verticals. Frank has also worked as a Senior Economist with Pricing & Purchasing service where he covered nonferrous metals, healthcare, and services. Before returning to the company, Frank worked as a senior operations manager at Uber Technologies. His areas of focus included incentives strategy and investment allocation for the US and Canada rides business. Frank has also worked as a federal consultant on analytics and data science-related engagements. He has been featured in media outlets such as American Metal Market, Bloomberg Television, Metal Bulletin, and Mining Technology. He has a Master's degree in International & Development Economics from the University of San Francisco and a Bachelor's degree in Economics from the University of Illinois.

Mckinsey Lyon is the Vice President of External Affairs at Perpetua Resources. She has worked on the Stibnite Gold Project since 2011. Her work is driven by the belief that a modern, responsible, mine should be transparent and accountable to communities and stakeholders. As VP of External Affairs, Mckinsey leads the direct advocacy and social license development for the Stibnite Gold Project including government relations, social license development, stakeholder engagement, messaging, and media communications. Before joining Perpetua Resources, Mckinsey was a partner at Gallatin Public Affairs. After years of consulting on the project, Mckinsey joined the team in 2017 because she believes that Perpetua is set to lead the way into the next generation of mining that will bring forward the responsible production of the metals and minerals that are essential for a more sustainable future. Mckinsey is a fifth-generation Idahoan.

Nedal Nassar is the USGS Materials Flow Analysis Section chief. His research team quantifies the global stocks and flows of nonfuel mineral commodities at each stage of their life cycle, analyzes trends and examine concerns regarding foreign mineral dependencies, develops supply and demand scenarios, and assesses the mineral commodity supply risk to the U.S. economy and national security. He received his Ph.D. from Yale University where he worked on the development and application of a methodology for assessing critical minerals. He has continued that work as a leading member of the U.S. National Science and Technology Council (Executive Office of the President of the United States) Critical Minerals Subcommittee. He also serves as the Chair of the Project Steering Committee for National Minerals Information Center, a member of the Executive Committee for the Council of Senior Science Advisors at U.S. Geological Survey (PECASE member), and on the advisory board of various international research projects.

Debra W. Struhsacker is a hardrock mining policy expert with over 30 years of expertise with the environmental and public land laws and regulations pertaining to mineral exploration and mine development. Since 1993, she has been an active participant in the legislative dialogue about the U.S. Mining Law when she helped start the Women's Mining Coalition, which continues to be one of the mining industry's most effective advocacy groups. In July 2021 and May 2022, Debra testified on the Mining Law before the House Subcommittee on Energy and Mineral Resources. She has received numerous industry awards and is currently one of the women featured in the National Mining Hall of

Fame and Museum's "Pioneering the Field: Women in Mining" exhibit. Debra is a Phi Beta Kappa graduate of Wellesley College, where she majored in geology and French, and has a Master of Science degree in geology from the University of Montana.

Abigail Wulf is the Director of the Ambassador Alfred Hoffman, Jr. Center for Critical Minerals Strategy at SAFE. Abigail brings broad Earth science expertise to the Center, from researching rare earth- and lithium-rich pegmatites to working with NASA researchers to convey the connections between Earth's component systems. She previously served as Senior Science Communicator for Research within NASA's Earth Science Division. She also served as Policy Manager for the American Geosciences Institute, a nonpartisan federation of more than 50 professional scientific societies. While at AGI, Abigail co-led the Minerals Science and Information Coalition, a broad-based alliance of organizations representing all stages of the critical minerals supply chain.

Moderators

Deborah Peacock is a Metallurgical Engineer, Registered Professional Engineer (registered in New Mexico and Colorado), and Registered Patent Attorney (licensed in New Mexico, Colorado and New York, and with the U.S. Patent & Trademark Office). In addition to managing her law firm, Peacock Law P.C., she is on the Board of Directors of THEMAC Resources/New Mexico Copper Corporation (TSX: MAC), which is involved in permitting and developing a copper/gold/silver/molybdenum mine property in southern New Mexico. She is also on the Board of Westwater Resources, Inc. (NASDAQ: WWA) a graphite mining/processing company with a mine site in Alabama. Ms. Peacock previously worked at a tin mine in Tasmania and a copper mine in Utah. Deborah is also on the Board of Directors of New Mexico Gas Company (natural gas utility) and Emera Technologies, LLC (DC microgrid technologies) (both companies are wholly owned subsidiaries of Emera). She is the Chair of the Board of Regents of New Mexico Institute of Mining & Technology and on the New Mexico Mining Safety Board. Both of these positions were appointments from the Governor of New Mexico. Previously, she chaired the New Mexico Environmental Improvement Board (also Governor-appointed). She has gained expertise in academia, mine safety, Federal and State environmental and mining laws and rules, and water rights. Because of these experiences, she is exposed to not only copper/gold/silver/molybdenum mining, but also graphite, vanadium, coal, uranium, and potash, because of her boards and the vast natural resources in New Mexico. She is also familiar with tribal issues regarding mining, particularly the legacy uranium mines in Western New Mexico. She is a member of the New Mexico and National Society of Professional Engineers; Society of Mining, Metallurgy and Exploration; Canadian Institute of Mining, Metallurgy and Petroleum; Women's Mining Coalition; New Mexico Mining Association; New Mexico Oil & Gas Association; Prospector and Developers Association of Canada (PDAD); American Society of Safety Engineers; and National Association of Corporate Directors. Even though many of her mining activities are on Earth, Ms. Peacock is also a national keynote speaker and published author regarding the future of mining on the Moon and asteroids. She earned her B.S. in Metallurgical Engineering from the Colorado School of Mines and her law degree from Harvard Law School.

Jeffrey N. Rubin was the emergency manager for Oregon's largest fire district from 2001 to 2019. His work focuses on hazard and threat analysis, planning, and risk perception and communication. Dr. Rubin served on the U.S. Department of Homeland Security (Science and Technology Directorate) First Responder Resource Group from 2009 to 2020 and was the vice chair of the Governor's Task Force on Resilience Plan Implementation in Oregon. He is a Fellow and elected Councilor of the Geological Society of America, a certified emergency manager, and a nationally registered emergency medical technician. He holds a B.S. in geology and geophysics from Yale University and a M.A. and Ph.D. in geological sciences from the University of Texas at Austin.

Jim Slutz is the director of study operations for the National Petroleum Council (NPC), an independent federal advisory committee to the United States, reporting to the Secretary of Energy. Prior to NPC, Jim led a global consulting practice with projects in North America, Asia, and Europe. Previously, Mr. Slutz served as Acting Assistant Secretary of Fossil Energy at the United States Department of Energy (DOE) and before that as Deputy Assistant Secretary of Oil and Natural Gas at DOE. Prior to joining DOE, Jim served as the Indiana Oil and Gas Director, regulating the State's upstream oil and gas industry and natural gas storage wells. He is a former Vice-Chair of the Interstate Oil and Gas Compact Commission. Mr. Slutz holds an MBA degree from The Ohio State University, Fisher College of Business, and a B.S. degree from The Ohio State University, School of Natural Resources. Jim serves as chair of the Committee on Earth Resources and is a member of the Board of Earth Sciences and Resources of the National Academies of Sciences. In addition, he serves as an advisor to the National Bureau of Asia Research and is a Board Member of the local chapter of the Society of Petroleum Engineers (SPE), currently serving as program chair for the Inaugural 2021 SPE/AAPG/SEG Washington DC Technology and Sustainability Symposium. Jim has published papers in collaboration with the American Enterprise Institute, The East West Center, the U.S. Chamber of Commerce Foundation, and the National Bureau of Asia Research.