LITHIUM

STATES OF EXHAUSTION

Eds. Francisco Díaz, Anastasia Kubrak, Marina Otero Verzier

Het Nieuwe Instituut

architecture
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Introduction

Marina Otero Verzier

Architect, Universidad Politécnica de Madrid, ETSAM, Spain, 2008. M.S. in Critical, Curatorial and Conceptual Practices in Architecture, Columbia University, 2013. Doctor in Architecture Design Theory, ETSAM, 2016. She directed the Global Network Programming at Studio-X in New York, and, together with After Belonging Agency, she was chief curator of the Oslo Architecture Triennale 2016. In 2018, Otero was the curator of "Work, Body, Leisure," the Dutch Pavilion at the 16th Venice Biennale, and in 2020-21 co-curator of the Shanghai Art Biennial. She has co-edited *More-than-Human* (2020), *I See That I See What You Don't See* (2020), *Unmanned: Architecture and Security Series* (2016-20), *Architecture of Appropriation* (2019), *Work, Body, Leisure* (2018), and *After Belonging* (2016). Otero currently is director of research at Het Nieuwe Instituut and head of the Social Design MA at Design Academy Eindhoven.

The idea of progress has been too often used as synonymous with the quest for reaching new horizons. Advancing towards the better, bigger, higher, faster. Bodies have been working on discovering and reaching their limits, pushing them even further to previously unimaginable accomplishments.

As the ecological catastrophe looms and Western notions of progress are being contested, this relentless search for more has also been critically examined. Humans' obsession with stretching the limits is not achieved without consequences. And the interconnected nature of bodies-under-pressure across scales – from the microbial to the planetary – makes this exhaustion collective, a paradigm that permeates every corner of the globe.

Yet, humans' uncompromising appetite for 'more' is channeled through countless formulas to 'keep on.' Bodies are technologically, chemically, biologically enhanced. Motivated. And persuaded, coerced, exploited.

Lithium is one of these formulas. A natural element found in high concentration only in a few places on Earth, such as the Atacama Desert in Chile. One that provides material for cheap and lightweight batteries through processes involving evaporating millions of liters of water every day in the world's driest desert. One praised for its almost mythical capabilities to keep bodies, and systems, on. Ready, running, efficient, smooth.

This book tells lithium stories. Words on volcanos, deserts, bacteria, batteries, and mobile phones. On brine pools, evaporation ponds, spas, and stars. On ecology and psychiatry. Its idea started with the – perhaps late – realization that our literal exhaustion and that of the planet are inevitably connected; and that our attempts to overcome the exhaustion without addressing its cause are just a headlong rush.

"Lithium: States of Exhaustion" was first a long-term research project and later an exhibition and public lecture series at Het Nieuwe Instituut (Rotterdam, The Netherlands). Now, it is also a collaboration between Het Nieuwe Instituut and Ediciones ARQ (Santiago, Chile) that takes the form of a book. The Atacama Desert is a prominent and pervasive figure in this volume. While not the only territory affected by lithium extraction, the book dives deep across the Atacama's layers to unveil the extent of its effects. After all, "Lithium: States of Exhaustion" is a collective attempt to imagine a world following a different rhythm and other ideas of achievement.

Anastasia Kubrak, principal researcher and co-editor of this volume, introduces the element lithium and its role as both mood stabilizer and fuel for the so-called green energy transition. Her essay is the backend of an image that has haunted our imagination for the last year: that of the button cell lithium battery next to the lithium bipolar treatment pill. Both their

lightweight, portable architectures hold the potential to change behavior, regulate activity levels, manage populations. They do so by controlling flows generated by polarities or imbalances in the system.

This condition of bipolarity and its intimate connection to the contemporary economy is at the core of co-editor Francisco Díaz's contribution. Polarities – alternate cycles of mania and depression, wealth and poverty, dominance and subjection – have generated a differential in power that feeds the endless loop of capitalism. When this feedback loop seemed to be broken due to exhaustion of the end poles, Díaz argues, lithium came to lubricate the system again. Lithium reenergizes markets with the promise of a capitalist system compatible with ecological concerns.

Architects Kate Davies and Liam Young look closer into these pledges for a technologically-enabled 'green future'; into the electronic devices and electric cars powered by lithium energy. Stored and consumed in our batteries, this energy that came to replace the fossil fuel epoch took billions of years to form inside the sacred landscapes of the *salares*, where "mountains give birth to minerals." "We power our future with the breast milk of volcanoes," Davies and Young write. They take us on a journey connecting our phones to the ancestral cosmologies of the Bolivian *altiplano* and showing that human's technological dreams have consequences. Lithium-powered 'green futures' are fabricated at the expense of environmental destruction and of the indigenous communities who care for the land.

In the Atacama '*salares*,' human, animal, vegetal and microbial ecosystems have coexisted for thousands of years. Now they are the site of legal battles and environmental disputes between those who protect these unique environments and those who see them as resources to be exploited. Architect Godofredo Pereira interviews some of the former: local communities, such as the stewards of the Salar de Llamara and Salar de Huasco. In conversation with Pereira, Cristina Dorador, professor of microbial ecology, talks about life in Atacama's salt basins. One of the biggest repositories of mineral resources on Earth – and consequently a major economic asset – this territory is generally portrayed as a lifeless space. Yet, it happens to be a hyper-diverse ecosystem. "Almost the entire periodic table is present in the soil," and "of the almost 100 bacterial *phyla* [...] that exist across the planet, more than 60 are present in a sediment sample of Salar de Huasco," explains Dorador. The Atacama's ground is alive.

This environment, however, is rapidly degrading due to water scarcity and contamination resulting from the extraction of lithium and other minerals in the region. Crucial to its safeguard is the recognition of the beings inhabiting that territory and the symbiotic relations between them. Dorador, for instance, works on creating awareness of the importance of cyanobacteria, the micro-organisms living in the *salares*. She is not alone. Protecting this unique yet fragile environment from the devastating effects of mining industries – and the neoliberal economy that sustains them – has been a long pursuit of the region's indigenous communities. Rolando Humire, a biochemist and indigenous leader, also contributes to de-naturalizing the understanding of the elements forming the environment. Humire does so through the lens of indigenous cosmic vision and stewardship practices, claiming the elements as living beings. As Dorador, he insists that the minerals exported from the Atacama to other territories around the world are not lifeless matter. These elements are not commodities – a designation that has been used to justify its extraction – but micro-organisms native to the desert and an intrinsic part of a living ecosystem. By doing that, Humire also confronts the notion that someone can actually 'own' a place, its resources, and export them in exchange for profit. "We don't own anything. We are part of everything," he explains. It is only with permission from the spirits, the ancestors,

and Mother Earth, '*Patta Hoiri*,' that his community interacts with the land; their activities are not only based on 'taking' but primarily on 'giving' back.

The caring practices and political opposition towards mining projects carried out over the years by Atacameño, Aymara, and Quechua communities have succeeded in ameliorating the effects of extraction on the territory. Litigation lawyers, mediators, and arbiters have also worked on behalf of these communities, supporting their efforts. Alonso Barros is one of those agents involved in environmental struggles in the Atacama Desert. His contribution echoes his work. It moves between the macro and micro scales to operate in the spaces where the extractive operations of mining companies collide with the indigenous peoples' lives and rights.

Whereas these battles generally are fought against the names of big corporations or agencies, journalist Daniel Matamala puts a man's face to the history of lithium extraction in Chile, that of Julio César Ponce Lerou, also known as the 'king of lithium.' Ex-son-in-law of dictator Pinochet and principal shareholder of the Sociedad Química y Minera de Chile (SQM) – the world's biggest lithium producer – Ponce not only profited from his connection to the regime but also managed to extend his influence under democracy. Despite being involved in scandals connected to fraud, tax evasion, and poor labor conditions in the extraction sites, Ponce has the second largest fortune in Chile. And he is not an exception.

The search for power (electrical and political) is generally entangled and embodied in characters such as 'king of lithium.' Anthropologist Emily Martin helps unpack those subjectivities through the relations between manic behavior and late capitalism. Since the 1980s, we have seen how the ideal businessperson and successful entrepreneur was someone of endless high energy, someone who didn't even need to sleep. An unconventional person with bold ideas, driven by success yet not failure averse. One who is always testing and breaking the limits to generate new businesses. Whose behavior matches the fluctuating market cycles and the imaginaries around the manic disorder. Whose ambitions exceed the power of lithium.

In fact, despite the benefits of lithium (included its price and unpatented nature) as medication to mitigate the effects of mania, other patented alternatives better align with the compulsive desires of these neoliberal subjects. Pharmaceutical companies sell the promise to optimize mood swings: to keep the most productive aspects of the manic state and deploy them as forms of high energy and creativity in the work environment. Yet, as Martin reminds, "No one has endless energy, endless resources [...] Human beings are not infinite reservoirs of energy."

Martin's arguments align with what philosopher Byung-Chul Han describes as a turn to 'psychopolitics' under neoliberalism. In search of self-optimization and in the name of efficiency, the neoliberal subject finally surrenders to self-exploitation: a compulsion that leads to exhaustion, burnout, and depression – the maladies of our time. And this self-destruction, the obsession with energy, growth, and (self) development, as researchers Marina Weinberg and Cristobal Bonelli point out, transcends our bodies to pervade and affect the entire environment. Under the theory of 'humors,' Weinberg and Bonelli describe these processes impacting bodily and terrestrial moods and fluids, and of which lithium extraction is part. Processes that are dependent on unequal and polarized forms of distribution, on imbalances that sustain the system, and that are too often imposed by the north onto the south.

The differential consequences of lithium mining are also evident in the photographs by Cristóbal Olivares and Cédric Gerbehaye. Against the pervasiveness of the aerial images of brine ponds in media and lithium-centered projects like this one, both Olivares and Gerbehaye show their realities on the ground. Bridging the gap between aesthetics and politics, Olivares focuses on

the infrastructures and human labor involved in the Atacama's SQM plant. Gerbehaye, on the other hand, looks at the worker's camps and daily lives in the Salar de Uyuni region of Bolivia – territories that the architect and scholar Pedro Alonso describe as a neoliberal dystopia. The inevitable aesthetic experience of these landscapes, Alonso points out, too often obscures the threat that these infrastructures pose for the survival of entire ecosystems. Our awe at these colorful pools, he stresses, sustains environmental destruction and corporate profit. It denies the rights of present and future generations in favor of the blind belief that lithium will keep the system running – as coal or oil did before.

Pools that keep the system running are also the concern of the architect Christie Pearson. Her contribution examines the public bath, and in particular, its European typology manifested in the spa. Spas, Pearson recalls, have always been architectures of power, whether connected to the empire, church, aristocracy, state, and capital. Yet, as Sigfried Giedion proposed in his book *Mechanization Takes Command* (1948), these architectures could also be deployed as a prototype to combat the effects of mechanization and its exploitative dynamics. Along with the invention of holidays, popular leisure, and modern architecture, the spa came as a cure to the fatigue decimating the 19th-century factory worker. Once seen as social advances and progressive measures, these 'healing' technologies have evolved into a contemporary multimillion-dollar industry and managerial technique, facilitating the exploitation of employees without burning them out. An industry of which lithium extraction pools and their vim contained in batteries and pills are part of.

Further reflecting on lithium's consumption, researchers David Habets, Cameron Hu, Stefan Schäfer dive into its seemingly magical capabilities to fuel the system and combat fatigue. "It's a matter of concentration," they claim, referring to the elusive presence of an element of which we demand endless supply to satiate our endless energy appetite. The search for *more* lithium takes them as far as the birth of the universe and the origins of life on this planet, an event that also preoccupies the scientist Francisco Förster. He makes us turn our sight from the land – its stories, struggles, and lives – towards what happens up in the sky and invites us to reflect on one of the biggest unsolved problems in cosmology: lithium scarcity. A setback to the plans of green futures' campaigners on Earth, lithium scarcity also prompts astronomers to question the current theories on the origin of the universe itself. Our origin.

Back from the start and into the very pages of this book, our journey can't end without acknowledging once more Alonso's contribution and his critical remarks. He confronts the role of cultural institutions and universities in the extractive processes affecting Atacama – processes to which this book inevitably contributes. Lectures, publications, and exhibitions are not only insufficient to fight against the transnational corporations and political powers destroying this ecosystem, but they are also too often complicit in normalizing images such as the colorful lithium pools.

We know this book is not enough to undermine these paths. In fact, it may not change anything on this subject. But we also know that for us, the three subjects who edited this book, it triggered profound transformations in our ways of living, working, and caring for each other. Still incipient and clumsy but, indeed, different worlds than the ones we previously supported, their reach still unfolding. They may or not be better, bigger or higher, but they will certainly be slower. After surviving our own processes of exhaustion, these new worlds open, at least for us, a different way of understanding progress. ⊘

This Extraordinary Rock

LiCo (David Habets, Cameron Hu, Stefan Schäfer)

LiCo (Lithops Corporation) comprises architect David Habets (Netherlands), anthropologist Cameron Hu (USA), and political theorist Stefan Schafer (Germany). Their collaboration examines past and future choreographies of mental and environmental life. LiCo's recent work includes the essay "The Missing Mineral" in *Migrant Journal* 5, and the video "This Extraordinary Rock" for Het Nieuwe Instiuut's exhibition *Lithium*.

Do you remember what normal felt like? I want to tell you that you can feel normal again. Let me tell you about this extraordinary rock. You might be suspicious. I understand it. It's hard to know who you can trust.

It is not easy to feel normal today. Life on Earth stopped being normal some time ago. It happened gradually. You may not have noticed it. As I have come to believe, things began to fall out of equilibrium in 1973. But others think 1973 was merely the year when longstanding tendencies became explicit. They see signs of global abnormality sprayed on the walls as early as 1971, or 1965, or 1944, or even earlier. They differ as to whether it started in New Hampshire, or Jakarta, or Tripoli.

However you date it, the world has gone off-kilter. Some of us pushed it out of balance. Some of us sent it off-course. We launched it on an erratic trajectory. Our intentions were good. Or at least they weren't more malevolent than was usual in those years. Yet, in important respects, we didn't know what we were doing. We didn't understand the forces we were setting into motion. We didn't understand the scale at which we had begun to act. And now there is such turbulence. There is such volatility. A profound unease spreads out through the metropoles. The system feels nervous. Our whole collective enterprise feels burnt out. Depleted. You can read the dismal situation off of the faces of people in the streets. You feel it when you pace in circles in your room, not knowing what to do next.

Under these conditions, after the end of the normal, when you can't recall what normal was, normality takes effort. Normal used to be the flow of things. You went with the flow. Now you have to resist the flow. Normal and natural parted ways. Normal is now a memory you recover by working against the nature of the world. Normal means reversing a natural history of disorder. Normal means continuously charging yourself in a world that will drain you of every last watt.

Thus, people talk of mindfulness. They enroll themselves in courses on meditation. Others are taking possession of themselves with the advice of dieticians, life coaches, personal trainers, mentors, gurus in exile. Some people talk with psychoanalysts, something I no longer recommend. After years of study – after 10,000 hours of reading medical journals and exchanging letters with leading minds in California, Afghanistan, and Bolivia – I have come to recommend the following. Allow me to tell you about this. I am not merely a salesman. I am like you. I feel the need to become normal again. What would push back against everything that is happening? The only thing that has worked for me is this extraordinary rock.

...

This is not a drug. There is no prescription required. You do not have to involve your doctor. It is a rock. Better than that: it is an element. A few protons, a few neutrons, and nothing more. It wasn't fabricated in a laboratory. No human made it. It is not made up of anything else. It comes from the Earth. It comes from the environment. It was placed here at the birth of the universe. That fact should claim our attention.

I have been to the mines. I have flown across the Atacama. I have to tell you: they are unexpectedly beautiful. These are not the same mines where we found seams of coal and gold and dug our way into the present crisis. The evaporation pits are a patchwork of brilliant greens, teals, and golds. From the air, the mines look like a chain of gemstones arranged across porcelain skin.

The very sight of it can change your waking life. Look at the men who make it flow from the deserts into ports, freighters, factories, storefronts, and ultimately, your pocket. The statesmen and moguls. They are spectacular. They seem like strangers to fatigue and boredom. They are not like you and me – not as we are, for now. Their bodies have not forgotten action and passion. They have declined to suffer, the way you and I suffer. Against the enervating demands of a world out of order, their lives concentrate an impossible energy.

Think of Morales, who had the kind of lungs that could breathe new life into dead political projects. Consider Musk, who launches cars into space and might remove us from the face of the Earth, forever. Where does their energy come from? I cannot say with certainty that they consume this rock every day. Perhaps they thrive on its mere contemplation. Their methods remain secretive, of course. But the results are unambiguous. I won't pretend that I know how it works. But I know that it does work. I know that this rock works. What else is there to know? What is left is to try. What is left is to act.

...

These days I sleep better than ever. Every night. I thank my mother. She introduced me to it. When no one could say what, precisely, was wrong with me, when the methods on offer made the problem worse, she went online. And it was online that she found out about this rock. That is how my research, my seminars, my Foundation got their start. That is how I began. Thanks, mom.

When I sleep, I often dream that I am her child again. I am always sitting at the kitchen table, and she is always standing over the counter. Her back is to me. She is shaking something on top of the breakfast she'll soon bring.

I was never going to be a genius. I never had the potential. But there are kids who have it. And I worry about them. I see them when I ride buses; when I do my shopping. I see their necks craned over screens. I see their fingers swiping and scrolling across the very devices powered by a few neutrons and a few protons from the desert. I see their vital energy dissipating into a world of images that always demands more scrolling and swiping. It only ever grows larger and denser. It never slows down.

It is not their own fault. The kids are fine. It is an environmental crisis. Your kid might have been a genius. Your kid might still become a genius if you know what to do. But every day, their environment is draining them of something that isn't being replaced. Imagine everything they aren't becoming.

Of course, we are not just individual women and men and families. We are a society. A species. A way of life. So, imagine what we aren't becoming, all of us together, when your kids aren't becoming what they could. Imagine how we may, in fact, be devolving together.

In my dream, my mother brings over my breakfast and, when I look into the bowl, somehow, I know that my suffering will soon be over. I look in the bowl and I see our entire predicament laid out before me. I see the mechanized farms of the plains. I see the industrial laboratories in New Jersey. The trading pits in Chicago. I see the bankers in the City of London and the private equity firms in Shenzhen. I see these places converging and colluding, whether by intention or some grander design. I see a world built to drain us of everything essential. In my bowl, I see the mines and the evaporation pits too. How many remain to be built. How the planet holds an endless supply of what we are missing. How bits of this extraordinary rock are spread out

across deserts, and in every drop of the ocean, awaiting someone with the will to concentrate it. It is not missing from the universe. It is simply missing from our lives. It is a matter of concentration. I mean this literally. The problem is entropy – entropy and the will to resist it. The will to pull something together that is constantly dissipating.

At some point, before things went awry, when there was no 'before,' everything was compressed. Nothing was distinct from anything else. Everything was intimate. Everything touched. Nothing was missing. It's a beautiful thought. And then came the universal blowout. It scattered the elements. Distance was invented. Longing was invented. Our crisis-ridden life was invented. Missing was invented. Now our problem is how to pull it all back together. To reverse entropy. It is a matter of concentration. Some of it has been concentrated already. You can sprinkle it on your food. It replaces what's missing. It looks like salt. It's tasteless. You can help them. The way my mother helped me.

...

At the Foundation, we are often asked why we should be trusted. There are so many foundations. There are so many methodologies. Everyone is trying to make sense of the present crisis, how it follows from the last, what may be extrapolated for the next. Everyone is offering a proprietary grip on our collective predicament. Confusion is rampant. The possibilities for fraud are infinite.

What recommends the Foundation – I believe – is the simple elegance of our diagnosis. And of our solution, too. A world that is no longer normal, a world erupting in system-wide disorder, a world we can no longer predict – as we see it, this is a variation on the 'only' crisis. The eternal crisis. The original crisis. The way that every can of soda goes flat, the way every oil well ultimately runs dry, the way each star dies, the way the incredible vitality of the universe can only dissipate into cold stillness – so too is each and everyone of us exhausting our personal reserves.

And rather than rage against the great dissipation, most of us have contributed to a global order that only rushes our common demise. The optimistic, hyperactive build-out of our world looks, in hindsight, like self-destruction. Like the stars and batteries exploding all around us. The pressure and the dissipation. It burns us up like 'white dwarfs.'

At the Foundation, our diagnosis is fundamental. We see the resonance of your life with the life of the stars. No other account will do. Every other description of our predicament misses the essence of things.

And just as our diagnosis is fundamental, our solution is elemental. We have placed our faith in an element: a few protons, a few neutrons, and nothing more. Something pure and irreducible, born in the earliest moments of the universe and distributed throughout it. There is enough of it everywhere but inside you. And we can do something about it. We know what we need and where to find it. What remains is a matter of concentration. What remains is to act.

You don't need to take it from me. You can read the studies yourself. From Texas to Japan, to Greece, after the last great crisis. The experts say the same thing. Where there is enough of this in public waterways – small doses distributed throughout the environment – we stop rushing toward the end. Suicide rates are lower. Happiness is 'environmental.' People seem to flourish when they draw nearer to this element.

...

In my dream, I look up from my breakfast, and the kitchen is replaced by the night skies arching over the Atacama. I am in the desert, where astronomers from across the world cluster to look at the stars. What do they see at the edge of the visible? Is everything falling apart, or is it winding back together? In the quiet of the desert, I hear the salts

crusting up, coming together. It is the sound of concentration. It is the sound of dissipation in reverse. It is the sound of 'normal' entwining itself with the natural, once again. The sound transports me back to the 'before.'

It is the sound of this extraordinary rock. ⊘

David Habets
Bachelor's in physics, Technical University of Eindhoven, 2009. MSc in Landscape Architecture, Academy of Architecture Amsterdam, 2016. His research operates on the crossroads of visual arts, landscape and applied science. Habets has made large-scale art installations as part of the core-team at RAAAF, such as "Still Life" (2019), "Deltawerk" (2018), and "Hidden Worlds" (2018); other exhibitions have been shown at Cappadox Contemporary Art Program, Istanbul Biennial, Zone2Source. He has published in *Architectural Review*, *Architese*, and *De Digitale Gids*. Habets has been invited as Art/Science honorary at the Royal Netherlands Academy of Arts and Sciences (2019), and as Vroman Fellow at the Jan van Eyck Academy in Maastricht (2020-2021).

Cameron Hu
Ph.D. in Anthropology, University of Chicago, 2021. He writes on the politics and aesthetics of technoscience, capitalism, environment, and empire, with an emphasis on contemporary North America and Southeast Asia. Hu has received awards and grants from the Wenner-Gren Foundation, Energy Policy Institute, and Center for International Social Science Research. He is the author of *Knowing Destroying: The Geopolitics of Fracking and the Metaphysics of Imperialism* (2021), and numerous articles, essays, and reviews. Hu is currently a postdoctoral fellow at the Konrad Lorenz Institute (Austria).

Stefan Schäfer
Master's in political science, philosophy, and history, University of Tübingen, 2009. PhD in International Relations, Freie Universität Berlin, 2016. His research focuses on the political, ethical, and epistemological dimensions of planetary sciences and technologies in the 21st-century. Schäfer has been a Guest Researcher at the Berlin Social Science Center (2009-2012); fellow of the Robert Bosch Foundation (2014-2015); Oxford Martin Visting Fellow, University of Oxford (2017); Visiting Fellow, Harvard University (2018), and Guest Professor at the University of Vienna (2020). Schäfer is currently a Research Group Leader at the Institute for Advanced Sustainability Studies in Potsdam and teaches at Humboldt University Berlin.

From Burnout to 7Up: On Bathing and Mining Grounds

Anastasia Kubrak

Bachelor of Arts, Design Academy Eindhoven, 2016. Designer, Master in Fine Arts and Design, Sandberg Instituut, The Netherlands, 2018. Kubrak co-curated the *Lithium* exhibition at the Het Nieuwe Instituut (2020) and contributed to *Digital Dilemma* at Bureau Europa (2019), to the 4th Istanbul Design Biennial (2018), to the São Paulo International Architecture Biennial (2017), and to the Bi-City Biennale of Urbanism/Architecture Shenzhen (2017). Her writing has appeared in the books *Design Dedication: Adaptive Mentalities in Design Education* (2020), and *IN/Search RE/Search: Imagining Scenarios Through Art and Design* (2020). Kubrak works at the Research Department of the Het Nieuwe Instituut, Rotterdam, and teaches at the MA Social Design at the Design Academy Eindhoven.

A late-night stroll through Google Street View takes me to the forgotten spa town of Vidago in Northern Portugal. I walk by the recently renovated luxurious Palace Hotel, once famous for its lavish bathing treatments and frequented by Portuguese monarchs. By the time it opened its doors in 1910, Vidago was already one of the most visited spa resorts in the country. The fame of its curative waters had spread so far that they were awarded prizes in Vienna, Paris, and Rio de Janeiro as early as 1876. Derived from deep bedrock of pure granite, the Vidago's thermal springs guarantee to ease one's digestion and soothe the exhausted nerves due to their unique mineral composition, which includes the element lithium. Today, not much of the former glory remains in the village, except for one opulent wellness hotel: as the industry went into decline with the advancement in medical sciences over the past century, most of the Vidago's amenities were abandoned or closed for sale.

Only 20 km West of the neglected resort lies Mina de Barroso, or Europe's own 'Lithium future.' At least, according to Savannah Resources, a London-based company awaiting governmental permission to begin the surface mining operation and to become the first European hard-rock producer of lithium. I learned this as I attended a Zoom conference on the state of the electric vehicle supply chain, amusingly titled "The World Tour West." Introduced by a moderator wearing a cowboy hat, the company's representative persistently reminded the viewers of the importance for the EU to secure its own independent lithium supply by exploiting the pegmatite rock, especially in the face of the looming ecological crisis.

What unites these two sites, apart from the adjacent locations? This mineral-rich geological formation continues to attract people and industries for the renewal of energy sources. A similar overlap occurs across the many territories in Europe and the USA, where former spa destinations are being rediscovered as prospective lithium mining sites. Silver Peak plant in Nevada, currently the only active lithium mine in the USA, was built around a tiny hot spring in Clayton Valley – and it is not a coincidence that it lies in proximity to the Tesla Gigafactory, the main driver of its supply. The exuberant bathhouses of Hot Springs, Arkansas, are located to the north of El Dorado, the proclaimed 'Lithium City' with the USA largest reported brine resource. Or take the recently discovered lithium deposit in Cinovec that sits near Teplice, one of the oldest spa towns in the Czech Republic. Both are situated on the slopes of the Ore Mountains, a protected geological region, where the histories of mining and drinking minerals have been for many centuries intertwined.

Since its discovery in 1817, lithium has promised to cure various states of exhaustion to which different bodies are subjected in the

energy-intensive capitalist regimes – be that the body of the human, machine, or the entire planet.[1] If the popularity of lithium in spring waters was once a response to the growing exhaustion of workers during the second wave of industrialization, the current boom of the lithium industry should be considered in line with this development: an attempt to capitalize on the geologically depleted planetary body.

As a remedy, lithium has transcended different epochs, ideologies, and economic conditions, responding to each energy crisis with a new set of promises. Yet, the growing dependence on lithium extraction and use further exacerbates the destructive symptoms that the element pledges to soothe. According to Byung-Chul Han, every age has its own signature afflictions. Given that the prevalent malady of today's neoliberal economy is a "burnout,"[2] I wonder: how do its symptoms manifest across different scales, bodies, and territories? And how exactly does one element come to be at the epicenter of this condition?

Lithium waters have been prescribed for the treatment of mania since antiquity.[3] But it was during the so-called epidemic of neurasthenia in the 1880s, that lithium waters gained proper popular attention.[4] The new nervous ailment was associated with the emergence of new cognitive forms of labor, affecting primarily overworked minds of businessmen and busy society women.[5] As rising preoccupation with mental exhaustion and 'brain gout' made it to newspaper headlines, lithium waters were commonly prescribed as 'nature's nerves tonic.' Around the 1910s, lithium spas were in such high demand, that many resorts started bottling their waters for commercial sale: one can still recognize the aftertaste of industrialization in the mineral waters of Lithia Springs, Vichy Catalan, Vincentka, or Gerolsteiner.

By this time, lithium waters were commonly consumed – drunk, inhaled, soaked in – by tired individuals, seeking to restore mental balance. Two weeks before the Wall Street Crash of 1929, the American supermarkets got filled with a new 'Lithiated Lemon Soda,' later known as 7Up. The drink was promoted as a mood enhancer for the exhausted workers and housewives during the Great Depression. And even if the mood stabilizing drug was removed from the soda in 1948, the calls to "fresh up," "keep on smiling," and get a "good disposition" continue to fuel today's culture of productivity through 7Up advertising.[6]

Throughout the 1970s, governments became increasingly interested in studying the calming effects of lithium on the level of populations. Since then, many studies revealed that cities with a higher concentration of lithium in the drinking water had lower rates of suicide and depression.[7] In El Paso, Texas, the higher presence of lithium was even linked to lower crime levels. Inspired by the reputation of lithium as a "Texas tranquilizer,"[8] in 1986, Stephen King speculated on the dark repercussions of mass medical treatment in a daunting sci-fi story titled "The End of the Whole Mess."[9] And even though there is no evidence that lithium has ever been added to water supplies artificially, many governments wondered if adding more of this mineral could serve to comfort citizens in times of crisis. Most recently, in the aftermath of the economic collapse of 2008, a study in Athens, Greece, curiously concluded that the addition of small amounts of lithium to the drinking water could provide an effective means to lower suicide mortality in the population.[10] Throughout the last centuries, and with each economic depression, lithium served as a restorative energy cure. However, the burnout of individuals was not the only condition that this element has been tasked to tackle.

Often portrayed as 'white petroleum,' lithium plays a paradoxical role in simultaneously energizing and depleting the body of our planet. As the Earth is exhausted of fossil fuels, the element has promised a 'green' redemption from the climate crisis while merely displacing the deficiency. The drastic consequences of lithium extraction on ecosystems have been subjects of many accounts – I will not attempt to cover them in this text. However, even

less known applications of lithium have inadvertently contributed to ecological damage. Used in thermonuclear bombs during the nuclear energy frenzy, lithium was also involved in accidents leading to mass destruction, including the infamous Castle Bravo test explosions conducted by the USA in 1954. Due to a miscalculation and unforeseen reactions involving lithium-7, the blast on Bikini Atoll, Marshall Islands, was 2.5 times larger than it was predicted.[11] The radioactive fallout proved lethal for local inhabitants, and it continues to affect countless human and non-human lives until the present day.

