MINERAL

FUTURE OBSERVATORY AT THE DESIGN MUSEUM
DESIGN RESEARCHERS IN RESIDENCE 2025/26

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AN INTRODUCTION

Abbie Adams

Sustaining hope in the face of hard truths is one of the many demands on those tackling the climate crisis. Design research, as a practice of reframing and reshaping the stories we tell, can help us do that. Stories, however, need a protagonist. In today's narratives around the 'green transition', many of the lead roles go to minerals.

At the heart of our transition from a fossilised system (in which emissions from cars, planes, power plants and industrial systems drive planetary warming) to renewable infrastructures sit sophisticated computational technologies, rechargeable batteries, data centres and silicon chips. This year's Design Researchers in Residence theme grew from questioning the push to simply 'swap' one set of characters – oil, coal and natural gases – for another: lithium, copper, silica and chalk.

'Indefinite growth … cannot be sustained by finite resources.'[1] This fact has not changed just because the resources have changed. The perversity of trying to fix problems caused by extracting and consuming non-renewable resources at great environmental and social cost by extracting and consuming non-renewable resources is an under-explored paradox. This year's theme is, in part, an attempt to re-centre this knowledge in the stories we tell ourselves and each other.

From kaolin pits in Cornwall to silica mines in Northern Scotland, the UK's geological landscape bears the scars of centuries of mineral extraction. These scars are often framed as part of a shared industrial heritage: technical ingenuity, dignified labour and economic development. But the contemporary frontiers of extraction have long been displaced elsewhere. The physical and ecological costs of sustaining our lives, and enabling a green transition facilitated by technological advances, are borne at a distance.

If you were to travel to the point where northern Chile meets southern Peru and western Bolivia, you would arrive at the Salar de Atacama, where fossilised brines[2] hold 75% of the world's known lithium resources and, deep in the Earth's crust, 27% of its copper. These are the minerals necessary for most electric batteries and the circuitry in solar panels. Here, you would find a stark warning: landscapes, ecosystems and societies devastated by rapacious extraction.

Today, in an increasingly unstable geopolitical context, resources such as lithium, copper and water are in the spotlight. The possibility of new extractive industries emerging closer to home is no longer remote. In the UK, the International Energy Agency estimates that by 2040 the demand for critical minerals will be four times greater than today. These minerals took even longer to form[3] and are often rarer and more destructive to extract than the coal, oil and gas we are trying to escape. Yet the dominant conversation is about assets and markets, rather than long-term sustainability, renewal and strategies for innovating beyond extraction.

This book aims to resist that simplification by telling mineral stories. This year's Design Researchers in Residence ask: should the green transition be sustained through the continued extraction of finite resources?

Alfred Yatlong Yeung leads us to a village in Cornwall living in the shadow of a reopened china clay pit, with lithium extraction on its horizon. For his field research, he cycled through this once industrial landscape, listening to local voices speaking about the cultural and emotional realities of reopening a mine. His research creates space for local voices and maps collective histories and possible futures.

Elise Limon transports us to an energy island off the north coast of Wales, where she walked trails stained violet by copper, where heather remediates once-mined land. Her research asks what it would mean to return to these extractive landscapes – to dig again at Parys Mountain. Reading that landscape, she reframes copper within its full human and non-human entanglements – craft, ecology and time.

Rafael El Baz brings us to a coastal city in North East England, once central to British glass production. He traces its lost industry to the country's silica capital, where vast quantities of glass waste await transformation. His research looks at the fragmented supply chains and challenges the 'purity' of transparent architecture. What happens when a country stops making things?

Rosa Whiteley guides us to a pond resting atop a vast chalk aquifer, a hidden cathedral of freshwater that has been mapped, financialised and now polluted by the privatisation of water. Her research traces the whole water system: groundwater to chalk streams, wet weather to morning dew. Puddles become a tool for community resilience, a dance where humans, amphibians and others co-create ecological resistance.

Since the de-industrialisation and privatisation of the UK in the 1980s and '90s, the material foundations of our everyday lives have become obscured. Thirty-six years later, the prospect of re-industrialisation raises unresolved questions. This body of research is an invitation to reconsider minerals as matter embedded in deep time and complex eco-social relationships. The question is not simply how to extract again but whether we should and under what terms.

So, how can design research help us better understand the UK's dependence on minerals? Each of these projects returns to hope: through community consultation, counter-infrastructure, an abundance of waste redefined and ecologies that are repaired by life. Sustaining hope is not about clinging to an illusion of infinite substitution. It is about cultivating new relationships grounded in reciprocity and remediation, and new narratives that honor the limits and costs of our material dependencies. In this way, design research becomes not just a tool for imagining what comes next but a practice for reshaping how we relate to the world beneath our feet.

1 Edward Goldsmith et al. (*The Ecologist*), *A Blueprint for Survival* (Harmondsworth: Penguin Books, 1972).

2 Lithium brine is a highly concentrated saline groundwater found deep underground. It is considered 'fossilised' because it is trapped in closed aquifers and has been accumulating minerals over thousands or even millions of years.

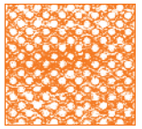
3 Ancient geological environments, which took millennia to develop, are frequently classified as financial resources rather than as an important part of our heritage and history. This abstraction allows for their transformation into units of value while negating the complex material and ecological relationships they embody.

MINERAL INDEX

What is a mineral?

In scientific terms, minerals are naturally occurring, inorganic solids. They are made of chemical elements arranged in regular, repeating patterns – known as crystalline structures – and form the building blocks for most of the Earth's crust.

Throughout human history, mineral compounds have been extracted from rocks and processed into everyday materials. The following index introduces the four mineral-based materials under investigation in this residency – lithium, silica, chalk and copper – and considers their relationship to the modern world.

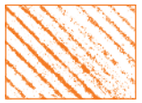


LITHIUM
Kaolinite – $Al_2Si_2O_5(OH)_4$,
Lithium Micas (e.g. Lepidolite and Zinnwaldite) –
$K(Li,Al)_3(AlSi)_4O_{10}(F,OH)_2$ and $KLiFeAl(AlSi_3O_{10})(F,OH)_2$

Kaolinite (also known as china clay or kaolin) is a very fine, powdery, bright-white mineral that absorbs water readily. It is widely used in ceramics, paints, paper coatings and cosmetics, and has become associated with the transition to low-carbon technologies.

Kaolinite forms through the gradual breakdown of minerals like feldspar and mica, both commonly found in granite. This process, known as kaolinisation, transforms hard igneous rock into a soft, clay-rich host for lithium-bearing minerals.

Cornwall, in South-West England, contains a significant proportion of the UK's kaolinised granite and has long been a centre of china clay production. Recently it has also attracted interest as a potential source of lithium – prompting plans to reindustrialise the region.

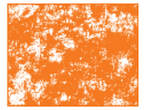


SILICA
Quartz – SiO_2

Quartz is the crystalline form of silicon dioxide and is colourless and transparent when pure. It is one of the most abundant minerals in the Earth's crust and has a wide range of applications: from electronics and construction to glassmaking and jewellery.

Quartz forms through a variety of geological processes, including the crystallisation of molten rock. Over time, this quartz-rich rock is worn down by wind and water and silica-rich sand is produced.

Sand-derived silica is a key raw material in the production of glass. In the UK, industrial centres like Sunderland have become closely associated with glassmaking and techniques that have shaped modern manufacturing practices around the world.

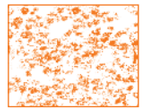


CHALK
Calcite – $CaCO_3$

Calcite is a very soft mineral with a pearly white or transparent appearance. As one of the most common minerals on the planet, it forms the basis of many recognisable geological features (including stalactites and stalagmites) and is a key component in the structure of many marine creatures.

Most calcite is produced by plankton (coccolithophores), which extract calcium and carbonate from sea water to make exoskeletal plates. When these organisms die, their remains accumulate on the ocean floor and, over millennia, become compressed into sedimentary rocks like limestone and chalk.

Chalk is the foundational geology of southern and eastern England and has shaped those landscapes, ecologies and water systems, including a significant proportion of the world's chalk streams, which provide vital habitats for wildlife and important sources of freshwater.

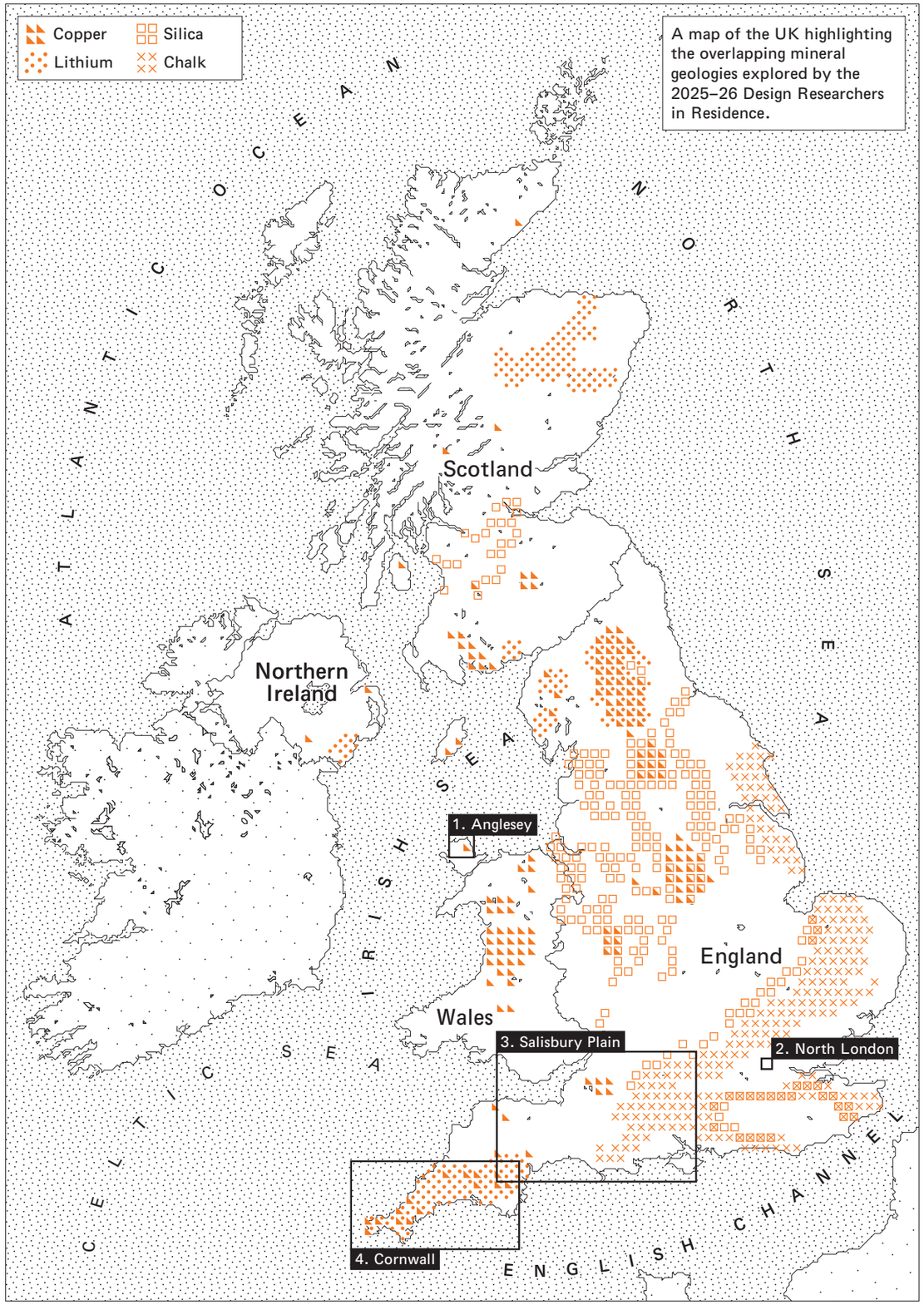


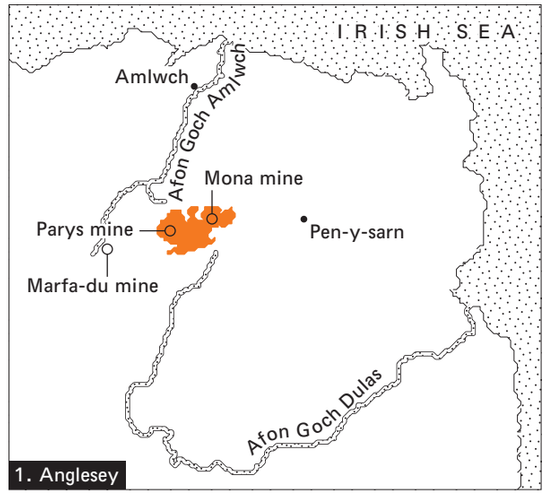
COPPER
Chalcopyrite – $CuFeS_2$

Chalcopyrite is a primary copper ore and one of the most important copper-bearing minerals on Earth. Its brassy yellow appearance resembles gold until the mineral is exposed to air, when it develops an iridescent blue-green film.

Chalcopyrite typically forms under high temperatures, when mineral-rich fluids deposit copper, iron and sulphur into the Earth's crust. Over geological timescales, these deposits concentrate as ores in rock formations and can be mined and refined for copper.

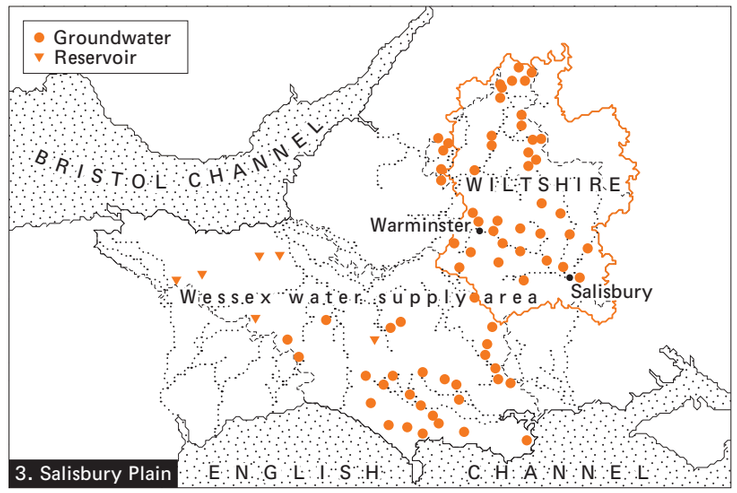
During the 18th century, deposits at Parys Mountain in Anglesey (Wales) became one of the largest copper mines in the world. The availability of this resource was a significant driver of the Industrial Revolution and its extraction has left an indelible mark on the surrounding landscape.



