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Submission to the NSW 'Critical Minerals and High-Tech Metals Strategy Consultation'

17 November 2023

School of Geosciences
Sydney Environment Institute

THE UNIVERSITY OF SYDNEY

School of Geosciences

Formed in 1997, the School of Geosciences at the University of Sydney is built upon Australia's oldest Department of Geology, which was established in 1893, followed by the foundation of Australia's first Department of Geography in 1921. The School offers a unique constellation of some 40 continuing academics and associated postdoctoral researchers across the fields of geology and geophysics, geography, and coastal and marine science. This profile allows us to offer a distinctive interdisciplinary perspective on the biggest challenges facing the world today, including climate change, energy transitions, resource management and sustainability.

Critical minerals has become a key strategic area for the School in recent times with respect to both research and teaching. In research terms, the School undertakes world-leading work on using geodata analysis to assist with critical mineral prospecting (the Earthbyte group), alongside critical social science work that seeks to understand the impacts of critical mineral extraction – both positive and negative – in the context of the wider global industries they supply. With respect to teaching, critical mineral mining in NSW is the new focus of an important interdisciplinary capstone unit that brings together around 100 students majoring in Geology and Geophysics, Geography, and Environmental Studies. These ongoing research and teaching activities strongly inform our arguments in what follows.

The Sydney Environment Institute

The Sydney Environment Institute vision is for a just and sustainable environmental transformation in which all life can flourish. The institute aims to extend and amplify the scope of engagement on environmental issues and bring together expertise from across disciplines to tackle the greatest challenges in favour of the common good. Recognising the breadth of the harms unfolding, The Sydney Environment Institutes leverages multidisciplinary problem solving to have an impact on the personal and cultural, the social and political, and the ecological and economic. The SEI partners with the wider community of people and organisations engaging on environmental issues.

The Sydney Environment Institute's Transitioning Systems research cluster explores the transitions required across a range of institutional spaces including politics, economics, food, finances, and energy. It examines the interconnections, opportunities and barriers, and the myriad ways in which individuals, communities, and governments are responding to these transitions in a climate-changed and climate-challenged world. Transitioning Systems aims to:

- Examine the opportunities and barriers relating to transitioning systems at a variety of scales.
- Elevate the role of communities in leading systems transitions to ensure communities receive optimal benefits from the transitions that impact them.
- Develop innovative policies and practices to support efficient and just systems transitions.

Introduction

Decarbonising the global economy through renewable energy and electrification is an urgent task. We wholeheartedly support every effort of the NSW Government moving rapidly towards renewable energy and away from fossil fuel dependence. The critical mineral industry represents additional contributions that NSW can make to global decarbonisation while facilitating a shift in the state's extractive industries away from fossil fuels towards low-carbon technologies. The critical minerals and high-tech metals sector, including upgrading domestic processing, promises to make a crucial contribution to a just transition for regions in NSW. We therefore welcome the commitment of the NSW government to this priority policy area – being the first major policy review since the 2023 election.

As researchers and educators, we are acutely aware that the mining industry globally, in Australia, and in NSW suffers from a reputational deficit. Few young people see mining as an attractive career. This manifests as decreasing student numbers in Geoscience degrees. In NSW, recent controversy about dust and heavy metals around Cadia mine have fuelled community anxiety. Continuous improvements in environmental and social outcomes are needed to overcome reputational damage done by Juukan gorge disaster, the fossil fuels industry, and the biodiversity crisis. This requires forward thinking.

Based on experience, we know students want to work in clean, green industries and meaningfully contribute to a just global future. Critical minerals offer an opportunity to change the prevailing reputation to one of a new, high-tech industry that is central to a sustainable global future. We provide degree pathways that engage, inspire and prepare students for diverse careers in (but not limited to) energy transition minerals. To support our vision of a mining industry that the graduates of the future will be proud to work in, young, tech savvy students need to see genuine commitments to improving the environmental and social performance of mining.

The main question that we address in this submission is: what can industry, the government and universities do in partnership to enthuse the next generation of students and professionals to work in NSW's emerging clean energy transition minerals sector?

The short answer is an urgent need to invest in the next generation of students and professionals while committing to genuine improvements in environmental and social standards. To that end, the **key recommendations** of this submission are to:

1. Integrate independent research on the drivers, constraints and opportunities for regional development within global financial and production networks.
2. Develop and implement best practice environmental planning tools, including cumulative impact assessment, bioregional planning and lifecycle assessments and free prior informed consent, especially in the Central West region surrounding the proposed Critical Minerals Hub.
3. Establish a roundtable with industry, government and universities to discuss skills and training needs for the future of the industry.