Soon after the series of nuclear escalations came a different kind of energy crisis, this time with petroleum shortages in the 1970s. It is precisely then that the first rechargeable lithium battery was invented by Stanley Whittingham.[12] The technology was – somewhat ironically – developed within the research lab of the oil giant ExxonMobil in the midst of the 1973 oil crisis.[13] During these years, the sudden realization of the finitude of resources sparked investments in renewable energy sources across the world, and major oil companies rushed to invest in electric cars. After the crisis seemed mitigated and the oil markets stabilized, the corporate interest in the batteries also dropped – and the dream of the electric car was abandoned for decades. This dormant dream became a reality only in 2008 when Tesla Motors leaped into the lithium-ion battery technology with its first model Roadster.

Before the loud breakthrough of the electric car, lithium batteries first reached the mass market quietly in the 1990s, with the advent of cell phones and portable electronics. Enabling devices to last longer without a need for recharging, batteries played an implicit role in a transition towards more flexible and mobile forms of labor. Assuring that office spaces sprawled out without boundaries, they were also complicit in pushing the expectations of productivity, setting the ground for today's compulsive achievement society.[14] In return, the chronic performance stimulated by the long-lasting devices has led to the appearance of new anxieties, from the "low-battery anxiety" to the existential dread of a dead phone.

Of course, the symptoms of mental exhaustion are not exclusive to the cognitive strain of a white-collar worker. To take one example, lithium miners of the Atacama Desert in Chile frequently suffer from depression and paranoia due to exploitative working conditions that have only worsened during the Covid-19 pandemic.[15] The bodies and minds of these miners continue to support the very material infrastructure behind the immaterial labor, absorbing the side effects of someone else's remote digital workflow and someone else's energy transition. Following Jussi Parikka, they register and embody "the chemical, metal, and mineral materiality of both hardware and hard work."[16]

Most batteries slowly die in our pockets, but sometimes they simply explode. The same reactive characteristics of lithium, which have complicated the work of nuclear scientists in the Atomic Age, continued to do so in the 2000s. Nokia, Samsung, Sony, and other companies have notoriously recalled millions of devices as some of their batteries overheated or set on fire – injuring people, burning down entire cars, offices, and airplanes.[17] The name of such an unstoppable chain reaction is "thermal runaway:"[18] once triggered, the battery's temperature starts rising exponentially within milliseconds, and the energy stored in it suddenly gets released. The risky explosiveness of lithium batteries is another trade-off for their high energy density – the quality that makes the technology economically appealing. While enabling humans to be more productive, devices burn out and strain under pressure too.

Personal, planetary, and technological exhaustion converge through the flows of lithium. Yet, while playing an implicit role in each energy crisis, perhaps the most destructive capacity of this element is if it further propels the fundamental idea of 'energy source' as something that is bound to govern every aspect of daily life – and

that is real, to begin with. The idea that the functioning of the human body should be primarily measured by the amount of energy it requires to perform certain tasks has been around for a relatively short time. The common metaphor that we live by, and which lies at the center of the current capitalist cosmology, emerged as recently as 1847, about the same time as the hot springs of Vidago attracted the first wealthy patients.[19] The discovery of the principle of conservation of energy by the German physicist Hermann von Helmholtz marked the birthdate of the scientific and cultural energetic doctrine that has once and for all recast humans, machines, and the planet, through one singular lens: labor power.[20] We all know where the story ends.

As described by Anson Rabinbach, the obsession with treating exhaustion in the late 19th-century "was not merely a sign of the 'real' weariness of individuals in industrial society, but of the negative aspect of the body conceived as a thermodynamic machine capable of conserving and deploying energy."[21] While the world energy consumption is expected to double by 2050, perhaps the treatment for the ongoing burnouts cannot be reduced to generating 'more' of the different kinds of energy – or generating them more sustainably, just with the right amount of lithium. The issue is that we continue to rely on the concept of energy after all. And as one single chemical element managed to launch and sustain an unstoppable chain of depletions across bodies, epochs, and territories, we better not expect the poison to become its own remedy anytime soon. ⊘

1. Fragments of this text were previously published as part of "Lithium," an exhibition at the Het Nieuwe Instituut, 2020-2021.
2. Byung-Chul Han, *The Burnout Society* (Stanford, CA: Stanford University Press, 2015).
3. Walter A. Brown, *Lithium: A Doctor, a Drug, and a Breakthrough* (New York; London: Liveright Publishing, 2019).
4. David Habets, Cameron Hu, Stefan Schäfer, "The Missing Mineral," *Migrant Journal*, vol. 5, no. Micro Odysseys (2018): 46-55.
5. George Miller Beard, *American Nervousness, Its Causes and Consequences: A Supplement to Nervous Exhaustion (Neurasthenia)* (New York: Putnam, 1881).
6. "Fresh up—keep smiling!" "Fresh up while you work!" "Laugh! A good disposition will help you win a better job... Keep going strong!" "Be a 'fighter-backer': your work is your weapon!" are some of the quotes and slogans from various 7Up advertising, published between 1929-1945, when lithium was still added to the drink.
7. Antonio Vita, Luca De Peri, Emilio Sacchetti, "Lithium in drinking water and suicide prevention: a review of the evidence," *International Clinical Psychopharmacology*, vol. 30, no. 1 (2015): 1-5.
8. "The Nation: The Texas Tranquilizer," *TIME*, October 4, 1971. Retrieved from: <http://content.time.com/time/subscriber/article/0,33009,905404,00.html>. Accessed 4 February 2021.
9. Stephen King, "The End of the Whole Mess," *Omni Magazine*, vol. 9, no. 1 (1986).
10. Orestis Giotakos; Paul Nisianakis; Giorgos Tsouvelas; Vera Giakalou, "Lithium in the Public Water Supply and Suicide Mortality in Greece," *Biological Trace Element Research*, 2013. The correlation between this study and the 2008 economic crisis was drawn by Habets, Hu, Schäfer in "The Missing Mineral." See note 4.
11. "Operation Castle," <nuclearweaponarchive.org>. May 17, 2006. Accessed, February 4, 2021.
12. The first rechargeable lithium battery was developed by Dr. Stanley Whittingham. In 2019, his work was awarded the Nobel Prize in Chemistry along with Dr. John Goodenough and Dr. Akira Yoshino.
13. Seth Fletcher, *Bottled Lightning: Superbatteries, Electric Cars, and the New Lithium Economy* (New York: Farrar, Straus and Giroux, 2011).
14. "Supercharged! Long-lasting. Keep going, and going, and going. The power to do more." Quotes from the selection of lithium-ion battery advertising, 1991-2001.
15. Godofredo Enes Pereira, "Lithium Dreams: Extraction in the Salar de Atacama." Video lecture from November 19, 2020, at the Het Nieuwe Instituut. Available at: <https://live.hetnieuweinstituut.nl/en/activities/lithium-dreams-extraction-salar-de-atacama>.
16. Jussi Parikka, "Dust and Exhaustion: The Labor of Media Materialism," *CTheory*, Theory Beyond the Codes, 2013.
17. Alana Semuels, "When Your Amazon Purchase Explodes," *The Atlantic*, April 30, 2019. Available at: <https://www.theatlantic.com/technology/archive/2019/04/lithium-ion-batteries-amazon-are-exploding/587005/>.
18. Xuning Feng, Minggao Ouyang, Xiang Liu, Languang Lu, Yong Xia, Xiangming He, "Thermal runaway mechanism of lithium-ion battery for electric vehicles: A review," *Energy Storage Materials*, vol. 10 (2018): 246-267.
19. Ivan Illich, "The Social Construction of Energy," *New Geographies*, vol. 2, no. Landscapes of Energy (2009): 11-19.
20. Ibid.
21. Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley, CA: University of California Press, 1992), 48.

The Architecture of the European Mineral Spa

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In his seminal work *Mechanization Takes Command* (1948), the architectural historian Sigfried Giedion sought inspirational architectural prototypes to combat the horrors of mechanization and war.[1] Giedion pointed to the public bath as an architecture for total regeneration, one that would be able to promote new cultures of collective holism. Today again we might look to the histories of the public bath as we seek ecological and social regeneration in the face of extractive economies and technologies. Within the European context, we find in the spa an architectural and urban typology.

Spas have always been architectures of power, where the elements are harnessed successively by empire, church, aristocracy, state, and capital. Largely dominated by neo-liberal capitalist regimes, contemporary spas could nevertheless be repurposed – following Giedion's reflections – as places for the equitable global distribution of power and the production of new spaces for shared enjoyment, architectures to combat the inexorable pace of extraction, production, and consumption powered by mineral bodies.

Mineral Springs

Before there was a spa town, there was a mineral spring: a source that remains at the center of the place. Plants and animals have drawn from it over millennia. Springing from below, pools and ponds, forming marshes and rivulets that connect to other bodies of water. These earthy waters continue to flow up, stubbornly resisting transformation in the neutral commodity of H_2O by the sheer unnerving funk of their taste and smell.[2] The water of a treasured source is not clear; its suspended mineral content gives it a scent and a hue. It stains the fabric with sulfur and oxides. It corrodes jewelry and pipes, and when we drink it or soak in it, it affects us.

These sources or *aquae* are the most visible landmarks identified by the ancient Romans on the *Tabula Peutingeriana* map of the empire from the 1st-century. Formalized and framed by the Roman Empire as it expanded, the mineral source, hot or cold, becomes the opportunity for the construction of a fountain, small baths, or large thermae at the heart of a new colony. The Roman Hammam Essalihine in Algeria was built over cold and hot mineral water sources and has been enjoyed continuously for two millennia. The Cluny Museum in Paris is a Roman thermae in ruin. Bath in England was a pre-Roman site of worship to the deity of the spring, later taken over by a Roman bathing and religious complex, now a museum. The waters remained in use through the Middle Ages, evolving into a spa town in the 17th-century, later rejuvenated as Thermae Bath Spa in 2006. In Aachen and Baden-Baden, Roman buildings were incorporated within active spas whose architecture continued to evolve.

The springs of Europe were not celebrated in the Middle Ages with distinct architectures. They served as healing centers where drinking and bathing were medicine

for the ill, tended and guarded by monks in compassionate service. Waters with unique compositions and qualities occupied the field of medicine more than hygiene. While public baths in medieval European towns and cities served, in fact, for hygiene, their buildings were largely indiscernible from the surrounding vernacular, and they used water sources as available. These bathhouses disappeared following outbreaks of the plague and other contagious diseases.

Wellbeing

In the 16th-century, the German physician and alchemist Paracelsus traveled throughout Europe seeking healing springs as he studied natural science, medicine, geology, and chemistry. His writings were widely read by doctors of the 17th-century, including Francois Blondel of Aachen, who introduced balneology as a medical and scientific discipline, prescribed both bathing and drinking cures to clients, and assisted in the design of bathing spaces in his region. The doctors of the wealthy begin to advise their sick patients to take 'water cures' at Vichy or Bad Ems in the 17th and 18th-centuries. Upon arrival after a long journey, they found minimal supports. It is from the desire for better accommodations to suit these affluent medical tourists that the architecture of the spa town rises.

When, in the hopes of curing her rheumatism, the French aristocrat Madame de Sevigne traveled to Vichy in 1676, she encountered magma-heated naturally sparkling water, rich in mineral salts and elements, including bicarbonate, lithium, calcium, iron, manganese, potassium, strontium, zinc, and fluoride. Under the doctor's direction, her daily schedule for a stay of some weeks included drinking glass after glass of water each morning at six o'clock, walking until evacuating, being sprayed with a hose for thirty minutes while supervised by a medic who read from Descartes to distract her from the ordeal, and, finally, being wrapped up in blankets to sweat in bed. She returned the next year to do it again, attributing her wellbeing to the waters.[3] Hotels of the spa towns grow under royal patronage, and with them come treatment buildings or cure houses, theatres, gambling houses, places of worship and merriment.

Enjoyment

In Imperial Europe, the spa offered extra-urban experimental sites of enjoyment for aristocrats and gentry. The 18th-century spa drinking hall was the social centerpiece, where the health-seekers assembled to fill and refill their cups from sculpted spigots. The hall was ringed with adjoining rooms for gambling, reading, games, eating, drinking coffee, and other amusements. Immersion and shower bathing in water-based treatment rooms occurred in the 'cure house,' a separate building. Lodgings for visitors and a theatre for their entertainment would complement the scene. The spa town expanded functional programs, and their buildings were increasingly developed as a kind of model city combining hygiene with leisure. The construction of the spa's outdoor spaces through landscaping and planning grew in importance alongside romantic philosophies of the 18th-century. The Swiss philosopher Jean-Jacques Rousseau (1712-78) was an advocate of cold-water bathing and fresh air, and his writing supported a revival of the natural as good, healing, and clean. The importance of the outdoor daily walks in the towns gain support by carefully designed parks and gardens, networked and planned in an ensemble of pathways leading to landscape follies, fountains, outlooks, bridges, open-air pavilions, funiculars, monuments, and colonnades. When Park of Springs was created at Vichy in 1812, following Napoleon's orders, its radial geometries set a new standard for open space design in the spa town.[4] A further empirical edict by Napoleon III in 1861 developed a 13-hectare riverside strolling park in an English style.

Control

Following the French Revolution and alongside industrialization and the rise of the bourgeoisie, the spa became a social destination for an increasingly middle-class visitor. Its users were able to travel affordably via growing railway networks. The spa town

more consciously reflected and absorbed the lessons of environmental degradation in the industrial city, experimenting with forms that might remedy that condition. Sunlight and open spaces imagined what design for health might be in a world of contagion. If Pasteur's germ theory explained how a water pump in the industrial city could spread cholera, death, and disease, the spa faucet served as an instrument of control for the spreading of health. The formal expression of the spa constellates the rise of industrialization and mechanization alongside trends in medicine and philosophy. In the 19th-century, industrial capitalism embraced exhaustion and excess as leisure time cleaves itself from work time. A trip to the spa to regenerate the white-collar worker will make them fitter, more ready to work.

As in the Roman era, the spring itself becomes designed as a feature at the spa in increasingly ornate displays of poetry and function. Each source of water will become celebrated with its own pavilion, a secular temple to the *genius loci* that protects an ever-flowing fountain. The pumps and the faucets extracting the earth's medicine are a show of power as much as abundance, claimed by the state or patron to whom it is dedicated. This control manifests through the work of the engineer in a tap that can be turned on and off. Of the dozens of mineral springs tapped beneath the spa town of Mariánské Lázne (Marienbad) in the Czech Republic, the most famous, bearing the names Rudolph, Caroline, Ferdinand, Ambrose, and Cross, are protected by ornate, dedicated pavilions, and colonnades.

The cities of this era developed the institutional architectures of the school, prison, hospital, and opera, framed by tree-lined avenues above ground and services below, as we find in Haussmann's Paris. If, as understood by Michel Foucault, these institutions were designed by the bourgeoisie for the management of populations under the rising functions of the state, rather than the aristocracy, we see the spa town starting to follow suit in terms of the planning and scale of the building. Foucault's work makes evident the double condition of the spa as a space for control and leisure. In *On Other Spaces*, written in 1966, the French philosopher offers an argument for spa buildings and towns functioning as heterotopias of purification.[5] In his later writings, spas are instruments of biopolitical regimes which institutionally inscribe bourgeois capitalist spatiotemporal rhythms onto bodies.[6]

As experimental forerunners of a new kind of urbanism, the cohesive density of the medieval town is opened up and expanded into the countryside. The spa becomes a testing ground and, at times, an inverse mirror that addresses the ills of contemporary city life with the expanding ambition and control previously reserved for the palace. The casino, cure house, treatment facility, museum, arcade, opera, thermal baths, assembly room, dance hall, grand hotels, become developed as buildings on their own, surrounded by green space. The buildings become individual players in a proto-suburban ensemble: a city set into a park, the prototypical garden city. While Neoclassicism dominates many iconic spa buildings, it gives way at the end of the century to exuberant exposed steel structures celebrating industrial production like Vichy's Hall of Springs.

With the onset of World War I, European spa life halts and then continuously declines as a fashionable destination and a cultural *locus*. Spa towns such as Vichy are frequently repurposed in wartime as military headquarters. Following the Russian Revolution, new centers of mass leisure emerged in the Soviet sanatorium.[7] An annual two-week holiday at the sanitorium was mandated by Lenin in 1922 to all citizens as an anti-imperial collective regeneration, with massive steel-reinforced concrete as the revolutionary material. The many surviving Soviet-era spas spread from Poland to Uzbekistan are inspiring in their ambition for egalitarian inclusivity.[8]

Regeneration

With the continuity of global public bathing cultures fractured by capitalism, colonialism,

mechanization, and technologies of isolation, these centers for regeneration promise a remedy for exhaustion. However, to what extent might these places offer us the elusive emancipatory architecture of *jouissance*, sought by Henri Lefebvre in his 1973 book *Towards an Architecture of Enjoyment?*[9] The spas can also inspire reflection on histories and practices of an expanded notion of the commons: access to clean air, sunlight, and water. They experimented with cultural rituals and architectural forms dedicated to the subterranean aquatic spirits of the place, offering them a form of protection. Both historic residues and living practices, in the architectures and cultures of the spa, we glimpse material and theoretical foundations to be reclaimed as we seek to build new architectures of enjoyment based on new relationships to power, regeneration, community, embodiment, and connections with all forms of life.[10] ⊘

1. "The bath and its purposes have held different meanings for different ages. The manner in which a civilization integrates bathing within its life, as well as the type of bathing it prefers, yields searching insight into the inner nature of the period. Bathing, in whatever fashion performed, is concerned with the care of the body. To maintain the balance of this delicate instrument, to dwell in harmony with our organism, is a prime necessity of life. Some periods have viewed bathing as part of a broad ideal: total regeneration. Other periods have seen it as a mere ablution to be performed in swiftest routine. One age may weave bathing into the well-being of the whole man. Another age may see it as an isolated act, or neglect it altogether. The role that bathing plays within a culture reveals the culture's attitude toward human relaxation. It is a measure of how far individual well-being is regarded as an indispensable part of community life. This is a social problem." Sigfried Giedion, *Mechanization Takes Command* (New York: Oxford University Press, 1948), 628.
2. Ivan Illich, *H20 and the Waters of Forgetfulness* (Berkeley: Heyday Books, 1985).
3. Katherine Ashenburg, *The Dirt on Clean* (New York: North Point Press, 2007), 120.
4. Ian Bradley, *Health, Hedonism & Hypochondria: The Hidden History of Spas* (London: Tauris Parke, 2020), 147.
5. "Heterotopias always presuppose a system of opening and closing that both isolates them and makes them penetrable. In general, the heterotopic site is not freely accessible like a public place. Either the entry is compulsory, as in the case of entering a barracks or a prison, or else the individual has to submit to rites and purifications. To get in one must have a certain permission and make certain gestures. Moreover, there are even heterotopias that are entirely consecrated to these activities of purification – purification that is partly religious and partly hygienic, such as the hammin of the Moslems, or else purification that appears to be purely hygienic, as in Scandinavian saunas." Michel Foucault lecture notes 1967, published as "Des espaces autres," in *Architecture/Mouvement/Continuité*, no. 5 (1984): 46-49. Translated by Jay Miskowiec.
6. Michel Foucault, *The Birth of the Clinic* (New York: Routledge, 1973; originally published by Presses universitaires de France, 1963).
7. Tijana Vujosevic, "The Soviet Banya and the Mass Production of Hygiene," *Architectural Histories* vol. 1, no. 1 (2013): p.Art.26.
8. Maryam Omidi, *Holidays in Soviet Sanatoriums* (London: Fuel Publishing, 2017).
9. "What it weighs upon is weightless, but it crushes what it rests upon: the body, the everyday, usage and wear, symbols of depression, femininity. Bound to pleasure and the body, humiliated like them, overwhelmed, exploited, reduced by the many stratagems of false praise [...] That there is no architecture, or to put it in simpler terms, that there exists no morphology of enjoyment, that it is barely conceivable and almost unimaginable, is terrifying." Henri Lefebvre, *Toward an Architecture of Enjoyment*, edited by Łukasz Stanek, translated by Robert Bononno (Minneapolis: University of Minnesota Press, 2014), 59.
10. "In our living condition we are constituted by the effects of forces, with their diverse and mutable relationships that stir the vital flows of a world. These forces traverse all the bodies that compose the world, making them one sole body in continuous variation, whether or not we are conscious of it. [...] We usually call 'intuition' the extra cognitive mode of decoding that is proper to affect's power of assessment. However, this is a word so worn out in our culture [...] that I propose to replace it with 'body-knowing' or 'life-knowing,' an eco-ethological knowing." Suely Rolnik, "The Spheres of Insurrection: Suggestions for Combating the Pimping of Life," *E-flux*, no 86 (2017).

From the Origins to the Ends of Life on Earth: Caring for Microorganisms in the Salt Desert[1]

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"From the Origins to the Ends of Life on Earth: Caring for Microorganisms in the Salt Desert" provides an overview of the ongoing conflict over the waters of Salar de Llamara. This is a singular case, where *stromatolites* – sedimentary rocks produced over 3.5 billion years by the accumulation of layer upon layer of cyanobacteria – have become unlikely protagonists of disputes that pit mining companies against indigenous, local, and environmentalist groups.

The Origins of Life on Earth

PAG. IV | FIG. 1

The Salar de Llamara is a salt basin located in the Tarapacá region, in the Atacama Desert in Chile. It is one of the most singular environments on Earth. A *salar* is a water body covered by a hard crust of sedimentary rocks – evaporites – formed by the extreme evaporation and concentration of saltwater due to the desert's arid climate. In Llamara, this crust is interrupted by naturally forming springs, waterholes locally known as *puquios* (a word taken from the Quechua language). Surrounded by low-level vegetation, *puquios* give the impression of oases in an extraterrestrial landscape.

In this environment, a rare type of microorganism thrives, which is classified as extremophiles (from Latin *extremus*, "extreme", and Greek *philia*, "love"). These microorganisms can survive in the *salar's* hypersaline environment in the form of microbial layers located in the edges of the water holes. Mucus produced by one of these saline extremophiles, cyanobacteria, has been layered over time into laminated accretionary structures called 'stromatolites,' considered to be the Earth's oldest fossil, and dating back to 3.5 billion years.[2] It was these microorganisms' ability to break down hydrogen peroxide into oxygen and water that, according to scientists, led to the Great Oxidation Event, facilitating the propagation of multicellular life on Earth.[3] Because of this, extremophiles are key to studying the origins of life on this planet.[4]

Extremophile microbial ecosystems are extremely rare. They are defined as environments that have a stable or fluctuating

exposure to one or more environmental factors, such as salinity, conductivity, desiccation, UV radiation, barometric pressure, pH, or temperature. A shift in any of these would result in the death of the microorganisms. Today, the unique ecosystem of the Salar de Llamara is experiencing dramatic changes. The water that feeds into it artificially is altering the chemistry of the *puquios*, and efforts to restore the situation have caused drastic shifts to the balance of the ecosystem. The reason for this: resource extraction.

SQM

PAG. V | FIG. 2

The Antofagasta and Tarapacá regions of Northern Chile have historically been places of intense mineral extraction. Since the last quarter of the 19th-century, nitrate mining (saltpeter) was amongst the most profitable activities in the region. This was focused on the gypsum evaporite systems – caliche ore- where extremophiles are sometimes found.

During the 20th-century, nitrate mining declined and was replaced by copper mining, becoming the main export coming from the Atacama. But in the last decades of the 20th-century, extraction companies returned to the region. Since 1993, the Chemical and Mining Society of Chile (SQM) started operating in the vicinity of the Salar de Llamara, upon the concession of the Chilean government. SQM mines caliche ore deposits that exclusively exist in the North of Chile and are the only source of commercially exploitable natural nitrates in the world. Its industrial areas around and within the Salar de Llamara occupy 199.2 km^2 and include mine areas, production plants, and evaporation ponds. SQM is the world's largest producer of potassium nitrate, iodine, and lithium (the last one extracted from brines found further South, in the Salar de Atacama). SQM's Sur Viejo facilities produce 11,000 tons of Iodine, while 1,200,000 tons of nitrates are produced by the Nueva Victoria evaporation ponds. Until 2015, SQM's chairman – now main shareholder – was billionaire Julio Ponce Lerou, the ex-son-in-law of Dictator Augusto Pinochet, and often associated with government corruption, fraud, and embezzlement.[5] Not only are SQM's minerals found in fertilizers, medicine, and a range of industrial uses worldwide, but thanks to lithium, they are also at the center of the energy transition – in the case of lithium, for both small and large-scale batteries. According to their website's statement, SQM provides "solutions for human progress."

Water

PAG. VI | FIG. 3

As in every other form of mining, water is at the center of SQM's operations. In the case of the Atacama, its role is even more crucial, given how this is the driest desert on Earth, with very low average levels of rainfall. SQM Nueva Victoria has the rights to extract waters from the Salar de Llamara since 1997. Water – or in the case of Llamara, brackish water, containing between 0-30 parts per thousand of salt – is essential for mineral processing. After being dug out, the extracted ore is heap leached. This is a process in which water is sprinkled over mountains of ore to generate a leaching process, using a solution of key chemical components that slowly leaks down into containers. These solutions are then moved to solar evaporation ponds – pools where water evaporates – so that the salts with high nitrate concentrations crystallize, later sent for further refinement, become iodine and nitrate.[6] Mining activities have access to 224.7 l/s, extracted through 7 wells located across the Salar de Llamara. As a reference, local indigenous communities like Huatacondo have the rights to between 2 and 17 l/s depending on the season.

After the indication in 2009 by the Chilean Dirección General de Aguas [General Water Department],[7] stating that the salar's ecosystem was being affected, SQM started reinjecting the extracted water in 2010. This was part of a plan to implement a "hydraulic barrier" halfway between the extraction wells (further up and north of the salt flat) and the area of the water holes (to

the south of the *salar*), and thus prevent the level of water in the *puquios* from dropping. The company built re-injection wells but soon realized that the measure didn't work, as the water table dropped steeply. SQM then decided to build eight new reinjection wells alongside the *puquios* without previous study nor due authorization. Such a superficial reduction of the *salar* to a water reservoir instead of a complex ecosystem was bound to have negative effects.

While the reinjection allowed the *puquios* to be refilled to their previous levels (and despite the surrounding water table it continued dropping), this led to an even worse problem: a change in the chemical composition of the underground water, lowering the levels of saltiness required by extremophiles and leaving the natural balance of underground aquifers seriously compromised. The problem was not only water but what *kind* of water.

According to a recent report published by the Center for Applied Ecology in Chile, under the responsibility of Dr. María Eugenia Farías, the water conditions of the *puquios* in Salar de Llamara have been altered due to water reinjection.[8] There was an increase in *chlorophylla*, as well as of planktonic diversity.[9] In practical terms, this means that as the water conditions are changing, there is a process of eutrophication and the balance of this unique ecosystem is at risk.

Legal Disputes

PAG. VII | FIG. 4

In 2012, the Salar de Llamara became an "area of restriction" but to little avail.[10] After complaints by the Dirección General de Aguas and several local indigenous communities, in 2016, the Environmental Superintendency filed charges against SQM for lack of reporting the environmental data collected, for tampering with water level measuring data and equipment, and, more importantly, for having changed its reinjection wells unilaterally, without authorization or an Environmental Impact Assessment. In 2017, the First Environmental Tribunal ordered a stop to water extraction from the wells that SQM owns in the Salar de Llamara. As the minister and lawyer of the First Environmental Tribunal, Mauricio Oviedo, stated:

> The decision is based not only on the findings of formal breaches of the RCA but also on the violation of Constitutional and International Law, which put the state in charge of the protection of the environment and the conservation of the environmental heritage.[11]

The statement is an important marker in the dispute. But, while it is true that International Law has been violated, both the ability and willingness of the state to properly operate as the main responsible for environmental protection is something that in Chile has been questioned for a long time and for good reason. For example, the court soon after received notice that because of the closure of the illegal reinjection wells, the water level of the *puquios* was dropping by 5 mm every day. In a context where a decrease in water tends to be symptomatic of environmental destruction, the court decided to re-allow the reinjection process, despite the Environmental Superintendency stating that for extremophiles (the object of protection), the drop in water levels was actually better than reinjecting the wrong type of water. However, for governments whose main concern is to demonstrate environmental credentials, more water and more green are always good.

Stewardship

PAG. VIII | FIG. 5

Indigenous people play a very important role in this region, in particular the Quechua Indigenous Community of Huatacondo, a territory where the Salar de Llamara is largely situated. As a people, Huatacondinos came into being together with this land: the desert, which might appear as a harsh and unwelcoming place for the most, was and still remains home for many. While their main settlements are located high in the Andes pre-cordillera, traces of *senderos* (pathways) and geoglyphs (markings and

drawings on hillsides) are scattered across the territory, together with smaller settlements, agricultural sites, and stone shelters for pasturing. Amongst many archaeological findings in this region, some are thought to be almost 13,000 years old, like Quebrada de Maní, considered to be the oldest settlement known so far in the north of Chile.

Huatacondo's territory extends from the top of the cordillera, at the border with Bolivia, down to the Pacific coast. At its center, the *salar* has been used since ancestral times by Atacameños, Aymaras, and Quechuas to transit from the mountain range to the sea in search of guano for their crops, and for barter and trade. They even have the namesake *puquio* – the Puquio de los Huatacondos – which, more than a water hole, is a site of pasture and overnight stay, a crucial marker in an ancestral territory – and an oasis where for thousands of years, generations of human, animal, vegetal and extremophile entities coexisted peacefully.

After the 1993 Indigenous Law came into force, Huatacondinos started a slow process of legal recognition and recovery of their ancestral lands. As of 2013, they also enlisted the help of archaeologists from the Atacama Desert Foundation. This is a matter of recovering ancestral lands in a desert mostly dedicated to resource extraction or, at least, preventing further incursions, thus implementing forms of sustainable environmental management so that communities can subsist. Currently, any mining expansion process has to submit an Environmental Impact Assessment Study to the Service of Environmental Assessment (SEA). Since 2009, due to the ILO's Convention 169 implementation, prior and informed consultation with local communities is required to obtain an environmental (operational) license. It is mostly through related mechanisms of independent baseline construction and due diligence, that indigenous people today manage to protect their environment with some degree of success.

