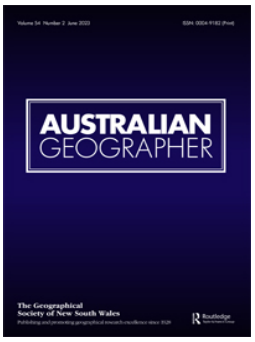

Australian Geographer

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cage20

Critical minerals: rethinking extractivism?

Amelia Hine, Chris Gibson & Robyn Mayes

To cite this article: Amelia Hine, Chris Gibson & Robyn Mayes (2023): Critical minerals: rethinking extractivism?, Australian Geographer, DOI: 10.1080/00049182.2023.2210733

To link to this article: https://doi.org/10.1080/00049182.2023.2210733

Published online: 17 May 2023.

AUSTRALIAN GEOGRAPHER
https://doi.org/10.1080/00049182.2023.2210733

Critical minerals: rethinking extractivism?

Amelia Hine [a], Chris Gibson[a] and Robyn Mayes[b]

[a]ACCESS, School of Geography and Sustainable Communities, University of Wollongong, Wollongong, NSW, Australia; [b]QUT Business School, Queensland University of Technology, Brisbane, QLD, Australia

ABSTRACT

Acceleration in political support for critical minerals industry development is linked to securing resource supply chains essential to low carbon futures. This commentary reviews the Australian critical minerals agenda, scrutinising urgency claims engulfing the 'rush' to extract critical minerals. First, we define critical minerals and examine their 'criticality' in relation to decarbonisation and geopolitical motivations. The idea that the emergent industry is premised on an ethics of climate action conflicts with evidence that reputational risk and market shifts are driving companies. Second, we problematise urgency claims, arguing that crisis narratives and regulatory fast-tracking mask serious socio-environmental justice concerns, while neglecting material blockages. We distinguish the production of materials central to low carbon futures from localised social and environmental impacts of their extraction and processing, raising concerns over the absolution work performed by urgency claims. The burgeoning critical minerals industry presents an epochal moment to reconstitute mining differently to meet socio-environmental justice goals. Instead, as currently imagined, it extends a frontier mentality and existing models of extractivism, reproducing colonial-capitalist legacies. We conclude by advocating for counter-urgencies that foreground materiality and view critical minerals as policy commons, enabling debates on the shape of the critical minerals industry before it is fully established.

ARTICLE HISTORY
Received 21 September 2022
Accepted 2 May 2023

KEYWORDS
Critical minerals; extractive industry; mining; green metals; green energy technology; energy transition

Introduction

In late August 2022, after years of careful lobbying and serious conflict with local communities, metallurgical coal mining company South32 withdrew an application to extend its Dendrobium Coal Mine, 90 kilometres south of Sydney. The extension had been contentious because of its local environmental impacts and proximity to Sydney and the Illawarra's drinking water reserve. The New South Wales Independent Planning Commission had initially rejected it until the New South Wales (NSW) Government

CONTACT Amelia Hine ahine@uow.edu.au ACCESS, School of Geography and Sustainable Communities, University of Wollongong, Wollongong, NSW, Australia

controversially overturned the decision by fast-tracking it as 'State Significant Infrastructure' (a regulatory category exempting large-scale, high dollar-value projects from normal planning processes). While campaigners are claiming South32's decision to no longer extend the mine as a win for the environment and local opposition (Protect our Water Alliance 2022), South32 CEO has suggested that the decision to shelve the expansion is instead related to the company shifting its investments towards 'green' metals—a forward-looking economic opportunity (Fernyhough 2022b). In a sense, this was a localised and specific decision regarding corporate strategy. South32's decision could also be seen as a decisive moment with broader reverberations: a signal that a threshold has been passed from 'old' forms of mining based on massive extraction and export, towards 'newer' niche forms of mining ostensibly geared towards decarbonisation and a low emissions future. Indeed, only a week after South32's decision the NSW Government (Toole 2022) announced new critical minerals and high-tech metals fund to 'turbocharge' the sector.

Amidst accelerating investments and government support for new mining projects, this *Thinking Space* piece takes such recent events as a launch point to review the critical minerals agenda, on the cusp of massive expansion. We do so as researchers presently tracing the shifting geography of Australia's industrial regions, including commodity routes and new energy sources (Hine, Mayes, and Hurst 2022). One of us (Amelia) has been on-the-ground as part of a research team examining the socio-environmental context of South 32's proposed Dendrobium mine extension, after an earlier project (with Robyn) exploring the socio-political drivers surrounding *mine* approvals (Mayes, Hurst, and Hine 2021). Most recently Amelia and Chris have been conducting research in multicommodity seaport Port Kembla, observing its transformation in industrial orientation, and mix of commodities; Robyn and Amelia have been examining multi-perspectival understandings of what might constitute 'good' mining. While coal exports continue unabated, imports flowing through Port Kembla increasingly include electric vehicles (it is the largest car importation terminal in NSW) and wind turbines—products that depend upon critical minerals for their manufacture.

Seizing this sense of imminent epochal change, we ask: to what degree will critical minerals development, stoked by the decarbonisation agenda and unfurling geopolitical forces, represent new and 'better' forms of extractivism that differ from traditional mining with its social and environmental problems? While the magnitude of the climate crisis compels urgent responses, to what degree might urgency itself act as cover for the *reconstitution* of colonial, state capitalist modes of extractivism? In what follows, we outline several ways in which geographers might address the current state of play and are scrutinising the critical minerals industry as its growth accelerates. There are several key issues to be teased out in relation to a critical minerals industry with its complex materiality, geopolitical roots and intersecting social, environmental, and economic issues. Geographers are well positioned to take up this inquiry.

What are critical minerals, and where are they?

Critical minerals (also called 'high-tech metals' and 'green metals') are elements necessary for advanced technologies central to our contemporary lives (e.g. smartphones, device batteries) and, notably, for manufacturing green energy technology such as wind turbines and solar panels. In using the industry terminology 'green metals', we refer to those minerals that are discursively positioned as materially necessary to a range of low carbon energy infrastructures and technologies, such as nickel, copper, and cobalt—what Sandiford (2022) terms 'energy transition metals'. *Critical* minerals are a type of 'green metal' that has an additional layer of supply chain securitisation driving their strategic development. Nickel, for example, is a green metal but not a critical mineral because it is needed for green energy technologies but the current available supply for major markets is viewed as secure—although demand is increasing and this categorisation may shift. 'Green' in this industry sense does not refer to the processes and labour dimensions of extraction, refining or transportation of the minerals nor to their corresponding environmental or social impacts during mining and refining. Indeed, Sandiford points out that realising the potential of net-zero energy production in Australia requires 'innovation in much less carbon-intensive approaches to mineral processing' (2022, 150). Rather, 'green' denotes the manner in which the industry itself promotes extraction of these minerals as core to enacting transformational change to address decarbonisation and climate goals.

Critical minerals can also be viewed as distinct from what industry refers to as 'traditional' minerals. Traditional minerals are minerals with well-established extraction and refining processes and supply chains. Such minerals may or may not have a place in green energy technology. In Australia this includes iron ore, bauxite, gold, nickel, copper, and coal, all of which are produced at significant global quantities and have long-standing operations that span many decades (Geoscience Australia 2023).