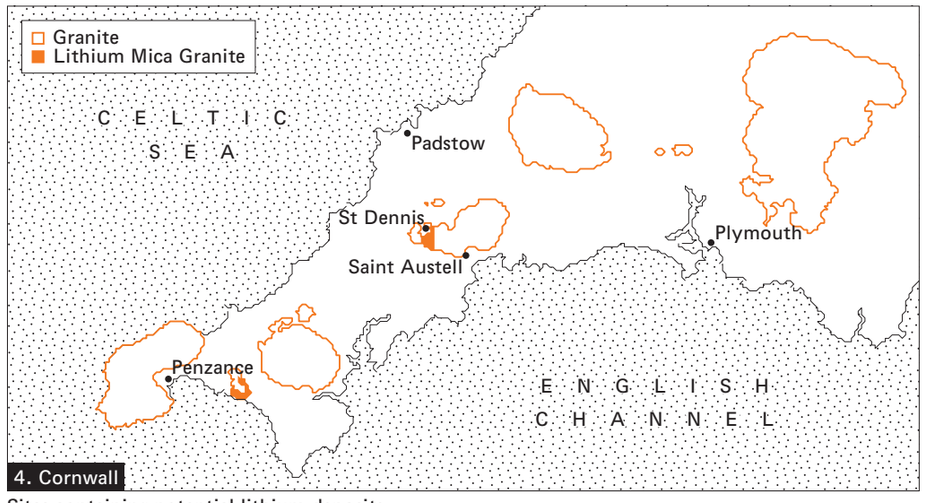


Former copper mining sites

Glass production and potential silica waste streams



Wessex Water supply area



Sites containing potential lithium deposits

L–R: Alfred Yatlong Yeung, Rosa Whiteley, Elise Limon and Rafael El Baz

A NEW KIND OF LANDSCAPE

A conversation between Janice Li and the Mineral cohort (Alfred Yatlong Yeung, Rafael El Baz, Rosa Whiteley and Elise Limon)

JL It's a pleasure to sit down with you all.

Looking at your work, I'm struck by how this year's theme has fostered such a coherent cohort. While your projects each anchor themselves in a specific mineral or material, they seem to share a common pulse. To start us off – what drew you to your respective minerals?

RW I thought chalk fit well with the brief because we're sitting on top of its water-saturated minerals all the time; they guide how we manage our lives.

I think I'm drawn to exploring ideas through minerals because I've thought a lot about metabolism and how we metabolise our environments. I've found it useful to follow, say, how calcium flows through bodies of water and aquifers to better understand issues like water contamination and privatisation. I think that stems from my background in food research, which involved reading ecologies through digestion.

JL In one of our earlier conversations, you described yourself as having been a 'thinking' (or external) researcher in previous projects, but there's a lot of 'you' in this particular one. It draws on your personal, embodied understanding of the landscape in a way that an external researcher would not be able.

RW Yeah. Lately, I have been questioning what it means to be 'fully in' an environment – to digest or be digested by it. In the past I mostly engaged from a distance but, increasingly, I am trying to work through place-based politics on the ground.

Southern England is a really complex place – both politically and ecologically – and having grown up there, its chalky landscapes have definitely imprinted on me.

Currently, I am going through a process of finding fascination in the things we consider mundane; and that includes paying closer attention to all the weird and wonderful complexities of the place I'm from.

JL That tension between the objective and the subjective is so central to place-based work. The findings may be presented in academic language but beneath them is a person whose unique way of observing and interacting shapes the output.

Alfred, you have also been very present in your site work. What was it that originally pulled you toward Cornwall and lithium mining?

AYY Before the residency began, I was working on a project about Welsh slate quarries and the connection between loss of industry and cultural identity. With its imminent mining resurgence, I became curious about Cornwall; would it experience something similar, or is that too simplistic a way to think about it?

I focused on lithium, though that's not actually a mineral – is it? It's a chemical element – an alkali metal – that's classed as a 'critical mineral' in political language. We'll be extracting lithium domestically, and I was compelled to see how this would materialise in comparison to Latin America's 'Lithium Triangle'. As an architect, I am well-versed in planning and want to see how effective it can be here; where are the holes and how can we, as designers, begin to plug them?

JL During the final crit, we spoke about the power of 'unlearning' and how the foundational ethic of conducting research is having the honesty to listen to what our findings are telling us. I think everyone here has been brave enough to do that and let it redirect the trajectory of their projects.

AYY I talk a lot about assumptions – the assumption that locals would be happy that mining is returning; the assumption that Cornwall would experience a reclamation of cultural identity … The reality is counter-intuitive.

As a designer, you always try to be propositional, but the magnitude of my research area is overwhelming – especially when the landscape is caught up in national centre-vs-periphery affairs and international geopolitics.

I realised there was a clear limit to what was achievable during the residency, so I paced myself and focused on evidence gathering (and developing better ways to do this). That was one of the reckonings after speaking with people on the ground.

JL You mentioned seeing how loss of industry transitioned into loss of identity – I think that's very similar to something you, Raf, have been realising?

REB Yeah, I first came to the residency with a waste stream and a material (glass) I wanted to play around with. But as I started investigating the wider landscape, it quickly became more complex and far-reaching.

The loss of industry in England is entangled with communal pride and politics and that was quite an unexpected turn for the project. Like Alfred, I had to slow down the pace, allow myself to move towards the story and be drawn to places I wouldn't normally go.

You can read a book or watch a video but it's not the same as being on the ground. By going to a factory, you're actually 'in the heat': seeing things change state and get created or destroyed.

JL Your initial proposal – focused on material exploration and scaling – was a solid design research project and many would have encouraged you to stay within those boundaries. But all of you seem to be redefining what design research can be.

As a designer, how have you married your interest in materials with a concern for community?

REB My interest in 'waste' comes from a curiosity about why we overlook certain things and how we could revalue them.

Had I just continued doing material sampling, I might've ended up with something beautiful or functional. But having a clearer understanding of people and place has helped me move towards an output that could have genuine cultural caché and value to the wider world.

It's actually quite hard to make something of value without the frames of social

and cultural context. There are ways around this, but I think the research has to be based in a location so it can take up residence there.

JL This focus on place and community is similar to that which you, Elise, explored on your recent research trip.

It seemed to tie together your earlier socio-cultural surveys and your understanding of copper's botanical entanglement with metallophytes. How did that happen?

EL My previous projects involved starting with a single material or site, from which I expanded out a set of research questions. In this case, I began with copper – in particular, its presence in certain plants – and that enabled me to explore a place, Anglesey in Wales, that has been deeply affected by mineral extraction.

This has resonated far beyond my research site, as it brings together so many different people: geologists, ecologists, artists and mining companies. Trying to articulate and make sense of those relationships has been a key part of my process.

JL I think all of you have been navigating various relationships and disciplines and I know you're still in the process of figuring out your role(s).

How would you define the potential of a design researcher within these ecosystems?

EL I think it comes down to storytelling.

We're all using one mineral to talk about other things: Raf's looking at silica to talk about waste and mainstream manufacturing; Rosa's using chalk to talk about water supply and politics and Alf's looking at lithium to talk about different communities' relationships with planning and policy.

As people who work with physical objects and aim to make things visible, there's a role we can play in visualising the things we learn from others. We can use our design skills to convey narratives in ways that reveal new things or complicate existing systems.

RW I think it's also about having agility with scale, whether that's focusing on a plant that reflects a wider mining industry or on a microorganism that has supported the creation of an entire geology.

Design research has the ability to connect the dots. Once you've identified all the different ways a landscape has been designed, or treated as a design object, you can begin to find ways to counter it. That's where the exciting propositional stuff happens: thinking about counter infrastructures; alternative forms of governance and a material and manufacturing transition.

AYY Another dimension is time – not just human-scale, but extending into geological time. In my project, that's involved looking at what came before lithium mining – china clay mining – and then what came before that.

Space becomes a container in which you see traces of different times coming together. Design research, and how we, as designers, were trained to develop collaborative ways of working, is well positioned to survey this.

REB I think we've all found, in different ways, that we've ended up becoming a nexus point for a lot of different people. We've created these webs that aren't achieved by

more standard research practices. And, though it might not be apparent immediately, this mapping is creating a new kind of landscape.

The assumptions we started with – that a community would be happy or unhappy; that something could or couldn't be done with a material – quite quickly disappeared on the realisation that a lot of it is about collaboration and willpower. It's more a question of whether you can bring the right people together with a shared vision. In a way, that is our job.

JL It's striking that you've all arrived at the same fundamental questions about collaboration and systemic change. To wrap up – as you look at the 'new landscapes' you're mapping, what gives you the most hope for how we might live differently?

EL Oil and fossil fuels have embedded energy-intensive patterns into the built environment that have become spatially solidified. Attempting to sustain those patterns through transitioning to solar, wind or other renewables risks leaving those underlying structures intact. So, more than that, we need to question the way we live; where are we getting our water from? Why do our windows look the way they do?

The implications of these questions, and the implementation of a genuinely sustainable and just transition, suggests not simply a shift in fuel but a reconfiguration of everyday life. That may involve a degree of discomfort, of slowing down, of accepting less-than-immediate access and a redistribution of resources.

But ultimately, it also presents us with a huge opportunity.

Alfred
Yatlong Yeung

Alfred Yatlong Yeung is an architect, researcher and writer. Through ethnography and co-design, his practice explores the juxtaposed cultural identities resulting from extractivism and the market-led drive for environmental sustainability. His heritage-focused approach is informed by his MPhil in Architecture and Urban Design (University of Cambridge) and his work on projects including a shortlisted proposal for the British Museum. Alfred's writing has been published in *The Architectural Review*, *Architects' Journal* and *Open City*, among others. He is an alumnus and mentor at the New Architecture Writers programme and was shortlisted for AJ100 New Talent (2025).

A LITHIUM HORIZON

Responding to the UK Government's Critical Mineral Strategy, which projects a 1100% increase in demand for domestic lithium by 2035, Alfred's research investigates the Cornish mining revival. He interrogates the tensions around reindustrialising a post-industrial landscape, focusing on Trelavour: a decommissioned china clay mine soon to be repurposed for lithium extraction, where mining heritage, renewable energy infrastructure and future extraction are all enmeshed. Fusing ethnography and co-design, his research culminates in a three-dimensional atlas of oral histories, active usage and local hopes – an invitation to see past mines as rich social terrains, and future mines as opportunities for planning authorities to nurture resilience.

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1 Lithium-ion battery

2 Kaolinite sample

3 Lepidolite (lithium-bearing mica)

A LITHIUM HORIZON: What does reopening a mine mean?

Alfred Yatlong Yeung

What does reopening a mine mean?

It is 6am. You climb out of your bed to make a brew in the dimly lit kitchen. As you crack open the window, a cool morning breeze strolls in. Steam rising from the kettle's spout veils the sage-coloured peaks in the near distance. This is the same view your great-grandparents had from their house, framed neatly by the landscape windowpane. A century ago, however, the two mountains were bone-china white – and artificial.

Lithium, a metal fundamental to electrical engineering and renewable energy storage, is highly sought after worldwide. To support the green transition, the UK 2025 Critical Minerals Strategy projects a 1100% increase of domestic lithium demand by 2035, a substantial portion of which is to be produced locally in Cornwall.[1] Six mining companies are currently carrying out explorations and pilot projects in the country's southernmost county, hoping to revive its long-dormant mining industry.[2]

The principal area for lithium extraction is in 'clay country' just north of St Austell in mid-Cornwall. This 40km^2 open pit mining[3] region historically produced kaolin, a form of decomposed granite.[4] Technological advancements allow lithium-rich mica – commonly found in the local granite and previously considered clay mining waste – to be processed into the lithium hydroxide and lithium carbonate essential for making lithium-ion batteries. This mining renaissance poses an unprecedented social challenge, in which a long heritage and an uncertain future are inextricably intertwined.

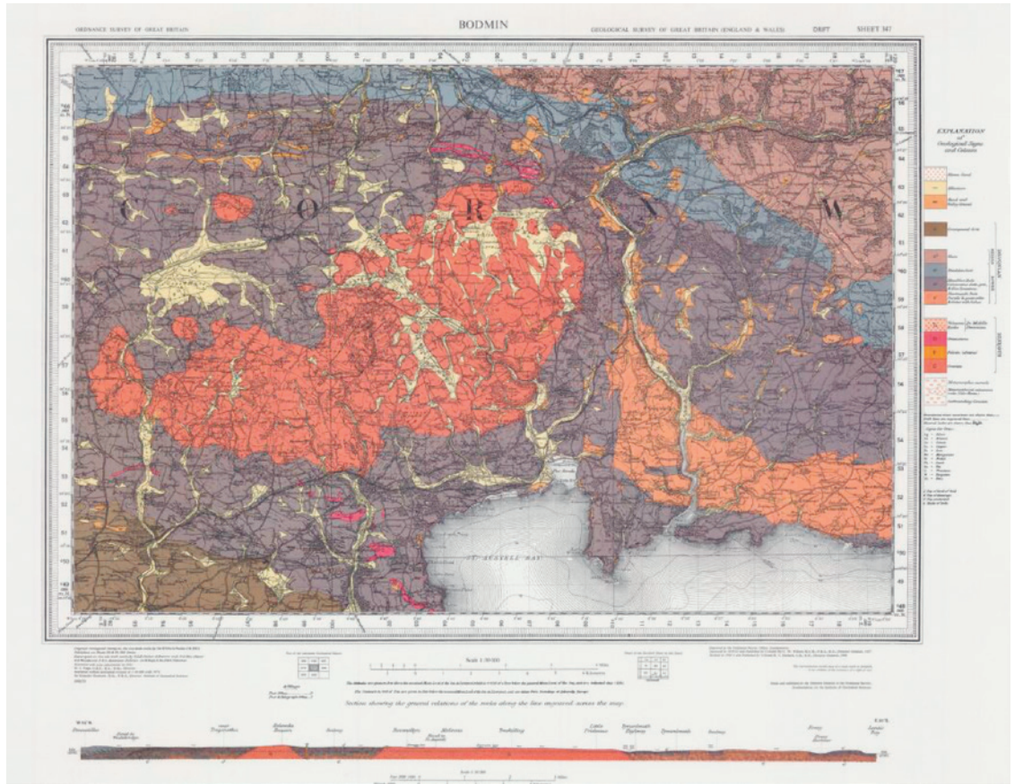
The general decline of mining in Cornwall from the late 19th century concluded with the closure of its last tin mine, South Crofty, in 1998. 200km^2 of former industrial sites (with a selective focus on tin and copper mining from 1700–1914[5]) were designated as a UNESCO World Heritage Site in 2006. Tourism replaced mining as the key industry in Cornwall. Clay country, however, received no such consideration.

Having peaked in the 1990s,[6] the china clay industry that once employed over 4,000 workers is at roughly one-quarter of its former size[7] [8] – down from over 100 working pits in the 1870s to just five today.[9] Great parts of the region have tentatively entered a post-industrial stage, and dormant extractive landscapes have acquired socio-cultural meaning beyond extraction.