Critical Minerals in NSW and global production networks

Critical mineral mines are the starting point of long, complex production networks encompassing multiple stages of processing and manufacturing ultimately leading to a finished product (such as electric vehicles and wind turbines). These various stages often straddle multiple countries and are organised through *global production networks.* This is a broader approach than the more commonly used notions of global value/supply chains and captures the wider range of actors and contestations involved in these industries. Adopting a global production network perspective provides a range of insights that are valuable for designing and evaluating potential policy interventions:

- Global production networks are controlled and coordinated by powerful corporations or lead firms, which – in the context of critical minerals - are increasingly likely to be large international battery manufacturers, or electric vehicle firms.
- Similarly, it is also important to have such a global perspective on the financial networks that underpin the development of mining and associated projects.
- Understanding the configuration of global production networks for critical minerals – i.e. which firms and other organizations are involved and what their interrelationships are – is important for explaining the different regional development impacts.
- Global production networks do not 'end' at the point of initial use, but also encompass recycling and reuse that are likely to become much more important in relation to future streams of critical mineral supply.

In general, when talking about critical minerals there is a tendency to assume that networks are organised similarly, and have similar effects, at the industry level. However, there are important contingencies in terms of different commodities (e.g., lithium or nickel), different countries and regions (e.g., Chile or Australia, Western Australia or NSW) and across networks with lead firms from different countries (e.g. USA or Australia or China). The extent to which geopolitical factors either directly or indirectly shape the networks will also vary, for instance with geopolitical influences likely being more important in rare earth elements as opposed to other critical mineral sectors. As a result, fine-grained analyses of individual mining/processing projects and how they connect into wider global production networks are required to assess their likely developmental benefits. Such analyses are also pivotal to understanding the likely impacts of strategic interventions by governments, e.g. the NSW *Critical Minerals and High-Tech Metals Strategy.*

Comparatively our analysis (Sinclair and Coe, *under review*) shows that the previous NSW strategy offers a financial commitment to the industry, notably through a $130m Activation Fund providing grants to progress early-stage critical mineral projects. While an important development, and more than has hitherto been offered by Western Australia ($72.2m), this is significantly less than the sums committed by Queensland ($310.2m). Most of the support for the industry comes from the Commonwealth, which has provided over $6bn in funding (mixed grants, loans, and R&D), with a strong focus on facilitating commercialisation of downstream processing.

In regional development terms, the creation of processing capacity and associated logistics within the state is essential for value capture in NSW. There is evidence that this is starting to happen in Australia, for instance lithium and rare-earth processing in WA, which should be translatable to NSW. Geographically co-locating mining, processing and associated logistics has potential. The previous NSW strategy, for example, promises to create a 'Critical Minerals Hub' in Central West NSW to

process minerals extracted in the central and far west of the state. The hub will be near or within the Parkes Special Activation Precinct and Central West Renewable Energy Zone where there is existing and planned infrastructure development. The relatively central location of Parkes within NSW potentially allows various ores, for example nickel-cobalt from several proposed and existing mines in the west and central west of NSW, to be collected, processed and refined before export. The plan needs more detail, however. For instance, there are labour supply issues that we return to below, and the promised 'streamlined approach' to developments should not reduce the opportunities for public consultation that are central to the social license to operate.

In short, critical minerals extraction alone will not be able to replace coal in the NSW economy in terms of exports or jobs unless there is development of onshore processing and potentially other down-stream activities. A more ambitious strategy could seek to develop the manufacture of components (e.g. battery cathodes and anodes) with the state, although the lack of an industrial base more generally may impose limits. In that context, another option may be to try and promote the development of critical mineral recycling in NSW as a complement to extraction and processing. As noted above, a detailed and comprehensive understanding of the entire global production network will be pivotal to such interventions.

Recommendation: Integrate independent research on the drivers, constraints and opportunities for regional development within global financial and production networks.

How can we support best-practice environmental and social standards in critical mineral regions?

