

CONCLUSION

How can we learn from the present to build a better future?

This work has been concerned with the frontier as defined by the mined and to-be-mined: particularly how and why, from among the hundreds of places endowed with rare earth deposits, have the sites examined herein emerged? Chapter 1 defined rare earths and provided a world-historical analysis of their entanglements with global politics following their discoveries. Chapters 2 and 3 showed how rare earths played a crucial role in the development of Inner Mongolia specifically: how embedding rare earth extraction, production, research and development in a comprehensive military-industrial project was essential for laying the foundation on which China's monopoly later emerged in the context of global neoliberalism. At the turn of the millennium, environmental and epidemiological costs of China's rare earth monopoly reached such a point of severity that the central government reoriented national strategy from export dominance to resource conservation. Chapter 4 analyzed the events that precipitated the 2010 crisis and its aftermath. The sudden shock to the global market drew unprecedented attention to the conditions of extractive policy and practice in Baotou and Bayan Obo, which then precipitated dramatic spatial transformations in other parts of the world, such as Afghanistan, Greenland, and the Americas. Chapter 5 unpacked the spatial paradoxes characterizing the Brazilian rare earth frontier, using rare earths as a lens through which to examine the ongoing struggles over the meanings of sovereignty—defined as the right to mine—in northwestern Brazil.

Chapter 6 showed how fictions about rare earth scarcity were productively mobilized as a justification to push the contemporary space race beyond the bounds of existing international treaties, which mandate the peaceful and collectivist use of lunar resources.

This book, though far from an exhaustive catalogue of all established, explored, and prospective mining sites, showed that geopolitical ambitions, territorial struggles, and the politics of sacrifice are as important as geology in determining which places emerge on the global rare earth frontier. The questions taken up here are: What have we learned from looking at three radically different sites? How might we take the best lessons from across history to build a more just and sustainable future?

First, something must be said for the fact that so much fiction surrounds the production of new rare earth frontiers. The myths of absolute scarcity and the persistent idea of “dwindling” rare earths despite abundant evidence to the contrary is an illustration of what contemporary philosopher H. G. Frankfurt (2005) describes as “the most salient feature of our age,” that is, bullshit. This is not so much a deliberate lie as a “lack of connection to a concern for the truth” (Frankfurt 2005, 33). Advocates for mining the Moon, Greenland, the Amazon, the ocean floor, and Afghanistan cling to the claim that rare earth elements are in fact rare on earth, and soon we will have used up all available resources. Hence the need to do what it takes to mine rare earths in these forbidding places. This myth works well with another sort, which is the claim that each new site is the largest deposit in the world. These claims are simply not true, but it is not enough to simply name the untruth. Rather, this book examined how misrepresentations, deliberate or not, have been productive for various agendas. These paired myths of global scarcity and local abundance intersect with longer-term territorial and geopolitical anxieties in the face of China’s growing global influence.

These fictions are especially potent because they are not entirely divorced from the truth. Rare earth elements are generally difficult to access, and all sites studied here do actually possess minable deposits of rare earths. Although the magnitude of actual deposits may be overstated, they are not entirely false. This requires a different way of looking at the situation, to identify where a lack of connection to a concern for the truth serves political and economic ends. One consistent attribute across all sites examined is that rare earth elements played a small but important part in significant territorial transformations on local and regional scales. This was the case for Baotou; this is what geologists and key figures among the Brazilian federal government desire for Cabeça do Cachorro; and this is what lunar mining advocates in the public and private sector desire: to transform the Moon into Earth’s “eighth continent.” Thus what is critical about the 2010 rare earth crisis is the way in which it stimulated a radical geographical transforma-

tion of the frontiers of prospecting and extraction. That many of the post-2010 discourses are based on false premises is perhaps less significant than the ways in which these imaginaries have transformed resource politics on multiple scales and redefined the scope of just how far some will go in pursuit of wealth and power.

