

Organized by the Asia Research Institute, National University of Singapore (NUS), with funding support from the NUS Presidential Young Professorship whitespace grant on the project titled "Critical Minerals in Context: Investment, Entrepreneurialism, and Techno-Diplomacy in Malaysia, Australia, and the United States"

CRITICAL MINERALS IN/AS CONTEXT

Resource Work and Knowledge Work
in the Circular Economy

6-7 May 2024 | Hybrid Format



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ARI 
ASIA RESEARCH INSTITUTE
National University of Singapore

This workshop is organized by the Asia Research Institute, National University of Singapore (NUS), with funding support from the NUS Presidential Young Professorship whitespace grant on the project titled “Critical Minerals in Context: Investment, Entrepreneurialism, and Techno-Diplomacy in Malaysia, Australia, and the United States”.

What exactly is the “circular economy,” and what kinds of workers and affective investments are coming into being as the concept of the circular economy has been taken up around the globe? In recent years, engineers and policymakers in many countries have leveraged anxieties over access to so-called “critical minerals” to justify new mines and to promote research on secondary extractive techniques, including processes for deriving minerals from mining wastes and discarded electronics – hopeful routes, some spokespersons promise, towards developing a new “circular economy” for materials production. The social entailments of this new economy, however, are far from clear. Emergent critical minerals development projects have alternately served as targets for rural economic development; sites for job training and technical capacity building; case studies for emergent “circular economy” initiatives and policy debates; arenas for debates over shifting environmental impact assessment procedures; and objects of citizen science. Across these spaces of engagement, prospective resource workers and members of affected communities have been positioned alternately as savvy entrepreneurs, communities at risk, and as passive beneficiaries of state-sponsored development. Such interventions are not simply economic or environmental, proponents insist: energy transitions must enable individuals to move beyond conventional resource labor by developing sophisticated technical skills and weaving these new skills into their future aspirations. While social scientists are beginning to examine the localized social impacts of the new mines, research sites, and waste processing facilities being developed to meet these demands, new approaches are required to understand the new kinds of social, spatial, and technological linkages being generated among these diverse forms of work. As processes for acquiring critical minerals are being redesigned and reframed, in other words, fundamental concepts of technoscientific interconnection are being remade.

This workshop will contribute to new research on the changing relations between resource work and knowledge work, and on the shifting temporalities and technological imaginaries through which the many people working at these interfaces experience economic life and environmental risk. The meeting will also offer a space for examining how shared engagements with complex extractive projects and emergent technologies enact new forms of anticipation and affective connection. Unlike large-scale mines, many of these spaces related to critical minerals development are not traditionally understood as spaces of politics. While job training programs and other initiatives designed to solicit local support for new mines have received increasing attention from social scientists, new forms of outreach around critical minerals exploration and processing sites entail different imaginative horizons. As critical minerals development projects become intertwined with complex supply chain issues, impact-benefit agreement negotiations, and environmental disputes, geologists and promoters must increasingly articulate residents’ interests with vernacular knowledge about global processes of exchange and multinational development. By encouraging conversation and comparative analysis, the workshop will examine how these and other vernacular forms of expertise emerge in everyday conversations about critical minerals and emergent technologies.

WORKSHOP CONVENORS

Asst Prof Tom ÖZDEN-SCHILLING

Department of Sociology and Anthropology, National University of Singapore

Assoc Prof Jiat Hwee CHANG

Asia Research Institute & Department of Architecture, National University of Singapore

6 MAY 2024 • MONDAY

10:30 – 11:00	WELCOME REMARKS
	TOM ÖZDEN-SCHILLING , National University of Singapore JIAT HWEE CHANG , National University of Singapore
11:00 – 12:30	PANEL 1
<i>Chairperson</i>	FATHUN KARIB , National University of Singapore
11:00	Unpacking Global Electric Vehicle Adoption from the Perspective of the Global South PRATAMA YUDHA PRADHEKSA , Rensselaer Polytechnic Institute
11:20	Critical Minerals for Energy Transition: Greenwashing to Green Extractivism NIDHI SRIVASTAVA , Jawaharlal Nehru University
11:40 <i>Online</i>	Extended Producer Responsibility to Reconstruct the Circular Value Chain XIN TONG , Peking University TAO WANG , Peking University JINLING LI , Peking University XUEJUN WANG , Peking University
12:00	Questions & Answers
12:30 – 13:30	LUNCH
13:30 – 15:00	PANEL 2
<i>Chairperson</i>	JOPPAN GEORGE , National University of Singapore
13:30	Generating Uncertainties to the Moral Imperative: The Material Politics in Indigenous Responses to Critical Minerals Mining, Chile SALLY BABIDGE , University of Queensland
13:50	Implementation of the Economic Constitution in the Regulation of Critical Minerals in Indonesia INDAH DWI QURBANI , Universitas Brawijaya
14:10	Calculated Conformity and Resistance: Examining Socio-Spatial Transformations in Indonesia's Nickel Industrial Parks RINI ASTUTI , Australian National University
14:30	Questions & Answers
15:00 – 15:30	AFTERNOON TEA
15:30 – 16:45	KEYNOTE ADDRESS 1
<i>Chairperson</i>	JIAT HWEE CHANG , National University of Singapore
15:30	Underground Philosophy: Thoughts on <i>The Eyes of the World</i> from a Hole in the Ground JAMES SMITH , University of California – Davis
16:15	Questions & Answers
16:45	END OF DAY 1
16:45 – 19:00	WORKSHOP DINNER (For Presenters, Chairpersons and Organisers Only)