In recent years, the community of Huatacondo has reported to the Superintendency for the Environment several violations carried out by SQM, which have severely impacted the natural systems of the region. Huatacondo is fighting not only SQM, located downstream from their main settlement, but also, upstream, the copper mines of Quebrada Blanca (Teck) and Collahuasi (Glencore, AngloAmerican, Mitsubishi), which have seized their waters and contaminated their environments. At stake for indigenous communities is the protection of incredibly fragile ecosystems, whose existence is deeply bound with the communities themselves, against the encroaching necropolitics of global mining corporations. And while national governments are typically the responsible entities for the protection of the environment, indigenous peoples all across the world, such as Huatacondinos, believe they are better suited for that role, as they tend to be more capable of establishing integrated plans of environmental stewardship, knowledge exchange, monitoring, and sustainable development.

The Ends of Life on Earth

PAG. IX | FIG. 6

The conflict around extremophiles in Salar de Llamara is paradigmatic of contemporary environmental disputes. While big oil has been under pressure for many decades to 'keep it in the ground,' companies such as SQM mine products for agriculture, medicine, and renewable energies, that remain crucial in most global energy transition scenarios (if even these ever come to pass). This means that the pressure over territories as fragile as Salar de Llamara is only increasing. Not to mention that SQM's more profitable product is lithium, and it will likely start its extraction from the Llamara as well. Against this, resistance is essential, be it towards the incorporation of better standards and norms to regulate extraction, or where possible, towards blocking extraction *tout court*.

And here, two key issues: the first, regards the necessary support for indigenous peoples in their seeking of territorial autonomy. That is, not only recognizing the commonality between extractivism and

the colonial project but also a decisive step towards promoting more adequate forms of collective environmental care. From an indigenous perspective, stewardship is not simply a matter of keeping things green and lush but a matter of care for environments in their uniqueness, imbued as they are of ancestral rights and presence. The second crucial issue will be the ability to articulate environmental struggles with a critique of capitalism, especially with Chile's neoliberal strand, long-promoted as a resounding success. While there is much to be hoped from the alliances in place between researchers and indigenous peoples, long-term success will only be achieved if broader alliances are established, moving away from extractive models of development. For if the future of resource extraction is being debated in the forums of the energy transition, current 'green new deals' remain too dependent on capitalist modes of land appropriation, exploitation, and plunder of resources.

In such a context, the struggle for extremophile microbial ecosystems is a vital marker. Requiring forms of environmental protection that do not disconnect discrete entities from their environments, the conflict around the Salar de Llamara makes evident the challenges facing environmental justice movements: to draw attention to the singularity of the beings and environments that populate the Earth while countering forms of 'protection' that may detach them from the environmental relations that sustain them. And here, the role of indigenous peoples is central. Through indigenous territorial knowledge practices, salt flats can be understood as caring devices for 'extreme' bacteria as well as for coexisting forms of life. Knowing more about extremophiles and caring for them is a way of connecting the remotest past to a possible future, where these relict beings are left to thrive. In this way, the 'tools of the oppressor' – in the form of classificatory modes of knowledge production – might be reverted to reclaim and exercise indigenous autonomies towards the rights of future generations. Looking at the strange and fragile beauty of the *puquios*, one cannot but think of the many peoples alongside which they coexisted for thousands of years, in the carefully fine-tuned form of indigenous collective care, and, in contrast, of the uncaring destructive violence of capitalism. ⊘

1. This text is the product of an ongoing collaboration between Godofredo Enes Pereira, the Lithium Triangle Research Studio at the Royal College of Art, London; lawyer and anthropologist Alonso Barros; and Fundación Desierto de Atacama, Chile.
2. Manuel Contreras, Maria Eugenia Farías, *Guía para la conservación y seguimiento de ecosistemas microbianos extremófilos*, Centro de Ecología Aplicada; SEREMI del Medio Ambiente de Antofagasta, 2017.
3. Ana Gutiérrez Preciado et al., "Functional Shifts in Microbial Mats Recapitulate Early Earth Metabolic Transitions," in *Nature Ecology and Evolution* 2 (2018): 1700-1708. Available at: <https://www.nature.com/articles/s41559-018-0683-3?WT.feed_name=subjects_ecology>.
4. Puri López-García, "Metabolic Evolution in Ancient Microbial Ecosystems," in *Nature Research Ecology and Evolution*, October 8, 2018. Available at: <https://natureecoevocommunity.nature.com/users/178164-puri-lopez-garcia/posts/39438-metabolic-evolution-in-ancient-microbial-ecosystems>.
5. See: Manuel Salazar, *Todo sobre Ponce Lerou de yerno de Pinochet a millonario* (Santiago: Uqbar Editores, 2015).
6. See: "SQM on the North," available at SQM's website: <https://www.sqm.com/sqmeninfografias/eng/presence.html>.
7. Dirección General de Aguas (DGA) General Directorate of Water, is the Chilean Government body that supervises water issues.
8. Manuel Contreras, Maria Eugenia Farías, *Guía para la conservación y seguimiento de ecosistemas microbianos extremófilos*, 2017.
9. Ibid.
10. "Areas of restriction" are hydrogeological sectors in which there is a risk of a considerable diminishment of the groundwater that is naturally contained, with subsequent harm to already existing third-party water right holders. The Salar de Llamara was declared a restricted area on the 16 of January 2012 (Resolution N°5 of the DGA), based on the data presented in Technical Report N° 517 of November 22, 2011. It was decided that groundwater rights could be granted provisionally, up to a volume of 4,298,357 m^3 per year. Also, according to Technical Report SDT N°281 "Re-evaluation of Groundwater Hydric Resources in the Salar of Llamara," of September 2009, the total sustainable volume of the aquifer is 6,591,024 m^3.
11. "Tribunal Ambiental autoriza clausura temporal de pozos de SQM en el Salar de Llamara," *La tercera*, December 13, 2017. Available at: <https://www.latercera.com/noticia/tribunal-ambiental-autoriza-clausura-temporal-pozos-sqm-salar-llamara/>.

On the Ground

Rolando Humire, Cristina Dorador, and Alonso Barros, in conversation with Godofredo Pereira

Rolando Humire
Biochemist, Universidad de Chile, 2010. Humire Coca was President of Consejo de Pueblos Atacameños, 2013, and commissioner of the Chilean Lithium National Commission, 2014. He was counselor to the Chilean National Institute for Human Rights (INDH), 2015. Humire Coca currently works as an independent researcher and advisor to local communities in the Atacama Desert.

Cristina Dorador
Microbiologist, University of Chile, 2002. PhD in Limnology and Aquatic microbiology, Leibniz Institute for Marine Sciences at the University of Kiel, Germany, 2007. Dorador has specialized in the microbial ecology of extremophiles and extreme environments of the Chilean Altiplano and Atacama Desert. She is Associated Professor, University of Antofagasta, Biotechnology Department. In 2021, Dorador was elected as one of the 155 Chileans who will write the new Constitution for the country.

Alonso Barros
For biography, see page 024.

Godofredo Pereira
For biography, see page 024.

For four years, the Lithium Triangle Research Studio at the MA Environmental Architecture program, Royal College of Art, London, has examined the socio-environmental impacts of lithium extraction in collaboration with indigenous leaders, researchers, and advocacy teams working on the Atacama Desert in Chile. Within the colonial-capitalist race for the underground frontier, the Atacama has become a unique underground attractor. Due to its mineral riches, the Atacama's peoples and environments have been dramatically impacted by the cycles of mining that ravage the desert since the early days of the Spanish colonization, from silver and gold to nitrates, copper, and now lithium. With each mining boom come new forms of land appropriation, new architectures of extraction, new events of environmental destruction, new forms of violence over the peoples and beings of the desert.

The conversations that follow, with the indigenous leader and biochemist Rolando Humire, the microbiologist Cristina Dorador, and the lawyer and anthropologist Alonso Barros, provide entry points to a much-needed awareness of what happens in extraction sites. From different perspectives, each of them speaks of worlds ignored by the 'green' transition while sharing knowledge developed in the struggle against mining companies. As a whole, these conversations highlight some of the different avenues by which the extractive gaze is fought against, claiming other modes of existence – windows into the multi-scalar and intertemporal complexities of the desert, which capture some of the impacts of the long *durée* of extraction, over peoples, ecosystems, microorganisms, cultures, cosmic deities, among many others.

Rolando Humire

Godofredo Pereira (GP): Can you tell us a bit about your involvement with the Lithium Commission?

Rolando Humire (RH): I was very curious about the indigenous movement because it was becoming important. It was very segregated at the time, but people wanted to unite. Given my background, I felt a kind of historic responsibility. So, I decided to commit to the movement, to be part of it, in order to

contribute through my knowledge, information, and experience. Afterward, I was elected leader of the eighteen local communities. I guess this was around 2013, when the lithium frenzy and the transition to electric mobility were starting. The main challenge during my period as a leader was the National Lithium Commission, created by President Bachelet in 2014. It was a lot of work. It was nice to take part in the conversations and presentations as someone with a background in biochemistry. The issues were quite technical: about how salt flats and groundwater hydrology work, as well as many other concepts of that kind that the elders don't really understand.

We defended our vision because, when this commission of experts was formed, they never considered the local people from the Atacama. But they came to Peine. I don't know if you've visited. It's a small town on the southern edge of the Atacama salt flats. They came and invited us to some sort of ceremony in which they told us what they were going to do in our land and that was that. But I have a very strong personality. And I stood up and said to the minister of mining that they wouldn't do anything without our blessing since the land was ours. Not because a piece of paper says so, but because of history.

I will make a comparison. There's proof that ancient peoples have lived here for more than 10,000 years. But the Chilean Republic arrived here after the Pacific War in 1878. If you compare 10,000 years with 100 years, it's 100 times. So, we are certain this land is ours, and we aim to get it back; that is our struggle. The entire district of San Pedro de Atacama is about 3 million hectares. We know it won't be an easy task to get our land back with papers (titles), but Chile is part of the ILO Convention 169 (C169), since 2008. That convention has some particularities, the most important being that it forces all signatory countries to consult with First Nations every time they are about to make a decision that might have some impact on the communities and their territories.

Thus, when the Lithium National Commission was created, we complained about not being part of it. But after my exposition to the minister, I was unanimously invited to join it. I had, of course, a scientific background, and I could understand what they were planning. It was a struggle because they still had old-fashioned ideas. They thought we were stupid, that we walked around half-naked and lived in caves. However, they realized we knew a great deal about the salt flats. We've been using salt and brine for a long time. We gathered a lot of salt, herbs, and flamingo eggs when these were abundant. I ate them as a kid. Nowadays, there aren't any. Flamingos are shy. If they see or hear anything they don't trust, they fly away. Now, there are almost no flamingos on the salt flats.

If we want our land back, it is because we want to protect and preserve it. Unfortunately, Chile depends on exporting these commodities. Copper, lithium, wood from the forests in the South, and so on. The land doesn't get much in return. The powder is exported to somewhere else in the world. The way they extract lithium is certainly not sustainable. The process involves evaporating millions of liters of water every day in a desert, the world's driest desert.

Also, Chile has no scientific information to guarantee that extracting water from here won't affect other areas. Nobody knows how much the desert can resist this. That is why, during the last years, there have been legal cases against SQM and other companies in order to reduce the amount of water that is being pumped out from the wells. However, the way in which they get lithium must change too. There already exists technology to extract it without having to evaporate water. But that technology is expensive and consumes a lot of electricity, and the current evaporation process costs practically nothing. That's the struggle these days.

On the other hand, we are sure this is a fake democracy, and it will take a long time to develop a real one. We never came out from Pinochet's dictatorship, and just now, we are getting the chance to change the Constitution we inherited from him. Chile is a bizarre country: there is no other country where water is private. It is one of the most capitalist countries in the world. We are now living a moment in history from which,

hopefully, something new and innovative can come out. New generations have nothing to lose; they are the ones claiming for public education, for a public health system, for changes in the Constitution that could bring equality for everyone.

It is interesting and really inspiring what is happening; to think how we can provide experience and knowledge to handle the ruins and fortresses of this place – since this is landscape planning of thousands of years. I don't think this happens only in Chile. In most countries where there still are First Peoples, they are the ones that better understand the geography and the ecology. We live in the territory. We know what happens when it rains. That's how we will support this revolution: with knowledge. That's why the 1% who own the entire country is so worried. Because if this revolution is properly guided, it could end capitalism. And they don't want that. Chile is quite a diverse country without a common vision. But after this, people are realizing that we have more similarities than differences. We are open to participating in this process. We want our land back to manage and to protect it. If we had economic autonomy, we'd be able to develop our own education programs and other things. And maybe we will never get our land back, but economic autonomy would help a lot.

What we have in the salt flats is a very fragile balance of different lifeforms. You can't just say: since I'm human, I have the right to make huge changes in nature, no matter if they cause temporary or even permanent damage to the environment. We depend on these environments. There is a kind of symbiosis here. We cannot live without those forms of life.

Nowadays, I am very enthusiastic: new generations and young people are starting to be interested in coming back because they have opportunities to work and to do things. This desert is huge. Imagine developing an artificial forest and planting it with medicinal plants on a large scale. Almost all of these plants would have pharmaceutical properties. If we were able to develop our own mini-country, we certainly could provide for our own necessities. In our cosmic vision, we don't own anything. We are part of everything. So, every time we go somewhere, we ask permission from our ancestors. Because when they pass away, they become one with the Earth. Every time you step on a path, you are stepping on people. If we go to a place that we don't know, or to a place where we get corn water or medicinal plants, we ask permission from the spirits, our ancestors, and, of course, to Mother Earth, '*Patta Hoiri*' in our language.

...

Cristina Dorador

Godofredo Pereira (GP): How would you describe the importance of the microbial ecosystems that can be found in the salt flats of the Atacama Desert in Chile?

Cristina Dorador (CD): Salt flats are interesting ecosystems. They are the remnants of ancient paleo-lakes that occupied the entire area of the Atacama Desert and northern Chile. They house an important evolutionary heritage because of the high biodiversity and the high quantity of endemic species, which only grow and develop in these systems. Each salt flat has unique microbial communities. When comparing and grouping all micro-organisms in them, you find these connecting nodes, where each node corresponds to a unique community found in a system.

When we analyze their function, it is already very interesting because these communities are present in all possible matrices: in water, sediment, air, soil, and so on. They tend to stratify until forming a structure in the water-sediment interface called 'microbial mats.' Most of these microbial communities are photosynthetic, especially the famous cyanobacteria that produce photosynthesis and release oxygen. Surely, they are the first forms of life and, due to their oxygen production, the planet's atmosphere was finally altered to more oxidizing conditions.

These microbial mats have not only a photosynthetic function. They also recycle gases from the atmosphere and convert them into other compounds. They capture CO_2, but at the same time, produce methane, CO_2, nitrous oxide, and other gases important in the future of climate change. If we extrapolate the local importance of salt flats' microbiology, we will find a quite interesting phenomenon, since salt-lakes extend for about 2,000 or 3,000 kilometers. From our work, we know that greenhouse gases are produced in the salt flat, and in that process, microbial mats play an interesting role here.

GP: Specifically, you have been looking into what is called the 'rare biosphere.' Why are these rare micro-organisms particularly relevant?

CD: Around the year 2010, a technological leap took place in DNA sequencing technology. We study micro-organisms that cannot be seen directly by the human eye – we have to use a microscope or isolate them in a lab, cultivating them. But we know that only 1%, or maybe even less, of all micro-organisms on this planet, can be cultivated. Hence, the great majority is invisible. The only way to access that knowledge is by obtaining DNA from the environment, from water samples, sediment, and, as I said, microbial mats, air, any matrix that can host micro-organisms. You obtain the DNA and sequence it. After that, the sequence is analyzed globally or individually, depending on what you need to know. And you can classify them taxonomically or at the level of the species, that is, of a different microbial type.

Before the 2000s, when I did my Ph.D., these technologies were still being developed. We could only observe a part of all micro-organisms present in a sample, which were the most abundant ones. We knew there were different microbial communities by simply looking at that part of all micro-organisms. After that, technologies were developed for mass sequencing – or next-generation sequencing – expanding the scope of observation on microbial communities. So, when we began using these technologies, we noticed highly diverse systems. I would even call them hyper-diverse systems. Of the almost 100 bacterial *phyla* – a taxonomic classification – that exist across the planet, more than 60 are present in a sediment sample of Salar de Huasco. There is a big concentration of different microbial groups in these systems.

When we look at what 'species' they are – we use quotation marks in 'species,' because that concept is very complicated when describing micro-organisms –, we notice that the great majority are different species in very low concentrations. If we were to draw abundance versus types of micro-organisms in a curve, we would see that some are very frequent and abundant while many other micro-organisms are rare: the 'rare biosphere.' However, this rare biosphere is very frequent in all of these systems. We do not know very much about its function still, yet it appears to perform many of the functions that abundant biospheres perform, but acting more like a backup. In other words, when there is an environmental change, and abundant ones diminish, the rare ones start to grow – they are no longer 'rare' in this situation – and to take over their functions. Even so, there is a lot of information that seems to indicate that there are metabolisms – perhaps different ones – that have not been described yet.

GP: You have said that the unique microbial diversity that can be found in the North of Chile results from its mineralogical diversity. Could you explain this?

CD: The Atacama Desert, besides its economic importance – with the main mining resources of Chile and the world – also contains large quantities of various minerals. Almost the entire periodic table is present in the soil of the Atacama Desert. Some authors have referred to it as a 'planetary anomaly.' It is a very rare event that a single geographic system could present such a large quantity and diverse types of minerals and elements.

If we think in terms of evolution, there is a correlation or interaction between habitat and micro-organisms: micro-organisms will adapt to their habitat and use the resources it provides, and at the same time, they will also change the environment because, biologically, they can produce minerals. The intimate relationship is interesting. We could even think there is a micro-organism that performs a certain function, such as reducing oxidation, for the various minerals in the desert. That would partly explain its huge diversity: there are so many resources and possibilities of diversification that they may explain why all those groups exist.

GP: Biologist Lynn Margulis said that it is possible to see how all life forms evolved from microbes, from the interactions between bacteria. Moreover, she argued that more than a competition, it is a symbiosis that lies at the heart of creative evolution. Would you agree with her? And if so, could you tell us how important are human alliances with microbes?

CD: Margulis' propositions are very important. They have been fundamental to give micro-organisms a new leading role in the environment. We know they used to have the role of 'villain' in our planet's biological history, mainly as pathogens. But, as human beings, or as eukaryotic cells, we are products of multiple microbial interactions that managed to survive under these circumstances and develop into more complex lineages. Symbioses are interesting relationships because they are associated with a mutual benefit.

There is also an interesting vision from ecology or microbiology, especially from microbial ecology. It's difficult to explain ecological processes at a micro level that are more or less evident on a larger scale. Think of the microbial mat with millions of different species in just a few millimeters or centimeters. This results in a system that is stable over time – time here is relative, it could be days or hours, but that's microbial time – where a multitude of functions that benefit the entire ecosystem is performed. If microbial mats didn't exist, we could have never contemplated the existence of important groups in our environment at the trophic level, including the most charismatic species in the salt lakes, such as flamingos. In that sense, symbiosis is key to maintaining these structures. All organisms work together without a clear purpose. You can observe that from the outside: One bacterium produces a compound that another bacterium degrades; in turn, that bacterium produces a compound that slows down a population's growth speed, thus benefiting another population. So, it's an interesting game of increases and decreases, but overall, there is equilibrium. Equilibrium, from our perspective, that is.

GP: Do you think that there has a real interest in caring for these beings?

CD: It's very complex because, when we speak of biodiversity, micro-organisms appear as mere anecdotes. It's known that they exist and that they are important, but they weren't given the role they need to be protected. At a global level, the discourse of biodiversity loss does not consider the loss of micro-organisms. They do not have a principal role at the COP (UN's Conference Of Parties) or any other form of environmentalism. Who protects the micro-organisms? Salt lakes are a great opportunity since they are microbial ecosystems. It is very difficult to see when a microbial system is lost.

For example, in a forest, a lake, or in the northern hemisphere, you would not notice them because of the large variety of species that also live there. But in the desert there are no forests. It has less apparent biodiversity, which allows micro-organisms to be protagonists because microbial mats are visible there. So, I think this is an opportunity to make the invisible visible from the Atacama Desert. There have been a number of lawsuits in our country for environmental damage to the salt lakes, which have micro-organisms as their objects of environmental protection.

We need to keep moving forward, emphasizing that they exist and fulfill an important role. They are not only linked to the Earth's biogeochemical cycles. They are also

used to produce bioactive compounds, which could have important roles in the treatment of diseases. Even at the industrial level, we see interest in culturing bacteria or other micro-organisms from extreme environments due to their applicability. Many people link these uses to their preservation. However, I think we need to look at this from an ecosystemic perspective. Not everything can be used, but we still must protect the entire ecosystem, including its invisible inhabitants.

GP: In what way is the extraction of lithium impacting microbial ecosystems and their ecologies, and how dramatic is its current and predicted future impact?

CD: The existence of these salt lakes and microbial communities is intimately linked to water. Water is key here. These salt lakes have served historically for sixty or seventy years, or even longer, as water sources for mineral mining. At first, the water came straight from the lake or rivers connected to these basins. Later, some salt lakes were used as physical sites to deposit mining tailings. This happened mainly before the 1993 environmental law. On the other hand, in Chile there is also the issue of water rights, which are private. So clearly, the salt lakes are severely and irreversibly damaged. They will never be like before. At least four or five lakes have suffered large-scale damage, but dozens more are still used to extract water for mining.

Recently, new procedures for desalinizing seawater have been implemented to use it directly in mining processes. In the last few months, a few big multinationals have stopped extracting water from the aquifers in the *altiplano* or highlands. Nonetheless, many of these ecosystems have already been seriously damaged.

Regarding lithium (because what I've mentioned is mostly linked to copper), it's even more particular because it is found in the water, in the brine – which is water with salt. This brine is extracted and put into large evaporation basins, a process favored by the ideal conditions for evaporation in the Salar de Atacama. This leads to an accumulation of lithium and salts used in the industry. Research, particularly by our Ph.D. student Carolina Cubillos, has shown that there are active microbial communities in this concentrated lithium brine, a human-made environment that did not exist before. Even in the most extreme conditions for life, such as these lithium-iodide-brines with the highest salt concentrations in the world, active bacteria live. We want to know how they do this, what mechanisms are these micro-organisms using, especially bacteria, to deal with such hostile conditions.

The point I want to make is: even in the most aggressive extractivist condition, there is a strong microbial life embedded. This means that not only minerals are being exported but also cells, micro-organisms native to the desert; they are taken by boat to different destinations in the world. This is why the ecosystem conception is so important. Linking life to something which is apparently lifeless generates new ideas and narratives about what is protected. On the other hand, the continuous water extraction from salt lakes for lithium production results in lower lagoon water levels in the long term. It produces a local climate change because the water heats up, its reflective surface leads to a higher water temperature and evaporation. In the long term, this leads to higher salt concentrations and changes in microbial communities, or even to their disappearance when lagoons dry out. Some groups may prevail, of course, such as spores or resistance systems, but all biodiversity will diminish. So, there will be a loss of the genetic, biological, and evolutionary heritage of humanity – involving its relationship with the environment, because this is nature, and it is beyond the human practice of mineral mining. This is an important topic that has not been fully addressed yet. Maybe, and precisely, because these systems seem to be completely inert, lifeless.

...

Alonso Barros

Godofredo Pereira (GP): How did you start working in Atacama?

Alonso Barros (AB): Just out of law school, a friend helped me find a job in the Chilean National Corporation for Indigenous Development (CONADI created in 1993 by Law 19.253, the "Indigenous Law"), in San Pedro de Atacama. In 1994 we were inaugurating the offices, and I started working on the legal structure of the Council of Atacameño Peoples (CPA), a union of presidents from each community formed associatively, as a guild. I worked in the CONADI for two years, helping create the statutes for the CPA and the Indigenous Irrigation Association, while also contributing to water registrations and land surveys.

GP: Water was crucial at the time, right?

AB: According to Law 19,253, the Atacameños and Aymaras – and all the communities of Northern Chile – have special rights, included three central issues including water, land, and cultural heritage (archaeology), but particularly, regarding surface waters, so we had to secure them legally. With water, it was a two-step process. First, we had to generate the legal instruments for indigenous peoples to organize themselves, and obtain legal personality as indigenous communities, with a fiscal number to be recognized by the government services. That was necessary for the second step: registering waters in the name of these communities. We also set out the initial measures to secure community landholding rights, so we made the first survey of indigenous 'patterns of occupatio' in order to subsequently register the lands in the name of the 'new' Atacameño communities. At this time, these communities kept the Salar de Atacama out of the survey, as they only saw themselves reaching its shores to collect flamingo eggs sustainably. They saw the *salar* as a common, but it also was a blind spot, that made lithium invisible.

The only thing that makes indigenous land and waters different from other properties in Chile, is that, by law, you can't sell them, rent them out, provide them as collaterals, nor can they be taken by the bank; you can't have easement rights over them. So it was a solid strategy to reclaim and demarcate all of these disputed lands that the state claims as its own, recovering them as protected indigenous property for the Atacameño people. But it also got into people's minds the idea that "we own this now, so we have to make the most of it to benefit directly from its exploitation and, at the same time, to protect it. Now that mining companies try to get to our property, we have to oppose them to get something out of this." The law constituted subjects and caught them in a neo-liberal trap because it made them 'proprietors.' With these waters and these lands, they got into this sort of eco-politics of mining. People began to perceive and understand that if you extracted water from the Salar de Atacama, you could dry out the flamingo-rich 'shores' and water sources further up and infuriate the mountain, so that they wouldn't have any snow or water for pastures and agriculture anymore.

GP: What was the first case that you took on after ten years of working elsewhere?

AB: I remember that, in 2008, I was presenting observations for the Aymara community of Quillagua against SQM. The project was called Pampa Hermosa, and it's currently being revised because it affected the fragile *puquios* (waterholes) in the Salar de Llamara. I also represented the Atacameño community of Peine on the Salar de Atacama's edge, negotiating in strong terms, first, in 1996, a landmark agreement with Escondida (the copper mine with the largest production in the world), for approximately US$ 15,000 per year. Although this sounds like very little money, it was the first time that 'benefit sharing' agreements were achieved. Today, I think they upped the payment to US$ 20,000.

They hated me in Escondida when, around 2007, we stopped their project to extract 1,000 liters per second of water from the

highland lagoons and transport it in a 100 km pipeline to the mining pit. Authorities of my university told me: "don't publish anything on human rights, of indigenous people, don't speak of territories, just shut up." Of course, I didn't comply and left my research position. Recently, with the town of Camar, we successfully opposed Escondida's water extraction projects in the nearby Monturaqui aquifer (with a 500-year impact).

Crucial to all this was that, in 2008, Chile signed the ILO Convention 169 (C169), with its mandatory consultation of indigenous peoples by the state. Any company project requires two licenses to operate: the environmental and the social. When dealing with indigenous peoples, you need to craft mutual consent through a formal consultation process of the peoples in whose territories a given project is set to operate. Otherwise, they could have problems. And if a company goes rogue, it gets a bad reputation that will impact its share prices. So there's a lot at stake in their image management.

This became the battle horse. In 2009, we presented observations in opposition to the Albemarle lithium extraction project, which were finally considered and approved a few years ago. I redacted these observations for Peine and Toconao and also other communities. The observations led to a benefit-sharing agreement with Peine in 2012. The community would receive about US$ 170,000 yearly, as indexed to production – if production grew, the community's funds would grow in the same proportion.[1]

The next thing was that, with Peine, we convinced Albemarle to reach a deal with the other salt pan communities through the CPA. We negotiated with Albemarle in a very different way than before because Rolando Humire – then the CPA's president – was part of Chile's National Lithium Commission. At first, Albemarle said no, arguing they just needed Peine's social license. This was because they were in Peine's territory and didn't see the need for an agreement with the CPA, which represents all the communities surrounding the *salar*. We imposed that. They knew that if they didn't give in to our demands, we could eventually bring the entire project down judicially due to lack of consultation, considering that the Atacama basin waters, whether surface or groundwater, formed a single body.

I also went twice to the Congress' Special Investigative Commission that oversees the competent public organisms in charge of inspecting and protecting glaciers, hydrographic basins, and salt lakes of Chile. So we had visibility and were active in a lot of ways defending the salt pans.

GP: What were the main legal strategies being used? Did the ILO C169 support the fact that the *salar* was part of the indigenous territory?

AB: No. It was the ILO C169 consultation terms and the social license because Albemarle could not operate without it. The only way to get their social license was to reach a direct agreement with all the communities and the CPA at once.

GP: Why is there a duty of consultation with communities with no territorial claim to the *salar*?

AB: Well, the Atacameños had their territories recognized generically as ADI (Indigenous Development Area). But consultation is something that has deterritorialized titling practices. Now it's not so important to argue about 'this being my land,' that 'being demarcated', and so on. That was the discourse in Chile and Latin American land struggles for a long time, until the ILO C169 opened the door to addressing all these nitty-gritty conflicts, saying, "let's consult" any legal or administrative measure susceptible of impacting indigenous peoples. "Let's consult," but the government was still the one who decides over natural resources. The consultation does not allow for an indigenous veto. If Atacameños had fully registered property rights, there would be no need for consultation because, as fully-fledged owners, they could simply say no to any project within their lands. There is neither full property nor full binding consultation.

GP: Then, the most significant shift was the ILO C169 coming into effect, insofar it puts forward the consultation. But does it remain a powerful tool despite not enabling a veto?

AB: Yes and no. That's what the Peine agreement states, that "the community owns the land in which the company operates" at the same time that "the company claims its own property rights over water and land, not accepting the community's view." But we agreed to disagree. According to Chilean law, most indigenous lands are in limbo, so communities cannot effectively oppose harmful projects based on their customary title alone. However, consultation forces some kind of mutual recognition of ancestral claims beyond what Chilean norms allow.

GP: There are cases in which things like the lagoons that border the *salar*, the flamingos, the quantity of water/brine pumped from the *salar*, or even the number of carob trees in the edge became an object of dispute. Is this still within the paradigm opened up by the issue of consultation? Or is this a slightly different avenue that coexists with that strategy?

AB: The ILO C169 created an incentive: the right communities have to be consulted and to participate directly in the benefits of the companies that operate in their territories or nearby. This is very clear-cut, but it adds to the environmental issues as you end up negotiating the environment. The logic is that you have to keep raising the environmental stakes, to protect and defend more and more, to ask for more and more measures.

You also negotiate at another level; say, demand for benefit sharing in terms of money, a royalty. This is what the CPA did when it negotiated a 3% royalty over lithium sales to benefit communities surrounding the *salar* and obtained a further 0.5% for R&D. Beyond ownership, the Atacameños successfully claimed some kind of intellectual property over *salar* developments. This was a landmark agreement worldwide and has set the standard for similar processes in Chile.

