On the Rare Earth Frontier

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Abstract

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Rare earth elements are not rare at all. They are essential for the hardware of contemporary life as we know it, every contemporary industrialized society depends on them, and there are no known alternatives. Yet the geography of their production is strange. In 2009, China accounted for 97% percent of global production, with the majority coming from the Bayan Obo mine operated by the state-owned enterprise *Baotou Rare Earth Group* on the southern Mongolian steppe. When gradually intensifying export quotas combined with a temporary halt of official exports in 2010, the rest of the world woke up to its near total dependence on China's rare earth monopoly. To address this crisis, a Brazilian firm (*Companhia Brasileira de Metalurgia e Mineração*) determined to capture rare earths from its niobium mine tailings in the state of Minas Gerais. Betting on the willingness of downstream firms to pay a premium for non-Chinese rare earths and subsidizing the effort with revenues from their niobium sales, they resolved to produce a steady output of rare earth oxides regardless of global market fluctuations. In 2012, CBMM successfully produced high-purity rare earth oxides. In 2013, the US, EU, and Japan won a WTO case against China's rare earth export quotas, restoring some semblance of the global status quo. But the story does not end there.

Despite the relative ubiquity of rare earth elements, the abundance of known reserves near existing infrastructure networks, and the dissolution of the 2010 crisis, global prospecting efforts—with the aid of national governments and militaries—have targeted São Gabriel da Cachoeira in the high Amazon and the Western Lunar Highlands on the Moon as the next major points on the global rare earth frontier. This dissertation addresses the question: **Given that rare earth elements are both abundant and vital, why is their production driven to so few, seemingly remote places?** This question immediately begets three others: through what processes did China's Bayan Obo mine emerge as the single greatest source of rare earth elements worldwide? What provoked changes in China's policy and practice, and how did this precipitate spatial transformations elsewhere? And for what purposes are state, military, and private actors pursuing rare earth mining in São Gabriel da Cachoeira and the Moon?

This dissertation proposes that the strange geography of the global rare earth frontier can be explained by world-historical shifts in the global division of toxic labor occurring within a

context of state-building and geopolitical contest. It thus advances three claims. First, China's monopoly emerged through a convergence of long-term historical processes shaping northern China in the context of early 20^{th} century imperialism, Cold War politics, and the epochal global economic shifts precipitated by Deng Xiaoping's 1978 reforms and the Reagan/Thatcher revolution. Second, the change in China's political economic priorities from export dominance to conservation has been stimulated by the acute environmental and epidemiological harms generated by rare earth production coupled with China's changing position in the global division of labor. Third, the contemporary geography of the global rare earth frontier is driven by more than geological determinism: although these sites are rich in rare earth elements, they are also historically contested regions and focal points for territorial agendas, for which a nationalist mandate for rare earth extraction provides a convenient pretext.

These claims are based in a world-historical analysis of rare earth mining, and draw on political economy, political ecology, transnational theory to examine the convergence of Baotou, São Gabriel da Cachoeira, and the Moon in the production of the global rare earth frontier from the late 19^{th} to early 21^{st} century. I engage scientific literatures, archives, expert interviews and other perspectives across the Anglophone, Sinophone, and Lusophone world which were gathered in China, Brazil, and the United States during 2010 – 2014. The multilingual approach is central to this project. Multiple forms of knowledge are evident in the discourses on the rare earth frontier, and there is a symmetrical inaccessibility to the working rationales across language barriers even as these rationales interpenetrate to shape thought and action across global space.

By examining the transnational historical production of the rare earth frontier across these sites, this dissertation refutes three dominant, yet persistent assumptions circulating in contemporary popular, policy, and academic discourse. First, that China's rare earth monopoly emerged because it possesses more rare earth elements than any other country; second, that China and Brazil possess mutually unintelligible histories precluding grounded relational analyses, and; third, that the Moon is a space of exception, beyond the purview of global economic activities and likewise, therefore, of critical concern.

The purpose of this work is to demystify the contemporary global rare earth frontier. This work therefore has three aims. The first is to equip the reader with a deeper understanding of rare earth elements—the peculiarities of their geology and production, their political economic significance and their role in geopolitics far beyond what is available in the flurry of reports and opinion pieces generated since 2009. The second is to interrogate the historical origins and ongoing ramifications of the recent 'crisis' not as an exceptional circumstance, but as an episode that can be understood as emerging from and indicative of global development politics. The third and broadest aim is to move beyond entrenched global imaginaries that insist on the mutual unintelligibility of 'China' and 'the West,' or which seek to explain global changes as a series of unidirectional 'impacts' of one place on another, of 'center' on 'periphery,' (Hart 2002) as exemplified by much recent (but important) work concerned with China and Latin America (Gallagher 2008, García-Herrero 2007, Jenkins 2008, Rodriguez 2006).

Although these sites differ in many important ways, each demonstrates a particular set of frontier attributes drawing especially from their respective histories at the margins of major imperial and territorial powers. These similarities help explain their convergence as points of extraction along the contemporary global rare earth frontier, while their differences account for the temporal and technological relationalities among these three sites in the global division of toxic labor.

Dedication

To the people of Bayan Obo, and Baotou, whose waters, soils, and bodies have borne a burden few outside of rare earth mining regions can imagine; to the people of São Gabriel da Cachoeira; to those devoting their lives to more just and sustainable regimes of rare earth production and consumption; this work, the first of many, is humbly dedicated to you.

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To my dear husband, life partner, and best friend, Nick Bojda. Thank you for circling the globe with me, for not only enduring long absences but cheering me through them, and growing with me over these years. Thank you for sharing this journey with me.

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Welcome to the Rare Earth Frontier

"Non-availability means that resource conflict is an immediate threat with negative short- and long-term geostrategic consequences."

Rare Earth Elements World Report 21, June 2012

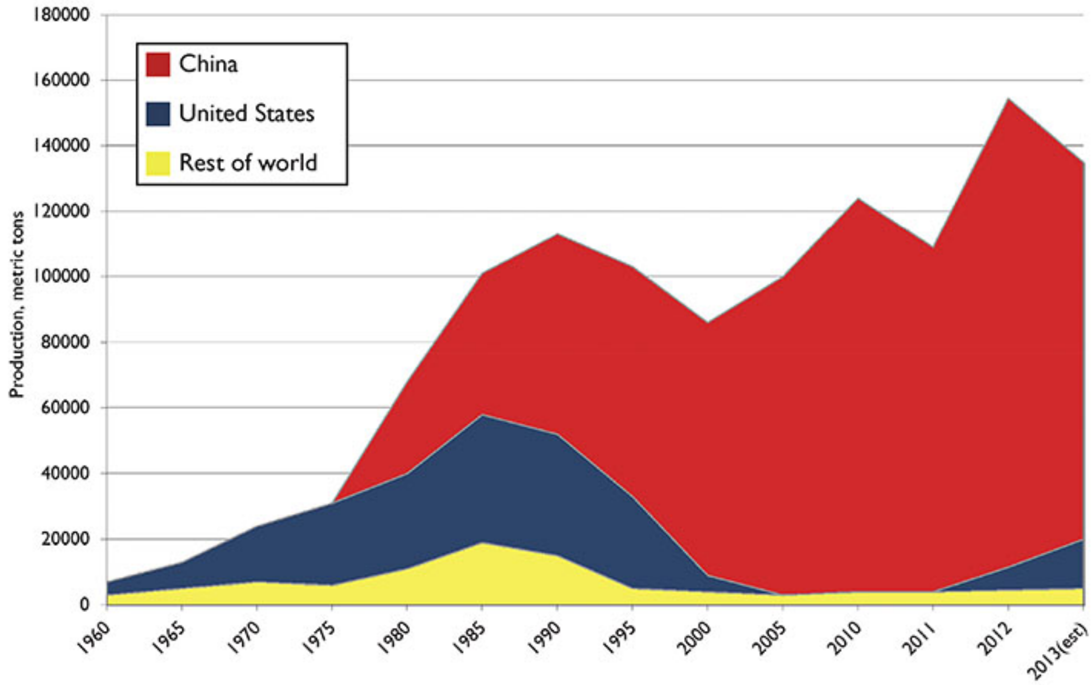
"The problem we face on earth is that beyond their scarcity, these elements are not evenly distributed throughout the world. We need to disrupt this market. By finally being able to reach the Moon and harvest the resources that are there, we can overcome the scarcity of rare earth elements and create the infrastructure necessary for innovation to continue."

Naveen Jain, Founder of Moon Express, 24 May 2012

"Unfortunately, 'strategic metals' are among those perennially misunderstood policy issues with strange lives of their own. The myth of shortage simply refuses to die."

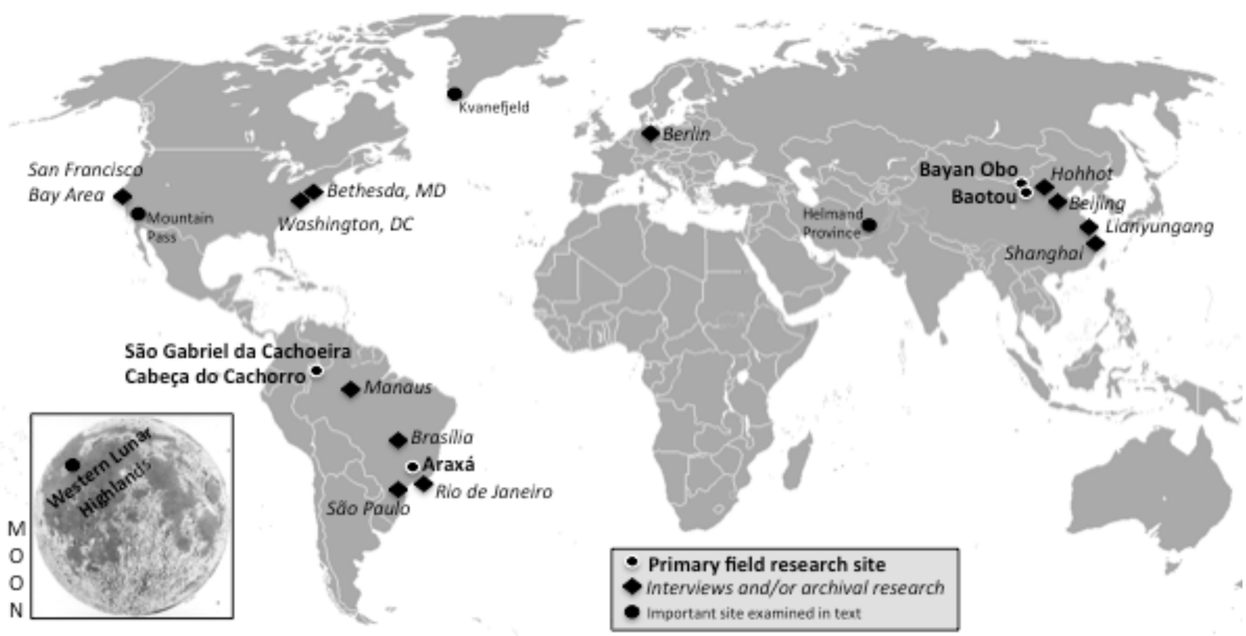
Russell Seitz and Jerry Taylor, 28 July 2005

Figure 1: Global Rare Earth Production



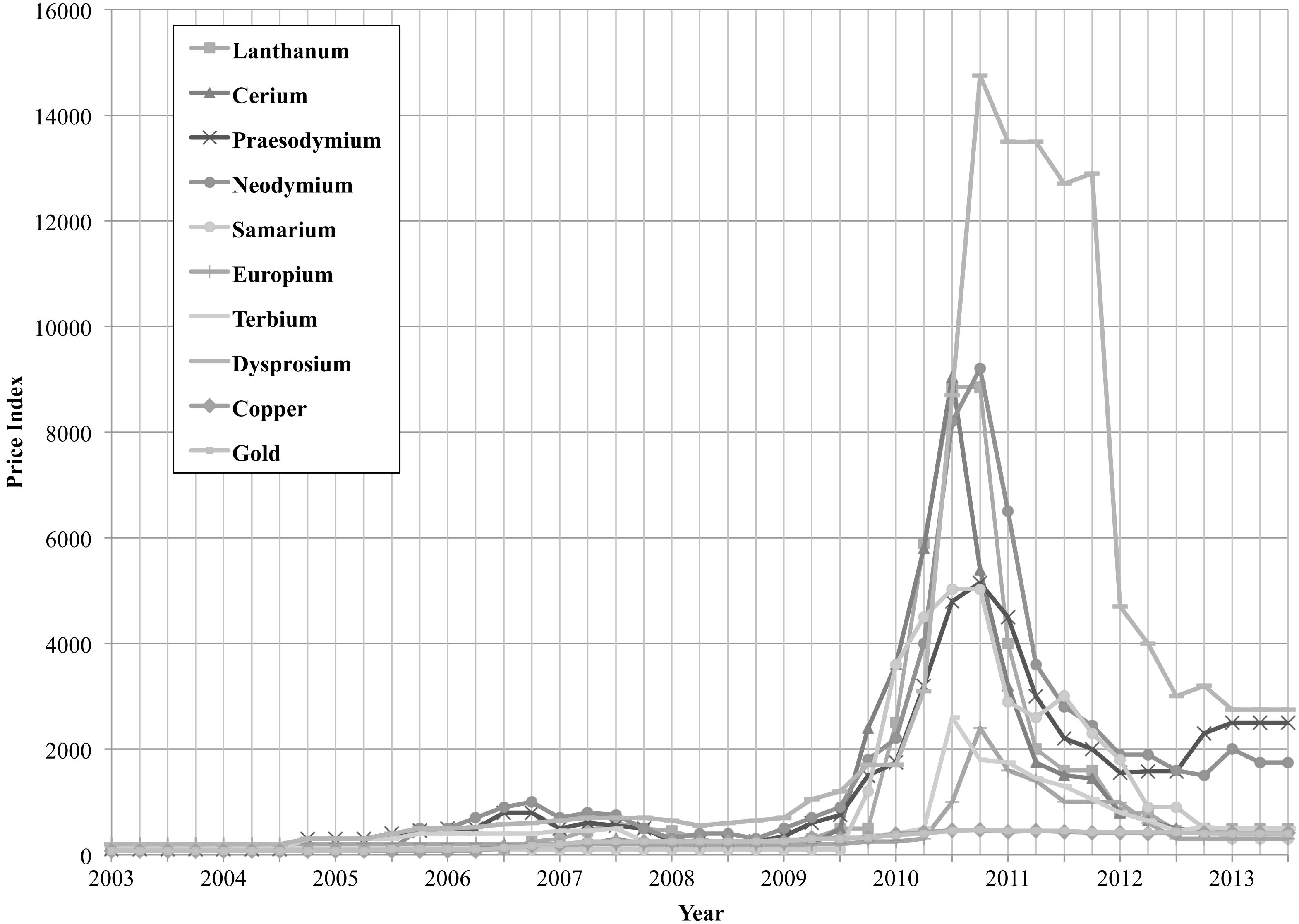
Sources: Orris (2013), Klinger (2013b) and Council (2010).

Figure 2: Sites Examined in the Present Work



The map indicates research sites visited in 2010 – 2014, with the exception of the Moon.

Figure 3: Prices USD/kg for Selected Rare Earth Oxides, 2003 – 2014, Compared to Copper and Gold.



Prices rebased to 100 for fourth quarter of 2003. Sources: Bartekova (2014) and Thomson Reuters DataStream (2014).

I. The Situation, the Questions, and the Sites

In late September 2010, China's military blocked a routine shipment of rare earth elements to Japan. What was initially an independent maneuver at a single port facility by the People's Liberation Army in the ongoing tensions between the two countries came to be interpreted as China flexing its geoeconomic muscle, exposing global dependence on the country for these critical metals. Although China's foreign ministry intervened to resume shipments in November 2010 (Hur 2010), and later denied that such an embargo had taken place (Areddy, Fickling, and Shirouzu 2010, Bradsher 2010a) the rude awakening had already happened: China then provided over 97% of the global supply of rare earth elements on which nearly every industrial country depends, and for which there are no immediate synthetic alternatives.

Although global annual consumption remains at just above 120,000 tonnes (Castilloux 2014),[1] rare earth elements are fundamental to global modernity as we know it: without them, the technologies on which we rely for global communication, transportation, medicine and militarism, as well as nuclear, petroleum-based, and renewable energy production would not exist. Sudden supply disruptions of this magnitude had never occurred since the elements had become so thoroughly embedded in contemporary life.

Over a decade prior to this incident, China's central government began implementing policies to curb production as a measure against alarming environmental crises in mining regions, and to enforce export quotas to protect against eventual resource exhaustion (Chen 2010b). The first discernible effect of these policies emerged in 2008, marking the first year in which exports decreased relative to the previous year (Zepf 2013). Between 2008 and 2011, prices increased as much as two thousand percent for some elements. For example, dysprosium, an element used in commercial lighting, lasers, and hard drives, rose from USD 110/kg in 2008 to USD 2031/kg in 2011. Prices fell precipitously between 2011 and 2014 to USD 470/kg as the supply stabilized, but chronic shortages have continued to keep the price elevated well above the 2008 norm (Humphries 2013). As an indicator of how this affected downstream industry, one study found that the price increases between July and September 2011 reduced the net incomes of major hard drive producers in the United States by 37% (Monahan 2012). Others reported 'a chilling effect' on renewable energy start-ups in the US (Bradsher 2011) while still others claimed that dependence on China for materials used in critical defense applications posed a 'national security threat' to the United States, among others (Coppel 2011).

This prompted market panic, unleashing waves of speculation, prospecting, and bellicose political discourse across the world as China's monopoly came to be seen in a new light (Caramenico 2012, Chen 2011b, Fulp 2011). It was no longer invisible within the global economic status quo, which had been running to no small extent on permissive pollution and labor practices that helped keep China's commodities cheap and therefore globally competitive. Instead, the concentration of rare earth production in China became known as a 'stranglehold' (Evans-Pritchard 2013) that threw the world into 'crisis' (Bourzac 2011) and constituted a

[1] For 2014. As compared to iron ore (1,610 million tonnes in 2013), gold (3,923 tonnes in 2014), or potash (56 million tonnes), for example (Basson 2014, Street et al. 2015, PotashCorp 2014).

‘threat’ (Hannis 2012) to the national security and economic stability of downstream countries (Portales 2011). In such a framing, the unexceptional origins of China’s rare earth monopoly were lost in accusations of conspiracy and geopolitical posturing. The situation generated a flurry of dramatic responses and counter-strategies across the globe.[2]

For example, since the crisis of 2010, trade and economic officials within the governments of the US, EU, and Japan acknowledged that their dependence on China’s rare earths arose from longer-term shifts in the global division of labor, whereby dirty industry relocated to China and then undersold Western firms to the point of the latters’ bankruptcy. Several government officials publicly advocated for a national plan to revive domestic industries in the Euro-American world (Bennett 2010, Clancy and Banner 2012). Although such initiatives require significant political and technological capital, the urgency of the period between 2010 and 2013 inspired efforts to restore domestic capacity through rather creative means, as illustrated by the Brazil and US cases. But at the same time, the US, EU, and Japan elected to file a WTO suit against China’s production and export quotas in order to preserve the very global division of labor that brought about the demise of rare earth mining and processing industries in the West.

Meanwhile, the Brazilian government announced in 2011 that it would invite firms to evaluate the feasibility of exploiting deposits on indigenous territory in a sensitive border region of the far northern Amazon, while NASA and the Department of Defense partnered with Silicon Valley firms to develop the required technological and legal infrastructure to extract these elements from the Moon. US entities have not been the only ones seeking these elements beyond Earth: China successfully landed the ‘Jade Rabbit’ rover on the Moon on December 14, 2013, with the purpose of gathering scientific data and exploring for minable minerals, including rare earths (Radio 2013, Wang 2013, Shefa 2014).

Such hyperbolic behavior would seem to suggest that rare earth elements are, in fact, rare. But many are more abundant than copper, as common as lead, and as of 2013 there were 799 known minable land-based deposits[3] on Earth (Orris 2013). Yet there are currently only five producing countries, with China providing approximately 85% of the global supply as of late 2014. **How, given the abundance of accessible rare earth deposits, has production concentrated in so few places?** More specifically:

- How and why did China’s Bayan Obo mine in Baotou, Inner Mongolia Autonomous Region *in particular* emerge as the single greatest source of rare earth elements worldwide?

[2] As will be examined herein, the extent to which the events of 2010 constituted a ‘crisis’ is a matter of considerable debate. The ‘crisis,’ real or not, had real effects and has become parlance for the price increases and attendant geopolitical and economic uncertainty that followed. That the crisis was not what many thought it to be, that China’s central government maintained plausible deniability throughout, and that commodity flows may have only been minimally disrupted will be thoroughly examined in Chapter four and therefore are not points that need to be belabored by keeping ‘crisis’ in scare-quotes hereafter throughout the text.

[3] According to the USGS: “A mineral deposit is a mineral occurrence of sufficient size and grade that might, under the most favorable circumstances, be considered to have economic potential (Cox and others, 1986). Deposits sharing a relatively wide variety and large number of attributes are characterized as a "type," and a model representing that type can be developed.” (Berger, Singer, and Orris 2009).

- What prompted the change in China's political economic priorities from export dominance to conservation?
- And with what implications for the contemporary geography of the global rare earth frontier?

China's contemporary rare earth production dominance—or more specifically, the international response to the central government's decision to curb output—has impelled the opening of vast new horizons on the global rare earth frontier: pushing exploration to previously unreachable locations (Fulp 2012); stimulating new waves of foreign direct investment in prospecting and mining activities; and renewing struggles over who bears the staggering environmental costs of production (Ives 2013, Bradsher 2009). Each of these developments are driven by the strategic value with which these elements are imbued (Lima 2012, Ting 2013, Wang 2010) underscored by recent price volatility and perceived global supply shortages (Hurst 2010, Brown 2013).

The importance and relative ubiquity of rare earth elements would seem more likely to drive exploitation 'closer to home,' so to speak, in infrastructurally-integrated regions within major consuming economies especially given the recent price declines, but this is not the case. In the race to open up rich new extraction points, less remote, apparently easier to access deposits have been overlooked in favor of the far northern Amazon and the Moon. What drives the production of this strange geography? Toward what end is the Brazilian government undoing its own indigenous and ecological protection laws to mine niobium in São Gabriel da Cachoeira, a historically contested border region shared with Venezuela and Colombia, when there are more easily accessible deposits in existing mining sites elsewhere in the country? And why have NASA and the Department of Defense chosen to partner with Silicon Valley start-ups to mine these elements from the Moon, while the US throws away hundreds of tons of REEs annually in mine tailings and e-waste?

As discussed in the following sections, the hazards involved in producing REEs exert an outward (or inward, depending on your perspective) pressure on the placement of rare earth mining and production. The twin desires to isolate the hazards while capturing the geopolitical benefits of keeping the production of these strategically vital elements within national (or imperial) borders drives production to the frontiers of empire, state, and capital. This tension explains why the rare earth frontier is found in borderlands and hinterlands, in places where local landscapes and lives are deemed sacrificable (Hecht 2005a, Johnson 2007, Campbell 2000) in the name of the greater good.[4] The 'greater good' operates transnationally to help resolve the otherwise impossible situation in which resources must be procured by industrialized countries, but for which they do not wish to assume the risk of extracting them from their own soils. The matter is perhaps never settled, but only resolved through periodic fixes: as will be shown in subsequent chapters, Euro-American production migrated almost entirely to China by the late 1990s, following a series of extensive—and expensive—environmental disasters at production sites. Over the last decade as ecological and epidemiological crises deepened in China's mining regions, China's production and export controls were conceived as part of a long-term effort to

[4] As discussed below in Section III, frontiers, borders and hinterlands are not ontological givens, fixed in place awaiting incorporation into political maps or extractive geographies. Rather, they are produced through shifting regimes of rule, technology, and extraction insofar as they delimit the spatial expressions of power and vulnerability.

shift from a net exporter to net importer of rare earth elements, thereby displacing the environmental burden of rare earth mining and processing elsewhere by externalizing and transnationalizing the country's rare earth hinterland.

Although Bayan Obo, São Gabriel da Cachoeira, and the Moon may seem radically different from the other, I argue that there are several key similarities that explain their conjuncture on the global rare earth frontier in a way that is linked to the story of China's contemporary dominance in rare earth exploitation in particular, as well China's global integration and attendant geopolitical developments more generally. Such an argument then begs the following question: what particular dynamics are at work in Bayan Obo, São Gabriel da Cachoeira, and the Moon that explains why these sites in particular have emerged on the global rare earth frontier? To what extent are these dynamics shared or exemplary? There are several ways to go about answering these questions, which concern seemingly strange geographies and surprising developments—and therein lays their value. The fact that a compelling link between Inner Mongolia and Amazonas on one hand, or between these extractive frontiers on Earth and those in outer space might seem far-fetched or counter-intuitive highlights the limits of received epistemologies with which we seek to understand contemporary global political economy.

Sites

Baotou, São Gabriel da Cachoeira and the Moon have much in common, emerging as key points on the rare earth frontier not simply because of their geological endowments, but also because they had been frontiers of another sort, and continue to pose a frontier problem to territorial interests. The value of this observation lies in the way it moves beyond entrenched notions of mutually unintelligible difference between China and Brazil, between 'east' and 'west'[5] across global space. By interrogating the colonial basis of our geographical imaginaries of difference—specifically how they are codified according to race, sex, hemisphere, and region—we can denaturalize our thinking about racially and sexually coded relations of domination to see them not as something fixed, but as flexibly deployed in context-specific manners by expansionist power to rationalize the brutalities of rare earth extraction.

In this way Baotou, São Gabriel da Cachoeira, and the Moon are drawn together as key constitutive points along the global rare earth frontier. As explored herein, each site illustrates particular dimensions of the historical, contemporary, and future-present of the global rare earth frontier in particular, and the multivalent character of frontiers in general. The industrialization of Baotou tells a history of multiple, sometimes overlapping 20th-century imperialisms[6] which each took the production of a militarized resource hinterland as the foundation of a socialist geopolitics and later ethno-national project, while the recent production controls forcefully indicate that the global division of labor is far from static. The emergence of São Gabriel da Cachoeira as a contested site of rare earth extraction is particularly illustrative of the fundamental

[5] The latter of which often only refers to Western Europe, the US, and Canada.
[6] As discussed in Chapter three, European, Manchu, Japanese, and Soviet imperialisms sought to render the Bayan Obo region into a resource hinterland. It was the critical conjuncture between the expansion of the Soviet military-industrial project and Mao's internal colonialism agenda that initiated the foundational regional urban-industrial project in the 1950s.

tension driving the rare earth frontier: which is the desire to confine the hazards of rare earth mining and processing far from population centers while securing production within national borders. Yet the unresolved logistical challenges, abundant reserves elsewhere in the country, and histories of competing sovereignties in São Gabriel da Cachoeira suggest that rare earths are providing a useful pretext to bring a rebellious region firmly within the control of the Brazilian state. However, there is an additional nuance to the situation that troubles theories of sacrifice zones. This is not simply a story of state and capital collaborating to exploit and discipline an elusive frontier. Indigenous inhabitants of the region have been lobbying hard to win the right to mine on their own protected lands, despite hard-won constitutional victories outlawing any such practice.

These two cases present instances in which multiple, perhaps unexpected actors draw on geological knowledge in order to legitimate border-making activities, while the Moon presents an extreme manifestation of how the intersection of geological knowledge and state territoriality abet the expansionary tendencies of capital—and how private capital leverages geopolitical anxieties to recruit the state to support enclosures and private accumulation in contradiction to existing legal conventions. The Moon presents an especially vivid example of the discursive power of the frontier signifier to mobilize capital, expertise, and political will to realize an activity that currently only makes sense under conditions of ecological apocalypse on Earth. The new race to mine the Moon indicates that, far more *rare* than the actual elements in question is a place where they can be mined beyond the purview of competing social and environmental claims.

By virtue of their locations on geologically analogous intracontinental cratons within large, established contemporary states with diverse populations, Baotou and São Gabriel da Cachoeira have certain commonalities that are not shared with the Moon. These commonalities stem from world-historical movements of exploration, colonial and imperial power, geological prospecting, and state-building as part of the dialectical production of frontier spaces. The temporalities of frontier dynamics studied differ across these two sites. Baotou was surveyed, territorialized by the contemporary state, and industrialized fifty years ago whereas struggles over the meaning and control of extractivism in São Gabriel is unfolding in anticipation of larger-scale, regularized rare earth mining. This means that there are very different qualities and quantities of data gathered in these cases, which is reflected in the organization of the dissertation. What is striking is that frontier processes unfolding at antipodes over half a century apart from each other are nonetheless characterized by analogous processes. By setting aside entrenched notions of mutually unintelligible difference between these two spaces, examining the analogous processes characterizing these two places contributes to theorizations of the constitutive elements of a frontier. Of the many analogous processes characterizing the historical geographies of São Gabriel da Cachoeira and Baotou, there are five that I would like to highlight here precisely because they are so often framed in exceptional terms in the histories of each place.

First, both Baotou and São Gabriel da Cachoeira are historical 'meeting places,' or zones of pre-modern interethnic and intercultural commerce. Baotou was a historic overland and riverine trading post between Mongolian, Han, Turkic and Tibetan peoples, with relics of commerce dating back to the Song dynasty (Representative 2013). São Gabriel da Cachoeira likewise was a riverine meeting point among indigenous peoples of different linguistic groups from what is now Amazonas, Colombia, and Venezuela (Wright 2005). These histories of cosmopolitan exchange predate the current nation-states that have drawn their borders across these regions. Despite periodic genocidal, migration and assimilation campaigns, long histories of mobility have proven difficult to imperial and state efforts to confine, even under conditions of heavy militarization.

Second, both are sites of former indigenous empires the descendants of whom are now minoritized under national laws. Baotou lies in a historically contested territory between Mongolian, Manchu, and Han peoples, with recorded border disputes dating back to 300 B.C. (Klinger 2013a). The Inner Mongolian Autonomous Region was established in 1947; the local majority demographics, Mongolian and Manchu, were minoritized in the 1953 census (Mullaney 2010); the former is a transborder polity with a sovereign state, Mongolia, to the north, the latter was the ruling ethnicity during the Qing (1644 – 1912), China's last dynasty which formed the territorial basis for the People's Republic of China. In Brazil's *Cabeça do Cachorro*, the Tukano, Baré, Baniwa, and Yanomami are three of twenty-six indigenous transborder polities unevenly governed by indigenous conventions of Brazil, Venezuela, and Colombia. In Brazil, they were placed under the protectorate of the state in 1950 following their encounter with government survey teams, and were granted their own legally recognized lands in 1992 after decades of struggle (Ricardo and Ricardo 2006). In demarcating borders, designating minorities, and granting qualified autonomy to inhabitants, the production of Inner Mongolia Autonomous Region in the People's Republic of China and Indigenous Lands in Brazil was also the production of social, political, economic, and legal difference. By claiming territory while granting indigenous inhabitants special legal status, the state in practice undermined local citizenship rights and claims that locals might make to their subterranean resources. In both cases, mineral resources have been framed as national patrimony and local indigenous groups have little legal control over their exploitation relative to the governing majorities. These differences have been instrumental to legitimating ongoing developmentalist interventions in the name of civilization and national progress (Quan 2012). The contemporary iterations of these extra-local developmentalist interventions have featured two temporally differentiated aspects of the rare earth extraction: in Baotou, the mandate to consolidate and slow extraction in order to provide some socioecological remediation to pollution-affected residents, and in São Gabriel, the struggle between military-backed corporate and small-scale miners to recodify the geological endowments on indigenous lands in order to allow extraction despite known hazards.

Third, in both sites, churches and states have collaborated to territorialize Baotou and São Gabriel da Cachoeira. Both are historical sites of imperialist catechization, confinement, and occupation as well as current sites of Korean and Euro-American Christian missionary activity. Baotou has been under Mongolian, Han, and Manchu imperial rule over the last 2,300 years (Klinger 2013a), with periodic occupations by agents of European, Japanese, and former-Soviet imperialism. The Qing dynasty enforced policies of exclusion during the early years of its reign, prohibiting in- or out-migration in central-Western IMAR in an effort to close and securitize its northwestern border; it later reversed this policy in 1863, promoting migration to Baotou and other parts of present day IMAR to alleviate displacement crises generated by the Opium Wars, warlordism, and European colonialism (Huang 1994). This facilitated the entrée of French, Portuguese, and Dutch missionaries to Inner Mongolia who were active in the political and territorial struggles over the region and were instrumental to colonial European knowledge production about Inland East Asia (Guo and Li 2005, Cammann 2008, CICM 2013).[7] Catholic and protestant churches maintained by foreign missionaries survived the Cultural Revolution and are important local centers of social ordering despite the state's official atheism. Likewise in Brazil, Portuguese, Spanish, and French colonizers claimed São Gabriel da Cachoeira and surrounding areas for their respective imperiums (Fay 1932, Roller 2012), implementing forced labor regimes among the indigenous inhabitants to aid the Europeans on their quest to find the golden continent of Inca legend (Scammelli 2003). Some of the first chroniclers of the region for European audiences were religious agents looking for souls to save. Colonizers encouraged the ingress of missionaries to capture souls for European Christian churches while early missions aided the Portuguese crown with its territorial agenda (Chernela 1998, Willeke 1958). Portuguese forts doubled as exile-prisons for political prisoners, but the contemporary military and state agenda is focused on populating the region with Brazilians from elsewhere in the country. Despite international denunciations, missionary activity, including the imposition of religious education and labor regimes continues aggressively into the present (Camargo and Albuquerque 2006). Both cases show how the rare earth frontier was preceded by spiritual and territorial conquest; they were resource frontiers of other sorts.

Fourth, Baotou and São Gabriel da Cachoeira were sites of early-mid 20th Century competing statehoods. Baotou was under local Han-Mongolian governance at the end of the Manchurian Qing Dynasty in the 1900s. During the Nationalist Rule (1927 – 1949), the Guomindang took over the Qing Dynasty Bureau of Mongolian and Tibetan Affairs, which incorporated present-day Mongolia into the Republic of China[8]. What is now Inner Mongolia Autonomous Region was then the site of periodic conflicts between the Nationalists and the Communists, barring a brief alliance to fight against the Japanese, and repeatedly coopted and thwarted efforts by Mongolian princes to incorporate the territory into an independent Mongolia. In 1945, Chairman Mao promised Wu Lanfu, head of the nascent Mongolian Communist Party, autonomous governance for Inner Mongolia if the ethnic Mongolians joined him to defeat the Nationalists. Thus the Autonomous Region was founded in 1947, two years before the founding of the People's Republic of China. Soviet planners prioritized mining development and industrialization in Baotou in order to provide the raw material for China's industrialization, as well as to supply munitions and heavy machinery to Soviet forces in Mongolia and Inner Asia. Thus over the first half of the 20th century, leading up to the Sino-Soviet split in the late 1950s, Baotou was under imperial Qing, Mongolian, imperial Japanese, Chinese Nationalist, Soviet and Chinese Communist rule.

With respect to Brazil: although the Portuguese founded the municipality of São Gabriel da Cachoeira in 1668 (IBGE 2008), this was over 150 years before Brazilian independence. Neighboring countries challenged the claim in the late 1800s. In the 1900s, Brazilian, Colombian, and Venezuelan survey teams demarcated a shared border zone; the 1907 Treaty of Bogotá conceded São Gabriel da Cachoeira to Colombia. In 1928 the Brazilian Government sent commissions to the northern Amazon to reassert the extent of national territory, which placed the border 90 kilometers north of the city of São Gabriel da Cachoeira (Silva 2006). FUNAI and Brazilian missionaries established posts in Yanomami, Tukano, and Baré territory beginning in

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[7] There are several denominations of Christian churches in Baotou as well as São Gabriel da Cachoeira.
[8] Even though Mongolia declared its independence from the Qing Dynasty in 1911.

1947 (Peters 1998). The Brazilian Air Force constructed a small airport in São Gabriel in 1952, and trained indigenous inhabitants in counter-insurgency jungle warfare in the case of Communist revolution during the dictatorship. In 2004 the base for the Second Brigade of Jungle Infantry (*Segunda Brigada de Infantaria de Selva*) was transferred from the state of Rio de Janeiro to São Gabriel da Cachoeira (CMA 2012). The failures of the Brazilian state and military to attend to the affairs of indigenous inhabitants over the years stimulated local groups to organize into a democratic political bloc, the Federation of Indigenous Organizations of Rio Negro *(Federação das Organizações Indigenas do Rio Negro: FOIRN)* that negotiates legal and development agreements with the state and federal government on behalf of all indigenous groups in the region. Therefore over the past century, São Gabriel da Cachoeira has been under religious, Colombian, Brazilian military, Brazilian civilian, and Indigenous governance.