In former mining settlements including St Dennis, St Stephen, Stenalees, Nanpean and Foxhole, more than 30,000 occupants have formed a multitude of new relationships with the post-industrial clay landscape.[10]

Fondly referred to as the 'Cornish Alps', the conical white waste heaps carry profound cultural significance despite receiving no statutory protection. In 2014 a slag heap – the iconic 1936 Great Treverbyn Tip – was rescued from being flattened after a successful local campaign.[11]

On the edge of the village of St Dennis, the pair of conical waste tips nicknamed 'Flatty' and 'Pointy' have stood for over a century.[12] Vegetation has taken over their surfaces,



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4 Geological Survey of England and Wales, The St Austell granite bedrock illustrated in pink (Bodmin sheet), 1973

5 St Dennis Village (photograph displayed at the local community centre)

6 Trelavour clay pit looking north, 1940

re-wilding the man-made piles into 'natural' mountains. The beloved landmarks have been a lifelong presence in the window frames of 3,000 residents,[13] and are even on the crest of the local primary school. They are now marked for demolition, to make way for lithium extraction.[14]

Rather than being merely an arrangement of matter under our feet, land is both nature and culture; there is no land without the imagined concept of land.[15] The legal protection conferred by designations such as 'Area of Outstanding Natural Beauty' or 'Area of Great Landscape Value' prioritise the aesthetic preservation of land in a picturesque tradition.[16] In 'Mineral Safeguarding Areas', however, where all surface developments that may negatively impact future mining are precluded, extraction is the priority. Designations like this impose an abstract economic value system onto a more-than-three-dimensional space.[17]

7 Trelavour Downs, St Dennis (nature-claimed clay works), 1983

Terra nullius, or 'nobody's land' was a colonial justification for land seizure. To see a land as empty of existing societies and meanings is to legitimise its co-option for economic extraction. The town planning system and the mining industry treats mid-Cornwall as a 'dynamic landscape'.[18] This implies that, because millions of tonnes of rocks were continuously displaced in the 19th and 20th centuries, the same can be done in the present – after a decades-long gap – without any serious socio-cultural impact. The administrative designation of 'dynamic landscape' can therefore be read as analogous to the violent *terra nullius*.[19]

The post-industrial clay country is not a *terra nullius* but an extensive landscape in active use by many communities. From skiing, biking or trail walking down a waste tip (now: mountain) to canoeing in a flooded pit (now: lake). Permitted informal use and trespassing have historically blurred the boundaries between natural and artificial,[20] and refashioned inactive clay mines into community backyards. Labelling landscapes like those in clay country 'industrial',[21] overlooks the fact that people have been living on, looking at and playing in the dormant post-industrial space for decades.

In her studies of Indigenous land rights, academic Jillian Walliss draws a distinction between the 'right to land' and the 'right to landscape'.[22] The former refers to legal property ownership, the latter speaks of social use value. Applying this concept to Cornwall and to the reopening of mines in the clay country, the limits of a town planning system originally designed to deter ill-conceived developments in cities become apparent.[23]

Cornwall's mining resurgence under the green transition should be seen by local authorities and planning offices as a policy opportunity to reconcile a mining past and min-

ing future. It should be an opportunity to foster social confidence through genuine consultation with inhabitants, developing qualitative understandings of a 'landscape' (lived in by communities) instead of just 'land' (privately owned for economic extraction). If we get this wrong, the balancing act between private development and public good becomes unattainable in this mineral-rich but economically poor region.[24]

8 Adventure group canoeing at the flooded Hendra Clay Pit, ca. 2000

9 St Dennis Primary Academy's playing field

The lithium horizon is both literal and metaphorical. Reopening mines means re-industrialising a post-industrial landscape, where the pasts and futures of people, land and matter are impossible to disentangle. Our unique local question, therefore, is not whether we have the right resources, but if we have the political will. The UK's robust legal framework, strong civil society and design expertise means that we have a real opportunity to do mining – or re-mining – right. For the past century mineral extraction has been outsourced to the Global South: associated with soil contamination, water depletion, Indigenous community displacement and human rights violations. A stark example can be seen in the Latin American 'Lithium Triangle' between Argentina, Bolivia and Chile, a region hosting over 50% of the world's lithium reserves.[25]

But beyond avoiding the obvious ecological horrors, mining master planning needs to be carried out under renewed policy guidance – from new Supplementary Planning Documents to appropriate Section 106 Agreements – with an understanding that the landscape is more than just 'industrial'. With the right leadership, this process could be re-imagined as a landscape 're-design' operation. Our ambitions should not only be to generate biodiversity net gain through long-term restoration plans, but also to create immediate social-use benefits and community infrastructure: from new affordable housing to public spaces where people can continue to make meaning with this unique landscape.

1 Department for Business and Trade, 'Vision 2035: Critical Minerals Strategy', *GOV.UK*, 22 November 2025, https://www.gov.uk/government/publications/uk-critical-mineralsstrategy/vision-2035-critical-minerals-strategy.

2 Frances Wall and Eva Marquis, 'Briefing Note: Update on Critical Minerals in SW England', Critical Minerals Challenge Centre, May 2025, https://criticalmineralschallengecentre.co.uk/wp-content/uploads/2025/07/Update_on_Critical_Minerals_in_SW_England_Critical_minerals_Challenge_Centre_Brief_1.pdf.

3 Open pit mining extracts minerals directly from the ground surface via drilling and blasting, as opposed to underground mining, which involves tunnels and shafts.

4 Also known as 'china clay', kaolin is a soft, powdery white mineral used in porcelain, paper, paint, plastics, cosmetics and pharmaceuticals.

5 Cornish Mining World Heritage Site, 'The Cornwall and West Devon Mining Landscape World Heritage Site Management Plan 2020–2025', *Cornish Mining World Heritage*, n.d., https://www.cornishmining.org.uk/media/Conservation/Management%20Plan/PDFs/CM_WHS_Management_Plan_page_01-23.pdf.

6 Derek Giles, *Cornwall's White Gold: The Boom Years of the China Clay Industry in the 20th Century*, 1st ed. (St Austell, Cornwall: Wheal Martyn Trust, 2025).

7 Terry Macalister, 'Blow for West Country as 800 China Clay Jobs Go', *The Guardian*, 4 July 2006, https://www.theguardian.com/business/2006/jul/05/money.frontpagenews.

8 'Imerys in the UK | Imerys', *Imerys*, n.d., https://www.imerys.com/united-kingdom.

9 Derek Giles, *Cornwall's White Gold: The Boom Years of the China Clay Industry in the 20th Century*, 1st ed. (St Austell, Cornwall: Wheal Martyn Trust, 2025).

10 'Build a Custom Area Profile – ONS', accessed 3 March 2026, https://www.ons.gov.uk/visualisations/customprofiles/draw/.

11 Simon de Bruxelles, 'Cornish Fight to Save Slag Heaps from Eco Scheme', *The Times*, 19 June 2014, https://www.thetimes.com/travel/destinations/uk-travel/england/cornwall/cornish-fight-to-save-slagheaps-from-eco-scheme-vscxh288q2s.

12 These tips were formed around 1906 as part of the Trelavour Clay Works, which closed in 1940.

13 'St Dennis Parish', *Parish UK*, 2021, https://st-dennis.parish.uk/.

14 Cornish Lithium, 'Trelavour Lithium Project Consultation Booklet', 2026, https://cdn.sanity.io/files/rui0grfj/production/1bf40906fb37b-81527ba0a114355957bc880be2a.pdf.

15 The influential historian of urban planning and architecture André Corboz advocates for land to be read as a palimpsest: historical layers are always present in a landscape, though they may not be fully visible at first. See André Corboz, 'The Land as Palimpsest', *Diogenes* 31, no. 121 (1983): 12–34, https://doi.org/10.1177/039219218303112102.

16 The picturesque is an 18th-century Romantic ideal in which painterly imagery was projected onto the English landscape.

17 Paola Viganò and Tommaso Pietropolli, 'How Will We "Occupy" Space and Land? Counterprojects of Coexistence', in *Transcalar Prospects in Climate Crisis: Architectural Research in Re/Action*, ed. Jeffrey Huang, Dieter Dietz, Laura Trazic and Korinna Zinovia Weber (Zürich: Lars Müller Publishers, 2024).

18 Peter Whitbread-Abrutat, '"Landscapes in Limbo" – Cornish Claylands', *Future Terrains* (blog), 18 July 2018, https://futureterrains.org/landscapes-in-limbo-cornish-claylands/.

19 Compared to areas outside the clay country, a higher number of renewable energy installations, including wind turbines, solar farms and, in 2012, a highly controversial incinerator power plant, have been constructed or proposed within the region. The historical 'dynamism' of the clay country has been used to justify these planning decisions despite strong local opposition.

20 A considerable quantity of concessionary 'permissive paths' currently exists between and around inactive mining sites in the clay country.

21 The Historic Landscape Characterisations of the clay country are primarily classified as 'Industrial: Disused' or 'Industrial: Active'. Cornwall Council, 'Cornwall Council Interactive Map', 2026, https://experience.arcgis.com/experience/a3074c31108a43ada55e21e660bc043d/.

22 Jillian Walliss, 'The Right to Land versus the Right to Landscape: Lessons from Uluru-Kata Tjuta National Park, Australia', in *The Right to Landscape: Contesting Landscape and*

Human Rights, ed. Shelley Egoz, Jala Makhzoumi and Gloria Pungetti (London: Routledge, 2016), https://doi.org/10.4324/9781315237350.

23 The Planning Act 1947 established the foundation of the permissive planning system such that no automatic development right is given with land. See Barry Cullingworth, *Town and Country Planning in the UK* (London: Routledge, 2015).

24 Ministry of Housing, Communities and Local Government, 'English Indices of Deprivation 2025: Statistical Release', *GOV.UK*, 30 October 2025, https://www.gov.uk/government/statistics/english-indices-of-deprivation-2025/english-indices-of-deprivation-2025-statistical-release.

25 Rowan Halkes, 'Responsible Extraction in South America's Lithium Triangle', *British Geological Survey* (blog), 8 February 2024, https://www.bgs.ac.uk/news/responsible-extraction-in-south-americas-lithium-triangle/.

RESEARCH DIARY 2025/26

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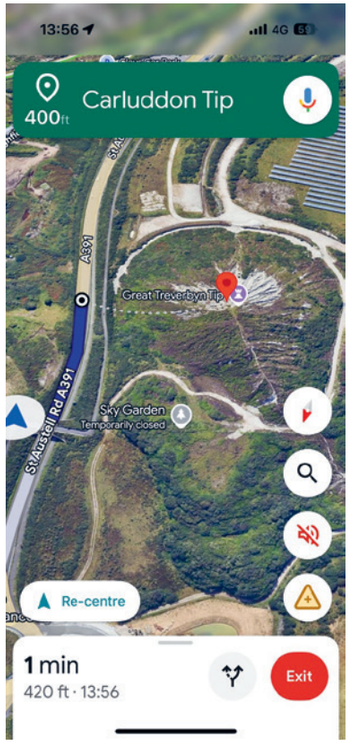

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1 The Great Treverbyn Tip seen from St Austell

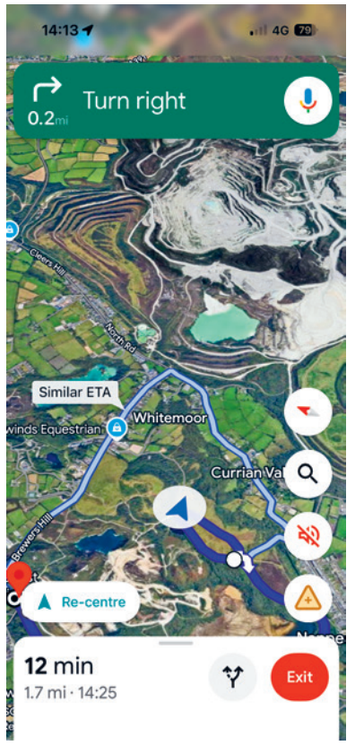
2 The Gunheath Tip seen from a quiet country road. Greensplat, Cornwall

3 Google Maps sat-nav route to the Great Treverbyn Tip

4 A stream turned white by china clay run-off after heavy rain. Ruddlemoor, Cornwall

5 The turquoise, flooded Blackpool Pit. Blackpool Lake, Cornwall

6 Author's gravel bike and the twin peaks 'Flatty' and 'Pointy'. St Dennis, Cornwall



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7 Google Maps non-functioning sat-nav route to St Dennis via permissive paths around the shut Trelavour Clay Works

8 Granite fireplace in the home of a former china clay worker. St Austell, Cornwall

9 The 2017-installed controversial incinerator dwarfing houses in St Dennis

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10 Cows feeding under the Gunheath Tip, photograph taken while the author was getting a lift home

11 Allen (pseudonym), the dog observing a community workshop in a historic pub-turned-home in St Dennis

12 A 1907 Ordnance Survey map brought to a community workshop at the community centre in St Dennis by participants

1 View from the hilltop of St Dennis village, formerly china clay, now lithium pilot production facilities in the distance

BEYOND THE LITHIUM HORIZON

A conversation between Alfred Yatlong Yeung and Jamie Hinch

In this discussion, Jamie Hinch (JH), a human geographer at the University of Oxford, and I reflect on our respective fieldwork in St Dennis; a Cornish village on the edge of a former china clay mine. Shut after WWII, Trelavour pit is poised to reopen in 2029 but, this century, the focus is on a different mineral: lithium.

JH Every week I see articles about the promises of lithium exploration in Cornwall, but would you agree that none seem to tell a full, grounded, human story?

AYY I work with heritage buildings to retain and adapt them to urban life. So, reading about extraction returning to an area which has mining at the heart of its history, I initially thought lithium mining would be widely welcomed locally: a continuation of generational identity and livelihoods. Once I began my fieldwork, it quickly became apparent the reality is much more nuanced. I had to 'unlearn' a lot before really learning about what lithium mining means in the clay country.

2 Photograph of the sky tip 'Pointy' marked for demolition, 2024

JH I think of it as the 'phoenix from the ashes narrative', where critical minerals extraction arrives as a potential economic, political, social, environmental and even spiritual saviour ... this was really what started my doctoral research four years ago; the absence of research into how Cornish communities actually feel.

Throughout my fieldwork, it was explained to me that lithium mining is controversial here because of the changes it might cause to the landscape.