You may also use each little detail to convey impact. At first, nobody knew or cared much about the extremophiles. Still, as we pushed judicially for more research, we were able to create an argument, a rhetorical device based on the origins of life. An environmentalist or a biologist would care for the microorganism, for the life of these beings. As a lawyer, I see them as devices that can generate interest from companies and the state to lead to changes.

Chile's environmental institutions – the Environmental Evaluation Service (SEA) for preventive action and the Superintendency of Environment (SMA) for supervision and sanctioning – guarantee the enactment of all these agreements. So, there's an upfront negotiation based on environmental impacts and measures. Communities can even reject a project; however, since they don't have legal veto power, they don't have the last word – the state has it. If you're an indigenous community, you can even say, "I disagree with the project because I think it harms my territory. But since I'm not the one called to decide this, I accept the money for protective measures." Such events are quite singular.

GP: How was that first moment of contestation of lithium extraction in the Salar de Atacama? Why it became the initial moment of political and collective mobilization?

AB: There was a need to renew a contract that SQM had with CORFO, which was entangled in a series of arbitrations and trials. Also, there was no direct supervision over the production and sales of lithium and potash. CORFO rented these properties to SQM until 2030. But through these environmental trials CORFO could have reclaimed all of its properties in the *salar*. Until then, SQM was paying a ridiculous US$ 15,000 rent or something similar (besides small royalties and tax on exports).

Thus, Eduardo Bitran[2] and SQM negotiated a new contract that could benefit both parties, with which the Chilean government

would get an extra billion dollars a year for ten years. That is US$ 10 billion. In other words, twice what the entire private copper mining sector would give to the state in the same period. This was a big contract. Perhaps the best one in the world. In fact, besides the hefty rent, the agreement stated that the owner/controller Julio Ponce Lerou could not be part of SQM's board anymore; and, above all, that if SQM was condemned for any environmental fault, it would lose everything and would have to return the land, and easements rights to CORFO.

Through these processes, the Atacameños (and other San Pedro inhabitants) became more conscious, not only because of what happened with Albemarle and the available resources to produce independent science but also because of the industrial dust in the *salar*, which they feel is destroying their crops. Now, the vast extension of the salt flat is covered with dust, and people realized that there are almost no flamingos left. There was a growing political consciousness mobilized by traditional leaders like Mirta Solis and many others. The young and the old, they were all together. And when SQM went to present its project at the neighborhood council, they were shooed out: they weren't allowed to present their views.

In November 2020 SQM reduced its exploitation of brine by 20%, and it is going to reduce it in half by 2030. But, before that, they put online all of the numbers, all the data, all of the former water 'secrets.' It's all online. It's the real thing. This is much more than (regulators) could otherwise have forced SQM to do. Of course, SQM is doing this due to the pressure from the German lobbies, the ecologist sector, EV companies, and so on. Some believe it's only due to this kind of market and political pressure but, truth be told, it is also because of the pressure the Atacameños have made and the company's urge for of social license to operate, without which SQM will lack in its corporate image (traded at the NYSE).

Now, SQM is actively seeking to obtain this precious social license in two salt flats: the Salar de Atacama and the Salar de Llamara. There are due diligence agreements underway with indigenous communities. In both basins, citizen participation processes have been opened, for which the state will likely convene Atacameño, Aymara, and Quechua communities for consultation.

Judicial activism is a road full of perils and uncertainties. Sometimes it backlashes, like when environmental cases are poorly defended, and judicial decisions reduce the breadth of indigenous litigation and take human rights standards down a few notches – or even backward. Indigenous communities have teamed up their political and legal resources with great success through the years while negotiating their social license royalties. In turn, this has allowed some communities to move from leniency towards impacts in return for great benefits, to more vocal and radical opposition to mining projects, now that they have secured, like the Atacameños have, a better living standard for themselves in the long run. This learning curve has not been free of political turbulence. However, trial and error have been extremely productive teachers, as Atacameño organizations have become over the decades stronger and more conscious about their environmental rights and plights, so much so that, to a certain extent and despite the state, they have gained a social veto power of sorts, beyond the law. ⊘

1. It was a kind of royalty, but it was indexed to production, not to sales, which was interesting and a first, standard-setting step to improve the Atacameño position.
2. Eduardo Bitran is the Executive Director of CORFO.

The King of Lithium

Daniel Matamala

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Although he became famous as "the-son-in-law," Julio César Ponce Lerou did not reach the peak of his power during the dictatorship of his father-in-law, Augusto Pinochet. That was just the first push of a career. Today, he is one of Chile's most powerful figures, the second richest man in the country, and a member of *Forbes* magazine's list of billionaires. His family relationship with the dictator helped Ponce Lerou to be crowned the "king of lithium." And having that "white gold" in his possession, he has manipulated politics for three decades since the return of democracy in Chile – and counting.

A Lucky Strike

Ponce Lerou is an outsider. He does not belong to one of the traditional families that possess and manage power in Chile's closed elite. Born in the small town of La Calera, his meteoric rise was due to a lucky strike. During the holidays on the beach of Maitencillo, he met the young daughter of a soldier, Verónica Pinochet. They got married in 1969. During the Salvador Allende administration, they moved to Panamá, where Ponce landed a job as a forestry engineer.

Yet, on September 11, 1973, Ponce's father-in-law led the bloody military coup that made him the dictator of Chile for the next 17 years. Ponce immediately saw the opportunity that opened up to him and, in his first conversation with Pinochet after the coup, "I told him that if there was anything I could do to help, he just had to call me."[1] On July 29, 1974, Pinochet appointed his son-in-law as executive director of CONAF (National Forest Corporation), the state corporation in charge of forest management and forestry exploitation. Immediately after arriving in Chile, the institution's official magazine, *La Conaf*, published a profile on Ponce, in which he said: "If I wanted to make more money, I would have stayed in Panamá."[2] This piece presented him as "a man of action," 1.9 meters tall (he is actually 1.83 meters tall), and married to some "María Verónica de Ponce," omitting his family relationship with Pinochet.

That is Ponce's signature: accumulating power while keeping a low profile. Between 1974 and 1983, he collected 15 senior positions at state-owned enterprises, a lot of them in parallel: the forestry company Celulosa Arauco; the sugar mill IANSA [Industria Azucarera Nacional]; the mining company ENAMI [Empresa Nacional de Minería]; the oil company ENAP [Empresa Nacional del Petroleo]; the communications company CTC [Compañía de Telecomunicaciones de Chile]; the electricity company ENDESA [Empresa Nacional de Electricidad]; the umbrella corporation of state investment, CORFO [Corporación de Fomento]; and the future source of his fortune, SOQUIMICH [Sociedad Química y Minera de Chile]. He got to know the state's entire productive apparatus that Pinochet's dictatorship was about to privatize. Then, he chose which one to claim for himself. These were the years of the Chicago Boys, the

group of economists trained at the University of Chicago to which Pinochet handed over full control of the economy to conduct a neoliberal experiment without precedent in the world.

When he was in charge of CORFO, Ponce privatized state forestry and issued Law-Decree 701. With subsidies to forestry plantations, this decree delivered million-dollar profits to the country's major economic groups, such as the Matte, Angelini, and the BHC. The latter was the largest group in the Chicago Boys era. Ponce befriended Javier Vial, head of the BHC, who, in turn, would give him funding for his private businesses.

But, within the regime, his growing power and unscrupulous style made him a few enemies. In 1983, a group of generals requested a "stealth investigation" into Ponce's use of public enterprises for private purposes.[3] The accusations became increasingly intense, especially after the spread of an anonymous text titled "Pinochet's Son-in-law on the Cusp of Corruption." Facing scandal, Pinochet asked him to resign in August 1983.

Ponce turned to private business, for which he received generous funding from CORFO. These were tough years for him. Amid his economic and judicial problems, he suffered a mental health crisis in 1986. "Visiting Brazil, Julio suffered a nervous breakdown which made him roam the Rio de Janeiro subway speaking nonsense," said the then-SOQUIMICH manager Eduardo Bobenrieth. "The patient claims he was going through a manic phase in 1986, which was being treated with Lithium and Rivotril, but he did not take this medicine regularly. That is why he had two relapses. Now, with a regular intake, he has not had any new relapses," notes a medical document attached to one of the many investigations against Ponce.[4] Years before becoming the king of lithium, Ponce already owed his mental stability to that product.

The New 'White Gold'

The first 'white gold' was saltpeter. In 1879, Chile declared war on Perú and Bolivia amid a trade dispute over taxes on the exploitation of nitrates in the Atacama Desert. Promoted by British and Chilean private commercial interests, the war gave Chile sovereignty over saltpeter lands. The British businessman John Thomas North gained ownership of the main deposits, fundamental to the manufacture of fertilizers and gunpowder.

Owning a virtual global monopoly, North – also known as "the King of Saltpeter" – clashed with José Manuel Balmaceda's government, which sought to increase production to achieve more profits for the Chilean state. North financed opposition to Balmaceda, which ended in the civil war of 1891 and the dismissal and subsequent suicide of the president. Back then, white gold marked Chilean politics.

That period of easy money for British and Chilean investors was brief; the saltpeter boom ended with the invention of a synthetic replacement during WWI and then with the Great Depression. The devalued saltpeter properties then passed to SOQUIMICH, which since 1971 was a 100% state-owned company.

By then, Chile had become dependent on another single-commodity export – copper – and SOQUIMICH looked like a fossil of the saltpeter's glorious past. But the Atacama Desert's salt flats contained a new wealth that, without much originality, would be named 'the white gold of the 21st-century:' lithium. Its use would range from the restricted fields of nuclear fusion and medicine to the most lucrative fabrication of laptop and cell phone batteries, and, lastly, to electric cars. All of which depend on lithium.

Northern Chile contained about half of the world's reserves. Who would take over that loot? Legally, there was no argument. Law-Decree No. 2886 of 1979 established that "by requiring it in the national interest, from the date of validity of this Law-Decree, lithium is reserved to the state." But Julio Ponce had other plans. If John Thomas North had been the king of 19th-century white gold, he would use the then state enterprise SOQUIMICH to be its 21st-century king.

Privatization

Two months before being forced to resign from his state office and leave SOQUIMICH in June 1983, Ponce had begun privatizing the company. As in other privatizations of the dictatorship, it was announced that it would be done through 'popular capitalism,' so that the company's own workers would become its owners. Yet, that was a smokescreen through which the regime's oligarchs would keep the companies. This was the case with the steel company, CAP, and with ENDESA. It would also happen with 'SQM,' SOQUIMICH's new name once privatized.

In September 1987, Ponce returned to SQM, now as president, elected with the votes of military directors appointed by the CORFO. In 1988, the state sold the company's last shares. By then, Ponce had already created a pyramidal structure known as 'cascades,' which would allow him to control the company through a group of figureheads. Amid reports of coercion and deception towards workers, there was a massive transfer of shares to the companies controlled by Ponce and his circle.

Privatizations accelerated as the end of the dictatorship got closer. SQM was an important part of the plebiscite campaign that would determine Pinochet's continuity. Here, "they convened meetings announcing the worst of all evils for those who voted for the 'No' option."[5]

After the defeat in the 1988 plebiscite, Pinochet called for the first presidential election since 1970. Ponce was one of the main funders of the dictatorship's candidate: Hernán Büchi, a close friend who, as Minister of Finance, had led the privatization of SQM and the other public companies. "I'm putting personal resources, of course, within my savings, and I'm not going to deny it. I think that's what the country deserves,"[6] Ponce said at the time.

Büchi was defeated by Patricio Aylwin, the candidate of the Concertación, an alliance that united Christian democrats and socialists who opposed Pinochet. The transition to democracy began in 1990. Aylwin and the Concertación held the presidency, but Pinochetism dominated the Senate – due to senators appointed by the dictatorship – and the Army, where Pinochet remained as Commander-in-Chief. On the other hand, Ponce turned SQM into a refuge for Pinochetism, welcoming as directors, the former ministers of the dictatorship, Sergio de Castro and Pablo Baraona.

Transition and Lithium

Ponce was an obvious target for the new democracy. A report by the Chamber of Deputies amounts to losses of US$ 2,223 million in the state's assets due to the privatizations in the last years of the dictatorship. The State Defense Council launched a case for fraud and tax evasion in operations between Ponce and CORFO. The Internal Revenue Service had begun investigations against Ponce. The Christian Democracy Senator, Eduardo Frei – Aylwin's successor in the Chilean Presidency – denounced that SQM workers in the Pedro de Valdivia saltpeter "live in a concentration camp environment, in filthy sewers, like animals."[7] This accusation was supported by Jorge Pizarro, Senator of the same party. Aylwin's government announced an investigative commission against SQM.

At that moment Ponce, who unlike anyone else understood the possibilities that the transition's precarious balance of power opened up to him, changed strategy. He began to use SQM's money to ally himself to the Concertación. He approached Genaro Arriagada, Frei's right-hand man, through their shared interest in horseback riding. The allegations started to fade. The State Defense Council and the Internal Revenue Service dropped the charges against him. And the government made the political decision not to challenge privatizations. For the Christian Democrat analyst and then ambassador to Germany, Carlos Huneeus, this was due to "the needs for funding of election campaigns and political parties."[8] Years later, Pizarro's family and Frei's political campaign would appear on SQM's payroll.

The "son-in law" reinvented himself as the benefactor of democracy. In 1993, he divorced

Verónica Pinochet, and SQM entered the lithium business thanks to an agreement with CORFO. As lithium was legally a strategic and uncompromising mineral, CORFO signed a 'lease' of the Salar de Atacama. SQM would exploit lithium in exchange for a payment of only 6.8% of sales.

Later, the then Minister of Interior, Enrique Krauss, would also be a paid advisor to SQM. Socialist Carlos Ominami, then Minister of Economy, would receive illegal payments from SQM in future campaigns to the Senate. While funding Pinochetist and Concertation politicians alike, SQM renegotiated its contract with CORFO, expanding its lithium dominance through ever-widening terms and extraction conditions.

When in 2015 Eduardo Bitran, head of the state-owned CORFO, sued SQM demanding US$ 36 million for rents owed, Ponce's power was felt. "Renowned politicians of the highest level demanded me to seal an agreement with Ponce," Bitrán stated.[9] A simple move demonstrated Julio Ponce's influence. Rafael Guilisasti, former president of the confederation of Chilean entrepreneurs, the CPC, was CORFO's advisor when the lawsuit was filed against SQM in June 2015. On September 3rd of that same year, he resigned CORFO and, 11 days later, assumed as president of one of Ponce's 'cascades' companies. He took with him all the confidential information about the litigation. "He has the information regarding CORFO's legal and business tactics and strategies," so his decision "is reckless and unpresentable,"[10] Bitrán claimed at the time.

The SQM Case

That same year, Ponce's influence came to public light. A judicial investigation showed that SQM used legal and illegal means to fund government and opposition politicians. Its payments were enough for everyone. "Julio wanted to support people of all beliefs. He wanted to maintain democracy in the country," said his lawyer and friend Darío Calderón.[11] SQM recognized unlawful payments to companies and individuals linked to the three leading candidates of the 2009 presidential campaign: Sebastián Piñera (right-wing); Eduardo Frei (Concertación); and Marco Enríquez-Ominami (left-wing). Three candidates that add up to 94% of the votes. Jorge Arrate, of the Communist Party, was the only one excluded.

Illegal money was also found to have funded the pre-campaign of the 2013 successful candidate Michelle Bachelet. Her government program, which promised to end the privileges of the "same-old powerful people," was partially funded by the company of the dictator's ex-son-in-law. The revelation forced the resignation of one of those benefited by lithium money, the then Minister of Interior, Rodrigo Peñailillo.

Under pressure from USA regulatory authorities, SQM commissioned an audit of Shearman & Sterling. The report shows that, in the audited five years alone, SQM legally delivered US$ 7 million to politicians while also giving US$ 14 million by illegal means. In addition to presidential and congressional campaigns, SQM funded the creation of political parties like the PRI and the PRO. It also paid the bills of the PPD, a party formed to democratically defeat Pinochet's dictatorship.

Lithium money also served to buy *a la carte* laws. The investigation found that SQM's General Manager and Ponce's right-hand man, Patricio Contesse, drafted an article of the mining royalty law, guaranteeing the company immunity from any tax hikes for six years. Contesse sent that article to the right-wing Senator Pablo Longueira, who ensured both Government and Congress approval. The investigation also discovered that the circle near Longueira received at least $ 730 million from SQM between 2009 and 2015. Before the Chilean Prosecutor's Office, Ponce only admitted to legal contributions to politicians for "more than US$ 1 million and less than US$ 10 million."[12] Prosecutors found no emails or messages to frame him. They only found instructions sent to his secretary from an anonymous email account (grillop10@hotmail.com). There was no way to prove that Ponce was the person behind

that Hotmail account. Contesse carried all the blame and denied that Ponce knew about the illegal operations.

The Cascades

Although Ponce financed the two campaigns of Sebastián Piñera (elected President for the 2010-2014 and the 2018-2022 terms), he did clash with him in business. Piñera entered the cascades companies as a minority partner in 1998 and unsuccessfully tried to contest Ponce's control. He retired in 2008. The following year, during the campaign that would take him to the presidency, SQM made payments of $ 446 million to Piñera's companies.

Under Piñera's first administration, the regulatory authority accused Ponce of leading a "fraudulent scheme" to harm minority shareholders (such as Piñera himself). Ponce came out of his usual public silence to attribute the accusation against him to the president.

After the so-called "Cascadas case," *Ponce* had to leave the SQM board. Still, he remains the controller and primary owner. His estate is in good health. According to *Forbes*, it is Chile's second-largest fortune, with US$ 3.5 billion. Piñera appears in third place, with a wealth of US$ 2.9 billion.

The case's outcome also showed that his power remains intact. Chilean law continues to protect white-collar crime. In 2020, the Supreme Court confirmed that Ponce was the "mastermind" behind the transaction scheme that gave him a "fraudulent utility" for US$ 128 million, which only cost him a US$ 3 million fine. In other words, 2.3% of the fraud's profits.

"In the United States, Ponce would have been imprisoned, without a doubt," reacted the former Minister of Finance Ignacio Briones. But not in Chile. After 30 years of democracy, Pinochet's ex-son-in-law, the one who privatized SQM and kept the company for himself, seized lithium's wealth, and illegally financed politicians, has not spent a single day in jail. Instead, he remains a *Forbes* billionaire, and he still wears the crown of the king of lithium. ⊘

1. Gloria Stanley, *Qué Pasa*, August 4, 1983.
2. *La Conaf*, August 8, 1974.
3. O Estado do Sao Paulo, July 17, 1983.
4. Cited in Victor Cofré, *Ponce Lerou* (Santiago de Chile: Catalonia, 2019), 121-122.
5. Manuel Salazar, *Todo sobre Ponce Lerou* (Santiago de Chile: Uqbar Editores, 2015), 159.
6. *La Época*, July 25, 1989.
7. *La Tercera*, May 25, 1992.
8. Carlos Huneeus, *La democracia semisoberana* (Santiago: Taurus, 2014), 136.
9. Cofré, *Ponce Lerou*, 370.
10. *El Mercurio*, September 16, 2015.
11. *The Clinic*, June 15, 2017.
12. Daniel Matamala, *Poderoso caballero: el pe$o del dinero en la política chilena* (Santiago: Catalonia-Escuela de periodismo UDP, 2015), 127.

On Bipolar Expeditions

Emily Martin, in conversation with Anastasia Kubrak

Emily Martin
Anthropologist, B.A., University of Michigan, 1966. Ph.D., Cornell University, 1971. Martin received the Prize for Distinguished Achievement in the Critical Study of North America by the Society for the Anthropology of North America (SANA), 2015; the Vega Gold Medal by the Swedish Society for Anthropology and Geography, 2019; and the John Desmond Bernal Prize by the Society for Social Studies of Science, 2019. Her books include *The Woman in the Body: A Cultural Analysis of Reproduction* (Boston, 1987); *Flexible Bodies: Tracking Immunity in American Culture from the Days of Polio to the Age of AIDS* (Boston, 1994), and *Bipolar Expeditions: Mania and Depression in American Culture* (Princeton, NJ, 2007). She is a Professor Emerita at the Department of Anthropology, New York University, USA.

Anastasia Kubrak: Emily, you are an anthropologist, feminist, and sinologist. In your book *Bipolar Expeditions: Mania and Depression in American Culture*, you explored the condition of bipolar disorder outside of the confines of psychiatry, focusing on its social, economic and popular appeal. How did you come to work on the link between manic depression and culture?

Emily Martin: I've been trained as a cultural anthropologist and have done work in the USA on the subject of immunology before. It became clear to me then that the immune system has become a large-scale organizing metaphor, useful for thinking not only about AIDS and health crises, but many aspects of our life. That's how I got the idea of exploring bipolar disorder, taking as a starting point a rather esoteric diagnosis that I received. I did so partly by interviewing people about what they thought or heard about it, and partly just by hanging out in various contexts, including support groups for people who also received the diagnosis. These studies were empirical in the sense that you only have a question at the beginning, but you don't have an answer in mind. Yet I was sure that, if bipolar disorder had become an object of interest beyond the medical world, then there would be a story to tell that shed light on American culture of the time, namely the early 2000s.

AK: Why did bipolar disorder become an object of popular interest?

EM: The characteristics of the classic manic-depressive diagnosis, on the manic side, are particularly well suited to late capitalism's notions of what a successful business venture is, what a successful entrepreneur is like. As wealth became more concentrated, there were more people at the top of the hierarchy who could enact these roles, such as CEO of a very successful company. I think popular attention naturally gravitated towards these characters and what they were doing.

At the time I wrote the book, Ted Turner was probably the most popular such character. Today Elon Musk fits the stereotype: a person who has brilliant ideas, some of which succeeded and some of which failed spectacularly, but who goes beyond the limits, who breaks barriers of thought or action or endeavor, who is unleashed from a strict adherence to convention, and who seems a bit manic.

Yet this is a fantasy. No one has endless energy or resources. And anyone who has it *sometimes* knows that it's a limited resource, which will wear out and there will be consequences. But in the mythology of it, these characters are the ideal type of a manic. An entrepreneur is endlessly able to throw money into the market, to foment new ideas and generate new businesses, and it's the ideal type of what it takes to succeed – hugely, bigly – in this untrammeled and relatively unregulated phase of late capitalism. And as long as deliberate effort to deregulate the market

continues, I don't expect that the figure of the manic entrepreneur will cease to be fascinating.

AK: What contributes to this imagination?

EM: It is certainly all over the place. You pick up a mystery story or television series, and find out the protagonist has bipolar disorder, and that's why she can stay up all night and doesn't need to sleep for three nights in a row. People who've maybe done illegal or slightly crazy things are often suspected to be manic depressive. The ideas are carried by social media, the media, television, literature, paintings, informal chats on the street, remarks that people make casually about calling somebody manic or bipolar. Calling somebody bipolar has become a compliment, not a slur or an insult. There is a hope, wish, fantasy that you could have just the parts of the disorder that you want, and not have the parts of it that you don't want. This is very problematic for people who have the diagnosis or who struggle with some of the characteristics of this condition.

AK: In your book, you draw a parallel between the cycles of bipolar disorder and those of the market. Can markets be bipolar too?

EM: People diagnosed with bipolar disorder have moods that are alternately high and low. There is a tendency to exalt the 'up' phase, the manic phase when it comes to the mental state of the person. But what happens to the low phase, which may be actually entailed by the excess energy that's required or was produced in the 'up' phase? Psychiatrists certainly do not cover this up. The *Diagnostic and Statistical Manual of Mental Disorders* (DSM) makes it very clear that people with the diagnosis are at risk of suicide. But when it comes to markets, who wants to talk about depression? There's certainly not much incentive on anybody's part to think about the low side of market phenomena. Even though some might say that it's inevitable that capitalist markets work through cycles, and there is an inevitable downward trend for various complex reasons.

AK: In our research, we came across other popular manic-depresive characters. One of them was Kurt Cobain from the rock band Nirvana, who wrote the iconic song "Lithium"; another is Carrie Mathison from the TV series *Homeland*, whose bipolar condition became central to the plot. How do you read these characters?

EM: Carrie Mathison is a good example. It seems that the producers had read the DSM descriptions of manic depression and used that as background for writing the script. For instance, the depiction of Carrie Mathison in the scenes where she is trying to figure out the plot and has all these post-its of different colors strewn on the floor. It's a complete, crazy mess. Then she sees a pattern and organizes the post-its on the wall, and suddenly sees the trajectory of the crime they're trying to solve laid out before her.

It's a perfect example of crazy, distractible, disorganized energy, that is thought to be part of a manic state. The one question is: can out of that come what happened in the series? Namely, a clear, linear cause and effect of the whole backstory of the crime they're trying to solve. Can a real manic episode provide a clear path to solving a problem? I would highly question that. There could be elements of it that produce new ideas, original theories, because you're in a very unusual place mentally, but I don't think it translates into what we think of as productive, efficient, insightful actions. Most people who've had a full blown manic state do not think that they were doing their best work.

Once I interviewed a psychiatrist in Hollywood, who said that his patients, famous actors, would come to him with their agents in tow. The agent's job was to make sure that the psychiatrist didn't dampen down their mania too much, just a little bit. So that they would continue to be these reservoirs of crazy energy, but not too much, enough so they would be able to come to work. The medication has a role in taking off the very worst, least productive aspects of mania. But there's a crazy idea behind it that you could optimize this condition into something that's perfectly suited to a profession. As if the totality of what a manic state is doesn't ever get transferred into popular culture, only little select pieces of it. It does make sense that *those* would be the particular

pieces that are exalted and made heroic. But it isn't true to life.

AK: Let's focus on lithium, one of the drugs used for treating bipolar disorder. What is particular about it? How would you describe its pharmaceutical character?

EM: Lithium is very commonly prescribed. It is practically the only drug that reduces the rate of suicide for people with this diagnosis, working as a deep safety net. But people really hate it, because of its felt effects. You feel repressed and subdued. You feel that your energy, or whatever it might be when you're manic, has had a lid placed on it. But the more interesting thing that people told me was: "well, that lithium, you know, it's an old drug." Lots of people knew that it had been used in the old 19th-century spas or mineral waters.

Now, compare that to fancy new high-tech drugs which have been scientifically produced as a result of complex technological and pharmaceutical manipulations. Each one of them comes at you on television (we still have pharmaceutical ads on TV here in the USA). The drugs that are being advertised can convey whatever the advertising agency hired by the pharmaceutical agency wants to convey: that you'll be happy, that you will be productive, that you will be creative. You often see scenes, in which a woman (usually it's a woman) is portrayed in a family setting. She's taking this drug and now she's sitting at the piano composing new music. Whoa, just like Liszt! Or a painter will be at an easel, making a beautiful, oil painting. Oh, just like Van Gogh! The ads often tap into the notion of optimizing mood swing so that you can get just that piece of the carefully tailored top of mania, which allows creativity and new ideas.

So compare that to poor, old lithium! It isn't under patent, can be produced very cheaply and is available for almost nothing. Lithium just comes off a real second cousin, lower down the hierarchy of the desirable drugs.

AK: Optimization of moods could also happen on the scale of the population. Some studies show the correlation between the higher amount of lithium in the tap water, and lower levels of depression and suicide among citizens. In the aftermath of the 2008 financial crisis, some governments have even inquired what would happen if lithium was added to tap water artificially. What do you think about that?

EM: People who are prescribed lithium have to have their blood tested. You can overdose, and it can potentially cause permanent damage to the kidney and liver. It's a substance for which the level of intake matters greatly for your future life. Not everybody would react the same way, not everybody would be getting the same dose. It's rather *Brave New World*-ish to imagine controlling populations without their consent or knowledge, through a substance whose effect would be impossible to manage. I think that's just a crazy idea [laughs].

AK: We continue to strive for more and more mental energy and think of it as a quantifiable resource. Where does the romantic ideal of 'high energy' take its root?

EK: A historian named Anson Rabinbach wrote a book called *The Human Motor*, discussing the role of fatigue in the 19th-century in the industrial sphere, and how it preoccupied the owners of capital or the managers of labor. It was considered to be a serious problem that needed to be addressed and handled. Somehow the notion that fatigue was an issue that you needed to manage has faded into the background, as a fantasy of endlessly throwing oneself into the market, into work, into making a profit has taken hold.

The cost of this to individuals, to their health, to their sanity, to their families, and to the environment is incalculable. It's a result of structures of oppression and hierarchical forms of power that enable the conditions for this so-called necessity to be put into place. The fantasy that we can just keep producing bits of resources to keep ourselves alive, endlessly and without cost is a dark fantasy. Human beings are not infinite reservoirs of energy. The only infinite reservoir of energy is the market. ⊘

Healing as Killing

Byung-Chul Han

Ph.D. in Philosophy, University of Freiburg, Germany, 1994. Han is a renown philosopher whose main topics of interest include burnout, depression, social media, neoliberalism, and their impact on contemporary politics, and power. Han has published over fourteen books on philosophy and has been translated to eleven languages. Some of his most influential work includes the books: *The Burnout Society* (California, 2015); *Psychopolitics: Neoliberalism and New Technologies of Power* (New York; London, 2017); *The Agony of Eros* (Cambridge, MA, 2017), among many others. He occasionally teaches at Berlin University of the Arts, and is a Faculty Member at the Karlsruhe University of Arts and Design.

Neoliberal psychopolitics is always coming up with more refined forms of exploitation. Countless self-management workshops, motivational retreats and seminars on personality or mental training promise boundless self-optimization and heightened efficiency. They are steered by neoliberal techniques of domination, which aim to capitalize not just on working time but on the person him- or herself: all the attention the individual commands and, indeed, his or her very life. Neoliberalism has discovered integral human being as the object of exploitation.

The neoliberal imperative of self-optimization serves only to promote perfect functioning within the system. Inhibitions, points of weakness and mistakes are to be therapeutically eliminated in order to enhance efficiency and performance. In turn, everything is made comparable and measurable and subjected to the logic of the market. It is not concern for the good life that drives self-optimization. Rather, self-optimization follows from systemic constraints – from the logic of quantifying success on the market.

The age of sovereignty was the age of levying and conscription: the expropriation and appropriation of goods and services. The power of sovereignty expressed itself as the right to seize and dispose at will. In contrast, disciplinary society banks on production. It is the age of active and industrial added-value. That said, the time for creating new value which is real is over and done. Indeed, under the financial capitalism of our day, value is being destroyed at the root – eradicated. The neoliberal regime is in the course of inaugurating the age of exhaustion. Today, the psyche itself is being exploited. Accordingly, psychic maladies such as depression and burnout define our times.