Fifth, both São Gabriel da Cachoeira and Baotou are ongoing sites of state territoriality, nation building, and subject formation. Recent and ongoing nationalist development projects aimed at integrating the regions with their respective countries have deployed rather heavy-handed campaigns to win the hearts and minds of local populations by creating cultural role models embodying national and civilizational ideals[9], simultaneous with propagandistic campaigns in metropolitan areas to inculcate a sense of compatriot entitlement to these places and their cultural heritages as part of the broader national 'imagined communities'(Anderson 1982). Ethnic Mongolians and indigenous peoples of the upper Rio Negro are both fetishized and problematized in broader national discourses and cultural campaigns, while their environs are promoted as national treasures and eco-tourism destinations to domestic urban audiences through popular television dramas and the tourism industry in both countries.

Yet these campaigns sit in direct tension with local ethnic politics. Pan-Mongolianists do not recognize IMAR as part of China; they refer to it as 'Southern Mongolia' under Chinese occupation. Since the 1950s, Inner Mongolia in general and Baotou in particular have been sites of state-orchestrated gendered labor migration to support regional industrialization. Baotou in particular (Representative 2013) and Inner Mongolia in general (Rossabi 2004, Klinger *under review-b*) are the sites of all manner of construction projects, propaganda campaigns, and ideological interventions in service of historical revisionism and citizen-subject formation to support the People's Republic of China claim to the region; and more precisely, to conflate rare earth exploitation with nationalist development and civic pride (Klinger *under review*). Intensifying this national feeling was the 1991 recodification of Bayan Obo mining district as a national security zone closed to unauthorized outsiders. Renewed geological prospecting since 1999 facilitated the rapid expansion of the mining industry for elements other than rare earths; since 2003 Inner Mongolia Autonomous Region has had the fastest growing provincial GDP; it is now the single greatest mining and energy resource hinterland for China (Wübbeke 2013).

In Brazil, the mid-20th century dictators had analogous intentions to develop the Amazon into a resource hinterland via infrastructure construction and strictly gendered labor migration campaign that recruited poor young men from elsewhere in the country to perform heavy labor and poor women to provide domestic support labor. Under military direction, and with a heavy reliance on conscripted indigenous labor, highway BR-307 in São Gabriel was excavated under executive orders of the Figueiredo administration (1979-1985). The portion heading north out of

[9] See the discussion of Wang Zhaojun in Chapter two and the discussion of Sivamzinho in Chapter five.

São Gabriel city the Morro dos Seis Lagos deposits has yet to be paved.[10] São Gabriel da Cachoeira could otherwise only be reached by a 24-48 hour journey up the Rio Negro, or by airplane, so sustaining state-orchestrated migration campaigns proved difficult. In light of the difficulties of settling the region, the Figueiredo administration redesignated the area as an ecological protection zone, which legitimated routine military patrols along the border while reframing the region and its inhabitants as part of the national patrimony. The region is populated by three main groups: indigenous peoples, among which those with the most mining activity are the Tukano, Baniwa, Yanomami and Baré; other small-scale miners (*garimpeiros*) from Colombia, Venezuela, and Brazil; and the Brazilian Military (IBGE 2008). Identifying São Gabriel da Cachoeira as an untapped niobium-coltan-rare earth reserve in 2011 and reframing it as the key to Brazil's self-sufficiency and global dominance in strategic resources has renewed calls for state-financed infrastructure construction (Gonçalves da Lima 2010), revised mining laws to allow exploration on indigenous lands (Jucá 1996), and securitization of the region (Monteiro 2011).

In both cases, state territoriality and nation building assume the form of developmental, environmental, infrastructural and military interventions. The purposes of these interventions are addressed to what is seen as a porous border and an unruly territory, and seek to: bring the territory and peoples in question firmly within the purview of the state; to render that territory into a hinterland for the state and broader circuits of accumulation; and to reconfigure *in situ* socionatures in service of nationalist mining mandates. This involves processes of subject formation and securitization, as evident in both cases, serving both biopolitical and geopolitical agendas.

Finally, both sites are imbued with mythic significance in dominant national imaginaries insofar as they are framed as exotic, backward, and inalienable parts of the national patrimony nevertheless at risk of expropriation by foreign actors. These analogous dynamics are significant because they indicate what sort of spaces have been sought for reconfiguration into a rare earth frontier, specifically: marginal, contested spaces. While the marginalities of these places both precedes and lends itself to the reconfiguration of these spaces into sites of extraction along the global rare earth frontier, such marginality is not given *a priori*; what the historical analyses presented in subsequent chapters show is that the marginality of these frontier spaces was *produced* through hotly contested territorial exercises of imperial, colonial, and state powers over time. No place is marginal unless it is forcefully produced as such; marginality implicates the gaze of extra-local power.

The Moon: A Few Distinctions

The Moon possesses some particular characteristics that are not shared with Baotou or São Gabriel da Cachoeira, though there are fewer distinctions than one might expect. These distinctions primarily have to do with the technology required to bring the Moon within the purview of material engagement,[11] and reduce transport costs.[12] A further distinction is that the

[10] In 1992, a moratorium was placed on further construction because the road passes through protected regions.
[11] Which has important similarities with the technological barriers to deep sea extraction.
[12] Which is in fact quite similar to the obstacles presented by São Gabriel da Cachoeira.

Moon is entirely unpopulated, and is effectively governed solely by international legal conventions, which prohibit claims of sovereignty or acts of enclosure.[13] As elaborated in Chapter six, this is the subject of rich legal and political debate, which is dominated by proponents of developing a property rights regime to stimulate private investment in lunar exploitation.

Many of the operative frontier elements that drove rare earth prospecting and industry to Bayan Obo and São Gabriel da Cachoeira are at work on the Moon as well. This will be discussed presently; it is important to highlight the distinctive frontier attributes that the Moon does not share with Baotou or São Gabriel da Cachoeira because that enables us to position the lunar frontier in technological and temporal relationality to Baotou and São Gabriel da Cachoeira, and thereby place these frontiers in their respective broader contexts.

The technological and infrastructure requirements are perhaps the most apparent example of the temporal and technological relationality among these sites: Bayan Obo was opened by rail and unpaved road, by mobilized migrant labor in post-WWII and Post-Revolution China; for mining to be feasible in São Gabriel da Cachoeira, reliable road or rail transport would have to be built, which has proven elusive over sixty years of campaigns to develop and integrate the Amazon into regional economies; for mining to be feasible on the Moon, transport costs would have to be dramatically reduced in order to bring elements back to Earth from outer space, so space-faring states as well as private firms have developed various strategies to work around or overcome these economic hurdles. In each of the cases, the logistical challenges leading up to rare earth extraction require significant capital, expertise, and political will to overcome. In this way, each of these transport technology situations is indicative of the broader contexts in which these sites emerge on the global rare earth frontier. In other words: the global prominence of Bayan Obo is one aspect of post-Revolution, post-Reform, neoliberal development between China and the 'West' over the past half-century; the contests over the future of exploitation of São Gabriel da Cachoeira is one aspect of shifts in the global division of specialized toxic labor intertwined with Brazilian expansionism and geopolitical ambition as a major BRICS power, against which indigenous peoples seek to both maintain and modify statutory protections won in the last three decades; the latest private-enterprise race to the Moon is an outcome of four decades of neoliberal policies resulting in an immense concentration of wealth in the hands of an extreme minority[14], the sub-contracting of state research and military operations to the private sector, and the resurgent geopolitical anxieties provoked by perceptions of intensifying resource scarcity dramatized by China's recent rare earth production and export controls.

Significantly, the number of commonalities between the Moon, Baotou and São Gabriel da Cachoeira exceeds the differences, which as noted above are legal and technological in nature. Considering the common processes in the production of Baotou, São Gabriel da Cachoeira, and the Moon should aid in overcoming entrenched spatial imaginaries (Lefebvre 1991, Castoriadis 1998) that anachronously place the Moon (and near-Earth outer space) beyond the purview of contemporary resource geopolitics, political economy and political ecology, or quotidian human activity.

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[13] In this way, the Moon is similar to Antarctica, the Deep seabed, and the Arctic Circle, all three of which figure in global resource and territorial geopolitics. (Macdonald 2007; Klinger *under review*)

[14] Many of whom came into this wealth by developing and innovating rare earth-dependent technologies.

First, although the geology of rare earth elements is covered in Chapter one, it is useful to gloss here to provide a deep historical context for the commonalities outlined herein. Rare earth elements are formed during repeated cycles of small degrees of partial heating and cooling within Earth's mantle. This gradual process produces alkaline magmas which, when they ascend and cool in Earth's crust undergo further changes stimulated by local temperature, pressure, and chemical variations (Long 2010). Too much melting, or too rapid cooling, and the rare earths fail to coalesce. The deposits of both São Gabriel da Cachoeira and Baotou are situated along accretionary orogenic belts between major intracontinental cratons (Lujan and Armbruster 2011, Nutman 2007), which formed after intense periods of the subduction of the Mongolian and Guianan oceanic plates beneath the northern cratons of their respective continents (Chao 1997, Voiçu, Bardoux, and Stevenson 2001). On the Moon, an analogous process is hypothesized to have taken place in the formation of the KREEP[15] deposits (Shervais and McGee 1999). It is believed that the Moon formed after a Mars-sized object smashed into Earth and broke off debris that eventually consolidated into the Moon we recognize today. The power of the collision liquefied much of the debris tossed into space, which formed lunar magma. The lower density of the Moon left an ocean of this magma trapped between the mantle and the crust, which cooled very gradually (Heiken, Vaniman, and French 1991). Although the characterization of rare earth deposits in new sites along the global rare earth frontiers tends to be prone to hyperbole, there is, nevertheless, a geological basis for the emergence of these three particular points on the global rare earth frontier. Elements of the crisis and the broader incidence of rare earth elements may be fictive, but the basic dynamics of their geological formation are not.

Second, Baotou, São Gabriel da Cachoeira, and the Moon are sites of 20th-century international geological prospecting. Dutch, Swiss, Japanese, and Soviet geologists visited Baotou, but the Chinese geologist Ding Daoheng is credited with discovering the iron reserves at Bayan Obo in 1927 and publishing his results in 1933. In 1935, a team of chemists discovered that the iron was associated with rare earths, which at that point played a marginal role in technological applications. Due to the Japanese invasion and the civil war, Bayan Obo remained undeveloped until the 1950s, although the Japanese imperial forces conducted some exploratory work in this area (Ding 1933, Ma 1995). In Brazil, in 1972, the Brazilian Geological Service and USGS identified sizable niobium-coltan-REE deposits in São Gabriel da Cachoeira, which some analysts claim are the largest in the world (Gomes, Ruberti, and Morbidelli 1990, Orris 2013). This deposit was further explored and mapped by the Brazilian Federal Mineral Resources Research Company (*Companhia de Pesquisa de Recursos Minerais)* in 1975 (Cuadros Justo and de Souza 1986). The São Gabriel da Cachoeira deposits are located in alluvial deposits close to the surface, requiring minimal blasting which would make production relatively cheaper there, provided infrastructural constraints could be overcome (Jacobi 2009). On the Moon, rare earth elements were identified in the lunar rock samples from the western lunar highlands brought back from the Apollo 12 and 14 missions (Shervais and McGee 1999) and the Soviet Luna 16, 20, and 24 missions (Zak 2013). Lunar samples are legally available for scientific research of all countries (UN 1967); these rocks have been examined by international geologists visiting NASA and affiliated Planetary Science institutes, the Russian Space Agency, and the European Space Agency, and the Chinese National Space Administration.

[15] KREEP: K = Potassium, REE = Rare Earth Elements, and P = Phosphorus

Initial international geological prospecting proceeded in these sites under broad (post/neo) imperial mandates of scientific knowledge acquisition in the 'peripheries' (Chambers and Gillespie 2001) for global centers of power and calculation (Latour 1983 in Braun 2000). In the early 20th century, these centers of power and calculation relative to Inner Mongolia were located in colonial European, imperial Japanese and Soviet states, and only toward the mid-20th century in Beijing. In the mid-twentieth century, the centers of calculation and power relative to the Moon were located in the space agencies of the former Soviet Union and the United States. In the latter quarter of the twentieth century, these centers of power and calculation relative to the far northern Amazon were located in Washington D.C., Brasilia, and Manaus. This illustrates Tsing's (2005) contention that frontiers are produced by extra-local powers reaching across the friction of distance to configure the space in question into something else. The act of interpellating the frontier is part of the processes of transforming the unknown into the known. The basic, key mechanisms through which this process unfolds in the production of the global rare earth frontier is the pursuit, production, and differentially controlled circulation of geological knowledge. This imbues the territory in question with an important aspect of verticality, thereby creating the conditions of possibility for valorization of those newly identified resources, their incorporation into circuits of accumulation (Braun 2000), and the capture of geopolitical and economic benefits garnered from controlling their exploitation.

Third, all three sites are characterized by partial, overlapping, or contested legal regimes. In Inner Mongolia, mining activities intersect with economic development, conservation, and minority protection laws. The first concerns the mandate to 'Develop the West'[16] and to better utilize the autonomous region's mineral resources in service of the national mandate of 'all-around scientific development,' (He 2009). The second requires that local pastoralists' livelihood interests be protected, meaning that mining cannot proceed without consent from and compensation for impacted pastoralists, which is overseen by both the local bureau of land and resources, and the head of the village collective, which often have conflicting interests. The third concerns a set of environmental protection laws containing quotas on the proportion of grassland that can be used for purposes other than conservation or grazing. Coordination, or 'harmonization' of these laws in practice has been partial at best; local, autonomous region and national leaders concede that 'economic resource needs' (i.e. mining) trump other concerns. The contradiction lies most starkly in the national mandate to exploit the autonomous region's mineral wealth,[17] which sits beneath the grassland resources fundamental to pastoralist livelihoods. These overlapping laws result in periodic conflicts between local leaders, mining bosses and their employees, and local pastoralists (Jacobs 2011, Reuters 2011, AFP 2015). But because rare earth elements are strategic national resources, the Bayan Obo mining district has been recodified to legally erase possible conflicts: officially, there are no farmers or pastoralists in Bayan Obo. This is of course not true—during fieldwork in 2013 I noted at least thirty agropastoral homesteads in the vicinity of the mine. But officially, land is used for mining, urbanization, or farming—the meaning of the latter in official discourse refers to wind farms.

In Brazil, ecological and indigenous legal protections overlap with national security mandates which designate all land within sixty kilometers of the national border to be part of the *Calha Norte* (northern trench) under the exclusive domain of Brazilian Military. Seis Lagos,

[16] 西部大开发战略
[17] Further incentivized by career pressures for local officials to increase the local GDP

which lies sixty kilometers south from the borders of Colombia and Venezuela, is the site of two national parks. One, Neblina Peak National Park, was established by executive decree in 1979, by the military-appointed president José Figureido following failed migration and construction campaigns. The second, Morro de Seis Lagos State Biological Reserve, was established by the state of Manaus in 1990 as part a land management and zoning plan (Flores de Oliveira 2009), which ostensibly provided employment and land use entitlements for indigenous inhabitants. In 1992, twenty-three indigenous groups were granted qualified sovereignty in their respective Indigenous Lands created by Executive decree of President Fernando Collor de Mello. In light of the 2011 presidential invitation to open up Brazil's Amazonian reserves as well as grassroots campaigns to decriminalize small-scale mining of rare earths, coltan and gold, divergent efforts to rescind the moratorium on mining in indigenous lands have been underway by state, corporate, and indigenous actors (PL 1610/96).

The Moon is governed by two international legal conventions, both of which have been ratified by a sufficient number of states to have entered into force. The *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (hereafter Moon Treaty) of 1984 bans any ownership of extraterrestrial property by any entity and requires that an international regime and protocols must be established "to govern the exploitation of natural resources of the Moon as such exploitation is about to become feasible," (UN 1984). However, only sixteen states have signed or ratified the Moon Treaty, excluding the US and other major space-faring powers. Thus the only 'live' legal convention governing the behavior of states in outer space is the 1967 United Nations *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (hereafter OST) which frames outer space as the patrimony of all humankind and prohibits assertions of national sovereignty. As Beery (2011) noted, framing the Moon as the patrimony of all human kind effectively reconfigures it as a global commons, vulnerable to processes of appropriation and enclosure that have characterized the fates of commons elsewhere. As discussed in Chapter six, there are two primary interpretations regarding the applicability of the prohibitions against national appropriation to private enterprise. The first argues, of course, that limits on national sovereignty do not apply to private enterprise. The second argues that private appropriation must be backed by the state in any case, so private appropriation is state appropriation after all, and therefore prohibited (Carswell 2002). The response by private sector actors and those more powerful space-faring states at the time of this writing consisted of propagating the fiction that no legal conventions govern the Moon; it is instead a "wild west," (Klotz 2015).

Frontier resource exploitation tends to benefit from or take advantage of unclear, contradictory, or non-existent legal regimes (Watts 2012). In all three sites, rare earth mining has required a regulatory offensive on the part of pro-mining interests in order to transform laws otherwise established to protect in situ socionatures, reconfiguring the subsoils of these spaces as strategically vital to a hegemonic set of interests.

Fourth, Baotou, São Gabriel da Cachoeira, and the Moon have been discursively cast as 'sacrifice zones' whose destruction—while perhaps contested or publicly lamented—has been promoted and tacitly consented to as necessary for sustaining the normatively constructed and culturally identifiable 'greater good' (Brownlow and Perkins 2014). Nationalist and geopolitical discourses surrounding rare earth elements are directed toward this purpose. As noted above, all three sites have been or are being legally and materially reconfigured in order to permit the destructive mining of rare earth elements essential to the infrastructure and hardware of global modernity.

Bayan Obo is 'the rare earth capital of the world,' and 'a model strategic resource development site' (BGXT 2013). Arsenic, fluoride, thorium, and heavy metals contaminated surrounding soil and water, poisoning livestock and people living nearby; these abandoned grasslands have been reclassified as conservation or wind farmland. This mode of rare production suited China's broader development goals and critically co-constituted with the global division of toxic labor. This was the case until the first decade of the 21st century when China's central government began to take steps control production in the face of growing local actions illuminating an epochal threat to one of the key water sources for north and northeastern China. Prior to late 2010, production practices in Baotou and Bayan Obo scarcely caught international attention with the exception of some investigative journalists and anti-renewable energy lobbyists seeking to expose 'clean energy's dirty little secret' (Margonelli 2009). Following the crisis, Anglophone discourse racially coded (Chen 2011a) toxic practices in China as both a 'Chinese' problem as well as a 'dirty trick' played by China's central government in order to achieve dominance in rare earth production.

In São Gabriel, as noted above, actors within the federal government have been working with corporate mining interests to renege the moratoriums on mining in indigenous territory in order to "develop the world's largest strategic minerals deposit" and "improve Brazil's position in strategic resource markets" (Jacobi 2009). Because of the known hazards of rare earth mining, as well as the extensive history of sovereign anxieties with respect to the region, planners in the military and federal government see large-scale mineral exploitation as a way to kill two birds with one stone. After all, infrastructure construction, industrialization, and resource extraction proved effective to industrialize and rationalize China's northwestern frontier. As the reasoning goes, many lives were lost, great sacrifices were made, but China modernized into a superpower: planners and policy makers in Brazil have hoped to reformulate China's northwestern development successes for integration of the amazon.[18]

The Moon is idealized by private space mining entrepreneurs and their legal advocates as a consequence-free terrain for resource exploitation ostensibly "for the benefit of all humanity," (ME 2013). The push to develop extraglobal extraction technology is legitimated according to the socio-ecological imaginary of Earth as planetary sacrifice zone (Autry 2011), described in neo-Malthusian narratives (Dudley-Flores 2013) of scarcity-induced (Guner 2004) civilizational collapse (Dolman 2002) in policy, industry, and academic literature. The greatest appeal of the moon, to those in the mining business, is the lack of requirements for environmental and social impact assessments.[19]

Fifth, conjuring the three sites[20] into points to be exploited on the global rare earth frontier requires considerable capital, political, and scientific investments to actualize. This is another way of saying that rare earth exploitation in these places does not make sense according

[18] China Academy of Sciences Delegation to Brazil, interview by author, March 2013
[19] China Academy of Sciences Public Health, ground water, and soil researchers, interview by author, August 2013
[20] …as well as Greenland and Afghanistan, examined in Chapter four.

to strictly economic logic. Rather, geopolitical imperatives—extending from great power politics to racialized reproductive regimes in the name of nation building—have been instrumental in the production of the global rare earth frontier. Brownlow and Perkins (2014) note that "sacrifice—of people, places and things—is part and parcel to security geopolitics." Security geopolitics are multivalent on the rare earth frontier. First, the space of exploitation itself is geopolitically significant: Baotou and São Gabriel da Cachoeira are in historically contested border regions; the Moon represents "the ultimate military high ground" (Dolman 2002) and the "most valuable piece of off-Earth real estate" (Bigelow in AFP 2013). Second, security geopolitics are reflected in a number of trade, policy or production measures adopted in response to the threat of rare earth scarcity and the presumed military, technological, and economic vulnerability that would result (see, for example Grasso 2013, NCPA 2013, SC 2012). Third, when resource extraction is at issue, security geopolitics entails not just the land in question, but the infrastructure, transport, and processing spaces as well as local labor and reproductive regimes. Each must be controlled against outside threats, real or imagined, as illustrated for example by the prohibition against foreigners or other unauthorized outsiders in both the Bayan Obo mining district and any economically-motivated extraction on Indigenous lands in São Gabriel da Cachoeira. Because Baotou, São Gabriel da Cachoeira, and the Moon are geostrategically desirable locations, resource exploitation is also a means of territorialization, which is evident in the terms in which claims to the resources are framed: in other words, diverting the resources necessary to open up and develop these places is considered necessary in hegemonic political, economic, and technological progress narratives, which are examined in their specificity in the body of this work. These visions, though broad and sometimes incoherent, are specific in their visions of who is in control of advancing the geopolitical agenda within the broader push to mine rare earth resources. The case of São Gabriel da Cachoeira shows that there is little space in federal government and military visions of the region for indigenous agency in strategic resource mining: even when indigenous mining proponents align their interests with the military, their proposals are dismissed by officials as coopted by transnational conservation interests seeking to undermine Brazilian sovereignty.

II. Aims, Approach and Methods

That such a contemporary geography should seem at all strange indicates certain tensions between established world-historical, political economic, and post-colonial epistemologies. From these tensions emerges a fertile point for empirical inquiry and theory building. This inquiry therefore proceeds in critical engagement with some major 20th century epistemologies while necessarily reaching beyond them. Much of what drives the production of the global rare earth frontier operates in the epistemological gaps of political economies, political ecologies and postcolonial theories that drew their ordering logic from the Cold War vision of a world thrice divided. Although Cold War geographies of extractive territoriality cast long shadows over the contemporary production of these particular places, the emergence of contemporary neoliberal authoritarianisms and the ongoing dynamism of the global division of labor are crucial factors in the global geography of the rare earth frontier. These factors emerge in the context of a critical encompassing comparison of the global rare earth frontier shaped by the processes cutting across Baotou, São Gabriel da Cachoeira, and the Moon. This is a world-historical analysis from an untried angle insofar as it draws together parts of the world typically segregated in area and disciplinary categories, but it is anchored in the fundamentals of political economy, political ecology, and post-colonial theory.

To wit: political ecology starts with the premise that environmental change co-emerges with social and economic change, with some debate on the relationship between structure and agency in explaining environmental practices. Although I agree with the post-structuralist perspective that emphasizes the role of discourse and representation in shaping individual agency and collective practices (Escobar 1996, Peet and Watts 1996), I do not adopt this analytic at the expense of classical structuralist approaches (Blaikie 1985). Rather, I share Hughes' (2000, 201) contention that Marx's theory of historical materialism is conducive to engaging environmental questions, both at the macro-level of global and historical processes that shape human-environment relations, and at the micro-level, in the detailed forms of labor relations, which are organized according to (in)formal regimes of race and gender extending through the present from colonial eras. Post-colonial theory (Yan 2006, Spivak 1999, Spivak 1985, Fanon 1965) with transnational feminist theory takes us further still, to critically interrogate the raced and gendered organization of labor relations (Massey 1994, Nakano Glenn 1985) in the production of state and global orders (Loomba 2005, Marchand and Runyan 2010) constitutive of the geography of the global rare earth frontier.

Some precision is therefore necessary when referring to the *global rare earth frontier,* because there is a sense at which rare earths drive the frontiers of simply everything: technology, warfare, post-petroleum possibilities, human exploration of sub-atomic and outer space, and indeed, contemporary geopolitics, power, and accumulation. The term could, and should, refer to the multiple sites and situations in which rare earth elements are used; where they are applied in the concerted efforts to force technology beyond current limits of possibility; where they are processed and to what extents they penetrate surface and subsurface environments as industrial run-off; how they are incorporated into everyday life in evermore intimate and mundane ways; and where they land when the larger machine of which they are part is discarded as waste. Much of that is for subsequent projects. This present work is concerned with the frontier that is fundamental to all others: the mined and to-be-mined. Where my questions require it, the dynamics of the other frontier dimensions of rare earths elements are drawn into the analysis; it must be so, because the constriction, closure, or (actual or feared) exhaustion of one site of extraction compels the search for others.

To demystify the contemporary global rare earth frontier, this work has three aims. The first is to equip the reader with a deeper understanding of rare earth elements—the peculiarities of their geology and production, their political economic significance and their role in geopolitics beyond what is available in the flurry of reports and opinion pieces generated since 2010. The second is to interrogate the historical origins and ongoing ramifications of the recent 'crisis' not as an exceptional circumstance, but as an episode that can be understood as emerging from and indicative of global development politics. The third and broadest aim is to move beyond entrenched global imaginaries that insist on the mutual unintelligibility of 'China' and 'the West,' or which seek to explain global changes as a series of unidirectional 'impacts' of one place on another, of 'center' on 'periphery,' (Hart 2002) as exemplified by much recent (but important) work concerned with China and Latin America (Gallagher 2008, García-Herrero 2007, Jenkins 2008, Rodriguez 2006). As discussed below, such framings are useful—crucial even—but they are insufficient to the task of understanding the production of the global rare earth frontier.

Toward these ends, I engage literatures, archives, expert interviews and other perspectives across the Anglophone, Sinophone, and Lusophone world which were gathered in China, Brazil, and the United States during 2010 – 2014. I analyze these materials within a world-historical framework that draws on political economy, political ecology, postcolonial and transnational feminist theory in order to historicize and contextualize the seemingly strange geography of the global rare earth frontier. The multilingual approach is central to this project, not least because multiple forms of knowledge are evident in the discourses on rare earth elements in the English-speaking world. More still are present in the Portuguese and Chinese spheres; and there is a symmetrical inaccessibility to the working rationales across language barriers even as these rationales interpenetrate to shape thought and action across global space. The result is that knowledge about rare earths has tended to be formulated reactively during troubled times, and is therefore rife with generalizations within the politically-expedient framing of the given context: among lobbyists and entrepreneurs in Washington, DC, for instance; in the state-run newspapers of Inner Mongolia, or among right-wing policy makers in Brazil.

These multiple sets of knowledge entangle with the ongoing production of the global rare earth frontier, but not necessarily in ways that are precise or coherent. Fictions abound (e.g. Salazar 2011; Lara 2013; Wang 2010); black market and clandestine mining comprise a sizable proportion of the oxides in circulation, and each new deposit is fabled to be the largest discovered thus far. Critical natural resources, prospectors' dreams, and nationalist passions generate a politically potent mix of developmentalist mandates that need not even be attainable in any basic, grounded sense in order to alter the fortunes of empires, to erase a human landscape, or to perpetuate a war, especially when there is money to be made and territory to be claimed as in the cases explored herein. Furthermore, the contingencies of the social—which includes local socionatures, prospecting activities, legal regimes, indigenous and environmental concerns, investment vicissitudes, and (re)productive activities crucial to the global rare earth economy—mean that development and industrialization agendas hardly proceed as planned. It is a mistake to assume that marshaling the capital, technology, labor, and political will to capitalize on the 2010 crisis and actually opening a new site on the rare earth frontier are the same thing, as it is likewise a mistake to assume mandated production policies, particularly those concerned with technological fixes to environmental and labor hazards (cf. Shaiken 1986) actually manifest in practice[21]. As this research shows, *which* deposits are identified as promising and *where* rare earths are mined has less to do with an allegedly exceptional geological incidence than with a host of other agendas and negotiations, which are simultaneously distinct to their own contexts and related across multiple sites.

The first aim, to acquaint the reader with an understanding of rare earth elements, is addressed in the first chapter, which discusses the discovery, use and political histories of rare earth elements, followed by an introduction to the geology and contemporary geography of the global rare earth frontier. As is often pointed out, 'rare' is a misnomer that was identified among specialist audiences over a century ago, yet the term continues in popular, policy, and scientific use. Which elements comprise the group of rare earth elements, in addition to the lanthanide

[21] As discussed in Chapters four and five

series between numbers 57 to 71 on the periodic table, is also something that changes over time according to technological and political imperatives. The geological exploration of rare earth elements is related to *longue-durée* geographies of power and resource conquest, yet as subsequent chapters will show, the geography of rare earth mining is not simply a matter of geological determinism.

The second aim, which is to place the origins and ramifications of the 2010 crisis in the context of global development politics, unfolds over the bulk of the work. Chapters two and three comprise Part I, which investigates the political economic history of rare earth mining across the globe over the mid to late 20th century in order to explain the origins and outcomes of China's monopoly. In Part II, chapter four details how changes in China's recent priorities from global market dominance to domestic conservation precipitated spatial transformations elsewhere, opening new frontiers across the globe. Part III examines the making of new rare earth frontiers in Brazil and the Moon. Chapter five focuses on the domestic dynamics in Brazil to explore the ends toward which multiple actors in Brazil have been working to undo indigenous and ecological protection laws to encourage mining in a historically contested border region shared with Venezuela and Colombia, despite the abundance of more easily accessible deposits in existing mining sites elsewhere in the country. Chapter six turns to the incorporation of extraglobal spaces into the geography of the global rare earth frontier, analyzing the relationship between civilian space programs, private sector start-ups, high profile investors, and international legal conventions instrumental to the push to mine the Moon since 2011. The concluding chapter explains the convergence of Baotou, São Gabriel da Cachoeira and the Moon as three key sites on the global rare earth frontier, and examines the theoretical significance of this new geography for global political economy, political ecology, geopolitics, and postcolonial theory.

This provides the empirical basis for the third aim, which is elaborated in the remainder of this current section and comprises the intellectual agenda and ordering logic for the research. What follows is a discussion of the conceptual and methodological approach[22] taken to examine the contemporary geography of the global rare earth frontier through the three selected sites. The geography of the contemporary global rare earth frontier has its origins in the global developments of the 19th and 20th centuries, yet the *contemporary* geography is forged by decidedly 21st century technologies and politics. This point is important for two reasons: first, the 2010 crisis, and responses, have generally been lacking an historical contextualization of the origins of the present predicaments. There is a general consensus among producers, industrialists, workers and policy-makers across the three sites that the status quo of the global rare earth economy is a problem, but for different reasons For all of the talk around the need for substantive change in how and where rare earth mining is done, state action across the three sites has had the effect of extending, rather than ameliorating, the problems associated with the current status quo. Second, the historical geographic approach draws attention to the concepts and commonsensibilities currently in use to understand global events in China, Brazil and the US, which rely primarily on epistemologies formulated in the context of the (post)colonial and Cold War eras of the 20th century in the Anglophone, Sinophone, and Lusophone literature on the matter (Kitchen 2005 inter alia). Under these framings, it is possible to mistake the current geography of the global rare earth frontier as a natural outcome of geological determinism and

[22] A discussion of the methodological practice and the details is provided in Appendix A.

rational economic choices within a global order defined by US hegemony or China-US bipolarity. Although China, Brazil, and other countries figure prominently in this story, this is not a historical comparison of the sort warned against by McMichael (1992), one which Agnew (1994) would describe as falling into a territorial trap by taking the respective nation-states concerned as the fixed units of analysis. As the three cases demonstrate, there is far more to the story than geological determinism, economic rationality, or the interaction of uniform national interests. .

It is important, therefore, to approach rare earths as both geological and social phenomena. The geophysical, political economic, and discursive properties of rare earth elements are all equally important to understanding their significance to state-making, the global economy, and geopolitics. They play a crucial role in the development of central Inner Mongolia, clarify the disintegration of indigenous and ecological protections in Brazil, and are reviving the space race in an era when US public investment in space exploration varies wildly. I use the material and discursive properties of rare earths as a device through which to examine the global rare earth frontier on multiple spatial and temporal scales: from the bodily to the extraglobal; and from the daily shifts in global commodity prices to the geological cycles of the lithosphere. The purpose of reflexively examining how these processes unfold across three sites is to provide a clearer picture of the 21st century global economy than our 20th century epistemes might otherwise allow (Swarr and Nagar 2010, McMichael 1990, 1992a).

By taking such an approach, I am claiming that the processes shaping Baotou, São Gabriel da Cachoeira, and the Moon: first, have something to do with each other; second, can be understood in critical comparative perspective, and third; that such a perspective raises important new questions about global arrangements of power and production while clarifying the epistemological foundations of the old ones. Adopting a comparative approach does not mean that I am looking at equivalent parts in each site, nor is any site upheld as the 'norm' against which the other sites are measured.[23] Rather, I am examining processes of territoriality, subject-formation, and nation building in the ongoing production of frontier spaces. Examining these processes is not dependent upon, as McMichael (1992a, 352) warned, "*a priori* assumptions in terms of their meaning and scope," but rather views these processes in their specific spatiotemporalities which can, nevertheless, be illuminated by theories of territory, power, and the production of frontier space.[24] There are several names for the type of *qualified* comparative approach advanced herein, which has been used in history, sociology, transnational feminist theory, and critical geography.

Pomeranz (2000) used a *reciprocal* comparison in his work between parts of Europe and parts of China that seemed to be similarly positioned within their relative contexts for his study of 'the great divergence' between 'Western Europe' and the 'Far East' just before the industrial revolution. This approach took care to work beyond the reified units of both the nation state and 'Europe' or 'Imperial China' while remaining attentive to their relevance—as in the relationship between cores and hinterlands, for example. In a reciprocal comparison, all "sides are viewed as

[23] Such approaches characterize the positivist, Eurocentric approach and all of its pitfalls, which have been roundly and rightly critiqued as a misguided way to study human geographies (Gregory 1989, Archer 1991, Cook 1994) and development histories (McMichael 1992a).
[24] See Figure 4: The Frontier Process

'deviations' when seen through the expectations of the other, rather than leaving one as always the norm," (Pomeranz 2000, 8). This helps lift area-focused scholarship out of the traps of determinism, exceptionalism, and state-centrism, also understood as spatial fetishism (Brenner 2004) which is evident in much research on China's history and geography (Han 2009) on Brazil's formation and development (Furtado 1999) and on human activity in outer space (Seedhouse 2010). Pomeranz argues that a reciprocal comparison, or one that moves in multiple directions, "justifies linking what may at first seem [to be] separate issues," (Pomeranz 2000, 9) which are constitutive of larger empirical and conceptual situation.

Baotou, São Gabriel da Cachoeira, and the Moon seem in many ways to be 'separate issues,' but these spaces have been materially and meaningfully transformed through geological exploration in search of rare earth elements as well as contests over the knowledge generated thereby. Geological knowledge about these sites shapes their contemporary political status in the context of ongoing global tensions surrounding rare earths, drawing Baotou, São Gabriel da Cachoeira, and the Moon together into the global rare earth economy. The 'larger empirical and conceptual situation' to which this research is addressed is the global rare earth frontier, the production of which is both ideal and material. The 'global' only comes into being through friction with specific places; through localized encounters of ideas, dreams, power and discipline across difference (Tsing 2005). This is another way of saying that the global is nothing without its local specificities, but nor is this to suggest a simplistic global/local binary. A particular 'global' situation is produced through dialectical entanglements with multiple specific places, driven above all by different kinds of actors interacting at multiple scales, rather than an ephemeral 'global' or place-less class counterposed to hyper-local 'others' (Swyngedouw 1997, Herod 1997, Tsing 2005). If we think otherwise, if we ascribe overwhelming agency to 'global' forces to which we are all subject, then "the local dissolves into ephemeral imagery while the global becomes invisible," (Burawoy et al. 2000). Likewise, it is meaningless to talk about the global rare earth frontier without talking about the places that make it, and the ways that ideas about it then (re)make other places. This is akin to what Tilly (1984) calls an *encompassing* comparison, wherein the sites are considered parts of a larger (dynamic and porous) whole within which they occupy different positions, and thereby shape and are shaped by it.