7 MAY 2024 • TUESDAY

09:30 – 11:00	PANEL 3
<i>Chairperson</i>	ROGER FOUQUET , National University of Singapore
<i>09:30 Online</i>	Green Nickel, Electric Vehicles and Mining Governance Challenges in the U.S. ROOPALI PHADKE , Macalester College
<i>09:50 Online</i>	Navigating Norms: Socio-Legal Perspectives on Mining Conflicts and Critical Minerals Development SARA K. PHILLIPS , Chulalongkorn University
<i>10:10 Online</i>	Critical Minerals, Carbon Sinks, and the Futurity of Sustainable Mining BENJAMIN BAKER , Stanford University
<i>10:30</i>	Questions & Answers
11:00 – 11:30	MORNING TEA
11:30 – 13:00	PANEL 4
<i>Chairperson</i>	WALKER DEPUY , National University of Singapore
<i>11:30</i>	Boundary Work in the Valley of Death: Refining Viability in Rare Earth Elements Research TOM ÖZDEN-SCHILLING , National University of Singapore
<i>11:50</i>	Chinese Strategic Manoeuvre in the Southeast Asian Critical Minerals: Reconfiguring Regional Dynamics and Local Contradictions HUI YUN CHER , Institut National des Langues et Civilisations Orientales
<i>12:10</i>	The Work of Waiting for the Future in the Singaporean Deep-sea JONATHAN GALKA , Harvard University
<i>12:30</i>	Questions & Answers
13:00 – 14:00	LUNCH
14:00 – 15:15	KEYNOTE ADDRESS 2
<i>Chairperson</i>	TOM ÖZDEN-SCHILLING , National University of Singapore
<i>14:00</i>	Thinking through Exhaustion: Reflections from the Chile/U.S. Mineral Trade JAVIERA BARANDIARAN , University of California – Santa Barbara
<i>14:45</i>	Questions & Answers
15:15 – 16:15	WRAP-UP & DISCUSSION
	TOM ÖZDEN-SCHILLING , National University of Singapore
16:15	END OF WORKSHOP

KEYNOTE ADDRESS 1

Underground Philosophy: Thoughts on *The Eyes of the World* from a Hole in the Ground

James SMITH

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This paper synthesizes some of the main ideas in the book, *The Eyes of the World*, focusing on artisanal miners' understandings of their place in global capitalism and the supply chain for digital minerals, their reflections on regulators' efforts to control that supply chain, and their struggle with industrial mining companies. Some themes that I plan to address include the competing temporalities of mining, "communist" holes, the ecological impacts of debt and the heart of darkness narrative, the spiritual substratum of the digital age, and the fallacies of industrial mining.

James Smith is Professor of Anthropology at the University of California, Davis. He is the author of *Bewitching Development* (University of Chicago Press, 2008), and co-author, with Ngeti Mwadime, of *Email from Ngeti* (University of California Press, 2014). His work concerns how people in postcolonial Africa make sense of, act on, and forge innovative responses to contemporary global processes and transformations, including dispossession and regulatory efforts aimed at controlling or restricting their mobility and movement. Since 2006, he has conducted ethnographic research in the Eastern Congo on the mining and regulation of coltan and what are sometimes referred to as the "3 Ts" (tantalum, tin, and tungsten), minerals essential for electronic and digital devices. His recent book about this research, *The Eyes of the World: Mining the Digital Age in Eastern DR Congo* (University of Chicago Press, 2021), examines the coltan supply chain, and other features of global capitalism, from the point of view of those at the bottom of the chain. For these actors, Smith argues, the "supply chain" is not just an economic system, but a mechanism of value transformation aimed at converting things of the forest, already embedded in a world of ancestors and spirits, into commodities that belong to others so that Eastern Congolese may experience what they refer to as "movement" following upon a long period of war and violent post/colonial exclusion. The second major theme of the book concerns conflict and peace: mainly, *The Eyes of the World* articulates a Congolese social theory based on movement and "many hands touching money", concepts that describe and celebrate a conflict-ridden collaboration across differences—this is a collaboration not only amongst people, but also between different political orders, temporalities, institutions, modes of existence, and spatial-temporal arrangements. Finally, *The Eyes of the World* shows how these bottom up-themes are mobilized in response to international conflict minerals regulations and tracking, like Section 1502 of the Dodd Frank Act and "bag and tag" conflict free mining initiatives. This imposed top-down system, based on concepts of separation and purification, turns out to be at odds with the thought and practices of Eastern Congolese miners and traders, which prioritize collaboration across differences and "being supple" (kuwa souple) and flexible.