The previous NSW Government's *Critical Minerals and High-Tech Metals Strategy* argued that "NSW leads the world in providing ESG opportunities for critical minerals projects and triple bottom line assessments" (p. 16). Our analysis (Sinclair and Coe, *under review*) shows this position is identical across the critical mineral strategies of Queensland, WA, the Northern Territory, and the Commonwealth. All justifiably argue that Australia's *relatively* high environmental standards provide a comparative advantage for Australian exports over international competitors.

The critical mineral strategies of every government in Australia remain rhetorical in commitments to ESG standards. None provide definite mechanisms, proposals or funding to enhance existing standards. This leaves them vulnerable to criticism, exposes the industry to risk, and discourages the best and brightest of the next generation to engage in critical mineral focused projects. Even in rhetoric, the previous NSW Government's strategy lagged behind Queensland and the Commonwealth.

For example, the Queensland government's strategy points to baseline studies and bioregional planning to support the proactive anticipation and management of cumulative impacts in critical mineral zones (Qld Department of Resources, 2023, p. 12). In turn, the Commonwealth's 2023 strategy points to efforts underway to reform the EPBC act and develop international standards (DISR, 2023, p. 40). Additionally, the Commonwealth also acknowledges Traditional Owner's right to *Free Prior and Informed Consent* (DISR, 2023, p. 32). The previous NSW Government's strategy did not even mention or acknowledge First Nations people, who are commonly directly impacted by critical mineral prospecting and extraction. Aboriginal cultural heritage protections urgently need reform in NSW, where current legislation "accord[s] unequivocal priority to developers, especially for major projects such as mining" (Lingard et al., 2021, p. 110). Permits to destroy Aboriginal cultural heritage are routinely granted without consultation, as was the case with the Juukan Gorge disaster in Western Australia which led to multiple inquiries and senior Rio Tinto executives losing their jobs (Nagar, 2021).

This Government's new critical minerals strategy is the perfect opportunity to demonstrate commitment to improving support for rigorous environmental assessment, social benefit and First Nations' rights. This could help maintain and enhance the value of NSW's mineral exports. Such a commitment could also facilitate companies' social license to operate around individual projects while addressing the poor reputation of the industry in the eyes of future students, graduates and professionals, ensuring that NSW remains ahead of the field. Thankfully, many tools are available and able to be integrated into undergraduate and postgraduate training as well as existing policy and legislative frameworks. We explore some of these tools in the context of several non-exhaustive examples that, from our research, are some focus areas for reform.

1) Expanding the temporality of environmental assessment in an era of climate change

The anticipated uptick in critical mineral developments will have complex effects over a century that will be characterised by rapid climate and ecological change. An extended, future-focused approach to environmental impact assessment is particularly relevant for new mine sites, which clear large tracts of land that, after many decades, will require rehabilitation. Given that climate change can impact species migration, fire regimes, and habitat structure over relative short timescales, plans to

restore a site to its prior condition, as is the current rehabilitation norm, may be costly and ineffective. The increasing quality and accessibility of remote sensed data, ecological databases, and modelling tools to predict the future distribution of native species and communities under different climate change scenarios means that the development of future-focussed, strategic and adaptive rehabilitation plans is plausible.

2) Accounting for impacts across the lifecycles of critical minerals

The location, methods and projected extent of critical mineral mining, processing, use and recycling/disposal over coming decades highlights the importance of fully accounting for specific impacts over mineral lifecycles. For example, Australia has limited experience in mining and processing rare earth elements (REEs), yet these are anticipated to be an important feature of our national mining portfolio (Weng et al., 2016). This brings considerable risk given that the relatively novel and under-researched impacts of REE mining and processing, such as radioactivity and toxicity, may be overlooked by inadequately trained environmental practitioners tasked with conducting and reviewing environmental impact assessments (Yin et al., 2021). Similarly, the toxicity and impacts of other critical minerals like nickel and cobalt are not well quantified in NSW, and could require significant regulatory challenges during extraction and refining (Mudd, 2021; Adeel et al., 2023). Further research is needed to understand how the impacts – positive and negative – of critical minerals accrue across the entire lifecycle, from extraction, processing, refining and recycling.

3) Regional, compounding, and cumulative impacts planning, assessment, and management

Critical minerals mining will be concentrated in regions, like Central West NSW, that have previously been dominated by agricultural landscapes. While this promises economic benefits and diversification, new developments are also accompanied by a degree of community anxiety. Proactive regional planning, cumulative impacts assessment and lifecycle analysis are particularly useful in such greenfield regions. This presents an opportunity to implement best practice bioregional planning and cumulative impacts assessment. Regional planning, collaborative governance, and cumulative impact assessment in Australia are policy tools most often used in relation to mine closure, but their benefits would be even greater in ensuring community consent during the initial stages of developing mineral provinces (Sinclair et al., 2022).