Wallerstein's (1974) world system theory is foundational to these comparative approaches. His framework explains the rise of Western Europe and the modern capitalist world through the dynamics of accumulation among a world divided into political economic cores drawing from peripheries and semi-peripheries while reaching to incorporate 'external' areas in the quest for continued economic growth. It is within this framework that the *frontier* as a spatial category emerges, but only as something "to be incorporated" (Hall 1989; Dunaway 1996 in Moore 2000) by the totalizing forces of global capitalism. This model explains a capitalist world system based on an international division of labor that determines relationships between regions as well as the labor conditions within each region. This approach facilitated the rationalization of far-flung and vastly different locales into a comparative historical framework in which their differences could be understood in terms of their relative position in relation to the Western European core as the epicenter of the world capitalist system. The problem here is an occasional exceptionalist overreach insofar as the polities of the world outside of Europe are scarcely attributed the agency or sophistication of European states: China was all too often simplistically described as a series of "ancient" or "agrarian empires," with "almost or entirely homogenous" populations whose nation-state formations coalesced in "response" to the West (Hobsbawm 1990), for example.

By the same token, the indigenous empires of South America, unseen by colonial agents except those which lent themselves toward fables of gold and barbarism, remained subordinated in subsequent histories of the area. They have been described as "aboriginal" tribes ruled by warrior-chiefs, rather than, say, city-states presided over by martial princes (Denevan 1966, Heckenberger 2009). Such a framing supposes mutual unintelligibility across civilizations, even with pre-industrial Europe. This discursive casting of Amazonian civilizations as ancient and backward, or "elsewhere in time," (Fabian 1983) was a crucial element in legitimating colonial occupation (Bunker 1984), religious intervention (Warren 2001), slavery (Ramos 1997), genocide (Ruggeri 2006), state custodialism (Rangel 1908), militarism (Albert 1992) and developmentalism (Bolaños 2011). The civilizational complexities granted to pre-industrial Europe were denied Amazonia, even as archeological evidence renders such a standpoint increasingly untenable (Baleé 2006, Heckenberger 2009, Meggers 2003). But if, in fact, "the fragmentation of European states allowed for greater intellectual, commercial, and technological creativity because entrepreneurial or dissident groups could escape to a rival prince," in Europe, (Perdue 2005, 525), how could it be possible that political fragmentation and conflicts in East Asia or South America would not, as a rule, also generate different yet significant sorts of dynamism and change? Yet both Anglophone and Sinophone world-histories tend to 'folklorize' (Jackson 1989) or 'fossilize' (Schrire 1984) advances in astronomy, navigation, horticulture among pre-Colombian Latin American empires, rather than describe them as civilizational accomplishments (Francis, Kense, and Duke 1981, Browder 1995, Chagnon 1983).[25] Although theories and histories relying on the simplification of non-European peoples into homogenous, isolated groups have been thoroughly critiqued as tales "of a world that never existed" (Keesing 1981, 144), this sort of thinking is crucial to the construction of various *–centrisms* that persist across linguistic canons, which then in turn legitimate violence against certain peoples and places in the name of a 'greater good,'—in this case a stable global rare earth supply furnished by large firms. A look at the world from the vantage point of the Mongolian Steppe or the Northwestern Amazon reveals other sets of cores and peripheries, indicating that the ordering logic of such spatial units according to the perspective of colonial capitalist powers of the West is but one of many. All are consequential, but in different ways, to the composition of the global rare earth frontier.

Drilling down beyond Wallerstein's 'center, (semi)periphery, and external' designations in which it could be tempting to organize Baotou, São Gabriel da Cachoeira, and the Moon, my historical analysis is concerned with these sites as frontiers of extraction and waste, as simultaneous hinterlands and ground zeros for the multiple faces of global modernity, and contested zones among states, firms and local alterities. As such, the historical processes through which these sites have been configured into key points along the global rare earth frontier are of

[25] …the latter of which are afforded the status of scientific achievements in historical China. Lusophone world-histories likewise adopt a reverential tone toward "ancient" China while exoticizing indigenous Brazilian inhabitants. There is a proliferation of literature and public debate around the question of un-contacted Indians (*indios sem-contato)* as part of the national patrimony or as evidence of Brazil's enduring backwardness. This is, of course, a generalization to which there are important exceptions. See, for example (Maldi 1998, 1995) who critiques the exoticization of indigenous peoples as a formative element of popular conceptions of Brazilian territory.

central interest. As discussed above, these three sites do not necessarily fit neatly within culturally and politically defined areas demarcated on national maps, nor have people living there capitulated to their prescribed marginality, at least insofar as statist gazes are concerned.

Baotou and São Gabriel da Cachoeira are peopled by those 'other' than the dominant national majorities, while the Moon, legally enshrined as the patrimony of all humankind in fact belongs to no one (Beery 2011, Dickens 2007). Kothari (2006) and Salvatore (1996) among others, have shown that racial othering is crucial to misperceiving places as empty and therefore open for exploitation, while Tsing (2005) *inter alia* has demonstrated that a lack of established private property regimes is sufficient for a space to be constructed as a 'commons' and therefore able to be enclosed upon and put to 'productive' use[26]. Globally, enclosures follow the contours of raced, classed, and gendered systems of oppression, (Federici 2004, Harvey 2003, Mies 1998). Writing respectively on the Han nationalist organization of northern China and the settlement of the Brazilian frontier, Bulag (2002) and Jaffary (2007) among others have demonstrated the centrality of a gendered division of labor among the colonizers in the construction of ethno-national hegemony, and in the problematization of indigenous inhabitants as moral, physical, and sexual threats requiring 'saving' through civilizing activity or 'elimination' through genocide.

Therefore Baotou, São Gabriel da Cachoeira, and the Moon sit in productive tension with current national and regional hegemonies insofar as they simultaneously challenge and yet are crucial constituents of the hegemons. Hegemonies of Euro-American, Chinese, and Brazilian state and corporate actors manifest differently through these sites which sit at the margins of several major powers and are actively produced through local regimes of raced and sexed divisions of labor.[27] When considering the the way the hegemonies of certain powerful actors actually *works* on the global rare earth frontier, it is most useful to consider them not as contiguous across national and global space, but as fragmented and scattered. This draws from Grewal's (1994, 7) concept of *scattered hegemonies* which describes "the effects of mobile capital as well as the multiple subjectivities that replace the European unitary subject." This concept, formulated in the post-Cold War context in which the US was imagined as "the world's only remaining superpower" (Tyler 1992, Gellman 1992, Huntington 1999) challenged the notion of US hegemony as uniformly diffuse across the globe, reigning supreme in all lives everywhere. People in different places work within different matrices of power.[28] The point is that hegemonies differ across space, according to positionality and subjectivity, and this is especially clear in the 'frontier zones,' (Cleary 1993, Redclift 2006) where rare earth prospecting, extraction and conflicting sovereignties have coalesced.

This difference across space and subjectivity generates friction against which totalizing territorial orders address themselves (Tsing 2005) in order to make space 'legible,' (Scott 1998) to the top-down gaze. Rather than seeing frontiers as inert sites of eventual incorporation, which

[26] How this plays out in each site is discussed in Chapters three, five, and six, respectively.
[27] As discussed in Chapter six, the production of outer space is also raced and sexed insofar as the question of *who* is vested with the decision-making power to determine *how* outer space is explored *for the benefit of whom* is inseparable from contemporary power relations which privilege some and foreclose life chances for other on the basis of race, gender, and class.
[28] For example, a minoritized woman in northern China is likely less concerned with the putative ideological supremacy of liberal democratic ideals on the other side of the globe that with the disproportionate power exercised by local Han elite determining whose children go to school and which women are targeted by sex traffickers.

suggests a linear historical transition (Dunaway 1996, Hall 1989) into a global capitalist totality, it is more useful to understand frontiers as crucibles for resource-driven territorial orders. Among the sparks of power and contest, in the thick milieus and sedimented histories of place, the elements of the dialectal production of globalization emerge. The power that seeks to territorialize; the capital that seeks to penetrate, the state that seeks to rationalize: these idealisms encounter friction once they hit the ground, so to speak, of their target sites, where local residents have their own ideas about how to structure and participate in their political economies. Smooth, coherent agendas entangle with local social and biophysical complexities to become something else entirely. As manifest in the three sites, that 'something' tends to be retroactively explained according to the dominant telos of the state and capital, which naturalize enclosure and the imposition of extractive labor regimes within narratives of national and technological progress.

This view, which takes rare earth elements as the material basis for both the hardware and bric-a-brac of contemporary global life[29], encompasses multiple regimes of accumulation and political economic rationales, insofar as they must, somehow, draw on 'natural resources.' In this way, world and environmental histories come together to help explain the strange geography of the global rare earth frontier and its role in global political economy and geopolitics. Such an approach answers Burke and Pomeranz' (2009, 4) call for "a more methodologically self-conscious and integrative environmental world history," to examine how "regionally specific political economies and cultural practices continue to shape the local instantiations of global transformation in the management of nature and society, [or] the developmentalist project." Binding the movements of world history and environmental history are struggles over how "the free gifts of nature" (Marx 1991, 879) are used, to enrich whom, at whose expense. Smith (2007, 26 - 27) notes:

> "…capitalist nature has always been commodified in the sense that naturally-provided use values, whether iron ore or labour power or services such as the ability to transport, are plucked for productive consumption and in turn alter the form of nature: the earth is gouged, soil is colonized, workers are transformed by work…the social provision of sustenance has always involved a certain 'production of nature.'"

Smith continues to specify the sort of productivist impulse under which the production of nature as an industrial input and accumulation strategy takes place: "In capitalist societies, however, the production of nature mutates from an incidental and fragmented reality to a systemic condition of social existence, from a local oddity into a global ambition," (2007, 27). But capitalism does not have a monopoly on this sort of production of nature. It is worthwhile to mention here that a central figure in this research, China's state industrial apparatus, does not envision its resource-driven 'going out' strategy as a capitalist activity (Zhao 2001, Cheng 2011b). In contemporary orthodox political economic thought in China, both the market and globalization are framed as neutral, insofar as they can both work for capitalism and socialism (Yu 2009). In this perspective, the practices of capitalist globalization and the capitalist mode of production are, discursively at least, put in service of a socialist state which is conflated with ethno-national exceptionalism (Hu 2007). Under such a framing, socialist-nationalist politics direct the capitalization of nature on a global scale in order to materially provision the Chinese socialist state (Liu 2012). However strange this view may appear to Euro-American observers, it is nonetheless important to understanding the operating rationales behind the China factor in the

[29] Detailed in Chapter one

global rare earth trade (Lin 2011).[30] Conventional Anglophone epistemes that draw sharp distinctions between capitalist and socialist political economies obscure rather than clarify what is going on here. O'Connor (1988) and Boyd (2001) *inter alia* have shown how the production of nature as Smith (2007) conceives of it is essential to any industrialist regime, not just capitalism. While capitalism orders and structures the interfaces between productivist power and nature, it too can be subjugated, at least conceptually and discursively, to other modes of political economy. The nature of state involvement in rare earth extraction differs dramatically across the three sites, but the exploitation of mineral wealth constitutes in all cases the material basis of history, economics, and politics.

Bunker (1984) critiqued the tendency of industrial theories to neglect the physical dependence of industrial production on resource extraction, as though it were possible to talk about mineral commodities without talking about mining. In some ways, this persisting trend is understandable: mineral commodities do, after all, take on complex lives of their own once they are wrested from the earth, fed into industrial processes, and circulated as commodities. Drawing the lives of commodities and geographies of extraction together, Moore (2000, 410) theorized the link between ecological transformation and the expansionary logic of global accumulation regimes as "commodity frontiers," which captures "the ways in which the production and distribution of specific commodities, and of primary products in particular, have restructured geographic space at the margins of the [capitalist world-system] in such a way as to require further expansion" driven by successive environmental crises. Yet it is not the presence of abundant deposits that determines the geography of the global rare earth frontier. The environmental and epidemiological hazards[31] involved with rare earth extraction means that the commodity frontier must also be a place which can be laid to waste (Bai 2001, Chen 2011b), however much local mining proponents might wish or claim otherwise.[32] Moore's useful concept guides much of this analysis, but where he insists[33] that China was somehow exceptional to or outside of the geoeconomic formation of the Early Modern world (by which he means Europe and the Americas), I endeavor to adopt the standpoint of world history as world history, from which it does not make sense to excise parts of the world while referring to the whole. All world histories are partial; to claim otherwise is to attempt the impossible feat of excising part of the world from itself, yet this tendency is consistent in much literature in both China and the West that seeks to explain the origins of our current global moment. Perhaps this is symptomatic of the geopolitics of sovereign fear described by (Chen 2011a), in which the toxic hazards of production are racially and sexually coded.

This tendency to mean only *parts* of the world when referring to the whole, or to segregate the world into racially coded political economic units is on one hand useful when referring to modes of production and power that reinforce difference and oppression across global space through the division of hazardous labor. The problem lies in taking these units for granted and therefore using historical geographical analysis to reify rather than interrogate their central organizing claims of homogenized difference (Pandey 1992, McMichael 1990). Such an

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[30] Discussed in Chapters two and three.
[31] Examined in Chapter 3
[32] As in the cases of Mountain Pass, São Gabriel, and Greenland
[33] rather groundlessly but in keeping with a tradition of Euro-American centrism in Anglophone world history critiqued by Pomeranz (2000) and Perdue (2005) inter alia.

approach reinscribes a colonial matrix of power and has been critiqued in postcolonial and decolonial theories as:

> "a racial system of social classification that invented Occidentalism (e.g. *Indias Occidentales*), that created the conditions for Orientalism; distinguished the South of Europe from its Center (Hegel) and, on that long history, remapped the world as first, second, an third during the Cold War…[creating] places of non-thought (of myth, non-western religions, folklore, underdevelopment involving regions and people)…[through] the long process of westernization," (Mignolo 2009, 161).

Of course, it is important to recognize the relevance of these units in structuring flows of capital and sovereign desire to transform landscapes and lives in rare earth mining regions. To do so is to see the historical and material continuities of geographical imaginaries in order to acknowledge, for example, that "while colonialism [in Latin America] ended with independence, coloniality is a model of power that continues," in thought, migration, trade, and exploitation (Walsh 2007, 229). Such a standpoint suggests 'de-westernization' as a solution, wherein "de-westernization means, within a capitalist economy, that the rules of the game and the shots are no longer called by Western players and institutions," (Mignolo 2009, 161). The assumption here is that non-Western dominants would conduct themselves in a way that might lead to the emancipation of subjugated peoples. Recent work on the chronic tensions among the BRICS, for example, or the exploitive terms of China, Brazil, and India's 'South-South Cooperation' and other partnerships in Africa, Central Asia, and South America indicates that on the contrary, imperialist extractivism is not the sole domain of the West (Broadman 2008, Oliveira 2007, Alves 2013, Lee 2009). This is the other side of the Eurocentric coin, which likewise reifies East/West divides. Aside from this overreach, the critical race/gender theories driving the transnational analytics of postcolonial theory are crucial to understanding why the global rare earth frontier looks the way it does, pushed into far corners of the world when there are much more accessible deposits closer to the 'cores.'

III. What is the frontier?

As a spatial, temporal, cultural, political, and scientific signifier, the word 'frontier' is used so broadly that it must be carefully defined if it is to serve any useful analytic purpose. Most basically, the frontier implies a limit: the limits of state power and rule of law, of the known and disciplined, and of a set of particular sociocultural relations. Therefore the frontier also implies intentionality insofar as it represents an expression of will to concretize a particular form of power and knowledge across space (Raffestin 1986). Thus frontiers tend to be characterized as zones of legal ambiguity (Haynes 2014) or lawlessness (Evans 2009). While this is sometimes the case, it can also be the case that in situ social relations, property regimes, and governance structures, by virtue of being unknown to distant state or imperial 'centers of calculation'[34] (Latour 1987), are simply misrecognized or ignored by state or imperial agents. This is because accumulation by extra-local actors cannot occur if those same actors do not possess orchestrative control over the land, property relations, and authoritative institutions (state

[34] Latour's concept describes the places in which the production of knowledge builds on the accumulation of resources gathered through imperial, colonial, and capitalist circuits of accumulation. For an overview of its use in geography, see Jöns (2011).

and non-state), so erasing in situ structures becomes the first and ongoing order of business. The (attempted) erasure of deep social logics and relations rooted in a particular place is what Deleuze (1987) describe as deterritorialization. A territorial order cannot be wholly or partially destroyed without another order taking its place, even if that so-called order is violent disorder. The (attempted) imposition of a new order is referred to as reterritorialization, which Deleuze and Guattari argue necessarily follows deterritorialization as two aspects of connected yet spontaneous processes. In either case, the (un)making of frontier spaces is characterized by violence and ongoing political negotiation (Baretta and Markoff 2006).

In cases of the global rare earth frontier wherein the elements in question are imbued with multifarious strategic qualities, "exploration and development has a praetorian cast, a frontier of violent accumulation [and dispossession] working hand in hand with militarism and empire," (Watts 2012, 438). As the historical vanguard of colonial imperial, socialist and capitalist expropriation (Richards 2003), mining marks uneven world-historical processes unfolding across global space but always in distinct local places. Therefore the movement of global "commodity frontiers" (Moore 2000, Moore 2011) implicates limits of another sort: as environmental limits are reached in one place—whether in the form of resource exhaustion, new conservation laws, or severe pollution—extractive interests look elsewhere for new *El Dorados* to conquer.

While it is true that, in the neoliberal era, barriers to extractive investment have diminished generally[35] across the globe, Bridge (2004) demonstrated that the chatter about a foreign investment-driven "bonanza" is inaccurate and ahistorical. Mining and attendant speculation continues to intensify on a global scale, but not in a manner that represents a qualitative break from the pre-neoliberal era. This indicates that mining has historically been fundamental to diverse regimes of accumulation, which supports Moore's insistence on viewing the geography of commodity frontiers in world-historical perspective.

The same can be said for the co-existence and entanglement of 'legal' and 'illegal' forms of mining. Although much has been made of campaigns in both Brazil and China to crack down on clandestine rare earth mining and the black market mineral trade, mining remains a loosely regulated activity in which large-scale extractive interests often collude with or bully the state into writing the laws to permissively govern their activities, often as a matter of exception or at the expense of small-scale and artisanal miners (Lahiri-Dutt 2011, Bradsher 2010d) who are criminalized by pro-corporate statutes. But in truth, mining companies have historically depended on artisanal miners to assume the risks of prospecting and exploration (Hecht and Cockburn 1990), and contemporary down-stream industries in practice do not discriminate between legally and illegally sourced materials—even those from known conflict zones—if the price is right.[36] Therefore the abundance of illegally mined rare earths estimated to be in circulation[37] is hardly novel or peculiar to these particular elements. In addition to viewing mining in world-historical perspective, it is crucial when considering issues of legality in resource extraction to heed critical legal geographers' call to view law as a set of "lived

[35] With specific exceptions in the U.S., China, and Brazil in recent years

[36] Senior Vice President for investor relations of an anonymous Rare Earth mining and processing firm, interview by author, June 2014.

[37] As discussed in Chapter four, illegal rare earth production and export in China is estimated to exceed official quotas by 10% to 40% (Els 2011, Topf 2013).

institutions and relations" in order to examine "how and why law works to perpetuate particular relations of social authority, power, exploitation and oppression," (Chouinard 1994).

That legal mining is often synonymous with corporate mining to the exclusion or attempted erasure of small-scale and artisanal mining should not be surprising. It is a logical outcome of an animating aspect of the expansive accumulationist imaginary, which conceives of to-be-exploited spaces as 'empty' or 'unproductive'. This conception is an important precursor to the reconstitution of space as a commodity frontier. This "frontier of the mind" (Redclift 2006) is key to legitimating all manner of violence against the peoples, environments, and embedded social relations preceding large-scale extractivist intervention. But far from being either empty or erased, this work demonstrates that frontiers have a life of their own that is much more rich and dynamic than the deterministic unfolding of capitalist relations. The findings in subsequent chapters support the arguments of Foweraker (1981), Cleary (1993) and (Sturgeon 2007) among many others, that frontiers are characterized by the co-existence of multiple relations of production. It is this pluralism that is often viewed as the problem to be solved through the rationalization of frontier space.

The rationalization of space is a social project: it is the ongoing projects states and firms to make people and places intelligible in ways that serve accumulationist and governmental objectives. Lefebvre (2009) identifies homogenization, fragmentation, and hierarchization as key processes of this worldwide project. Homogenization is evident in the imposition of similar patterns of spatial organization across vastly different spaces.[38] While Lefebvre was referring to highways, airports, and other features of the built environment that are identical even at antipodes, Poulantzas identified how the state homogenizes both space and time in the process of demarcating frontiers "…when it constitutes what is within (the people-nation) by homogenizing the before and after of the content of this enclosure," (Poulantzas 1978). Fragmentation is an act of power that segregates and compartmentalizes in order to impose control. This manifests in the frontier process wherein a space is interpellated as 'frontier' in order to be carved out of its organic and shifting expanse and then made into something else, as in the northwestern Brazilian Amazon or the Mongolian Steppe: two territories historically peopled with mobile polities spanning past and current states. Hierarchization is evident in the spatial division of labor, power, and vulnerability of which the production of frontier regions is one necessary outcome.

The frontier is conjured in order to be spectacularly destroyed; its environments mythologized in order to be pillaged or policed; its inhabitants exoticized or vilified in order to be minoritized or murdered. Frontiers, once brought to order through settlement, infrastructure construction, or militarization, can be reconstituted by the state: in other words, remade as hinterlands or the peripheral regions from which the 'cores' draw their resources (Pomeranz 1993, Lefebvre 2009).[39]

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[38] For example, the repetition of a particular urban form from Southern California (Soja 1996) to urbanizing Inner Mongolia by way of Beijing (Gaubatz 2008).

[39] Yet it is because of the multiple meanings of this term and the way in which it works intimately within scientific thought, technological development, ethnonational projects and capital mobilization that this work concerns the geography of the global rare earth frontier, rather than the global rare earth 'economy' or 'politics.' Because of the diverse applications and incidence of rare earth elements, there is no singular rare earth 'economy' to speak of, while the politics of rare earth are inseparable from the spatiality of their exploitation.

Figure 4: Theories and Descriptions of the Production of Frontier Spaces

Moon	Problematization ↓ Exploration	Interpellation	The frontier signifier implicates a gaze from elsewhere. As Tsing (2005) notes, it is an imaginary place forcefully conjured into being by extra-local power endeavoring to exercise power across friction of distance. Therefore the frontier must be enacted, but before it is enacted it must be conceived as a space of problems, threats, or opportunities. Fictions and speculation abound. Thus frontiers are problems to be solved, whether in the form of resources to be captured, places and people to develop, unruly economies to discipline, knowledge to acquire, threats to neutralize, or weak borders to enforce.	*l'espace conçu* ↕	Lefebvre (1991)
Saõ Gabriel da Cachoeira	↓ Exploitation ↓ Exhaustion	Intervention	Once problematized, labor, technology, and institutions are marshaled to solve the problems conjured by the extra-local power; exploring and exploiting *ad infinitum*. The relationship among these steps is iterative, wherein the problematization of frontier space necessitates both intervention and exploration in order to define and legitimate interventions on an ongoing basis. Whether in the name of extraction, development, or national security, there comes a time when projects end, resources get exhausted, market conditions shift, pollution thresholds are surpassed, and/or local groups succeed at advancing claims to control their space on their own terms. This may stimulate fresh attempts at problematizing space, or extra-local interests (be they states, militaries, firms, or development organizations) may direct their efforts elsewhere.	*l'espace perçu* ↕	Deleuze (1987) / deterritorialization ↓
Baotou	↓ Unmaking ↓ Remaking	Continuation	Where the intervention has diminished or ceased, life goes on. The space does not return to some imagined pre-intervention state, but local economies and *in situ* socionatures continue to evolve and adapt as residents go about everyday life. This is consistent with Foweraker's (1981) critique of the tendency to take extra-local interests at their word in the characterization of frontier space, at the expense of local political economies that precede, succeed, and dialectically produce the specific form and substance of a frontier signifier. This is not to diminish the transformative power of the interventions described above, as ample literature on post-frontier (Cleary 1993) and post-development spaces (Sidaway 2007) attests, but to specify the temporary character of the frontier signifier. As the cases herein show, a place may be successively (re)configured into multiple types of frontiers over time, as extractive and territorial interests assign new problems and potentials to these places.	*l'espace vécu*	reterritorialization ↓ assemblage
	a	b	c	d	e

The table depicts (a) iterative, (b) periodized, (c) narrative, (d) Lefebvrian and (e) Deleuzian spatial dynamics useful for characterizing the frontier processes examined in this study. While there is fluidity among these depictions, each has a slightly different emphasis. (a) emphasizes the iterative steps in (un)making of resource frontiers, particularly that frontiers do not exist *a priori* but emerge through the problematization of space; (b) emphasizes the temporary and interventionist character of the frontier signifier, it is imposed in a particular place, rich with social meanings that precede and succeed specific interventions; (d) conveys Lefebvre's (2011) conceptual triad which emphasizes that the production of space is both material and ideal; it is conceived, perceived, and lived. *L'espace conçu* refers to instrumental and imagined space of logic, maps, and planners. *L'espace perçu* is the perceived, physical space that is used and manipulated. *L'espace vécu* refers to the both material and ideal, real-and-imagined space that is produced over time, through practice, and infused with meaning. (e) is aligned with the iterative process (a) from exploitation to remaking to convey Deleuze and Guattari's argument that a spatial order cannot be imposed without subjugating that which came before, yet the imposition of one order does not obviate the preceding. This results in a territorial assemblage characterized by multiple social orders struggling over meaning and control of space. The temporal differences among the three primary sites examined in this work are conveyed on the left side of the table, with the Moon, São Gabriel da Cachoeira, and Baotou corresponding with different moments of becoming in the frontier process.

As such, frontiers are not ontological givens: they are epistemological constructions conjured into being by an extra-local power reaching across time and space (Tsing 2005). They are produced as an orienting device to direct expansionist aims, differentiating sites of imminent colonization (or de/reterritorialization) from the expanse of *terra incognita*. State strategies to rationalize frontier spaces into the 'national geo-body' (Thongchai 1988) tend to involve imposing borders to concretize hegemony and delineate the extent of state power and coercion while producing a hinterland within the newly bounded territory in order to reorient local (re)productive activities toward the enrichment of the state.

As a term that is meant to provoke or problematize, the frontier is necessarily a temporary signifier, invoked precisely because it is meant to be subsumed. A successful frontier project inevitably exhausts itself whether by local resistance (Scott 2009), resource depletion (Moore 2011) or the homogenization and integration (Lefebvre 2009) of local culture and territory into a larger national polity. The remainder of this section first clarifies the relationship among these terms: frontier, border and hinterland, and then probes the developmentalist, biopolitical and geopolitical efforts exerted in the production of such spaces.

Rare earths and frontiers, borders, and hinterlands

Flights of fancy are typical of the production of frontier spaces. Such spaces are seldom as 'wild' nor as 'rich' as frontier fantasies would claim, even those drawing upon official statistics. The persistent myth of rare earths' 'rarity' amplifies the discursive power of the frontier signifier; the combination of these two loaded terms in recent years has revived deep cultural imaginaries of bold, even mercenary, exploration of far-flung and perhaps dangerous places in pursuit of treasure (e.g. Fulp 2012). Just as the myth of rare earth scarcity is invoked to legitimate far-out prospecting activities, the 'frontier' is invoked to recast a given space in terms of riches to be captured and a problem to be solved. The frontier as a zone in which the known and governed fades into the unknown and ungoverned is simultaneously its defining characteristic, the 'problem' to be solved by non-local interests, and the irresistible opportunity at hand. In this way, the invocation of the rare earth frontier involves a geopolitical *project* of some sort.

Border-marking is a critical component of the frontier project insofar as it represents an effort at greater precision: the frontier may be a zone, but a border is a line. Borders represent inward assertions of the physical boundaries of 'imagined communities' (Anderson 2006) and outward assertions of geopolitical power. They are markers of political and economic difference imposed across space (Brown 2010; Weizmann 2007). Because both frontiers and borders tend to be produced through a gaze from elsewhere, their very production is an act of both incorporation and peripheralization: As the cases of China and Brazil will show, it takes quite a bit of violence across multiple generations, and in the context of massive in-migration, to inculcate a frontier subjectivity in local inhabitants, to propagate the profoundly alienated sensibility that the native soil on which one stands is somehow 'distant' or 'peripheral' as well as fundamentally different than the soils nearby, occupied by one's kin, but nevertheless on the other side of the border. This cognitive-cultural sleight requires that local inhabitants reconceptualize their central political economic sensibilities as subjugated to a larger territorial order, ordered in the cases of São Gabriel da Cachoeira and Baotou according to a geologized governmentality (Braun 2000) imposed by a distant yet locally proliferated central state.

What is (un)known and (un)governed about a designated frontier space is defined not by local polities but by far off powers; hence the boundaries between (un)known and (un)governed tend to cleave along racial and cultural lines. The project of concretizing this line in the form of a border generates ambiguities and violence across competing sovereignties. In the northwestern Amazon as well as on the Inner Mongolian Steppe, the history of border-marking and resource extraction has been 'written in blood' (Pinheiro 1995, Mote 1999), characterized by struggles between Luso-Brazilian and Han Chinese colonizers on one hand, and indigenous peoples on the other. It is atop such histories of contestation that rare earth reserves have been be framed as part of the national patrimony in China and Brazil despite the concentration of benefits in the hands of a few, and their illegal or unsustainable exploitation for export framed as a crime against the citizenry (as in China), or as evidence of an ineffective state (as in Brazil).

The invocation of collective interest is hardly peculiar to rare earth extraction; the justification for sacrificing *in situ* socionatures is consistently framed in terms of a 'greater good' (Fox 1999). In Brazil and China, the case for rare earth mining is made in nationalist terms, while in outer space, where assertions of national sovereignty are forbidden, resource exploitation is framed as a necessity for 'all humankind'(ME 2013). The very absence of borders in 'the final frontier' is a central problem for private outer space mining enterprises, which have enlisted the expertise of legal scholars since the mid-1990s (Lewis 1996) in order to develop a property-rights regime for the privatized exploitation of outer space (Al-Rodhan 2012). Without clear borders for mining concessions and a secure private property regime, private investors claim they have little incentive to exploit off-Earth resources (Wells 2013, Anonymous 2012).

The cases will further show how convergence of the drive to mine rare earths and the urge to territorialize difficult regions has resulted in a opportunity for symbiosis between capital and the state with important geopolitical consequences, not least because access to these rare earth deposits is contingent upon a three-part process: (i) possessing a stable, hegemonic claim to the soils containing economic REE deposits; (ii) establishing or retrenching borders in order to keep out competing claims and interests, and; (iii) deploying cultural and political processes of subject formation within and in relation to these locales in order enlist the populace in the project of enforcing the hegemonic claims to the land and resources in question. What is key here is that the strange geography of the global rare earth frontier is driven by a host of other agendas, formulated according to resource-driven geopolitical ambition directed toward the so-called 'extreme' peripheries of Inner Mongolia, the northwestern Brazilian Amazon, and the Moon.

The purpose of imposing a border is to assert a sovereign claim over a given space, and the resources therein. In the case of commercial mining enterprises, resources are almost never consumed on site in their final commodity form (Baldwin 1956).[40] Such spaces are generally known as hinterlands, which are the prize of frontier-taming and border-marking activities.

[40] For a discussion of how artisanal mining practices differ and interact with large-scale commercial mining enterprises, see Hecht and Cockburn (1990), Lahiri-Dutt and MacIntyre (2011), and Hinton, Viega, and Beinhoff (2003).

Taming a frontier and reorienting local (re)productive activities for the enrichment of the state or other centers; hinterlands are national, urban, and commercial necessities. Like frontiers, the hinterland designation implicates a vantage point from elsewhere: if not a self-proclaimed center, then an urban or commercial space (cf. Pomeranz 1993). As population flows condense within (sub)urban centers of spectacular consumption (Debord 2006) glittering with flat screens, ringing with smartphones, and ensconced within the durable steel-alloy architecture all of which depend on rare earth elements, the land and resource area needed to sustain high-technology consumption expands. Although as this geography of the global rare earth frontier indicates, resource hinterlands are not contiguous features of centers of accumulation: they are scattered across the globe.

Development and biogeopolitics on the rare earth frontier

Development is seldom undertaken for its own ends, and in the historically fluid territories of Inner Mongolia, São Gabriel da Cachoeira, and the Moon, extraction-driven development serves important geopolitical purposes beyond the explicit value attributed to rare earth elements. As each of the cases will show, the potent discursive combination between the frontier signifier and the mystique of rare earth elements serves a host of territorializing agendas which lacked political will prior to the emergence of rare earths as strategic elements.

Some definitions are necessary before proceeding. By geopolitical, I refer firstly the conventional notion concerned with the balance of power among states, for which establishing a sovereign national territory is a precondition for credible state sovereignty. But the geopolitics of the global rare earth frontier are about much more than conventional notions of state power: I also mean 'geopolitical' in the manner proposed by Hyndmann (2001, 210) which is concerned with "examining politics at scales other than that of the nation-state; by challenging the public/private divide at a global scale; and by analyzing the politics of mobility…" Because of the difficulty, hazards, and questionable urgency of rare earth mining in these particular regions, contemporary rare earth discourses deployed by the states, militaries, and firms[41] have endeavored to frame rare earth mining as a matter of national and human survival to audiences within 'centers of calculation' (Braun 2000, 17). That the feasibility of mining in each of these sites has been predicated on destruction of human and environmental health requires a very particular framing of human and national survival in order to mobilize labor and quiet local claims for production on different terms.

One way to understand the public/private divide and the politics of mobility is through the Foucaultian concept of biopolitics, insofar as "the basic biological features of the human species become the object of political strategy, of a general strategy of power," (Foucault 1978).[42] According to Federici (2012), the public/private divide refers to the violently-enforced

[41] …in each of the sites examined herein

[42] Although Foucault formulated his concept of biopolitics in relation to a particular historical period in parts of Europe, several (e.g. Lu 2007, Werneck and Rotania 2004, Greenhalgh 2009, Salter and Waldby 2011, Guzmán 2013, Sampaio and Wortmann 2014) among others have shown that the concept is useful for characterizing technologies of state power in Brazil and China. In each of the analyses, the authors are careful to distinguish the historical and geographical specificity of the contexts in which they conduct biopolitical analyses. In other words,

difference between paid and unpaid labor in maintaining economic status quos. Because reproductive work is generally devalued, considered a private matter and women's responsibility, the public/private divide is gendered, with men traditionally performing alienated labor in exchange for wages, on which women depend to sustain their unpaid reproductive labor. This has historically translated into marking men and women respectively as legitimate and illegitimate agents of political and economic life. This division of labor in society does not stop at gender: Guillamin (1995) has shown that such a division is also characterized by the imposition of racially-coded difference between hegemonic self and subaltern other, with its spatial corollaries of core and periphery, capitol and frontier, and metropole and hinterland. According to such grids of intelligibility, the risks and benefits of rare earth mining and processing have been unevenly distributed among bodies and across space.

In the frontier regions examined herein, this is intricately related to the politics of mobility insofar as the states and firms concerned recruit, constrain, and exclude people on the basis of (un)desirable characteristics in relation to large-scale rare earth extraction. These (un)desirable characteristics have been formulated on the basis of raced, classed, and gendered designations codified into law and enforced in everyday practice through the proliferation of institutional, economic, and cultural strategies.[43]

The historical antecedents to the transformation of these sites into rare earth frontiers were characterized periodically by 'sovereign power' and 'necropolitics' (Agamben 1998, Mbembe and Meintjes 2003). As a result of decades of local and transnational struggle, the states studied herein have refocused their territorial strategies in the regions studied through the technologies and approaches recognizable as biopolitics.[44] In cases of Brazil and China, this is most conspicuous in the switch from genocidal to developmentalist approaches, including cultural campaigns and securitization on the rare earth frontier. This work demonstrates, among other things, that the biopolitics and geopolitics cannot be neatly separated in the production of the global rare earth frontier: biopolitical techniques of subject formation are deployed as part of a geopolitical agenda framed as development.