KEYNOTE ADDRESS 2

Thinking through Exhaustion: Reflections from the Chile/U.S. Mineral Trade

Javiera BARANDIARAN

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Chile's Atacama Desert has been supplying the world with mineral commodities for over a century, yet even here the scale of mining has recently accelerated dramatically. In the last decade, five new copper mines opened and the rate of pumping lithium-rich brines more than doubled – all destined for electric vehicles on Chinese, European and U.S. roads. Through an analysis of the mineral trade between Chile and the United States over the long 20th century, this talk challenges today's dominant sustainability discourses and reflects on what transnational histories can contribute to efforts to define this contested concept. Chile and the U.S. are strategic territories; since 1880, Chile has been a leading producer of nitrates, copper, and lithium, and the U.S. a leading consumer of these materials. Based on archival materials and secondary literature, I identify three periods in the Chile/U.S. mineral trade which reflect changing power dynamics between the state and industry and changing roles for science. I develop the concept of exhaustion—in contraposition to the manufacturing of mineral scarcity and the challenges involved in managing their overproduction—as a more solid foundation for thinking about sustainability than what mining science has offered to date.

Javiera Barandiaran is Associate Professor in Global Studies at the University of California, Santa Barbara. Her work explores the intersection of science, environment, and development in Latin America. She has published three books on environmental politics in Chile, exploring the market for science and Rights of Nature there, as well as numerous articles on lithium, fossil fuel decommissioning, energy, astronomy, and environmental conflict. She currently directs the Center for Restorative Environmental Work (CREW).

Unpacking Global Electric Vehicle Adoption from the Perspective of the Global South

Pratama Yudha Pradheksa
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The paper illuminates the often-overlooked social and environmental impacts of Electric Vehicles (EVs). EVs have been lauded as a low-carbon transition solution, but they also provide a complicated web of new and old inequities and vulnerabilities. This paper contends that EV adoption should be examined in the context of global environmental justice, analyzing its effects on the Global North and South.

The paper investigates Norway's quick EV adoption, demonstrating the Global North's enthusiasm. The worldwide supply chains and environmental impacts are examined further. It highlights nickel mining in Indonesia, which is crucial for EV lithium-ion batteries. A critical look at waste colonialism and primitive accumulation illuminates the historical and socio-economic factors behind EV adoption. The effects of resource extraction on the environment and labor conditions in these locations highlight the need for social and environmental justice.

A sociotechnical approach emphasizes technology, society, and the environment to traverse this complicated landscape. This strategy protects miners, e-waste workers, and other nickel supply chain stakeholders' human rights using global justice concepts.

The paper concludes with a call to action to identify key actors and their vulnerabilities in EV manufacturing, assign responsibilities, and change research funding priorities to address the environmental and social impacts of nickel mining and e-waste production. It emphasizes the importance of humanities and social sciences in promoting global justice in EV adoption while recognizing EVs' potential to reduce global emissions.

Pratama Yudha Pradheksa is a PhD student in the Department of Science and Technology Studies (STS) at Rensselaer Polytechnic Institute. His areas of interest in study include postcolonial STS, energy, and environmental STS. Prior to joining Rensselaer, he completed a research fellowship at Japan's Takagi Fund for Citizen Science in 2021 and a job as a researcher at Loughborough University under the Climate Compatible Growth initiative at COP26. His most recent works have been published in *South East Asia Research*, *East Asian Science, Technology and Society: An International Journal*, *Renewable and Sustainable Energy Transition* (forthcoming), and COP26 policy brief.

Critical Minerals for Energy Transition: Greenwashing to Green Extractivism

Nidhi SRIVASTAVA

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A shift towards low carbon pathways is integral to global and local action for reducing GHG emissions. It is now widely accepted that minerals like lithium, cobalt, rare earth elements are building blocks for energy transition (ET). Various estimates suggest that demand for some critical minerals needed for ET will rise by 4–5 times in the coming decades. Even with attention to circular economy, there will be increased pressure to explore and extract new mineral resources, due to limited recyclability. Reserves and production of these minerals are concentrated in a few jurisdictions of the global south, making it a contentious issue for energy equity, international trade and geopolitics, especially when used by the Global North to meet their net zero targets.

The increasing attention towards essentiality of minerals in ET, provides a moral impetus to expanding and expediting extraction. In one sense, it green washes extractivist approaches in resource rich regions, which have traditionally not benefitted from their natural resource wealth. The spatial distribution of benefits and burden of critical minerals-energy transition nexus is more complex due to the export oriented nature of extraction – both for processing as well as use in clean energy technologies. Most critical mineral mines are either controlled by transnational companies or closely linked to a processing industry in another country, and fueling ET in another jurisdiction.