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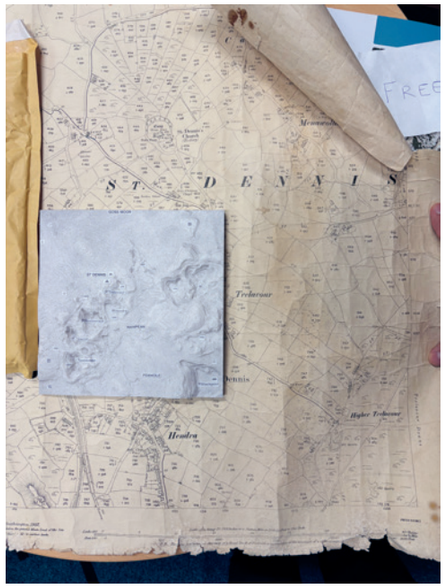

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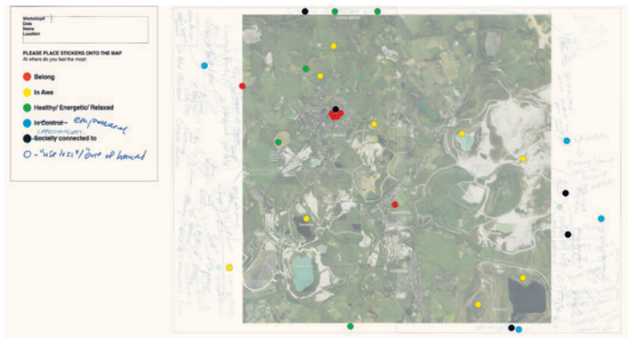

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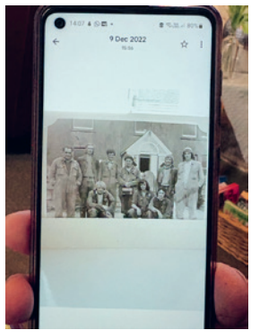

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3 Photograph of the co-authors' campervan and bike during a brief meeting in St Dennis, 2026
4 Photograph of a handheld topographic model and a 1907 Ordnance Survey map of St Dennis brought to the co-design workshop by a participant, 2026
5 Collated digital scans of co-design workshop mapping exercises, 2026
6 Photograph of a digital album brought to the co-design workshop by a participant, 2026
7 Photograph of an album brought by a workshop participant showing a now-decommissioned china clay pit when it was in operation, 2026

AYY When you think that mining history is so celebrated in Cornwall, it's interesting that the past – the 'heritage' of sky tips like Flatty and Pointy, which are prime examples of clay mining remnants – was in fact *why* some in St Dennis are so against lithium mining.

From afar, one is tempted to read the locals as simply polarising historical clay mining and future lithium mining along 'old is good, new is bad' lines. But, for many, even the historic clay mining is perceived in terms of damage to the earth, pollution and destruction. So an old, healed wound is seen as being ripped open again.

Their recognition of mining as heritage yet not wanting it to happen again was a humbling discovery for me. It made me rethink the meaning of a heritage untainted by nostalgia and, ultimately, what a sensitive, responsible mining masterplan would really look like.

That's the designer in me speaking. Can you tell me how your background in human geography informed your approach to researching in St Dennis as an 'outsider'?

JH My approach is a long-term fieldwork method: a deep dive into a certain place and issue, while allowing for open-endedness around what emerges as important to the community.

In January 2024 I set off for the clay country – in my bright blue campervan – and lived there for the following nine months or so. I met a lot of people by spending time at the pub and the community centre, ClayTAWC. The manager, Kerry, was a 'gatekeeper' for me; people trusted me way more because of my closeness with her.

AYY I like that you mentioned your mode of transport. I similarly think my decision to travel around the clay country by bicycle was beneficial, in both forming my own personal relationship with the landscape and in encouraging people to open up to me. I'm so apparently not from the clay country, but when I turned up soaking wet after cycling in the rain to the village people were more trusting of my intentions and willing to strike up conversation with me.

JH I did warn you it rains a lot! Can you tell me about your architectural research methods?

AYY My design-led research approach is very much about asking the question, 'what would be needed to inform a sensitive masterplan for mining – with residents at its core?' It attempts to apply urban design principles to a mining setting.

As planning policies around mines do not currently prioritise leveraging social benefits for the people,[1] I felt compelled to create a spatialised set of data that could link the 'clay past' with alternative 'lithium futures'.

In co-design workshops with individual local community members, I brought printed maps and a 3D-printed topographic model for structured exercises where I asked participants to locate, for instance, where they felt belonging, healthfulness, social connection … Then we identified existing assets in the landscape that made people feel positively.

Participants sometimes shared photobooks or personal maps in return, which, along with the model, helped them tell oral histories in an unstructured, spontaneous manner. These stories about the landscape, in turn, were then geo-referenced onto the maps.

8 Photograph of Trelavour pit reclaimed by nature, 2024

It was especially helpful that the people you introduced me to had memories of the landscape as both extractive and post-extractive, so that we could track interpretations and social uses of the landscape across time.

JH I loved the topographic model. How did your design-led workshops help with the unlearning and relearning process you mentioned earlier?

AYY If unlearning is about dropping assumptions and listening attentively to local voices on the past and present, relearning is about projecting into the future. This was the most challenging part of my workshops.

After talking through the model and maps, I asked what participants would keep and change in the landscape for future generations, intentionally leaving room for people to imagine any future. I shared examples of post-mining landscapes like the Eden Project or spoil-heap-converted vineyards and dry ski slopes in France and Germany. Most were dismissed as tourist fads, and natural habitat restoration was almost unanimously the favoured option of the people I spoke with.

Feeling let down by the planning system, people were often so resigned to, or so against lithium mining that they struggled to picture alternatives, or to see the point of imagining landscape reformations.

This demonstrates strongly how planning processes for lithium and other Cornish mining futures must be a long-term collaborative community project.

JH Indeed.

AYY I think this leaves us with an interesting point to end on. When we challenge a 'good news story' like lithium mining in Cornwall, how do we situate our work in relation to *hope* when it is so desperately needed for the green transition under a climate crisis?

JH Well, while on-the-ground realities are not all positive, being honest and embracing complexity presents an opportunity to meaningfully include local communities. This way, the green transition narrative will be more robust against nefarious interests who might misappropriate local frustrations.

AYY Very true. I believe it is only when a portrayal is truthful that real public debates can happen and, in turn, appropriate planning policies around the reopening of mines – a truly new phenomenon – can emerge.

1 The only Supplementary Planning Document (SPD) made specifically for the clay country is the St Austell China Clay Restoration and Tipping SPD.

Rafael
El Baz

Rafael El Baz is a designer and artist working at the intersection of material research, traditional craft and contemporary fabrication. His practice transforms overlooked materials and industrial remnants into works that carry narratives, preserve local histories and foster deeper connections within communities. Drawing on his background in industrial design, Rafael's work ranges from the creation of bespoke objects to large-scale public realm commissions with clients including the V&A, HS2 and the EU Commission. He co-founded GoodWaste and HereUs and his work has been featured in *Vogue*, *The Evening Standard*, *Dezeen*, *Forbes* and *Culturalee*.

IN THE PRESENCE OF HEAT

Rafael's residency interrogates our varied assumptions around silica: from the ways it is transformed into glass, to the development of design's contemporary fixation on purity and perfection. His research examines the UK's post-industrial glass manufacturing landscapes: taking us to Sunderland, where communities and livelihoods were built around this material, and exploring what remains in their absence. This enquiry is a reconsideration of glass waste, not as an end point but as a starting point; the project investigates whether discarded material can be re-introduced into the industrial process and, in doing so, challenges what we have come to expect of glass itself.

1 Saint-Gobain Glass UK, furnace of the float glass factory, 2026

IN THE PRESENCE OF HEAT

Rafael El Baz

Long before humans began extracting and refining silica, nature was already turning sand into glass.

Deep within volcanic landscapes, lava sometimes cools rapidly and solidifies as obsidian: a dark, glossy, sharp-edged rock. When broken open, its surfaces reveal flowing textures, preserving the motion of heat in the stone and the faint crystalline ghosts of minerals that never had time to fully form. Each fragment carries a record of magma moving through the Earth.

2 Obsidian

Above the surface, too, heat can arrive and depart suddenly. When lightning strikes sandy ground, the electrical discharge briefly melts the surrounding silica, which cools into delicate branching tubes known as fulgurites. These hollow glass roots follow the exact path of the lightning through the sand, tracing the moment when the sky touched the earth.

3 Fulgurite

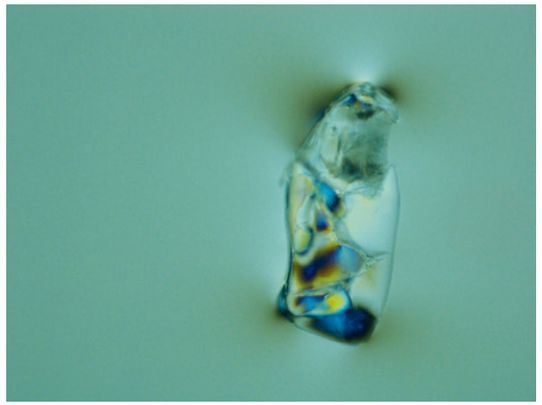
Sometimes the heat comes from even farther away. Around twenty-nine million years ago, a meteor exploded above the Sahara Desert.[1] The energy released was intense enough to melt vast areas of sand, briefly transforming the desert surface into a pool of liquid silica. As it cooled it formed a pale yellow glass – now known as Libyan Desert Glass[2] – that spread across the ground as a thin vitrified crust before shattering. Fragments have been found across roughly 6,500 square kilometres, an area four times the size of Greater London.

Obsidian and other natural glasses have been prized for decorative, practical and ritual uses for millennia. In each of these cases the glass preserves the moment of its formation. Bubbles of ancient atmosphere remain suspended within the material. Mineral fragments from surrounding rocks become embedded in the melt. Colour variations reflect the composition of the sand itself. Natural glass remembers where it came from.

Eventually, humans learned to make their own glass. Approximately four thousand years ago, early glassmakers gathered sands with unique mineral signatures[3] from riverbanks, dunes and coastlines. Iron tinted the material green or brown. Other elements produced faint blues, ambers or cloudy surfaces. The resulting glass was rarely transparent; it carried the colour of the land.

4 Libyan desert glass

From the first century CE, Roman craftsmen discovered that adding manganese dioxide could counteract the green tint produced by iron impurities. It was sometimes called



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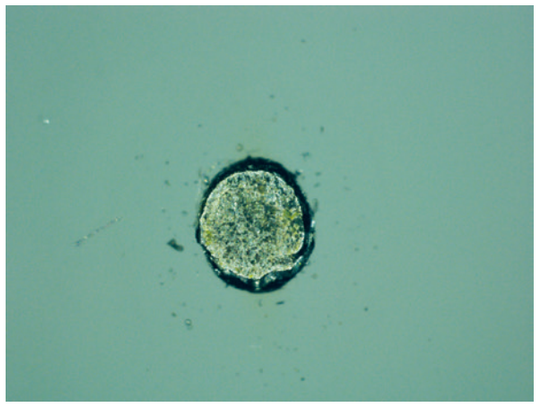

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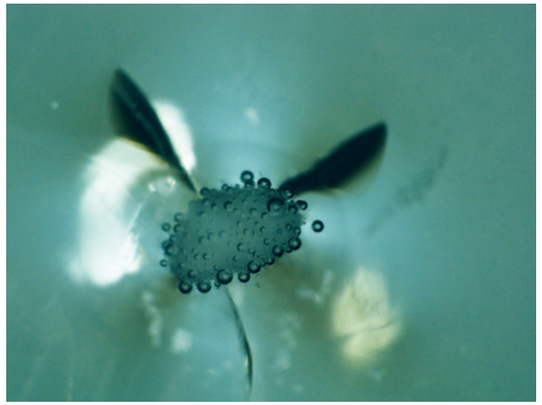

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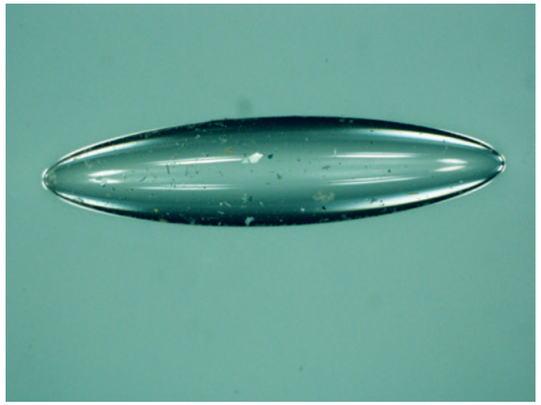

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5 Saint-Gobain defect: Tridymite frost

6 Defect: top tin
7 Defect: porcelain stone

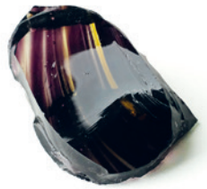
8 Defect: open bottom bubble

'glassmaker's soap' – as if the material had been washed clean. Even then, the glass still revealed traces of its making. Bubbles formed during blowing. Mineral fragments remained suspended in the melt. Surfaces warped slightly as the material cooled.

For centuries, this imperfection shaped the scale of glass itself. Roman windowpanes were small and uneven. Medieval glassmakers in 14th-century Europe produced circular disks known as crown glass, cut into segments and assembled with lead frames.[4] The stained-glass windows of cathedrals were mosaics of hundreds of individual pieces, each with unique colours, distortions and irregularities.

Industrialisation gradually changed this relationship. During the 19th century, new techniques allowed glass to be cast into large plates, ground and polished into smooth surfaces, producing clouds of fine silica dust, microscopic fragments drifting away in pursuit of clarity. The development of float glass allowed molten glass to spread naturally into flat sheets, reducing the need for grinding altogether,[5] getting glassmakers closer to 'perfection'.

Even in Murano, Venice, where glassblowing remains a living, tactile practice, the pursuit of clarity is central to the craft. Bubbles or slight distortions can render a piece unusable, though the rejected work remains beautiful. Frozen gestures of molten glass with twisted colours are sorted into piles of fragments that came close – but not close enough.



9 Murano glass offcut sample

Inside modern float glass factories, such as those in Doncaster, raw materials, silica sand, soda ash and limestone, arrive continuously, stored in towering silos before being measured and mixed. The pale mixture moves along conveyors towards the furnace, where the temperature climbs to 1,600°C and it transforms into a slow orange river. At the float bath, it spreads across molten tin like a glowing sheet of liquid light. Scanners sweep the cooling surface, searching for anything that interrupts optical uniformity. When a defect appears, that section is cut away.

Much of this rejected glass is crushed and returned to the furnace as cullet, but waste persists throughout the system. Cutting produces offcuts. Polishing creates unrecoverable silica dust. Across fabrication and installation, as much as 15 to 20% of flat glass becomes breakage or scrap. The pursuit of clarity leaves a trail of rejected fragments. Beyond the factory, too, rivers are dredged for suitable sand, and landscapes are reshaped by extraction.

Not all human-made glass emerges from craft or industry. On 16 July 1945, the United States military detonated the first nuclear weapon over the White Sands desert in New Mexico. The fireball briefly heated the ground to temperatures that rivalled the surface of the sun, causing the sand to fuse into a thin pale green glass named Trinitite.[6] No one designed this glass or even intended it to exist. It is a byproduct of destruction, not production – a material memory of violence. Like Libyan Desert Glass scattered across the Sahara, Trinitite records the conditions of its creation through overwhelming force.

Nuclear weapons are an example of humanity's desire to create and deploy forces of equivalent strength to those found in nature. In glassmaking, too, humanity has long drawn on these forces; furnaces replicate volcanic heat; molten sand flows and solidifies much as it does in nature. Yet, over time, the ambition has shifted from capturing these conditions to refining them. Impurities are removed, colour neutralised, surfaces flattened. The ideal becomes a material that reveals as little as possible about its origins.

Selected moments in the history of glass, from obsidian tools to cathedral windows, suggest that optical perfection was never a requirement for beauty and function. Obsidian,

fulgurites and Libyan Desert Glass are not concerned with perfect clarity. Trinitite tells a story that should be remembered. Their bubbles, inclusions and colour variations remain as evidence of the forces that created them. If we take our cues from nature and historical craftsmanship, glass becomes a material open to reinterpretation, its colour, texture and variation not flaws to be refined away but qualities still waiting to be explored.