At the time of writing, Australia has amassed a list of 26 minerals classified as critical (including two mineral groupings—rare-earth elements and platinum-group elements —which collectively include 23 extra minerals, totalling 47 critical minerals, see Table 1) for which it 'has significant potential to be a major supplier' (Hofstra et al. 2021, 01), including beryllium, lithium, and zirconium. For some of these minerals, such as lithium, there is already a well-established supply chain linked to downstream consumer goods manufacture; for others, like rare-earth elements processing, Australia will need to establish a new industry (Bridge and Faigen 2022; Martinus and Nunez-Picado 2022; Australian Government 2022b). Notably, the U.S. has constructed its list of critical minerals using different parameters to Australia, with an emphasis on supply risk via natural hazards or human-made disruptions, trade exposure, and economic vulnerability (Kelley, Huston, and Peter 2021), rather than on its internal ore deposits. While the 2022 Critical Minerals Strategy (first published in 2019) was released under the former Coalition federal government, the now Labor government is set to grow the industry as part of its Powering Australia Plan, Australian Made Batteries policy platform, and National Reconstruction and Value-Adding in Resources Funds (Australian Labor Party 2022a, 2022b, 2022c). The Greens are also supportive, viewing the green metals industry as a sensible option for just transition that offers coal miners closely related jobs as fossil fuels are phased out (The Australian Greens 2022). Australia's national ambition is now clear: to position itself as a key critical minerals extractor, processor, and exporter.

Before new critical mineral supply chains can be established, deposits need to be located. Predictably, Australia is positioning itself as a resource hotspot. Australia 'has been blessed', according to the former Minister for Resources and Water, Keith

Table 1. Australian critical minerals and their common uses.

Australian critical mineral list	Uses
High purity alumina	LED lights, electronics semiconductors, wristwatch faces, optical windows, smartphone components, separator sheet in lithium-ion batteries
Antimony	Semiconductor devices (infrared detectors and diodes), battery alloys, bullets, cable sheathing, flame-retardant materials, paints, enamels, glass, pottery
Beryllium	Gyroscopes, springs, electrical contacts, spot-welding electrodes, non-sparking tools, high-speed aircraft, missiles, spacecraft, communication satellites, x-ray lithographs, nuclear reactors
Bismuth	Fire detectors and extinguishers, electric fuses, solders, yellow pigment for cosmetics and paints, pearly effect to cosmetics, cure for indigestion
Chromium	Hardened steel, stainless steel, chromium plating on steel and plastic, leather tanning, industrial catalysts and pigments (in bright green, yellow, red and orange colours), rubies, emerald green glass
Cobalt	Powerful magnets, jet turbines, gas turbine generators, electroplating, brilliant blue colours in paint, porcelain, glass, pottery and enamels, treat cancer, preserve food
Gallium	Silicon substitute in electronic, semiconductors, solar panels on the Mars Exploration Rover, Blu-ray technology, mobile phones, red, blue and green LEDs, pressure sensors for touch switches
Germanium	Wide-angle camera lenses, objective lenses for microscopes, fluorescent lamps, infrared spectroscopes
Graphite	Pencils, lubricants, crucibles, foundry facings, polishes, arc lamps, batteries, brushes for electric motors, cores of nuclear reactors
Hafnium	Control rods in nuclear submarines, plasma welding torches, electrical insulator in microchips, polymerisation reactions
Helium	Cooling medium, cooling satellite instruments, cooling liquid oxygen and hydrogen, decorative balloons, weather balloons, airships, inert protective atmosphere for making fibre optics, semiconductors, arc welding, detect leaks in car air-conditioning systems, inflate car airbags after impact, artificial atmosphere for pressurised conditions, barcode scanning, helium-ion microscope
Indium	Touch screens, flatscreen TVs, solar panels, transistors, microchips, a mirror finish to windows, protective film on welders' goggles, coat ball bearings in Formula 1 racing cars, fire-sprinkler systems in shops and warehouses
Lithium	Rechargeable batteries for mobile phones, laptops, digital cameras and electric vehicles, non-rechargeable batteries for heart pacemakers, toys and clocks, armour plating, aircraft, bicycle frames, high-speed trains, special glasses, glass ceramics, air conditioning, industrial drying systems, all-purpose high-temperature lubricant, treat manic depression, storing hydrogen for use as a fuel
Magnesium	Aeroplane and car construction, car seats, luggage, laptops, cameras, power tools, added to molten iron and steel to remove sulphur, flares, fireworks, sparklers, a mordant for dyes added to plastics to make them fire retardant, heat-resistant bricks, added to cattle feed and fertilisers, medicine
Manganese	Steel, manganese steel, railway tracks, safes, rifle barrels, prison bars, drinks cans, a catalyst, a rubber additive, to decolourise glass that is coloured green by iron impurities, fungicide, fertilisers, ceramics
Niobium	Stainless steel, jet engines, rockets, beams and girders for buildings and oil rigs, oil and gas pipelines, superconducting magnets for particle accelerators, MRI scanners and NMR equipment, increase the refractive index of glass
Platinum-group elements	
Platinum	Jewellery, catalytic converters for cars, trucks and buses, a catalyst to produce nitric acid, silicone and benzene, a catalyst to improve the efficiency of fuel cells, computer hard disks, thermocouples, optical fibres, LCDs, turbine blades, spark plugs, pacemakers, dental fillings, chemotherapy drugs
Palladium	Catalytic converters for cars, jewellery, dental fillings and crowns, white gold, ceramic capacitors in laptops and mobile phones, a catalyst for hydrogenation and dehydrogenation reactions, separating and purifying hydrogen

(*Continued*)

Table 1. Continued.

Australian critical mineral list	Uses
Rhodium	Catalytic converters for cars, a catalyst for making nitric acid, acetic acid and hydrogenation reactions, coating optic fibres and optical mirrors, crucibles, thermocouple elements, headlight reflectors, electrical contact material
Ruthenium	Chip resistors, electrical contacts, to coat the anodes of electrochemical cells for chlorine production, catalysts for ammonia and acetic acid production, solar cells, electrical contacts for severe wear resistance, jewellery
Osmium	Fountain pen tips, instrument pivots, needles, electrical contacts, a catalyst.
Iridium	Pen tips, compass bearings, the standard metre bar, contacts in spark plugs
Rare-earth elements	
Scandium (listed separately to REE in the critical minerals list)	Russian MIG fighter planes, high-end bicycle frames and baseball bats, added to mercury vapour lamps to produce a highly efficient light source resembling sunlight, a tracer in oil refining, in underground pipes to detect leaks
Yttrium	Microwave filters for radar, a catalyst in ethane polymerisation, lasers that can cut through metals, white LED lights, camera lenses, superconductors, liver cancer treatment
Lanthanum	Hydrogen gas storage, hybrid car anodes, 'flints' for cigarette lighters, studio lighting and cinema projection, special optical glasses, catalysts for petroleum refining, a biological tracer for Ca^{2+}, treating cancer
Cerium	'Flints' for cigarette lighters, a catalyst, the inside walls of self-cleaning ovens, catalytic converters, an additive for diesel fuel, a pigment, flat-screen TVs, low-energy light bulbs and floodlights
Praseodymium	Aircraft engines, 'flints' for cigarette lighters, permanent magnets, carbon arc electrodes for studio lighting and projection, to colour glasses, enamel and glazes an intense and unusually clean yellow, didymium glass
Neodymium	Very strong permanent magnets, car windscreen wipers, wind turbines, didymium glass, colouring glass delicate shades of violet, wine-red and grey, the glass for tanning booths, lasers, laser pointers, catalysts in polymerisation reactions
Promethium	Specialised atomic batteries for pacemakers, guided missiles and radios, making phosphor give off light and this light is converted into electricity by a solar cell, a source of x-rays, radioactivity in measuring instruments
Samarium	Magnets, microwaves, optical lasers, infrared absorbing glass, a neutron absorber in nuclear reactors, glass and ceramics, carbon arc lighting for studio lighting and projection
Europium	Euro banknotes, low-energy light bulbs, control rods for nuclear reactors, laser material, thin super-conducting alloys
Gadolinium	Iron and chromium alloys, magnets, electronic components, data storage disks, magnetic resonance imaging (MRI), the core of nuclear reactors
Terbium	Solid-state devices, low-energy light bulbs and mercury lamps, medical x-rays, laser devices, loudspeakers that sit on a flat surface
Dysprosium	Neodymium-based magnets, motors, generators, wind turbines, electrical vehicles, halide discharge lamps, nuclear reactor control rods
Holmium	Nuclear reactors, magnets
Erbium	Infrared absorbing glass, sunglasses, imitation gems, broadband glass fibre
Thulium	A lightweight, portable x-ray machine for medical use lasers with surgical applications.
Ytterbium	Memory devices, tuneable lasers, an industrial catalyst
Lutetium	A catalyst for cracking hydrocarbons in oil refineries
Rhenium	Oven filaments, x-ray machines, an electrical contact material, single-crystal turbine blades
Silicon	Dynamo and transformer plates, engine blocks, cylinder heads and machine tools, to deoxidise steel, silicones, silicone oil is a lubricant, cosmetics, hair conditioners, silicone rubber, a semiconductor in solid-state devices, civil engineering projects, concrete, cement, glass, pottery, enamels, high-temperature ceramics, lasers
Tantalum	Electronic components, capacitors, surgical implants, equipment for handling corrosive materials, electrodes for neon lights, AC/DC rectifiers, glass for special lenses, turbine blades, rocket nozzles, nose caps for supersonic aircraft