It is imperative that raw material security for ET does not merely relocate environmental and social externalities from fossils to other minerals, and consequently from one jurisdiction to another. The proposed paper delves into why and how energy justice and just transition must be revisited in the context of critical minerals needed for energy transition. It studies the complexities of securing critical minerals needed for energy transition through the lens of extractivism and green extractivism.

Nidhi Srivastava is a PhD scholar at Energy Studies Programme, School of International Studies, Jawaharlal Nehru University, India. She holds a Bachelor of Laws degree from Delhi University and Masters degree in Energy and Environmental Law from Katholieke Universiteit Leuven (KU Leuven). She is a law and policy consultant with experience of working in the area of energy, environment and minerals for government, think tanks and multilaterals. She is also a guest faculty at the Centre for Post Graduate Legal Studies, TERI School of Advanced Studies, National Law University Delhi, and Honorary Fellow at Centre for Multilevel Federalism. Currently, she is writing her doctoral thesis on governance of critical minerals for energy transition in India. Nidhi has published and presented widely in national and international fora, including on the topic of critical minerals. Her research and publications can be accessed at <https://www.lawpolicy.org/>.

Extended Producer Responsibility to Reconstruct the Circular Value Chain

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This research explores the role of extended producer responsibility (EPR) as an enabler of circular value chain in the Chinese context. The driven forces and key stakeholders were identified to extend producer responsibility in developing the national-circular-economy strategies. An evaluation system was established to link the eco-design strategy of the producer with the downstream-recycling performance of products. The eco-design information was retrieved from the self-disclosure information in the sustainable development report of producers. The downstream-waste-flow information comes from multiple platforms of reuse and recycling companies. The aim of reforming the EPR system is to establish an open forum for competition and cooperation among different stakeholders to achieve a continuously-improving target of circularity and life cycle environmental performance of the products. With the evaluation results, the producers are encouraged to fully explore all opportunities in the circular value chain instead of focusing only on the final disposal or disassembly of waste. The conclusion suggests that EPR policies should break the restrictions on eco-design and innovation in business models by creating and capturing values of circularity along with the world's collective climate change mitigation efforts.

Xin Tong received her PHD in the College of Urban and Environmental Science of Peking University, and is now working there as Associate Professor in the field of industrial ecology. She worked as a visiting scholar in Yale Center of Industrial Ecology in U.S. in 2004 and Lund International Institution of Industrial Environmental Economics in Sweden in 2014. With the support of China National Science Foundation, she has been working on the Extended Producer Responsibility in e-waste management in China for years, especially focusing on the interactions between the global environmental governance and the technological change in developing countries.

Tao Wang is a PhD candidate in the College of Urban and Environmental Sciences, Peking University.

Jinling Li is a research assistant in the College of Urban and Environmental Sciences, Peking University.

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Generating Uncertainties to the Moral Imperative: The Material Politics in Indigenous Responses to Critical Minerals Mining, Chile

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Framing the challenges in terms of an analytic of material politics, this paper will examine the social and transnational effects of critical minerals drawing on collaborative work with members of Indigenous organisations in Chile and Australia. In Chile, Atacameño-Likanantay scientists from the Council of Atacameño Peoples are using the substantial funds they gained from negotiating a development benefits agreement with a lithium mining company to respond to extractivist science, producing studies that challenge the dominant definitions of ecological subjects and territories. The organisation's work is newly informational, technological, and entrepreneurial, as they seek to respond to the critical minerals boom. Their work also describes uncertainties vital for questioning the moral imperative of criticality and the shifts in speed and scale that define the rush for transition minerals. The paper explores how Indigenous-led scientific teams are challenging the definitional relations with geophysical, technical, ecological and other animate life. 'Material politics' thus refers both to the contested nature of technological and informational materials by which extractive business is done, as well as the live, lively and productively uncertain relations people articulate with ecological and mineral material subject to extractive activity. I suggest that the engagement of this material politics is (and perhaps has already begun to be) key to altering the speed and scale of critical minerals.

Sally Babidge is Associate Professor of Anthropology at the University of Queensland, Australia who writes about the social and ecological effects of extractivism in Chile and Australia. She is the author of a number of scholarly articles on these topics, a book (*What Surfaces: Advanced Extractivism and Slow Resistance*, Berghahn, In Press) and author of ethnographic and historical work with Gudjala peoples in Australia (*Aboriginal Family and the State: The Conditions of History*, Ashgate 2010, and with P. Dallachy and V. Alberts, *Written True, not Gammon! Histories of Aboriginal Charters Towers*, Black Ink 2007). She has undertaken research with authorisation from the Indigenous Community of Peine and funded by the Australian Research Council (DP1094069) and both pro-bono and contractual analyses of mining impact in partnership with numerous Indigenous organisations.