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using Foucaultian theory to analyze Inner Mongolia or Amazonas is in no way meant to suggest that the same conditions prevail in these places as in modern Europe. Rather, the concept is applied because it is useful for identifying process and dynamics of power at a certain level of abstraction.

[43] Examined in detail in Chapters Two and Five

[44] Mbembe formulated the concept of necropolitics because he found Foucault's idea of biopolitics—assemblages of disciplinary apparatuses concerned with the formation of proper subjects—inadequate to explain the forms of subjugation emergent in many parts of the world in the wake of the 2001 attacks on the World Trade Center in New York and the launch of the so-called 'war on terror.' Without disputing Mbembe's application of this term to specific 21st century instances, I maintain that it is useful to understand the massive, intricate, and intimate technologies of destruction deployed in other times and places, and which historical events have shown necropolitics not to be the end of the story. I have discerned in objections to this abstracted and historically-qualified use of the term an unexamined investment in a linear notion of time with respect to conditions of social existence, as if the era of necropower is now upon us because biopower was not bad enough, what comes next is apocalypse, and there is no 'going back' from here. To the contrary, the cases herein (and, I might add, Mbembe's example of contemporary colonial occupation of Palestine also) illustrate that even in the horror of 'death-worlds,' people are still living and do still organize themselves in such a way as to subjugate the necropolitical predilections of contemporary power. Biopower appears to be a state compromise when necropower becomes untenable.

Development is seldom undertaken for its own ends. In the historically fluid territories of Inner Mongolia, São Gabriel da Cachoeira, and the Moon, extraction-driven development serves an important geopolitical purpose beyond the discursive value attributed to rare earth elements. As each of the cases will show, the potent discursive combination between the frontier signifier and the mystique of these resources, serves a host of territorializing agendas which lacked sufficient political will to execute prior to the emergence of rare earths as strategic elements.

Like frontiers, borders and hinterlands are problematic spatial units. The people living in these areas have been iteratively problematized by those naming these spaces from afar, further complicated by the fact that such spaces are neither static nor strictly within to domain of the state, the people, or the firm. These three terms are therefore spatial signifiers, connoting a reconfiguration of spatial relations through: peripheralization through extra-local interpellation; the production/destruction of difference, and; a reorientation of local (re)production to serve the state or the metropole. The physical manifestations of this effort—infrastructure construction, industrialized resource extraction, monumentality—cannot proceed apart from the social dimension, which includes interpellation, migration, and frontier subject formation.

Interpellation is practiced on the inhabitants of the region in question as well as those mobilized to transform it. The people that live within these regions, when they are not simply taken for some primeval part of the landscape, are imagined as 'less than' urban inhabitants; they are cast as underdeveloped and placed elsewhere in time (Fabian 1983). As noted above, their polities are 'tribal' and not 'national;' this designation serves, among other things, the formation of an interventionist 'developmentality.' This is an adaptation of the Foucaultian notion of governmentality, and refers "to the organized discourses and programs that render subjects and spaces developed…[and] some subjects and cartographies underdeveloped" (Quan 2012, 25). In the developmentalist gaze, 'underdeveloped' spaces and people are in such conditions because they do not have the means to develop themselves, held back by climate, tradition, or ignorance. It therefore becomes imperative, as in the cases of Baotou and São Gabriel da Cachoeira, for the developmentalist state to 'improve' the land and its peoples through industrialized mining, generally as a matter of vital importance to the state (Fei 1986, Li 2007).[45]

Baotou, São Gabriel da Cachoeira, and the Moon emerged as different points along the global rare earth frontier at different times. But before their present status, they were frontiers of another sort. Their respective histories are crucial to understanding the strange geography of the global rare earth frontier in light of the relative ubiquity of rare earth elements. Because the temporalities differ among the three sites, different aspects of this process are definitive of contemporary Baotou, São Gabriel da Cachoeira, and the Moon and likewise, there are differing degrees of information available about them.[46] Nevertheless, the history of these spaces preceding their (re)production as points along the global rare earth frontier figures significantly, especially insofar as it sets the terms for the interventions of capital and the state. Contrary to the conceits of power, too often uncritically reproduced in contemporary discussions of industrial development and nation building with respect to rare earth elements, it is the local material histories—a combination of geological knowledge, polity, and history—that set the terms for intervention in dialectical tension with global political economic change.

[45] I explore the particular forms taken by these processes in-depth in Chapters three, five, and six.
[46] This difference is reflected in the structure of the dissertation and is further discussed in Appendix A.

Conclusion

Chapter one introduces the history, significance, geology and geography of rare earth elements. Drawing on national archives, interviews, and field visits in China, Brazil, and the United States between 2010 - 2014, the subsequent chapters present findings on the origins of China's rare earth monopoly, the constitution and evolution of China's domestic rare earth industry leading up to the recent quota system, and the manner in which changes in China's domestic production practices are reshaping the global rare earth frontier, as exemplified by São Gabriel da Cachoeira and the Moon.

In the process, I advance three claims about the contemporary geography of the global rare earth frontier. First, the contemporary geography of the global rare earth frontier is driven by more than geological determinism: although each of these sites are rich in rare earth elements, they are also historically contested regions and focal points for (post/neo)colonial, nation building and geopolitical agendas, for which a nationalist mandate for rare earth extraction provides a convenient pretext. Second, the contemporary geography of the global rare earth frontier is driven by the intersection of political, economic, and geological rationalities within a context of acute environmental hazard. Third, it is both the material properties and strategic value of rare earth elements that accounts for the seemingly strange geography of the global rare earth frontier, the production of which is intertwined with contests of territoriality, power, and difference on multiple scales. As such, the dynamic geography of the global rare earth frontier is a spatial transcript of the movement of power and vulnerability; a crucible of state formation; a vehicle for pursuing various geopolitical agendas, and a pedagogical tool for the production of spatially-bounded difference insofar as valuation of rare earth endowments reconfigures the relationship between local inhabitants, legal conventions, capital, and the state in service of raced, classed and gendered regimes of labor and sacrifice.

Chapter One

What are Rare Earth Elements?

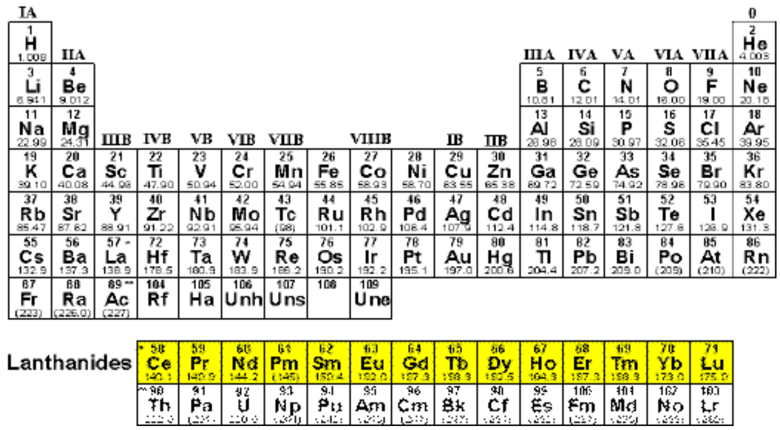
"These elements perplex us in our searches, baffle us in our speculations, and haunt us in our very dreams. They stretch like an unknown sea before us—mocking, mystifying, and murmuring strange revelations and possibilities."

Sir William Crookes, February 16, 1887

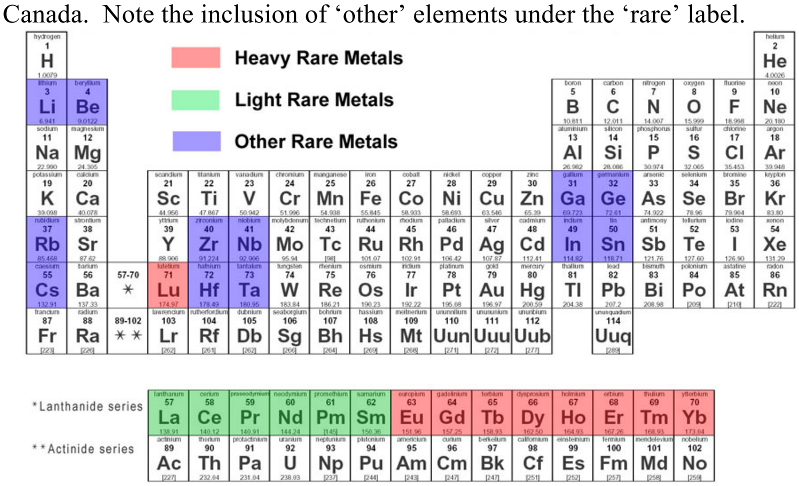
"Rare earths: neither rare, nor earths."

BBC World Service, March 23, 2014

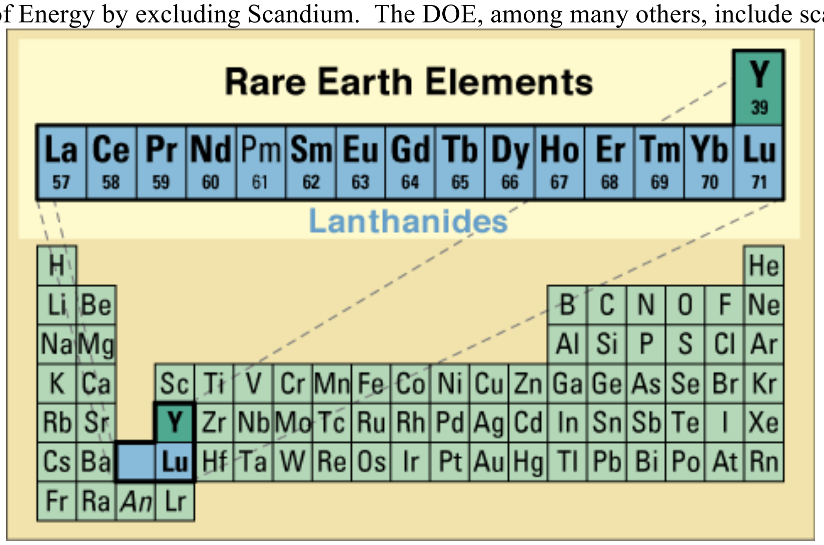
Figure 5: Various periodic tables with rare earths indicated. The term rare earths refers primarily to the lanthanide series, shown in the table below from the International Union of Applied and Pure Chemistry.



The table below is from a mining company with lithium, tungsten, and uranium projects contending to break into the rare earth market in Canada. Note the inclusion of ‘other’ elements under the ‘rare’ label.



The table below is that used by the United States Geological Survey. It differs from the table used by the United States Department of Energy by excluding Scandium. The DOE, among many others, include scandium.



The differences among the tables illustrate the flexible designation of rare earth elements as technology and politics change over time. Sources: The International Union of Pure and Applied Chemistry (2011); Aben Resources (2012) and the United States Geological Survey (2005).

Figure 6: Timeline of Major Developments in the History and Politics of Rare Earth Elements

1639 Portuguese explorer Pedro Teixeira surveyed São Gabriel da Cachoeira

1695 Carmelite missionaries established a religious settlement at São Gabriel da Cachoeira under orders from the Portuguese crown

1788 Unidentified rock found by miner in Ytterby, Sweden

1789 Johan Gadolin discovers Yttrium

1789 Uranium discovered by Martin Heinrich Klaproth

1794 Rock identified as new type of 'earths' and named Gadolinite after discoverer, Johan Gadolin

1802 Tantalum discovered by Swedish chemist Anders Gustaf Ekberg

1804 Cerium discovered independently in Bastriäs, Sweden by Jöns Jakob Berzelius and Wilhelm Hisinger and in Germany by Martin Heinrich Klaproth

1808 Electrochemistry, a field which studies chemical reactions occurring at an electrode interface, succeeds at isolating certain rare earths from their compounds Sir Humphrey Davy pioneered techniques in electrolysis using a voltaic pile - the first electrical battery that could provide continuous electrical current to a circuit - to split common compounds He later damaged his eyesight in a laboratory explosion, which compelled him to hire Michael Faraday as a lab assistant He gave popular public lectures where he demonstrated the physiological action of certain gases, including nitrous oxide, on his poet friends Samuel Taylor Coleridge and Robert Southey

1828 Yttrium isolated in relatively pure form by Friedrich Wöhler

1829 Thorium, discovered by Jöns Jakob Berzelius

1839 Lanthanum discovered by Swedish chemist Carl Gustav Mosander

1841 Uranium isolated by French chemist Eugene-Melchior Péligot

1843 Terbium discovered by Swedish chemist Carl Gustaf Mosander

1843 Erbium discovered by Swedish chemist Carl Gustaf Mosander

1846 Niobium discovered by Heinrich Rose, Doctoral student of Jöns Jakob Berzelius

1878 Holmium co-discovered independently by Swiss chemist Marc Delafontaine and Jacques-Louis Soret and Swedish chemist Per Teodor Cleve

1878 Ytterbium discovered by Swiss chemist Jean Charles Galissard de Marignac

1879 Scandium discovered by Lars Frederick Nilson

1879 Thulium discovered by Swedish chemist Per Teodor Cleve

1879 Samarium discovered by French chemist Paul Émile Lecoq de Boisbaudran

1880 Gadolinium discovered by Swiss chemist Jean Charles Galissard de Marignac

1885 Carl Auer van Welsbach patents gas mantle lantern which used a mixture of thorium, magnesium oxide, lanthanum oxide and yttrium oxide First commercial application of thorium

1885 Carl Auer von Welsbach separated didymium into two elements, discovering praseodymium and neodymium

1886 Dysprosium discovered by French Chemist Paul Émile Lecoq de Boisbaudran while working with holmium

1887 Monazite sand mining on the beaches of North and South Carolina by British Mining interests

1896 Radioactivity discovered by French scientist Henri Becquerel

1898 Marie Curie discovers radioactivity in thorium and uranium

1901 Samarium isolated in relatively pure form by Eugéne-Anatole Demarçay; no direct application until nuclear age, when it was added to nuclear control rods as a neutron absorber

1901 Europium isolated and named by French chemist Eugéne-Anatole Demarçay

1902 Relatively pure sample of tantalum isolated by German scientist Werner von Bolton

1903 Tantalum used in filaments for incandescent light bulb in 1902

1905 German Thorium Syndicate begins exploiting monazite placers in Brazil

1905 High-purity niobium produced by Von Bolton

1907 Lutetium independently discovered by French scientist Georges Urbain, Austrian Carl Auer von Welsbach, and American Charles James

1909 Austrian Welsbach Company begins exploiting monazite placers in India

1911 Thulium isolated in nearly pure form, after 15,000 attempts by New Hampshire College chemist Charles James

1914 English physicist Henry Moseley hypothesized that rare earth separation might shed light on nuclear fission; confirms that lanthanide series consists of 15 elements, no more and no less, even before the discovery of promethium

1923 Lanthanum isolated in relatively pure form

1925 Neodymium isolated in relatively pure form; first commercial application two years later to create highly prized decorative glassware by Mose Glass Company

1927 Northwestern Scientific Expedition departs Beijing for Inner Mongolia

1933 Geologist Ding Daoheng publishes his findings on the iron deposit at Bayan Obo

1933 Niobium used for stabilizing stainless steel

1935 Niobium used as constituent of superalloys

1936 14 November, Japanese-backed Mongolian army unsuccessfully invades Suiyuan in an effort to gain control over mineral resources at Bayan Obo

1939 German scientists Hahn and Strassman discover neutron-induced nuclear fission of uranium and identified rare earth elements in fission products; Outbreak of WWII

1940 Frank Spedding develops ion exchange technique, which allows several (terbium, dysprosium, lutetium) elements to be isolated for the first time

1940 British and Allied embargoes halt German imports of Brazilian monazite

1941 Frank Spedding joins Manhattan Projects Using his ion exchange technique, his research team in Ames, Iowa produced over two million pounds of high-purity uranium between d1941 and 1945

1942 The USSR opens a rare earth-uranium-thorium mine and processing plant in Ak-Tyuz, Kyrgyzstan, shortly after Stalin received word that Allied Powers were developing a nuclear weapon

1942 Tantalum added to anti-tank projectiles for use during WWII

1943 Rare earth reserves at Bayan Obo iron deposit demonstrated by chemist He Zuolin

1944 Union Carbide, in cooperation with the Manhattan Project scours the globe and all available technical literature in any available language to determine the best sources of rare earths, thorium, and uranium

1945 Promethium produced and characterized for the first time at Oak Ridge National Laboratory by separating and analyzing fission products of uranium fuel irradiated in a graphite reactor

1947 Inner Mongolia Autonomous Region established in coalition with communists to fight Republicans

1948 India's Atomic Energy Act prohibits the export of thorium-rich monazite sands

1948 US Department of State attempts negotiating with China's Republican Government to obtain rare earths, thorium and uranium from China

1949 Mountain Pass, California rare earth mine discovered by uranium prospectors

1951 Sino-Soviet urbanization and industrial development plan begins in Baotou, Inner Mongolia

1952 United States resumes rare earth production for first time since 1915

1953 Ytterbium first isolated, allowing its precise chemical and physical properties to be examined

1956 Fifth Academy of the National Defense Ministry, home of China's earliest space and long-range missile development programs, established

1956 Xu Guangxian, research professor of chemistry at Peking University, joins China's nuclear efforts

1957 Third National Women's Committee Congress in Baotou passes resolution to mobilize women to work in industries of national strategic importance, including metallurgy and arms production

1958 Huge pyrochlore (niobium-rare earth) deposits discovered in Araxá, Brazil

1958 Niobium microalloyed HSLA steels developed for high-pressure pipelines

1959 Journal of the Less Common Metal launched

1960 Scandium isolated for first time; subsequently used in aluminum alloys in military aircraft

1963 Ministry of Metallurgical Industry establishes Baotou Research Institute of Rare Earths

1964 16 October, China's first nuclear weapons detonation

1967 The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, entered into force

1969 First lunar rock samples brought back to earth

1971 Rare earths identified in lunar rock samples from the western lunar highlands

1972 Rare earth-niobium-coltan reserves identified at Morro dos Seis Lagos in São Gabriel da Cachoeira

1973 Xu Guangxian develops the cascade theory of countercurrent extraction, which achieved praseodymium and neodymium concentrates of 99999% purity

1973 The Brazilian Army's 21st Engineering and Construction Company, with the Battalion of the Caicó Highway, relocated to São Gabriel da Cachoeira to initiate regional infrastructure and industry construction and to train local indigenous mercenaries in defense against communist guerillas

1974 Xu Guangxian travels to Inner Mongolia to implement his theory on an industrial scale at the Number Three Baotou Rare Earth Factory

1975 August, Xu Guangxian announces theory and industrial application of cascade countercurrent extraction, signaling the beginning of China's technological superiority in the rare earth sector

1975 Official date of Geological reconnaissance project RADAM-BRASIL survey of São Gabriel da Cachoeira

1978 Deng Xiaoping announces China's 'Open Up and Reform' policy

1984 Scandium lasers developed for US President Ronald Reagan's Strategic Defense Initiative (SDI – frequently referred to as Star Wars)

1986 Geochemical analyses of lunar rock and meteorite samples containing rare earth elements first published in domestic Chinese scientific journals

1987 Yttrium barium copper oxide discovered to achieve superconductivity above the boiling point of nitrogen – important for maglev trains, among other things

1992 Deng Xiaoping makes oft-quoted statement "The Middle East has oil; China has Rare Earths"

1997 US Food and Drug Administration approves Samarium-containing anti-cancer drug Quadramet

2000 China imposed rare earth export quotas

2003 Tantalum reported by United Nations to fuel conflict in the Democratic Republic of the Congo

2004 Magnequench, supplier of 85% of neodymium-iron-boron magnets used in cruise missiles and smart bombs, closed its last remaining facility in the US and moved production to China

2007 Google Lunar X Prize announced

2011 Brazil's Ministry of Science, Technology, and Innovation jointly hosts first national seminar on rare earth elements with the Ministry of Mines and Energy

2013 April, approximately 700 indigenous people and allies occupy House of Representatives in Brasília to halt a constitutional amendment that would give Congress exclusive authority to modify the boundaries of indigenous lands

2013 December, China launches Jade Rabbit lunar rove to conduct selenological surveys The rover contained over a thousand components composed of domestic rare earth alloy technology that had been developed exclusively for the space program

2014 WTO special panel rules that China failed to demonstrate that production and export quotas were imposed for environmental reasons

2015 January, China eliminates export quotas

2015 February, US Federal Aviation Administration issues memorandum coordinated with Department of Defense, State Department, Department of Commerce and NASA stating federal support for private property claims made by US citizens in outer space

Industrial Phases

1891-1930	First phase of industrial usage for rare earth elements characterized by lighting, glassware, and pyrophoric applications
1930-1963	Second phase of industrial usage for rare earth elements characterized by military, aerospace, and nuclear applications Significant advances in alloying technologies
1964-1980	Third phase of industrial usage for are earth elements, inaugurated with the Yttrium oxide-sulfide activated europium phosphor, which produced red color for televisions
1980-Present	Fourth phase of industrial usage for rare earth elements, characterized by the use of permanent magnets in information, military, medical, and transportation technology; Internet infrastructure, and advanced energy and consumer electronics applications

Major Production Phases

1887 - 1960	Monazite placer era of global rare earth production, concentrated on the coasts of Brazil, the Southeastern United States, India as well as in Idaho
1960-2000	Mountain Pass era of global rare earth production dominance
2000 - Present	Bayan Obo era of global rare earth production dominance

I. What are rare earth elements?

"In a way," writes Abraham (2011, 101), "it begins with semantic confusion." Rare earths are not rare; the name says more about their scientific beginnings than their actual qualities. In 1788 a miner in Ytterby, Sweden, found a strange black rock which was identified in 1794 as a new kind of 'earth,' which is an archaic reference for acid-soluble elements[47] (Rowlatt 2014). Since it had not been found anywhere else, it was presumed to be scarce. Hence the name, *rare earths.* The implication of rarity mobilizes all sorts of sentiments have legitimated the ruthless pursuit and capture of these elements over the past century, and perhaps that is why it persists even over a hundred and twenty-five years after this misnomer was identified among specialist audiences[48]. As illustrated in each of the cases examined in subsequent chapters, this misnomer continues to be operative for geopolitical posturing, state formation, capital marshaling, and legitimating the imposition of sacrifice zones.

The dark rock unearthed in 1788 was named Gadolinite, after its discoverer Johan Gadolin, which was later found to be a mineral consisting of cerium, lanthanum, yttrium and iron. When Mendelyeev, Meyer, and other chemists inspired by the 1860 Karlsruhe conference put together their respective drafts of the periodic table, there was no place for most of the lanthanides, which are the fifteen elements from lanthanum (atomic number 57), to lutetium (number 71) (Mendelejew 1869, Scerri 2007, Spedding 1961). Yet at the time, a few of the known elements (Lanthanum, Cerium, Terbium and Erbium) suggested the presence of an REE family, what would later come to be known as the lanthanide series, that "distant island to the south" of the rest of the periodic table (Atkins 1995).

The elements that are included with the lanthanide series in references to rare earths changes over time: during the race to build the nuclear bomb, thorium and uranium were also referred to as rare earth elements because of their chemical affiliation and frequent geological coincidence. For the same reason, scandium and yttrium are currently counted as rare earths, although they are found elsewhere on the Periodic Table: 21 and 39, respectively. Niobium, principally mined in Brazil, is often grouped with rare earth elements in political and popular discourse, but it is not currently considered a rare earth element beyond the political sphere despite its geological coincidence and similar ductile properties. Therefore at present, *rare earths* refers to a group of 17 chemically similar elements sharing certain exceptional magnetic

[47] At the time, metallic oxides were referred to as earths, for example: magnesia was known as bitter earths; zirconia as zirconium earths, and beryllia as beryllium earths (Greinacher 1981).

[48] "Until 1885, though by that time the scientific interest of the group had been fully demonstrated by the discovery of several new elements, it was supposed that the minerals were almost entirely confined to a few scattered localities in Scandinavia and the Ural mountains. In that year Dr. Auer von Welsbach announced his application of the rare earths to the manufacture of incandescent mantles. Immediately there was a great demand for raw material for the preparation of thoria and ceria. The agents of the Welsbach Company visited all the important mining centers of Europe and America, intent on a search with shortly made it clear that the metals of so-called 'rare earths' are really quite widely distributed in nature,' (Levy 1915).

and conductive properties (Goldschmidt 1978, Beaudry 1974, Liu 1978). The rare earth group comprises about 17% of all naturally occurring elements (Cardarelli 2008).[49]

Although most rare earths are relatively abundant, they are dispersed through Earth's crust, threaded through iron, phosphate, or copper-gold deposits. They are also found in placer and residual deposits formed by the long-term erosion of igneous rocks, which explains why they show up on the black sand beaches of Brazil and India. There is some disagreement as to their actual quantities in Earth's crust. Some, such as promethium, are not found on Earth outside of nuclear reactors, but are used to produce batteries that power pacemakers and space crafts as well as to manufacture luminescent paint for watch dials (Krebs 2006). Others, such as thulium, are so scarce that only a few kilos can be extracted from five hundred tons of REE-rich earth (Emsley 2001). Yet it is essential to the production of surgical lasers used to treat neurological and prostate conditions (Duarte 2010), and because it shines blue under ultraviolet light, it is stamped on Euro banknotes as an anti-counterfeiting measure (Wardle 2009). Then there is scandium, which is so difficult to separate from other REEs and uranium that annual global trade in the pure metal has yet to exceed a hundred kilos. Yet it is used in the metal halide lamps the illuminate streets, stadiums and film studios (Krebs 2006) and it is part of the secret recipe of high-performance handguns, bicycle frames and baseball bats (Bjerklie 2006, Wesson 2014, Staff 2009).

Other REEs are hardly as scarce but their uses are as wide-ranging. Because of their exceptional magnetic and conductive properties, this family of soft, ductile metals is essential for a diverse and expanding array of high-technology applications fundamental to globalized modernity as we know it. Global finance, Internet communications, satellite surveillance, oil transport, jet engines, televisions, GPS and emergency rooms cannot function without rare earth elements. REEs are necessary to produce the navigation components of the most advanced remote warfare technologies, such as drones and 'smart bombs' (Kidman 2012, Hedrick 2004). They are critical components of green technologies, such as wind turbines (Humphries 2013, Hashimoto 2009) solar panels and hybrid fuel-cell batteries (Jones 2013a, Armand and Tarascon 2008). They are essential in the development of nano-technologies, and are used in the production of consumer electronics such as smartphones, hard drives and flat screen monitors (Krishnamurthy 2005).

So thoroughly embedded are REEs that an analysis of their role in modern life precludes a straightforward commodity-chain or sector-specific analysis, unless one looks exclusively at a certain kind of magnet (Zepf 2013), for example. There is no singular 'Rare Earth Market' to speak of, but rather, multiple markets for the seventeen elements (and combinations thereof) with widely divergent availabilities and applications. The production process of a single rare earth resembles more of a web than a chain because it graces such an array of goods with its properties. For example: erbium, which turns pink when oxidized, lends its hue to rose-colored glasses and porcelain tableware (Hammond 2000) while also acting as an amplifier in fiber optic cables, enabling the construction of global Internet communications networks (Becker 1999).

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[49] Promethium is occasionally excluded from the rare earth group because it is a synthetic radioactive element produced during nuclear fission and is only found, on Earth, in spent nuclear fuel. It is also found in the center of certain stars in the Andromeda galaxy (Cardarelli 2008, Jørgensen 1990).

This gives rare earths an air of ineffability—they are seemingly everywhere, but in too minute quantities or in too sophisticated applications to quantify compellingly.

This is because of the nature of their application, which like their material incidence is both ubiquitous and dispersed. They are most commonly used in alloys, mixed with other elements such as iron or nickel to make them better, stronger, faster, and lighter. Scientific parlance for adding rare earths to other elements is referred to as 'doping,' borrowing the slang describing the use of performance-enhancing drugs in competitive sports (Digonnet 2001). In China they are called the 'MSG of industry' (Klinger 2011b) to capture the sense that, much like how a pinch of MSG[50] enhances one's cooking, just a little bit of rare earths enhance the quality of industrial output. In German industry they are referred to as 'spice' metals (Zepf 2013). The USGS describes them as 'vitamins,' which, when added to other elements produces results that neither could achieve alone (Koerth-Baker 2012). In Japan, they are characterized with the following serial metaphor: "oil is the blood, steel is the body, and rare earths are the vitamins of a modern economy," (Dent 2012). These metaphors convey a sense of the relatively small quantities generally (but not always) required to achieve desired effects: only a tiny percentage of most consumer electronics are composed of rare earths, for example. Their dispersal, the difficulties involved in isolating individual elements, and the fact that a few rare earths are actually extremely uncommon excites political economic passions around their scarcity. These passions, somewhat paradoxically, are most prominent in places where rare earths are most plentiful, as in China, Brazil, and the US.

Although rare earths are now essential to the technological infrastructure of modern life as we know it, for nearly a century after their discoveries, there was little use for them. During that first long century, which spanned from 1788 – 1891, rare earth elements were discovered and scientifically examined to a limited degree: "A great many learned men with famous names busied themselves with rare earth elements and reported interesting work…nevertheless, no applications or industrial usage came out of these efforts," (Greinacher 1981, 4). The first successful application addressed a long-standing problem in newly urbanized industrial zones before the advent of urban electricity: how to produce light cheaply and reliably over a large area. This imperative was driven by the industrialist desire to maintain production even after dark, especially during long winter nights in northern Europe (Koslofsky 2011, Bogard 2013, Ekirch 2005).

Carl Auer von Welsbach's invention of gas mantles (Eliseeva 2011, Welsbach 1889) at the turn of the 20th century inaugurated the first phase of industrial usage[51] of mixed or simply separated rare earth elements. Although the gas mantle lantern contained only 1% of the rare earth element cerium[52], the production scale was massive: by the 1930s, over five billion had been sold (Niinistö 1987), providing networks of city lights before the widespread establishment of electrical grids. Welsbach's first invention engendered the second: gas mantles were difficult to ignite, and large quantities of unseparated rare earth wastes left over from the production of

[50] Monosodium Glutamate, a byproduct of salt refining processes, is used to impart an umami flavor to foods.
[51] Periodized by Greinacher (1981) as lasting from 1891, when Auer von Welsbach was awarded his patent, to 1930, when the properties of rare earth elements began to be used more widely, but before the launch of various atomic research programs during which the properties of rare earth elements were more systematically discovered.
[52] The other 99% was radioactive thorium, which coincides with rare earth elements.

the incandescent mantles were prone to combustion. By blending these rare earth wastes with 30% iron, he developed the alloy called 'mischmetall' that sparked when struck. He patented this as the 'flint stone,' which is still used in all manner of ignition switches, from lanterns to cigarette lighters to automobiles (Krishnamurthy 2005).

These initial technological and commercial innovations sparked tremendous interest in the broader applications of rare earths. But it was not until the atomic, television, and computer age that more than the most basic applications could be found for them. Still, the inventions of the gas mantle and the flint stone were so successful that they expanded the rare earth industry dramatically and drove the quest for raw materials beyond Europe, to the Americas, colonial India, and China. Until 1895, gadolinite and bastnasite from Sweden furnished most of the raw materials for rare earth elements and thorium (Greinacher 1981). In 1887, a British mining interest began extracting rare earths from the monazite sands on the beaches of North and South Carolina; the operations were soon taken over by the Welsbach Light Company of New York (Levy 1915).

The German Thorium Syndicate and the Austrian Welsbach Company began exploiting monazite placers in Brazil in 1905 and in India in 1909, which drove US production out of business in 1910, except for a brief interlude during WWI (Mertie Jr. 1953). Brazil and India then supplied the global market—consisting of Europe and North America; Russia was self-sufficient—until 1948. The Indian Atomic Energy Act of 1948 prohibited the export of monazite because radioactive thorium, abundant in the sands, was named a source of atomic energy and therefore a strategic mineral for domestic use only (McMahon 1994). This abrupt interruption in supplies to the US had a temporary chilling effect on research and industry[53] until domestic production expanded again in late 1952 (Congress 1952).

Part of the lag time in identifying applications had to do with the approaches of early experiments, which generated mistaken opinions on what rare earths were and how they behaved. "Even as late as the early part of this century," wrote the Director of the Institute for Atomic Research at Ames Laboratory in 1961:

> "One could find statements in textbooks that that the rare earths were all very much alike and resembled lanthanum. As we all know now, this is far from the truth. The differences in the properties of these elements are as great as the differences between the members of other series in the periodic table, such as sodium, potassium, rubidium and cesium, or copper, silver, and gold. The melting points of the rare earth metals vary from around 800 to 1650 degrees Celsius. The vapor pressures of the metals at a given temperature differ by a factor of more than a million from the most volatile member to the least volatile member. Some of the metals are magnetic, others are not. Lanthanum is a super-conductor. Some, such as lanthanum and cerium, corrode readily in air, while others corrode inappreciably at room temperatures." (Spedding 1961: 2).

Through most of the 20th century REEs were still treated as rare, and research interest was confined to highly specialized audiences, such as readers of *Journal of the Less Common Metals,* inaugurated in 1959. Although small, this journal drew together materials scientists, chemists, and physicists experimenting with alloys and compounds during a time of tremendous

[53] "The development of new uses for the rare earths has been discouraged because the supply has been considered limited and the price, even of foreign ore, has been unstable (Congress 1952, 23)."

expansion in communications, military, and aerospace industries. The mid-20th century seemed to be a golden era for experimentation, as there was tremendous interest in the usefulness of rare earth elements along with political and economic imperatives to exploit potential applications, yet many basic characteristics still remained unexplored. An excerpt from an article published in 1961 conveys a sense of the times, in which laboratories occasionally caught fire as scientists figured out which elements could and could not mix together:

> "Attempts to make alloys of thorium and ytterbium by arc-melting were unsuccessful; the two metals appear to be virtually immiscible even at the melting point of thorium. At this temperature the volatility of ytterbium is serious, resulting in heavy losses of the metal which, when deposited in the form of a thin film on the inside of equipment proved to be pyrophoric[54] on subsequent exposure to air," (Evans 1961, 179).

Prior to the late 1980s, the majority of rare earth elements were not used in electronics; most of the applications were in catalysis[55], glass/ceramics, and metallurgy (Niinistö 1987).[56] It was not until the late 1980s and early 1990s that their expansion in communications and consumer electronics really took off.[57] In information technology and consumer electronics, the rare earth element neodymium is especially important. Its exceptional magnetic qualities enabled the miniaturization of computer hard drives and speakers; without small hard drives and tiny speakers, we would not have personal computers, smart phones, or ear buds (Croat 1997, Guenther 2003), billions of which are in use worldwide.

No other material comes close to the magnetic power of neodymium, and perhaps it is the best representation of the promising and dystopic applications of rare earth elements. Powerful neodymium magnets are essential to the latest, most efficient renewable energy technologies, including hybrid fuel cell batteries, water and wind turbines, and solar panels (Hatch 2008). A two-megawatt wind turbine contains about 360 kilograms of neodymium and 60 kilograms[58] of dysprosium (Stover 2011), while a three-megawatt turbine contains 1800 kilograms[59] of these rare earths. To put this in perspective: for every tonne of rare earth produced, approximately one tonne of radioactive wastewater; seventy-five cubic meters of acid wastewater; 9,600 to 12,000 cubic meters of waste gas containing hydrofluoric acid, sulfur dioxide, and sulfuric acid; and approximately 8.5 kilos of fluorine are generated (Hurst 2010). Each *Prius* (as of 2013) used a kilo of neodymium and ten kilos of lanthanum (Hilsum 2009). Neodymium and neodymium alloys are fundamental to the terrible hardware of contemporary militarism: cruise missiles, smart bombs, and drones also contain praseodymium, terbium, samarium, and dysprosium. Yttrium, Europium, and Terbium are used in radar, sonar, and radiation detection devices for targeting and detection in warfare; these same elements lend their optical properties to medical imaging devices such as x-rays and MRIs[60]. Rare earth elements are the material basis for the

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[54] *Pyrophoric:* liable to ignite spontaneously upon exposure to air. Google analytics show that use of the word peaked mid-20th century, suggesting that Evans *et al* were not alone in watching their lab equipment go up in smoke. 9 February 2014

[55] *Catalysis*: a modification and especially increase in the rate of a chemical reaction induced by a material that is chemically unchanged at the end of the reaction. (Merriam-Webster 2004)

[56] These are extremely broad categories.