10 Trinitite

1 Robert A. Weeks, James H. Underwood and Robert Giegengack, 'Libyan Desert Glass: A Review', *Journal of Non-Crystalline Solids* 67, nos. 1–3 (1 September 1984): 593–619, https://doi.org/10.1016/0022-3093(84)90177-7.

2 J. F. McHone, M. Killgore and A. Kudryavtsev, 'Cristobalite Inclusions in Libyan Desert Glass: Confirmation Using Raman Spectroscopy', Lunar and Planetary Institute, 2000, https://www.lpi.usra.edu/meetings/lpsc2000/pdf/1877.pdf.

3 Corning Museum of Glass, 'Origins of Glassmaking', *What's On | Corning Museum of Glass*, 2026, https://whatson.cmog.org/exhibitions-galleries/originsglassmaking.

4 D. B. Harden, 'Ancient Glass, III: Post-Roman', *Archaeological Journal* 128, no. 1 (January 1971): 78–117, https://doi.org/10.1080/00665983.1971.11077479.

5 Developed in the 1950s and commercially launched in 1959, the Pilkington float process transformed glass manufacturing by enabling the continuous production of large, optically uniform panes. Molten glass was poured onto a bath of liquid tin, where gravity and surface tension produced a perfectly flat surface. This innovation marked a decisive shift towards uniformity, scale and efficiency, establishing a method that would become the global standard for flat glass production.

6 Nelson Eby et al., 'Trinitite – the Atomic Rock', *Geology Today* 26, no. 5 (24 September 2010): 180–85, https://doi.org/10.1111/j.1365-2451.2010.00767.x.

RESEARCH DIARY 2025/26

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1 Murano defective glass sample

2 Iron glass-blowing moulds

3 Waste glass putty

4 London glass factory

5 Waste float glass

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6 Float glass silica mix

7 Nason Moretti factory offcut

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8 Bag of waste glass putty

9 Murano furnace

10 Nason Moretti factory yellow glass for reuse

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1 Pyrex negative held up to a ceiling light for inspection, 2026

2 X holding a card catalogue drawer of Pyrex records

3 Worker handling molten glass at the Wear Flint Glass Works, Alfred Street, Millfield, Sunderland, 1961

ENCOUNTER

IN THE ABSENCE OF HEAT

Rafael El Baz

Silica (silicon dioxide) is everywhere. It's in the sand beneath your feet, in quartz, in stone. Silicate minerals collectively account for more than 90% of the Earth's crust by mass.[1] When exposed to extreme heat, silica liquifies before stabilising between states as an amorphous solid:[2] glass. Both barrier and lens, glass mediates our relationship with the world. The façade of a skyscraper; the smooth surface of a smartphone; the Pyrex dish that moves from oven to table – each depends on a substance engineered to feel effortless. Good design often aims to disappear, removing friction between user and world, but few materials have shaped everyday life so completely while remaining so conceptually absent.

My investigation into silica started with the supply chains, processing, waste streams and manufacturing systems. But, as often happens, the material led me somewhere else. It led north, to Sunderland, and to 'X', a home-grown expert on the UK glass industry and what you might call an 'underground archivist'. We've spoken on the phone a few times and they've told me about Pyrex;[3] about the demolition of industry; about saving thousands of technical drawings and photographic negatives from being crushed into rubble. I have kept X anonymous given how the material was salvaged.

I arrive in Sunderland after four hours on a train from London, stepping into January drizzle. Sunderland feels quiet in that particular post-industrial way. X is about my height, and greets me warmly. We drive to the flat where X offers coffee while I set up my laptop and the conversation begins – not with Pyrex, or the archive, but in 674 AD.

Before England had specialist glassmakers, X tells me, Benedict Biscop brought 'experts from France to manufacture stained glass windows for St. Peter's Church'. Sunderland, X says proudly, was the 'first town in Britain to have stained glass windows manufactured here'. By the early 20th century Sunderland was also the 'biggest shipbuilding town in the world'. Ships left on the River Wear loaded with coal and came back with sand for making glass.

Jobling & Co.'s Wear Glass Works in Millfield[4] brought Pyrex into this established glass ecosystem. Technically it was borosilicate glass.[5] Practically it was what everyone used to cook their 'tea'.

'You left school, you got a job in Pyrex,' X says. 'If you didn't work there, you knew somebody who did.'

This isn't abstract history for X. 'My mother was 15 when she first went in the factory. My dad was the same age – worked there 30 years.' The labourers weren't just 'industrial workers', X insists, they were 'highly skilled artisans'.

X describes the city as moving to a mechanical rhythm. As a child, lying in bed, they would hear 'a surge of noise as all the generators were fired up' then 'a great trampling of feet on the street clumping past your window'. The whole place woke up together. 'Every table had Pyrex on it,' X says. The output travelled globally, embedding itself in kitchens and laboratories across Britain and beyond. X stressed how important it was for the workers to see the results of their labour out in the world. Pride came from that visibility.

Eventually X takes me into the archive. The room is dim. Curtains half-drawn. Steel drawers. Boxes stacked. This is what remains of an industry that once powered a city.

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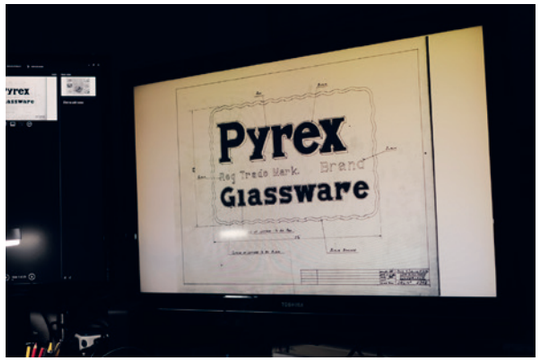

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4 Pyrex negative of a pinion gear technical drawing held to the light

5 Underside of a Pyrex dish showing the 'Made in England' crown maker's mark and mould number 279

6 Pyrex dish made in the Wear Flint Glass Works

7 Original Pyrex glassware trademark artwork displayed on screen from the home archive

In 2007, rising energy costs shut the plant. Coal had already gone. Shipbuilding had declined. Glass was the last big industrial pillar left in Sunderland. What had once felt permanent disappeared fast.

During the factory's demolition, X asked to go inside and 'see if there was anything of historical significance'. In an abandoned drawing office, they forced open a jammed door and found a dark room full of steel cabinets. Inside were trays of negatives, engineering drawings and pattern studies.

From that moment, X began frantically saving what they could. 70,000 negatives, large-format photographs and microcards now sit in their Victorian flat. 'It's not perfect conditions,' X admits, 'the temperature in the winter, I log it each day.' Curtains stay half-drawn to control light. There is no conservation team or institutional infrastructure. The responsibility rests on one person's routines. X lifts negatives to the light, pointing out dates, production runs and pattern changes. There's a kind of excitement in the way they handle them. Later, we visit the National Glass Centre,[6] where X introduces me to activists trying to prevent its closure. Its loss would further erode what remains of Sunderland's glassmaking legacy. The National Glass Centre represents the final physical nod to Sunderland as a making place, glass as one of its defining materials.

8 Workers on the glassware production line at the Wear Flint Glass Works, Alfred Street, Millfield, Sunderland, 1961

Back near the station, we get a pint before my train leaves. X talks about industry – about its decline – and about wanting the archive to find a proper home; they're determined that this history should not fade.

Silica hasn't gone anywhere. Sand still moves across global trade routes. Glass still fills our cities. But the infrastructure of knowledge that once turned that mineral into secure livelihoods in Sunderland has fragmented. Production moved offshore. Supply chains stretched. The furnaces cooled.

The problem extends far beyond Sunderland and far beyond glass. This is not simply a silica story. It is a wider UK story: one about manufacturing, raw materials and the gradual erosion of domestic capability. We import raw materials, export waste and outsource transformation. When we lose manufacturing ecosystems we lose more than jobs. We lose tacit knowledge,[7] intergenerational skill and the ability to innovate in an ever-changing world.

1 World Economic Forum, 2021.
2 An amorphous solid is a non-crystalline material with a disordered molecular structure. It is often described as a ‘frozen liquid’ and lacks a fixed geometric form, softening gradually rather than melting at a single temperature.
3 Pyrex is a brand of heat-resistant borosilicate glass used for cookware and laboratory glassware, designed to withstand sudden temperature changes without cracking.
4 Founded in 1922, Jobling & Co.’s Wear Glass Works in Millfield, Sunderland, grew into one of Britain’s largest glass manufacturing sites employing thousands of local workers and producing tens of millions of Pyrex pieces annually until its closure in 2007.
5 Borosilicate glass is a type of glass made by adding boron to silica to make it more resistant to heat and sudden temperature changes. It is used for items like Pyrex dishes and laboratory beakers so they can go from hot to cold without cracking.
6 The National Glass Centre in Sunderland is a public museum and cultural venue dedicated to the history and craft of glass, live glassmaking demonstrations, artist studios and educational programmes.
7 Tacit knowledge refers to knowledge that is difficult to articulate or transfer through written or verbal means; it is learned through experience, practice and embodied doing rather than formal instruction.

Rosa
Whiteley

Rosa Whiteley is a designer, writer and researcher. Her practice explores the intersection of architecture, food systems, critical ecology and atmospheric politics, often relating to a specific site or resource to read environmental politics. Rosa is an Assistant Lecturer of architecture at the Royal College of Art and Central Saint Martins. She has previously held design and research positions at CLIMAVORE and Cooking Sections, developing long-term transdisciplinary projects that investigate the systems shaping our world through food. She is now one third of TUFF – a design and research group based in London.

CHALKOPHILES

Through dew pond building, fieldwork, mapping, analogue photography and material experimentation, Rosa investigates chalk aquifers that supply millions of people across southern England and sustain globally rare chalk streams. These systems are increasingly threatened by the cascading effects of water privatisation, which degrade ecological relationships across aquifers, rivers and skies. Rosa explores chalk landscapes through researching dew ponds – manmade water bodies built on chalk uplands. Her project proposes small ponds and collective care of chalk ecologies as counter-infrastructures to privatisation, reframing the aquifer not as a store of financial value, but as a shared living system.

1 William Smith, *A Delineation of the Strata of England and Wales, with Part of Scotland*. This is the first geological map of the UK, spatialising chalk for the first time

CONTEXT

TO SEE THE AQUIFER IN THE POND

Rosa Whiteley

To find chalk you first must find a mole or badger, as Andrew Farrant, a geologist, explained, while teaching me to read aquifers beneath chalk hills.[1] We searched for fossils on the doorsteps of burrowing animals and spoke of calcium-fixing algae and spiky sponges blooming in shallow seas. Over millions of years, their calcite remains pressed into rock layers, rising from the sea that birthed them and becoming chalky land, harbouring waters of its own.

Chalk acts as an aquifer,[2] storing and releasing 60% of England's freshwater supplies.[3] On William Smith's 1815 geological map of Britain, chalk appears as a light-green hand stretching across England; spilling across the hills of Wiltshire, under London, into Kent and Sussex, soaking into the Norfolk Broads.

From its first mapping, chalk was financialised. Smith believed geological knowledge could drive the expanding economy of imperial Britain.[4] As the badgers know, chalk's softness makes it easy to dig. Bands of chalk, once mapped, became corridors for roads and canals linking industrial centres to ports, and later, high-speed rail lines.[5]

2 Chalk excavated for HS2, laid out near the south portal of the Chiltern Tunnel, 2022

3 Chalk and flint excavated by a badger near Folkestone in Kent, 2026

Once mapped, chalk's capacity to hold water was calculated, and artesian wells were drilled around London for the first time.[6] In 1851, a particularly deep well was sunk beneath the Bank of England: keeping London's banking system churning with new springs of chalky water.[7]

Smith's economic reading of the bedrock laid the groundwork for Thatcher's privatisation of English and Welsh water in 1989. The right to draw water from the chalk was sold, and public water boards were transformed into privately owned companies.[8] Through the neoliberal sell-off of our common waters, the chalk aquifer was defined as both a literal and financial store.[9] Water became a commodity, and the chalk that held it became the bank.

In 1995, the Labour government sold its golden share in English water companies on the global market, channeling neoliberalism even further into our water system.[10] The four companies responsible for English chalk aquifers are currently owned by international banks, insurance companies and investment funds. Through the lens of privatisation, water bodies become objects of design; relying on infrastructures of extraction and containment, with engineers and designers framing aquifers in terms of value and yield. This financial lens has contaminated every level of the hydrological cycle, with human waste found in groundwaters, rivers and even the skies,[11] as private companies leak sewage from degraded infrastructure and siphon profits offshore.

The global trade of English water, and the related ways water systems have been designed to be banks, actively separate water from the worlds that make it: the chalk streams, water voles, newts, grassland catchments, morning dew, river trout and fossilised bedrock. The aquifer is not only a geological formation, but a hydrological and social system – produced through rainfall, soils, vegetation, infrastructure and regimes of abstraction as much as through rock itself. Privatised water draws a line between people and their waters, but chalk will always smudge.

4 The River Ebble in Wiltshire. Analogue black-and-white photograph developed using water collected from the river when elevated E. coli levels closed the area for bathing, December 2025

The word aquifer derives from *aqua*, meaning water, and *fere*, meaning to bear or carry. This carries gestational meanings; fere insists on movement: the water must be born.[12] The aquifer more than the bedrock; it is the cloud arriving laden with rain. It is every river rushing forward, flowing in channels, flooding banks, bursting from taps. As guts gurgle with water, bodies become aquifers. These aquifers speak of and through each other.

You may learn about a puddle by watching an ocean, or of mist by watching a pond. As folktales from the chalklands teach us, reflections in pools reveal portals to others. When looking into the surface of a chalkland pond, you may notice white clouds reflecting from above. As hydrogeologists have learnt how the aquifer is replenished with water and rain, their attention has shifted from bedrock to weather.[13] Advances in meteorology have brought new capacities to control clouds. Chalk, the porous keeper of groundwaters, is now being tested as a pigment in solar geo-engineering projects,[14] to whiten clouds and reflect sunlight.

Chalk-seeding can be understood as a photographic process, wherein the ‘exposure’ and ‘aperture’ of the clouds are shifted, to create new images in the sky. In 2025, the UK government announced new funding to develop projects to spray chalk into the sky,[15] influencing cloud formation on the coasts of England. These experiments may reduce effects of drought on chalk ecologies in England, but have drawn criticism for altering the weathers elsewhere.[16] Through such engineering attempts, the financial language used to define and control the aquifer underground begins to circulate above it, condensing and falling again as chalky rain.