Implementation of Economic Constitution in the Regulation of Critical Minerals in Indonesia

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Mining regulation in Indonesia is ideally based on the provisions of the Indonesian constitution which states that the earth, water and all natural resources contained therein are controlled by the State and used for the greatest prosperity of the people, also known as the Indonesian economic constitution. The logical consequence of the economic constitution is the State's recognition of sustainable development, natural resource sovereignty, social welfare, and an environmental perspective. Indonesia currently has a Law on Mineral and Coal which regulates substances including: mining licensing management carried out centrally by the Government, strengthening environmental aspects in the form of the National Mining and Coal Activity Plan, as well as strengthening State-Owned Enterprises to coordinate and ideal divestment schemes. From the substance of the existing law, it only regulates mineral and coal mining in general. Until mid-March 2024, the Government of Indonesia has not made rules that specifically regulate critical minerals. This research uses a statutory approach, conceptual approach and comparative approach as well as the use of economic analysis of law theory. This research compiles the concept of the implementation of the economic constitution in regulating critical minerals in Indonesia which is divided into 3 (three) main aspects in regulating critical minerals. *First*, the critical mineral paradigm must be in line with the mandate of the economic constitution, namely for the prosperity of the people. *Second*, it is necessary to initiate a new regulation, namely the Critical Mineral Mining Law as a form of legal certainty for the existence of critical minerals. *Third*, community involvement in strategic policy making to realize distributive justice.

Indah Dwi Qurbani is Associate Professor in the Faculty of Law at Universitas Brawijaya. She has completed a doctor of law program in 2014. She is currently Head of the Master of Law Studies Program at the Jakarta Campus, Faculty of Law, Brawijaya University, and Head of the Center for Mining Law and Energy Law Studies, Faculty of Law, Brawijaya University. Furthermore, she has competence in constitutional law, economic constitution, energy law, mineral and mining law, and legislative drafting. She is also an associate professor of economic constitution focusing on natural resource management. In addition, she has joined several times to carry out joint research including Justice and Criticals Minerals Development in Indonesia Across Asean, Review and Evaluation of Law Number 39 of 2009 concerning Electricity, and Urgency of Formation of local regulations on Mining and Minerals in East Java Province. As for publications that have been published, namely *Political Law of Oil and Gas Management in Indonesia*, *Ensuring Justice in Oil and Gas Management in Indonesia*, and *Legal Principles of Social and Environmental Responsibility of Mining Companies: A New Paradigm of CSR in Indonesia*.

Calculated Conformity and Resistance: Examining Socio-Spatial Transformations in Indonesia's Nickel Industrial Parks

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The imperative of decarbonisation for climate change transition contains important contradictions and associated policy dilemmas. Moving towards a decarbonised economy will require vast amounts of critical mineral extraction and processing for the manufacture of low-carbon technologies. In Indonesia, more than a dozen permits for new integrated nickel industrial parks have been issued in eastern Indonesia to support the industrialization and value-adding processes for raw nickel ores. Private investments from China are inundating Indonesia's nickel belts in Sulawesi and North Moluccas in the hope of transforming abundant low-grade ore into Class 1 refined nickel, used in electric vehicle batteries. The emergence of these integrated nickel industrial parks in Indonesia sheds light on the socio-spatial process underpinning resource works through which natural resources are converted into diverse commodities. While presenting economic opportunities, these industrial parks rapidly transform socio-spatial relations in Indonesia's nickel belt communities, in ways that may amplify environmental and economic inequalities. Drawing from spatial imaginaries literature, this article highlights the political struggles between the conceptions and ideals of park investors and the perceptions and lived experiences of local communities during the construction of an integrated nickel industrial park in Central Sulawesi. Employing qualitative research and a case study approach, this article reveals how the spatial imaginaries of industrial parks shape, enable and legitimate particular spatial orders and practices based on extractive relationships. The continuous negotiation of these spatial imaginaries is explored, emphasizing ongoing processes of calculated conformity and resistance. Through an examination of these socio-spatial dynamics, the paper contributes to a nuanced understanding of the complex interface between place, imaginaries, and resource works.

Rini Astuti is Research Fellow in the Center for the Public Awareness of Science at Australian National University. Her research focuses on climate and environmental governance, including on energy transitions, sustainability imaginaries, and agrarian studies. She is informed by theoretical approaches that draw upon human geography, political ecology, and development studies, and is grounded empirically in Southeast Asia, especially Indonesia. Her extensive fieldwork-based ethnographic investigations explore how concepts of power, agency, scale, and exclusion/inclusion are crucial in understanding global climate governance's impacts and pursuing more just and equitable outcomes.

Yeremia Lalisang is Senior Assistant Professor at the Department of International Relations at the University of Indonesia. Yeremia's research focuses on the rise of China and its impacts on various level and dimensions. He is an expert on foreign policy analysis and diplomacy.