[57] As Chapter two details, this technological shift occurred contemporaneously with broader shifts in the global division of labor which were crucial to laying the foundation for China's rare earth monopoly.

[58] Or 800 pounds of neodymium and 130 pounds of dysprosium

[59] or two tons

[60] MRI machines use over 680 kilos of magnets each (Molycorp 2012).

hardware of global technological modernity: from the darkest and most dystopic to the greenest and greatest.

II. The Political Life of Rare Earths

The shifting characterizations and ubiquitous applications of rare earth elements complexifies efforts to quantify and trace their value over time, especially because the contemporary category of rare earths now excludes elements–like thorium and uranium–that were once discussed collectively with REEs and as such were intrinsic to the 20th century political economy and political ecology of rare earth extraction, and therefore fundamentally shape our contemporary geography of rare earth production. In this way they are qualitatively different then other elements such as gold, silver, or mercury, whose storied pasts are accompanied by price tables and tales of these discreet commodities moving along a limited set of commodity chains over the centuries. It is the combined qualities of rare earths as both ubiquitous and dispersed in their geological incidence and applications as well as their persistent mischaracterization as *rare* that is key to understanding the bizarre potency of their political life and the strange geography of their prospecting and production.[61]

Rare earths have entangled with contentious politics, imperialism and militarism since the end of the 19th century and their political life has been shaped by the Cold War in critical ways. For example, the nuclear arms race depended on rare earth elements (Kosynkin et al. 1993, Chakhmouradian and Wall 2012); the strides in the ongoing fight against cancer are fueled by rare earths (Townley 2013); and the technologies essential for oil prospecting, drilling, transport, and refining all rely on the conductive, magnetic, and enhancement powers of rare earth elements (Sie 1994). This section will introduce the atomic, environmental, and global trade entanglements of rare earths.

The political life of rare earth elements began with the European quest for raw materials in colonial lands around the turn of the 20th century, when British and German interests prospected in India and the Americas to feed the expanding gas mantle and flint stone industry. During this time leading up to WWI, not all the rare earths had been properly identified. Likewise, thorium, uranium, tungsten, platinum and vanadium were grouped with rare earth elements because of their geological coincidence and complementary applications (Martin 1915). The English physicist Henry Moseley hypothesized that rare earth separation might shed light on nuclear fission and was the first to confirm, in 1914, that the lanthanide series must consist of fifteen members, no more and no less, including promethium which was not discovered until 1942. Moseley resigned from his research activities in late 1914 to enlist with the Royal Engineers of the British Army. He was shot in the head in 1915 while serving the British Empire in Turkey; it took nearly three decades for the scientific community to pick up his research where he left off (Asimov 1982).

[61] A few efforts to catalog rare earth applications; environmental, social and economic impacts; and sites of extraction, enclosure and pollution are under way. Most notable among these is *The Rare Earth Catalog: Tools for Reckoning with Anthropocene*, currently being organized by Elizabeth Knafo and Jesse Goldstein.

Atomic (post)colonialities

During WWI, the pyrophoric properties of rare earths were used in fuses and explosives; early applications of steel and iron alloys were used in the manufacture of weapons (Martin 1915). Rare earths were both inputs and outputs of the nuclear war effort. In 1939, the German scientists Hahn and Strassman discovered the neutron-induced nuclear fission of uranium and identified rare earth elements in fission products (Cardarelli 2008). Although thorium and uranium are no longer grouped with rare earth elements, mid-20th century prospecting and procurement procedures sought them collectively. In this way, the race to build the atomic bomb reconstituted global rare earth politics along the emergent fault lines of the Cold War. The US and Germany both drew their rare earth and thorium[62] supplies from India and Brazil until the outbreak of WWII in 1939; Germany then dodged British and Allied embargos before ceasing commercial operations with Brazil[63] and India in late 1940. Shortly thereafter, US and British leaders concluded that:

> "…the best future interest of the two countries would be served by a joint effort to seek out and gain control over as much of the world's uranium and thorium deposits as possible; this policy […] would ensure their governments ready access to major new resources of inestimable value and would keep these resources out of the hands of their potential enemies. Furthermore, project leaders perceived that, strictly from the viewpoint of national interest, it would be better for the United States to conserve its own apparently limited domestic resources and use whatever raw materials it could acquire from other countries instead," (Jones 1985, 293).

Executing this agenda required a survey of unprecedented scope into global rare earth, thorium and uranium resources. Union Carbide, working in cooperation with the Manhattan Project, assembled a team of approximately 130 geologists, translators, and clerks in New York to search through all available technical literature in any language. In the first six months of 1944, they examined sixty-five thousand volumes and carried out field expeditions in thirty-seven states and twenty countries. They determined that the Belgian Congo, Brazil, and India would provide the most abundant high-quality materials to support the nuclear arms race, with Canadian and Western US minerals as good alternatives (Jones 1985). The US could not secure supplies in colonial territories without the assistance of the British Empire, while the British Empire had interest in the global intelligence capacities of the US, hence the formulation of a joint undertaking to extend the atomic hinterlands of Britain and the United States in "areas outside of American and British territory," (Stimson 1944 in Jones 1985, 299). Russia, meanwhile, extended its own rare earth hinterland into Kyrgyzstan, opening a rare earth-thorium-uranium mine and processing plant in Ak-Tyuz in 1942 (Djenchuraev 1999) shortly after Stalin received word in April of that year that Allied powers were developing a nuclear weapon (Kojevnikov 2004).

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[62] "When thorium 232 captures a slow neutron, it converts to thorium 233. The thorium then disintegrates quickly into protactinium 233, which then decomposes, but more slowly, into uranium 233. Uranium 233 is fissionable by slow neutrons and thus potentially a material for sustaining a chain reaction. Thorium, like uranium, occurs widely in the earth's crust, but similarly not often in sufficient concentration to provide economically workable deposits. Before WWII, it was most commonly used in the manufacture of gas mantles," (Jones 1985, 292, footnote 1).

[63] Brazil-Germany relations during the 1930s suggested that Brazil would support Germany in the event of war. President/Dictator Getulio Vargas (1930 -1945; 1951 – 1954) reportedly enjoyed Hitler's company, was sympathetic to Nazi-fascism in the 1930s. Germany was Brazil's second greatest trading partner up to 1940 (Penteado 2006).

Getting ahold of minerals from the Belgian Congo was difficult for the US. The principle mine of interest, the notorious Shinkolobwe, had flooded and closed. The mine Director Edgar Sengier had returned to London. Sengier reportedly understood the potential of harnessing atomic power and the role his mine could play in such an endeavor, but did want to make any commitments to foreign militaries that he might later have to justify to the Belgian government (Gowing 1943 in Jones 1985), unless the US and Britain could make an offer that "served the interests" of the Belgian government in exile. In exchange for considerable sums of money, no timetable requirements, new equipment and assistance in "procuring labor,"[64] Sengier agreed to re-open the mine to provide uranium to the US beginning in mid-1945 (Helmreich 1998).[65] In the meantime, the US continued to rely on India and Brazil for thorium and rare earth elements.[66]

The US was unprepared for the post-colonial disruption to the resource status quo. When Brazilian production failed to make up the difference following the 1948 Indian embargo on monazite exports, rare earth and thorium prices rose precipitously between 1948 and 1952 (Mertie Jr. 1953). Brazilian monazite production was reportedly exhausted by 1950, but a closer look at the production data suggests that it is more likely that no one was able to fully resume the primarily German-run monazite operations after WWII (USGS 1953). Sensing opportunity, domestic US geologists, prospectors, and mining firms set out in search of lucrative deposits in the American West; it was during this time, in 1949, that a uranium prospector discovered the rare earth mine at Mountain Pass, California (Olson 1954) which would dominate global rare earth production from 1960 - 2000. But in the immediate aftermath of WWII, and in a way that is strikingly similar with today, the US government preferred to source the elements from overseas despite known domestic abundance. Congress resolved to slow research and production among rare earth-dependent sectors rather than pursue domestic self-sufficiency (Congress 1952). At the expense of domestic firms ramping up production in Idaho, the US Department of State aggressively pursued an agenda with India to liberalize its monazite exports at the dawn of the Cold War.

India restored independence in 1947; in the post-WWII, post-colonial contests, nuclear weapons were seen as guarantors of newly won sovereign power. In 1949, the Soviet Union was nearing its first nuclear bomb test, China expressed atomic intentions, and the United Nations had called for the elimination of nuclear weapons. Developing nuclear weapons was a top priority for Prime Minister Jawaharlal Nehru's government (Chengappa 2000), along with finding a means to relieve the famine (Lawn 2008) and assuage the violence surrounding the

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[64] That is, capturing and enslaving local inhabitants (Helmreich 2014). Harrison (1998), Headrick (1978), Dumett (1985), Israel (1987) and Von Eschen (1997) *inter alia* demonstrated how winning the war *and* the nuclear arms race depended on exploitation of the colonized world, although the lives lost through forced labor regimes are seldom included in tallies of WWII casualties.

[65] These records, based on US Military archives, do not cohere with the findings reported Adam Hochschild's in *King Leopold's Ghost: A Story of Greed, Terror, and Heroism in colonial Africa*: "With the start of the Second World War, the legal maximum for forced labor in the Congo was increased to 120 days per man per year. More than 80 percent of the uranium in the Hiroshima and Nagasaki bombs came from the heavily guarded Congo mine of Shinkolobwe. The Allies also wanted ever more rubber for the tires of hundreds of thousands of military trucks, Jeeps, and warplanes," (Hochschild 1999, 279).

[66] Harrison (1998), Headrick (1978), Dumett (1985), Israel (1987) and Von Eschen (1997) *inter alia* demonstrated how winning the war *and* the nuclear arms race depended on exploitation of the colonized world, although the lives lost through forced labor regimes are seldom included in tallies of WWII casualties.

India-Pakistan partition (Pandey 2001). The Indian Atomic Energy Act of 1948 indicated thorium as a source of atomic energy, thereby naming it a strategic mineral and immediately ceasing the export of thorium-rich monazite. This embargo seriously disrupted the US' strategic monazite supply, coinciding with the sharp reorientation of US foreign policy toward containing the spread of Soviet influence and suppressing communist movements in India (Merrill 1990). India had a famine; the US had grain. President Truman reckoned that relieving the misery would undermine the communist appeal, generate favorable attitudes toward the US, and open the door to negotiating around India's monazite embargo. Although famine relief discussions between Indian Ambassadors to Washington and the US State Department had been under way since 1947, broad factions in Congress opposed the bill for famine relief to India because of Nehru's criticisms of the West, or, as one congressman put it, his "hatred of every white man" (Senator Tom Connelly 1951 quoted in McMahon 1994, 93). When the State Department reframed the proposed food aid as "Indian Food Crisis—Opportunity to Combat Communist Imperialism," Republican opponents to famine relief reformulated the transfer of US grain as a *quid pro quo*:

> "India needs grain immediately; we have the grain. We need strategic materials from India over a period of years; India has those materials. We should make India a loan which can be repaid in strategic materials," (Congressman John M. Vorys quoted in McMahon 1994, 96).

As this line of thinking gained momentum, the proposed $190 million gift to India became a loan repayable in strategic materials. India's famine relief became contingent on breaking its embargo against strategic mineral exports. Prime Minister Nehru refused on the basis that such conditionality violated India's sovereignty. He later relented with the proviso that India would continue to provide strategic materials other than any which could be used nuclear weapons development, which precluded monazite. Hence the plan to "bring India closer to the West" backfired miserably, generating bitterness toward the US in India, and all manner of US State Department hand-wringing over the possible expansion of the "communist threat" across South Asia, while leaving the monazite issue unresolved (McMahon 1994). But if this plan had not backfired and instead resolved US rare earth needs, it would have been economically impossible for development activities to begin at the Mountain Pass deposit in California.

Meanwhile, in Baotou a comprehensive Sino-Soviet mining, industrialization, and urbanization program was under way in order to transform the ores at the Bayan Obo Iron-Thorium-Rare Earth mine into steel, machinery, and weapons.[67] Beginning in 1951, building the Baotou Iron and Steel complex was reportedly the flagship project of a massive aid portfolio of 149 Soviet development projects in China. As will be discussed in detail in Chapter 2, both Mao and Stalin intended to convert the windswept steppes of Inner Mongolia into a military-industrial heartland that could provision both Republics in the struggle against capitalism and Western imperialism. But the relationship was tricky; China supplied the Soviet Union with uranium and complied with Soviet military requests to set up communications and military bases throughout northern China in exchange for training and technology transfer in order to support a Chinese nuclear weapons program. By the mid-1950s the Chinese counterparts were disappointed at

[67] "…after World War II, owing to the recovery of lanthanide elements in fission products during the reprocessing of spent nuclear waste, the separation of rare earths was greatly improved, and this led to the large commercial-scale solvent-extraction process now widely used to recover lanthanides for industrial applications," (Cardarelli 2008, 423)

what they viewed as Soviet withholding of nuclear expertise (CMO 1958), and began pursuing their own nuclear agenda outside of the Sino-Soviet Plan (Gobarev 1999). In 1956, the 'father of China's rare earth chemistry' Xu Guangxian left his teaching and research position at Peking University to support China's effort to build nuclear weapons. In his memoirs, he explained that his expertise working with rare earths transferred well to his new focus on nuclear fuel extraction, which later inspired his breakthrough in rare earth separation (Jia 2009).[68]

It is important here, when reviewing the history of US, British, Indian, Chinese and Soviet rare earth extraction and weapons development, to view these Cold War competitions in context. Yes, the world was divided into ideologically and culturally oppositional spaces, but these antagonisms emerged from postcolonial continuities and above all constituted a world-historical moment characterized by the coalescence of modern warfare, atomic aspirations, competing imperialisms, and the exploitation of rare earth elements across global space. It is worth noting, too, how each colonial and state power chose to construct its own rare earth hinterland, because such patterns indicate the spatiality of power in the allocation of environmental destruction: 19th-century German interests went far afield, to the beaches of Brazil and India, to mine monazite sands. Britain opened up interests in the Carolinas and India; New York likewise exploited the Carolinas; the US and Britain collaborated with Belgian imperialists to exploit the Congo; Russia and China sought these resources in inland West Asia, in lands peopled by 'ethnic minorities'. Although these mining sites may seem remote from the perspective of Berlin, Moscow, Beijing, New York or London, they were central to the people who lived there and were not handed over without a fight (Tipper 1930, Zoellner 2009).

The tension: necessity vs. pollution

During the first half of the 20th century, Euro-American powers drew on colonial networks of exploitation to source the raw materials for industrialization and militarism. At the height of WWII, the US and Britain framed this global division of labor as essential to preserving the "future interests of civilization," insofar as "the protection of civilization required effective control of said ores," (Spaak 1944 quoted in Jones 1985).

Because mining tends to lay waste to the socionatures that precede it, the global mining frontier is characterized by the ongoing production and subsumption of margins, or commodity frontiers (Moore 2000, Moore 2011). Mining is the historical vanguard of expropriation (Richards 2003); as fonts for the ambrosia of industry on national and global scales, rare earth mining frontiers are conjured into being by the neo-imperial edge of militarism, industrialism, and capitalism which must always produce new spaces to penetrate in the quest for territory, minerals, wealth, and the geopolitical power that comes from possessing all three (Luxemburg 1913, Tsing 2005, Graulau 2003). There is a tension, therefore, between securing access to vital minerals and isolating the desolation generated by mining activities.

[68] The chemical and conceptual symbiosis drove advances in rare earth and nuclear research on opposite sides of the globe through the mid-20th century. Frank Spedding's discovery of ion exchange for rare earth separation proved crucial to isolating uranium in the 1940s. Xu Guangxian's work on isolating uranium was crucial to his discovery of the cascade theory of countercurrent extraction, which revolutionized rare earth production and greatly increased the global rare earth supply in the 1970s.

The geography of the global rare earth frontier is defined by this fundamental tension between the absolute necessity of these elements and the acute environmental and epidemiological costs[69] generated by their extraction. There are four primary stages where environmental hazards emerge. The first is the mining process, during which certain rare earths and radioactive elements such as thorium and uranium pose health risks to miners. Then there is the refining process, where toxic acids are used to separate elements (Hao 2011). The third is the waste management from the primary processing and beneficiation activities which contain hazardous levels of heavy metals, radioactive salts,, and radon gas. The fourth concerns disposal of rare-earth containing products (Weber 2012, Gullett et al. 2007). All rare earth elements cause organ damage if inhaled or ingested; several corrode skin; five[70] are so toxic that they must be handled with extreme care to avoid radiation poisoning or combustion (Krebs 2006). A further problem is that rare earths tend to coincide with radioactive thorium and uranium. This means that rare earth mining is also a radioactive waste management situation (Bai 2001).

Because of their radioactive properties, even the most minimal environmental regulation dramatically increases costs (Goldenberg 2010) of an already capital-intensive enterprise (Lazenby 2013). The production site must bear tonnes of radioactive wastewater generated by the separation and refining processes (Ives 2013, Li 1987, Wang 2007) which remain toxic for millennia (Najem and Voyce 1990). Between 1965 and 1980, the deserts of southeastern California generated most of the global supply of rare earth elements. But as discussed in Chapter 2, the environmental costs were simply too high: between 1984 and 1998, over sixty spills of radioactive wastewater occurred, many of which were unreported. Conservative estimates by the Environmental Protection Agency maintain that over six hundred thousand gallons of radioactive wastewater spilled onto the desert floor, and much more leached into ground water from unlined holding ponds (Danielski 2009). Because of their toxicity, 'remote' regions are preferred for mining and processing (Bai 2001, Wang 2007). This is true on national and global scales: mines in relatively sparsely populated, but comparatively better-regulated, southern California and Austria went bankrupt in the late 1990s in the face of cheaper imports from China (Humphries 2013). This ended the brief post-WWII period of western self-sufficiency by closing down the rare earth frontiers in the US and Austria. But moving the rare earth frontier to China also freed these two places from the environmental burden of production (Ellis 2013).

From the mid-1980s until 2010, mines in China gradually supplied a greater share of the global demand. For most, this workably subsumed the tension between environmental hazard and industrial necessity by concentrating the most toxic aspects of the commodity chain in places with less power of refusal in the economic globalization game, characterized by 'cheap labor' and 'lax environmental regulations' (Lin 2011). As discussed in Chapter three, the origins of China's rare earth monopoly are best understood in this context. With the high value of refined rare earths as well as the heavy financial, environmental, and social costs of their extraction and processing, global rare earth production has followed a similar 'race to the bottom' (Evans 2002) and 'environmental outsourcing' (Ellis 2013) trajectory that has marked other industries over the

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[69] The environmental and epidemiological effects are examined in-depth in Chapter 3 with a detailed analysis of Baotou, Bayan Obo, and vicinity.
[70] Promethium, gadolinium, terbium, thulium, holmium

past four decades of neoliberal globalization. China's export-oriented growth and Western de-industrialization are two aspects of the same process characterizing the contemporary global division of toxic labor.

But the global division of labor is hardly static. The steps taken by China's central government to rein in production and remediate damaged environments since the early 2000s have renewed prospecting efforts across the globe. With greater understanding of the hazards involved in rare earth mining, the impetus to open up new sources further afield, beyond the reach of enforceable environmental and occupational health and safety regulation has likewise increased. The high cost of waste management, the sheer difficulty of passing any legitimate environmental and social impact assessments, and the political blowback in the case of an accident discourage new production in sites already integrated in regional economies with adequate infrastructure and urbanization to support large-scale industry (Hilsum 2009, Davis 2013).

This combination of factors makes the far northern Amazon and the Moon particularly appealing to states and private firms with particular views toward the robustness of regulatory monitoring and political accountability on the frontiers. The driving assumption behind these seemingly far out objectives is that extracting from such places, where the wastes are cloistered far away from major population centers, will be more sustainable and cost effective in the long run compared to developing advanced recycling facilities to reclaim rare earth elements from waste (Meyer 2011, Jain 2012). But as will be discussed in Chapters five and six, these factors too are an insufficient impetus to drive extractive interests to such great lengths. Brazil has abundant rare earth deposits in the already active Araxá iron mine, but as will be examined in Chapter six, actors in the Brazilian government and international firms harnessed the geopolitical moment generated by global concern around China's rare earth monopoly to penetrate a contested and historically rebellious region of the Amazon. The Moon, examined in Chapter six, is of a class of new resource frontiers that require increasingly specialized knowledge and technology for rare earth exploration: parallels have been made elsewhere between the rediscovery of the deep oceans and exploration of our near solar system in the ongoing race for resources (Macdonald 2007).

These remote sites demonstrate that the spatiality of the frontiers of extraction are limited only by technology, political will, and the potential for power and profit rather than by the confines of Earth, land, or sea. In any case, the rare earth frontier is no longer limited to Earth. This alone indicates a significant qualitative difference from other strategic commodity frontiers, derived from the peculiar material properties of rare earths: they are sufficiently useful and valuable in small enough quantities that they could, in theory, be economically exploited off-Earth. While exploitation of such far-out sights is hardly as fantastical as one might think, it was not so imminent to neutralize the political economic effects of China's export quotas in the short term.

Trade, Sacrifice, and Security

The global division of labor for rare earth elements has been characterized by (post)colonial exploitation and environmental injustice. Rare earth production concentrated in China because of the convergence among the central government's emphasis on building up its domestic rare earth industry to support broader technological innovation in the space, defense, and energy sectors; the deregulation of capital in the west; and China's 1978 economic reforms. The monopoly emerged because actors on all sides stood to gain from subcontracting components of rare earth processing to China and thereby building up industry there (Klinger under review-a). Downstream industries in the rest of the world benefitted from the cheap and abundant raw materials coming from China. Not until China temporarily halted exports in 2010 did the rest of the world come to see global division of labor and China's de facto monopoly as problematic.

Although the production quotas began before the 2010 incident, the sudden disruption in rare earth exports to Japan woke the world up to the its dependence on China, prompting speculation that China would use its de facto monopoly as leverage in global politics. Despite assurances from Chinese premier Hu Jintao and Foreign Minister Yang Jiechi that China would never use rare earth elements as a weapon in global affairs (Grasso 2013), the international community was quick to sound the alarm over China's "stranglehold" on the rest of the world (Plumer 2011). Policy-makers, lobbyists, military personnel and pundits warned that China's monopoly could bring global industry to a halt (Galyen 2011) and seriously undermine national security (Parthemore 2011). Absent decisive action to diversify supply streams, rare earths could be China's political and economic "ace in the hole" (Hurst 2010) in international negotiations. Indeed, in light of China's production and export restrictions, and without a concerted effort to diversify supply, rare earths could become the next "conflict mineral" in Asia (Ting 2013). More concretely, the shortage and attendant price increases brought significant pressure to bear on renewable energy start-ups, leading US President Barack Obama to blame renewable energy economy's failure to launch in the US on the fact that China "broke the rules,"[71] (Chapple 2012).

The US, EU, and Japan brought two unsuccessful lawsuits against China's rare earth quotas, in 2009 and 2011. In these cases, the WTO Special Panel ruled that China's export quotas were justified under Article XX of the General Agreement on Tariffs and Trade, which holds that member states may withhold the export of strategic natural resources for environmental or national security reasons. News broke in October 2013 that China had lost the third suit because it failed to provide convincing evidence of environmental harm (WTO 2014a). One local scientist in Bayan Obo commented that those hoping for a WTO victory against China were missing the fact that sustaining the global supply of these resources is less important to China and neighboring countries than stemming the tide of toxic and radioactive waste contaminating extensive reaches of Inner Mongolia, including the Yellow River watershed on which nearly 200 million people rely for drinking water, irrigation, fishing, and industry.[72] A week after the leaked decision from the third WTO ruling, China's Ministry of Commerce released rare earth production quotas for 2014, but liberalized rare earth exports in January 2015 following a significant consolidation of industry.

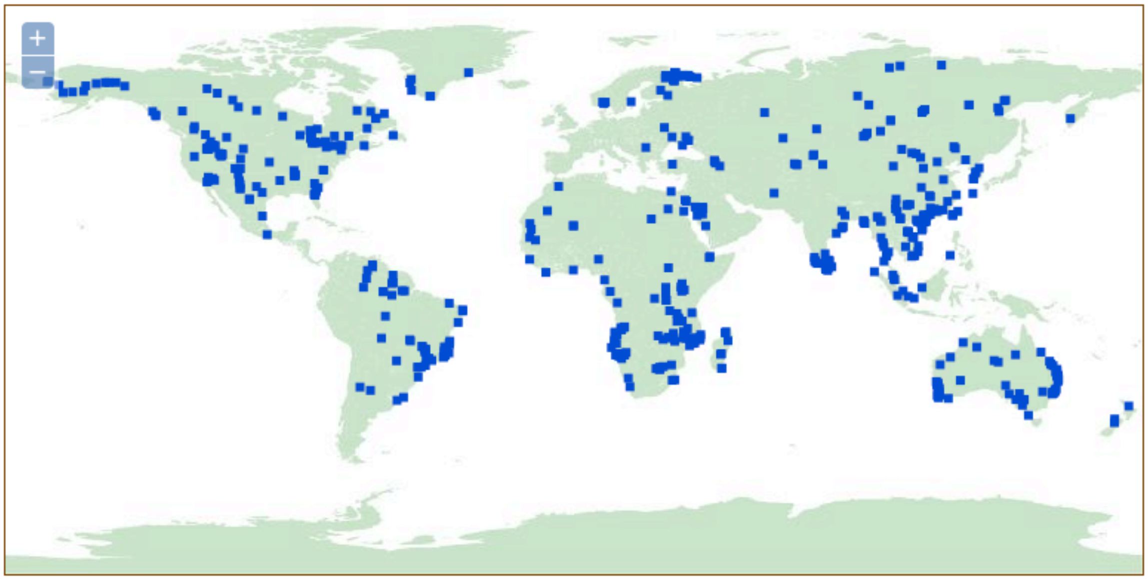
[71] "We have got to take control of our energy future and we can't let that energy industry take root in some other country because they were allowed to break the rules." (Obama quoted in Chapple, 13 March 2012)
[72] Chairman of the Ministry of Land and Resources for Baotou Municipality, interview by author, September 2013

Interviewees in China's Ministry of Foreign Affairs noted "a precedent of major powers selectively ignoring WTO rules that do not match particular national circumstances."[73] Furthering this sentiment, a principle researcher with the Beijing-based China Rare Earth Research Association observed in late 2013 that rare earth elements were not "so hot anymore," because prices were stabilizing and China's policy was clear and consistent. Given this, it fell to the industrialized countries of rest of the world to "take responsibility for their own rare earth needs."[74] In some ways, this has already happened. Prospectors and speculators have embarked on a "new gold rush" to identify minable deposits in central Asia, the south Pacific, Greenland and Southern Africa (Jeffries 2014) and of course, the Amazon (Farias 2013b) and the Moon (Lazaro 2014).

Because rare earths confer tremendous power on those who acquire them, power is exercised in the capacity to make hegemonic claims to the subsoils containing REEs, and power is manifest in the ability to subject some and exempt others from the toxic and radioactive byproducts of mining and processing (Bruce, Hietbrink and DuBois 1963; Hirano and Suzuki 1996; Li, Yang, and Jiang 2012). Therefore these elements are contentious at every scale, from the local to the (extra)global. Despite what these contentious politics might suggest, the global rare earth frontier is vast, dynamic, and plentiful. There are currently 799 identified land-based deposits of sufficient concentration to be feasibly mined (USGS 2013), bringing the total known land-based deposits to over 110 million tons (USGS 2011), while recent exploration of the Pacific has identified deposits potentially totaling over 1000 times as much (Pritchard 2013; Kato et al 2011).

[73] Representative of International Economic Engagement of the Ministry of Foreign Affairs of the People's Republic of China, interview by author, September 2013
[74] Mr. Chen (Chinese Society of Rare Earths), interview by author, September 2013

Figure 7: United States Geological Survey Map of Major Land-Based Deposits



Source: Orris (2013)

Figure 8: University of Tokyo Map of Pacific Ocean Deposits and Concentrations

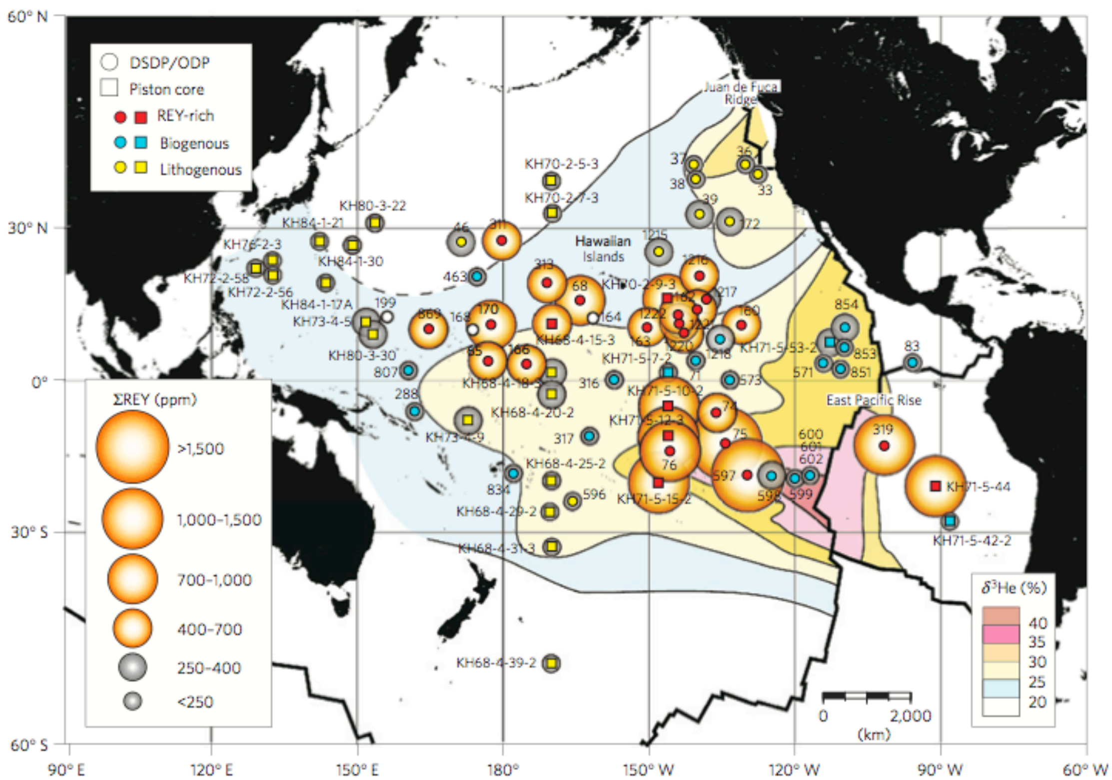


Figure 1 | Distribution of average ΣREY contents for surface sediments (<2 m in depth) in the Pacific Ocean. Circles represent DSDP/ODP sites and squares represent the University of Tokyo piston core sites, with colours corresponding to the dominant origin of surface sediments. Open symbols are sites lacking samples from the sediment surface. Contours represent helium-3 anomalies (δ^3He) of mid-depth seawater[12]. REY-rich mud with average ΣREY >400 ppm is designated as a potential resource in this study.

Source: Kato et al. (2011)

III. Geological Incidence, Formation, and the Contemporary Geography of the Global Rare Earth Frontier

Rare earths have the maddening characteristic of being relatively common yet incredibly difficult to exploit and amass. Many of them occur between 20 and 30 parts per million in the earth's crust (compared to lead at 14 ppm), but in deposits that are difficult to mine (Long and Van Gosen, 2010). This is because of the peculiarities of their formation and their geological coincidence with hazardous minerals. Furthermore, no two rare earth ores are alike, so there is no uniform process for mining or refining them (Long et al 2010). Rare earth elements occur in bunches which are dispersed through other kinds of mineral deposits, such as iron or phosphorus. Because there are seventeen separate elements, the possible combinations and compositions of rare earth deposits vary such that no two deposits are alike, so likewise no two extraction or separation processes are identical from site to site. Furthermore, each element requires a distinct chemically intensive process to separate it from its medium. This means that wherever a minable concentration[75] is discovered, the ores must undergo extensive tests to develop the most optimal extraction and processing techniques. Unlike other metals, which can be refined through a few smelting and separation steps, rare earth ores must go through several dozen chemical processes, such as acid baths and controlled heating, to separate them from surrounding minerals and remove impurities, including radioactive thorium (Long et al 2010; White et al 1979)[76].

Rare earths are geological peculiarities, borne of intricate geological processes that begin in Earth's mantle. They are formed in comparatively rare alkaline magmas, which are distinguished from the more common tholeiitic magmas by their chemical composition; alkaline magmas are higher in iron and magnesium, which keeps them more stable than tholeiitic magmas as they cool. This stability is important for the separation and formation of rare earths and related elements such as thorium and uranium.[77] As alkaline magmas cool and iron begins to solidify, a process called fractional crystallization begins, wherein certain minerals solidify as the temperature drops below their melting point, changing the composition of the remaining magma. Picture it like this: hot magmas, when cooling, sweat discreet minerals in solid form. Once these elements solidify into discreet crystals, they no longer constitute the chemical make-up of the liquid magma. The elements that do not solidify into crystals during this initial phase of cooling are called incompatible elements, and it is from this soup of incompatibles that rare earths eventually form, if the conditions are right. For the formation of rare earth elements, the critical difference between alkaline and tholeiitic magmas is that in the latter, the fractional crystallization process radically alters the chemistry of the magma and destabilizes the medium. But in alkaline magmas, the high iron and magnesium content facilitates the formation of relatively stable lattice structures that cradle the incompatible elements which ever so slowly

[75] A minable concentration is generally defined as a percentage 'in the low single-digits;' a spatially defined area of concentrated minerals is called an occurrence. If it is minable, then it is called a deposit, ore deposit, or mineral deposit (Zepf 2013).
[76] On the black market, elements are immersed in crude acid baths to partially separate them, and are then sold to downstream refining facilities via independent traders (Bradsher 2010). This, in part, explains why there is such an extensive delay between discovery and production, and why production is so environmentally devastating.
[77] For the sake of simplicity, I am talking about the formation of a bastnasite Iron-REE-Th deposit here, such as those found in Bayan Obo and Mountain Pass.

solidify into rare earth elements, niobium, uranium, and thorium over repeated cycles of gradual degrees of heating and cooling. A dramatic temperature change in either direction, such as that caused by a volcanic eruption or tectonic upheaval, and rare earths fail to coalesce in useful concentrations.

This means that the places most amenable to the formation of alkaline magmas are the seismically quieter zones, tucked away from the edges of tectonic plates in the anorogenic plaines and plateaus. Although 'anorogenic' means free from mountain-making disturbances, it does not mean stillness. If the spasms at the edges of tectonic plates are too much for the formation of rare earth elements, then the slow undulations toward the centers of tectonic plates are generally too stable to provide the gradual heating and cooling cycles that are just right. It is in the 'goldilocks zone' between orogenic mountain-building activity and the sleepy center of the tectonic plate that the deposits of Seis Lagos and Baotou are situated, along accretionary orogenic belts between major intracontinental cratons (Lujan and Armbruster 2011, Nutman 2007).

A craton is an old, stable part of the lithosphere that has survived repeated cycles of rifting, merging and mountain building. 'Craton' refers to the shields and platforms that form the continents. The deposits at Seis Lagos and Bayan Obo formed after the subduction of the Mongolian and Guianan oceanic plates beneath the northern cratons of their respective continents (Chao 1997, Voiçu, Bardoux, and Stevenson 2001), which formed the landmasses we now recognize as North-central Asia and South America. It was in the following extended period of relative geological calm within the orogenic belts that the REE-bearing bastnasites were formed in gradual magmatic upwellings protruding from the mantle into the crust (Bai 1996, Giovannini 2013).

The bastnasite mining era began with Mountain Pass and Bayan Obo in the 1950s. The sites that supplied Welbach's gas mantles and the nuclear arms race featured monazite sands which are comparatively more abundant, but not as highly concentrated as REE-bearing bastnasites. Monazites, too, have their origins in the alkaline magmas. Although alkaline magmas are less common than the tholeiitic magmas, they nevertheless occur in all tectonic plates. Many igneous and metamorphic rocks produce rare-earth bearing minerals such as monazite and xenotime, which when weathered produce the monazite-bearing placers found in the rivers of Idaho and the black sand beaches of Brazil, India, and the Carolinas. To extract monazite sands requires shallow, surface mining or riverbed dredging, as rare earth elements tend to be present between the surface and a few meters depth. The REEs encased in bastnasites require blasting, grinding, and several more sophisticated separation processes.