Understanding the Frontier

Each of the three primary sites enriches our notions of “the frontier” as an operative spatial category and potent geographical imaginary. Just as rare earths are embedded in an array of important commodities, an array of important meanings and agendas are embedded in the creation and exploitation of the rare earth frontier. As elaborated in the introduction, frontiers have been theorized as spaces of conflicting regimes of governance, law, and property rights. This is because, as Tsing (2005) notes, frontiers do not exist *a priori* but are conjured into being by extralocal powers. What exists, or had existed at the moments of conjuring were, in the cases of Baotou and São Gabriel, mobile, multiethnic polities. Successive efforts to impose borders ranged from genocidal to integration to developmentalist campaigns, the effectiveness of which has never been absolute. In the case of the Moon, the latest discursive and regulatory offensive seeks to enclose what Cold War-era treaties had designated as global commons. Each of these endeavors are driven by a desire to turn the spaces concerned into something else to serve the geopolitical and accumulationist ends of multiple competing actors.

Invoking a frontier signals an expression of ownership, or an aspiration thereof, while the production of geological knowledge can signal (or be read as) an intention to territorialize. In the case of the Moon, international treaty regimes claimed the “final frontier” for all humanity. Accordingly, these treaty regimes mandated that all materials and research findings be made available to all. This is unique among the cases examined herein. By contrast, following the failure of decades of national integration and infrastructure construction campaigns in Cabeça do Cachorro, President João Figueiredo designated portions of the region with considerable geological wealth as Biological Reserves: if massive, state-orchestrated capital could not access the resources, then nor should anybody else. This sentiment is especially apparent in the divisions between the military and large extractive interests on one hand, and indigenous small-scale miners on the other. Actors on both sides agree that mining should be permitted to occur in the region, but they are locked in an intense struggle over the meanings and entitlements according to which extraction should be organized. Under the current legal regime, the visions of both sides are illegal. The territorial orders of late twentieth-century conservationism and state custodialism reign.

But as with any reigning power, political economies at the level of everyday life are much more complex. Ultimately the frontier cannot just circulate as a disembodied idea. It must be enacted in a specific time and place by specific people. Territorial assemblages result from the encounter between the frontier vision and complex local realities. A person's idea about what that means differs according to their positionality. In São Gabriel da Cachoeira, this is especially visible in the draconian penalization of small-scale indigenous miners despite corporate dependence on *garimpeiro* activity, and broad support on the part of certain state actors for small-scale mining. In Baotou, as noted in chapter 3, local officials and police officers play an important role in maintaining small-scale, illegal production while viewing their actions as consistent with national policy mandates to consolidate and rationalize the rare earth industry. In either case, seemingly identical interests—liberalized mining on indigenous land or advancing resource policy mandates—produce radically different outcomes as local actors negotiate different needs, priorities, and identities in relation to the state. This helps explain the “elasticity” of frontier spaces (Weizmann 2007), where local actors maintain an apparently looser relationship to law and order by selectively reinterpreting and incorporating broader political changes into everyday practice.

In the case of the Moon, multiple actors within the state and private sector are actively working to conjure conditions of lawlessness where one of the most effective international treaties to date has held force for sixty years. When examined in comparative world-historical perspective, a consistent trend emerges across all sites examined in this work. Watts (2012) noted how frontier resource exploitation tends to leverage unclear, contradictory, or nonexistent legal regimes. In the cases examined herein, we are actually seeing regulatory offensives to criminalize customary, inclusive, and pacifist resource governance regimes. Where these offensives succeed in criminalizing the customary and litigating against inclusion, they also create the local spaces in which the hazards can be placed. This practice is vividly demonstrated in each of the cases. The Euro-American world externalized its production to colonial frontiers, and later to China. China's central government and the Soviet government externalized rare earth mining and processing to Inner Mongolia Autonomous Region (IMAR). Australia externalized to Malaysia; Mountain Pass to Estonia and China; and China is looking to externalize rare earth mining beyond its borders. Now, multiple high-profile actors are looking to the Moon.