Geger Riyanto is Lecturer at the Department of Anthropology at the University of Indonesia. His main research interests are in the areas of social theory, violence, intergroup relationships, and identity. He is the author of *Peter L. Berger: An Examination in Metatheoretical Perspective* (published by LP3ES).

Green Nickel, Electric Vehicles and Mining Governance Challenges in the U.S.

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New critical metals mines are being prospected throughout the U.S. to meet the needs for batteries for electric vehicles, as well as solar and wind technologies. Mineral prospecting is meeting growing opposition from coast to coast, including Arizona, Idaho, California and Alaska. This article draws attention to the northern state of Minnesota where a complex social movement is emerging to challenge the devastating local contamination that might result from new “green nickel” mining. Focusing on Talon Metal’s Tamarack project as a case study, the article describes how tribal communities and their social movement allies are challenging this green energy paradox through cultural, legal and political strategies.

Roopali Phadke is Professor of Environmental Policy at Macalester College, where she has taught since 2005. She also serves as Associate Director of the Serie Center for Teaching and Scholarship at Macalester College. Her teaching and research focus on energy, water and climate policy, with a focus on public engagement and community based research methods. She received her PhD from the University of California Santa Cruz in Environmental Studies, as well as a Masters degree from Cornell University and a Bachelor of Arts from Wellesley College. She also served as a National Science Foundation postdoctoral fellow in the Science, Technology and Society Program at the Kennedy School of Government at Harvard University. She recently completed a multiyear National Science Foundation study titled “Mining Futures” examining social acceptance and siting politics for critical minerals mines. Her research also examines the circular economy of metals through remining and e-waste collection. She is also a member of the Future Mississippi Collaborative, a research collective focused on the potential for dam removal on the Upper Mississippi. Dr Phadke serves on many local and national boards including: World Learning, Native Sun, Northern Lights.mn, and Recycling Electronics for Climate Action (RECA). She also recently served a three-year term on the Governing Council of the Society for the Social Studies of Science (4S).

Navigating Norms: Socio-Legal Perspectives on Mining Conflicts and Critical Minerals Development

Sara K. PHILLIPS

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This paper considers how the promulgation of norms, understood through a legal pluralism lens, influences the mining conflict lifecycle and subsequent outcomes. Drawing on fieldwork undertaken in central Thailand, the paper employs a sociolegal approach to glean insight into how various actor groups understand and engage with norms in a conflict context and how that engagement imbues actors with the power to shape the mining lifecycle at various stages of development. In particular, this paper focuses on how actors employ the vernacular of official legal systems and mining technologies in a strategic sense and as a path toward social and legal empowerment. The paper also analyses actor strategies for their scalar significance, seeking to better comprehend mining actors' understanding of, and subsequent engagement with, local, national, and international legal systems that frame a given mining project.

Drawing on data gained through individual interviews and focus groups, the paper seeks to offer a nuanced understanding of mining conflicts that extends beyond the conventional economic and legal perspectives. It aims to provide valuable insights for policymakers, stakeholders, and scholars interested in comprehending and addressing the intricate dynamics inherent in mining activities within the framework of a circular economy and increased critical minerals development. Sites of contestation offer valuable insight into how the language of norms is purposefully pursued to address power imbalances and shape development outcomes. The research demonstrates that expressions of vernacular knowledge that are readily measurable in sites of mining contestation offer insights into how and why such expertise emerges and what impacts might emerge from circular economy approaches to critical minerals and supply chains. By emphasizing the intricate interplay between legal pluralism, mining conflicts, and sociolegal dynamics within the context of resource development, this research seeks to illuminate how vernacular knowledge shapes global engagements and sheds light on the evolving landscapes of resource work and knowledge domains.

Sara K. Phillips is Associate Researcher with the Center for Social Development Studies at Chulalongkorn University, where her doctoral studies focus on resource development decision-making, investigating how the law enables structural inequalities that lead to mining conflicts and how actors utilize norms to shape the resource development lifecycle. Sara is also a visiting lecturer with the Center for Global Law and Policy at Santa Clara University, where she lectures on sustainable development, and the intersections of business, human rights, and climate change. Additionally, she is a doctoral fellow in Sustainability and Environmental Politics with the Stockholm Environment Institute-Asia. Sara is a qualified attorney in the United States (New York) and holds a Juris Doctor from Vermont Law School, a Master of Laws in environment from McGill University, and a Bachelor of Arts from the University of Colorado at Boulder.