On the Moon, an analogous geological[78] process is hypothesized to have taken place in the formation of the KREEP[79] deposits. It is believed that the Moon was formed after a Mars-sized object smashed into Earth and broke off debris that eventually consolidated into the Moon we recognize today. The power of the collision liquefied much of the debris that was tossed into space, which formed lunar magma. The lower density of the Moon left an ocean of this magma trapped between the mantle and the crust, which cooled very gradually. The conditions of lower

[78] The field of lunar geology is known as selenology
[79] KREEP: K = Potassium, REE = Rare Earth Elements, and P = Phosphorus

gravity slowed the temperature flux, which resulted in the formation of higher concentrated deposits of rare earth elements than typically found on Earth (Heiken, Vaniman, and French 1991). On the Moon, the surface features of the KREEP zone are characterized by highlands and depressions, referred to as seas, which suggests that cooling processes in earlier years of the Moon's formation were shaped by impact events that altered the form and chemistry of the magma ocean surrounding the Moon (McSween Jr. and Huss 2010). In Inner Mongolia, the surface features of the orogenic belt are characterized by high mountain ranges emerging out of wide desert and grasslands leading to the Mongolian steppe in the north. A similar geomorphology characterizes northern Brazil, where reserves are found in the northern Amazon, in the foothills of the Neblina range leading to the plateaus of the Guiana shield to the northeast. These geologic formations have been used as national barriers by past empires, imperial powers and contemporary states. This is emphatically not to suggest environmental determinism, but rather to point out that these geographical features have been used in the territorial exercise of power in a way that is consequential for contemporary rare earth politics.

That rare earths tend to be prospected for in border regions is crucial insofar as they are further imbued with a nationalist economic and geopolitical significance, and therefore, like petroleum, tend to become the subject of territorial disputes where borders are not unanimously agreed upon (Triggs and Bialek 2002, Nevins 2004). As illustrated by the cases of Baotou and São Gabriel da Cachoeira, the uneven geological distribution of REE-bearing bastnasites and their incidence in historically contested areas compels state-making and border-marking activities by national actors intent on securing reserves. It would be compelling (and often is) to conclude that rare earth elements have preternaturally high incidence in border regions, but this would be a false conclusion drawn from the fact that prospecting for economic minerals tends to be carried out in such places, which tend to be characterized as marginal.[80] In fact, a closer look at Figure 7 shows a curious absence of rare earth deposits in continental Europe. This is not because there are no rare earths; quite the contrary. This is due to the fact that mining rare earths in this place is not politically feasible.

Geological survey has historically played an important role in imperialist adventure and nation building. The rare earth deposits in Bayan Obo, Seis Lagos, and Mountain Pass were found when prospectors were looking for other things: iron, gold, and uranium, respectively. In both the China and Brazil cases, these initial surveys were undertaken at a time when the respective central regimes were seeking to rationalize national territory and take stock of domestic mineral wealth to fuel national development schemes. The geological survey of the Moon began as a minor outcome of Cold War superpower politics, but has come to provide the central basis for a privatized space race. In his history of the role of geological rationality in settler colonialism, Braun (2000, 14) argued for a consideration of "the consequences of 'geologizing' of the space of the nation-state for forms of economic and political rationality, including efforts by the state to compel individual and corporate actors to 'do the right thing' in relation to a territory that now had an important sense of verticality." As subsequent chapters show, this 'right thing' is to exploit resources in the name of national development and prosperity. Under such a framing, mining is recast as an indicator of progress and therefore the capacity of the state to implement or enforce large-scale extractive regimes becomes a measure of the potency of national sovereignty or of human advancement. Once mining is understood in

[80] Foweraker (1981) has observed that 'marginal' and 'frontier' tend to overlap

this way, leaving an extractivist agenda unexecuted becomes a dereliction of moral obligation felt among mining proponents as impotence, or a loss of effective power.

The geography of rare earth extraction is inseparable from geographies of power and vulnerability. On one hand, it is far easier to prospect for rare earths in 'remote' regions populated by already-marginalized polities, or at the very least, characterized by ambiguous or incomplete legal regimes. On the other, the imperative to capture strategically valued resources serves as a convenient pretext for a host of territorializing agendas that allow the state to bring historically independent spaces within the purview of political economic control. As the three cases show, the formation of local social relations necessary to carry forth rare earth extraction, processing, and production therefore become part of the pedagogy of the state. In all cases, rare earth resources are framed in terms of a collectively-held entitlement despite struggles over the question of whom defines and controls their extraction and distribution, and despite the expropriation and dispossession that precedes production (Rangel 1908, Bulag 2002). Rare earths, then, like other strategic elements, stimulate the invocation of ethnonational "community," (Watts 1999) in order to mobilize the necessary social, political, and financial capital to extract them. Such is the case between Japan and China with respect to maritime boundaries; Brazil, Colombia and Venezuela have recently militarized their strategic Amazonian reserves (Maize 2012). Although assertions of national sovereignty are forbidden in outer space (UN 1967), the Moon is legally defined as a global commons, and therefore subject to familiar processes of use-based enclosure (Beery 2011). As discussed in Chapter six, the agitation over *whom* shall be entitled to exploit lunar resources is stimulating a debate in Anglophone and Sinophone discourse over the viability of upholding existing legal conventions. In all cases, collective rhetoric concerning rare earth production is invoked to legitimate dispossession.

Although practical applications for the rare earth discoveries in China and Brazil were not immediately apparent, their discoverers noted their strategic value. Ding Daoheng, the Chinese geologist credited with the 1933 discovery of rare earth elements at Bayan Obo reportedly said: "These deposits will become an important treasury of China," nearly thirty years before rare earth processing began (Shi 2012). Similarly, in Brazil, the military geology expedition that publicly announced the discovery of the Seis Lagos deposits in 1972 declared that the yet-to-be exploited minerals located on indigenous lands "belong to the patrimony of Brazil, for the good of the Brazilian people" (Oliveira 2013). The first lunar rock samples in 1969 ignited cornucopian fantasies (Lewis 1996) that are now at the heart of the contemporary resource driven space race: NASA, private space companies, and the China National Space Administration have recently invoked the moon as "an offshore island," "rich with strategic natural resources," "desperately needed on Earth," (Jain 2012, CM022 2013). Indeed, the specific industrial uses of geological knowledge need not be readily apparent in order to direct political and economic efforts toward rationalizing territory. Discovery is enough. Geologizing history and space is an important part of a territorial project; the newfound legibility afforded by geological knowledge transforms the complexity of existing socionatures into a stratified schemata of mineral wealth waiting to be put to productive use.

Conclusion

This chapter has shown that the term ‘rare earths’ is political shorthand for a rotating cast of strategic minerals based around the lanthanide series at the bottom of the periodic table of elements. The term is extended to incorporate other elements as technology and politics change. Although the term ‘rare earth’ is hardly an accurate descriptor for this suite of soft, ductile metals, it continues to function as a politically expedient term in the ongoing quest to acquire these resources, whether the intention is to avoid or impose the hazards associated with their extraction. This chapter has further shown that the political life of rare earth elements extends well over a century beyond the crisis of 2010, and that the geography of rare earth extraction has followed the contour lines of imperial, colonial, Cold War, and neoliberal power over the long 20th century. The next chapter examines the origins of China’s rare earth monopoly.

Part I:

The Origins and Outcomes of China's Rare Earth Monopoly: 1920-2010

Part I addresses the apparent paradox of China's near total global dominance of rare earth production in light of the relative ubiquity of rare earth elements. The Chapters in this section argue that China's rare earth monopoly emerged from longer term world-historical processes beginning in the first half of the 20th century.

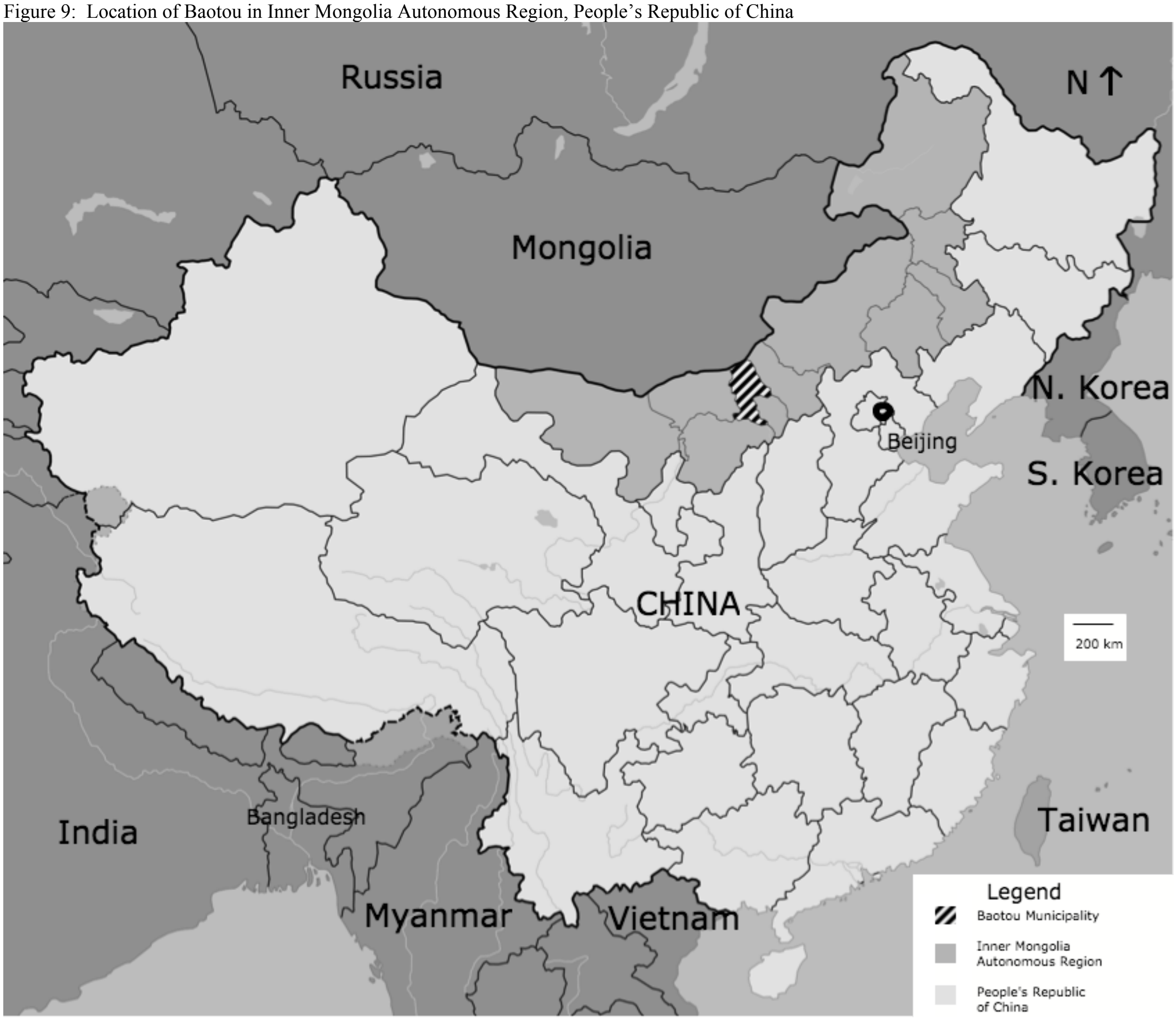
Chapter two completes the first part of the task of placing China in the world-history of rare earth discovery, production, and use by considering the territorial contests that were instrumental to carving Inner Mongolia Autonomous Region, Baotou, and Bayan Obo out of the expanse of the Mongolian Steppe. Imperial and Nationalists initiatives to explore Baotou's mineral wealth and bound the region into global extractive networks were essential for generating the geological knowledge that informed post-Revolution Sino-Soviet military and industrial development programs. These programs enacted raced and gendered regimes of labor and sacrifice that were essential to territorializing the frontier. The Maoist social engineering programs were significantly enabled by Soviet aid and expertise, particularly concerning the transfer of metallurgical and technological knowledge that was crucial for Baotou and Bayan Obo's emergence as the rare earth capitol of the world. These integrated atomic, industrial, scientific, and manufacturing efforts laid the foundation for China's rare earth monopoly. But this is only one half of the story.

The second part of the analysis is covered in Chapter three, which examines the convergence between the historical developments shaping Baotou and subsequent global shifts in political economy characterized by Deng Xiaoping's Reforms and the Reagan/Thatcher revolution. These shifts stimulated the piecemeal transfer of western rare earth industries to China during the 1980s and 1990s. These chapters refute the claim that China's rare earth monopoly is attributable neither to geological determinism nor to a single-minded conspiracy on the part of China's central government, but rather to a convergence of multiple disparate processes unfolding over nearly a decade across global space.

Chapter Two

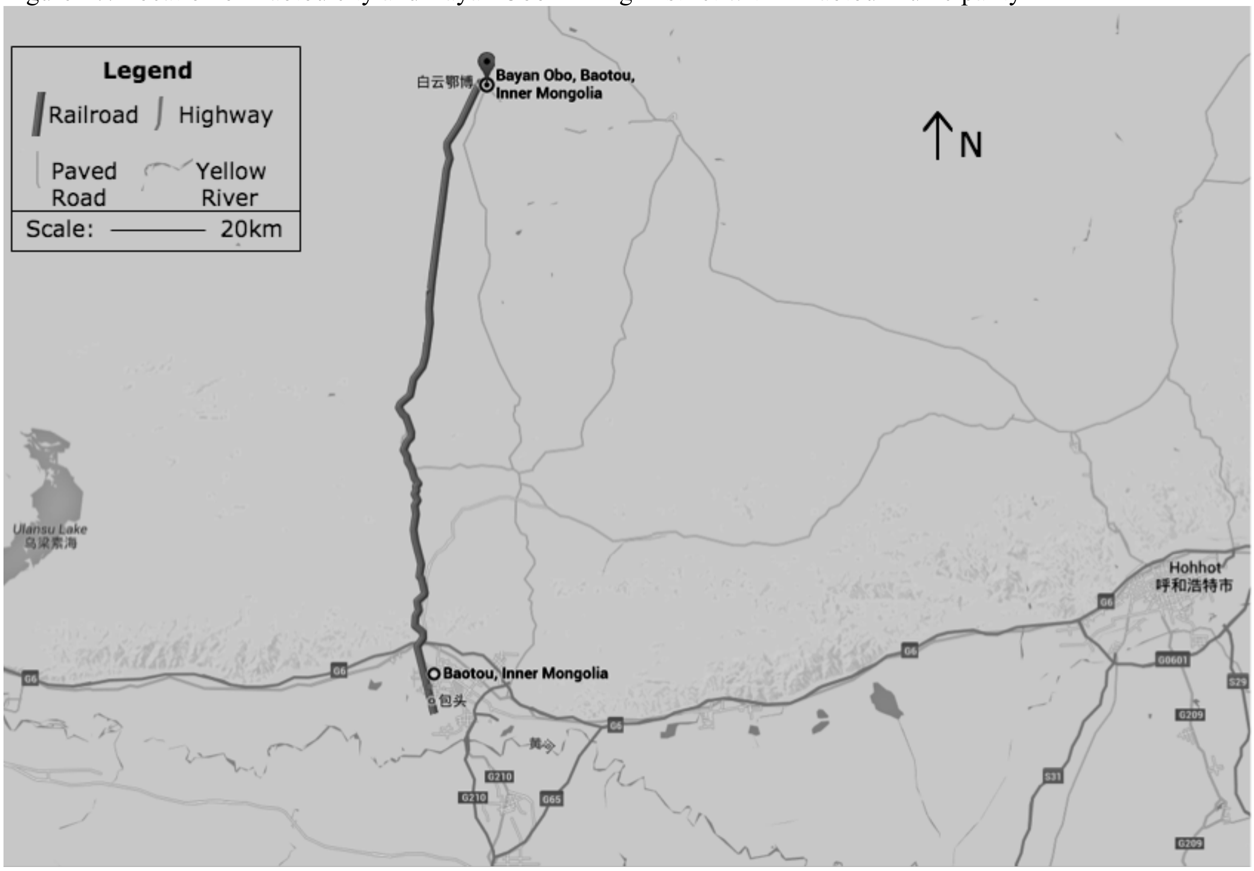
Placing China in the World History of Discovery, Production, and Use

Figure 9: Location of Baotou in Inner Mongolia Autonomous Region, People's Republic of China



Baotou municipality is located in Inner Mongolia Autonomous Region. It borders Mongolia to the north and the Yellow river to the south. Image rendered by Nicholas Bojda, 2015.

Figure 10: Location of Baotou city and Bayan Obo Mining District within Baotou Municipality



The Bayan Obo mine is located in the northernmost portion of Baotou Municipality. One rail and one road connect it with Baotou city, located in the south of Baotou Municipality along the Yellow River. Because water is scarce in the north, the heavy industry, urban, military, and supporting agricultural base are located in Baotou city, in the south. Major highway and rail lines connect Baotou city to the south, east, and west. Image rendered by Nicholas Bojda, modified from Google Maps, 2015.

Introduction

The Bayan Obo mine is the single greatest source of rare earth elements worldwide, producing approximately 50% of the global supply. Banners and sculptures leading into town proclaim Bayan Obo to be the 'Hometown of Rare Earths;' it was until very recently thought to be the largest rare earth deposit in the world (Ling 2013). As this chapter shows, the discovery of the mineral wealth at Bayan Obo is an accident of competing imperial contests, while its emergence as the rare earth capitol of the world would not have been possible without the territorial, industrial, and cultural campaigns to claim the inland frontier and bound it into a larger resource hinterlands for China, the former USSR, and other imperial powers. These campaigns were essential to laying the foundation for the Bayan Obo mine in Baotou, Inner Mongolia Autonomous Region to later become the 'Rare Earth Capitol of the World,' as it is called in contemporary literature.

China's de facto monopoly tends to be taken for granted in contemporary rare earth discourse: 'China as the world's richest rare earth nation,' or 'the only nation possessing all 17 types of rare earth elements,' (Wang 2010, 15) was a common trope in popular commentary in China and across the globe in the years immediately following the 2010 crisis.[81] This trope revived the scarcity theses of Malthus (1798) and Hotelling (1931) which state that as population grows and demand increases, non-renewable resources will be depleted and prices will rise (Schoolderman 2011).

This logic serves three conflicting objectives. First, the myth of China as the world's richest rare earth nation has been deployed in domestic discourse to justify recentralization and greater state control over production (Cheng 2010). The positive effects of this lie in the greater importance placed on environmental conservation and regulation, while the negative effects can be seen in the manner in which state-run media used the rare earth scarcity myth to reframe legitimate concerns over production practices into a nationalist paranoia about how the rest of the world conspired to rob China's strategic mineral wealth (Wang 2010). Second, outside of China, the myth of rare earth scarcity justified prospecting in places previously considered off-limits, such as the Brazilian Amazon (Kinch 2011), Greenland (Gravgaard 2013), the deep ocean (Davis 2014), and the Moon (Vergano 2013). Third, China's purported geological privilege has been useful internationally to justify the WTO suits brought by the United States, Japan, and the European Union against China's production and export quotas, advanced on the argument that the rest of the world depends of China's particular reserves so the quotas give China an unfair advantage. Paradoxically, a successful suit against China to remove its production and export quotas has had the effect of bringing prices of some elements closer to pre-crisis levels, thereby eliminating the incentive for others to invest in the prospecting and technological development necessary to mine rare earths in a more sustainable manner outside of China.

Although the Malthus and Hotelling theses possess a compelling logic, logic is not the same as truth. As with most non-renewable resources, the global rare earth supply is not fixed. While it is true that at any given period there is only a certain quantity of known reserves, the

[81]中国是世界上稀土最丰富的国家，已探明的工业储量约占世界的 36%， 目前已知的 17 种稀土元素，中国都有一定储量，这在世界上是唯一的。' (Wang 2010).

historical tendency is that as resources are depleted, new deposits are found. In the years since the 2010 crisis, estimates of China's reserves as a percentage of the global total have been decreasing annually (Chen 2011; USGS 2013), from 50% in 2009 (Zhao quoted in Hilsum 2009) to 23% in 2012 (OSC 2012). This percentage does not account for the recent discovery of the largest known global deposit at the bottom of the South Pacific (Evans-Pritchard 2013; Kato 2011), or the undetermined but reportedly immense finds in North Korea (Bruce 2012, Schearf 2014). As the post-2010 wave in global prospecting and research illustrated, scarcity-induced price increases incentivized exploration ever further afield, as well as investment in the technologies required to exploit resources in remote places. Indeed, as this chapter shows, China's now famous Bayan Obo deposits were discovered under precisely these conditions several decades ago. Therefore, China's rare earth dominance is only marginally explained by geological circumstance. Most countries have ample reserves to be self-sufficient (Baltz 2013).[82]

The previous chapter detailed the pre- and post-war production history of rare earth elements—one which spanned the globe. With the global context presented, this chapter lays out the situation within and with respect to China, whose mineral resources, struggles over their definitions, and their role in state-building played a critical role in the global politics of the early 20th century. In the mid-twentieth century, Mao and Stalin's agenda to convert the windswept steppes of Inner Mongolia into a military-industrial heartland that could provision both Republics in the struggle against western capitalism and Japanese imperialism laid the foundations for China's long-term rare earth strategy.

This history underscores the point that China's rare earth monopoly arose from particular political and economic circumstances rather than fabled resource abundance. The concentration of global production in China followed a contingent and uneven process over the course of several decades of cultural, political and economic transformations across the globe, broadly associated with but seldom acknowledged in relation to post-WWII decolonization, Cold War politics, the global liberalization of capital and the emergence of a shifting global division of labor. This chapter completes the first part of the task of placing China in the world-history of rare earth discovery, production, and use. In order to overcome the tendency in Sinophone, Anglophone, and Lusophone literature to attribute China's rare earth monopoly to geological determinism and the foresight of the Chinese state on one hand, or the vagaries of global (western) capitalism on the other, this and the next chapter cover two halves of the story: the first half considers the territorial contests that were instrumental to carving IMAR, Baotou, and Bayan Obo out of the expanse of the Mongolian Steppe. The second half, covered in Chapter three, examines the convergence between these historical developments and subsequent global shifts in political economy characterized by Deng Xiaoping's Reforms and the Reagan/Thatcher revolution.

The sections in this chapter show, in turn, that the origins of China's rare earth monopoly lie in a historical conjuncture between three processes. Section I discusses how Baotou was the site of territorial ambitions of several powers through the first half of the twentieth century. Geological knowledge served as a tool of empire, and later, as a basis for nation building and internal colonization after the founding of the People's Republic of China in 1949. Section two

[82] "Self-sufficiency is a very *Chinese* term. We are committed to an efficient, global system of free trade in order to keep prices low for American companies," (United States Trade Representative, January 2014).

argues that contrary to possessing a grand strategy to use its rare earth monopoly to hold the world hostage (e.g. Khosla 2011), the development of China's rare earth capitol emerged from a broader policy to tame a border and render a red hinterland[83] out of a historically recalcitrant and stateless steppe through industrial development and cultural campaigns that were predicated on explicitly raced and gendered regimes of labor and sacrifice. China's central government emphasized the importance of rare earth elements in the early 1950s as part of the construction of a socialist military-industrial complex with significant assistance from the former Soviet Union (Congress 1955). The third section examines the significance of atomic aspirations in driving the establishment of a military-industrial urbanity on the inland frontier even amidst national turmoil, how they were instrumental in producing the cultural landscape recognizable today, and shows how these geopolitical imperatives laid the foundation for establishing the 'rare earth capital of the world' in China.

I. Inland Frontier: Geology, Imperialism, Territory

> "And China began its survey in the early years of the twentieth century as it endeavoured to build up military and economic strength to combat Western and Japanese imperialist threats. It was the powerful countries that interested themselves in matters geological; and so it has continued to the present day (with power now projected under the oceans and towards other regions of the solar system), (Oldroyd 1996, 123)."

Recalling the discussion from the previous chapter, global rare earth extraction in the first half of the twentieth century was defined by the contours of colonial power, driven by the resource demands of industrial modernization and accelerated by the fervor of the atomic age. The complexity of this situation in China deserves distinctive treatment, as imperial contest and competing nationalist agendas surveyed China's terrain with the intention of rationalizing a mysterious empire. The material basis—in the sense of ores and elements, and their geographies—of the breathtaking innovations surrounding the end of WWII is much less well understood than the technologies, hazards, and politics it generated. Fundamental to this was the expanding scope of global geological prospecting alongside the reconfiguration of geological knowledge as a tool of state power (USAF 1952)in the global struggle between communism and capitalism (Duracinsky 2010, USAF 1952).

In the latter decades of the nineteenth and the first half of the 20th Century, geological survey teams from Germany, Japan, Soviet Union, and China prospected among the steppe and desert of what was to become, in 1947, the Inner Mongolia Autonomous Region. Each team came to survey the region with the intention of bounding its geological wealth into a larger resource hinterland, whether for Imperial Europe, Nazi Germany, Imperial Japan, or the USSR. It is worth noting that the industrial orientation of geological survey activities, the cartographic portrayal of mineral wealth and the construction of the infrastructure required to extract it were cited as symbols of progress and modernity for imperialist, nationalist, capitalist and communist interests alike (Davis 1926). Struggles around these issues were not necessarily struggles against industrialization or mining *per se,* but rather struggles over their meaning and purpose. Where imperial powers saw the extension of their surveyors and technologies to China as tangible

[83] Red hinterland is a term that captures the production of inland resource bases as part of the socialist territorial project between China and the former USSR.

evidence of the reach of their empires, nationalists viewed foreign-constructed mines, railways, road and ports as symbols of imperial humiliation, which had to be reclaimed and improved for the development of the Chinese nation (Chen 1954).

This supports the contention of Braun (2000) and Winchester (2009) *inter alia* that geology evolved as a science of territoriality. It is a way to rationalize *terra incognita* in service of state, empire, and nation building. Wu (2010b) and Shen (2014) argue that the evolution of geological science in China is inseparable from imperial designs on China's territory and resources, beginning in the late Qing during the latter decades of the nineteenth century. From the 1880s, colonial actors in the German Foreign Ministry looked to China to expand their reach with the objective of eclipsing the more extensive British and French empires. The means to do so were overwhelmingly material: diplomatic transmissions from both the Chinese and the German sides were dominated with concerns over mining technology transfer, land use, and mining rights (Wu 2010b). During this time, Western missionaries sought to capitalize on Chinese interest in the industrialization of the Euro-American world. Their strategy was to educate their target populations on science and technology in order to legitimate ongoing efforts at religious conversion. In Baotou and Bayan Obo, the legacies of these efforts are present in the somewhat surprising abundance of protestant churches (Liu 2009).[84]

China's Geological Society was the first scientific institution established in modern China in 1922 under the Republican government, with the express purpose of understanding the nation. As Shen (2014, 13) observed: "any viable understanding of the nation had to suit the twin criteria of protecting Chinese existence and promoting geological activity, and often the boundaries of one effort would shift to accommodate the other." Early geological research activity in China was characterized by international collaboration and open exchange of information[85]; the first meetings of the geological society featured international speakers which cultivated a reputation of Beijing as "the center of scientific life in Asia," (Leader 1923 in Wu 2014). There was considerable inequality between Chinese and foreign researchers, however. The former were cash-strapped and relied on state directives and commissions from mining companies to keep China's Geological Society afloat. The latter were convinced that only an established colonial power could tackle the vast unknown represented by China's geology (Margerie in Wu 2014, footnote 5) which put Japan in pride of place because of their control over key infrastructure extending inland from northeastern and southeastern China.

To support their imperial efforts in Northern China, Japan organized local puppet governments, engaged in prospecting activities and took over heavy industry and munitions factories. In the 1930s, Japan held almost a third of China under its control, primarily the coastal and northern regions were the majority of China's government, research, and industry was located. The joint Communist-KMT forces organized a mass retreat to the interior while the militaries attempted to hold back the Japanese Army. Geologists and other technically-trained

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[84] These churches survived the purges of foreign influence in the early years of the PRC by aligning themselves with nationalist campaigns. They were particularly active in the "Three Self-Sufficiencies Patriotic Campaign" [三自爱国运动委员会] of the late 1950s and early 1960s, which consisted of "Self-governance, Self-teaching, and Self-Support [自治、自传、 自养]," (Wang 2010, 15).

[85] Reports from the first year of meetings recount several instances of Japanese, American, Russian and Chinese researchers quite literally opening their field notebooks for one another (Liu 2009)

personnel focused on opening up new resource bases in central and western China and rebuilding industry to support the war effort (Wu 2010b). The force of China's resistance surprised imperial Japan and Western observers; instead of conquering the whole of China in three months' time, China's defensive compelled Japan to pour ever more resources into their conquest of the mainland (Utley 1937) until their surrender in 1945.

From the late 1920s through the 1930s, the KMT sought to reunify China, integrate China's economy with the world economy, and engage as equals in international relations. During this time, Germany exerted arguably the greatest influence among the KMT's governing elite. Chiang Kai-shek viewed Prussian fascism as a model of rapid national development to emulate in order to mobilize and discipline the populace into breathing 'New Life' into the nation[86] (Kirby 1984). Looking to revive the domestic German economy struggling under the aftermath of WWI and the global slowdown of the Great Depression, the Nazi leadership looked to China as both a source of cheap resources and an immense potential market for German industry. The two countries brokered a set of barter agreements in which China exchanged raw materials for German military equipment,[87] railroad materials, and industrial equipment. The German government sponsored Chinese students to receive training in Germany; when they returned, many staffed agencies overseeing China's industrial and military modernization (Kirby 1984).

In addition to soy, food oils, and eggs, China exported tungsten, antimony, tin, and copper, which were crucial for Germany's post-WWI rearmament. Tungsten is an important element of war because it is extremely hard, so it is used to make projectiles. It also has the lowest coefficient of thermal expansion of any pure metal, so it was an important predecessor to rare earth superalloys in the construction of airplane engines, tanks, rockets, and other steel alloys (Li 1955). Antimony was used to build ignition switches, to produce flame retardants, and to harden the lead used in bullets (Butterman 2004). Both were important predecessors to rare earth elements in the development of modern industry and warfare.[88] But they were heavy and cracked unpredictably, so scientists sought replacements. It is important to note that as the 2010 crisis stimulated the search for rare earth replacements, rare earths themselves were once replacements for other things.

During this time, Germany provided the majority of China's foreign credit, so the KMT sought to expand the terms of the agreement as much as possible in order to build an industrial and raw materials basis to resist Japanese Imperialism. Because minerals and metals formed the basis of the agreement, the KMT leadership worked to expand China's mineral output as much as possible (Kirby 1984), enlisting German, Swiss, and Danish experts to explore and map the subsoils of Inner Mongolia and Xinjiang. The international teams of geologists, archeologists

[86] A euphemism for purging communists and other 'undesirables,' which culminated in the Shanghai Massacre of 1927. See Stranahan (1998) and Wakeman (1995) *inter alia.*
[87] This was huge: tons of ammonium nitrate (for explosives), heavy artillery, airplanes, and submarines.
[88] The production of both is currently concentrated in China. As of 2013, China produced 80% of the global supply of antimony, and was aggressively buying up and then closing foreign firms (1995). China currently produces about 85% of the global supply of Tungsten (Bromby 2013), and global shortages in recent years have driven the US and Russia to sell off domestic stockpiles. Both, like rare earths, are considered critical materials. The fixation on rare earth elements has perhaps hindered a more holistic approach to strategic questions concerning the geography of critical materials production and consumption.

including John Gunnar Andersson, and geographers including prominent Swiss Sven Hedin formed the Northwestern Scientific Expedition Team[89] which identified mineral, fossil, and archeological treasures in this 'Western Asian frontier' (Deng 2007, Hedin et al. 1944).

In April 1927, this team of forty left Beijing by train and traveled to Baotou—then a border outpost before the 'uninhabited' steppe and desert—where they provisioned themselves for the long prospecting journey by mule and camel from Baotou to Alashan tribe in Ejina Banner (Xing 1992). Under these circumstances in July 1927, the geologist Ding Daoheng discovered the resources at Bayan Obo (Ding 1933). Although he is upheld as a national hero for identifying what was, for a long time, thought to be the world's largest rare earth deposit, he was part of a group within the expedition that was entirely focused on identifying iron sources to provision German, Russian, and nascent KMT industry. The presence of rare earths at Bayan Obo was not demonstrated until ten years later by the chemist He Zuolin[90] (Zhang 1995).

Ding did not publish his results until 1933 because he remained active in the expedition for the entirety of its five-year duration, discovering dinosaur fossils and leading a KMT political expedition through Xinjiang (Luo 2007). The following year he went to Berlin to complete his PhD, a fact that is often omitted from popular retellings of his illustrious career, which tend to omit international collaboration or experience. He returned in 1937 on the eve of the Japanese invasion, and took up a teaching post in Wuhan during the Western retreat (Luo 2007). After the founding of the PRC, he served on various high-level committees in central and western China, but never returned to Bayan Obo. The Annals of the District of Bayan Obo reports that he wished deeply in his heart to return to the northern borderland so loaded with significance in his life and that of the nation. When he received the 'joyous news' of the government planned 'geological assault' on Bayan Obo, he reportedly looked northward, wept tears of excitement, and fervently uttered his best wishes for the exploitation of Bayan Obo to begin as quickly as possible[91] (Zhao 2010, 386).

At the time of the Northwest Expedition, Inner Mongolia was officially under control of the Nationalist government of Chiang Kai-shek, headquartered in Nanjing over a thousand kilometers away. The native Mongolians were organized into tribes[92] which were further divided into Banners[93], the latter of which collectively owned the soils and subsoils of Inner Mongolia. Although they maintained a certain degree of autonomy under the Republican government despite the best efforts of the latter, there was a growing independence movement aggravated by the Chinese policy, initiated in the Qing and continued under the KMT, of encouraging Han migration to the region (Committee 1941, Archive 1916). For centuries, the sandy soils of Inner Mongolia had generally discouraged large-scale migration by the agrarian Chinese. The soils can support fodder for nomadic pastoralists, but generally not for settled agriculture. Despite this, the Qing dynasty (1644 – 1911) began a resettlement campaign for Chinese peasants who had lost their land to war or natural disasters elsewhere in China. Although the Qing dynasty

89 西北科学考察团
90 Also romanized as Ho Tzao-lin
91 "1950 年，当他听到政务院地质调查队开赴白云鄂博，开始大规模地质会战的喜讯后，这位著名的科学家愿望北方，抹着脸上激动的泪花，祝福白云鄂博早日开发。"
92 盟 *meng*
93 期 *qi*

collapsed (1911) before agrarian colonization could be extended into Mongolia, the Republican government (1912 – 1949) adapted this strategy and renamed it the *land reclamation program*[94] to alleviate land crises elsewhere while territorializing the northern border (Fieldnotes, 21 January 2013). Over the first half of the twentieth century, this and related policies stimulated the migration of an estimated 4.5 million people, primarily Han Chinese, to IMAR (Cai 2007).

Inner Mongolian leadership feared that their lands would be overwhelmed by the growing Han Chinese population, and wanted independence from China. The leading Mongolian Prince Demchegdongrov[95] had already held a conference on Inner Mongolian Self-Rule in 1933. The Imperial Japanese Army exploited this, establishing a puppet government and organizing armies under Mongolian Princes to fight on their side against the Chinese. Prince Demchegdongrov announced his break with the Nationalists in February 1936 and gathered his military at Bailingmiao located within present Baotou municipality and just twenty miles southeast of the Bayan Obo mining district. At the time, Bailingmiao and Bayan Obo were within two neighboring provinces, Chahar and Suiyuan, that have since been subsumed into Baotou under Inner Mongolia's contemporary administrative units (Tighe 2005). On 14 November 1936, the Japanese-backed Mongolian army invaded Suiyuan in order to set up a puppet government and exploit the region's mineral wealth. They—and the rest of the world, judging from Anglophone news articles at the time—were surprised by the ferocity of the Chinese nationalist resistance led by General Fu Tso-yi, which left the Mongolian armies in disarray. It was also, notes Jowett (2005), the first time that the international press reported that Chinese forces successfully fought off Japanese-led forces, though Anglophone media was quick to attribute the success to military aid from Siberia, Czechoslovokia, and Indo-China (Press 1937c). Determined to capture Suiyuan and its mineral wealth under the guise of incorporating the territory into an independent Mongolian state[96] (Press 1937b), the Japanese led small-scale skirmishes over the next eight months without conquering Suiyuan (Jowett 2005). Bayan Obo stayed within Chinese control[97], but the historical coincidence of Ding Daoheng's discoveries and the threat of Japanese occupation is frequently cited in local histories in order to construct Bayan Obo as a national treasure nearly lost.