Legal regimes, whatever their qualities, are *produced*: the diverse but immense regulatory offensives undertaken by pro-mining interests across the rare earth frontier shows that where a permissive “wild west” climate does not prevail, certain actors strive to make it so. From the perspective of large-scale mining interests,¹ indigenous and environmental protections act as a barrier to accumulation

in the northwestern Amazon, while environmentally motivated consolidation and mining control efforts in Baotou exacerbate overcapacity (and therefore profitability) problems in local industries. The effort to create conditions of lawlessness on the frontier is especially vivid in the case of the Moon: there is one very clearly worded and detailed international treaty which a majority of countries, including all space-faring states, have signed or ratified that explicitly prohibits anything resembling enclosure or privatized gain from lunar resources. This is, of course, anathema to the accumulationist dreams of high-profile new space investors whose insistence that there are no rules—and that China will beat the United States—moved the US government to enact new laws in direct contradiction to international treaties. Although the particular context might be new, the practice of disavowing existing conventions governing land and resource use has been fundamental to colonial, capitalist, and socialist expropriation.

It is important to note that these spaces are not as empty as people sitting in offices would claim. All three spaces are occupied—if not with people, then with transnationally held meanings inhospitable to large-scale mining. But they are also far from “centers of calculation,” where political decision-making power and relatively more politically empowered populations tend to reside (Latour 1987). This feature explains the aims to concentrate a destructive and toxic industry away from metropolitan areas despite the logistical challenges involved, while simultaneously serving an important geopolitical purpose by territorializing a region far from centers of power. It is through this spatial relation to centers of power that such spaces come to be described as “marginal,” as the extensive ideological and subject-formation campaigns examined in chapters 2 and 5 attest. It is an immense project to convince local residents that the ground beneath their feet is somehow distant, and that their (re)productive activities must be valued and evaluated in terms of their compliance with the interests of a far-off state that maintains an inconsistent presence. Because frontiers are placed at the edges of the known and governed, where the frontier is said to lie is an indication of where centralized power imagines its own limits to lie. There is another side to this dynamic, wherein inhabitants within the frontier region may seek to leverage the imposition of the frontier signifier as a way to gain greater recognition, in the global economy, or as legitimate national citizens, respectively.

The cases of Cabeça do Cachorro and Greenland show that sacrifice zones are not unilaterally imposed from the top-down, but also can be sought after and fought for by local actors who wish to set the terms of the creative destruction characterizing our contemporary economy as it unfolds in their particular place. Local mining proponents feel strongly, if somewhat naively, that the geopolitical and economic spoils of rare earth extraction will outweigh the potential hazards simply because they intend to do mining their own way, on their own terms. They

hope for deeper integration into global economies, greater control over local destinies, and broader recognition of local importance won by supplying the world with these vital elements.

The aspirations of people on the new rare earth frontiers are further complicated by the fact that despite their importance, rare earths simply are not gold. Although some post-2010 commentators characterized the global waves of exploration and speculation as a new gold rush (BBC 2011; Gustke 2011; Jeffries 2014), the analogy quickly fell apart in practice. The lucky miner with a gold nugget in hand holds instant wealth, but the same cannot be said for rare earth elements. Rare earth ores, by themselves, are worth very little without undergoing complex and hazardous beneficiation processes. Processing high quality rare earths has proven to be risky business, not just because of the environmental and epidemiological hazards, but also because despite their importance and proliferation, the global market remains decidedly small.

As a result, firms specializing exclusively in rare earth oxides have not fared well. Baotou emerged as the rare earth capital of the world in no small part because of the integration of rare earth mining, processing, and research with regional military, heavy machinery, and high technology industries. With the subcontracting and deindustrialization in the West following Reagan and Thatcher's deregulations and Deng Xiaoping's reforms, Baotou's industrial-scientific architecture became the center of gravity for global rare earth production. In Brazil, CBMM subsidized the development of reclaimed rare earth oxides with its booming niobium monopoly. The Mountain Pass mine in California, which specialized exclusively in rare earth production, reopened in 2012 under the since discredited pretense that it was leading the way in repatriating environmentally superior rare earth production. But prior to declaring bankruptcy in 2015, it relied on the same subcontracting practices that precipitated its demise—shipping minimally processed ore to China and Estonia for further value-added processing. This situation sheds some small measure of light on the seemingly runaway efforts to exploit the Amazon and the Moon when there are abundant resources available from far more accessible and far less controversial sources: to succeed, it appears that the enterprise of rare earth mining must be yoked to other industrial and territorial endeavors.