The *Environmental Planning and Assessment Regulations* 2021 (NSW) and *Cumulative Impact Assessment Guidelines for State Significant Projects* (2022) provide mechanisms for both strategic-level (or regional-scale) and project-level cumulative impact assessments. At the Commonwealth level, the *Environment Protection and Biodiversity Conservation Act* 1999 provides mechanisms for proactive bioregional planning. While the *Central West and Orana Regional Plan 2041*, developed under the previous government devotes a section to growing critical mineral production in the Central West, it only commits to 'reduce red tape' and does not include any commitment to strategic level cumulative impacts assessment. Without assessments of baseline environmental conditions, cumulative effects prediction and threshold values and proactive management plans, Government, communities, and industry will be ignorant of both the likely effects and whether this meets community expectations.

To adequately predict and manage impacts while establishing social license, given the 1) compounding effects of climate change 2) uncertainties about toxic and radioactive impacts of critical minerals and 3) the opportunity for regional planning, we recommend the next NSW critical minerals and high-tech

battery metals strategy include clear commitments and funding for research and development of such cumulative regional impact assessments over mineral lifecycles and holistic regional planning. Moreover, we see the clear potential for assessments and plans to be integrated across space via open access databases (e.g. WABSI, 2021). This would allow for an ongoing evaluation of extant adaptive rehabilitation strategies within new mine project impact assessment and, theoretically, could provide opportunities for integrated bioregional adaptive rehabilitations strategies.

Recommendation: Develop and implement best practice environmental planning tools, including cumulative impact assessment, bioregional planning and lifecycle assessments, and free prior informed consent, especially in the Central West region surrounding the proposed Critical Minerals Hub.

How can universities provide the best education the professionals of the future?

Universities need to create the environment and skills for the next generation of professionals, but first they need the students in well-supported geoscience courses. In November 2022, the Australian Geoscience Council released its *Australian Geoscience Tertiary Education Profile 2003-2021.* Several of the findings demonstrate the difficulty in attracting students despite demonstrated research and teaching excellence:

- In world rankings, geosciences in Australian universities outperform other science disciplines.
- Within science faculties, geoscience accounts for 10% of research income, making it a "major contributor to university research productivity and reputation."
- However, undergraduate geoscience enrolments nationally have decreased from 3,230 EFTSL in 2013 to 1,900 in 2021.
- Geoscience courses are dominantly funded by domestic students, unlike engineering or business with a majority of international students and Universities have been increasing cross subsidies to geoscience degrees.
- Commonwealth reforms in 2020 reduced funding per student in sciences from $27,021 to $24,417 p.a. per FTE student, only 35-45% of which is provided to departments.
- Across NSW several Universities have recently abolished their geology majors or entire departments, due to relatively small undergraduate student numbers, even though geology graduates are a key for future growth of the critical minerals sector (as emphasised in the recent round table discussions).
- Even where geoscience survives at the University level, it may be at a reduced scale within larger Schools, jeopardising the delivery of comprehensive resource-oriented geology majors.

It is not straightforward to simply redeploy people from other disciplines (e.g. coal or oil and gas) as their numbers are not sufficient and their skill-base not well matched. It is also not straightforward to simply fill positions for exploration and future mine sites from overseas, as geology degrees in many other parts of the world are suffering a similar fate to Australian/NSW tertiary geology education, and the "tyranny of distance" often stands in the way of attracting qualified overseas geologists. Australian universities will not act in the interest of the NSW state unless they are incentivised to do so – however, potential financial incentives are largely in the hands of the federal government.

The NSW government should intercede with the Federal Government to halt and reverse the decline of geoscience in Higher Education across Australia. Saving the remaining Schools or Departments is critical for the state, and Australia, economically and environmentally. Support could be in the form of a federal funding boost to maintain geology tertiary education at a level that is suitable for the next generation of critical mineral mining geologists. This capability should be maintained at the very least in a select number of Universities to supply the critical minerals industry with a future workforce. The point was made at the recent critical minerals roundtable with Natural Resources Minister Courtney Housso that without meeting this requirement, there may not be a future functioning and growing critical minerals industry in NSW.