(*Continued*)

Table 1. Continued.

Australian critical mineral list	Uses
Titanium	Aircraft, spacecraft, missiles, golf clubs, laptops, bicycles, crutches, power plant condensers, desalination plants, hulls of ships, submarines, joint replacements (especially hip joints), tooth implants, a pigment in house paint, artists' paint, plastics, enamels and paper, solar observatories, sunscreens because it prevents UV light from reaching the skin
Tungsten	Incandescent light bulbs, arc-welding electrodes, heating elements in high-temperature furnaces, cutting and drilling tools, dental drill, fluorescent lighting
Vanadium	A steel additive, armour plate, axles, tools, piston rods, crankshafts, nuclear reactors, a pigment for ceramics and glass, a catalyst, superconducting magnets
Zirconium	Nuclear reactors, superconducting magnets, ultra-strong ceramics, crucibles, furnace linings, foundry bricks, abrasives, glass, scissors, knives, cosmetics, antiperspirants, food packaging, microwave filters, gemstone zircon, synthetic gemstone cubic zirconia, blue and yellow pigments for glazing pottery

Sources: Royal Society of Chemistry (2022), Altech chemicals (2022), Encyclopaedia Britannica (2022).

Pitt, 'with extraordinary reserves of the critical minerals needed' (2022b). While widespread, their geography is particular and, thus far, poorly understood (Kelley 2020). In 2021, Geosciences Australia, in collaboration with the Geological Survey of Canada and the US Geological Survey, released the Critical Minerals Mapping Initiative (CMMI) that uses 'geochemical data generated by each agency on ore samples collected from historical and active mines and prospects from around the world' (Hofstra et al. 2021, 01). Locating critical mineral deposits has therefore largely relied on analysing existing data sources. The CMMI is developing predictive models for platinum-group elements (a type of critical mineral) deposits based on their tendency to be present alongside other geological occurrences like certain types of zinc-lead deposits (Lawley et al. 2022; Ford 2022). Based on these predictive maps it is likely there are concentrations of platinum-group elements across the northern half of Western Australia, much of the Northern Territory, southeast Victoria, southeast South Australia, much of Tasmania, and northern Queensland (North West Minerals Province) (Ford 2022). Despite a comprehensive countrywide map of critical mineral deposit locations being still under development (Figure 1), there are a growing number of sites where extraction and processing are already underway. Buttressing approvals for early projects are arguments about the economic potential of Australia extracting and value-adding to critical minerals through investment in renewables and related industrial specialisations. Yet impeding the industry's growth are substantial material unknowns at the continental scale. A potential gulf exists between the actual and discursive potential to consider renewables and critical minerals as an amalgam in terms of co-location of potential deposits and renewables investments. The industry itself suggests that future growth potential is an exploration problem to be solved by geotechnical experts. Yet, the reliance on historical surveys and existing concentrations of mine activity far removed from suitable labour markets and industrial infrastructure suggests there is also a material-political problem layering economic geographic path dependencies with colonial extractive legacies. Much remains unknown about the actual potential for place-based industry development—warranting scrutiny of the industry's urgency claims and accompanying policy support.

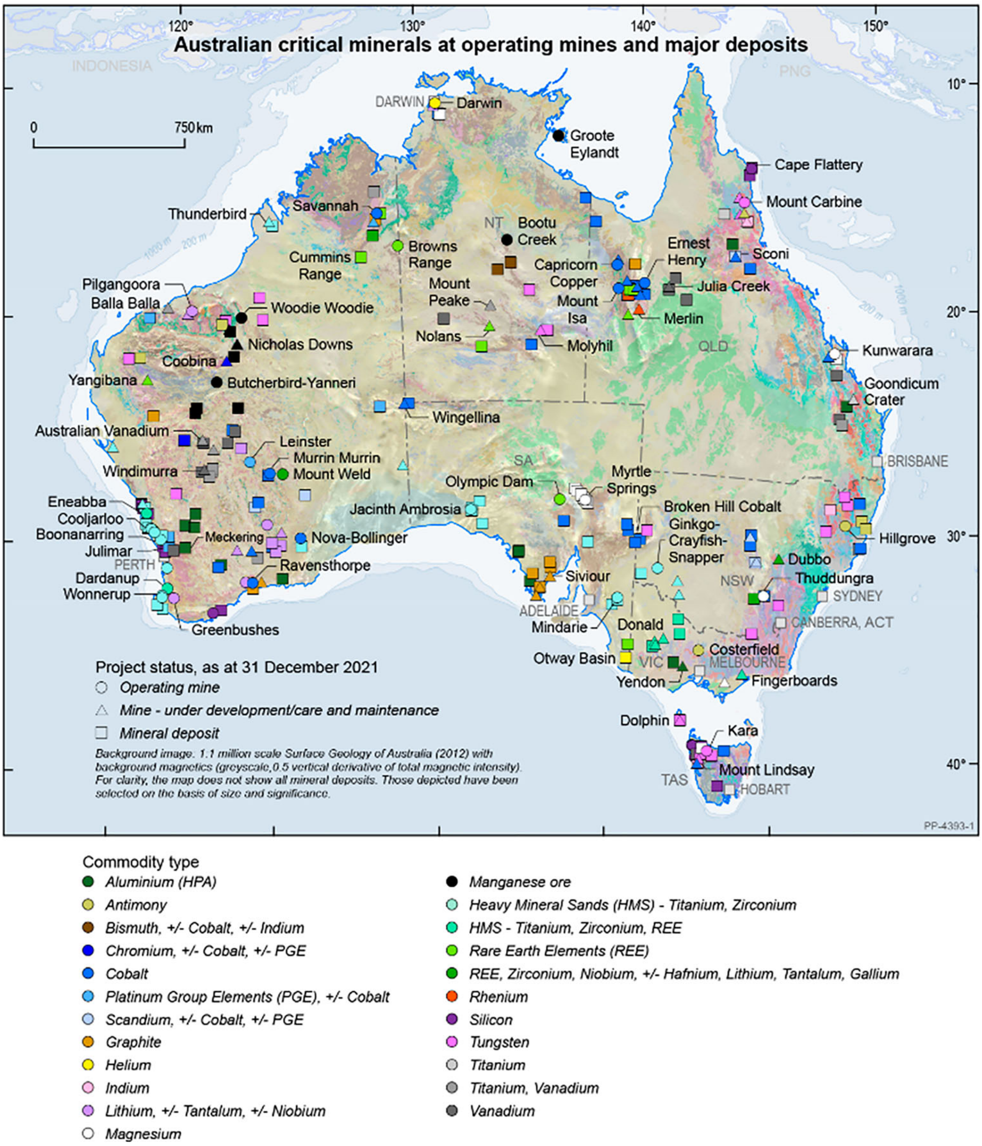

Figure 1. Australian Critical Minerals Map 2021.
Source: Britt (2021).