In this way, Baotou is unique in history because the tremendous investment in building a regional integrated military-industrial base contextualized rare earths and their broader (potential) applications in a very concrete way. Research and development on rare earth applications was integrated with the development goals of nearby munitions, aerospace, energy, heavy machinery, and information technology industries. This was complimented by the multi-mineral extraction approach to the Bayan Obo mine, which in addition to rare earths, is exploited

for iron, gold, and niobium. The economic successes of Baotou and the failures of other sites of rare earth mining suggests that large-scale rare earth mining needs to be closely integrated with complementary industries and publicly funded research institutes in order to weather the vicissitudes of global political economy. If this is the case, the glaring absence of strategies to develop regional auxiliary or support industries at new points on the global rare earth frontier leads us to two possible conclusions: first, that mining proponents, investors, firms and policy-makers are profoundly unaware of what it takes to build a successful rare earth enterprise, and second, that the quest to open up these new spaces is about something else besides rare earths.

Rare earth elements were not the sole reason that Baotou developed into a hinterland metropolis, but neither were the other interests entirely removed from the industrial and economic realities related to rare earth mining and processing. In some ways, the consolidation of China's rare earth monopoly was one outcome of a much larger set of processes in which rare earths played an important, but by no means exclusive, part. Baotou was built into a military-industrial hinterland to serve the developmental and military needs of the USSR and the People's Republic of China. Rare earths emerged in prominence contemporaneously with the establishment of iron and steel works, aerospace and defense industries, and aligned research institutes. This scientific-industrial base is thoroughly integrated into broader development strategies that evolve over time in response to changing global political economic conditions and domestic needs and aspirations. In many ways, Baotou is a success story of China's nationalist development and Open Up the West Campaign, which is currently a subject of intense interest and ongoing academic interchange between Brazilian and Chinese scholars.

There is a small but growing body of Brazilian scholars who study China's Western development model in order to apply it to the Amazon. The goal is to definitively exercise sovereign control over a region that has provoked territorial anxieties since imperial times. The abundant resources of the Amazon, it is envisioned, could be unlocked to fuel Brazil to a place of global political economic prominence that may one day rival China's.² This would require massive infrastructure investment, annihilation of local landscapes and lives, and unprecedented waves of migration and resettlement in order to provide necessary labor power. These scholars look at China's one-party system and echo China's criticisms of democracy as creating chaos. "I would prefer a dictatorship, at least then things got done," is a trope that, unheard in 2010 fieldwork, was repeatedly uttered on long-distance bus rides and in Federal ministries in Brazil in 2014. These comments presaged the political turmoil and rightward shift of national politics in 2016. In Brazil, the idea that economic development and prosperity was more important than anything else, including the integrity of the biosphere and hard-won

civil liberties and legal protections, had gained considerable ground against earlier ideas about equitable sustainable development and the need to move Brazil away from the status of primary commodity producer.

This example shows that there are constructive and destructive lessons to be learned from the rise of Baotou and Bayan Obo. When it comes to matters of regional and industrial development, policymakers and planners in the rest of the world would do well to consider the broader industrial, research, and policy support networks that are necessary to sustaining a robust rare earth industry. Studying the rise of Baotou, however, should not be confused with a naïve celebration of authoritarian industrialism. Nor should the eventual rise of China's rare earth monopoly be used to justify the necropolitics that preceded the rise of the military-industrial complex in IMAR. Instead, the best lessons should inspire new thinking on industrial organization, while the particular histories related in this book should serve as a cautionary tale of how nationalist development projects can provide cover for racialized violence. To figure out how to source rare earth elements in a stable, ethical, and sustainable way, we need to understand why they have been sourced in unstable, unethical, and unsustainable ways.