In contemporary American self-help literature, the magic word is *healing*. The term refers to self-optimization that is supposed to *therapeutically eliminate* any and all functional weakness or mental obstacle in the name of efficiency and performance. Yet perpetual self-optimization, which coincides point-for-point with the optimization of the system, is proving destructive. It is leading to *mental collapse*. Self-optimization, it turns out, amounts to total self-exploitation.

The neoliberal ideology of self-optimization displays religious – indeed, fanatical – traits. It entails a new form of subjectivation. Endlessly working at self-improvement resembles the self-examination and self-monitoring of Protestantism, which represents a technology of subjectivation and domination in its own right. Now, instead of searching out sins, one hunts down negative thoughts. The ego grapples with itself as an enemy. Today, even fundamentalist preachers act like managers and motivational trainers, proclaiming the new Gospel of limitless achievement and optimization.

It is impossible to subordinate human personhood to the dictates of positivity entirely. Without negativity, life degrades into "something dead."[1] Indeed, negativity

is what keeps life alive. Pain is constitutive for *experience* (*Erfahrung*). Life that consists wholly of positive emotions and the sensation of 'flow'[2] is not human at all. The human soul owes its defining tautness and depth precisely to negativity:

> That tension of the soul in unhappiness which cultivates its strength [...] its inventiveness and courage in enduring, persevering, interpreting, and exploiting suffering, and whatever has been granted to it of profundity, secret, mask, spirit, cunning, greatness – was it not granted through suffering, through the discipline of great suffering?[3]

The imperative of boundless optimization even manages to exploit pain. Thus, the famous motivational speaker Tony Robbins has written:

> When you set a goal, you've committed to CANI (Constant, Never-Ending Improvement)! You've acknowledged the need that all human beings have for constant, never-ending improvement. There is a power in the pressure of dissatisfaction, in the tension of temporary discomfort. This is the kind of pain you *want* in your life.[4]

Now, the only pain that is tolerated is pain that can be exploited for the purposes of optimization.

But the violence of positivity is just as destructive as the violence of negativity.[5] Neoliberal psychopolitics, with the consciousness industry it promotes, is destroying the human soul, which is anything but a machine of positivity (*Positivmaschine*). The neoliberal subject is running aground on the imperative of self-optimization, that is, on the compulsion always to achieve more and more. Healing, it turns out, means killing. ⊘

* Originally published in: Byung-Chul Han, *Psychopolitics: Neoliberalism and New Technologies of Power*, translated by Erik Butler (London; Brooklyn, NY: Verso, 2017). Reproduced with permission of the Licensor through PLSclear.

1. Georg Wilhelm Friedrich Hegel, *The Encyclopedia Logic (with the Zusätze)*, translated by T. F. Geraets, W. A. Suchting and H. S. Harris (Indianapolis: Hackett, 1991), 236.
2. Cf. Mihaly Csikszentmihalyi, *Flow: The Psychology of Optimal Experience* (New York: Harper Perennial, 2008).
3. Friedrich Nietzsche, *Basic Writings*, translated by Walter Kaufmann (New York: Modern Library, 2000), 344.
4. Quoted in Barbara Ehrenreich, *Bright-sided: How Positive Thinking Is Undermining America* (New York: Picador, 2010), 94.
5. Cf. Byung-Chul Han, *Topologie der Gewalt* (Berlin: Matthes & Seitz, 2011), esp. 118-127.

Architectures of Bipolarity

Francisco Díaz

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Human bodies are in a permanent state of exchange. Through the nose and mouth, our lungs perform a continuous process of inhaling oxygen and exhaling CO_2. Our skin permanently exchanges water with the environment, releasing or receiving humidity. Blood is continuously flowing in our veins, feeding the different organs that make up the body. Electric impulses are always traveling through our nerves. Even in a state of total rest – as in profound sleep or total relaxation – the atoms in our body are continuously moving. But not only human bodies. Air, fluids, or electricity work on the same physical principle: the difference of potential. Contained in a channel of communication between A and B, the potential becomes energy – stored power. And when it is released, a flux appears. A light-bulb lights up when we release the path through which electrons move from negative to positive. Water runs into our sink when we open the faucet that contains the stream. Due to the temperature difference, hot air leaves the room as soon as we open window, forcing an equivalent volume of cold air to sneak in. However, the power of such streams has to be controlled; otherwise, it may damage the channel of communication. That's why the electric grid provides a specific voltage, and water has to meet certain pressure levels. The same happens in our bodies. Our blood has to be within specific ranges of pressure, the rhythms of inhaling and exhaling have to be continuous, and our skin can only be exposed to low voltages. We have power inside our bodies. Yet, its potential has to meet certain ranges – beyond which our lives may be threatened.

Polarities

Since everything in our universe is composed of atoms containing protons and electrons, all that we see and all that surrounds us has positive and negative charges. Thanks to these poles that generate electric flows, everything is in a permanent state of movement. Polarities are the chemical architecture of the universe. The imbalance between poles is what creates potentiality. Such imbalance is what makes the electrons flow through a copper cable, light the resistance, and then return to the power grid. For like a river basin or a highway, the power grid does not store energy; it is not a pond or a parking lot – it is a device that allows electricity to flow. A battery 'stores' power only because it can contain the potentiality of an energy imbalance – which is released when a device acts as a channel through which electrons can flow (a resistance). Thus, if we manage to induce a permanent imbalance between the two poles, we could create an endless power source.

Our body's perceptual apparatus can't directly notice the endless movement of electrons. Just like we don't feel the Earth's rotation but we can perceive the days and nights, we can't see the movement of subatomic particles, but we can see their effects, like the incandescence in a lightbulb.

In fact stones, which seem to be inert objects which have been in a frozen state for millions of years, are actually a chemical composites or elements full of subatomic movement we can't perceive. They seems to be cold and hard to our senses, but some of them – like coal or lithium – have the potential to prompt energy flows.

Li

Due to its usage in batteries and as a treatment for bipolar disorder, lithium has become a sort of miraculous chemical element in the last years. But, what are the actual properties that make it so miraculous?

The lithium atom has three electrons. Two share an inner orbit while the third spins in an outer one. This structure allows it to easily lose and regain the third outer electron. Besides, as the lightest metal, it's the smallest electron-giver element so it needs less space to generate the potential necessary to release a flow of energy. Since there is no element with more electrons to share in a given volume, lithium is the most efficient among those that 'store' energy.

In batteries, potentiality is generated by a contained flux of electrons, ready to jump from negative to positive when connected to a resistance. In the average lithium-ion battery that mobile phones have, the negative side (anode) is composed of graphite and lithium, while the positive (cathode) is mainly composed of cobalt, an element that attracts electrons. When the phone is in use, lithium's third electron flows through the circuitry drawn by cobalt. Once all the electrons have crossed to the cathode, the battery loses its charge. And when we recharge it, electricity reverses the flow as if we flip an hourglass: lithium electrons meet again with their atoms in the anode, and, in so doing, they re-create potentiality.[1]

From the psychiatric point of view, lithium is, so far, the most successful treatment for alternate cycles of mania and depression – which we know today as "bipolar disorder."[2] Although there are no positive and negative poles, the opposite condition of these moods caused by alterations in neuronal action is what accounts for bipolarity. Interestingly, lithium works well in both conditions.

Remember that neurons are like a tree: the more the branches and leaves, the more the sunlight and CO_2 they can collect to photosynthesize. In the case of depression – caused by a lower exchange between neurons – lithium seems to boost the number of dendrites (branches) and links (leaves), thus increasing the exchange levels. In mania, on the contrary, the exchange between neurons starts to speed up until they get exhausted (as if you drown a plant when watering it). Here, lithium seems to drag and absorb the excess of exchange so that the process recovers a regular rhythm. Thus, in the two moods that account for bipolarity, lithium helps recover homeostasis.[3] Now, seen abstractly, mania and depression are opposites in terms of energy: the former implies an excess and the latter a lack. By dragging the excess in mania or allowing more exchange in depression, lithium seems to regulate the energy flows. Hence, although its effect is visible in a change of mood, its operation actually happens at a chemical level. Lithium is not a mood stabilizer but rather a flux regulator.[4]

Architectures of Bipolarity

The architectural layout of bipolarity is straightforward: two poles that feed each other through imbalance and, in so doing, create movement and energy. Today, such architectures are visible in those polarities that generate a differential in power – a potential – which feeds an endless loop. Wealth and poverty. North and South. Right and left. Mania and depression. No matter if they are positions or dispositions – paraphrasing Keller Easterling[5] – the result is a loop or a dynamo that feeds from such polarities.

In fact, the 'dynamism' of the global economy is also fueled by these bipolarities. Capital flows move due to the potential of revenues, interest, or taxes. As David Harvey argues, "it is flows of money that make the contemporary environment what it is," so that "any interruption in those

money and commodity flows" will have catastrophic ecological consequences, thus, "the circulation of money is a prime ecological variable [...] essential if the material qualities of the environment are to be maintained."[6] Just like blood or electricity, capital is in a state of flux. Even when it is stored – in a savings account or an investment fund – it generates potential through interest rates, and is ready to be invested when the opportunity arises.

Lithium helps these different flows to reach another level of efficiency and independence from inconvenient factors that might stagnate them. By allowing electrons to flow inside a battery, lithium enables portable devices such as computers, cellphones, or cars to be detached from the grid. Also, by regulating the flows of energy between cells, it helps balance individuals' moods, thus liberating their bodies from the need of external care. By unblocking these aspects, which imply the individual's need to rely on certain material and social infrastructures, lithium helps capital flows achieve new horizons.

In fact, the current lithium-fever can be understood under the lens of capitalism's history: animal power, coal, oil, the electric grid, and now lithium. As Nancy Fraser points out, "capitalism's history can be viewed as a sequence of socio-ecological regimes of accumulation" that end in eco-development crises, which are partially solved by the next regime until they fail again and are replaced by a new one.[7] Just when the neoliberal dynamism was getting exhausted by the rampaging inequalities that choke the flow and bring social and ecological devastation – draining the planet with it – lithium came to lubricate the system again and generate new avenues for capital accumulation. By encouraging the chance of an actual detachment from the burdens of society, the old promise of autonomy finds in lithium a perfect ally, as it has the potentiality of enhancing capital and chemical exchanges while circumventing certain social structures and interactions.

Thus, if the pill empowers individuals and the battery powers their devices, lithium powers markets that see in this element the potential to conceal the next phase of capitalism behind the facade of green energies and apparent commitment to ecological concerns. However, as a potential, the enthusiasm about lithium should move within certain ranges. Otherwise, life on this planet may be threatened with the danger of its exhaustion. ⊘

1. Christian Julien, Alain Mauger, Ashok Vijh, Karim Zaghib, *Lithium Batteries: Science and Technology* (Cham, Switzerland: Springer International Publishing, 2016).
2. American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders: DSM-5* (Washington, DC: American Psychiatric Publishing, 2013), 123.
3. Heinz Lüllmann, Lutz Hein, Klaus Mohr, Detlef Bieger, *Color Atlas of Pharmacology*, 3rd edition revised and expanded (Stuttgart; New York: Thieme, 2005), 230-231.
4. A recent study proposes that lithium acts over a specific protein – CRMP2 – which was inactive in bipolar patients. See: Brian T. D. Tobe et al., "Probing the Lithium-Response Pathway in hiPSCs Implicates the Phosphoregulatory Set-Point for a Cytoskeletal Modulator in Bipolar Pathogenesis," *PNAS Proceedings of the National Academy of Sciences of the United States of America*, vol. 114, no. 22 (May 30, 2017). Available online: <www.pnas.org/content/114/22/E4462>.
5. We usually understand the stance of an actor, agent, or organization as a 'position,' but Keller Easterling has also coined the notion of 'disposition' to speak about the potential of one of these, which may not be declared. See: Keller Easterling, *Extrastatecraft: the Power of Infrastructure Space* (Brooklyn, NY: Verso, 2014), 72-73; and Keller Easterling, *Medium Design: Knowing How to Work on the World*. (London, UK; Brooklyn, NY: Verso, 2021), ix.
6. David Harvey, "What's Green and Makes the Environment Go Round?," in *The Cultures of Globalization*, edited by Fredric Jameson and Masao Miyoshi (Durham and London: Duke University Press, 1998), 332.
7. Nancy Fraser, "Climates of Capital," *New Left Review* 127 (January-February 2021).

Lithium: Towards a Theory of Bipolar Transitions

Marina Weinberg, Cristóbal Bonelli

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> It may seem paradoxical to say that we have been expelled from the present, but it is a feeling we all have had at some moment. Some of us experienced it first as a condemnation, later transformed into consciousness and action. The search for the present is neither the pursuit of an 'earthly paradise' nor that of a timeless eternity: it is the search for a real reality. For us, as Spanish Americans, the real present was not in our own countries: it was the time lived by others, by the English, the French and the Germans. It was the time of New York, Paris, London.
> Octavio Paz [1]

Three decades after Octavio Paz shed light on the colonial grammar that dislocates the present in our Latin-American territories, this dominant logic still continues to be expressed through discourses and practices associated with climate change and the urgent need to implement strategies aimed at reducing the planet's temperature.

In fact, reducing CO_2 emissions through the technological replacement of fossil transport with an electric one powered by lithium-ion batteries is a good example of how colonial logics continue to fuel the dream of 'earthly paradise,' and to pursuit the bucolic present of green cities vitalized with renewable energies. Buenos Aires, La Paz, or Santiago, capitals of the countries that today extract and export lithium, the essential material for the creation of these green future, continue to yearn for the time of New York, Oslo, or Shenzhen. The growing demand for lithium, necessary for the development of batteries that will enable electromobility in the United States, Europe, and China, is accompanied by celebratory discourses and *humors* that, embodying the delirium of capital, express messianic commitments and linear and unequivocal promises about the dream of the 'earthly paradise' of climate neutrality.

To implement this planetary energy project, these discourses embody what Walter Benjamin called "homogeneous and empty time," a time understood as a succession of

discrete moments, where each successive moment replaces the moment it followed.[2] Europe promises to be "the world's first climate-neutral bloc by 2050," while making sure that "no one will be left behind."[3] In Chile, the private lithium producer SQM, joins this great project by offering nothing other than "solutions for human progress," committing to "reduce brine extraction by 50% by 2030, [...] [thus] reduc[ing] continental water consumption by 65% by 2040," and becoming a carbon-neutral company "in all of its products by 2040 and, in the case of lithium, potassium chloride, and iodine, by 2030."[4]

Lithium is used to stabilize increasingly profitable renewable energy markets, which will foster uninterrupted economic growth in the Global North.[5] But this celebration of lithium-based technical arrangements sharply contrasts with the 'current real realities' where this element is exploited through extractive practices involving the destruction and dispossession of ecosystems and life forms.[6] In this context, Octavio Paz's decolonial concerns take a renewed shape: 'for whom' and 'where' such an energy transition will be beneficial and sustainable is still controversial. Hence, the ethical imperative of questioning, opening, and critically thinking of how this 'we' of energy transition, and the modern temporality and spatiality of the strategic planetary-scale, becomes crucial. From Latin America, it is not difficult to see how the energy transition's genealogical tree is the same as the capitalist transition. Nor is it difficult to see globalizing projects breaking in and interrupting local spaces. Less so, to realize how these transitions make the interdependence of localized processes that seek 'planetary' decarbonization invisible. By separating the world into continents, discrete and distinct, and imposing a unique and universal linear time, these transitions, designed from the Global North, operate without considering the ecological relevance of the sustainability of interdependent ecological processes.[7]

...

Chile's position as one of the world's leading lithium suppliers is part of a broader history about the implementation of a neoliberal development matrix in Latin America, inaugurated with the Chilean coup in 1973. The extractivist industry exacerbated productive work and needed to separate water from land to turn it into a profitable commodity. By means of privatization, through the 1981 Water Code – which defined water rights as private property with minimal state regulation – Chile became an international leader in pro-market water policies. These markets have strengthened financial abstraction on major stock exchanges. Feeding on water overexploitation, they boost practices of extractivist accumulation, causing conflicts between users, severe water crises, and inequality.[8]

Therefore, the need to consider the relevance of water within these capitalist transitions prompts us to develop a processual theory of the *humors* – including both moods and fluids at stake in these processes. It also forces us to design a conceptual apparatus that accounts for how these transitions stabilize and destabilize human and non-human moods and fluids.

In Western imagery, the theory of *humors* is ancient. It goes back to Greece and its cosmology of the human body as a container of basic liquids (blood, yellow bile, black bile, and phlegm) related to the four essential elements (air, fire, earth, water). Stabilizing these liquids led to good health, good humor, and, consequently, a good life. In our current scenario of climate change and ecological crisis, these four key elements and their concomitant basic fluids appear to be highly destabilized.

...

Besides considering mythical Greek *humoral* theory, we understand these disarrangements of the planet from mental health and contemporary psychiatry (especially through the definition of bipolar disorder published in the latest psychiatric diagnostic manual *DSM-5*[9].) Here, the first criteria for mania

is "a persistently high period, expansive or irritable 'humor'" and "an abnormal and persistent increase in task-oriented activities or an 'energy' boost," thus proving the first conceptualizations of this psychiatric entity made by Kraepelin a century ago, when he emphasized the 'increase of being occupied' as fundamental in mania.[10] The increase in persistent energy, the duration of which is "present throughout the day, each day," established as a requirement for manic episodes in the *DSM-5*, intensifies the criteria of the previous manual, *DSM-4*, which only required this increase to last one week in order to be diagnosed. This continuous manic humor can be likened to the capitalist one, expressed, for example, in the never-ending water extraction in many places in Latin America. This *humor* and its related water-fluid destabilizations produced in non-human materialities, allows us to think of the energy transition as a bipolar one. The maniac appears as a Northern polarity in apparent tension with a Southern one – poles that do not necessarily coincide with a geographical territory, as Octavio Paz established.

With 'bipolar transitions,' we want to offer a diagnosis that allows us to unpack the more pathological side of energy and capitalist transitions. Also, to illuminate this contemporary pathology characterized by manic-capitalist mood to face problems of climate change. 'Bipolar transitions' signals how the same pathological mood that proposes frantic decarbonization benefits for very few, rearticulates depressive moods, and generates dystopian environments in many. This notion of 'bipolar transitions' considers North and South as categories that sometimes coincide with geographical areas and are often articulated as 'humoral areas' related to the unequal distribution of fluids fundamental to life.

...

Through this conceptualization, we propose a *humoral* theory of transitions that is useful to account for the unequal, unbalanced, and polarized distribution of human and non-human moods and fluids present in the *modus operandi* of capital. We think of these bipolar transitions by partially connecting the languages of mental health – manic and depressive moods – with the mythical Greek languages related to the basic fluids in the human body and on the planet.

Within extractivist Latin America, 'bipolar transitions' have a peculiar articulation and imbalance between capitalist manic humor and the use of water, particularly when it comes to lithium and its exploitation of freshwater (used for the production process) and brines (used for the production of different lithium compounds depending on the country of extraction). Thinking about bipolar transitions also allows us to connect two discourses that tend to become dissociated in the public domain: the discourse of energy transitions – framed within a capitalist regime – and the discourse of mental health and its detection of mood disorders. The 'bipolar' category allows us to displace 'energy' from the present of the South, decolonizing the pivotal obsession with energy, economic growth, and development imposed by the North. From the critical perspective of bipolar transitions, North and South are related to worlds associated with the typical *humors* of bipolar discourse: the North as being animated by a manic mood and the South as prone to a depressive state of mind.

This emphasis on polarized *humors* allows to understand transport decarbonization as a manic-capitalist response, part of a larger syndrome of unequal distributions. Moreover, the manic decarbonization temper drives not necessarily towards energy transitions but most of the times to energy additions.[11] The notion of 'bipolar transitions' makes it possible to become aware of this process by diagnosing the manic state of capitalism,[12] which faces climate change with more production and business: more batteries, more cars, more work, more economic growth – elements and promises that cannot exist without competitive individuals. This resonates again with Benjamin's "homogeneous and empty

time," which the bipolar category radically questions: the energy transition is one that renders invisible the conflicts and side-effects present where the planet's resources and possibilities are unequally distributed.

What we call bipolar transition, therefore, also has to do with the times and spaces dictated by the current capitalist regime. Just as the shift from Fordism to flexible accumulation within a financial economy required the acceleration of time and the collapse of certain frontiers, this form of capital accumulation requires a new configuration of space-time.[13] In addition, promises of great milestones and decarbonization goals to be achieved by 2030, 2040, or 2050, assume an unequivocal space-time and ways of life.[14] Thus, not only do they fade, hiding transformations that take place in multiple presents, but they also omit and eliminate the need to decolonize or provincialize the temporalities and spatialities of energy transitions.

The proposal of bipolar transitions shifts the linear time imposed by capitalism and proposes to think about the oscillation between manic and depressive moods, human and non-human, in a multiple present characterized by unequal struggles, living conditions, and enormous instability. In this context, lithium is an element 'used' by manic bodies – those that accumulate energy – obsessed with battery production.

Thus batteries, understood as objects in the world that stimulate theoretical formulations,[15] express the imperative of renewable economy: to dispossess, to produce, to accumulate, and reproduce *ad infinitum*. Through the promises of a better future, visualized from a homogeneous and empty present time, the battery appears as a fractal that allows us to understand how capitalism works, controlling and exploiting nature to continue to produce value (exponentially).[16] The energy-capitalist transition evaporates *humor*-water (the phlegm of the Earth in the Greek tradition) to store energy detached from the environments. Lithium batteries, allow fot the increasing of the modern individual's energy and their ability to produce, thus expressing what we provisionally call 'storage by extractivism.' While, in a generic form, the *modus operandi* of capitalism has been defined by Harvey as a predatory process of capital accumulation by dispossession,[17] the battery offers us its material instantiation: a device that stores energy so that some continue to accumulate capital in the name of the global good, and where the dispossessed remain unseen and overexploited within an empty time. ⊘

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1. Octavio Paz, "In Search of the Present," Nobel Prize Conference 1990. *The Nobel Prize*. Available in: <https://www.nobelprize.org/prizes/literature/1990/paz/25350-octavio-paz-nobel-lecture-1990/>. Accessed on February 23, 2021.
2. Walter Benjamin, "On the Concept of History," in *Walter Benjamin: Selected Writings Volume 4:1938-1940*, edited by Howard Eiland and Michael Jennings (Cambridge: Cambridge University Press, 2006).
3. "Financing the Green Transition: The European Green Deal Investment Plan and Just Transition Mechanism," *European Commission*, Press release, January 14, 2020, Brussels. Available in: <https://ec.europa.eu/commission/presscorner/detail/en/ip_20_17>. Accessed on February 23, 2021.
4. "SQM entre las cinco empresas chilenas más sustentables según ponderación ESG," *Timeline Antofagasta*, January 25, 2021. Available in: <https://timeline.cl/2021/01/sqm-entre-las-cinco-empresas-chilenas-mas-sustentables-segun-ponderacion-esg/>. Accessed on February 23, 2021.
5. For an analysis of lithium as a stabilizer, see David Habets, Cameron Hu, and Stefan Schofer's contribution in this volume.
6. For discussions on extractivism in Latin America, see: Alberto Acosta, "Extractivismo y neoextractivismo: dos caras de la misma maldición," in *Más allá del desarrollo. Grupo permanente de trabajo sobre alternativas al desarrollo*, organized by Miriam Lang and Dunia Mokrani (Quito: Fundación Rosa Luxemburg/Abya Yala, 2011), 83-118; E. Gudynás, "Modos de producción y modos de apropiación, una distinción a propósito de los extractivismos," *Actuel Marx Intervenciones*, 20 (2016): 95-121; M. Svampa, *Las fronteras del neoextractivismo en América Latina: Conflictos socioambientales, giro ecoterritorial y nuevas dependencias* (Germany: CALAS, 2019).
7. For an analysis of how European policies do not consider the sustainability of processes in ecology, see: A. Mol, "Natures in Tension," PBL Netherlands Environmental Assessment Agency, *Nature in Modern Society Now and in the Future* (The Hague: PBL Netherlands Environmental Assessment Agency, 2017), 88-103.

8. On the process of privatization of water in Chile, see: C. J. Bauer, "Water Conflicts and Entrenched Governance Problems in Chile's Market Model," *Water Alternatives*, vol. 8, no. 2 (2015): 147-172; M. Prieto, "Bringing Water Markets Down to Chile's Atacama Desert," *Water International*, vol. 41, no. 2 (2016): 191-212; N. Yáñez, R. Molina, *Las aguas indígenas en Chile* (Santiago: LOM Ediciones, 2015).
9. American Psychiatric Association, *Diagnostic and Statistical Manual of Mental Disorders – DSM-5* (Washington, DC: American Psychiatric Publishing, 2013).
10. E. Kraepelin, *Manic Depressive Insanity and Paranoia*, edited by G. M. Robertson, and translated by R. M. Barclay (Edinburgh: E&S Livingstone, 1921).
11. See: B. Fornillo, "Hacia una definición de transición energética para Sudamérica: antropoceno, geopolítica y posdesarrollo," *Prácticas de oficio*, vol. 2, no. 20 (2018): 46-53; R. York, S. E. Bell, "Energy Transitions or Additions?: Why a Transition From Fossil Fuels Requires More Than the Growth of Renewable Energy," *Energy Research & Social Science* 51 (2019): 40-43.
12. E. Martin, *Bipolar Expeditions: Mania and Depression in American Culture* (Princeton: Princeton University Press, 2007).
13. David Harvey, *Spaces of Global Capitalism: Towards a Theory of Uneven Geographical Development* (London: Verso, 2006).
14. M. Weinberg, M. González, C. Bonelli, "Políticas de la evidencia: entre posverdad, objetividad y etnografía," *Antípoda. Revista de Antropología y Arqueología*, vol. 41, no. 4 (2020): 3-27.
15. Peter Galison, *Einstein's Clocks, Poincaré's Maps: Empires of Time* (New York: Norton, 2003).
16. Karl Marx, *El Capital* (México: Siglo XXI, 2008[1859]); J. Moore, "The Value of Everything? Work, Capital, and Historical Nature in the Capitalist World-Ecology," *Review (Fernand Braudel Center)*, vol. 37, no. 3-4 (2014): 245-292.
17. Harvey, David. *The New Imperialism*. (Oxford; New York: Oxford University Press, 2003).

Evaporations

Pedro Alonso

PAG. LXXXVIII | FIGS. 1-9

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"They look like watercolors," a friend of mine told me while looking at Ignacio Infante's aerial photos of the enormous lithium evaporation pools in the Atacama Desert. And that is precisely what they are. When pumped to the surface, the brines of the Salar de Atacama carry a diverse array of dissolved minerals which become the natural pigments of a colorful landscape. In these ponds, potassium, boron, magnesium, calcium, and, of course, lithium, create a range of whites, yellows, ochres, oranges, sky blues, and greens, as water evaporates into the dry atmosphere of the desert. The colors depend on the amounts of the elements, the degree of oxidation, and the purity of the lithium achieved in each stage of the process. It is hard to look at these vibrant ponds and not be awestruck by their beauty.

These artificial landscapes are so aestheticized, and the scale is so operatic, that one could even characterize the whole procedure not as an engineering process but as an artistic one – or at least, as something not far from Robert Smithson's celebrated fascination with geology and the industrial alterations made to the Earth's surface by bulldozers. For Smithson, the artist and the miner had to be conscious of themselves as natural agents, with art becoming the physical resource mediating between the ecologist and the industrialist.

Regarding the production of lithium, however, there is a paradox, if not a catastrophe: in the driest desert on Earth, these beautiful pools evaporate approximately 1,900 liters of water for every kilogram of lithium produced.[1]

Bearing that in mind, talking simply about the beauty of these landscapes is an approach as shallow as the pools themselves. Instead, for an art that mediates between industry and ecology, the sublime is a more suitable category. Despite being artificial, these overwhelming structures, like all that is vast or capable of inspiring awe, can be admitted to aesthetics under the description of the sublime. But, as noted by Mark Cousins, this characterization is incomplete since the sublime "essentially consists in a certain relation between an object which is fearful or awful and a subject who survives the experience of that object."[2]

Cousins's incorporation of survival into the aesthetic experience of the object is something quite relevant to the Atacama, where survival clearly needs to be assessed in practical terms. These pools are the result of a colossal process of geo-constructivism, a tangible example of environmental impact in fragile ecosystems. The subject, therefore, performs a double survival: of the aesthetic experience and of the actual experience of the environmental changes produced by the Atacama's long history of evaporation.

For some individual subjects, however, the awe provoked by the sheer scale of the pools consuming precious water is experienced not

as fear but instead as profit: this ecological calamity obviously does not register in the sensory experience of miners despite their presence at the scene of the catastrophe. The darkest aspects of the final act of water consumption, as experienced by the great majority of Atacama's entrepreneurs, have remained a kind of shameful secret, a secret that perhaps will never be fully acknowledged as long as devastation takes the form of evanescent vapor.

But this terrifying degradation of the desert environment is something that will not only be experienced by individual subjects but also by a collective subject: a trans-subjectivity that brings together different times and generations. In revisiting Nikolai Fedorov's "Philosophy of the Common Task," Boris Groys explains that for Fedorov, there was an outrageous historical injustice, "the exclusion of all previous generations from the realm of socialist utopia. Socialism thus functioned as an exploitation of the dead in favor of the living – and as an exploitation of those alive today in favor of those who will live later."[3] The rather global capitalist model behind the exploitation of lithium seems to provide an inverted – if yet equivalent – injustice: the exclusion of all future generations from the wealth extracted in the present. Capitalism functions as an exploitation of the unborn in favor of the living. Unborns that have no rights as they do not yet exist. Fedorov's socialist utopia yields its place to a neoliberal dystopia that, once again, manages to dissolve itself into evanescent water.

Generally, economists tend to conceive the environment as a subsystem of the economy. But the reality is the reverse. No economy is possible in the absence of the environment.[4] It is, therefore, no wonder that the current economic model is in open denial of its own destructive powers. In aesthetic terms, nothing is more frightening than an overwhelming landscape of devastation. In "Entropy Made Visible" (1973), Smithson noted that mining's disregard for the way a landscape looks after its operations have ceased shows "a kind of blindness." Such is the case in the Atacama, given that the evaporation pools are absent from all forms of cartography, concealed within the classified files of mining companies, and, therefore, removed from public discourse. They are instead contrived aesthetic objects which are, perhaps, visible to perception but invisible to politics – objects that, as we have seen, are sublimated by a collective, transhistorical subject.