Why are they 'critical', and how are they 'urgent'?

What is meant by the 'critical' in critical minerals? While such minerals are key to low carbon technologies, and Australia has long been predicted to enjoy advantages given its resource endowments, the serious push towards developing an Australian critical minerals extractive industry only began as recently as 2019 and has ostensibly been prompted by the supply chain disruptions attributed to the COVID-19 pandemic. These disruptions have exacerbated the drive towards national securitisation of critical minerals that has been growing in urgency since China, which has a 'near monopoly' on rare-earth elements, halted exports to Japan and more generally reduced international exports by 40% in 2010 (Kalantzakos 2017, 02). More recently, in March 2023 the EU released the Critical Raw Minerals Act that aims to reduce the EU's reliance on 'quasi-monopolistic third country suppliers' of critical minerals (European Commission 2023). This is explicitly motivated by the European energy crisis prompted by Russia's invasion of Ukraine and the subsequent ramping up of energy alternatives alongside increasing risks to secure supplies of minerals. COVID-19 also had significant impacts on critical minerals supply chains, with temporary closures of mines and refineries globally leading to material shortages at the manufacturing stage, emphasising the need for supply chain resilience (Dyatkin 2020). Australia's interpretation of securitisation is about positioning the need for 'reliable, secure and resilient' critical minerals supplies as a matter of national security (Australian Government 2022b). This designation is currently reinforced through reports of bots linked to China launching campaigns to besmirch rare earth element mining and refining companies operating in Australia, Malaysia, Canada, and the United States (Fernyhough 2022a). Australia is in the process of forging strategic international partnerships with a range of nations including South Korea, India, and Japan to encourage investment in Australian projects, and is hoping to establish itself as a key supplier of minerals to 'mature markets' (Australian Government 2022b).

While policy emphasis has been on the potential to value-add upon endowments of critical minerals with investment in upstream processing and manufacturing clusters (e.g. batteries) (Wilson and Martinus 2020), work by resource and economic geographers is also revealing that the emergent global production networks for downstream product manufacture using critical minerals are consolidating the status and power of lead firms at great distance from the resources themselves. The majority of lithium is extracted from Australia, Chile, China, and Argentina, for example, and Tesla (US based) followed by VW (Germany), BYD (China), and Renault (France) are the EV companies consuming the largest amounts of lithium (Bridge and Faigen 2022).

At the same time, Australia's role is less as a supplier of minerals critical to technological responses to climate action, than a supplier of diverse specialist metals required in the manufacture of complex consumer goods—cars, ovens, smartphones, lighting, etc.—for global production networks (the lead firms of which are not Australian, nor manufacturing nor assembling goods in Australia) (Bridge and Faigen 2022). While decarbonisation as climate change response provides an important 'green' motivation to turn to critical minerals, it is far from the only motivator, with geopolitical and strategic trade advantages also informing governmental aspirations for the sector. As Table 1 establishes, the material usage of critical minerals is far more expansive than just decarbonisation technologies. Integrated into everything from self-cleaning ovens to antiperspirants, Euro banknotes to nuclear reactors, critical minerals are more than just obscure resources for the zero-carbon agenda. More accurately, they are the heterogenous matter of contemporary, globalised mass production and consumption.

Critical minerals are also not new to science and the idea of their scarcity is largely a fallacy. The perception that rare earth elements are 'rare', for example, is linked to their historical discovery in 1788 and later the relegation of their toxic production to the geopolitical margins to 'outsource environmental degradation' (Klinger 2015, 574). Most recently, the Malaysian government upheld conditions preventing the rare earth elements (REE) company Lynas, the largest REE producer outside China, from operating its cracking and leaching plant section in Malaysia, citing concerns around radioactivity levels (Chang 2023). While REE processing has been particularly visible as a result of its geopolitical significance, one of the most notable features of the broader critical minerals industry is the invisibility or lack of shared knowledge on the refining processes. Transformation of ores even into separated minerals is technologically complex. Each mineral type requires the development of new and commercial-in-confidence refining technologies. Amanda Lacaze, CEO of Lynas, emphasised in a panel discussion: '… we [Lynas] don't share our IP [Intellectual Property]. If we really want to develop a rare earths industry in WA [Western Australia], then the fastest way to do that would be for Lynas to share some of its IP. I have no motivation to do that right now' (AusIMM 2022). Such material blockages impede the industry's development, confounding urgency claims, while at the same time making a comprehensive understanding of the material impacts of extraction and processing, and subsequently its social and environmental consequences, difficult to determine.

Critical minerals are constituent ingredients of modernity associated with high-tech consumer products and decarbonising futures, but they have important back-stories that underpin their contemporary geopolitical relevance. Akin to coal—where the material complexities of its deep time stratigraphic formation are crucial to fully understanding the politics of international energy networks (Lobo and Hine 2022)—the specific mineral relationships and material histories of critical minerals can reveal much about their contemporary usage and production logistics. We know that the resource deposits of critical minerals are generally smaller deposits, which has economic as well as material consequences regarding the scale of extractive operations (CSIRO 2022). Critical minerals also present a greater opportunity for mining 'secondary minerals', that is minerals that were present in previously extracted material but were not removed for a range of reasons and have ended up in mine tailings (CSIRO 2022). Critical minerals are also often co-located within the same deposit, presenting additional difficulties in separation and processing (CSIRO 2022). The material relationships and deep time logics of particular resource distributions are central to the emergence of new supply chains and the geopolitics of securitisation (Melo Zurita and Munro 2019; Lobo and Hine 2022) but have yet to be comprehensively explored and understood across the wide range of heterogeneous critical minerals. For geographers engaging with debates around materiality, volumetric geographies, and subterranean agencies, herein lies an important emerging research agenda.

Relatedly, geographers and other critical scholars would be well served to scrutinise urgency claims around critical minerals, and to consider what is allowed to proceed under the cover of crisis. There is a sense of urgency to establishing an Australian critical minerals industry that echoes the historical urgency of the Australian gold rush of the 1850s (though with the added corporate element prioritising shareholder value extraction). While the industry's marketing centres on the need to mitigate climate change impacts on humanity through the strategic extraction and use of critical minerals in clean energy technologies, in reality companies do not operate altruistically. Governments in the U.S., Australia and elsewhere are offering substantial funding to encourage domestic industry development, drafting legislation such as the *Inflation Reduction Act* in the U.S. that privileges domestic supplies of critical minerals through end consumer rebates (Temple and Crownhart 2022). At the same time, countries and end product manufacturers have created a 'new race to secure uninterrupted access to critical minerals' in their efforts to decarbonise and to lead new technology advancement such as 5G and AI (Kalantzakos 2020, 01). The industry's internal discourse focuses on the financial opportunities and risks and the race to locate and secure resource deposits.