Basic critical support infrastructure is also being lost. For example, it is increasingly difficult to get microscope rock slides produced in NSW. This is an essential tool for understanding rocks and

mineralization processes. The Critical Minerals hub should ensure that such basic requirements are met in NSW in consultation with NSW Universities.

The profile of geosciences, and especially geology, needs to be upgraded in High Schools before students arrive at University. NSW should fund a role in the NSW Geological Survey that is explicitly focussed on assisting collaboration across Secondary and Tertiary institutions and boosting public awareness of the crucial role of geoscience and geology.

While universities provide the skills and education for world leading industry, it is also crucial to stay up to date with the needs and expectations of industry and policy makers – who are the employers of future graduates. To ensure this mutual understanding we need continual dialogue between all parties.

Recommendation: Establish a roundtable with industry, government, and universities to discuss skills and training needs for the future of the industry.

Biographical Statements

Lian Sinclair is a postdoctoral research associate in geography in the School of Geosciences and member of the Sydney Environment Institute. Lian completed their PhD in political economy at Murdoch University in 2020 on corporate-community conflicts around mine development in Southeast Asia. Her current research is on critical mineral global production networks in Australia. Lian previously worked as a postdoc associate with CRC TiME (Cooperative Research Centre – Transitions in Mining Economies) on cumulative impact assessment for post-mining transitions.

Neil M. Coe is Professor of Economic Geography and Head of the School of Geosciences at the University of Sydney. Since January 2023, he has been an Adjunct Professor at Copenhagen Business School, affiliated to the Centre for Business and Development Studies (CBDS). His research interests are in the areas of global production networks, regional economic development, and labour geographies. His current research is focusing on critical mineral global production networks and regional development in Australia, and export-oriented, high-value horticulture on the North-East coastal strip of Australia. He recently authored the *Advanced Introduction to Global Production Networks* (Edward Elgar, Cheltenham, 2021) and coedited *Labour Regimes and Global Production* (Agenda, Newcastle, 2022).

Rebecca Hamilton is a physical geographer based at the School of Geosciences at the University of Sydney. Her research uses geographical tools, namely palaeoenvironmental reconstruction and GIS, to unravel how ecosystems change through time in response to human and climate influences. She is especially interested in the applications of her work for the management of thriving landscapes in a time of rapid environmental change.

Dietmar Müller is Professor of Geophysics at the School of Geosciences, University of Sydney. He received his undergraduate degree from the Univ. of Kiel, Germany, and his PhD in Earth Science from the Scripps Institution of Oceanography, UC San Diego/California in 1993. After joining the University of Sydney he built the EarthByte Research Group, pursuing geodata synthesis through space and time. He is leading the construction of a Virtual Earth Laboratory, assimilating the wealth of disparate geological and geophysical data into an experimental planet, with a special focus on resource exploration, with end-users across over 190 countries. He led the ARC Basin Genesis Hub with 5 industry partners from 2015-2020 and held an Australian Laureate Fellowship from 2009-2014. He is a Fellow of the American Geophysical Union and the Australian Academy of Science.

Susan Park is Professor of Global Governance in Government and International Relations at the University of Sydney. She focuses on how international organisations and global governance can become greener and more accountable, particularly in the transition to renewable energy. Her most recent books are: *The Good Hegemon* (2022, OUP) and *Environmental Recourse at the Multilateral Development Banks* (2020, CUP). She is co-lead Editor of the journal *Global Environmental Politics.* She is a Senior Hans Fischer Fellow at the Technical University of Munich (2019-2023) and a Research Lead of the Earth Systems Governance project.

Derek Wyman is an Associate Professor in the School of Geosciences at the University of Sydney. He has studied the relationships between tectonics and ore deposit formation since 1988 and was a developer of what is now known as the Ore Systems approach to understanding and exploring for ore deposits. He has supervised PhD, Masters and Honours students on industry-related studies in Australia, PNG and Canada and co-supervised a PhD study with the Rio Tinto Centre for Mining

Automation. He is a highly cited author and was among the top 2 percent in his field globally, according to the 2022 Clarivate Highly Cited Researcher list.

Gemma Viney has recently completed her PhD in the Department of Government and International Relations and is a member of the Transitioning Systems research cluster at the Sydney Environment Institute. Her work examines the Australian experience of environmental justice.

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Sydney Environment Institute Transitioning Systems Research Cluster

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