This is, as it were, blindness by design that would delay in time the whole experience of the sublime. We choose not to see because we take for granted that lithium will solve the problems of a century that has no precedent in environmental risks, while deploying the same 19th-century economic model that caused the disaster in the first place (after all, neoliberalism is one of the offspring of neoclassical economics). It seems easier to believe that we will innovate by encouraging new lithium technologies than by promoting a project to redistribute our ways of life. There is a false idea of innovation, fostered by a logic of programmed obsolescence, labor deskilling, and digital human degradation that utilizes lithium as its fundamental input. This principle of innovation is naturally revealed as incapable of providing solutions to the problems that it has created, following a long history of extraction of mineral reserves by foreign companies and transnational corporations – too often headquartered in the Global North.[5] The natural history of evaporation in the Atacama Desert for lithium is just the continuation of the 19th-century extractive model of drainage by remote actors.

This history, of course, exceeds the current relevance of lithium. There are many other examples of the sublime in the Atacama: the world's largest open-pit copper mine at Chuquicamata, enormous slag heaps of mining debris, the scratching of the desert's surface in search of saltpeter, as well as the most recent interventions of large astronomical facilities and solar-thermal-power stations.

These economic activities are possible because of the unique characteristics of the desert environment. The high altitude

of the Andes, the lack of light pollution due to the distance from large cities, and the thin dry air of the region make the Atacama the perfect place for both optical and radio astronomical observations. Under such conditions, by 2030, the Atacama will contain more than half of the astronomical capacity of the world. A glimpse at the economic scale of these infrastructures is provided by the two largest projects now under development: The Extremely Large Telescope (with a mirror 39.3 meters in diameter) at Cerro Armazones, a US$ 1,16 billion project led by ESO; and the Giant Magellan Telescope (with a mirror 25.4 meters in diameter) at Las Campanas Observatory, a US$ 1 billion project led by the USA, in partnership with Australia, Brazil, and South Korea. Other multinational conglomerations already in place include the Atacama Large Millimeter Array (ALMA).[6] These infrastructures and operations activate a whole international economy that has significant environmental burdens.

The Atacama is also the region with the highest rate of direct solar radiation on the planet (9kWh/m^2/day). The perfect site for the evaporation of water is also perfect for the production of electricity through the use of solar generation, either using conventional panels or the mirrors of Concentrated Solar Power (CSP). According to Francisco Förster, an area of twenty by twenty kilometers in the Atacama, one quarter covered with mirrors, could produce all the electric energy that Chile needs by 2025.[7] An example of this potential is the solar-thermal-power plant in Cerro Dominador, equipped with 10,600 movable mirrors for sun collection and a 250-meter-high solar-power tower.

We see, then, the manner in which metallic and non-metallic ores, solar radiation, and sky observation (not to mention tourism) have already transformed the Atacama with their encroaching economic activities, each dependent on the environmental conditions of the region's different ecosystems.[8] Quite understandably, contemporary accounts stress the global relevance of lithium, but the ways in which saltpeter, copper, lithium, astronomy, and solar power connect has rarely been discussed. These industries still remain unbalanced and scattered as they all respond to different external demands with no cohesive plan for a country like Chile, that within dependency theories, was not allowed "to move from developing to developed by following models of innovation that included adopting Western models for scientific practice and industrial technologies for economic growth."[9] Instead, its successful underdevelopment has been the outcome of international policies that were necessary "for the developed nations to amass their wealth and argued that Latin American nations could not follow the same trajectory as nations such as the United States."[10] Consequently, Chile produces and exports lithium bags and copper bars but imports lithium batteries and copper cables.

There is, therefore, a large chain of value extraction where almost every feature of the desert's ecosystems has been exploited, and nothing is wasted. There is, as it were, a proper trophic web of resource exhaustion that, we must acknowledge, includes us: architects, academics, and researchers.

Professing interest in the desert and making pious noises about the seamless web of the desert ecology, we may not identify ourselves as part of that web, although we carry the Atacama in our laptops and cellphones. Through research methodologies, we also arrive as foreign investors, while our "production of knowledge" consumes the water and disturbs the fragile ecology of the desert floor. Our work is not so different from other processes of extraction. Our arguments and findings feed an academic industry that is far from the Atacama: newfound agendas that translate into lectures, books, and exhibitions. Powerless against the strength of transnational corporations and political lobbyists, we nonetheless engage in the same economies: ones that work at different scales, including the sublime, the outrageous, and the excessive. We come

after miners and corporations, to lurk within the exquisite corpse of an exhausted drained desert. Pouring money into research projects, former colonial powers – rather paradoxically – promote theoretical frameworks to decolonize the Atacama, connecting data, ethnography, and the environment. Just like copper and lithium, these ideas will be traded in the international marketplace. ⊘

1. The Chilean company SQM alone produced, in 2019, 62,300 metric tons of lithium carbonate at its Salar de Atacama mine.
2. Mark Cousins, *The Ugly I, II, III*, edited by Francisco Díaz and Pedro Alonso (Santiago: ARQ, 2020), 11.
3. Boris Groys, "Russian Cosmism and the Technology of Immortality," in *Russian Cosmism* (Cambridge, MA: e-flux, Inc. and MIT, 2018): 6-7.
4. Manfred Max-Neef interviewed by Amy Goodman, *Democracy Now!*, November 26, 2010.
5. For instance, the Guggenheim Brothers, the Kennecott Corporation, the Anglo-Chilean Nitrate and Railway Company, the Braden Copper Corporation, the Andes Copper Mining Company, Barrick Gold Corporation, BHP Group, and the Chinese Tianqi Lithium Corp.
6. The Atacama Large Millimeter Array (ALMA) is a project funded by the European Organization for Astronomical Research in the Southern Hemisphere (ESO) and the US National Science Foundation (NSF), in cooperation with the National Research Council of Canada (NRC), the National Science Council of Taiwan (NSC), and the National Institutes of Natural Sciences (NINS) of Japan together with the Academia Sinica (AS) in Taiwan. For full reports on the Atacama Desert observation capabilities, investments, and infrastructures, see: Addere Consultores, "Capacidades y oportunidades para la industria y academia en las actividades relacionadas o derivadas de la Astronomía y los Grandes Observatorios Astronómicos en Chile," a study by the Ministerio de Economía de Chile, División de Innovación (2012), in: <https://www.economia.gob.cl/wp-content/uploads/2012/06/OPORTUNIDADES-ASTRONOMIA-EN-CHILE-INFORME-FINAL.pdf>; and Eduardo Unda-Sanzana, "Cálculo de la capacidad astronómica instalada en Chile," Centro de Astronomía Universidad de Antofagasta (2020), in: <https://sochias.cl/wp-content/uploads/2020/05/2020-05-14-Sobre-la-capacidad-astronómica-instalada-en-Chile.pdf>.
7. Francisco Förster, "Concentrated Solar Power (CSP): Sustainable Energy in The Atacama Desert," in Pedro Alonso, *Deserta: Ecology and Industry in the Atacama Desert* (Santiago: ARQ, 2012), 248.
8. The three main ecosystems of the Atacama Desert are Loma, Puna, and Riparian.
9. Eden Medina, Ivan Da Costa Marques and Christina Holmes, (eds.), *Beyond Imported Magic: Essays on Science, Technology, and Society in Latin America* (Cambridge, MA: The MIT Press, 2014), 9.
10. Ibid.

The Cosmological Lithium Problem

Francisco Förster

B.Sc. in astronomy and engineering, University of Chile. PhD, University of Oxford, UK, 2009. He led the installation of a robotic telescope in Cerro Tololo in 2011 and led the High Cadence Transient Survey (HiTS) program that pioneered the real-time discovery of supernova explosions using large digital detectors. Since 2018, he is leading the ALeRCE astronomical alert broker, a next generation tool in the interface between astronomy and data science to sift through millions of nightly alerts generated by large etendue telescopes. Förster is an Adjunct Professor at the Center for Mathematical Modeling and Astronomy Department of the Faculty of Physical Sciences at the University of Chile, and associate researcher at the Millennium Institute of Astrophysics.

Found in a few places on Earth, such as the Atacama Desert in Chile (where an ancient ocean used to exist), lithium is a light and rare element. Although its scarcity is a challenge for the energy revolution required for the 21st-century, an even deeper cosmic lithium scarcity makes astronomers wonder about the nature of the universe itself.

During the last century, a series of discoveries in physics and astronomy revolutionized our understanding of the universe's origin and evolution. In 1929, while observing the velocities of nearby galaxies, the American astronomer Edwin Hubble discovered that the farther a galaxy is located, the faster it recedes from us. Moreover, their velocities were proportional to their distances, in what is known today as the Hubble-Lemaître law. This simple observation led to the amazing realization that the universe is not static – it is actually expanding.

Consider the following question: what would you see if you were a raisin inside an expanding cake? If the cake doubled its size in one hour, a raisin that is 1 cm away would end up being 2 cm away after sixty minutes; thus, it would move 1 cm/h. Now, since the cake doubled its size, a raisin at 4 cm would end up being 8 cm farther after one hour – which means that it would move at a rate of 4 cm/h. Hence, the farther another raisin is, the faster it would move away, and its speed would be proportional to its distance from you. This is exactly what an observer in any galaxy would see if the universe were expanding at a constant rate. In fact, that is exactly what the Hubble-Lemaître law shows.

Yet, the Hubble-Lemaître law was not a surprise to everyone. Only a few years before its discovery, a theory that could explain it was developed. In 1922, Russian physicist Alexander Friedmann applied the new theory of general relativity, developed by Albert Einstein, to the universe as a whole. He found that it was governed by a very simple equation that predicted it would not be static. Einstein initially rejected this idea. To make sure that the universe would remain static he added a new term to his equation, the 'cosmological constant,' something he later regretted after hearing from Hubble's discovery and which he called his "biggest blunder."

But if the universe was expanding, the obvious next question was: what would happen if we put the time in reverse? We would see the universe shrinking, but how far back in time could we go? Is this evidence of an origin where everything was infinitely dense? In fact, after hearing Friedmann's equation, Belgian priest George Lemaître noted in 1927 (before Hubble's discovery) that an expanding universe would imply an origin in a single point, where everything would be infinitely close. This theory gained popularity after Hubble's findings. However, a competing explanation was developed, where the universe was always expanding, matter was continuously being created, and which required no origin: the 'steady state' universe,

developed by the English astronomer Fred Hoyle – who mockingly called Lemaître's postulate the "Big Bang" theory, the name we still widely use.

The Big Bang Theory and the Origin of the Elements

Russian physicist George Gamow was a strong supporter of the Big Bang theory. He realized that it could help explain one of the biggest mysteries in physics at the time: what determines the abundance of elements observed in the universe? In 1925, American astronomer Cecilia Payne found that, contrary to what was believed, stars were made mostly of two elements: hydrogen and helium. This suggested that the composition of stars and the universe was very different from the Earth's. If close to the Big Bang the universe was very hot and dense, Gamow noted, the known elements of the periodic table would not have survived. Instead, there would be a primordial soup of subatomic particles. They would react with each other at incredibly fast rates as the universe expands and cools at very high temperatures. This rapid cooling process would imprint the universe with a particular distribution of the most common elements, which would freeze after nuclear reactions ceased. In fact, approximately three minutes after the Big Bang, the temperature and density were expected to drop below this critical threshold, effectively freezing the nuclear reactions and imprinting the universe with its current element composition.

Known as Big Bang Nucleosynthesis (BBN), Gamow's theory could help explain the abundance of the lightest elements in the periodic table – hydrogen, helium, and their isotopes – and trace elements such as lithium. All the other elements (a small fraction of the total hydrogen and helium), would be later generated inside stars, in supernova explosions, or by the merger of neutron stars. However, Gamow's theory had one important blindspot: the ratio between the density of normal or baryonic matter and photons (light particles) at early times, or η. A given value of η determines the relative abundances of the lightest elements. The challenge then became to find an independent measurement for η or to measure the abundances of light elements to infer η.

In 1964, a key discovery provided the final proof for the Big Bang theory and for the independent measurement of the η parameter that Gamow needed for his BBN theory. Arno Penzias and Robert Wilson – engineers working at Bell Labs in the USA – were experimenting with a new microwave communication antenna. They observed a persistent source of noise that could not be explained by known sources of instrumental noise. After a careful rejection of all possible known sources – and discussing this with a team of physicists from Princeton University that were trying to measure the same effect – they realized that the source of noise was the relic emission from the very hot universe close to the Big Bang, when hot plasma was transitioning into neutral atoms (electrons bonded to atomic nuclei), around 300,000 years after the Big Bang.

This observation was not only the final confirmation of the Big Bang theory. Since this hot plasma had tiny fluctuations that could be tracked and studied, it also allowed the measuring of the ratio between the energy stored in normal matter versus light at these times – the η parameter. With a relative error of only 2.4% (an incredibly precise margin), the value of η was about 6 baryonic particles for every ten billion photons. This allows us to precisely predict the abundances of helium-4, helium-3, deuterium, or lithium-7.[1] Remarkably, observations of pristine gas (unpolluted by the heavy elements produced in stars) in very old galaxies allowed astronomers to measure the abundance of the original helium-4, which coincided with the value predicted by the BBN theory. Something similar happened with deuterium and helium-3. Nonetheless, despite these matches between theory and observation, our best measurements of the abundances of lithium – either of lithium-7 or lithium-6

measured in the surface of very old stars – are far from the predictions of the BBN theory.

The Missing Element

The abundance of lithium-7 predicted by the BBN theory is between 3 to 4 times larger than what we observe. It is a highly significant difference, which cannot easily be explained by measurement errors. Known as "the cosmological lithium problem," this discrepancy between theory and observations has three possible explanations.

The first is that we cannot measure the pristine abundance of lithium-7 because it is destroyed inside the stars. Some stars develop convective motions at their surface, which can move matter from their outer to their inner regions, where nuclear reactions could destroy some of the lithium-7. Yet only stars with no convective surfaces are used to measure lithium-7. Moreover, this effect would be even stronger for lithium-6, which would be almost completely depleted if this were the case, but whose measured abundance is significantly 'above' the predictions of the BBN theory.

The second possible answer is that the nuclear reaction rates we use for the BBN theory are wrong or that we are missing some relevant nuclear reactions. However, these nuclear reaction rates can be precisely measured in delicate experiments designed by nuclear physicists, and several studies have looked for missing reactions without any success. Moreover, we can measure neutrinos produced in the Sun, very light particles produced in nuclear reactions, in the same nuclear reactions responsible for the creation of lithium-7, and the observations agree with the predicted reaction rates.

The third, and most interesting possibility, is that some new particles, perhaps those responsible for the mysterious dark matter – that, we know today, is the most common form of matter – were relevant in the reactions of the first three minutes of the universe. If this was the case, they could affect the abundance of lithium. In fact, theoretical predictions show that, if these particles were present and their properties were just right – for example, that their characteristic lifetime was between 100 and 1000 seconds – they could reduce the predicted abundance of lithium-7 by a factor consistent with observations. Alternatively, there are other explanations such as changes in the fundamental constants of nature close to the Big Bang or abandoning the principle of isotropy, therefore assuming that we live in an underdense region of the universe.

Thus, the abundance of lithium is inconsistent with the predictions of standard cosmology, stellar evolution, and nuclear physics, and the solution to this problem could come from different areas of physics and astronomy. Yet, as of today, it remains one of the biggest unsolved problems in cosmology. Lithium, one of the light elements created in the first three minutes after the Big Bang, provides not only material for cheap and lightweight batteries but also intellectual nourishment for physicists, astronomers, and cosmologists, and is perhaps the key to unlocking some of the biggest mysteries of the physical sciences in the 20th-century. ⊘

1. Atomic nuclei are made of protons and neutrons, held together by nuclear forces. The number of protons determines its main chemical properties (that is why the periodic table of elements is organized based on that figure). But the number of neutrons is also important for their nuclear properties. The same element can have different isotopes, with different numbers of neutrons for the same number of protons. For instance, the lightest and most common atomic nuclei in the universe are hydrogen-1, containing only one proton. Yet hydrogen can also be found as one proton and one neutron, in hydrogen-2 or deuterium, or as one proton and two neutrons, in hydrogen-3 or tritium. Only some combinations of protons with neutrons can exist in a stable fashion. In the case of lithium, these are three protons and three neutrons in lithium-6, and three protons with four neutrons in its most common form, lithium-7.

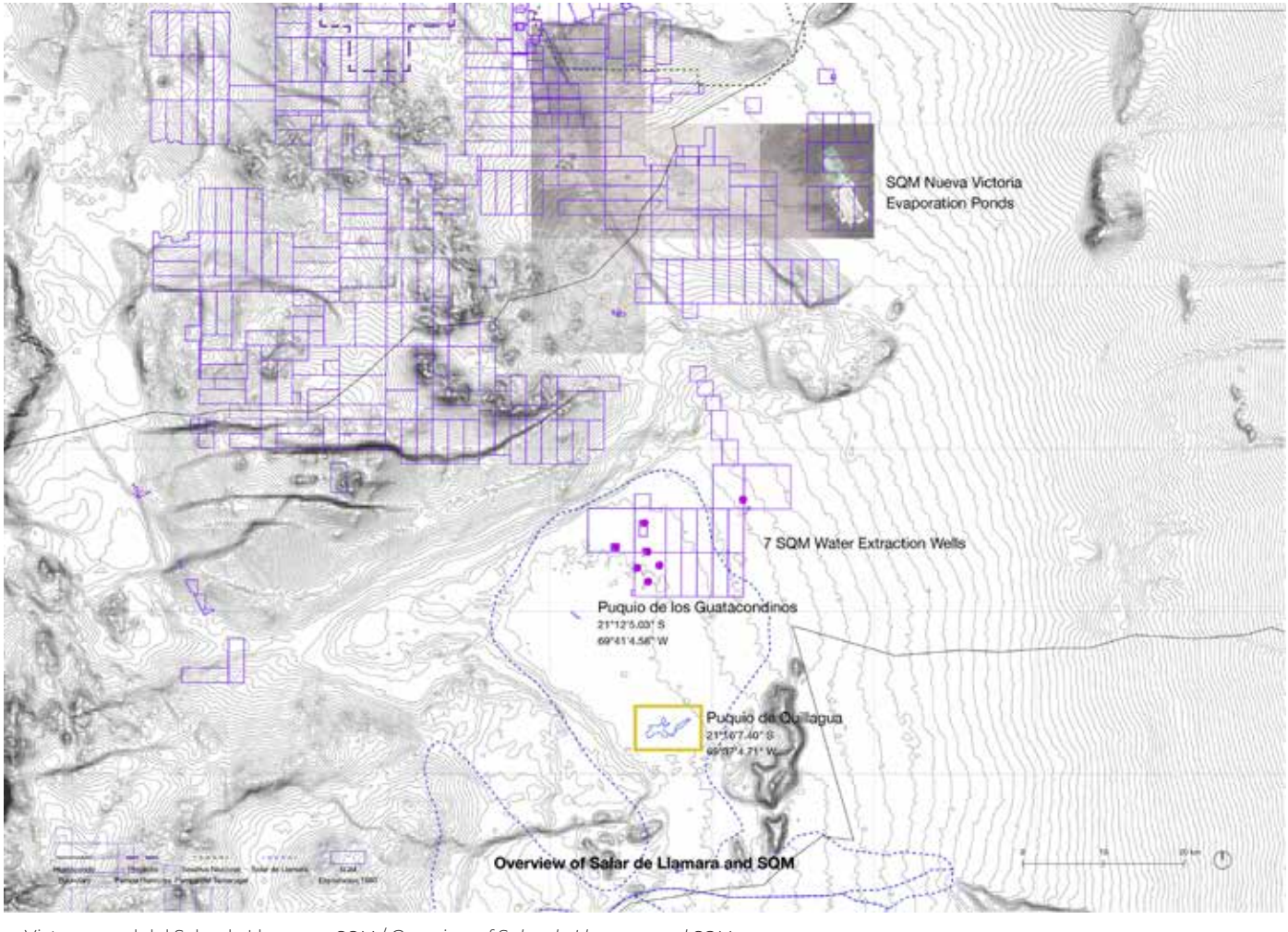
SALAR DE LLAMARA
CHILE

PAG. 37 | 024 FIGS. 1-7

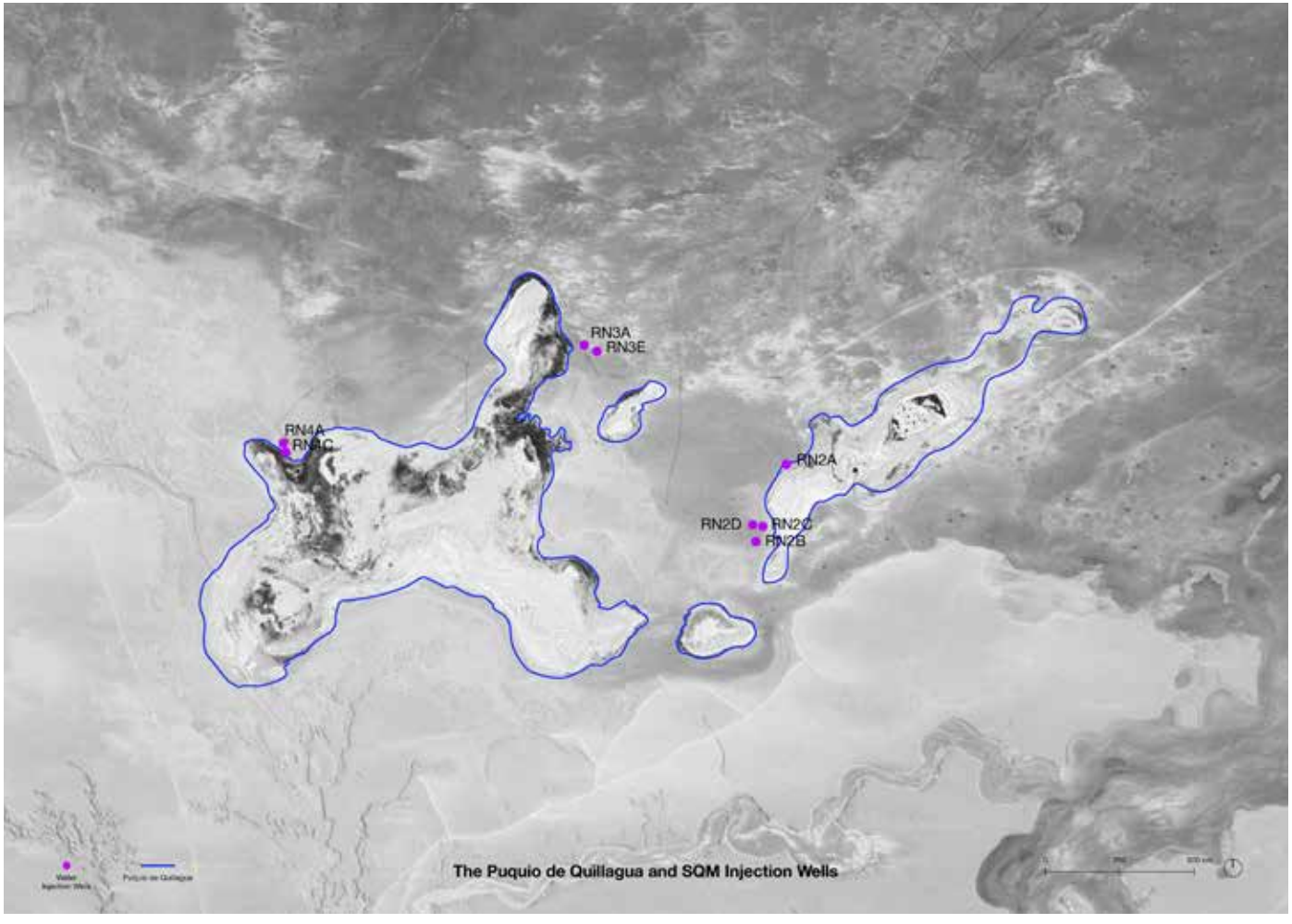
Lithium Triangle Research Studio

Puquio de Quillagua, Salar de Llamara, Chile, 2020.

Puquio de Quillagua, Salar de Llamara, Chile, 2020.



Vista general del Salar de Llamara y SQM / *Overview of Salar de Llamara and SQM*



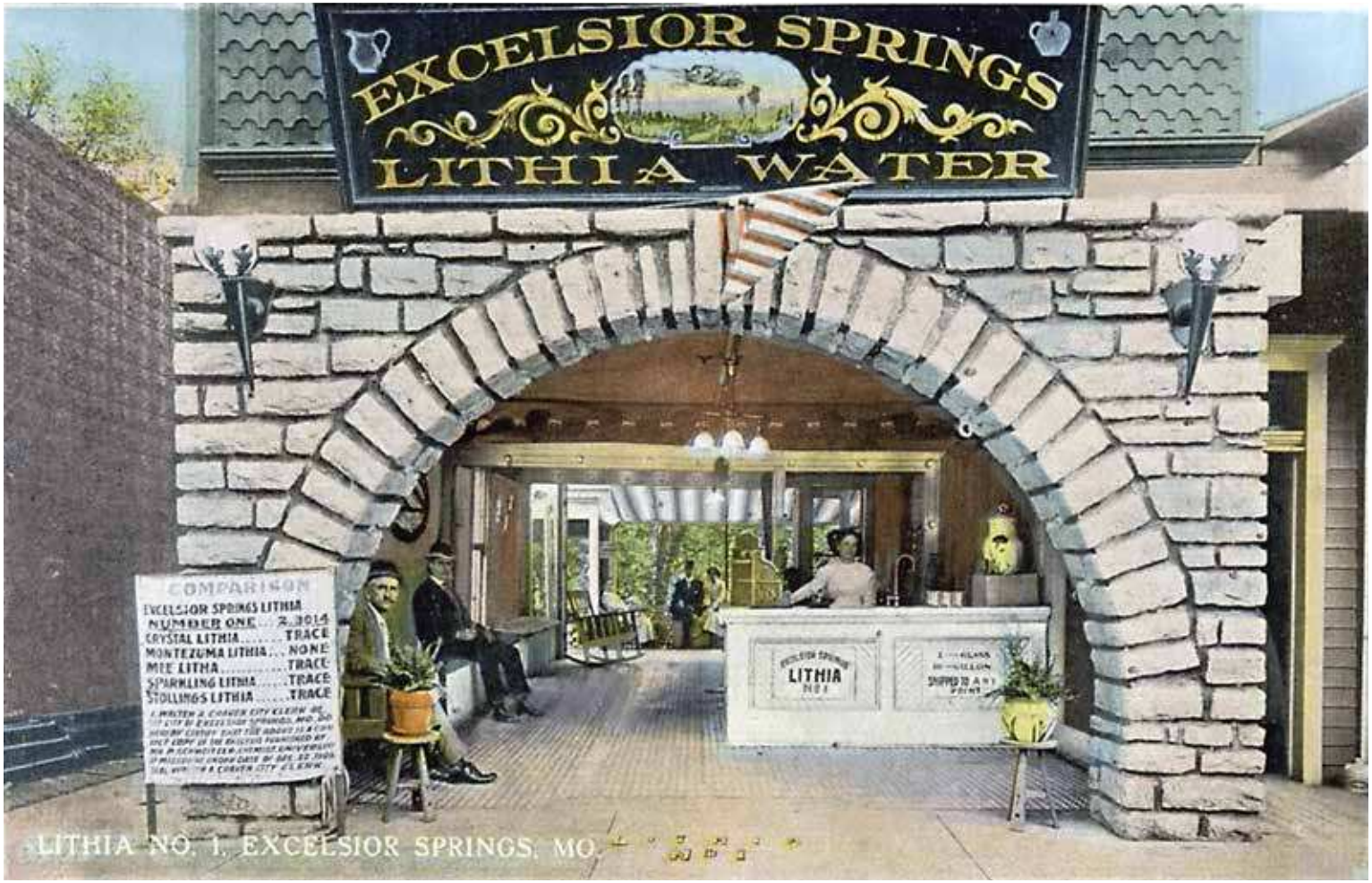
Puquio de Quillagua y pozos de inyección de SQM / *The Puquio de Quillagua and SQM injection wells*

Quebrada de Huatacondo, Chile, 2020.

Puquio de Quillagua, Salar de Llamara, FDA, Chile, 2020.

LITHIUM

Het Nieuwe Instituut



Lithia Water, Excelsior Springs, USA, c.1910.
Courtesy of Geoff Haggins.

Carslbad, Czech Republic, 1910.
Courtesy of Brück & Sohn Kunstverlag Meißen.

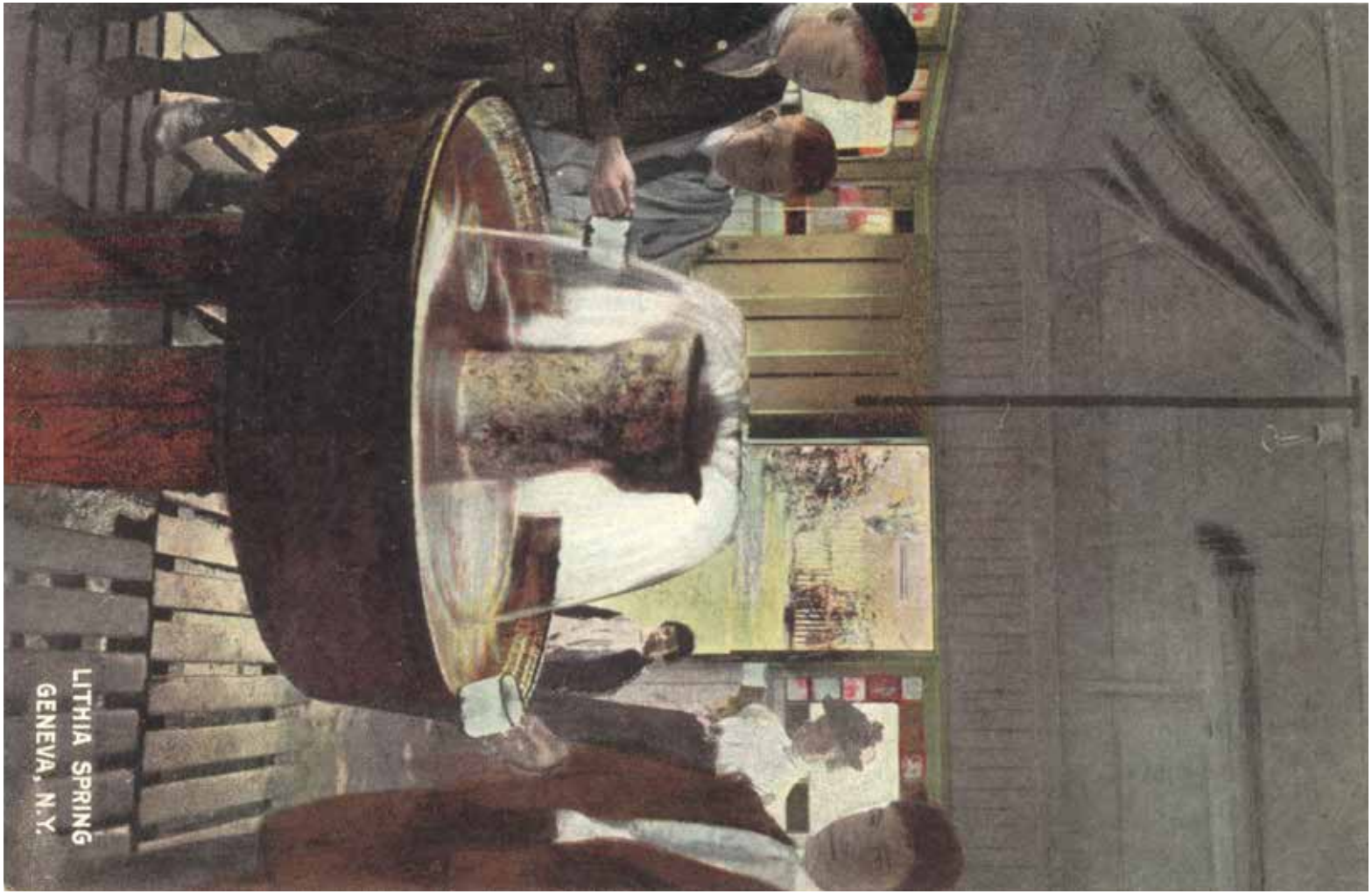
Crystal Lithium, Excelsior Springs, USA, 1909.