In an industry spotlight video at the 2022 International Mining and Resources Conference, Australia's biggest mining conference, Shaun Fox, founder and chairman of Foxi Global noted:

> *I remember back in 2012, 2010, we saw a lot of lithium mines and you know we were sort of pushing the other way, looking at silica, one of my favourites, we were messing in that space. Now I've spent the last 18 months hunting around, we've been to like 270 mines in Australia and Northern America, 37 that we're buying, not one of them is lithium – because no one's letting go of it! There's not a chance.* (International Mining and Resources Conference 2022)

In response to Fox asking whether there were any opportunities for junior miners to pick up lithium tenements, Tony Sage, Executive chairman of European Lithium emphasised:

> *Well there is still opportunities around the world, but you can tell when something's hot when a company like BMW, Mercedes, VW,* Tesla*, buy mines. That's when you know there's going to be a shortage, right, they want to lock it in and vertically integrate all the way up. So, when you see that happening you know it's hot.* (Ibid.)

With the global economy shifting towards decarbonisation, critical minerals are becoming strategic commodities—unleashing plans, goals, and corporate strategies couched in 'gold rush' style language and metaphors. The critical minerals race involves competition among corporate and institutional investors to locate resources and establish advantageous supply chains as countries and corporations collectively 'continue to set net zero 2050 emissions goals and look to establish supply chain sovereignty in the aftermath of the COVID-19 pandemic' (CSIRO 2022, 02).

Urgency claims for critical minerals development are premised on decarbonisation, not only as economic opportunity but as central to combating climate change through technological means. Yet, the framing of climate action as a global emergency, and critical minerals as a key element to its resolution, 'risks heralding a post-political Anthropocene, one that demands falling in line, putting questions of difference, justice, rights, and responsibilities aside' (Kumar 2022, 03). Rather than engaging carefully to envision and plan for an ethical, equitable low carbon future, urgency provides cover for monopoly plays among established corporate miners, as well as quick approvals for disruptive start-ups, while reducing accountability (Hine, Mayes, and Hurst 2022). As in the infrastructure and urban development sectors, 'state significant infrastructure' designation and unsolicited/market-led proposals processes through which critical minerals projects are approved obfuscate regulatory and financial dealings, with impact assessment studies frequently now succeeding rather than preceding initial approval (Gibson 2022; White, Legacy, and Haughton 2022).

The more difficult issues of social impact, equitable distributions of benefits, and First Nations rights, are sidelined in favour of geotechnical and commercial imperatives (where are the critical minerals, and how can they be extracted for profit). The NSW Government's recently announced critical minerals funding, for example, will support research on feasibility studies, mine re-use processing studies, metallurgical testing and infrastructure, water, and environmental studies, but it appears social research such as understanding community impacts, employment shifts, and First Nations land rights are not considered necessary to 'help deliver a diverse, vibrant, investment-ready industry' (Toole 2022). Urgency performs absolution work for government and private sector actors, sidelining more rigorous planning processes and relaxing checks and balances while hastening the speedy redistribution of funds.

If they're green, where's the problem?

Indeed, in the 'rush' to find and extract value from critical minerals, we witness a disturbing echo of frontier mentalities and colonial 'terra nullius' (and 'sub terra nullius') rhetoric—positioning surface terrain and subsurface volumes not as First Nations Country[1], but as unknown, 'empty' space (Melo Zurita 2020) to be (re)discovered for its critical minerals potential. The Australian Government's 'Investing in critical minerals in Australia' web page (2022a), for example, brazenly states that: 'Australia has potential for more undiscovered minerals. Well-established mining regions cover just 20% of Australia. The remaining 80% is largely under-explored'. This claim effectively encapsulates our national response to decarbonisation: a business opportunity with an expansionist agenda. Critical minerals are being positioned as our new frontier, and the nation's extractives industry is on the precipice of a new boom. These mineral reserves are widespread throughout the country, prompting exploration and licencing applications in areas that have not previously been 'blessed' by mining. Urgency discourses that travel with critical minerals obscure the reproduction and reinforcement of modes of settler colonial extractivism.

This is a pressing issue in light of not only the material nature of extractive activities and the potential for further widespread, long-term impacts to Country, but also because there is formal recognition of Indigenous rights and interests through mechanisms such as Native Title across over 50 per cent of the country's landmass (NIAA 2023). Fair and equitable Indigenous Land Use Agreements (ILUAs), one of the key avenues to facilitate development on land covered by Native Title, not only require a legislative overhaul to include veto rights (see Chandrashekeran 2021) but notably take time to negotiate. The urgency narrative around decarbonisation and the race to develop Australia as a preferred international supplier has the potential to undermine Native Title rights, and stands in contrast to what constitute better practices of negotiating with First Nations as sovereign peoples. This was evidenced recently in relation to Andrew Forrest's financially significant decision not to build a green hydrogen facility—another emergent decarbonisation-centred industry—in Western Australia because of 'government red tape'. The Western Australian government alleged this 'red tape' was actually the need to negotiate an ILUA with the Native Title holders of the site (Borrello 2021). Forrest instead located the facility in Queensland, where such negotiations were apparently not an issue.

There are two further points to draw out here. The first is that the critical minerals industry is driven by financial opportunity/greed and reputational risk and *not* a code of ethics. Established industry players like South32, BHP and Rio Tinto are divesting from coal and pivoting towards critical minerals because these are logical commercial decisions for the long-term prosperity of their companies. This is not to say that activism has not played a significant role, with the growth in investor activism via organisations such as the Australasian Centre for Corporate Responsibility (ACCR) and correspondingly increasing investor demands, particularly from large super funds such as HESTA seeking ethical investment options for their members (Macdonald-Smith 2022). Investor activists are pushing companies towards better governance on several fronts, including climate action, labour, and human rights (ACCR 2022). However, improvements are not simply altruistic, but are made on the basis of reputational risk, Environment, Social and Governance (ESG) investor ratings, competitiveness, and financial penalties through threatened withdrawal of substantial investments. Indeed, the challenge that investor activism presents to established ways of operating highlights the role that shareholder interests more broadly have played in driving forward profit-based extractivism.

The critical minerals industry brings increased risk that new companies and pivoting older ones will employ greenwashing tactics that emphasise their commitment to renewable energy, green technology, and low carbon futures while obscuring other interests and on-the-ground practices that contravene ethical or publicly acceptable practice. BHP's 2022 'The future is clear' advertising campaign emphasises their interests in green metals essential to a decarbonised future (nickel and copper), while mentioning only their metallurgical coal interests and avoiding thermal coal altogether (BHP 2022). While espousing a focus on the 'resources essential for the world to grow responsibly, and decarbonise sustainably' (BHP 2022), the company has wavered on its thermal coal divestment plans, mostly recently with its 2022 decision to seek an extension to the life of Mt Arthur thermal coal mine (Stringer and Biesheuvel 2022). Across the mining industry, 'future-focused' resources are providing reputational cover for ongoing, contemporary high emissions mining (see for example Glencore's national advertising campaign (2022) and Fortescue Future Industries (2022)).