Racist politics complicate the global rare earth frontier in many different ways. The ideas of which landscapes and lives are deemed sacrificable in the name of rare earth mining is often informed by and reflective of existing racial inequalities. Although the abundance of potentially minable deposits identified globally may convey the sense that “everywhere on Earth” has been explored, this should not be misinterpreted to the effect of depoliticizing the practice of geological knowledge production. As the cases examined herein demonstrate, the production of geological knowledge is an act of power, and contests over its meaning have defined struggles between local and extralocal interests over the last long century. Agents of questing European powers, Chinese nationalists, Japanese imperialists, US atomic interests, and Sino-soviet revolutionary communists carried out the surveying and prospecting in Inner Mongolia that led to the identification of the deposits at Bayan Obo. São Gabriel da Cachoeira was surveyed by Imperial Portuguese explorers, the US Army Corps of Engineers during World War II, and later under the military dictatorship before such activities were outlawed in the 1980s and 1990s. It is important to note that localized geological knowledge production continued despite changing legal regimes. As indicated by the ongoing struggles of indigenous *garimpeiros* on the one hand and the continued conferral of mining permits by Departamento Nacional de Produção Mineral to outside mining interests on the other, criminalizing activities essential to the production of geological knowledge did not stop them. As for the production of selenological knowledge, the anxieties circulating in Anglo-phone discourse surrounding the *Jade Rabbit* mission exposes the geopolitics of

scientific exploration when one party insists on framing the other party's activities as trespass. Although China's lunar program has proceeded in compliance with existing international treaties, in Anglophone discourse their research has been reframed as a violation of the US frontier.

The relationship between existing collections of geological fact and the conditions under which they are collected is critical to informing ongoing struggles over the geography of the global rare earth frontier. In chapter 5, this is pitched between indigenous people and small-scale miners on one hand, and military and corporate mining interests on the other. On the Moon, neoimperial Cold War politics under which the selenological data was gathered are refracted through the private sector mining race, where firms selectively present themselves as proxies for state power when politically expedient. The politics of geological knowledge production in each of the cases reflected longer-term relations of domination. This is something to bear in mind as we consider how to build a more just and sustainable future. Although the production of scientific knowledge cannot be separated from its political and social context, paying careful attention to the social context in which data is gathered and plans are made can help us avoid reinscribing the structural and direct violence of our bloody history.

In a different way, the racialization of toxic rare earth production as a distinctly Chinese problem obscures the common challenge of isolating the dangers of rare earth mining and processing. As detailed in chapters 1 and 3, highly toxic and radioactive elements geologically coincide with rare earth elements, many of which are themselves hazardous to living tissues. Rare earth separation generates tonnes of pollutants, both in the form of industrial acids and the liberation of lead, arsenic, fluoride, uranium, thorium and radon gas in the form of waste products. This is a challenge common to rare earth mining across the globe. Developing and disseminating the best practices for controlling these hazards should be privileged as a point of international cooperation.

What Can We Do?

These cases are particularly illustrative of the dynamics defining the global rare earth frontier: global modernity depends on these resources, yet exploitation is both toxic and expensive. There are compelling reasons for states to develop rare earth production on national soil, but conventional mining and processing methods are too toxic, expensive, or controversial to develop anywhere other than on land that is deemed marginal and sacrificable. Yet, even with the emergence of viable greener alternatives and the elimination of China's export quotas, rare

earths remained politically relevant in the push to territorialize lands that had historically eluded centralized state power. In essence, the securitization and crisis narratives surrounding rare earths helped the states involved resolve their own longer-standing frontier problems, the contemporary manifestations of which generated new social and geopolitical meanings for rare earth elements.