Critical Minerals, Carbon Sinks, and the Futurity of Sustainable Mining

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This paper explores the interwoven connections between critical mineral-bearing ore and their geochemical propensity to become carbon sinks. Drawing on interviews and treating scientific papers as ethnographic documents, it explores how geologists re-imagine ultramafic rocks as possible resources for carbon sequestration. Ultramafic rocks provide several kinds of critical minerals, including but not limited to Nickel, Platinum Group Metals, and Copper. While ores provide minerals necessary for green energy technologies, their mineralogy is also a vital part of the global carbon cycle—through weathering processes, ultramafic minerals react with carbon dioxide, removing it from the atmosphere and transforming it into various carbonate minerals. Once in mineralogical form, carbon is effectively removed from the atmosphere for upwards of millions of years. By harnessing tailings' mineralogic properties, geologists re-imagine tailings not as a dangerous waste substance from mineral extraction but as a resource to sequester carbon dioxide permanently. Through said reimaginings, critical minerals discourse and decarbonization work dialectically to create the foundations for sustainable mining. Resourcifying tailings for carbon sequestration transforms mining into a carbon-neutral or carbon-negative endeavour and resolves the environmental harm posed by tailings. Taken together, this resource work enables the extension of mining well beyond the present and as a key industry providing the building blocks of green futures.

Benjamin Baker is an environmental anthropologist whose work focuses on the intersection of the environment and the geological. Currently, he is a doctoral candidate at Stanford University, where he is finishing his dissertation project titled “Anthropocene Alchemy: Geology, Carbon and Resource Making in the Age of Climate Change”, which explores how geologists and economists transform geological materials (tailings) into resources for carbon sequestration in Canada and Australia. A central theme of this project is exploring the multiple temporalities (human, geological, and economic) involved in resource production and the ongoing implications of temporal meddling during the Anthropocene. His project also explores how various discourses (sustainable mining, critical minerals) and market infrastructures (carbon markets) work as political tools for green future-making and practical elements to ensure the sustainability of resource-making projects.

Boundary Work in the Valley of Death: Refining Viability in Rare Earth Elements Research

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In recent years, hundreds of collaborative research initiatives have emerged around the world to support the commercialization of new rare earth elements (REE) processing technologies. The rationales supporting these initiatives are diverse. Some frame investments in research primarily as catalysts for diversifying downstream industries. Others insist that any new REE production must proactively account for environmental legacies by prioritizing the development of cleaner processing techniques, including recycling and waste re-use, over immediate economic competitiveness. Despite this diversity of commitments, Western governments, universities, and large corporations all remain loathe to support emergent projects through the intermediate stages of commercialization – a zone that scientists and financiers refer to as the “valley of death.” As a consequence, the vast majority of REE-focused R&D labor continues to be performed by small companies and research groups, whose collective horizons are defined not by shared political visions or epistemic commitments, but by their lack of durable institutional attachments, their capacity for opportunistic alliances, and their relentless search for capital. In the rural American west, these fragile connections are taking shape amidst deepening political polarization, where conversations about energy futures draw on sharply divergent social and economic imaginaries. This essay follows an ad-hoc collaboration between a mineral exploration company, students at a rural university, and a group of elite government scientists brought together to develop new processes for biological mining (i.e. methods for extracting REE metals through the use of plants, enzymes, and other bio-organisms). In particular, I explore how each group of participants conceptualizes their own particular “valley of death” while imagining future relationships with other researchers and articulating senses of place. As calls for collaborative innovation intensify even as the risks of research flow to individual knowledge workers, small firms, and communities living near sites of extraction, I argue that collaborative life among the diverse actors involved in energy transitions research is increasingly structured by intimate preoccupations with “viability,” rather than with the processes of social and epistemic differentiation often foregrounded in analyses of interdisciplinary work.

Tom Özden-Schilling is Presidential Young Professor in the Department of Sociology and Anthropology at the National University of Singapore (NUS). His research examines the lives of rural resource experts and the intimate attachments that experts develop to places and people within spaces undergoing radical environmental and institutional changes. His first book, *The Ends of Research: Indigenous and Settler Science after the War in the Woods* (Duke University Press 2023), is a historical ethnography of twenty-first century environmental deregulation in British Columbia, Canada, and its effects on both Indigenous and settler researchers’ struggles to maintain long-term forestry experiments and sovereignty projects in the wake of government downsizing. Tom’s current project examines the emergence of new critical minerals exploration and research and development initiatives in Australia, Malaysia, and the American Mountain West. Prior to joining NUS in 2023, Tom was an assistant professor in the Department of Anthropology at Johns Hopkins University, and postdoctoral fellow at Harvard University’s Weatherhead Center for International Affairs. Tom obtained his PhD in the History, Anthropology, and Science, Technology and Society program at the Massachusetts Institute of Technology, and his research has been supported by the Wenner-Gren Foundation, the Social Science Research Council, and the U.S. National Science Foundation.