This leads into the second point of localised environmental and social impacts in the emergent critical minerals industry. The diverse nature of critical minerals and their peculiar distribution (geological knowledge of which is still very much unfolding) will undoubtedly reshape the geography of Australia's resource regions, with unknown and potentially complex local consequences. These include impacts on First Nations communities; significant jumps in neighbouring towns' housing and retail rental prices (Razaghi 2022); rampant real estate speculation; displacements of residents and small businesses; and loss of local economic diversity as localities become 'boom and bust' towns increasingly beholden to their nearby single resource extraction enterprise (Dahlgren 2019). Even without immediate local townships, extractive industries prompt significant ethical concerns. As Ellem notes, '[f]ew people are employed or live in the Pilbara but massive profits are generated for (mostly) multinational corporations, corporations which wield significant influence over national political-economy' (2015, 323). Contemporary mining treats remote regions not as places to invest in people, communities, or the environment, but as 'resource banks' from which to extract maximum value (Tonts, Martinus, and Plummer 2013), while minimising on-the-ground costs. Against the grain of the mining industry's public-relations campaigns boosting their centrality to the national economic imaginary, the emphasis has been on smooth profit extraction *from* regions rather than endogenous development of skills and capacities *within* regions.

Similarly, the localised material conditions of extraction and processing deserve concentrated attention to understand the consequences of their production. With extraction will come the development of new and complex supply chains, with upstream manufacturing and distribution, mobility of minerals through consumer products, and their end of life in landfill or recycling into new forms dependent on economic viability (Herod et al. 2014). Undergirding the critical minerals industry will be material flows of chemicals and contaminants. Pell et al. (2019, 474) note, for example, that '[c]hemicals used in the refining process have been involved in REE [rare earth element] bioaccumulation and pathological changes in local residents'. The urgency with which a critical minerals industry is being enacted runs the risk of enabling a 'neoliberal environmentality' (Nel 2015, 249–250) that accepts localised social and environmental 'sacrifice zones' as justifiable to preserve our unevenly distributed 'consumption-centric' contemporary way of life.

Although processing and refining minerals figures heavily in the political conversation in relation to onshore value adding (Wilson and Martinus 2020), fundamentally the critical minerals industry is extraction. The expansionist rhetoric espoused by politicians and parties on all sides is significant because the real, physical outcome of enacting a critical minerals industry is the establishment of new mine sites in greenfield areas. These mines may provide the component materials essential to establishing a low carbon world and halting climate change, but they are very likely to simultaneously create significant social and environmental impacts across the country if their regulatory pathways and extractive processes replicate existing modes of operation (Heffron 2020). As yet, such impacts have not been central to the national critical minerals discourse, and it is unlikely that they will be recognised without significant effort and collective mobilising on the topic. Drawing upon extensive research over decades on mining's social and environmental impacts (e.g. Howitt, Connell, and Hirsch 1996; Tonts, Martinus, and Plummer 2013), gender and class imaginaries (Pini and Mayes 2012, Pini, McDonald, and Mayes 2012), the intersection of mining and First Nations lands and People (Connell and Howitt 1991; Marsh 2013), and labour geographies (Ellem 2015; Macdonald-Smith 2022), this is another important area in which geographers are well positioned to contribute.

Rethinking extraction for decarbonisation: towards a critical minerals policy commons?

The entanglement of critical minerals' complex histories and geographies with the contemporary rush to locate and establish domestic production warrants more careful, considered public debate than what has transpired. While major government and corporate investments are now flowing into critical minerals exploration, as yet unclear is how their distribution will also reshape the geography of regional development and, in consequence, influence the distribution of benefits and impacts. It is almost certain, however, that if the critical minerals industry is built upon existing models of extractivism it will reconfigure and reconstitute socio-spatial inequalities, envisioning new mining regions 'less as a community and more as a globally determined resource site' (Ellem 2015, 334). Exploration interests are currently fixed on the geology of these minerals and their potential locations. There is an equally imperative opportunity for geographers to mobilise our suite of tools to understand the social and material complexities engulfing critical minerals across scales.

This requires a rethinking of the urgency proposition. We argue that alongside the urgency of establishing a critical minerals industry is an accompanying *counter-urgency* to scrutinise critical minerals expansion approvals and activities, and to advocate for just outcomes (Kumar 2022) before the shape of the critical minerals industry is firmly locked in place. Transnational corporations are seen as wearing the cost of corporate misconduct across their supply chains, and therefore as responsible for ensuring social and environmental standards expected by the consumer are being met (Brockhaus et al. 2019). While companies like Tesla and Apple do have supplier codes of conduct in place that encompass critical minerals supply chains, leaving industry to make socially responsible decisions based on reputational risk is less than ideal. We need only consider what happened with Rio Tinto at Juukan Gorge to know that reputational risk alone will not ensure just and ethical decision-making in the face of economic gain.[2] We ought not depend upon corporations to reform mining ethically within a market created on the very logic of extractivism. Nor should it be left to those technical disciplines with a direct financial interest in critical minerals to act as 'experts' in related public debate (cf. Castree 2017).

Herein lies a distinctive role for geographers. The emergence of a new critical minerals industry is an opportunity to depart from traditional mining practices and pathways, and further, to rethink the relationship between regions, communities, and the extractive industry. We have a clear, once in a lifetime chance to revision what a mining industry might look like if it was disentangled from distant corporate interests and crafted instead in the public interest, for the environment and for Country, and for a low impact world. With continued government funding support for major critical minerals projects likely, their exact nature must be viewed as a question of public good—a policy commons. The present push for transparency and integrity in government, catalysed in the recent federal election, provides momentum for this. Starting points for greater scrutiny would include: the likelihood of greenwashing in miners' PR campaigns; conflict around environmental impact; spatial and material intersections between the critical minerals and renewables industries; promised versus actual jobs and value-added industry growth (and distribution of benefits among workers and local communities); poor track record around informed consent and recognition of First Nations perspectives and land rights; and government fast-tracking of approvals under the guise of climate change action. The task of turning Australian extractivism towards more genuinely ethical alternatives is massive; geographers are well placed to make a contribution to this task just as these contributions are crucial to any hope of success.

Notes

1. Country is the term that describes the 'lands, waterways and seas to which [Aboriginal People] are connected' (AIATSIS 2023).
2. The Juukan Gorge incident occurred in May 2020 in the Pilbara region of Western Australia, when two caves containing highly sensitive and significant cultural heritage for the Puutu Kunti Kurrama and Pinikura People were destroyed by blasting. Rio Tinto employees opted to destroy the caves to access higher grade iron ore, despite prior company knowledge of the 'ethnographic and archaeological significance' of the sites (Nagar 2021, 381).

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Amelia Hine is a Postdoctoral Research Fellow with the Helmholtz Institute for Functional Marine Biodiversity (HIFMB) in Oldenburg, Germany, and is also an Honorary Research Fellow in the School of Geography and Sustainable Communities at the University of Wollongong, Australia.

Chris Gibson is Senior Professor in the School of Geography and Sustainable Communities at the University of Wollongong, Australia.

Robyn Mayes is Professor in the Faculty of Business and Law at Queensland University of Technology, in Brisbane, Australia.

Funding

This research was made possible by funding from the Australian Research Council under the Discovery Project 'Continuity and change in the Australian industrial landscape'; [DP200100633].

ORCID

Amelia Hine http://orcid.org/0000-0002-4832-1976

References

ACCR. 2022. A History of Shareholder Participation. https://hub.accr.org.au/shareholder/a-history-of-shareholder-participation/

AIATSIS. 2023. Welcome to Country: What is Country?. https://aiatsis.gov.au/explore/welcome-country#toc-what-is-country-.

Altech Chemicals. 2022. High Purity Alumina (HPA). https://www.altechchemicals.com/high-purity-alumina-hpa/.