The primacy of territorial politics in determining the global geography of the rare earth frontier explains why our global geography of production is so strange, and why the strangeness persists despite better alternatives. But what can we do? There are at least three concrete ways to approach this issue. The first is to make the territorial politics explicit, so we can address the underlying and perhaps unrelated interests that drive rare earth mining to controversial and conflict-prone places. This requires critically interrogating the grandiose claims made by aspiring firms and developmentalist states, while also taking the concerns highlighted by social movements and researchers seriously. This will enable us to more readily focus on substantive and collaborative efforts to build a more sustainable, just, and rational rare earth economy. Programs such as the Extractive Industries Transparency Initiative, and the growing practice of incorporating social and environmental safeguards into major mining and infrastructure development projects provide useful blueprints for rethinking rare earth mining in a way that prioritizes the integrity of local landscapes and lives.

The second is to support the market for more sustainably produced rare earth oxides, such as those extracted from existing waste sites using certified sustainable processes rather than from new holes in the ground. The fact that recaptured rare earth oxides are already being produced by an ISO 14001 certified company shows that the greatest challenge—producing greener rare earths from existing mine wastes—has already been overcome. The reason greener rare earths have not yet gained greater market share is due solely to pricing rather than availability issues. This state of affairs undermines environmental remediation efforts in China and undermines the sustainable development potential of an array of rare earth reliant industries in the rest of the world. A straightforward solution would be to provide tax incentives to rare earth reliant firms engaged in the production of medical equipment, scientific instruments, renewable energy technologies, and energy efficient transportation technologies for a decade or two. This would help create market certainty for greener rare earths and incentivize other enterprises to reprocess rare earths from existing waste sites in a certified environmentally responsible manner. This could also allow time for robust monitoring and certification programs to be developed specific to the rare earth industry, which would further build consumer confidence in the sustainability of rare earth-bearing products. A broader positive outcome would be the reduction of the waste foot-

print of existing and former mining sites across the globe, and perhaps one day the end of the need to sacrifice new lands to open new rare earth mines.

The third concrete solution is to recycle rare earth elements. In addition to the abundant rare earths present in mine tailings across the globe, less than 1 percent³ of rare earth elements consumed are currently recycled. This is, in no small part, due to the physical manner in which rare earth elements are used: they are additives, used to “dope” other materials, referred to as “spices” or the “vitamins” of industry. Effective recycling involves energy and chemically intensive processes of separating elements from magnets, alloys, lasers, batteries, hard drives, and other technologies into which they are blended. In her research on the viability of rare earth recycling in the European Union, Verrax (2015) identified the central obstacle to this worthy initiative. The exact composition of each component, as well as the precise quantities of which particular elements are used, varies according to brand and model. In other words, not all laptops, smartphones, or lasers are created equal: the exact composition of each product is confidential. Even laboratory analyses detailing the composition of particular electronics, and how best to extricate rare earths, remain protected under trade secrets.

Furthermore, the feasibility of any rare earth recycling initiative is currently predicated on industry demand, which varies according to element; downstream buyers have been unanimous in their negative response to the prospect of paying premiums for recycled elements, because the quality of recycled rare earths has not yet been demonstrated. There is also a serious social constraint, which is the lack of a large-scale waste collection system for both industrial and individual rare earth technologies: How to systematize the collection of jet propulsion systems on one hand, and broken laptop speakers on the other? And of course, how much more would recycled elements cost compared to those being produced in China?

These are clear obstacles to implementing viable rare earth recycling programs. But clear obstacles also present clear solutions. Just as there are standards governing the material composition of manufactured goods, there can also be standards that require rare earth components to be more readily extricable from potentially recyclable electronics. Likewise, the infrastructure and organizations for collecting multiple forms of waste are already well developed in major consuming economies. Developing a system to collect rare earth bearing products would hardly require starting from scratch. Rather, developing the facilities, training the processing personnel, and educating the public would likely follow similar practices as recycling and composting campaigns that took place in previous decades.

Pursuing any and all of these options would lead to a more just, sustainable, and stable global rare earth production regime. It is entirely possible to live in a world where the hardware of modern life is built on sustainability rather than suffering. It is also possible that our growing demand for rare earth-dependent technologies will continue to be used to justify all manner of brutality in vulnerable landscapes across the globe. The choice is ours.