Twin Plunges, Ashland, Oregon, USA, c.1910.
Courtesy of Southern Oregon Historical Society.

Marienbad, Czech Republic, 1913.
Courtesy of Brück & Sohn Kunstverlag Meißen.

Bad Mergentheim, Germany, 1936.

Vidago, Portugal, c. 1910.



Lithia Springs, Geneva, NY, USA, 1910.

Lithium, Het Nieuwe Instituut, 2020-21 © Johannes Schwartz

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LA LECHE MATERNA DEL VOLCÁN
THE BREAST MILK OF THE VOLCANO

Unkown Fields
Kate Davies, Liam Young

Unknown Fields (Reino Unido/Australia) es un estudio de investigación de diseño nómada dirigido por Kate Davies y Liam Young. Su trabajo explora las ecologías industriales y la precaria naturaleza creada por la tecnología y la cultura de la ciudad contemporánea. Narran sus expediciones en una serie de libros titulada *Unknown Fields: Tales from the Dark Side of the City*, y su trabajo ha sido extensamente publicado en T*he Guardian*, *BBC*, *Wired*, *New Scientist*, entre otros medios; sus proyectos han sido recogidos por instituciones como el Museo Metropolitano de Nueva York, el Victoria and Albert Museum, M+ en Hong Kong, y el Museo de Artes y Ciencias Aplicadas en Sídney.

Unknown Fields (UK/AU) is a nomadic design research studio directed by Kate Davies and Liam Young. Their work explores the industrial ecologies and precarious wilderness set in motion by the technology and culture of the contemporary city. They chronicle their expeditions in a book series titled *Unknown Fields: Tales from the Dark Side of the City*, and their work has been published extensively in *The Guardian*, *BBC*, *Wired*, *New Scientist*, among others; their projects have been collected by institutions such as The New York Metropolitan Museum, Victoria and Albert Museum, M+ in Hong Kong, and the Museum of Applied Arts and Sciences in Sydney.

Volcán Tunupa desde el salar de Uyuni / *Tunupa volcano from Uyuni salar*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields. © Liam Young

PRÓLOGO

Aquí, en estos antiguos salares, las montañas sagradas hacen guardia sobre un paisaje cargado de potencial eléctrico. Un nuevo futuro aguarda. Este paisaje es fundamental para la cultura y la mitología del pueblo aymara*, y está preñado de posibilidades de miles de millones de dólares. Este lugar etéreo se convertirá en el sustento de una revolución global de energía verde.

El desarrollo de pequeñas y potentes baterías hizo de este paisaje uno de los más codiciados de la Tierra. Bajo él yace un oro gris llamado litio – la energía en nuestros bolsillos. Fundamental para cargar y recargar millones de dispositivos electrónicos brillantes, y el futuro de los autos eléctricos. La mitad de las reservas del mundo están disueltas en salmuera bajo esta corteza salada, sin explotar; y, para la gente del Altiplano boliviano, su extracción conlleva preguntas sin responder sobre la propiedad de la tierra, regalías de recursos e impactos ambientales. Muchos recursos naturales fundamentales para nuestras tecnologías contemporáneas se originan en paisajes sagrados como estos. Cuando imaginamos futuros, estas tecnologías se aseguran de que rara vez reconozcamos los orígenes culturales de los materiales que contienen. Los paisajes de los que se forjan a menudo son espacios muy importantes para las personas que los llaman hogar.

¿Cuál es el verdadero origen de nuestro futuro potenciado por baterías? No es la historia usualmente presentada al lanzar un producto, ni la pasa fugazmente en una conferencia tecnológica. Es una historia que entreteje todas las fuerzas salvajes y misteriosas que hicieron posible este futuro. Desde el Big Bang hasta la batería, es tanto la historia de llamas bailarinas y de volcanes llorones como de química, física y geología: todo esto da forma a nuestro mundo. Este paisaje es aún, y por ahora, un territorio de posibilidad – atrapado entre los valores de un pasado ancestral y la promesa de un mañana luminoso. Pero, si el futuro es eléctrico, entonces ya está aquí, a la espera del mundo.

Horizonte del salar desde el drone / *Salar horizon from drones*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields. © Liam Young

Prologue

Here on these ancient salt flats, sacred mountains stand guard over a landscape charged with electric potential. A new future awaits. This landscape is central to the culture and mythology of the indigenous Aymara* people, and it's pregnant with billion-dollar prospects. This ethereal place is set to become the feeding ground of a global green-energy revolution.

The drive for small and powerful batteries has rendered this landscape one of the most sought-after on earth. Buried here is a grey gold called lithium – the power in our pockets. It's fundamental to the charging and recharging of millions of gleaming electronic devices, and it's the future of electric cars. Half the world's reserves lie dissolved in brine beneath this salt crust, untapped, and for the people of the Bolivian Altiplano, its extraction brings with it unanswered questions of land ownership, resource royalties, and environmental impacts. Many of the natural resources so fundamental to our contemporary technologies begin their lives in sacred landscapes like these. When we imagine the futures, these technologies promise we rarely acknowledge the cultural origins of the materials contained within them. The landscapes from which they are forged are often spaces of deep significance to the people who call them home.

What is the true creation story of our battery-powered future? Not the story typically pitched on a product launch stage or flashed through in a tech conference presentation. It's one woven together from all the wild and mysterious forces which have brought this future into being. From the Big Bang to the battery, it is as much a story of dancing llamas and weeping volcanoes as it is one of chemistry, physics, and geology – all of these things give shape to our world. This landscape remains, for now, a territory of possibility – caught between the values of an ancient past and the promise of a luminous tomorrow. But if the future is electric, then the future is here, lying in wait for the world.

Observatorio ALMA desde el drone / *ALMA Observatory from drone*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields. © Liam Young

HISTORIA DE LA CREACIÓN
Big Bang

En el principio, al comienzo del comienzo, a segundos del cero, empieza la historia de la creación del litio. Hace 13.800 millones de años, en el caliente y denso gas primordial del *Big Bang*, el hidrógeno y el helio generaron la luz de las primeras estrellas y, al enfriarse, se formó el litio, forjado en los fragmentos de la colisión entre rayos cósmicos. El tercer elemento – número atómico 3.

Al otro extremo del tiempo, cinco kilómetros sobre el nivel del mar, en el desierto de Atacama, el paisaje tiene ojos. Sesenta y seis pupilas blancas voltean al unísono buscando las huellas más finas de estos orígenes cósmicos en el aire delgado y en los cielos oscuros – más allá del espectro visible, en la profundidad de las oscuras nubes interestelares de las partes más frías y antiguas del universo. Unidos, los telescopios más poderosos del mundo buscan señales del principio de los tiempos en los cielos. Estos son los fantasmas de la creación del litio.

En el llano Chajnantor*, el hogar ancestral del pueblo likanantai*, los ojos siempre han estado en las sombras del cielo. Delineados a contraluz de la Vía Láctea, el 'Río Oscuro' que observa el telescopio ALMA*, contiene las constelaciones sombrías del pueblo andino. Bailando dentro de una nube interestelar están la llama Yacana, su bebé y su pastor; el zorro Atoq; la serpiente Mach'acuay; y Yutu, el pájaro que persigue al sapo Hanp'atu a través del cielo.

Vía Lactea / *Milky Way*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields.

Creation Story
Big Bang
In the beginning, the beginning of the beginning, seconds from zero, the creatiwon story of lithium begins. 13.8 billion years ago in the hot dense primordial gas of the Big Bang, hydrogen and helium sparked the light of the first stars and, as they cooled, lithium was formed – forged in the fallout fragments of cosmic ray collisions. The third element – atomic number 3.

At the other end of time, five kilometers above sea level, in the Atacama Desert, the landscape has eyes. Sixty-six white pupils turn in unison to search the thin air and dark skies for the faintest traces of these cosmic origins – gazing beyond the visible spectrum and deep into the dark, interstellar clouds of the coldest, oldest parts of the universe. Together, the world's most powerful telescopes scan the skies for signals from the dawn of time. These are the ghosts of lithium's creation.

On the Chajnantor* plateau, the ancestral home of the indigenous Likan Antai*, eyes have always been on the shadows in the sky. Silhouetted against the light of the Milky Way, the 'Dark River' that the ALMA* telescope observes contains the shadow constellations of the Andean people. Dancing within an interstellar cloud is Yacana the llama, her baby and her shepherd; Atoq the fox; the serpent Mach'acuay; and Yutu, the bird, who pursue Hanp'atu the toad across the sky.

Salar de Uyuni, volcán Tunupa / *Uyuni salar, Tunupa volcano*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields.

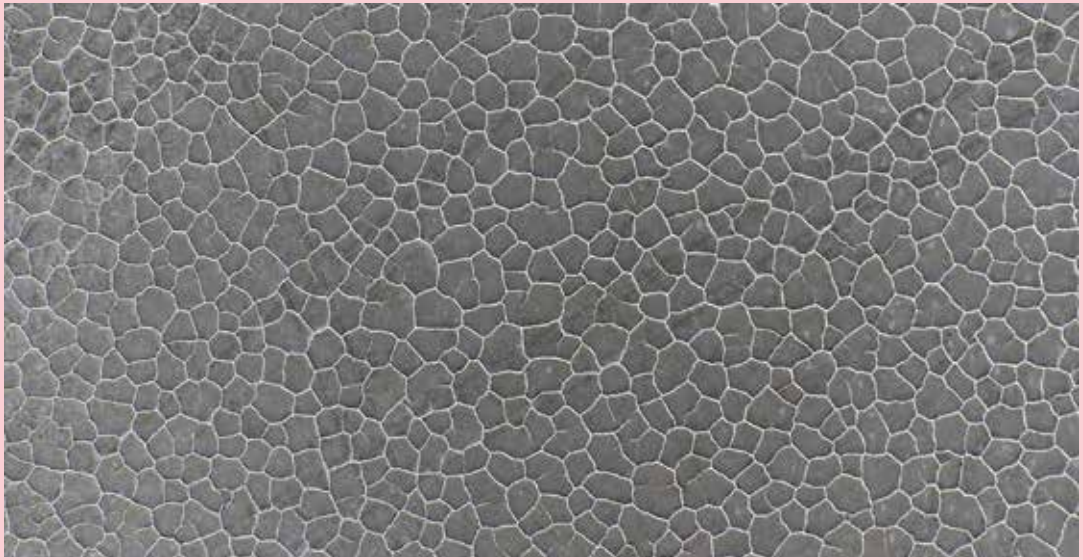
Corteza terrestre

Quizás estas criaturas han cargado el litio hasta la corteza terrestre desde el principio de los tiempos, bailando entre los restos de la explosión de una supernova de hace 4.600 millones de años, mientras la gravedad y el violento colapso formaban una gran nube de materia cósmica arremolinada, forjando un planeta. El litio – misterioso y volátil – no puede existir en la tierra en su forma elemental, reacciona muy violentamente con el aire y el agua. Está en compuestos, en rocas ígneas y manantiales. Aquí, en la meseta boliviana, se cree que los metales preciosos y las piedras están vivos: el oro no se extrae, se cultiva, y las montañas dan a luz a los minerales.

En este vasto llano, los gigantes caminaron por la tierra, entre ellos, la hermosa Tunupa. Enamorada del joven y fuerte Cuzco, tuvo a su hijo, Calicatin. Pero su amante pronto la dejó por otra y huyeron juntos, para nunca regresar. Los dioses, cansados del engaño y la traición del gigante, decidieron castigarlos a todos convirtiéndolos en montañas. Tunupa, el volcán, lloró arrojando ceniza y rocas desde las profundidades del planeta. Las lágrimas rodaron por sus mejillas y su leche fluyó por su cuerpo, apozándose a sus pies. Milenios de derretimiento de las cimas nevadas se filtraron a través de las rocas – ricas en elementos livianos como magnesio, potasio, boro y litio – depositando minerales en el lago.

Hace diez mil años, una serie de lagos como estos se formaron en lo alto de la meseta andina entre Chile, Bolivia y Argentina, actualmente conocida como triángulo de litio. El más grande se evaporó con el feroz sol andino y formó el Salar Boliviano – una corteza cristalina sobre la reserva de litio más grande del mundo.

Congelados en lados opuestos del salar blanquecino, Tunupa y Calicatin hacen guardia sobre el salar más grande del planeta, el alma de nuestros sueños tecnológicos.



Textura de sal del salar / *Salar salt texture*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields. © Liam Young

Earth's Crust

Perhaps these creatures have carried lithium from the beginning of time to the crust of the Erth – dancing through the wreckage of an exploding supernova 4.6 billion years ago, as gravity and violent collapse gave shape to a vast cloud of swirling cosmic matter – and forged a planet. Lithium – mysterious and volatile – can't exist on Earth in its elemental form, it reacts too violently with air and water. Instead, it's found in compounds, in igneous rocks and mineral springs. Here on the Bolivian plateau, precious metals and stones are thought to be alive – gold is not mined, it is grown, and mountains give birth to minerals.

On this vast plain, giants once walked the Earth, among them the beautiful Tunupa. She fell in love with the strong young Cuzco, she bore his son, Calicatin. But soon her lover became infatuated with another and they ran off together, never to return. The gods, tired of the giant's deception and betrayal, decided to punish them all and petrified them as mountains. Tunupa, the Volcano, began to cry, spewing ash and rock from the depths of the planet. Tears rolled down her cheeks, and breast milk flowed down her body, pooling at her feet. Millennia of meltwater from the snowcapped peaks seeped down through rocks – rich in light elements like magnesium, potassium, boron, and lithium – leaching minerals into the lake below.

Ten thousand years ago, a series of lakes like these formed high on the Andean plateau between Chile, Bolivia, and Argentina – what is now known as the lithium triangle. The largest of these evaporated in the fierce Andean sun to form the Bolivian Salar, a vast salt pan – a crystalline crust over the world's largest lithium reserve.

Frozen on opposite sides of the milk-white *salar*, Tunupa and Calicatin stand guard over the largest salt lake on the planet, the lifeblood of our technological dreams.

Mina de litio Rockwood / *Rockwood lithium mine*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields.

Minería
Las montañas sagradas observan cómo el Salar vuelve a entrar en erupción. La salmuera bombeada desde la corteza yace frente a ellas en las piscinas de evaporación de una mina de litio. Desde la orilla del pozo menos concentrado no. 15 – 0,2% de litio, azul claro y con una playa de cloruro de sodio – la salmuera de litio migra por 15 meses en piscinas de retención. Brillantes azul turquesa y cian pasan a verdes viridianos y caqui, hasta convertirse en amarillos fangosos.

Un grupo de mineros llamados *rock-lickers* monitorea el proceso, deciden cuándo continuar. Hasta que, finalmente, en las profundas aguas café del estanque no. 1 – 6% de litio – la cosecha está lista para dejar la tierra de los gigantes para siempre.

Mina de litio Rockwood / *Rockwood lithium mine*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields.

Mining

The sacred mountains look on as the *salar* erupts again. Brine pumped from beneath the crust is laid out before them in the tessellated evaporation pools of a lithium mine. From the shores of the least concentrated pond no. 15 – 0.2% lithium, azure blue with a sodium chloride beach – the lithium brine migrates over 15 months through holding pools. Shimmering turquoise and cyan blues fade to viridian and khaki greens, and on to muddy yellows.

A group of mineworkers called Rock-Lickers monitor the process, deciding when it's right to move on. Until finally, in the deep coffee waters of pond no. 1 – 6% lithium – the harvest is ready to leave the land of giants forever.

Mina de litio Rockwood / *Rockwood lithium mine*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields.

Tecnología
Cerca de 50 mililitros de las lágrimas y de la leche de Tunupa son vertidos en nuestros teléfonos. Tres electrones orbitan un núcleo, pequeños planetas giratorios esperan cargarse. Al dejar nuestros teléfonos cargando en el velador, los iones de litio se mueven de cátodo a ánodo. Una vez cargados, los iones regresan al cátodo, y la pantalla parpadea a la vida – brillando con el dolor de las míticas montañas. Es lo primero que buscamos al despertar, lo último que vemos antes de dormir. Las mantenemos cerca, son una parte de nosotros, cálidas al tacto. Pero si miramos de cerca, reflejada en el vidrio pulido de nuestras pantallas está la blanca extensión cristalina de un antiguo salar.

Los milisegundos de este baile de iones puso en marcha un sueño de energía eléctrica de miles de millones de años. La historia de la creación abarca desde galaxias espirales hasta la herida espiral* de los electrodos de una célula de batería, desde el *flash* del *Big Bang* al *flash* de un electrón.

Alimentamos nuestro futuro con la leche materna de los volcanes.

Mina de litio Rockwood / *Rockwood lithium mine*
Still from The Breast Milk of the Volcano, Dir. Unknown Fields.

Technology

Around 50 milliliters of Tunupa's tears and breast milk are poured into each of our phones. Three electrons orbit a nucleus, tiny revolving planets waiting for a charge. As we plug in our phones on our bedside table, lithium ions move from cathode to anode. Once charged, the lithium ions drift back to the cathode, and the screen flickers to life – glowing with the heartache of mythic mountains. These are the first things we reach for as we wake, the last things we look at before we sleep. We keep them close, a part of us, warm to the touch. But if we look closely, reflected in the polished glass of our screens is the crystal white expanse of an ancient salt lake.

This millisecond dance of ions has set in motion a dream of electric energy billions of years in the making. This creation story spans from spiral galaxies to the spiral-wound* electrodes of a battery cell, from the flash of the Big Bang to the flash of an electron.

We power our future with the breast milk of volcanoes.

MICROORGANISMOS EN EL DESIERTO
MICROORGANISMS IN THE DESERT

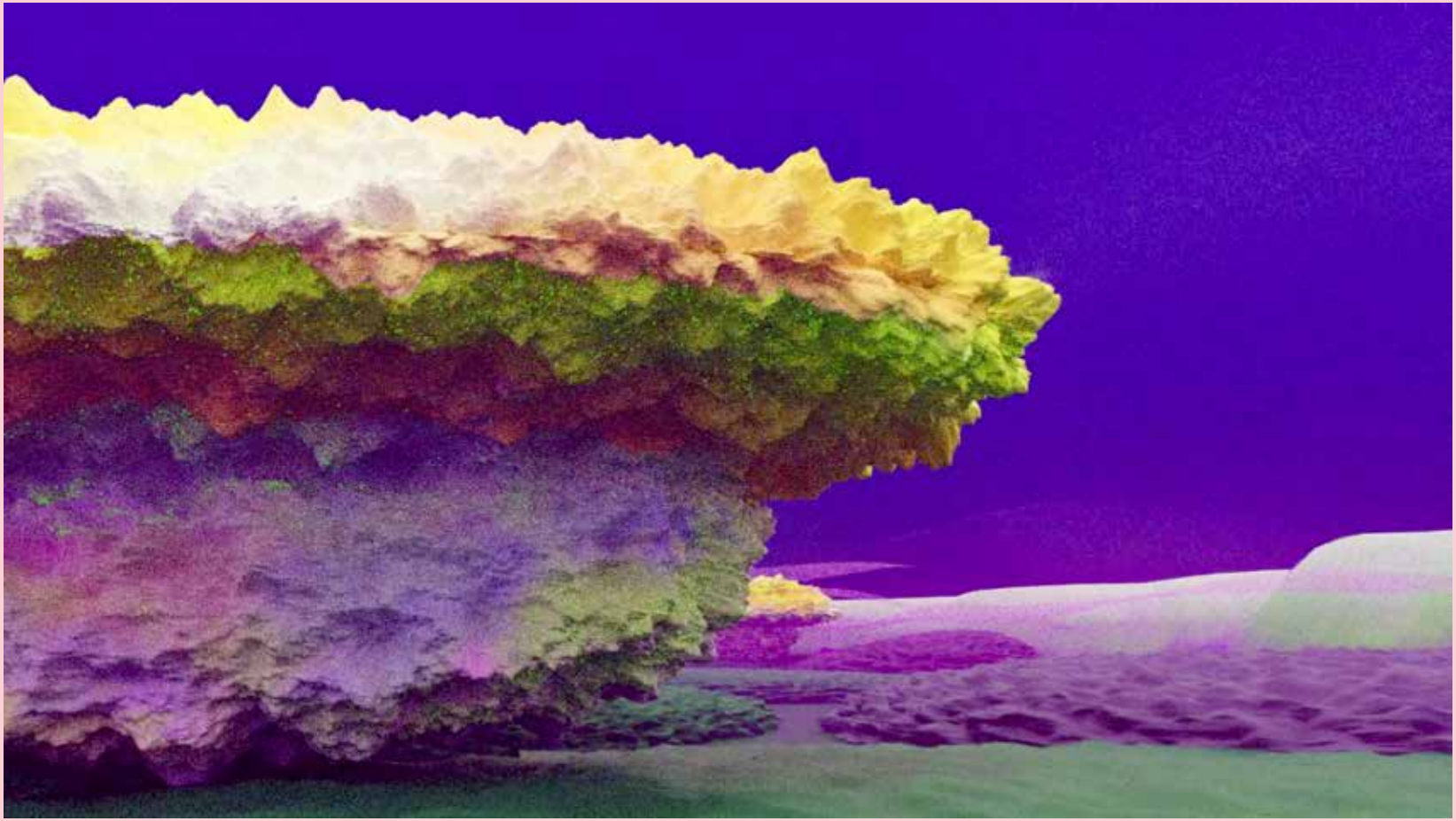
Como parte de "The Ends of the World", la contribución del Lithium Triangle Research Studio a la exposición "Lithium" de HNI, este ensayo visual de Mingxin Li analiza los *estromatolitos* y las esteras microbianas del Salar de Llamara como arquitecturas ambientales de mil millones de años. A estar en el centro de una disputa ambiental que enfrenta a empresas mineras, grupos ambientalistas y comunidades indígenas [ver contribuciones en las páginas 37 y 46], los ecosistemas microbianos son sensores ambientales increíblemente frágiles. A través de la reinterpretación de formas y colores existentes, la recreación de Li de estos entornos microbianos tiene como objetivo extender su existencia como un hogar para otros que no sean humanos y, al hacerlo, poner en primer plano algunos de los otros mundos del mundo.

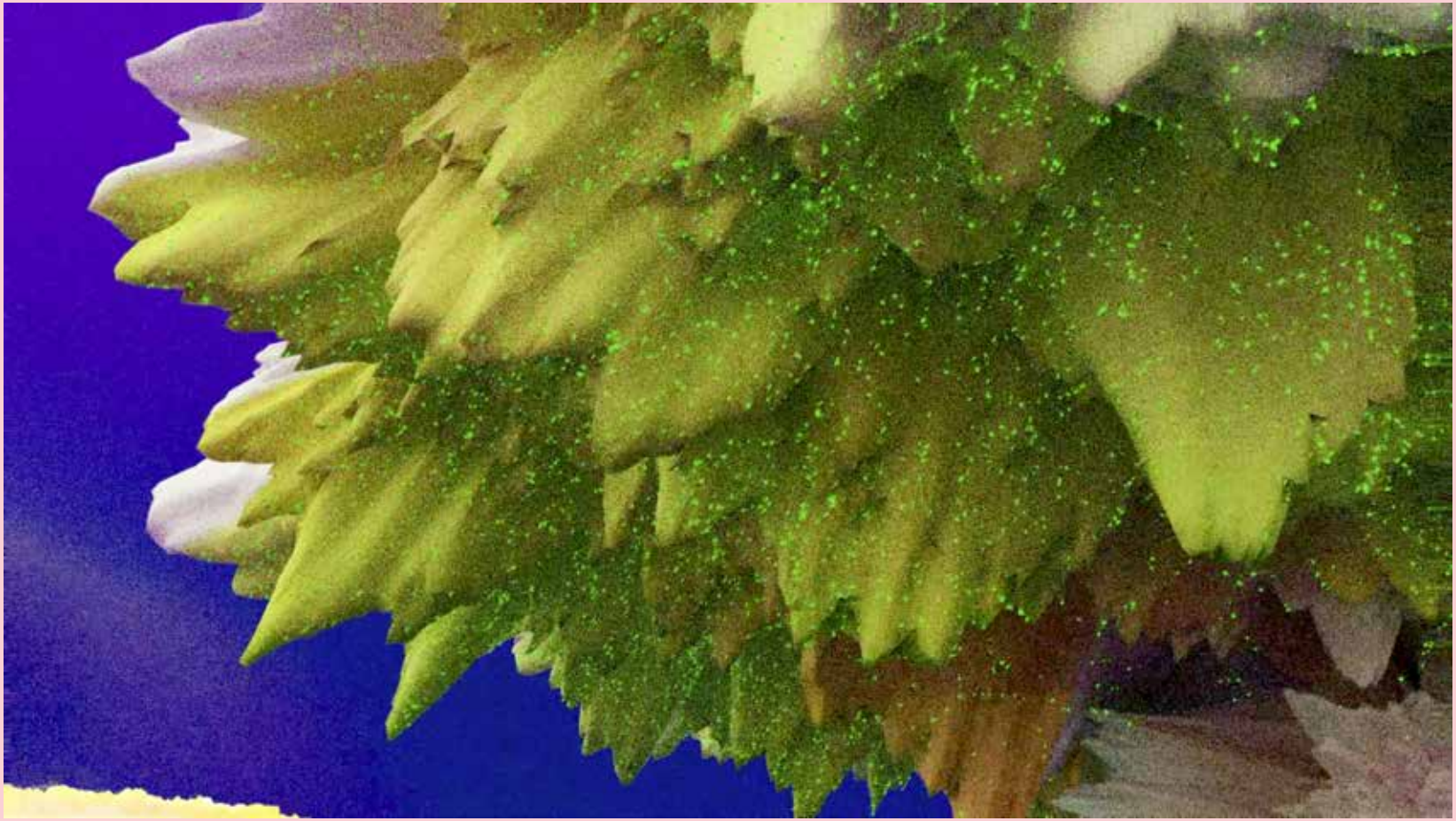
As part of "The Ends of the World," the Lithium Triangle Research studio's contribution to the HNI exhibition "Lithium," this visual essay by Mingxin Li looks at the stromatolites and microbial mats of Salar de Llamara as billion-years old environmental architectures. Currently at the center of an environmental dispute that pits mining companies, environmentalist groups and indigenous communities [see contributions in pages 024 and 029] microbial ecosystems are incredibly fragile environmental sensors. Through the reinterpretation of existing shapes and colors, Li's recreation of these microbial environments aims to draw out their existence as a home for others than humans, and in doing so, to foreground some of the other worlds in the world.

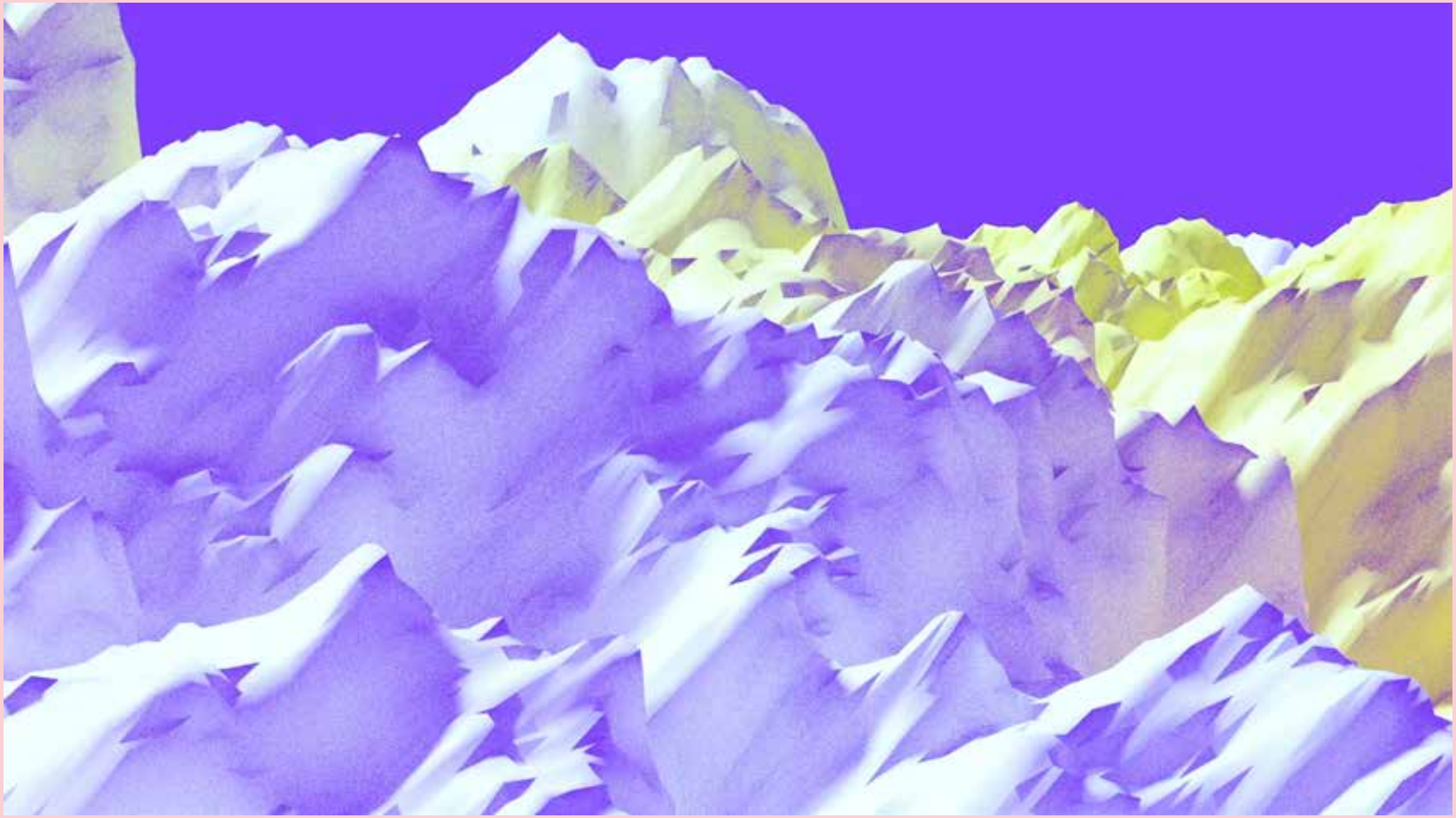
Lithium Triangle Research Studio
Imágenes de / Images by Mingxin Li

Licenciado en Artes, Universidad de Jiangnan, China, 2018. Arquitecto Ambiental y máster en Artes, Royal College of Art, Londres, 2020. Mingxin Li es ayudante en la Escuela de Arquitectura, Royal College of Art, Reino Unido, donde también cursa un doctorado en representación multiescalar.