AusIMM. 2022. Thought Leadership Series 2022: Critical Minerals. https://www.ausimm.com/conferences-and-events/tls/Topics/critical-minerals/.

Australian Government. 2022a. Investing in Critical Minerals in Australia. https://www.industry.gov.au/policies-and-initiatives/critical-minerals-facilitation-office/investing-in-critical-minerals-in-australia Retrieved 31st August 2022 Retrieved 31st August 2022.

Australian Government. 2022b. 2022 Critical Minerals Strategy. https://www.industry.gov.au/data-and-publications/2022-critical-minerals-strategy Retrieved 31st August 2022.

The Australian Greens. 2022. Greens Launch Plan to Turn Queensland's Sunshine into Steel, 7th March 2022. https://greens.org.au/news/media-release/greens-launch-plan-turn-queenslands-sunshine-steel Retrieved 1st September 2022.

Australian Labor Party. 2022a. Powering Australia. https://www.alp.org.au/policies/powering-australia Retrieved 1st September 2022.

Australian Labor Party. 2022b. Australian Made Batteries. https://www.alp.org.au/policies/australian-made-batteries Retrieved 1st September 2022.

Australian Labor Party. 2022c. Value-Adding in Resources Fund. https://www.alp.org.au/policies/value-adding-in-resources-fund Retrieved 1st September 2022.

BHP. 2022. The future of BHP. https://www.youtube.com/watch?v = yc6pVlkbQqU Retrieved 12th September 2022.

Borrello, E. 2021. Andrew 'Twiggy' Forrest says red tape cost WA big hydrogen project. ABC News. https://www.abc.net.au/news/2021-10-14/why-wa-missed-out-on-twiggy-s-first-big-hydrogen-project/100539976.

Bridge, G., and E. Faigen. 2022. "Towards the Lithium-ion Battery Production Network: Thinking Beyond Mineral Supply Chains." *Energy Research & Social Science* 89: 1–19. doi:10.1016/j.erss.2022.102659.

Britt, A. F. 2021. Australian Critical Minerals Map 2021. Geoscience Australia, Canberra. Distributed under Creative Commons Attribution 4.0 International Licence. https://doi.org/10.26186/146350.

Brockhaus, S., S. E. Fawcett, S. Hobbs, and A. S. Schwarze. 2019. "Boldly Going Where Firms Have Gone Before? Understanding the Evolution of Supplier Codes of Conduct." *The International Journal of Logistics Management* 30 (3): 743–771. doi:10.1108/IJLM-02-2018-0043.

Castree, N. 2017. "Speaking for the 'People Disciplines': Global Change Science and its Human Dimensions." *The Anthropocene Review* 4 (3): 160–182. doi:10.1177/2053019617734249

Chandrashekeran, S. 2021. "Rent and reparation: how the law shapes Indigenous opportunities from large renewable energy projects." *Local Environment* 26 (3): 379–396. doi:10.1080/13549839.2020.1861590.

Chang, L. K. 2023. Sidang media YB Chang Lih Kang mengenai isu Lynas. https://www.facebook.com/changlihkang/videos/1499103123917341/.

Connell, J., and R. Howitt. 1991. *Mining and Indigenous Peoples in Australasia*. Sydney: University Press in association with Oxford University Press.

CSIRO. 2022. Critical Energy Minerals Roadmap. https://www.csiro.au/-/media/Do-Business/Files/Futures/Critical-energy-minerals-roadmap/21-00041_MR_REPORT_CriticalEnergyMineralsRoadmap_WEB_210420_text_version.txt Retrieved 7th September 2022.

Dahlgren, K. 2019. "Blaming in the Boom and Bust: Greed Accusations in an Australian Coal Mining Town." *Cambridge Anthropology* 37 (2): 90–109. doi:10.3167/cja.2019.370207.

Dyatkin, B. 2020. "COVID-19 Pandemic Highlights Need for US Policies That Increase Supply Chain Resilience." *MRS Bulletin* 45 (10): 794–796. doi:10.1557/mrs.2020.258.

Ellem, B. 2015. "Resource Peripheries and Neoliberalism: The Pilbara and the Remaking of Industrial Relations in Australia." *Australian Geographer* 46 (3): 323–337. doi:10.1080/00049182.2015.1048587.

Encyclopaedia Britannica. 2022. Graphite. https://www.britannica.com/science/graphite-carbon.

European Commission. 2023. Critical Raw Materials: ensuring secure and sustainable supply chains for EU's green and digital future. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1661.

Fernyhough, J. 2022a. Rare Earths Producer Lynas Attacked by China-linked bots. Sydney Morning Herald, August 27 2022. https://www.smh.com.au/world/asia/rare-earths-producer-lynas-attacked-by-china-linked-bots-20220827-p5bd7l.html?btis Retrieved 1st September 2022.

Fernyhough, J. 2022b. Hydrogen Could Replace Coking Coal in Two Decades, South32 Says. Bloomberg, August 25 2022. https://www.bloomberg.com/news/articles/2022-08-25/hydrogen-could-replace-coking-coal-in-two-decades-south32-says Retrieved 1st September 2022.

Ford, A. 2022. Mineral Potential: Narrowing the Exploration Search Space. Presentation in Exploring for the Future Showcase 2022, Geosciences Australia. https://www.youtube.com/watch?v = DjghAig51Ao.

Fortescue Future Industries. 2022. Leading the Global Energy Transition. https://ffi.com.au/about/ Retrieved 13th September 2022.

Geoscience Australia. 2023. Australian Mineral Facts. https://www.ga.gov.au/education/classroom-resources/minerals-energy/australian-mineral-facts.

Gibson, C. 2022. "Regional Futures in Crisis: Lived Experience and the Generative Role of Intermediaries." *Australian Planner, Ahead-of-Print(Ahead-of-Print)*, 1–12. doi:10.1080/07293682.2022.2105916.

Glencore. 2022. untitled [advertising video]. https://www.facebook.com/GlencoreAUS/videos/1540885066327485/ Retrieved 1st September 2022.

Heffron, R. J. 2020. "The Role of Justice in Developing Critical Minerals." *The Extractive Industries and Society* 7 (3): 855–863. doi:10.1016/j.exis.2020.06.018.

Herod, A., G. Pickren, A. Rainnie, and S. McGrath Champ. 2014. "Global Destruction Networks, Labour and Waste." *Journal of Economic Geography* 14 (2): 421–441. doi:10.1093/jeg/lbt015.

Hine, A., R. Mayes, and B. Hurst. 2022. "The Finch in the Coal Mine: Interrogating the Environmental Politics of Extinction Narratives." *Geographical Research* 60 (4): 521–533. doi:10.1111/1745-5871.12560.