Dew ponds (also known as cloud disks or mist pools) are man-made ponds found on high ground in chalky landscapes. Instead of relying on groundwater or rain, they condense water from the air.[17] Their shallow depth, curved form and chalk-white surfaces encourage low fogs, morning dew and sea mists to condensate. In landscapes shaped by porous chalk, where water slips quickly into the ground below, dew ponds become vital infrastructure.[18] During drought, or over-abstraction, when too much water is being pumped from the aquifer below, dew ponds are often the last place water can be found.[19]

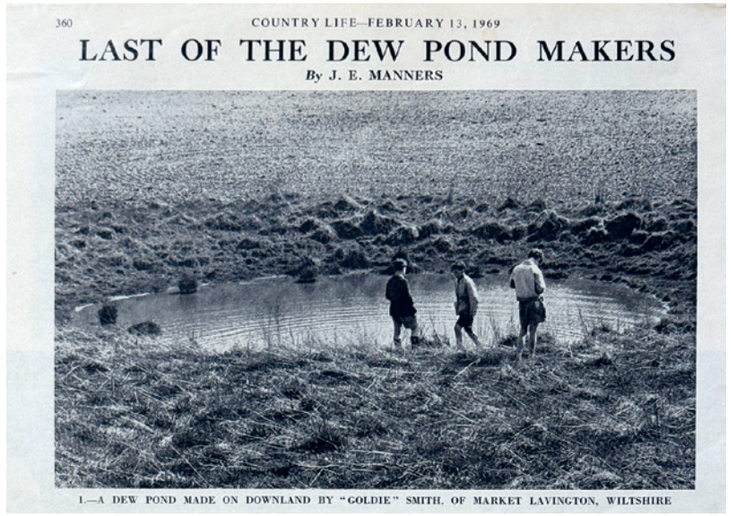
5 Clouds forming over the chalk ridge, Cranborne Chase, Wiltshire. Analogue black-and-white photograph developed in pond water collected from Cranborne Chase, April 2026

England once had millions of these ponds, but a large majority were drained as agriculture became intensified.[20] In recent years, dew pond rebuilding has gained momentum among ecological groups who recognise their importance across chalk landscapes. Dew ponds are built using puddled clay for waterproofing, straw for insulation and chalk to protect the surface and regulate temperatures.

Building ponds has always been a more-than-human affair. The use of clay may mimic ‘licks’: small patches of clay that hold water at the surface, attracting animals seeking a mineral-rich drink. Their repeated visits gradually puddles the ‘lick’ into a pond.[21] A friend once shared footage of a stag persistently digging at a patch of clay on the Norfolk Downs, until a pond emerged. Infrared cameras revealed deer returning nightly, deepening the basin. In historic village ponds, ducks helped maintain water levels; their paddling pushed mud into cracks, and their droppings added waterproofing. In chalk landscapes where water is scarce, ponds serve as gathering places for plants, insects, birds, livestock

and people, who find food, water and love in the act of making and remaking ponds. At a landscape level, ponds support more species than rivers.[22]

Hydromancy is a practice of looking at reflections cast in pools to tell the future. Peering into the portal surfaces of chalk dew ponds – miniature aquifers designed, built and maintained by multi-species communities – reveals other ways of collaboratively managing waters. The responsibility of designers, circling and circulating chalky waters, is not to own or contain them within cartographic lines and structural or metaphorical banks, but to keep them moving, visible and alive. If the aquifer exists not only as chalk bedrock but also as a pond at the surface and a cloud above, then the shift from aquifer-as-financial-store to pond-as-lived-aquifer reframes how water might be managed, meandering away from centralisation and economic yield, and carving channels towards counter-infrastructures of atmospheric attention and multi-species upkeep.


360 COUNTRY LIFE—FEBRUARY 13, 1969

LAST OF THE DEW POND MAKERS

By J. E. MANNERS

1.—A DEW POND MADE ON DOWNLAND BY "GOLDIE" SMITH, OF MARKET LAVINGTON, WILTSHIRE

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6 The Wiltshire-based Smith family built dew ponds across England, collectively puddling clay and chalk using wooden 'boitles', 'The Last of the Dew Pond Makers', *Country Life*, 1969

7 The Wiltshire-based Smith family, Building a dew pond near Devizes, Wiltshire, 1969

8 Stag building a pond in the Norfolk Broads. Repeated visits and digging captured by local trail cameras, September 2025

9 Ditchling Beacon dew pond, South Downs National Park. Analogue black-and-white photograph developed using water collected from Ditchling Beacon, where mineral splotches and sedimentation appear on the surface, reflecting its chalk-rich source, March 2026

1 Since the growth of 'no-till' farming and cover cropping – practices that aim to help keep water in the ground and improve the health of groundwater – geologists have struggled to find fossils, which were often found in traces of till across chalkland farms, for mapping.
2 Thomas Sheppard, *William Smith: His Maps and Memoirs* (Hull: A. Brown & Sons, 1920).
3 Institution of Civil Engineers, 'The Channel Tunnel', 2024.
4 An aquifer can be understood as a body of permeable rock underground that supplies springs, wells, streams and rivers.
5 Alan M. MacDonald and David J. Allen, 'Aquifer Properties of the Chalk of England', *Quarterly Journal of Engineering Geology and Hydrogeology* 34, no. 4 (2001): 371–84.
6 An artesian well is a well drilled into a section of a chalk aquifer where groundwater is trapped beneath less permeable layers, such as London clay. Because the water is recharged at higher elevations in the chalk hills surrounding London, it is held under pressure and may rise up the borehole without pumping – sometimes even flowing at the surface.
7 Standidge & Co., *A Drawn Section of the Well Sunk at the Bank of England in 1851* (1852), Geological Society Archive, LDGSL/447. Note: the Bank of England was initially built straddling the buried Wallbrook stream.
8 Boreholes, treatment works and distribution networks all become financial assets, with the ability to abstract from chalk becoming embedded in company valuations. From 1989, groundwater was no longer a local common resource; it became revenue-generating infrastructure.
9 Here, 'neoliberal' describes economic policies promoting privatisation and market governance, through which shared public resources such as water infrastructure and aquifers came to be managed as financial assets rather than common goods. 'Common goods/waters' refers to water understood as a collective ecological resource, historically shared across communities and ecosystems as a common right prior to privatisation and market governance.
10 Ibid.
11 There are only 200 chalk streams in the world, and England is home to 85% of them; 83% of England's chalk streams are in critical danger, according to *CaBA Chalk Stream Annual Review 2024/25*. Sewage has been found in groundwater springs (Environment Agency, *Sewage Risks to Urban Groundwater Science Report: SC030134* [Bristol: Environment Agency, 2008]). Other scientists have suggested that sewage pollution events at sea during high winds can drive aerosols into the air (Lauren Biermann et al., 'The Theoretical Role of the Wind in Aerosolising Microplastics and Nanoplastics from Coastal Combined Sewer Overflows', *Scientific Reports* 15, no. 1 [2 July 2025]: 23623, https://doi.org/10.1038/s41598-025-06115-5).
12 Themes of birth and pregnancy in chalk aquifers run through the chalk streams of the downs, where 'winterbournes' are streams that run only in winter. Old English *burna/bourne* (stream) often appears in place names tied to streams, and the source, or spring, is often feminised through myth (naiads, wells, holy springs).
13 Aquifer recharge refers to the process by which rainfall infiltrates soil and porous rock, slowly replenishing underground water stores. In chalk aquifers, recharge depends on sustained winter rainfall capable of penetrating thin soils and fractured rock before evaporation or runoff occurs. This can make them vulnerable during heatwaves and drought conditions, when rainfall quickly evaporates before penetrating the ground.
14 Solar geo-engineering refers to large-scale climate interventions that aim to counter global warming by artificially increasing the Earth's reflectivity, for example through cloud brightening or atmospheric particle dispersal. The effects of solar geo-engineering on weather formations are contested and remain broadly unknown.
15 Shaun Fitzgerald, Centre for Climate Repair, University of Cambridge, 2024.
16 Solar geo-engineering alters cloud formation and may redistribute precipitation, shifting how and where rain falls, with uneven regional consequences (see Intergovernmental Panel on Climate Change, 2021; Royal Society, 2009).
17 David Rivière, *Dew Ponds* (Chalford: Amberley Publishing, 2025).
18 Wiltshire also has the most chalk streams per square mile in the world. Chalk streams are globally rare, fragile ecosystems, with 85% of the world's approximately 161,000 km found in southern and eastern England. Fed by chalk aquifers, these clear, nutrient-rich streams have consistent temperatures that support high biodiversity. They are severely threatened by pollution (sewage, agriculture), over-abstraction and habitat modification.
19 Ibid.
20 In the 20th century, new machinery demanded wider fields, and industrialised aquifers pumped water from further afield, detaching food production from local water ecologies.
21 Edward A. Martin, *Dew-Ponds: History, Observation and Experiment* (London: T. Fisher Unwin, 1917).
22 South Downs National Park Authority, 'Restoring Dew Ponds to Create New Habitats for Birds and Insects', 8 February 2021.

RESEARCH DIARY 2025/26

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1 Chalk cliffs and hills show, quite literally, the aquifer emerging from the ground. Here, flint beds and vertical fissures point to deposition and sedimentation, as well as fractures that allow water to seep through to our taps

2 Searching for fossils in chalk excavated from a building site, Folkestone, Kent

3 British Geological Survey archive: 130,000 records of wells, boreholes and springs across England and Wales. Used by hydrogeologists to predict floods, signal droughts and plan new wells, British Geological Survey, Nottingham

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4 Boitle – the head of a puddling mallet made from apple and ash wood, used in dew pond construction by the Smith family, c. 1950s

5 Learning how collective effort puddles a pond, Bethnal Green Nature Reserve, London

6 Examining the textures and colours of chalk to determine its age while mapping the aquifer across a chalk stream region running dry, Folkestone, Kent

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7 Frogspawn in early spring in a dew pond, East Sussex. Marking ecological recovery following relining and repuddling by the South Downs National Park Authority

8 Piles of flint at the Bulford Kiwi chalk geoglyph. Flint forms within chalk as silica from marine sponges permeates porous stone, crystallising in its cavities. Historically, flints were thought to be born, while small circular fossils unearthed by ploughing were taken as signs that stones could grow from the earth like plants

9 Examining the archive of 'The Last Dew Pond Builders of England', Market Lavington Museum, Wiltshire

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10 Waterproof Nikonos film camera and flash set up in a dew pond to document toads spawning in early spring, Wiltshire

11 Uffington White Horse following a recent scrape by community volunteers. Widely considered the oldest chalk geoglyph in Britain, Wiltshire

12 Team members from South Downs National Park Authority 'Downs to the Sea' project, spotting great crested newts in a recently restored dew pond

1 Frogspawn on the surface of a dew pond, East Sussex, 2026

PUDDLING CONVERSATIONS, PONDING TOOLS

Rosa Whiteley

To build a dew pond you dig a large hole and fill it with a thick layer of clay. Clay and chalk are almost chalk and cheese; surface chalk makes water disappear underground, clay holds it at the surface – making ponds. Once laid, the clay is puddled: trampled repeatedly until it becomes dense and watertight. Walking in circles compresses the clay into a plastic seal. The more circles that are walked, the more reliable the pond becomes.

Puddling became a method within my fieldwork: walking around chalk ponds and water sources with people closely tied to them, until something settled in our minds. As I spoke with geologists, ecologists, conservationists and storytellers, we traced circles together, conversations compressed through movement – soft clay under hard feet.

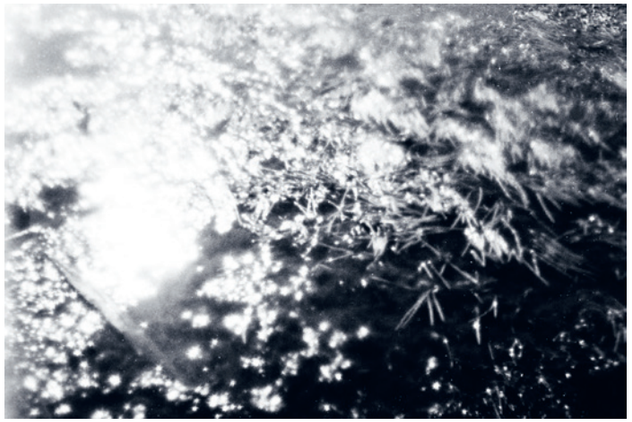
2 Dew, Dagger, Pond: puddling a test pond in the norfolk broads, 2025

These encounters wrote a manual for me and created a toolbox for pond building in the chalklands. Some tools were practical: a shovel to break the surface, a boitle[1] to beat clay into place or lime to hold back the worms. These tools were described in the family archives of the last traditional dew bond builders in England.[2] Others were territorial, like those described by David Riviere, who spent years tracing historic archives, mapping the disappeared dew ponds of the South Downs. Sasha Waddle, a garden volunteer at the Design Museum, taught me that a voice can be a tool to resonate with hidden waters. To call for the end of the private water industry requires tools of conviction and resilience, as I learnt from Sophie Conquest of We Own It.

The sediments and residues of these puddled conversations slowly reshaped my understanding of how ponds are made, and why.

One of these conversations puddled my understanding of the images and stories we make of chalkland waters, and why it's useful to rethink them. Ifor Duncan and I walked round Peckham Rye Duck Pond in south London, discussing his work on rivers, archives, mythology and turbid information. We circled the ducks while speaking about in-between states: fog, haze and water heavy with sediment.

ID This water is pretty scuzzy here, isn't it? It always seems to be. And yet, in images of water, there is always a bias towards a clean image, whether that's underwater or above ground. It's just like fog, which is measured by its obstruction of visibility. But actually, fog is visibility manifest. You might say: 'Oh, I can't see anything!' But, really, you were saturated. There was too much to see.



3 Surface of a dew pond with overexposed edges, East Sussex, 2026

Spooling analogue film in a canister with Chris Mann, a photographer who – patiently – taught me to develop photos from these visits, I learned that an overexposed image is one with too much data, like a dense white fog. In the sediments of the ponds I photographed, I saw data suspended; stories held aloft in the grain of the image as mineral waters leached across the paper. Analogue cameras became tools – not for clarity, but for revealing density, as film span in chalky waters.

RW Last time we spoke, you spoke of rivers and aquifers as archives.

ID If we think of a river's sedimentary processes as a form of archiving, this disrupts the idea of static stores, banks and enclosed archives. The river, as an archive, encounters many influences as a living ecosystem.

Archiving aquifers has long been a scientific practice. The borehole libraries of the British Geological Survey, for instance, are full of cylindrical cores extracted with each new water well. This geological data helps us develop hydrogeological knowledge, yet the nature of these archives miss the eco-social cultures tied to our interaction with aquifers. Walking between the duck pond and Peck Stream, a chalk stream that emerges at Peckham Rye, before disappearing into the sewers,[3] we reflected on the stories we'd heard of chalky waters.

We shared a fascination with how folklore might open new ways of understanding water spaces, while remaining wary of nationalist undercurrents and eco-fascist appropriations: stories that construct a particular image of England and English streams, and of who gets to belong to them.[4]

4 Ghost pond identified as an abandoned dew pond by David Riviera for South Downs National Park, East Sussex, 2026

5 Inside the ghost pond, searching for signs of dampness, 2026

RW I've been tracing folklore related to chalk aquifers. One story, from Wiltshire – a particularly chalky county, and where I'm from – is that of the 'Moonrakers': villagers hiding contraband brandy from excise men by submerging it in the local dew pond. When the excise men arrived, the villagers feigned stupidity by raking the pond's surface for a 'cheese' – the full moon reflected there – hiding the brandy with rakes and ripples. Wiltshire people are still colloquially known as 'moonrakers'. What interests me is this link between reflection and misdirection, and the pond as both portal and concealment. The story also ties the dew pond to 18th-century smuggling networks linked to colonial exploitation, where brandy functioned as a circulating currency.[5] The connection between waters and colonial trade was something you raised in our last conversation through Welsh mythology, sheep mills and empire.