Areas for Further Research

In addition to the concrete options offered above, the findings presented in this work have several implications for future research. Chief among the epistemological questions to be further researched are those concerned with how to truly think globally in research, theory building, and action from the standpoint that “the global” is dynamic and composed of distinct local instances (Tsing 2005). Foregrounding the local in global studies has had its own perils. For example, it is important to examine global political economy in a way that treats Euro-centrism and Sino-centrism critically without going so far as to propose that the “center” should simply be somewhere else, as proposed by Mignolo (2009), for example. The crucial next step is yoking broad global-scale inquiry to the concept of scattered hegemonies (Grewal 1994) to work beyond colonial and Cold War-era epistemic straits that might incline globally minded researchers to take at face value hemispheric divides, teleologies of development, and particular relationships between the private sector and the state under neoliberalism. On a related note, thinking in a global yet grounded manner also requires that we think of our “globe” in context (Cosgrove 2005). The technologically empowered extension of economic, extractive, military, and political interests to spaces beyond Earth requires that we rethink global epistemologies now that human life is co-constituted with extraglobal technologies, power struggles, and possibilities. It is time to consider outer space as an “area” worthy of the comprehensive study afforded to other places that comprise “area studies” programs.

With respect to Baotou and Bayan Obo, the most obvious need for further research concerns the outcomes of the industrial restructuring and liberalization of rare earth exports at the beginning of 2015. It will be important to evaluate whether removing the export and production quotas had any effect on efforts at environmental remediation and suppressing unauthorized and unregulated rare earth mining. If so, what these were and whether they have been discernible in the everyday life of local inhabitants is of utmost importance if we are to identify possible practices that could inform the production of less devastating future prac-

tices of rare earth mining and processing. Of further interest is how industrial restructuring in China's rare earth sector relates to and is informed by the New Silk Road campaign, which involves, among other things, conducting geological prospecting and constructing infrastructure across central Eurasia. This would support a nascent body of scholarship on "global China" (Lee 2014), which seeks to bridge the gap between research on China's overseas activities and scholarship on domestic China.

During fieldwork in São Gabriel da Cachoeira, I learned of an extensive, and entirely unwritten history, of indigenous practices regulating mining activities on their lands, including the establishment of a permitting and tax collection system to ensure that allowing outside small-scale miners also brought benefits to the host communities. This history flies in the face of established narratives of small-scale mining as an entirely unregulated disaster wrought by outsiders on victimized indigenous communities. It is important, therefore, to investigate how certain indigenous groups in the region engage with the practice of mining over time, including their participation, regulation, and control over such practices. This could begin by supporting local efforts to construct an archive of this experience. This would support the expansion of a small but extremely important body of literature pioneered by Graulau (2001) and Lahiri-Dutt (2011) that focuses not just on the place of mining in indigenous livelihoods, but also on the ways in which the importance of this enterprise differs along gender lines. There is important work to be done on the intersection of indigenous and women's agency in mineral extraction and how that contradicts and entangles with visions of masculinized dominion over vertical space.

A further site of considerable ethnographic interest concerns the coproduction of Silicon Valley techtopias, narratives of apocalypse, and west coast utopian experiments. Although utopian experiments such as communal living and festivals of radical self-expression are often cast as the antidote to apocalyptic futures,⁴ my findings among nascent private sector space mining firms suggest that, in fact, the utopian experiments inform apocalyptic common sensibilities in a selective convergence of extreme leftist and extreme rightist ideologies. Based within the spectacular accumulation of wealth surrounding technological innovation in Silicon Valley, what remains underexamined are the ways in which promises of technologically enabled futures of convenience and interconnection rely on preserving the current unsustainable political economic status quo. Desires and claims for a utopian future as exercised in the rarified atmosphere of Silicon Valley solidify rather than undermine imaginaries about the inevitability of apocalypse and societal collapse. Given the deepening relationship between technology firms and the US government, this would be a fascinating area for participant observation, ethnographic and archival research.

Finally, because of the contemporary nature of the issues studied, they require ongoing engagement to see where the geography of rare earth extraction settles in the near-term, how practices improve and change over time, and whether the fiction of rare earths as rare will remain operative in agendas to territorialize the places examined in this work.