Hofstra, A., V. Lisitsin, L. Corriveau, S. Paradis, J. Peter, K. Lauzière, C. Lawley, et al. 2021. *Deposit Classification Scheme for the Critical Minerals Mapping Initiative Global Geochemical Database*: U.S. Geological Survey Open-File Report 2021–1049, 60 p. https://doi.org/10.3133/ofr20211049.
Howitt, R., J. Connell, and P. Hirsch. 1996. *Resources, Nations and Indigenous Peoples*. Melbourne: Oxford University Press.
International Mining and Resources Conference. 2022. Why Lithium? European Lithium (ASX: EUR). https://www.youtube.com/watch?v = QLzb5ZKavrI&list = PLXrhyWorqYQDTcU42YtEQ_HI-NTyjnlAb&index = 41&ab_channel = InternationalMiningandResourcesConference.
Kalantzakos, S. 2017. *China and the Geopolitics of Rare Earths*. New York, NY: Oxford University Press.
Kalantzakos, S. 2020. "The Race for Critical Minerals in an Era of Geopolitical Realignments." *The International Spectator* 55 (3): 1–16. http://dx.doi.org/10.1080/03932729.2020.1786926.
Kelley, K. D. 2020. *International Geoscience Collaboration to Support Critical Mineral Discovery*: U.S. Geological Survey Fact Sheet 2020–3035, 2 p. https://doi.org/10.3133/fs20203035.
Kelley, D. K., D. L. Huston, and J. M. Peter. 2021. Toward an Effective Global Green Economy: The Critical Minerals Mapping Initiative (CMMI). SGA News, March 2021, no.48. https://e-sga.org/fileadmin/sga/newsletter/news48/SGANews48_low.pdf.
Klinger, J. M. 2015. "A Historical Geography of Rare Earth Elements: From Discovery to the Atomic age." *The Extractive Industries and Society* 2 (3): 572–580. doi:10.1016/j.exis.2015.05.006.
Kumar, A. 2022. "Energy Geographies in/of the Anthropocene: Where Now?" *Geography Compass* 16 (10). http://dx.doi.org/10.1111/gec3.v16.10.
Lawley, C. J. M., A. E. McCafferty, G. E. Graham, D. L. Huston, K. D. Kelley, K. Czarnota, S. Paradis, et al. 2022. "Data–Driven Prospectivity Modelling of Sediment–Hosted Zn–Pb Mineral Systems and Their Critical raw Materials." *Ore Geology Reviews* 141: 1–23. doi:10.1016/j.oregeorev.2021.104635.
Lobo, M., and A. Hine. 2022. "Storying Strata: Entangling Coal and Energy Futures in Australia and India." *Geopolitics* 28 (2): 490–512. doi:10.1080/14650045.2022.2040485.
Macdonald-Smith, A. 2022. HESTA Gives AGL, Santos Last Chance on Climate. Australian Financial Review, 6th September 2022. https://www.afr.com/companies/energy/hesta-gives-agl-santos-last-chance-on-climate-20220905-p5bfe4 Retrieved 13th Sept 2022.
Marsh, J. K. 2013. "Decolonising the Interface Between Indigenous Peoples and Mining Companies in Australia: Making Space for Cultural Heritage Sites: Indigenous Peoples and Mining Companies." *Asia Pacific Viewpoint* 54 (2): 171–184. doi:10.1111/apv.12017.
Martinus, K., and A. Nunez-Picado. 2022. *Accelerating Battery Industry Hub Development*. Perth: Future Batter Industries CRC.
Mayes, R., B. Hurst, and A. Hine. 2021. Understanding the Social and Political Stakeholder Environment of Contemporary and Future Mining: Delivering Tools for Navigating Multiple Perspectives. CRC ORE Project Report P4-010: Summary Report. https://eprints.qut.edu.au/212045/1/Summary_Report_reduced_size.pdf.
Melo Zurita, M. de L. 2020. "Challenging Sub Terra Nullius: A Critical Underground Urbanism Project." *Australian Geographer* 51 (3): 269–282. doi:10.1080/00049182.2020.1723829.
Melo Zurita, M. de L., and P. G. Munro. 2019. "Voluminous Territorialisation: Historical Contestations Over the Yucatan Peninsula's Subterranean Waterscape." *Geoforum; Journal of Physical, Human, and Regional Geosciences* 102: 38–47. doi:10.1016/j.geoforum.2019.03.019.
Nagar, A. 2021. "The Juukan Gorge Incident: Key Lessons on Free, Prior and Informed Consent." *Business and Human Rights Journal* 6 (2): 377–383. doi:10.1017/bhj.2021.18.
Nel, A. 2015. "The Choreography of Sacrifice: Market Environmentalism, Biopolitics and Environmental Damage." *Geoforum; Journal of Physical, Human, and Regional Geosciences* 65: 246–254. doi:10.1016/j.geoforum.2015.08.011.
NIAA. 2023. Land and Housing. https://www.niaa.gov.au/indigenous-affairs/land-and-housing#:~:text = Aboriginal%20and%20Torres%20Strait%20Islander%20peoples'%20rights%20and%20interests%20in,cent%20of%20Australia's%20land%20mass.
Pell, R. S., F. Wall, X. Yan, and G. Bailey. 2019. "Applying and Advancing the Economic Resource Scarcity Potential (ESP) Method for Rare Earth Elements." *Resources Policy* 62: 472–481. doi:10.1016/j.resourpol.2018.10.003.

Pini, B., and R. Mayes. 2012. "Gender, Emotions and Fly-in Fly-out Work." *The Australian Journal of Social Issues* 47 (1): 71–86. doi:10.1002/j.1839-4655.2012.tb00235.x.
Pini, B., P. McDonald, and R. Mayes. 2012. "Class Contestations and Australia's Resource Boom: The Emergence of the "Cashed-up Bogan."." *Sociology* 46 (1): 142–158. doi:10.1177/0038038511419194.
Protect our Water Alliance. 2022. Dendrobium Bites The Dust – South32 Cancels Expansion Plan. https://protectourwateralliance.org/2022/08/26/dendrobium-bites-the-dust-south32-cancels-expansion-plan/ Retrieved 1st September 2022.
Razaghi, T. 2022. "The Green Energy Mineral Towns that Could Fuel their Own Property Booms." *Sydney Morning Herald*. April 22 https://www.smh.com.au/property/news/the-green-energy-mineral-towns-that-could-fuel-their-own-property-booms-20220420-p5aerx.html?btis.
Royal Society of Chemistry. 2022. Periodic Table. https://www.rsc.org/periodic-table/.
Sandiford, M. 2022. "3 The Net-Zero Opportunity for Australian Minerals." In *The Superpower Transformation: Making Australia's Zero-Carbon Future*, edited by Ross Garnaut, 143–161. Melbourne, Victoria: Black Inc.
Stringer, D., and T. Biesheuvel. 2022. BHP Abandons Thermal Coal Exit as Investors and Prices Shift. Bloomsberg news, 16th June 2022. https://www.bloomberg.com/news/articles/2022-06-16/bhp-scraps-exit-from-thermal-coal-as-investors-and-prices-shift#xj4y7vzkg Retrieved 12th September 2022.
Temple, J., and C. Crownhart. 2022. Here are the Biggest Technology Wins in the Breakthrough Climate Bill. MIT Technology Review. https://www.technologyreview.com/2022/07/28/1056531/technology-wins-breakthrough-climate-bill/.
Tonts, M., K. Martinus, and P. Plummer. 2013. "Regional Development, Redistribution and the Extraction of Mineral Resources: The Western Australian Goldfields as a Resource Bank." *Applied Geography* 45: 365–374. doi:10.1016/j.apgeog.2013.03.004.
Toole, P. 2022. Sourcing the Minerals and Metals of the Future. Media Release 6th September 2022. https://www.nsw.gov.au/media-releases/sourcing-minerals-and-metals-of-future.
White, I., C. Legacy, and G. Haughton. 2022. "Infrastructure in Times of Exception: Unravelling the Discourses, Governance Reforms and Politics in "Building Back Better" from COVID-19." *Environment and Planning. C, Politics and Space* 40, 1570–1588. doi:10.1177/23996544221094678.
Wilson, J., and K. Martinus. 2020. The Governance of Battery Value Chains: Security, Sustainability and Australian Policy Options. Future Battery Industries CRC. https://fbicrc.com.au/wp-content/uploads/2020/05/PU-141-Energy-Report-WEB.pdf.