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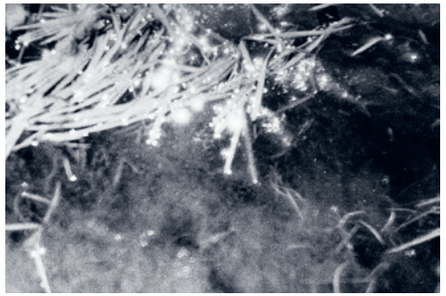

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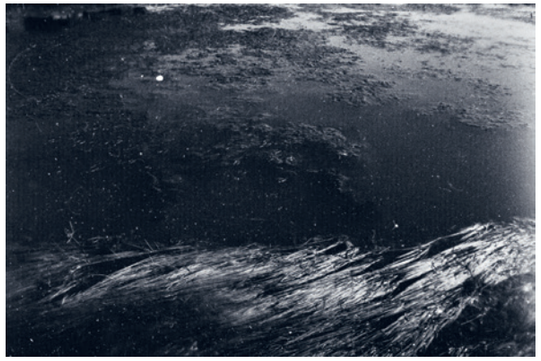

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6 Dew pond near Chanctonbury Ring with team members from South Downs National Park 'Downs to the Sea' project, 2026

7 David Riviera (author of *Dew Ponds*, 2025) and Fay Pattinson (South Downs National Park ranger) with dew pond near Chanctonbury Ring, 2026

8 Pond weeds on the surface of a dew pond, Wiltshire, 2026

9 Reeds growing in a dew pond with great crested newts swimming in the shadows, Kent, 2026

10 A ghost pond at the top of a chalk hill, likely a former dew pond later drained by industrial agriculture, near Chanctonbury Ring, 2026

11 Light reflecting off frogspawn in a dew pond in Sussex. Dew ponds are excellent habitats for spawning frogs, as their shallow depth and steady temperature is ideal for egg development, 2026

ID Yes, I've been thinking a lot about portals lately. Celtic folklore could be used as an analytic device to examine the entangled histories of rural communities in the British Isles and their engagement with colonialism. If we see the pond or well as a portal, we can understand a relationality to other places, economically or socially linked to these waters, and that exploitations [within the waterbody] stretch across distinct geographies and cultures. Evoking tools from situated mythologies allows us to understand the radical relationality of water. These readings also push back against narratives of pristine, clean landscapes, through the very tools that are used to promote them: myths.

RW Martin Shaw teaches that folk stories are made alive through each telling and retelling, because stories change in each new embellishment.[6] Stories, therefore, can continuously shift, like the environments they are from. This contrasts with eco-fascist approaches to storytelling, where narratives are fixed in a rigid form, where the chalk stream cannot stray, embrace change or accept new arrivals.

Ponds, rivers, streams and aquifers all store stories, politics and histories in their sediments, allowing us to understand the present of our chalky waters, and begin to plan other futures. These traces do not settle cleanly. They remain suspended, shifting, like silt, shit and wasted ammonia in a stirred pond.

To build a pond is to work with that movement, even as you try to hold it still. Clay is compressed, and air is pushed out. Water seeps, evaporates and returns elsewhere. Fogs are caught and dews accumulate. Walking in circles, again and again, something begins to settle. Not into clarity, but into density. Conversations, like clay, are worked until they can hold something. Not a fixed answer, but a way of staying with water long enough to notice how it gathers, how it escapes and how it might be held – gently, briefly, together.

1 A *boitle* is a wooden mallet used to puddle ponds.

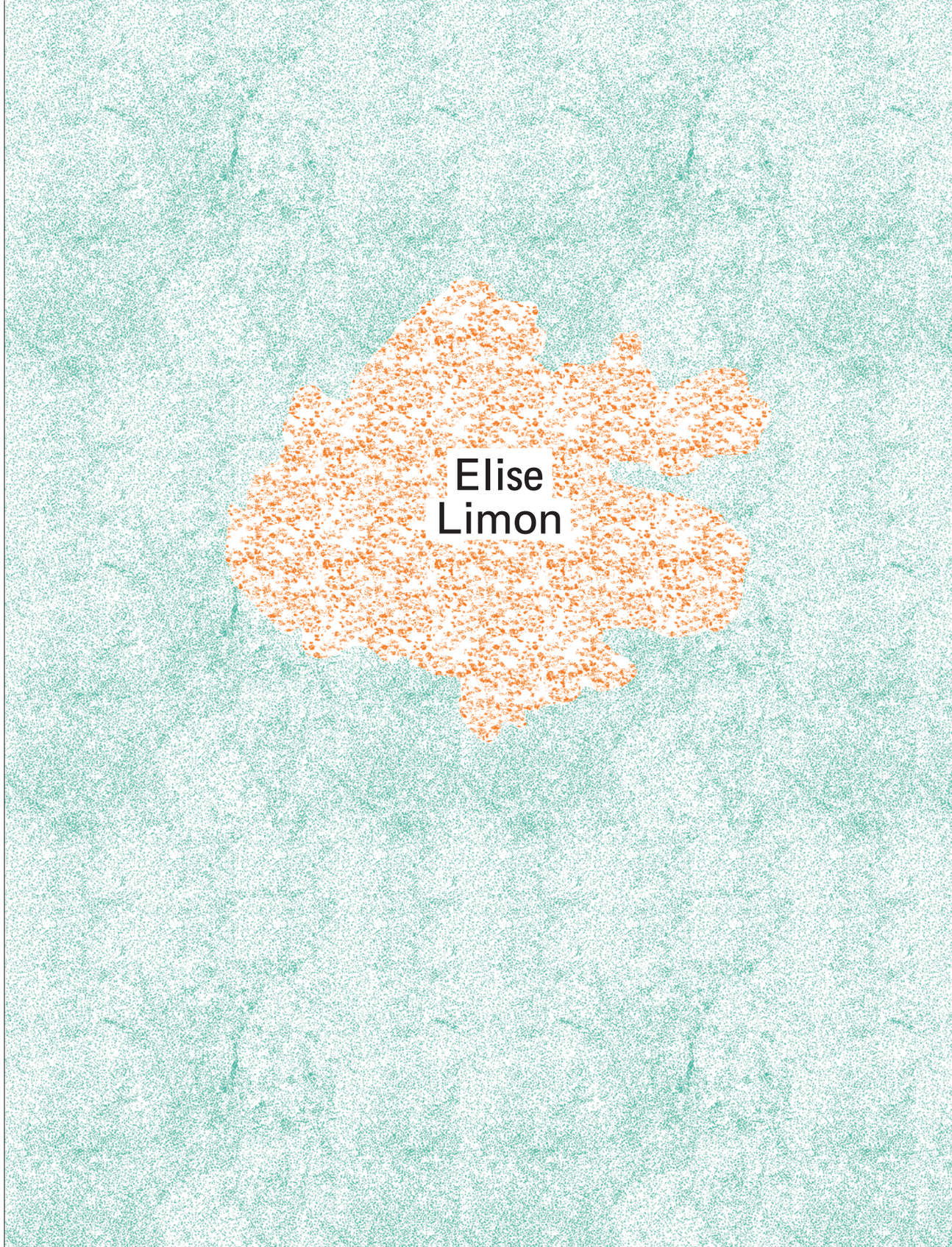
2 The Smith family's pond-building methods are recorded through oral histories and archived material within Market Lavington Museum, in northern Wiltshire.

3 After the Great Stink of 1858, many chalk stream tributaries of the Thames were progressively buried and culverted into sewer networks, transforming visible waterways into hidden infrastructure.

4 Eco-fascism refers to ideologies that combine environmental concern with exclusionary or nationalist politics. In Britain, rural landscapes have been mobilised within narratives of heritage, purity and belonging, often obscuring histories of enclosure, empire and exclusion. Nature writing has sometimes contributed to this framing.

5 Smuggling networks in southern England were entangled with imperial trade systems, circulating goods such as brandy, rum and tobacco tied to colonial economies. Brandy, for instance, was traded for enslaved people by 18th-century merchants. By 1769, a slave was worth '6 anchors of brandy' (approx. 80 gallons). Gomer Williams's *History of the Liverpool Privateers and Letters of Marque* (published in 1897).

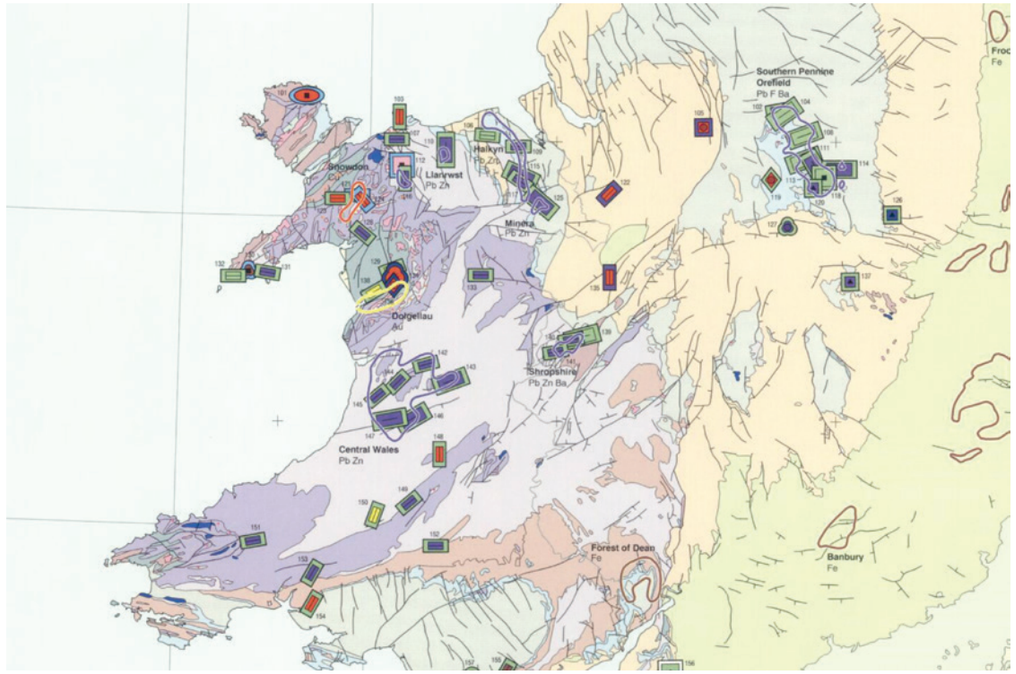
6 Martin Shaw is a British mythographer and storyteller whose work focuses on the role of oral tradition and folklore in shaping cultural and ecological understanding.


Elise
Limon

Elise Limon is a writer, researcher and architectural designer. Her practice explores the future of landscapes, ecologies and architecture's entanglement with extractive material and economic logics. She is interested in broadening the impact of design research by articulating complex environmental processes to a wider audience. She was previously Critic and Housing Fellow at the Yale School of Architecture, where she taught Advanced Design Studio and History and Theory seminars. She holds an MArch from Yale University and a BA in Architecture from the University of Cambridge. Currently, she is working with architecture studio DK-CM.

SLOW ORE

Elise's research investigates the long-term implications of copper mining infrastructure, unearthing narratives about the afterlife of mineral mining across the spoil heaps, rivers and acidic ecologies of North Wales. Set against the rising demand for copper in the technologies of the energy transition, Elise asks what it means for the UK to be returning to these landscapes of extraction as future sites of resource. Her research explores this through a close investigation of metallophytes and hyper-accumulators: plants which metabolise copper and other metals. Through fieldwork, experimental photography and material exploration, the project reframes copper and places it within a wider geography, wherein toxicity and value must be continuously renegotiated.



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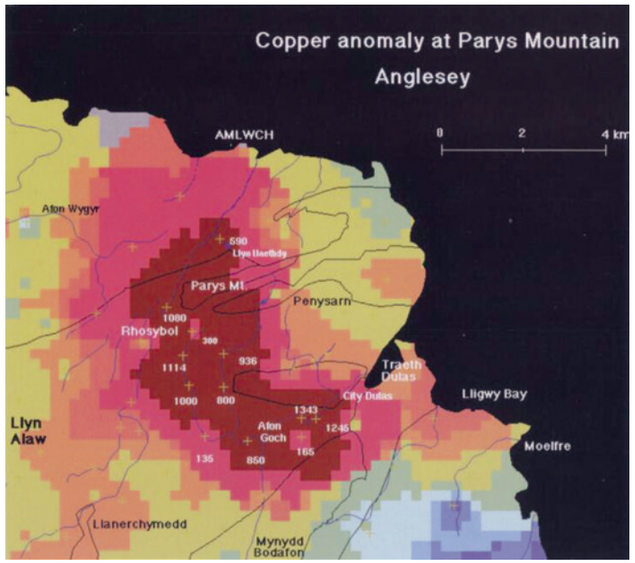

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1 The intricate geology of the west coast and its metal mineralisation is exemplified on the island of Anglesey in North Wales

2 Geology conspires to create a copper-rich anomaly on a Welsh island

RED PLANETARY THREADS

Elise Limon

Four hundred and forty million years ago, the ground that would become the west coast of Cornwall, Wales and Scotland lay much further south: along a restless ocean margin where continents drifted towards collision. Under the weight of the sea, the marine floor was split by faults that drew rivulets of hot water from even deeper below, through broken volcanic rock. This mineral-rich fluid travelled slowly, carrying metals dissolved by ancient 'smokers'[1] – iron, sulphur, copper – moving in currents only witnessed by the lively geology. Layer by layer, copper gathered: bound into sulphides, buried by shale, mud and time.

On the island of Anglesey (Ynys Môn) in North Wales we approach, through fields of tall wind turbines, a site that, by the end of the 18th century, was the largest source of copper in the world. Here, the sliding continents folded the earth back on top of itself, hiding the minerals until they were discovered in 1768, roughly 439,999,700 years after they first settled. The open-cast mine, known as Mynydd Parys (Parys Mountain, or 'Copper Mountain', has left the landscape snaked with tendrils of rust, ochre and lilac.

Dr Rob Crossley, a local geoscientist, points out the dry stone walls leftover from old mining infrastructure: dark rocks set vertically, tall and thin rather than laid in horizontal courses. This, he tells me, is evidence of the Cornish miners' engineering knowledge. Through various walks to different copper-related sites, I begin to understand such features as entry-points into the layered histories embedded in the landscape.

The land at Mynydd Parys is now in the twilight years of a long mineral history, being protected and re-categorised through institutional systems of care: Scheduled Ancient Monument, Global Geo-park, Site of Special Scientific Interest. These labels suggest a stabilising of what extraction had previously unsettled. Visitors arrive each day: dog-walkers, mountain bikers and scientists engaging with the unlikely life that has adapted to the post-industrial toxicity. A landscape no longer mined, but not quite finished with mining.