Chinese Strategic Manoeuvre in the Southeast Asian Critical Minerals: Reconfiguring Regional Dynamics and Local Contradictions

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Chinese mining investment strategies are deeply intertwined with the politico-economic interests of Southeast Asian countries in the ever-changing geopolitical and institutional landscape of the region. This paper aims to analyze the Chinese strategies employed to establish technical, industrial, and political presence in the mining sector of Southeast Asia, as part of its global pursuit of critical minerals. It examines the regional dynamics by assessing the degree to which China has incorporated strategic data and sustainability concepts, and how these structures and discourses have configured responses in Southeast Asia. In the context of the increasing interest in rare earth resources in Malaysia, this paper explores the local encounters and compromises that arise from various local and Chinese actors in the rush for rare earth in Malaysia. Drawing on political and institutional economy approaches, this study argues that the institutional coordination between China and ASEAN has exacerbated contradictions and normalized compromises regarding ecological risks in the Malaysian rare earths' context. Consequently, it prompts reflections on Malaysia's strategic position within the paradigm shift towards environmental concerns, considering the regional dynamic that positions Malaysia as a pivotal entry point for China to implement and consolidate its vision for critical minerals in Southeast Asia. The research methodology employed in this study includes interviews conducted with firms, industry associations, and government officials from both Malaysia and China.

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The Work of Waiting for the Future in the Singaporean Deep-sea

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Singapore's history with ocean territory has been told from the point of view of land reclamation, commercial shipping and port infrastructures, and amphibious architectures both vernacular and high-tech. This paper figures a different place, the deepest seabed of the central Pacific Ocean, where the firm Ocean Minerals Singapore (OMS) holds an exploration contract for prospecting deposits of polymetallic nodules — ores rich in copper, cobalt, manganese, and nickel. OMS has held this contract for over a decade, though the speculative deep-sea mining industry has existed in a state of perpetual deferral for more than half a century. This paper examines the work of waiting for polymetallic nodules in Singapore. That is, what transpires to keep the seabed plot pried open for speculation and investigation? The social entailments of deep-sea mining are best understood here by tracing through thin archival traces and encounters how diverse actors draw together legal & diplomatic history with the contemporary sustainability imperatives of circular economic aspirations, to maintain OMS's plot in the timespace of ongoing delay. In conversation with work on speculative extractive frontiers in STS and critical geography, I argue that the work of waiting, and the spatiotemporal dynamics of territorialization, are tightly related. Topological orientations to territory structure conditions for the work needed to wait productively, with effects on how kinds of desirable Singaporean futures are imagined. If realizing a Singaporean circular economy is about closing infrastructural and material gaps, then this history refigured from the central Pacific abyss suggests that it is also about learning how to wait well.

Jonathan Galka is a doctoral candidate in the History of Science Department at Harvard University. In 2023-2024, he is a visiting scholar in the Department of Environmental Studies at Yale-NUS College and with the Centre for Contemporary Art at Nanyang Technological University on its Climate Change and Cultural Loss project. His dissertation examining the 20th-century identification of deep-sea manganese nodules as scientific, political, and economic resources, uses historical and ethnographic methods to query how the construction of nodules as a mineral resource frontier imbricated the biological and geological sciences with Cold War and postcolonial ocean law and politics. Jonathan has been continuing this work in Singapore, as deep-sea nodules take on renewed significance in new energy transitions. His historical and ethnographic work on oceanic resource frontiers appears or is forthcoming in *Historical Studies of the Natural Sciences*, *Social Studies of Science*, and *History and Philosophy of the Life Sciences*. Jonathan is also beginning a second project on the history and future of ocean thermal energy conversion (OTEC). Prior to beginning his doctoral research, he completed a BS in the history of science, and in ecology and evolutionary biology at Yale University, before completing a Fulbright research grant on pre-exposure prophylaxis for HIV among marginalized Malaysian communities.

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Fathun Karib is a joint appointment postdoctoral fellow under the ARI-DIJ Research Partnership on Asian Infrastructures and affiliated to the Inter-Asia Engagements and Science, Technology, and Society clusters at Asia Research Institute (ARI), National University of Singapore. He holds a PhD in Sociology from the State University of New York at Binghamton. His current research interests are energy and environmental history, critical agrarian studies, Anthropocene/Capitalocene, political economy of disaster, commodity frontiers, and the history of geology as a science. While at ARI, he will work on a research project titled “Global Gasification: The Emergence of the Indonesian Natural Gas Frontier and the Making of Gas Assemblage”. This project is part of his dissertation, *Living in the Ruins of the Capitalocene*, which is being developed into a book manuscript.

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Joppa George is Research Fellow in the Science, Technology and Society Cluster at the Asia Research Institute, National University of Singapore. Trained as a historian of modern South Asia, he studies the transformations of colonial society under the impact of science and technology. Currently, he is finalising the manuscript of his first monograph, *Airborne Colony: Ballooning and Aviation in India, 1889-1939*. Besides the history of colonial aviation, he is interested in environmental history, colonial epistemologies, history of media technology, and literary translations.

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electric lighting provided in the nineteenth and early twentieth centuries. He is the editor of *Handbook on Energy and Climate Change*, *Handbook on Green Growth*, and the volume on *The Economics of Renewable Energy*. He is also an associate editor of *Journal of Energy History*.

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