Although the Mongolian desire for independence and the collaboration with Japan has been sanitized out of Chinese accounts of the War of Resistance in this area, the Inner Mongolian Construction Committee[98] under the Communist Party has worked hard to maintain a living memory of local conflicts. The story is retold as one of popular resistance against both the forces of Japanese imperialism and KMT feudalism, although many sources outside of China indicate that the Nationalist Army was responsible for defending Suiyuan until the leading

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[94] 放垦 *fangken*

[95] Also known in the Sinicized form as Teh Wang.

[96] Called Mongokuo, modeled with Japanese advice after Manchukuo in Northeastern China. Japan claimed that their imperial forces had nothing to do with this, even claiming that the land was 'too barren' for them to be interested in incorporating it. This conflicts with reports from missionaries at the time, which corroborated with Chinese reports that Mongolian forces were under Japanese command.

[97] "The reports said the new nation carved out of northern Chahar province included and area roughly the size of the state of Ohio. Bounded on the north by outer Mongolia, one the east by Jehol province, and on the west by the strongly-fortified Chinese province of Suiyuan, its southern border was said to have been placed along the Great Wall, extending at one point with 20 miles north of Kalgan," (Gandhi 2013)

[98] 内蒙古老区建设促进会

general, Fu Zuoyi, became disillusioned the Nationalists and agreed to fight under the Communists (Press 1937d). Official accounts of the changeover from nationalist to communist control emphasize the peaceful character of it, wherein a leading opponent saw the errors of his ways and converted to the communist cause[99] (Bai 1999). What is emphasized in the stories, local monumentalities, and official history around Inner Mongolia, particularly in Hohhot, Baotou, and Bayan Obo is the unity of the ethnically diverse Chinese nation in the name of revolutionary Communism (Li 2005). As one official in Hohhot wrote:

> "In Inner Mongolia's glorious revolutionary tradition of opposing imperialism, opposing feudalism and opposing bourgeois capitalism in a revolutionary struggle of over a hundred years, countless Inner Mongolian revolutionaries of Mongolian, Han, and other ethnicities shed their blood and laid down their precious lives (Chao 2000, 1)."

In the Sino-Soviet Treaty of 1945[100], Stalin agreed that the Soviet Union would enter into the War against Japan on the condition that China recognize the status quo of de facto independence of Outer Mongolia (Rupen 1955).[101] The Nationalist diplomats opposed this, but eventually capitulated when Stalin offered Inner Mongolia to China against the wishes of his Mongolian allies. This was the first formal division of Mongolia, reinforced by the terms of the Yalta Agreements (Liu 2006). After Japan's surrender in 1945, Mao Zedong leveraged the rift between the Mongolians and the Nationalists by offering autonomous governance to Inner Mongolia if they joined the Communists in fighting off the Nationalists. After two betrayals of Mongolian hopes for self-rule, once from Japan, another from the Soviet Union, and stirred by the hope that Inner Mongolian autonomy might lead to Pan-Mongolian unification, the Inner Mongolian leadership agreed to the offer (Liu 2006). What followed was an intensive Party education campaign of an ethnically Mongolian cadre elite to build a socialist Inner Mongolia (Wu 1999). Those who continued to fight for true independence or reunification with Mongolia were branded Japanese collaborators or 'counter-revolutionaries' and later purged (Bulag 1998, Brown 2007b) According to some estimates, 10% of the ethnic Mongolian population of Inner Mongolia of approximately 1.5 million people were executed between 1945 and 1949 (Oyunbilig 1997).[102]

On the eve of the 1949 revolution, the US Department of State was in negotiations with China's Republican government to collaborate in geological "exploration of China for minerals

[99] In his remarks on March 5, 1949, Mao emphasized the 'Suiyuan Style' of revolutionary victory 'as a bloodless method of struggle, but that is not to say it isn't struggle…that captures a portion of the nationalist army and strives for them to stand up on our side of politics," (Bai 1999, i).

[100] Also known as the Yalta Agreement

[101] This, although Article 5 of the previous treaty "Agreement on General Principles for the Settlement of Questions between the Republic of China and the USSR," signed 31 May 1924, contained the following language: "the Government of the USSR recognizes that Outer Mongolia is an integral part of the Republic of China and respects China's sovereignty therein." In December of 1924, Chicherin, the Foreign Affairs Commissar of the USSR issued the following statement which was taken to define the 'status quo' as used in the Yalta Agreements: "We recognize the Mongolia People's Republic as part of the Chinese Republic, but we recognize also its autonomy in so far-reaching a sense that we regard it not only as independent of China in its internal affairs, but also as capable of pursuing its foreign policy independently." (Press 1937a)

[102] One ethnic Mongolian official in Hohhot explained in confidence that Mongolians do not like to celebrate mid-Autumn festival, because once as a putative gesture of friendship the PLA distributed thousands of poisoned moon cakes to ethnic Mongolian families. IMAR People's Standing Committee Ethnic Affairs Representative, interview by author, September 2013.

of importance in the atomic energy programs of the two governments," (Stuart 1948). The Atomic Energy Commission and affiliated private firms sought to secure low-cost monazite sands outside of India, while the Chinese Republican government hoped that guaranteeing high volume sales to the United States would help generate foreign exchange which then could be used to purchase the necessary equipment to develop its own nuclear program (Stuart 1948, 748). In exchange, the US Department of State arranged for Chinese scientists to receive training in the United States. This agreement, which was all but approved in late November 1948, never reached fruition as the People's Liberation Army defeated the KMT south of Baotou, driving them out of the hinterland, forcing their surrender in the Northeast, and retaking Beijing. Shortly thereafter in 1949, the Republican government fled to Taiwan with the Sino-American survey documents for Chinese uranium and allied minerals, where they would be kept safe from the "unauthorized" hands of the Chinese communists (Stuart 1948, 751). But the geologists, by and large, stayed on the mainland. They maintained that "governments might come and go, but geological knowledge would always benefit the nation, so the development of a geological enterprise was inherently patriotic," (Shen 2014, 186).

The members of China's Geological Society adapted to the prevailing ideology immediately following the founding of the People's Republic of China in 1949. They denounced Republican-era practices as 'capitalist' and criticized their recent international collaborators as conducting shallow research to serve the narrow interests of business and the Western imperialism, citing US and British activities in the Middle East, which they characterized as lacking both objectivity and long-term viability. They argued that Socialist geology, by contrast, had a boundless and bright future supporting the development of society and improving the standard of living for all workers (Cheng 1950). To correct the error of their past ways, the Society advised geologists to "learn to grasp the Marxist-Leninist standpoint, perspective, and method," (Shen 2014, 187).

Although much has been made of the setbacks dealt by Maoism and the Cultural Revolution to the development of modern Chinese science (Hsü 1982 inter alia), Oldroyd observed that the East-West divergences in geological theory during the Cold War period were due to the fact that much geological data was being gathered for military purposes, and therefore scientists across the globe had less access to each other's data. The hindrances that geopolitical tensions impose on the advancement of geological knowledge are stark; it is very difficult to understand the formation of the Earth when scientists in one region cannot collaborate with scientists in another. Since China's 1978 reforms and the end of the Cold War, the communist-nationalist ideological orientation has undergone revision. Contemporary geologists now criticize the Marxist-Leninist approach as hindering the development of new theories necessary to bring the discipline closer to the "objective reality of the Earth," (Li 1996).

Perhaps because foreign interest in China's mineral wealth is still fresh in living memory, geological knowledge continues to be highly politicized and controlled. The recent WTO cases have been interpreted in domestic China in terms of Soviet, Japanese, and Western imperial interests in the region during the first half of the twentieth century (Wang 2010). As a result, geological practitioners in the government, academies, and state-owned enterprises maintain the air of a priesthood: most of the pertinent knowledge one might need is available in writing if the researcher knows precisely where to look and which questions to ask, but there is an abundance of self-styled gatekeepers who insist that what lies in Bayan Obo is a secret known only to the initiated. The operating theology is nationalism positioned against perceived threats of international resource appropriation.

But the professional pressures to publish in internationally-recognized journals means that the debate over the formation of Bayan Obo has migrated from the cloisters of government agencies to international forums. This is somewhat distinct from the question of politics shaping the formation of geological knowledge about the region, but it is important to note that the project of geological knowledge formation about Bayan Obo is not yet complete. Papers continue to be published in Chinese and English on the 'Bayan Obo Controversy,' which refers exclusively to the geological debate surrounding its origins and formation. Briefly, the controversy concerns how the deposits at Bayan Obo—which are rich not only in rare earth elements, iron and niobium but also gold, uranium, and thorium—were formed (Bai 1996, Wu 2007). One camp maintains that they were formed through sedimentary and later low-grade metamorphic processes, citing evidence of the presence of fossils and high amounts of silica which support theories of an ancient inland sea (Meng 1982). The other argues that, like the general process of formation described in Chapter 1, they are the result of a carbonatitic intrusion typical of infrequent, low-grade seismic activity (Le Bas 2006, Fan et al. 2006, Le Bas et al. 1992). A third has attempted to unify the theories by distinguishing their underlying models (Wu 2007) and placing them both in a geochronology (Smith, Campbell, and Kynicky 2014, Ling et al. 2013): the abundance of minerals suggests that sedimentary, metamorphic, and carbonatitic processes occurred over several heating and cooling periods (Ren, Zhan, and Zhang 1994).

The scientific stakes of this debate concern the foundational theories of the geological life cycle of Inner East Asia, the range of possible conditions under which REEs are formed, and the validity of the claim that Bayan Obo is in fact an exceptional geological formation (Smith, Campbell, and Kynicky 2014). The political stakes follow from the lattermost point: if Bayan Obo is a found to be a truly exceptional formation, then popular fictions concerning China's unique geological endowment gain legitimacy, lending further weight to central government initiatives to slow production, restructure industry, and control the production of knowledge about Bayan Obo. If it were found to be unexceptional, most likely through ongoing comparisons with other rare earth deposits elsewhere, then criticisms that those very same initiatives were thinly disguised geopolitical exercises of economic strategy with little basis in geological fact would be validated. This would cast a new light on Deng Xiaoping's oft-quoted statement "The Middle East has oil; China has Rare Earths." While provocative, it is too often wrongly invoked in Chinese and international discourses to naturalize the dominance of either region in the production of these strategic resources when in fact the top three largest known oil reserves are in the Americas[103], and as previously noted, estimates of China's portion of known global rare earth reserves continue to fall.

Deng's comments were made in 1992; decades after oil deposits in the Americas had displaced Middle Eastern sources as the largest known reserves. Viewed in context, it is hardly a statement of geological fact. It is rather a savvy geopolitical observation on China's position in the global division of labor made during a critical historical moment characterized by the

[103] These are: the Pinceance and Uinta Basins in the United States; the Orinoco Belt in Venezuela, and; the Alberta Oil Sands.

conclusion of the first Iraq war and the first year that China's trade and GDP returned to pre-1989 levels,[104] driven in no small part by the proliferation of subcontracting networks into China's hinterland as international firms sought to cut production costs by moving the dirtiest and most labor intensive portions of their production chains overseas (Muldavin 1993, 2003). In China's orthodox political discourse of the time, the Persian Gulf War was understood as an enforcement of a resource-based status quo under the banner of capitalist democracy.[105] Put differently, it was an exercise to preserve the global division of extractive labor. Further, China's trade and GDP had suffered significantly following the international response to the Tiananmen Square massacre in 1989, which was framed in the orthodox political discourse of the time as an attempted imposition of western ideology. Given this context, it is most plausible that Deng Xiaoping was commenting on not just the significance of natural resources, but also on the global geography of their production in the first major military exercise following the Cold War.

While the production of geological knowledge was central to territorializing Inner Mongolia over the first half of the twentieth century, geological fact has not been what has mattered most in the contemporary politics surrounding China's rare earth monopoly. Rather, it is the fictions have arguably been most important in generating domestic resource nationalism and reviving protectionist tendencies in China as well as in Europe and the United States. Even as geological fact percolates into popular and official discourse—most commonly with the prim assertions that rare earths are not that *rare,* actually—it has not addressed the often unspoken fears expressed in the Malthusian and Hotelling theses of resource scarcity. Thus the power of those fictitious logics remains on all sides in lingering fear that the wrong party—whomsoever that may be—will seize control of these strategically vital elements. This is why actual and structural scarcity are so seldom distinguished, and this is why rare earth elements are classified as critical and spoken of as treasures (Wang 2010, Congress 2011, AP 2013).

This section has traced the complex political and economic circumstances over the 20th century under which Bayan Obo's resources were identified, characterized, and produced as a national treasure. This history demonstrates that geology has served as a both a practice of territoriality and an exercise of power in the contest over the land and resources of Inner Mongolia. Far from being an isolationist measure by a single-minded party state, the process by which Inner Mongolia, Baotou, and Bayan Obo were explored, captured, defended and rationalized was in fact a transnational military and ideological struggle among powers great and small to reconfigure a historically contested frontier region into a strategic hinterland to provide the material basis of modernist statecraft, namely war and industry. Resource exploitation served as a motor of imperialism and nationalism: once the sacred mountain was expropriated from Mongolian pastoralists, *whether* the resources at Bayan Obo should be exploited was never the question. Then, as now, the struggles concern the meaning, control, and purpose of mining Bayan Obo.

[104] More on historical convergences in section III
[105] IMAR People's Standing Committee Ethnic Affairs Representative, interview by author, April 2013

II. Red Hinterland: Frontier Territoriality, Biogeopolitics, Ethnic Unity

If the material basis of modern statecraft is war and industry[106] (Lauren, Craig, and George 2007, Clausewitz 1976, Guo 2013), then the material bases of war and industry are land, labor, and minerals. The mobilizing forces that transform land, labor, and minerals into the substance of war and industry in frontier regions are *territoriality* and *biogeopolitics*. I define *territoriality* according to Deleuze and Guattari's (1987, 174; 180-182) formulation which holds that territorialization is also *de-* and *re-*territorialization: a spatial order cannot be imposed without expropriating that which came before, yet the imposition of one order does not mean total obliteration of the preceding. What emerges then are territorial assemblages, or in other words a space characterized by multiple and often antagonistic social orders struggling over meaning and control of a specific place.[107] Biogeopolitics refers to a specific form of territoriality in these resource-rich and historically contested frontier regions that emerged after campaigns involving state-directed mass death become untenable. As a matter of both compromise and strategy, the state switched from racially coded 'purges' to the formation of desirable frontier subjects in order to achieve developmentalist and geopolitical ends in frontier spaces. Hence territoriality refers to the broader process of wresting a red hinterland out of a historically independent and contested region, while biogeopolitics[108] refers to its specific forms exercised through cultural and development campaigns—and the assertion of lethal force when they fail—distinct to frontier regions imbued with geopolitical significance.

It is the mobilization of these processes that rationalizes a frontier into a hinterland, but as explained in the introduction, this transformation is neither a teleological outcome of the consolidation of state power nor the relentless march of global capitalism. Frontier spaces are dialectically produced and are therefore defined by much more than their interpellation as such (cf. Foweraker 1981) by non-local powers (Tsing 2005): it is the local material histories—a combination of geology, polity, and history—that set the terms for intervention in dialectical tension with global political economic change. Territoriality and biogeopolitics are processes, which is to say that they are recognizable in motion, change, and tension over space and time. These processes have been legible in Bayan Obo and Baotou since 1947 as ongoing nation building projects characterized by industrial extractivism, and explicitly raced and gendered campaigns aimed at ethnic unity and the formation of the model modern Chinese socialist citizen-subject.

[106] Or politics and economy, or policy and markets, or power and technology. There are rich literatures devoted to defining these couplets and the relationship within them; 'war and industry' is decidedly more antiquated than the others; I use it deliberately in order to capture the particular form of the political and economic imperatives that sought to render the southern Mongolian Steppe into a Red Hinterland for the People's Republic of China and the former Soviet Union (Hurst 2010, Jia 2009). For an excellent discussion on the relationship between war and the state, see *Treatise on Nomadology—The War Machine* (Deleuze 1987).

[107] "…there is more to the picture than semiotic systems waging war on one another armed only with their own weapons. *Very specific assemblages of power impose significance and subjectification* as their determinate form of expression, in reciprocal presupposition with new contents: there is no significance without despotic assemblage, no subjectification without an authoritarian assemblage, and no mixture between the two without assemblages of power that act through signifiers and act upon souls and subjects. It is these assemblages, these despotic or authoritarian formations, that give the new semiotic system the means of its imperialism, in other words, the means both to crush the other semiotics and protect itself against any threat from the outside," (Deleuze 1987, 418 - 420).

[108] Elaborated in the Introduction.

Figure 11: Front page headline from *Inner Mongolia Daily,* 1 January 1948

内蒙古日報

1948年1月1日創刊　第2951号　社址：呼和浩特市新城

貫徹民族政策　發展經济文化

我区少数民族逐步改变落后面貌

（据新华社呼和浩特消息）新华社記者白树廉报道：內蒙古自治区成立十年中，自治区境內的回、滿、达斡尔、鄂倫春、鄂溫克、朝鮮等少数民族的政治經济和文化等事業有了很大發展。

內蒙古自治区是多民族地区。解放以前，反动統治阶級对区內少数民族实行了極端殘暴的压迫、剝削和消灭的政策。使他們不仅沒有政治权利，甚至連民族的生存都沒有保障。在內蒙古推行区域自治的十年中，自治区党和政府坚决地貫徹执行了各民族一律平等的政策，积極帮助各少数民族發展了經济文化事業，使他們获得了自由、繁荣的新生活。

居住在大兴安嶺的鄂倫春族在1952年就实行了区域自治，建立了鄂倫春自治旗。达斡尔族区域自治的筹备工作，正在进行。其他各旗县少数民族聚居的地区，也分别建立了以朝鮮、回、达斡尔和鄂溫克等民族为主的民族乡。鄂倫春自治旗机关已基本上实現了民族化，这个旗人民委員会委員中鄂倫春族占65%，散居在各地的少数民族也都得到了民族平等的权利。現在，各民族在各級人民代表大会和人民委員会中，都有自己的代表和委員。內蒙古自治区人民代表大会代表中少数民族代表即占8.7%，而他們的人口則仅占全区人口的1.5%。保証了各少数民族人民当家作主的权利，提高了少数民族的政治积極性，加强了民族团結。

少数民族干部大量成長，是自治区工作中的一項重要成就。据1956年底統計，少数民族干部共有四千九百零三名，占总人口数的4.1%。同时还出現了一批工人和技术人員。他們都是在各項社会改革、生产建設和各种学校訓練班中培养提拔出来的。在这些干部和工人中，有相当一部分是共产党員和青年团員。

历史上遺留下来的各少数民族經济文化落后面貌，随着国家和自治区建設事業的發展也迅速改变着。目前，在农村中已有95%以上的少数民族农民参加了农業生产合作社。在边沿山区和林区以經营牧業、獵業为生的鄂倫春、鄂溫克等族普遍建立了牧業獵業或农牧獵業相結合的生产合作社或互助組。其中鄂倫春族就組織了五个獵業和农牧林業多种經营的生产合作社。生产的合作化，使少数民族的生产和收入增加了。莫力达瓦旗达斡尔族和鄂溫克人合作建成納文农業生产合作社后，粮食产量逐年增長，現在不但粮食能够自給，而且在去年还卖給国家余粮三十九万五千斤。額尔古納旗鄂溫克獵人的收入1956年比1953年增長了兩倍多。同时，獵区和林区实行定居的亦越来越多，到目前为止，已有37%的鄂倫春人和25%的鄂溫克人定居下来，并建立了本民族的經济文化中心。

随着經济生活的上升，少数民族的文化教育事業有了很大發展。达斡尔族聚居的莫力达瓦旗解放前只有小学三十所，到1956年已發展到五十二所。朝鮮族小学由解放前一处發展为十七所，并建立了一所中学。过去沒有学校的回、鄂倫春等族，已建立起十六所小学和一所中学。現在，90%以上的少数民族学龄兒童都入了学，全区少数民族小学生已由1946年的一千零三十八名增加到一万五千三百一十九名，十年中增加近十五倍。另外还有二千八百七十四名中学生和八十八名大学生。

少数民族地区还普遍建立起医疗衞生机構，并且广泛推行新法接生，大力开展了妇幼保健工作，对鄂倫春、鄂溫克族人民还实行了免費治疗。由于衞生保健工作的普遍开展，在各族人民中流行的性病、克山病等疾病已停止蔓延，人口呈現兴旺景象。鄂倫春族人口五年中增加了10%，回、滿、达斡尔、朝鮮等八个民族在1950年只有九万二千多人，現在已上升到十二万人左右。

为了不断改进少数民族的生产和生活，国家除每年發放大量貸款和物資外，还帮助少数民族發展了榨油厂、乳品厂和窰業生产合作社等小型工業和手工業生产。同时，特别注意發展少数民族地区国营商店和合作社，大力收購土特产品，及时供应生产及生活資料。去年供銷部門从鄂倫春自治旗收購的杂皮、药材、木耳等土产品，总値达一十二万七千四百多元。他們需要的打搂草机、双輪双鏵犁和粮食等也及时得到供应。

The circled headline reads: “Ethnic Policy: Develop Economy and Culture. My Region’s Ethnic Minorities are Gradually Changing Their Backward Attitudes.” The article reports on the policy progress in education, ethnic political representation, and the state support for increasing the productivity of ethnic peoples and ethnic enterprises.

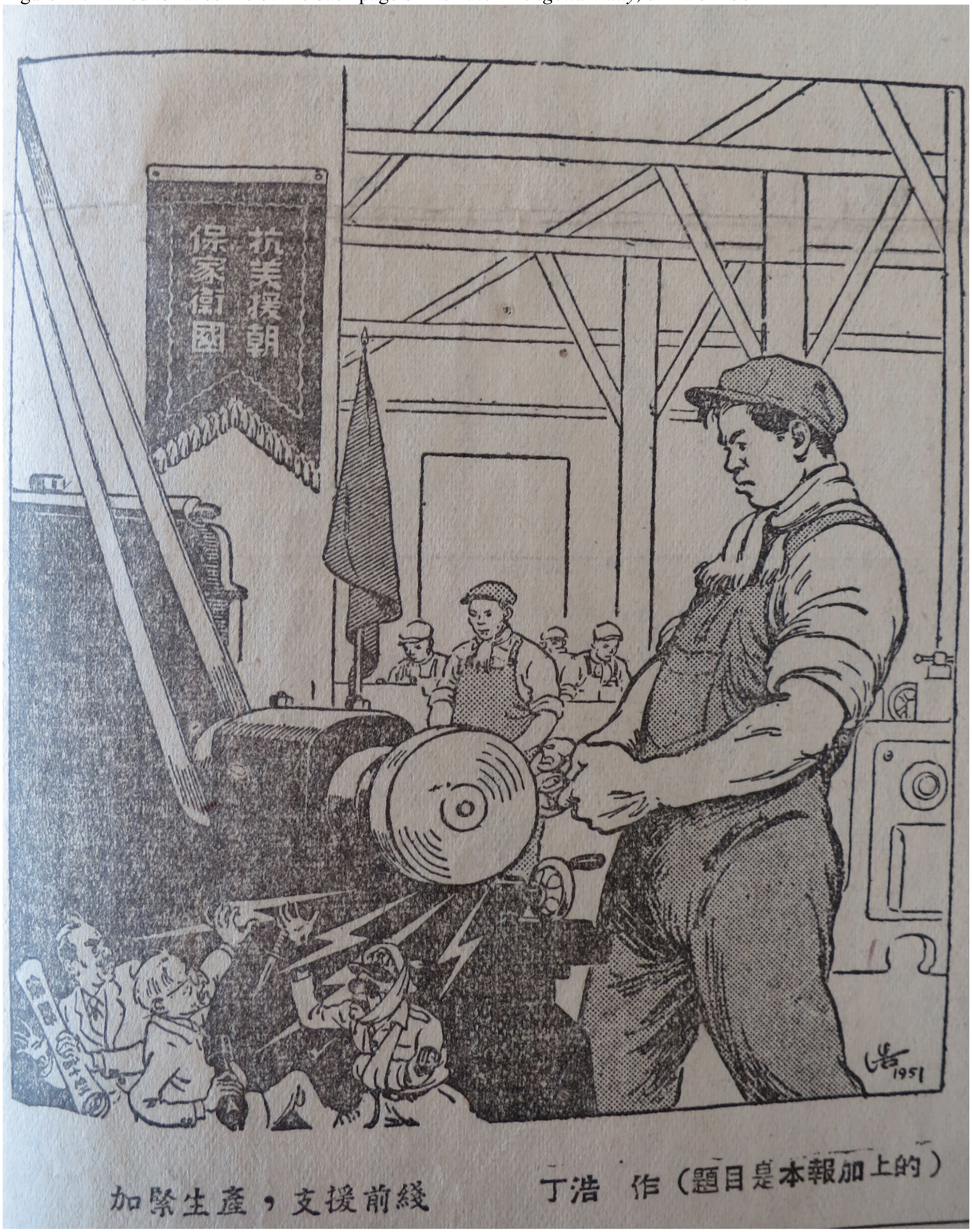
Figure 12: Photo from *Inner Mongolia Daily* special edition entitled 'Today in Baotou: Part I' from 16 November 1954.

The photo shows Han and Mongolian women posing in the foreground while men unload the truck in the background. The caption reads: 'People from all over fervently support the construction of the Baotou Industrial Base. Workers are busy unloading a foreign machine parts delivery.'

Figure 13: Photo from *Inner Mongolia Daily* front page article on women's committee progress, 12 June 1952

The photo shows a Han women's committee representative posing with new ethnic Mongolian delegates from a pastoral region.

Figure 14: An editorial comic on the back page of the *Inner Mongolia Daily,* 5 March 1952



The comic portrays a male industrial worker thwarting western imperialists with his machine. The caption reads: ‘Speed up production, support the front line.’

Figure 15: Photos excerpted from a special to the *Inner Mongolia Daily* entitled “Young Women Build Socialism!” 12 June 1953

A team composed of young Han women shown surveying and cataloging Inner Mongolia’s natural resources.

The new Communist leadership was intent on taming the northern frontier and set to work bounding its people and resources into the task of building ‘New China.’ Three core issues defined this agenda. The first were border threats: there remained a restive Mongolian independence movement, while the Soviet Union determined to incorporate these same regions into its own industrial hinterland (Liu 2006, Tighe 2005, Nachukdorji 1955). The second issue stemmed from the first: the question of urban infrastructure construction and transportation—to bring labor and supplies in while getting raw materials out—and its guiding rationale of what has been identified as socialist governmentality (Gaubatz 2008, Lu 2006, Quan 2012). Third was the convergence of the housing, land, and employment crises elsewhere in the country, particularly in post-War Manchuria, in a region in which the Soviet Union held investments and privileges on par with those enjoyed by former colonial powers—particularly Britain and Japan. Mao’s security strategy relied foremost on mobilizing people through grand social engineering projects that have been well studied elsewhere (Eberstadt 1980, Schwartz 1968, Shapiro 2001, Terrill 1999, Pye 1999, Lin 1990, Hinton 1966, Chan 1992) to solve all three problems at once.

The housing, land, and employment problems stemmed from surplus population while the Mongolian and Soviet problems could be addressed by ‘Sinicizing’ the frontier through large scale migration and construction campaigns (Han 2011 *inter alia*). But attempting to bind the region to national territory by physically relocating people was hardly a new strategy, nor, especially, was ‘sinicization’.[109] Mao continued the migration and agrarian resettlement campaign initiated under the Qing and furthered by the Nationalists which was overseen by former Nationalist General Fu Tso-yi to populate the border region with Han military and civilian personnel (Tighe 2005). The Chinese Communist Party launched a massive ‘Ethnic Unity’ propaganda and education campaign to integrate Mongolians and Han Chinese in Inner Mongolia Autonomous region, thereby circumscribing any promised Mongolian Autonomy in the region (Editor 1948 - 1958). This hinged upon an explicitly gendered division of labor orchestrated to advance urban and industrial development on the Inner Mongolian frontier with the objective of bounding the territory into the national hinterland through industrial and

[109] For a sense of the debate concerning the long history of sinicization, see (Rawski 1996) and (Ho 1998).

reproductive measures (Wang 2000). The development of China's rare earth industry cannot be understood apart from these three processes, which channeled labor and resources to the region while constructing a particular ethnonationalist culture around the mineral resources in Baotou and Bayan Obo.

Frontier territoriality

One primary objective of state strategies to rationalize frontier spaces into the 'national geo-body' (Thongchai 1988) by imposing borders to concretize hegemony and delineate the extent of state power. The objective of this is to produce a hinterland within the newly bounded territory. The moment of transformation from frontier to hinterland is marked by the reorientation of local (re)productive activities toward the enrichment of the state or other extralocal power. Both China and the USSR had territorial ambitions for Baotou that figured in the earliest official relations between the two republics. On December 16, 1949, ten weeks after the founding of the People's Republic of China, the newly established Ministry of Heavy Industry[110] held its first working meeting in Beijing with the objective of planning a new steel and metallurgical center in China's interior. That same month, Chairman Mao Zedong left China for the first time on a diplomatic visit to the Soviet Union. Shortly thereafter in January 1950, Premier Zhou Enlai traveled to Moscow with a group of officials prepared to negotiate a strategic partnership and development assistance portfolio with the Soviet Union (Su 2004). In the cold months of early winter, both sides hammered out the details of the *Sino-Soviet Treaty of Friendship, Alliance and Mutual Assistance* in Moscow which contained overlapping and conflicting expressions of frontier territoriality as envisioned by each republic. In exchange for development aid and the promise of comprehensive military, industrial, and scientific knowledge-transfer, Mao's delegation granted the Soviet Union special privileges in Xinjiang, Manchuria, and parts of Inner Mongolia.

These territorial privileges represented a continuation of Soviet geostrategic practices since the 1930s, which had been formalized in concessions granted by Chiang Kai-shek in the Sino-Soviet Treaty of 1945 (Kraus 2010). The regions attributed to the 'Soviet sphere of influence' were vast: they included Manchuria, Xinjiang and what is now Eastern and Western Inner Mongolia (Li 1998). But it is a mistake to assume continuous rule in practice simply because it was agreed upon in Moscow and Beijing. These two metropoles were thousands of kilometers away from these immense spaces peopled by nomadic civilizations scattered across vast regions divided by mountains and deserts long traversed by cosmopolitan groups of long-distance traders and missionaries hailing from the farthest reaches of the Eurasian land mass (Lattimore 1962, Gao 1908). Although imperial Japan had made efforts at regional integration in Manchuria and parts of Inner Mongolia by constructing roads and railroads, there was very little infrastructure integrating these regions with Beijing, and even less with Moscow. At least twenty-two different ethnic groups peopled this region from Manchuria to Xinjiang, many with strong cultural memory or ongoing practice of independent self-rule (Liu 2006).[111] Under the

[110] 重工业部

[111] In Bulletin 16 of the Cold War International History Project, Zhou Enlai reportedly explained to Anastas Mikoyan in February 1949: "We do not have contacts with the Xinjiang democratic groups. Our former people there were arrested by [one time governor of Xinjiang] Sheng Shicai. Now we are sending a small group of

Soviet and the Han Chinese, there were periodic independence movements from East Turkestan in what is today Western Xinjiang, to Southern Mongolia in what is today the Inner Mongolia Autonomous region, a region spanning some three thousand miles (Bulag 2004, Rossabi 2004).

But as the previous section shows, the resources in this region beckoned to expansionist powers and arguably continue to do so. Successive Chinese, Russian, and European governments preceding Mao and Stalin had looked to these regions with the expectation of mining necessary resources and forging new trade routes (Millward 1998, Perdue 2005, Fletcher 1978). State presence had a fluid history in these regions, varying between occasional military occupations, religious fiefdoms, and the periodic rise of city-states and oasis towns (Barfield 1989, Lattimore 1962). Peopled by ethnic others atop immense mineral bounty just beyond the reach of the regular operations of centralized national power, the regions were problematized by both industrializing powers as lawless, porous, and underutilized.

This was precisely 'the frontier problem'[112] to be solved by Beijing, which the Communist leadership sought to accomplish through militarization, industrialization and resource extraction. However, lacking the infrastructure and technology, Beijing granted resource and military concessions to the Soviet Union to develop oil and other mining interests in Xinjiang and parts of Inner Mongolia. There are two divergent interpretations of this history present in both English and Chinese literature: in this case it is time that accounts for changing perspectives. The first is that Stalin forced his Chinese counterparts to accept unfavorable terms in the territorial concessions, in essence creating semi-colonies on Chinese territory which Mao later found repugnant (Zubok 2001, Khrushchev 1971). The second view holds that Mao intended to build an industrial corridor to connect the Soviet and Chinese economies, and saw sites of ongoing Soviet presence as potential industrial hubs to jumpstart China's economic recovery and stabilization (Kraus 2010, 135, Westad 2003).

Based on the portrayal of these concessions in the Chinese newspapers of the time, it appears that the Chinese leadership sought to build Baotou into an industrialized mining hinterland by granting the Soviet Union qualified access to the mineral wealth and territorial power to be gleaned by exercising privilege in Xinjiang and Inner Mongolia's vast spaces (Editor 1948 - 1958). Regional state-run newspapers recast this arrangement as friendship, and exhorted the readers to strive in every way to deepen the friendship between China and the Soviet Union. The fruits of this were displayed in photographs of military technology, survey reports, and industrial construction featuring Chinese and Soviet personnel (Editor 1949, 1948 - 1958). Indeed, in assessing "the present character and probable future courses" of Sino-Soviet relations, the US Intelligence Advisory Committee,[113] surmised that China "provides the USSR with a defense in depth, constitutes a valuable potential source of manpower and other resources, and is an important political and psychological asset," (CIA 1952, 4). Although Soviet political and economic influence along China's northern border was extensive, a 1952 CIA report found that "Chinese political and territorial interests have apparently not been sacrificed in the interest of

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comrades there." As quoted in the "Memorandum of Conversation between Anastas Mikoyan and Zhou Enlai, 1 February 1949 (Evening). In Kraus (2010, footnote 7).

[112] Defined in the introduction.

[113] Composed of the intelligence organizations of the US Departments of State, the Army, the Navy, the Air Force and the Joint Staff.

Soviet expansion," and further predicted that the trend since the ratification of the Sino-Soviet treaty appeared "to be towards and increase in Chinese Communist administrative control," in the region (CIA 1952). Were frontier territoriality so firmly and explicitly within Chinese control, it is unlikely that territorial tensions between the two powers would have culminated in the Sino-Soviet split. The ongoing confusion appears to stem from a generalized tendency to accept orthodox narratives of the founding of the PRC as a stark break with the colonial and feudal past instead of a dynamic and specific set of historical continuities.

Postcolonial China scholarship (Xu 1998, Shih 1998, Brook and Luong 1999, Xu 1996) has largely accepted the epistemic rupture insisted upon in the orthodox founding narrative of the People's Republic of China as historical ontology insofar as the Soviet presence in China tends to be treated distinctly from Japanese and European colonialism. As a result this scholarship has missed the fact that the enduring Soviet presence in northwest China was a direct contradiction to the territorial ideals of new China (Kraus 2010). The ongoing censorship of archival materials generated by Soviet activities in China from over half a century ago attests to the continuing sensitivity of the territorial narrative. Yet—and especially given that Mongolia was a Soviet satellite at the time—it is unlikely that the Soviet investment in developing industry, infrastructure, and expertise in Baotou and Bayan Obo would have proceeded without the presumption that these regions would serve as the resource base for world communist revolution controlled from Moscow. Provisioning this revolution required the imposition of a raced and gendered regime of labor and sacrifice to transform Baotou and Bayan Obo into a red hinterland.