Bachelor of Arts, Jiangnan University, China, 2018. Environmental Architect and Master in Arts, Royal College of Art, London, 2020. Mingxin Li is a teaching assistant at the School of Architecture, Royal College of Art, UK, where he is also developing a Ph.D. on multi-scale representation.







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SALAR DE ATACAMA
CHILE

Cristóbal Olivares

Estudios fotográficos, Instituto Profesional de Arte y Comunicación Arcos, Santiago, 2009. Es fotógrafo documental con especial interés en problemáticas sociales contemporáneas. Es fundador de Buen Lugar Ediciones, editorial independiente especializada en libros de fotografía y zines. Es becario de fotografía y justicia social de la Fundación Magnum, 2019. Su trabajo ha sido reconocido con premios, residencias y becas de diferentes organizaciones como Magnum Foundation, World Press Photo, Open Society Foundation (EE.UU.), New York Portfolio Review (EE.UU.), entre otros. Es autor de *-42°* (Chile, 2013); *Visviri* (Valparaíso,2014); *A-MOR* (Santiago,2015), y *Sète #16* (Marsella, 2016).

Photography studies, Arcos Arts and Communications Institute, Santiago, 2009. He is a documentary photographer with special interest in social contemporary affairs. He is the co-founder of Buen Lugar Ediciones, an independent publishing house specialized in photography books and zines. He is a 2019 Magnum Foundation Photography and Social Justice Fellow. His work has been awarded with prizes, residences and grants from different organizations such as Magnum Foundation, World Press Photo, Open Society Foundation (USA), New York Portfolio Review (USA), among others. He is the author of *-42°* (Chile, 2013); *Visviri* (Valparaíso, 2014); *A-MOR* (Santiago, 2015), and *Sète #16* (Marseille, 2016).

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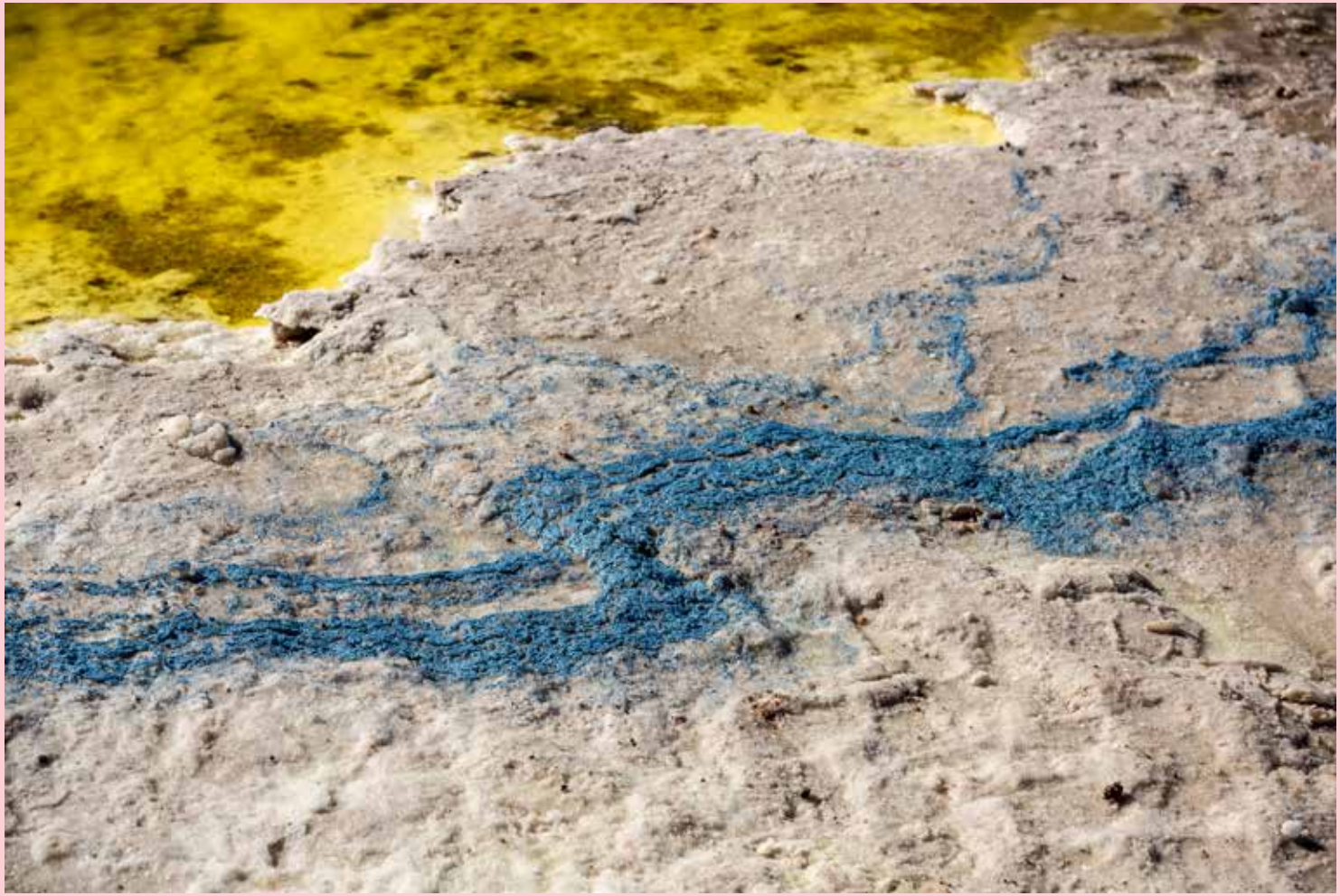

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SALAR DE UYUNI
BOLIVIA

Cedric Gerbehaye

Fotógrafo, máster en Comunicación / Periodismo, Institut des Hautes Etudes des Communications Sociales (IHECS), Bruselas, 2003. Autor de los libros *Congo in Limbo*, *Land of Cush*, *Sète # 13* y *D'entre eux*. Recibió el premio Olivier Rebbot del Overseas Press Club of America, el premio Amnesty Media Award, y World Press Photo. Las imágenes de Gerbehaye se encuentran en las colecciones del Museo de Bellas Artes de Houston, el Museo de la Fotografía de Charleroi, la Maison Européenne de la Photographie de París y el FotoMuseum de Amberes. Miembro fundador de la Agencia MAPS y colaborador de la revista National Geographic.

Photographer, Master in Communication / Journalism, Institut des Hautes Etudes des Communications Sociales (IHECS), Brussels, 2003. Author of the books *Congo in Limbo, Land of Cush, Sète#13* and *D'entre eux*. Received the Olivier Rebbot Award from the Overseas Press Club of America, The Amnesty Media Award, and World Press Photo. Images by Gerbehaye are to be found in the collections of the Museum of Fine Arts in Houston, Musée de la Photographie in Charleroi, Maison Européenne de la Photographie in Paris and the FotoMuseum in Antwerp. Founding member of MAPS Agency and National Geographic Magazine contributor.

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ACUARELAS
WATERCOLORS

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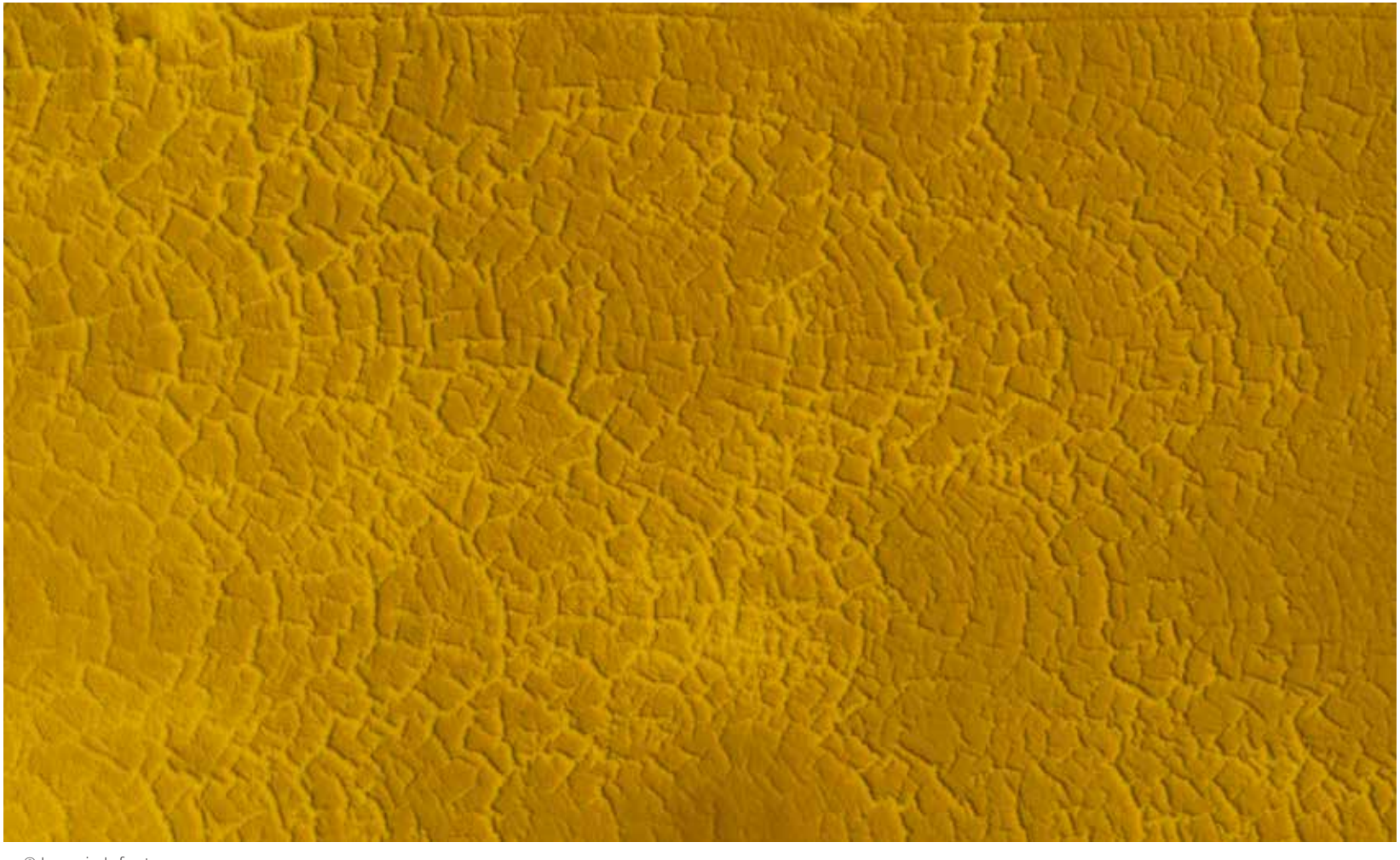
Pedro Alonso + Ignacio Infante

© Ignacio Infante



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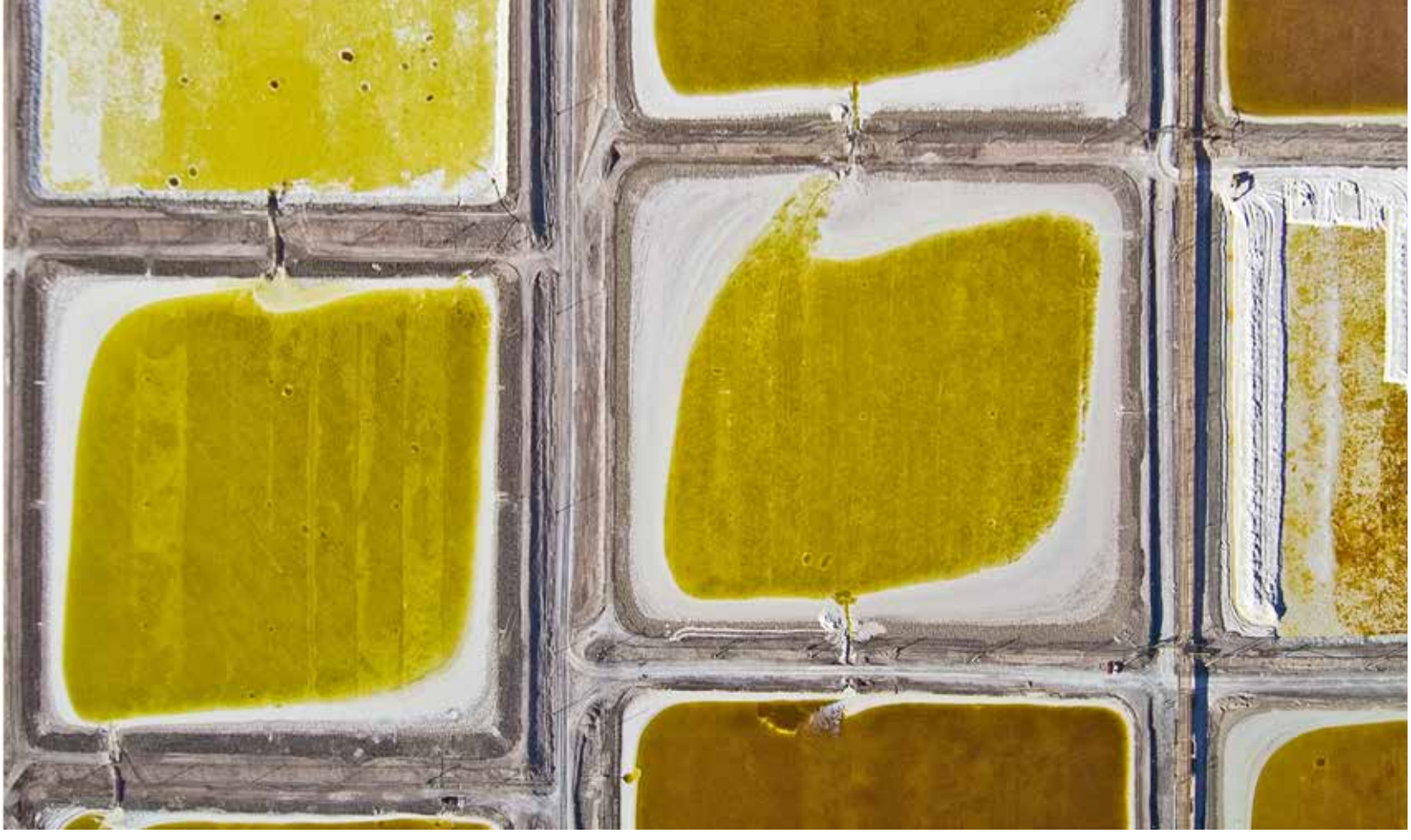

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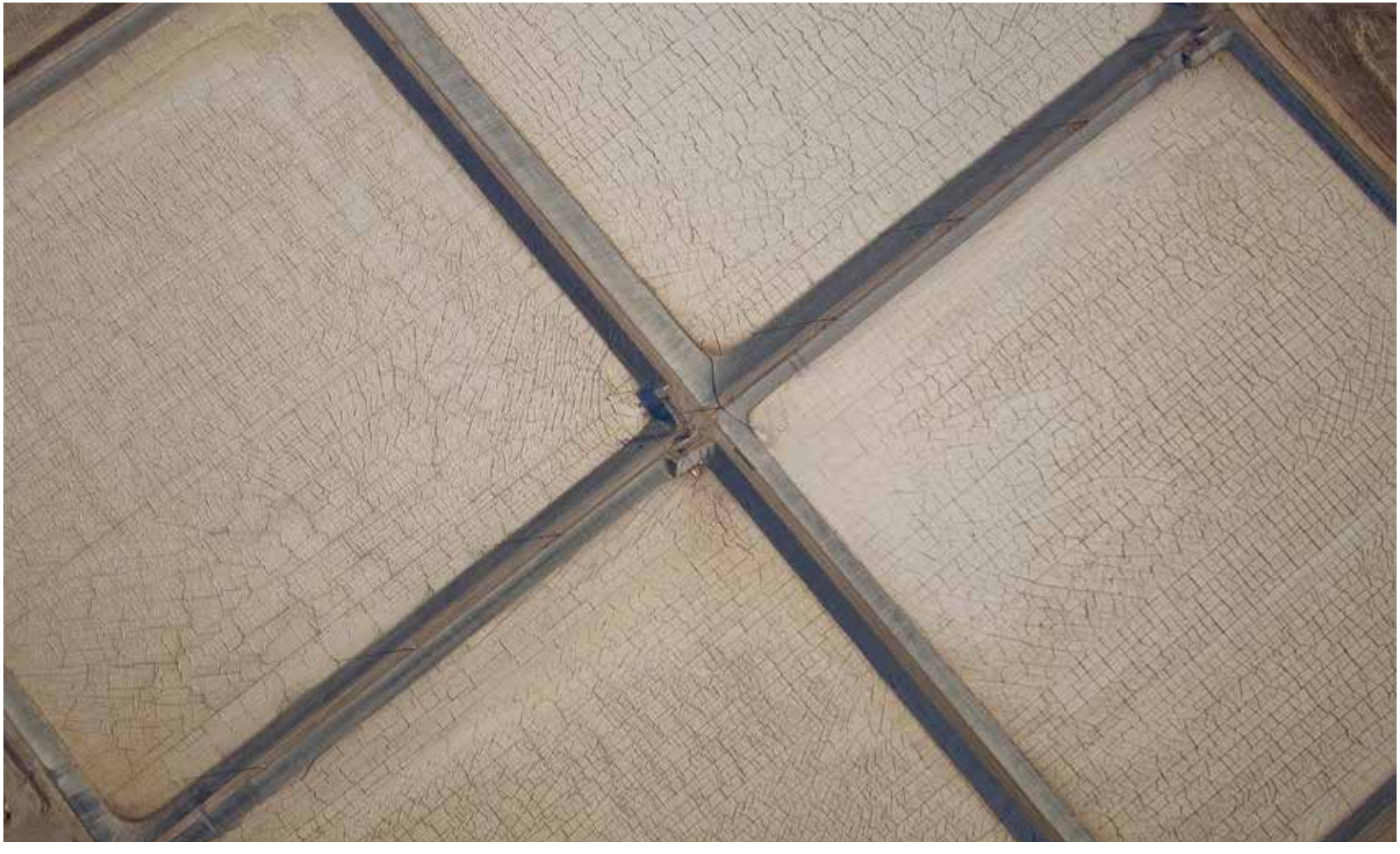

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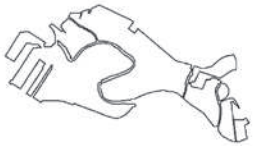
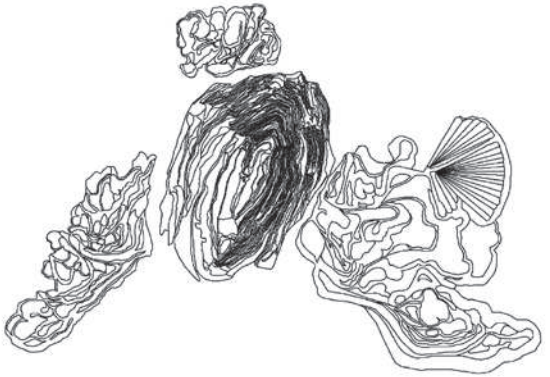
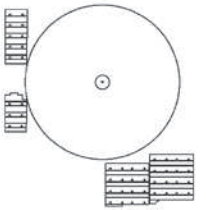


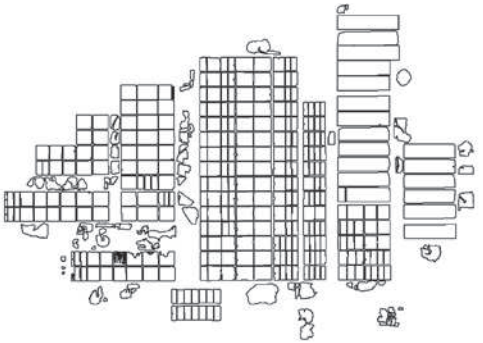
Venice, Italy
Latitude: 45°26'03.63"S
Longitude: 12°20'19.59"E
H:+ 10 mts



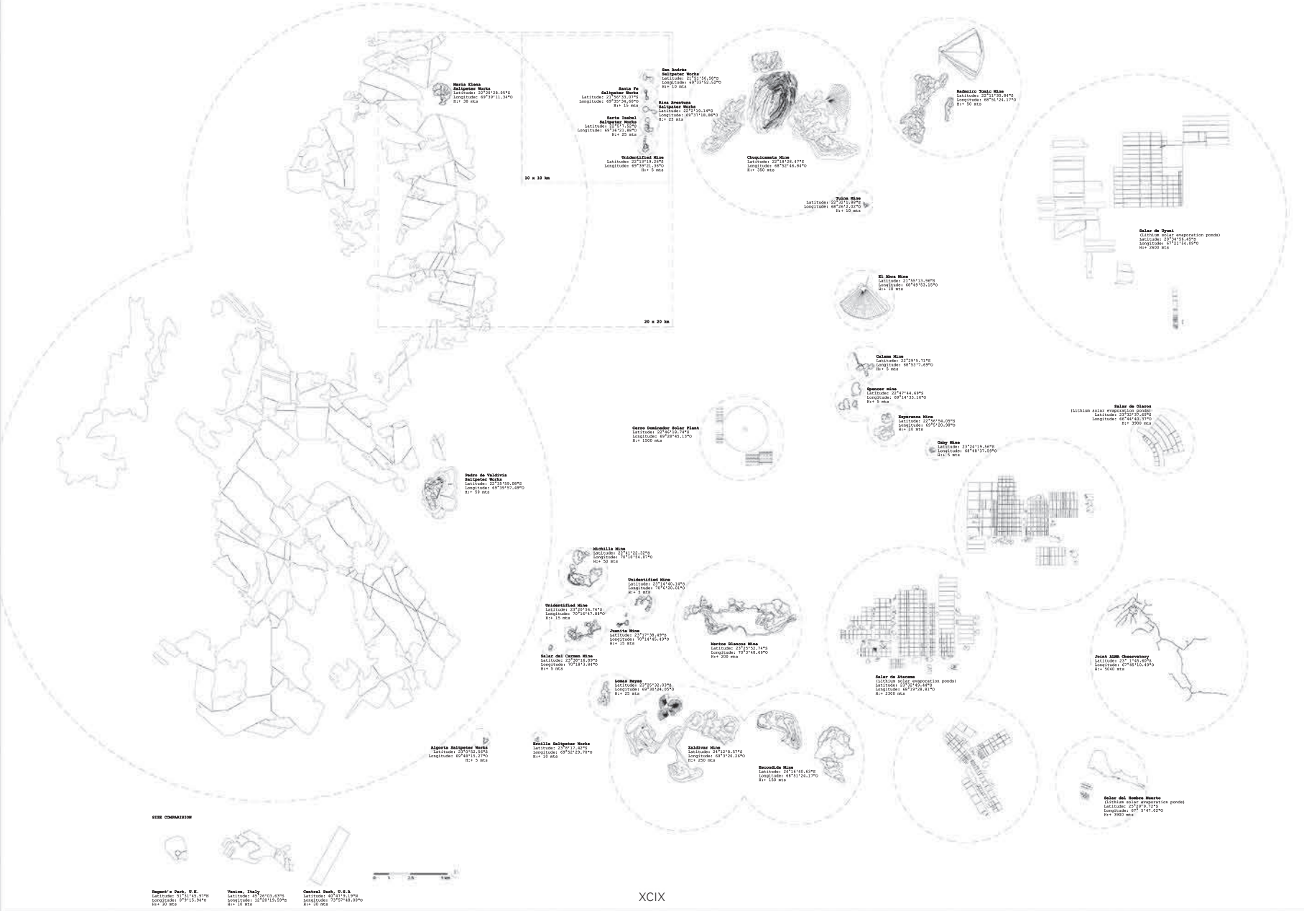
Chuquicamata Mine
Latitude: 22°18'28.47"S
Longitude: 68°52'46.84"O
H:+ 350 mts



Cerro Dominador Solar Plant
Latitude: 22°46'18.74"S
Longitude: 69°28'45.13"O
H:+ 1500 mts



Salar de Atacama
(Lithium solar evaporation ponds)
Latitude: 23°32'49.44"S
Longitude: 68°19'28.81"O
H:+ 2300 mts


Maria Elena
Saltpeter Works
Latitude: 22°20'28.05"S
Longitude: 69°39'31.34"O
H:+ 30 mts
San Andres
Saltpeter Works
Latitude: 21°51'56.58"S
Longitude: 69°33'52.52"O
H:+ 10 mts
Santa Fe
Saltpeter Works
Latitude: 23°56'33.07"S
Longitude: 69°35'54.66"O
H:+ 15 mts
Rica Aventura
Saltpeter Works
Latitude: 22°27'19.14"S
Longitude: 69°51'10.86"O
H:+ 25 mts
Santa Isabel
Saltpeter Works
Latitude: 23°56'33.07"S
Longitude: 69°34'21.89"O
H:+ 25 mts
Unidentified Mine
Latitude: 23°17'19.26"S
Longitude: 69°37'21.36"O
H:+ 5 mts
10 x 10 km
20 x 20 km
Chuquicamata Mine
Latitude: 22°18'28.47"S
Longitude: 68°52'46.84"O
H:+ 300 mts
Radomiro Tomic Mine
Latitude: 22°17'30.84"S
Longitude: 68°51'24.27"O
H:+ 50 mts
Tuina Mine
Latitude: 22°31'1.88"S
Longitude: 68°26'2.02"O
H:+ 10 mts
Salar de Uyuni
(Lithium solar evaporation ponds)
Latitude: 20°58'56.45"S
Longitude: 67°21'54.09"O
H:+ 2400 mts
El Abra Mine
Latitude: 21°50'13.96"S
Longitude: 68°49'53.15"O
H:+ 20 mts
Calama Mine
Latitude: 22°29'5.71"S
Longitude: 68°53'7.69"O
H:+ 5 mts
Spencer mine
Latitude: 32°47'44.69"S
Longitude: 68°14'33.16"O
H:+ 5 mts
Esperanza Mine
Latitude: 21°56'54.05"S
Longitude: 69°5'20.96"O
H:+ 30 mts
Salar de Olaroz
(Lithium solar evaporation ponds)
Latitude: 23°32'37.65"S
Longitude: 66°44'40.37"O
H:+ 3900 mts
Gaby Mine
Latitude: 23°28'19.16"S
Longitude: 68°48'37.59"O
H:+/ 5 mts
Cerro Dominador Solar Plant
Latitude: 22°45'10.74"S
Longitude: 69°28'45.13"O
H:+ 1500 mts
Pedro de Valdivia
Saltpeter Works
Latitude: 22°31'59.06"S
Longitude: 69°39'57.68"O
H:+ 50 mts
Michilla Mine
Latitude: 22°41'22.32"S
Longitude: 70°18'54.57"O
H:+ 50 mts
Unidentified Mine
Latitude: 23°14'40.16"S
Longitude: 70°6'30.01"O
H:+ 1 mts
Unidentified Mine
Latitude: 23°25'56.76"S
Longitude: 70°26'47.88"O
H:+ 15 mts
Juanita Mine
Latitude: 23°27'38.49"S
Longitude: 70°14'45.69"O
H:+ 15 mts
Salar del Carmen Mine
Latitude: 23°26'16.89"S
Longitude: 70°18'3.84"O
H:+ 5 mts
Mantos Blancos Mine
Latitude: 23°25'52.74"S
Longitude: 70°5'48.68"O
H:+ 200 mts
Salar de Atacama
(Lithium solar evaporation ponds)
Latitude: 23°32'49.44"S
Longitude: 68°13'28.31"O
H:+ 2300 mts
Joint ALMA Observatory
Latitude: 23° 1'41.68"S
Longitude: 67°45'10.49"O
H:+ 5040 mts
Lomas Bayas
Latitude: 23°25'32.03"S
Longitude: 69°30'24.05"O
H:+ 25 mts
Algorta Saltpeter Works
Latitude: 25°0'52.26"S
Longitude: 69°48'15.27"O
H:+ 5 mts
Escilla Saltpeter Works
Latitude: 25°0'17.42"S
Longitude: 69°32'29.70"O
H:+ 10 mts
Zaldivar Mine
Latitude: 24°12'0.57"S
Longitude: 69°3'20.26"O
H:+ 250 mts
Escondida Mine
Latitude: 24°15'40.63"S
Longitude: 68°51'24.11"O
H:+ 150 mts
Salar del Hombre Muerto
(Lithium solar evaporation ponds)
Latitude: 25°29'9.72"S
Longitude: 67° 5'41.02"O
H:+ 3900 mts
SIZE COMPARISION
0
1
2.5
5 km
Regent's Park, U.K.
Latitude: 51°31'45.91"N
Longitude: 0°9'12.94"O
H:+ 30 mts
Venice, Italy
Latitude: 45°26'03.63"N
Longitude: 12°20'19.09"E
H:+ 10 mts
Central Park, U.S.A
Latitude: 40°47'9.15"N
Longitude: 73°57'48.09"O
H:+ 30 mts

LITHIUM

ESTADOS DE AGOTAMIENTO

Eds. Francisco Díaz, Anastasia Kubrak, Marina Otero Verzier

Het Nieuwe Instituut

architecture
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digital culture

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ediciones