Starting in the late 19th century, the extraction of copper shifted elsewhere. Today it is mostly mined in Chile, where the metal is blasted from rock and refined from flotation pools in the Atacama desert – a complex landscape shaped by dryness, lithium, copper and nitrate. The historical web of extraction, refining, recycling, and supply and demand connects vastly different geographies: Chile, Peru, the African copper-belt, the London Metal Exchange, the manufacturing districts of East Asia, and the islands and valleys of Wales. Copper is embedded in the dominant flows of modernity: electricity, water and finance. It is a leading protagonist in every technology of the energy transition.[2] It is in high demand.

In headlines, the exact amount of copper required to satisfy future needs is framed in various ways: '293 new mines must be built by 2030';[3] '115% more copper is needed in the next 30 years than has been mined throughout history';[4] 'in 2035 supplies will have fallen short by 30%'.[5] Their shared tone of urgency reflects the connected (but also competing) desires to meet Net Zero goals and to feed copper-hungry data centres. The anticipated shortage has prompted a renewed interest in the possibility of more metal in the rocky folds of the UK's geology.

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3 The metal is bound within many different types of mineral ores

4 Copper is used in most modern technologies, including wind turbines and grid electrification, where it is drawn into fine wires

5 Fragment of a copper-alloy sculpture found in Wales

6 A special coin was minted to pay mine workers at Parys Mountain

7 Copper is associated with the planet Venus and the goddess Aphrodite

Industry and government bodies[6] are releasing new reports on potentially exploitable mineral deposits, and this island might once again become a site for primary extraction. What happens when familiar landscapes with apparently settled histories are once again read as a resource? How will foreknowledge of their toxic afterlives change our ongoing relationships with these places?

Copper is named for its association with the island of Cyprus; in Latin it is *aes Cyprum*: metal of Cyprus. This bound its myth to that of Aphrodite, the Ancient Greek goddess of love, who was born from the sea beside the island and is often depicted holding a copper mirror. As one of the only metals that occurs naturally in its pure form, it quickly became useful to Neolithic peoples, who combined it with tin to form bronze and shaped it into tools, bowls and charms.[7] Copper can take on many forms, be used, discarded, melted, refined and reshaped infinitely; almost 80% of the copper ever extracted from the ground remains in use today.

We are part copper too. It is an essential trace element in our bodies. Copper is absorbed in the small intestine, transported by our blood and stored in the liver or expelled. Metabolising the metal is key for antioxidant defences, the formation of tissue and for nervous system function. In contrast, the copper intrauterine device (or IUD) used by many people creates an inhospitable environment for reproductive cells by releasing copper ions inside the uterus.

The lust of global capitalism and its new technologies for copper (and other mineral resources) leaves scars of violence on communities and landscapes. In his *Elemental Odes* (1954), Chilean poet Pablo Neruda writes: 'The vein is discovered, is drilled and dynamite blows up, the rock crumbles, it purifies: copper is being born. Before, nobody would know the difference from the mother rock. Now, it is man. Part of man, a heavy petal of his glory.'[8] Set against this idea of 'purification' is the contaminating residue; for every ton of copper produced, 100 tonnes of toxic waste is too.

Hyperaccumulators is the term given to some species – including plants, mosses, fungi, lichens, rabbits and crabs – that can draw up metals in unusually high amounts, a kind of flourishing that defies the toxicity of extraction. Accumulate comes from the Latin *accumulare*, which means to heap, to pile or to mound. Plants' ability to 'pile up' metals like nickel, zinc, iron and copper in their leaves and stems suggests it is possible to re-negotiate the terms of inhabiting polluted ground.[9]

Endless accumulation is a defining characteristic of extractive capitalism, but the lively world of hyperaccumulators and metallophytes suggests another kind of ledger: slower vegetal stockpiles, a way of dealing with contamination. Organisms with these qualities live quietly across the landscape at Mynydd Parys, but they are also beginning to be seen as a potential alternative to conventional mining operations. Start-ups are designing processes to facilitate the extraction of metals from fields of flowers, and miners are turning to bacteria for copper sources.[10] Distinctions between living being, metal and 'resource' are blurry.

As prospecting companies now engage in re-surveying for in-demand metals and minerals, the British countryside must remember its entanglement with distant mines, markets and infrastructures. Standing at Mynydd Parys, we encounter not a finished site but an ongoing state. The pastoral and the planetary fold into one another. The Afon Goch ('red river' in Welsh) still runs red from copper's disturbance, its arteries channelling iron-rich waters into the Irish Sea, reorganising life, relationships and ecologies along the way. To understand the implications of the energy transition, we must see copper clearly, in all its entanglements. Like Aphrodite's mirror, in confronting it we confront ourselves.

1 Hydrothermal vent systems are dramatic sea-floor chimneys of mineral deposits, billowing clouds of fine mineral particles from within the Earth's crust into cold seawater. This geological process concentrates copper into solid sulphide minerals such as chalcopyrite ($CuFeS_2$). Ancient forms of these deposits are mined for copper today.
2 Copper is one of the most efficient conductors of electricity. It is used in renewable technologies such as wind turbines and solar panels, in the expansion and upgrading of electricity grids, and in electric vehicles and charging infrastructure, all of which require significantly more copper than fossil-fuel-based systems. As a result, any movement towards large-scale decarbonisation is expected to accelerate global copper demand, raising fresh environmental, political and labour concerns.
3 Didi Bostock, 'How Many Mines Are Needed for the Energy Transition?', *Benchmark Source*, 30 January 2025, https://source.benchmarkminerals.com/article/how-manymines-are-needed-for-the-energy-transition.
4 Fiona Harvey, 'Demand for Copper to Dramatically Outstrip Supply within Decade', *The Guardian*, 21 May 2025, https://www.theguardian.com/environment/2025/may/21/copper-supply-demand-analysis-internationalenergy-agency.
5 'UK's Copper Crunch May Be Solved by Household Copper Mining', *Material Focus*, 13 May 2025, https://materialfocus.org.uk/?pressreleases=uks-impending-copper-crunch-could-be-solved-through-uk-household-copper-mines.
6 The UK Critical Minerals Intelligence Centre, the British Geological Survey and the Department for Business and Trade.
7 Copper and its alchemical transformation into bronze led to the naming of an entire archaeological era: the Bronze Age.
8 Pablo Neruda, 'Ode to Copper', in *Elemental Odes* (Buenos Aires: Sudamericana, 2003).
9 In the 19th century, electrical science adopted the word for a device that stores energy for later release: the battery.
10 Camilla Hodgson, 'Miners Turn to Bacterial "Bugs" to Extract Copper as Prices Soar', *Financial Times*, 26 January 2026, https://www.ft.com/content/c4bb91b2-ce03-4df6-90e5-68fec5be942b.

RESEARCH DIARY 2025/26

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1 Spoil heaps, flotation pools and unlikely ecologies at Parys Mountain, Parys Mountain, Wales

2 Sampling soil where ore was burnt and tipped into spoil heaps as part of the copper extraction process, Parys Mountain, Wales

3 Water run-off from decommissioned copper mines pools and pours back into surrounding water sources, Parys Mountain, Wales

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4 A dried out Calluna vulgaris (common heather) surrounded by a ring of living plants of the same species, Parys Mountain, Wales

5 Sign for the ‘Copper Mine Trail’ spattered with dust from the adjacent spoil heaps, Parys Mountain, Wales

6 Exploring different ways to measure and record the landscape, Parys Mountain, Wales

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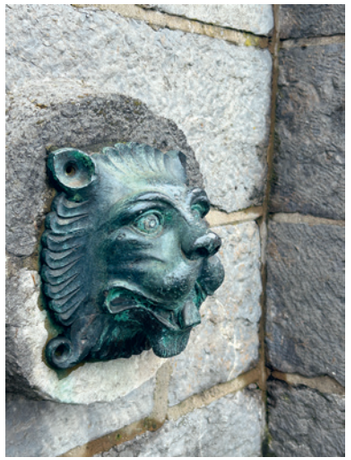

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7 Amlwch Port, where copper was shipped elsewhere, retains traces of the extraction process, Amlwch, Wales

8 Following copper's appearance in public spaces, Town Square, Wales

9 GeoMon's headquarters and research gallery, Anglesey, Wales

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10 Discarded ore from mine in Swansea, Swansea, Wales

11 Discussing core samples with geologist Dr. Rob Crossley, Anglesey, Wales

12 Mapping mining infrastructure and newly planned energy transition projects, Wales

1 Ignacio Acosta, *Old mining camp of Sewell*, Sewell mining town, Andes Mountains, Chile, 2012

TALKING COPPER GEOGRAPHIES

A conversation between Elise Limon and Ignacio Acosta

Artist Ignacio Acosta (IA) and I reflected on our respective research into the mineral landscapes related to copper and the energy transition. Acosta's work Copper Geographies invites viewers on the journey of copper from extraction to stock market exchange, smelted commodity and recycled material. The project helps articulate how copper moves around the world and how its journey affects the different geographies through which it passes.

EL Ignacio, your project Copper Geographies has been really influential to me as I've investigated copper throughout this residency. I've been thinking a lot about how minerals move through landscapes and the traces they leave. When did you first start thinking about copper as something that connects places in this way?

IA In 2005 I was taking part in activism around the construction of a new copper mine in Chile. Photography offered a way to deal with the industry and its consequences through researching, exposing and tracing. The invisibility of copper and its presence in so many of the systems which sustain our life made it a compelling subject.

My PhD thesis looked at historical moments of de-nationalisation in Chile, when copper went from being a natural resource to being part of a global network of commodity exchange … In comparison to gold, which has a story attached to the Spanish colonies, copper was entangled with Wales. When the mines in Britain eventually closed, the companies came to Chile, but smelting still happened in Wales. Ore from Coquimbo and the Atacama Desert was being shipped over the Atlantic to the Lower Swansea Valley, which became known as 'Copperopolis'. My work became about mapping and following these movements.

EL What I find functions so well in your work is the placing side-by-side of images of different settings. In photos from Chile the presence of the mineral industry on the landscape is often much clearer than images from the UK. Here, settings often 'trick' the viewer with a pastoral, 'natural' feel. What has been your experience doing fieldwork in places where the residues of copper infrastructure are much more dispersed – or even deliberately obscured?

IA As you say, it can be hard to see the traces, but not seeing can be productive too. There was one warehouse full of copper futures[1] in Liverpool I had tried to get access to for a long time. While its abstract value circulates, its physical form still requires storage. It sits waiting in these vast warehouse complexes. In the end I wasn't allowed inside.

The photo that eventually resulted, taken from outside the warehouse perimeter fence, in the haze of a cloudy day, ended up telling a more accurate story about the opacity of these systems and networks. At moments of friction like this it can also be useful to find other ways of rendering connections visible, through documents, historical photos, maps or critical writing.

EL My own background is in architecture and spatial thinking, and my research is in the context of a design research residency. Can you expand more on this question of medium?

IA It is very difficult for me to tell a story through image-making alone. A multi-modal approach is necessary. This includes visual documentation, but also something researcher Susan Schuppli has termed 'material witnessing': the practice of attending to what matter itself records and retains. It is also important to acknowledge that, as researchers, we have a perspective too. In a way, our project is about making sense of what is happening and creating new narratives about how to live with these broken landscapes.

2 Ignacio Acosta, *Panoramic view of a former copper smelting site*, Lower Swansea Valley, Wales, 2014

EL On that question of broken landscapes, I wanted to ask about your photograph of the Eucalyptus forest in the Los Vilos commune. Part of my research has involved working with ecologists and botanists to look at what grows in the afterlife of these mining landscapes. In particular hyperaccumulators – species that certain groups are looking to as future sources of critical minerals. The eucalyptus forest feels like an image that sits in tension with that idea.

IA The story of the forest is more layered than it first appears. To explain, we might start with copper concentrate, which is a thick mud-like substance made during the processing of copper. This intermediary state allows it to be transported through the Andes to the Pacific through tubes. When it arrives at the port they have to dry it out in order to ship it to places like China or Bulgaria. This produces a massive excess of heavily contaminated water. Eucalyptus trees were brought over from Australia by the mining company. The water cannot be put into the sea or the river, so it is distributed to the eucalyptus, that absorb the metal into their tissues.

In the photo, if you look closely at the forest ground you can see there are some pipes distributing the toxic water to the roots.

EL A strange kind of irrigation system. Do the eucalyptus drink the copper-rich water?

IA The trees become dependent on the water in a way. The company uses the forest as part of a narrative of environmental contribution. In fact, they had to get rid of the original diverse forest to make way for the infrastructure, the tailings dam and the eucalyptus. The trees can't be used as timber, and they are very prone to wildfires. It is a highly constructed environment.

EL Since the question of critical minerals, and their demand in energy infrastructure and data centres, is currently so relevant to many unfolding crises, do you find yourself coming back to this body of work?

IA Yes of course. I thought at some point I would dedicate my whole life to mapping minerals, but now I am working on the boreal forest. Yet they are connected – you can also look at the boreal forest through the lens of extraction. The research becomes a tool for continued engagement.

3 Ignacio Acosta, *Forest of eucalyptus trees planted to absorb contaminated water from Los Pelambres mine*, Los Vilos commune, Chile, 2012

EL This transferability feels important. The spatial, design and visual frameworks become something others can pick up and use to think about their own environment differently.

IA Yes, as a researcher you can offer a perspective and create a narrative that can be used to change ways of seeing how designed systems operate, or to organise around resisting certain projects, or to imagine alternative futures. My initial question in this project was: how do we document these damaged landscapes? As the work progressed, I became increasingly drawn to the life I saw occurring in and around its traces. It is a kind of slow resistance.

1 'Futures' contracts are agreements to buy or sell something at a set price on a future date. Before that date arrives, the commodity can be traded many times over.

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RAFAEL EL BAZ, IN THE PRESENCE OF HEAT

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Design Researchers in Residence 2025/26
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MINERAL

Design Researchers in Residence 2025/26
Alfred Yatlong Yeung, Rafael El Baz,
Elise Limon, Rosa Whiteley

This publication features the work of the 2025/26 Design Researchers in Residence. It accompanies a display at the Design Museum, which runs from June to September 2026.

Minerals are a finite resource. Yet in an increasingly unstable geopolitical context, mineral resources – such as lithium, copper, chalk and silica – are in the spotlight. This year's Design Researchers in Residence have been interrogating the UK's intersecting mineral landscapes – past, present and future. Through case studies, field research and the building of human and non-human relationships, their projects ask:

Should the 'green transition' be sustained through the continued extraction of finite resources?

How can design research help us better understand the UK's dependence on minerals?

Design Researchers in Residence is Future Observatory's programme for emerging design researchers hosted at the Design Museum. Future Observatory is a national research programme for the green transition, established in partnership with the UKRI Arts and Humanities Research Council (AHRC). We act as a catalyst, supporting design research that can have real impact.

Edited by Abbie Adams and Leilah Hirson-Comley

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