Biogeopolitics and Ethnic Unity on the Frontier

A principal problem in building up Baotou lay in the need for tremendous labor power to render an industrial hinterland out of a historically recalcitrant frontier region belonging to nomadic polities. Inner Mongolia was sparsely populated; eastern Chinese cities were crowded, and there was an acute need for raw materials to supply the industrialization and urbanization drives. As noted above, Mao's security strategy relied foremost on mobilizing people through grand social engineering projects that have been well studied elsewhere (Eberstadt 1980, Schwartz 1968, Shapiro 2001, Terrill 1999, Pye 1999, Lin 1990, Hinton 1966, Chan 1992). Migration would solve several problems, easing housing, subsistence, and work shortages in eastern China while peopling the frontier with Han Chinese. Furthermore, Li (1989) writes that China's leadership:

> "long perceived the security of the Sino-Soviet border along China's northern frontier to be of particular concern to the nation's territorial integrity…The efforts made to encourage migration have often stemmed from clear strategic, economic, and political motivations…Since the country's ethnic minorities are concentrated in border regions, China's government has pursued efforts to assimilate minority peoples by moving Han Chinese to the border areas…Given national security considerations, it is not surprising that between 1953 and 1982…the population grew by…79.9 percent in Inner Mongolia" (Chou 1982 and State Statistical Bureau 1986 quoted in Li 1989, 503 - 504).

Because securing long-term extraction and industrial modernization depended not only on having plentiful labor but also on establishing a stable, hegemonic claim to the land above these rich geological deposits, the state coordinated labor migration in such a way as to encourage permanent settlement and multiethnic integration. If biopolitics is concerned with life, and geopolitics is concerned with sovereignty, then the transformation of Baotou was a biogeopolitical project replete with the overt and diffuse forms coercive power associated with both sovereign and governmental power. Conditions in war-torn, post-revolutionary Baotou and Bayan Obo were hostile compared to those in more established cities (Bi 2007). Winters were bitter, travel was arduous, and the work was dangerous. The first generations that migrated to IMAR via Xikou (Wang 2012) or along the Japanese-built Tianjin-Baotou railroad are regarded as pioneers who toiled hard and 'ate bitterness'[114] in order to build modern China (Chao 2000). The state propagandized migration to IMAR as part of national construction and reunification, promising migrants not only the chance to settle down and live the proletarian dream of new China, but also to restore millennia-old peaceful and prosperous relations between Han and Mongolian peoples through historical revisionism, development campaigns and (re)productive regimes (Klinger 2011a).

These millennia-old relations were asserted on the basis of one very potent cultural figure, Wang Zhaojun,[115] who was a first century BCE imperial concubine of the Western Han Dynasty (207 BCE – 25 CE). The story of *Zhaojun* concerns an alliance between herself, a Han Chinese woman and Huhehanye, the leader of the Xiongnü people whom occupied the present-day Mongolian steppe. The Xiongnü are remembered as aggressive nomads with fabled cavalry and archery skills, which drove various Chinese empires to build the Great Wall of China. After a decisive battle between the powers in modern-day Shanxi province, Huhehanye visited the Western Han Imperial Palace and demanded a bride. In modern versions of the tale, Zhaojun was spying on the conversation and fell in love at first sight with this fierce Xiongnü leader. Zhaojun's greatness lies in her allegedly pro-active request to leave the comforts of the harem in China to marry a northern 'barbarian,' thus integrating—the story goes—China and Mongolia, bringing about a period of lasting peace between the two peoples, and setting the historical precedent for the inclusion of IMAR into China's contiguous national territory. Her commitment to this lasting peace is demonstrated by her willingness to go beyond China's northern border, to endure the hardships of living on the Mongolian Steppe, and to persuade her husband's people to maintain regular tribute relations with the Han Chinese Empire.

Zhaojun's virtues, true or not, have been framed and disseminated in such a way as to resonate with the revolutionary memory among the elder Han citizens of IMAR and to a lesser extent their now grown children who, unlike their counterparts on the eastern seaboard, still speak in Maoist phraseology (Klinger 2011a). Zhaojun agreed to go far away from home and family for the sake of nation building; she often pined for the culture and cuisine of her native place; in short, she suffered, but she answered a higher calling. This great cultural heroine is therefore 'just like' the early waves of Chinese migrants encouraged by Mao to build the frontier mines, cities, and railroads in the desolate periphery of newly founded IMAR along China's north-central borderland. Zhaojun revivalism was—and continues to be—a key component of this biogeopolitical project in asserting Chinese territoriality in IMAR to secure its status as a resource hinterland.

[114] 吃了很多苦
[115] 王昭君

Figure 16: Statue of Wang Zhaojun and her Husband, Huhehanye, at the Inner Mongolia Autonomous Region Museum in Hohhot, Inner Mongolia

Photo by author, 2011.

Mao's famous maxim that "women hold up half the sky"[116] was driven among other things by the need to unleash the labor power of the majority sex in order to realize the Herculean task of national construction, and the egalitarian recruitment plans were driven by an explicitly reproductivist agenda to territorialize the lands beyond the Great Wall. Nevertheless, Gao (2007) noted the tendency to portray the rationalization of China's frontier regions as a men's story, which has erased women's work in the revolution and created a serious blind spot in studies of early post-Revolution China's territorial project on the northern frontiers. The Zhaojun myth is an important answer to that in local Han culture in Baotou. Memorializing her fabled

[116] 妇女能顶半边天

experience validates the lived experience of those who carried out Mao's contentious project of frontier territoriality, legitimizing the latter by way of affective association with the former.

The People's Liberation Army enlisted women soldiers from the earliest days of the PRC to 'liberate' the northern frontier regions (Gao 2007) but it was not until 2014 that women were deployed to the front lines of national security in Inner Mongolia (Zou 2014). Others were recruited to be teachers, doctors, laborers and farmers. The intersection of race and gender played out differently in Baotou than at other points along the inland frontier. However, there was a common concern that a male-dominated Han population was simply unsustainable. Of Xinjiang, which was territorialized by agro-military initiatives, Gao writes:

> "The PLA could not really settle down in the frontier unless the party assisted the soldiers in establishing families…in a male-only world, the soldiers would likely become bandits, [the PLA leadership] worried. In addition, to avoid ethnic conflict [in Xinjiang], the party initially prohibited Han Chinese men from marrying non-Han women," (Gao 2007, 199).

As a solution, the PLA recruited Han women from eastern China and sent them to Xinjiang to marry soldiers in couplings arranged by the party: "They were told that the guiding principle was 'the party assigns and the woman agrees,'" (Gao 2007, 198). Women's inclusion in the public sphere was a revolutionary development, but it did not signal liberation from the gendered division of labor: "although the Communist Party required the employment of more women in government offices and encouraged women to participate in society, the family was the focus of a woman's life, and the ideology of domesticity predominated," (Gao 2007, 199) on the far Northwestern frontier. In Baotou, although high-ranking soldiers in the region also looked forward to being "rewarded" with a "pretty young woman" from Chengdu or the Northeast in exchange for their service building and securing the IMAR frontier,[117] [118] The territorial campaign in Baotou in particular was characterized by a comparatively greater urban and industrial program which nevertheless was structured by similar reproductivist concerns. Men had come first to build Baotou Iron and Steel and to open the Bayan Obo mine, but:

> "Those early leaders knew that having a lot of young men working in the mines and smelting plants would quickly create the conditions for chaos. A lot of men in one place—such a social arrangement is unsustainable. So they recruited women from Sichuan and the Northeast to come live here, and built textile *danwei* where they could live, work, and start families,"[119]

In contrast to Xinjiang, corporeal integration of the Chinese nation by way of interethnic marriage was encouraged in Inner Mongolia. Both Han and Mongolian women were recruited to aid in the urban industrialization project in Baotou. The successful 'mixing' that resulted from this is cited as a point of pride from the official point of view, something that makes Baotou more 'cosmopolitan and tolerant' than other frontier cities.[120]

Organizing and mobilizing women in Baotou began almost immediately after the founding of the PRC. The Baotou Municipal Women's Committee held its inaugural meeting in

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[117] In popular imagination, women from these places are thought to be exceptionally beautiful.
[118] Mr. Li (People's Liberation Army veteran on Northwestern Front), interview by author, April 2013
[119] Representatives of Baotou Municipal Women's Committee, interviews by author, April 2013
[120] Representatives of Baotou Municipal Women's Committee, interviews by author, April 2013

early December 1949 under the leadership of the communist party, less than three months after the peaceful liberation of Suiyuan[121] in September 1949. At this meeting, the women's committee coordinated with the outgoing Nationalist military government planning committee to develop a 'work plan' and 'work groups' to build up Baotou. Their primary tasks were to: "deepen the women's masses at every level; understand their conditions, study thoughts and feelings, propagandize the party's policies, build a solid base of mass feeling, and work hands-on to build a democratic women's committee," (Zuo 2000, 244). This involved visiting every village and town in the municipality, organizing women, and establishing local women's committee offices. Those who opposed the women's movement were branded as counter-revolutionaries for failing to follow Mao Zedong's thought and not respecting the party's leadership.

After getting established, the Baotou women's committee focused on integrating women under its jurisdiction into the national productivist project using Zhaojun as a model of virtue, bravery, and sacrifice as retold through revolutionary songs and plays. The committee was an important force for integration and subject formation. It identified and celebrated peoples' heroines among local Han and Mongolian women, and organized study groups to propagate the examples of virtuous, revolutionary women who helped liberate China, defend Suiyuan, or resist imperialism. To recruit workers to build up the local textile industry and spread its message of good hygiene, the committee held towel embroidery contests to celebrate the artistry of Han and Mongolian women. In 1957, the Third National Women's Committee Congress resolved to mobilize more women to work within strategically vital national industries. This was significant for Baotou, where five integrated industries had been built to build up China's military: Baotou Iron and Steel, which oversaw mining and beneficiation of the Bayan Obo output; Baotou Smelting Plant, which separated metals from the ores; Inner Mongolia First Aviation Factory which built airplanes for China's nascent air force; Inner Mongolia Northern Heavy Industry Factory, which built tanks and trucks; and China 202 Nuclear Fuels Production Facility, which built critical components for China's atomic and hydrogen bombs.

Mao's comment that women hold up half the sky was meant to liberate them from the "whole feudal-patriarchal system and ideology," (Mao 1967, 44). One conspicuous practice of this former system was the practice of offering high-status Han women to outlying princes in order to cement interstate relations and integrate outlying peoples to the Chinese nation through transmission of the "kin substance." Although the practice was vilified even before Mao (Eoyang 1982), with the intensification of migration it was revived, revised to emphasize individual choice, and romanticized as an ideal way to integrate IMAR with China, with Zhaojun as the model (Bulag 2002). The late Premier Zhou Enlai reportedly encouraged his niece, on the eve of her 1968 departure to IMAR as part of Mao's 'sent-down' youth campaign, to:

> "…be the 'Wang Zhaojun of the new era' in helping enhance the unity between the Han and the Mongols. Eventually she did marry a Mongol, a professional singer, in 1979. Although like many other sent-down youths she returned to Beijing, taking her husband with her, she sees herself as an Inner Mongolian," (Caoyuan Qishilu Bianweihui 1991, pp. 557 – 61 in Pan 2006; 235).

[121] Pre-revolution name for Baotou, assigned during the Qing Dynasty. See *Constructing Suiyuan* (Tighe 2005) for an excellent history.

Women were thus liberated from imperial reproductive servitude but put in service of nationalism to further the state's reach into the northern frontier. "Mongolian-Han blood mixing" continues to be fetishized in local and popular discourse (Representative 2013).[122] But this excitement is differentially raced and gendered: observing the attitudes in one IMAR village, Williams (2002, 97) noted that "nobody seems to mind if Mongol men take a Han wife, but residents frown upon 'losing their women' to the Han, even if the couple remain in the village." Conversely, among Han male contacts, the view was casually expressed that a Han man marrying a Mongolian woman was positive because he would get a spirited and healthy wife, while a Han woman marrying a Mongolian was potentially endangered by his wild masculinity. But in most cases, such commentators were quick to mention the Zhaojun myth to concede that, nevertheless, a Han woman would have a positive influence on her Mongolian husband, and was thereby serving the nation, just like Zhaojun.

Such raced and gendered tension cuts across major questions of values, territory, and memory. The orthodox Chinese discourse insists on a long, happy history between the Han and Mongolians dating back to Zhaojun's marriage to Huhehanye in 200 BCE. But veteran anthropologist Bulag (2002) notes that he has "tried in vain to find any 'folk' literature on Zhaojun among the Mongolians, written in Mongolian language." One Mongolian researcher with an IMAR government research academy stated: "Mongolians are very annoyed with this so-called Zhaojun culture. You can't uphold some unwanted concubine given as war booty to the extinct Xiongnü as a hero of Han-Mongolian harmony any more than you can claim that Genghis Khan was the son of China"[123] Yet the dominant cultural discourse has both since the founding of the PRC.

[122] Representative of Baotou municipal family planning bureau, interview by author, April 2013
[123] Mongolian culture and economy specialist with Inner Mongolia. Autonomous Region Social Science Research Institute, Interview by author, April 2013.

Figure 17: Full page excerpt from *Inner Mongolia Daily* depicting an ethnic unity and nationalist education day around a Genghis Khan memorial ceremony.


〈星期五〉 夏曆癸巳年四月初三日 〈第四版〉

加强民族團結發揚愛國主義精神

—伊金霍洛成吉思汗大祭

↑ 華北少數民族訪問團團長平杰三在大會上講話，號召各族各界人民加強團結，建設各族人民友愛合作的大家庭。

↑ 這是内蒙古自治區人民政府代表團團長高博澤佈在大會上講話的情形。

↑ 伊盟牧民的文化生活已大大提高，這是到會的男女牧民在新華書店書攤上買各種書籍、畫報的情形。

↑ 這是兩位牧民婦女穿着節日盛裝，騎馬趕赴大會的情形。

→ 伊盟盟長額齊爾呼雅克圖在大會上講話，號召加強民族團結，發揚愛國主義精神，繼續加強抗美援朝鬥爭。

→ 成吉思汗大祭儀式全景。

→ 這是牧民們在交易市場上買布疋及日用品的情形。

→ 參加大會的蒙漢人民從遠路成群結隊的趕來。

→ 成吉思汗大祭儀式開始前，伊盟蒙族人民把成吉思汗靈位移到大祭場所。

→ 成吉思汗靈位的正面。

→ 這是農牧民業餘劇團在大會上表演舞蹈的情形。

→ 這是伊盟文工隊演出歌舞劇「好光景」。

→ 成吉思汗大祭會上的工作人員，向農牧民宣傳一九五三年的三大任務。

→ 參加祭典的喇嘛在跳[illegible]。

內蒙畫刊

第一五三期

（這期畫刊的照片是本報記者烏勒、張竹平照的）

The headline reads 'Strengthen Ethnic Unity and Propagate the Nationalist Spirit: Ejinhoro [located to the south of Baotou] commemorates Genghis Khan.'[124]

[124] The present day Genghis Khan Mausoleum is located in Ordos, Southwest of Baotou city. The Mongolian government disputes the Chinese claim that Genghis Khan died in this location and has a large memorial in Ulaanbaatar.

The fact that state entities have been charged with creating and publishing positive, conciliatory accounts of relations between Han settlers and native Mongolians speaks to the complex histories around the socialist modernization project realized through building up a military-industrial base in Baotou and Bayan Obo. One telling example is an attempt to overwrite a particularly painful incident in which PLA soldiers distributed poisoned moon cakes to Mongolian nomads on Mid-Autumn Day with a 'Han-Mongolian Social Gathering Festival.' The official work, published by the Bayan Obo Historical Literature Editing Committee, concedes that "owing to a historical incident," Mid-Autumn Day is "the only unhappy date between the Chinese and Mongolian peoples." But, because Mongolians reportedly assisted a Central Government geological survey team in Bayan Obo in 1950, there is a historical basis for such a holiday (Zhao 2010)

In another example, the periodic *Annals of Bayan Obo* extolls the virtues and wisdom of exploiting the local mineral resources. Because of the national investment and party leadership in Bayan Obo, mining has transformed this place into 'the hometown of rare earths,' bringing international fame, development, prosperity, and happiness to all local peoples. Yet interviews with Mongolians in and around Bayan Obo conveyed the opposite. Bayan Obo referred to a sacred mountain, so named because is looked like a great stone yurt[125]. Mining desecrated the sacred peak by literally emptying it out and inverting the mountain into a great hole in the ground: "this is what the Han do to us; they take everything that is ours."[126]

The feeling of ethnocultural injury was present even among 'sinicized' Mongolians interviewed, whom were model members of the communist party. While passing a plaque marking the northernmost point of the great wall outside of Bayan Obo, my escort who was a communist party youth volunteer explained: 'the Han are crazy about marking everything in IMAR. They do that to make the statement: "look everyone, this land is ours. You Mongolians trespassed."'[127]

In Hohhot, the history of ethnic displacement during the development of the nuclear weapons program is recast as a patriotic cause that united the hearts of all ethnicities. Figure 18 shows a life-sized diorama of a Mongolian family leaving their ancestral land on foot in order to help the PRC conduct its nuclear weapons tests. This continues to be cited as evidence of Chinese destruction and contamination of Mongolian lands by independence activists (Oyunbilig 1997). But the explanation at the museum explains that they made this choice for the glory of the People's Republic of China:

> "To support the Motherland's national defense and aerospace industry, from April 1958, the Ejina banner let go of tens of thousands of square kilometers of land. The banner government moved to a place 140 kilometers away from the original site...The entire population of the migration covered one third of the population of the banner, more than half of the total livestock, and more than 3000 mu of arable land," (Klinger 2013a).

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[125] The large circular tents are typical of Mongolian nomads and celebrated as symbols of life, home and wellness. Natural features that resemble yurts are attributed sacred status in Mongolian spirituality.
[126] Traditional Mongolian medicine practitioner in Bayan Obo, interview by author 2013
[127] Communist Party youth volunteer Ms. Han, escorted survey and interviews in Bayan Obo and vicinity, September 2013

Figure 18: A life-sized diorama at the Inner Mongolia Autonomous Region Museum in Hohhot, Inner Mongolia depicting migrating Mongolian families happily leaving their ancestral lands to support the glorious nuclear achievements of the motherland.

Source: Photo by Author, July 2011.

On the wall beside the display is a quote from Marshal Nie Rongzhen, architect of China's nuclear strategy and head of the nuclear commission that oversaw the development of the bomb. It reads: "All ethnic peoples made a mighty sacrifice in the service of the national defense of the Motherland. We must work for them in return," (Klinger 2011b). The construction of Bayan Obo, Baotou and IMAR was predicated on an explicitly raced and gendered division of labor and, likewise, a raced and gendered regime of sacrifice. While many Han migrants sacrificed their bodies and their lives in the hard labor of building up a Han-dominated military-industrial complex, many Mongolian natives were compelled to resettle. Of both ethnicities, women were recruited and coerced into reproductive labor, while men of both ethnicities were compelled to join military and construction campaigns. Resistance was counter-revolutionary, and punished by imprisonment, hard labor, and execution.

III. Rationalizing Space: Socialist Governmentality and Atomic Aspirations in Cold War Baotou

This section examines the role of Socialist governmentality and atomic aspirations driving the establishment of military industrialism in the red hinterland even amidst national and international turmoil. Many have argued for the applicability of governmentality to states undergoing market liberalization, including China since its reforms in 1978 (Wallis 2013, Ong 2006, Jeffreys 2011). In his adaptation of governmentality to revolutionary China, Dutton (2008) writes that China's particular position during the Cold War as near the very 'hot' sites of Hiroshima and Nagasaki resulted in a very different sort of political calculus in the atomic age, insofar as:

> "…the West…reconfigured the horror of nuclear annihilation as a 'great game' and, in so doing, changed the nature of the military equation. This rationalist disposition turned away from reliance upon the political commitment of the revolutionary toward an even more powerful reliance upon technology. It was different in the East," (Dutton 2008, 101).

Dutton further argues that revolutions are not driven by the cold calculations that emphasized 'a steady hand' and dominated the Cold War framework in the West. Rather, they depend on mass action sustained by intense political commitment. In this context, he writes "strong affective bonds of commitment are, at the very least, just as important as a real concrete enemy," and concludes that "in the heat of revolution, the cold, hard calculation of technological advantage gives way to human struggle—to a world, perversely, that is the world of affect," (Dutton 2008, 101). In practice, this became in China a campaign-style politics recognizable, albeit with some different forms, today (Brady 2012). These campaigns converged both the 'facilitative' and 'authoritative' aspects of governmentality in order to encourage self-development into a proper communist subject (Dutton 2009, Jeffreys 2009) to be mobilized in the name of frontier development and industrial modernization to literality "build the mother country,"[128] (Whyte 1973, Richman 1969). Within the context of the Cold War, in the shadow of the atomic bombings of Hiroshima and Nagasaki, modernity as expounded in revolutionary China had a heavy martial connotation.

The modernization of war and industry as we know it was realized in part through the discovery of new applications of rare earth elements. In the early 1950s, researchers across Eurasia and the Americas were developing rare earth alloys to use in the steel production process to transform the skeletal system of modernity from heavy, rust-prone and brittle to stronger, lighter, and more durable (Morena 1956, Kent 1953), and to make the weapons of war more precise, long-range, and devastating (Bungardt 1959, Hickman 1955). Soviet researchers experimented with nickel-based rare earth superalloys beginning in 1950 in order to move away from the high-temperature instability of iron-tungsten alloys used during WWII. Rare earths are the key to developing materials that remain stable in temperatures as high as 1500 degrees Celsius, the sorts of temperatures needed for rockets and airplane engines. Soviet experts shared their discoveries with Chinese researchers shortly thereafter, and trial superalloys were being developed in China by 1956 (Jiang 2013) as a necessary step in China's quest to develop its own aircraft and ballistic missiles. In both the first and second five year plans of the People's Republic of China, developing these technologies was of utmost importance, not just because they signaled unequivocally the establishment of a modern industrial society, but also because these were viewed as the essential tools to bring about world socialist revolution.

[128] 建设祖国

As such, the first and second five-year plans designated Baotou to be built up as a national industrial foundation[129] (Geng 2007), and emphasized the importance of rare earth metallurgy in basic national industrialization. In the first five-year plan:

> "Industrial development calls for increased production of non-ferrous metals. Since it is still a weak link in our heavy industry, the expansion of non-ferrous metals industry is one of the important tasks of industrial construction under the First Five-Year Plan…We must improve and expand experimental and research work to raise the quality of [metallurgical] products to higher standards. We must increase the output of raw materials needed for production of iron and steel, fluxes and refractory metals…" (Congress 1955, 58 - 59)

With a few exceptions (Clark 1973, Hogan 1999, Wu 1965), accounts of heavy industry development in mid-20th century China tend to emphasize the abundance of low-quality pig iron produced during the 'fanaticism' (Richman 1969) of the Great Leap Forward (1958 – 1961). But there is a parallel story of carefully planned, generously funded, and judiciously managed iron and steel-based industrial production in the Sino-Soviet programs which were focused on building an innovation-oriented industrial base in north-central China in order to supply both republics with the hardware of modernity and war. A CIA intelligence report from 1952 found that:

> "Except for captured equipment, the Chinese Communist forces are wholly dependent on the USSR for heavy items of military equipment, and the large scale of Soviet logistics support has presumably further increased Moscow's influence with the Chinese military. The Chinese Communist Air Force is largely a Soviet creation and is wholly dependent on the USSR for equipment and supply," (CIA 1952, 3)

What these reports missed was that much of the Soviet military aid was projected to come from the shared red hinterland of Inner Mongolia, which would provision the military industrial needs of both countries from a site considered to be remote and secure. Most prominent among these was the Baotou Project, which shares pride of place as the most successful comprehensive Sino-Soviet industrial planning project with Anshan iron and steel, the latter of which has been extensively studied elsewhere (Byrd 1992, Clark 1973, Anshan 1953). Although both projects were beset with problems—the solutions to which served broader territorial ends of the state—they were nonetheless treated as models in establishing a modern industrial base to produce some of the latest, greatest technology in steel production to feed into modern urbanization, infrastructure, and defense industries.

But developing the capacity to mine, process, and produce rare earth doped goods required first a massive reorganization of society on the order of building entire cities and extensive infrastructure networks. This mobilization was realized through a Maoist 'conduct of conduct' on a massive scale. Substituting propaganda for guns following the Communist victory in 1949 (Katzenbach 1955, Pfeffer 1972), the instruments of Maoist governmentality included heavy propaganda (Huang and Xu 1997, Hung 2010), grassroots revolutionary struggle and (re)education (Ma 2001, Zhang 2004, Brown 2007a), youth militarization, and labor mobilization to build the infrastructural and industrial base deemed necessary to modernize China (Liu 2006, Bulag 2002, Blecher 2010).

[129] 工业基地

Although rare earth elements are essential for atomic weapons, it is the spatial aspects of the atomic program—particularly border disputes, the formation of securitized sacrifice zones, and the need for raw materials—that is crucial to understanding the contemporary significance of Baotou and Bayan Obo. The geological prospecting, the creation of a securitized mining and weapons-manufacturing landscape, and training thousands of personnel in the context of the Cold War were crucial to producing the cultural landscape recognizable in IMAR today as well as laying the foundation for establishing the 'rare earth capital of the world' in China. As noted above, it is essential to see beyond the propensity in Anglophone literature to characterize the 'Cold War' as 'Cold.' The atomic bomb radically transformed the political calculus of the post-WWII world, but it was difficult for leading analysts in the US to discern these rationalities in Mao-era governance:

> "Mao's mind may still envision catastrophe, like victory, as a cumulative effect. He may, therefore, fail to appreciate the dangers of atomic war, the war of massive and instantaneous destruction…his values are in a different balance from those of the Western world," (Katzenbach 1955, 338 - 339).

This is, of course, inaccurate. But it is reflective of the context of US establishment thinking on China during the Cold War, wherein those vested with the responsibility to produce knowledge about China did so from afar. There were few checks in place to correct gross errors in analysis. Those that did emerge came from Westerners living and working in China who possessed language competency and detailed ethnographic knowledge, but whose findings tended to be seized or suppressed during the years of the 'Red Scare' in the West (Hinton 1966).

Whereas detonating atomic bombs on the other side of the world might facilitate the conception of the Cold War as 'Cold' in the West, it is important to appreciate how differently the US bombing of Hiroshima and Nagasaki were perceived by Japan's neighbors. The Sino-Soviet response to this was to create a credible deterrent to the threat of a US nuclear attack by building the atomic bomb in China. Set between 'brotherly states' in the Inner Asian heartland of present day IMAR and Xinjiang, the two powers began building up China's nuclear capacity shortly after 1949.

When the search began for uranium in China under the PRC is the subject of debate. US intelligence reports from the time estimate that the search for uranium began in 1950, under the auspices of the newly-founded Sino-Soviet Non-ferrous and Rare Metals Corporation joint venture. Following conventional usage, Western observers assumed that 'non-ferrous' included uranium and thorium, and so dated the official beginning of prospecting efforts in 1950[130] (Committee 1960). However, Lewis and Xue (1988) cite Chinese documents (e.g. Li et al. 1987) and interviews with former nuclear program personnel who insist that uranium and thorium were not part of the non-ferrous and rare earth prospecting activities in Northern China in the early 1950s, in fact did not begin until 1956:

> "According to one official Chinese account, in 1954 the corporation had put into production the largest ore-dressing plant for non-ferrous metals (but not uranium) in Northwest China, and thousands of technicians had been trained with young Chinese in charge of most operations. ...The Chinese, in working alongside

[130] "During the period 1950 – 1954 the Chinese Communists, with some Soviet aid, explored a number of areas for uranium resources. In 1955 this quest for uranium, as well as the supporting Soviet aid, was intensified," (Committee 1960, 2).

> Soviet specialists in the Non-Ferrous and Rare Metals corporation, undoubtedly did gain experience that was useful to their overall nuclear program..."(Lewis 1988, 76 - 77).

Lewis and Xue cite the official narrative that maintains that Chinese geologists had not developed sufficient know-how or technologies to begin uranium prospecting until 1956. While this is possible, it leaves unanswered the question of what sort of prospecting activities were taking place while Soviet, Polish, and Hungarian experts were training Chinese geologists in the early days of the liberation (Lewis and Xue 1988; 76) or on what basis the US and Germany were negotiating with the Republican Government in the 1930s and 40s. It is difficult to reconcile the accelerated production of nuclear weapons manufacturing facilities—most of which were approved for construction between 1951 and 1956—with the claim that uranium prospecting did not begin until 1956.

While the authors deserve credit for producing the most authoritative Anglophone account on the history of China's nuclear development, I question their conclusion that repeated denial that the Non-Ferrous Metals Corporation was prospecting for uranium and thorium undermines the findings of other reports published in China and elsewhere[131]. In my interview experience from 2011 - 2013, it appeared to be standard practice to deny the existence or knowledge of radioactive materials regardless of known facts: only one official working in a public health capacity acknowledged the presence of thorium in the Bayan Obo mine output despite the fact that the rich thorium content of the mine is generally referenced in scientific and official literature. The official operating rationale seemed to be given that radioactive materials *writ large* are a sensitive topic, it was best not to talk about them. Academic researchers, by contrast, exhibited no such compunction. Thus while it is possible to conclude that geological prospecting for uranium began in earnest in the 1950s, which year this occurred remains disputed. The stakes of this dispute concern how much credit the former USSR, US, or other European Countries receive for developing China's nuclear weapons program. If it occurred after 1955, then China had already taken over full control of the non-ferrous metals companies as well as other key Sino-Soviet joint ventures. If it had occurred before 1955, then it would be necessary to acknowledge that uranium prospecting in China had been led, at least in part, by outside powers (Chi 1990).

Baotou was a key cite in the production of Post-Liberation China's military-industrial complex. In 1956, the Second Ministry of Machine Building selected Baotou as the location for a large plant to produce uranium tetraflouride, nuclear fuel rods, and materials for hydrogen bombs. With the assistance of Soviet advisors, Plant 202 was built just north of Baotou city, integrated to other industrial facilities built up around the Bayan Obo mine. Furthermore, China's primary producers of tanks and other armored vehicles were located in Baotou. These facilities were built in Baotou with the original thinking that its position between the 'brotherly states' of China and the Soviet Union would provide optimum access to the resources at Bayan Obo to provision both powers and be well shielded from the 'imperialist aggressors' of the West. When China and Russia were on the brink of war in 1969 and 1970, these weapons manufacturing facilities became very vulnerable. There were periodic shut-downs and evacuation exercises to protect those possessing the nuclear know-how to produce Uranium-235 in the event of a Soviet attack on Baotou (Bachman 2007).

[131] See, for example: Di (1976); Committee (1960).

One of the notable things about the development of China's nuclear program was the fact that it developed even amidst a period of intense turmoil: the Great Leap Forward (1958 – 1961), which precipitated one of the greatest human disasters in history; the Sino-Soviet Split (1960 – 1989), which resulted in the abrupt loss of equipment and expertise as Soviet advisors withdrew, and cancelled their outstanding equipment deliveries; and the Sino-Soviet border disputes (1961 – 1969), which threatened China's grip on the northern frontier and exposed strategic industries to possible Soviet take-over. Despite the upheaval of these events, nuclear construction—as well as the requisite social mobilization and forced resettlement—continued on the northern frontier.

The latter two issues generated unexpected outcomes that were instrumental in producing the cultural landscape recognizable in IMAR today, as well as laying the foundation for establishing the 'rare earth capital of the world' in China.[132] The border disputes between China and the Soviet Union in the early 1960s turned on the tenuous claims of both powers to regions peopled by diverse, autonomous groups, and highlighted the fact that China's northern border was largely unguarded (Li 1999). In the *Yita* incident of 1962, Soviet agents had allegedly urged tens of thousands of local Mongolian and Uighurs in Northern Xinjiang to flee to the Soviet Union; Chinese analysts suspected Soviet instigation of numerous other 'separatist' incidents along the Mongolia-IMAR border during that time (Fravel 2008). The response was to depopulate majority-minority regions in border areas deemed 'sensitive,' and resettle inhabitants in more 'interior' regions, effectively emptying the frontier of those whom would have competing claims to statehood. Some were conscripted for armed service or manual labor in other Northwest development projects (Lewis 1988). As the Figure 18 shows, some histories of forced resettlement have been revised to demonstrate voluntary patriotism on the part of non-Han peoples.

The disruption of the Sino-Soviet split catalyzed an important development in China's production of nickel-rare earth alloys which were essential for equipment used to produce uranium tetrafluoride at Baotou's 202 Nuclear Fuel Component Plant. Lewis and Xue (1988, 98) note:

> "To meet the emergency, Premier Zhou Enlai authorized the Baotou Plant to draw 40 tons of these alloys from the central state reserves. The ministry asked a factory, a welding research institute, and an iron and steel academy to cooperate in fabricating the missing apparatus, and the result was the manufacture of China's first heavy equipment made with metal alloys."

After the first nuclear weapon detonation on October 16, 1964, Mao declared that that China would not use nuclear weapons in a first strike and would design them "for defense and for protecting the Chinese people from US threats to launch a nuclear war." Now that China had deliverable nuclear weapons, the Americans "would not be so haughty, their policy of nuclear blackmail and nuclear threats [would] not be so effective," (Mao 1964 quoted in Lewis and Xue 1988). With China's nuclear weapons manufacturing facilities up and running, senior researchers and technicians branched out to other enterprises in industry, planning, education, and research.

[132] The hardships of the Great Leap Forward are extensively documented elsewhere (Bo 1991, Manning and Wemheuer 2012, Bachman 1991).

The nuclear program planted the seeds for China to assume prominence not just with rare earth extraction, but, importantly, separation. Xu Guangxian, considered the father of China's Rare Earth Industry, went to Washington University in St. Louis to conduct graduate work in chemistry in 1946. He finished his PhD at Columbia University and returned to China with the outbreak of the Korean War in 1951, and went to work on China's nuclear program in 1956. He participated in the race to separate uranium isotopes for China's atomic program, and then joined the chemistry faculty at Beijing University after China's first successful nuclear weapon detonation in 1964. During the Cultural Revolution in 1969, he and his wife's US education implicated them as foreign spies. After being detained in his university dormitory for six months, they were placed in a rehabilitative agricultural labor camp in eastern China until 1971 (Stone 2009).

Shortly after his return to Beijing, he was given 'an urgent military mission:'[133] that he devise a way to separate praseodymium and neodymium (Deng 2009). He applied his previous research in extracting isotopes of uranium to rare earth extraction and succeeded (Jia 2009) after four years. Separating uranium isotopes is complicated enough; but the proximity in atomic structures and chemical properties among the rare earth elements posed a considerable challenge that had not yet been resolved in any scientific community, anywhere. Recalling the four years of concerted effort required to develop the separation theory and method, he explained in an interview with the Bulletin of the China Academy of Sciences: "In Latin, praseodymium means 'the green twin'; neodymium 'the new twin.' They were the most inseparable twins at that time," (Xu quoted in Xin 2009, 100).

The now elderly scientist relates stories of working long days following established but time-intensive methods of shaking funnels and recording extraction data. Then one day he was fed up with shaking funnels. He started to think back on his graduate work on quantum chemistry and the glory days of successful uranium and plutonium extraction in China's nuclear program. He came up with the 'cascade theory of countercurrent extraction,'[134] which achieved 99.999% purity (Xin 2009). In 1974, he traveled to the Number Three Baotou Rare Earth Factory[135] to develop the techniques to implement this theory on an industrial scale. When he announced these findings at the first national rare earths meeting in August 1975, this signaled a fundamental shift in the global division of labor. Until this point, China exported raw materials and imported separated and refined rare earths from the United States, France, and Japan, who had until this point controlled rare earth extraction processes (Deng 2009). The transformation did not happen over night, but it was the beginning of China's technological superiority in the rare earth sector.

In addition to the political and economic considerations, this theory and method is hailed as a milestone in rare earth separation because it can be applied to ores of different composition

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[133] 一项紧急军工任务

[134] This is the basis of the solvent extraction methods used today, which utilizes the slight variations in the solubility of rare earth compounds between two liquids that do not dissolve into each other (the same principle as oil and water). Countercurrent cascades is basically a system in which many extraction steps are carried out in a continuous stream that progressively increase the degree of separation until the substance in on phase approaches total purity (Gray 2009).

[135] 包头稀土三厂

on an industrial scale; much of the research since this discovery has focused on expanding or applying this theory to separating other rare earth elements (Yan et al. 2006). This finding stimulated research throughout China, as reflected in the expansion of the Baotou Research Institute on Rare Earths. Established in 1963 under the former Ministry of Metallurgy Industry (Yang 2013), the institute in its early days was primarily focused on developing alloys for use in the regional weapons and heavy industry manufacturing. Xu's innovations stimulated a research and industry renaissance, as government support for identifying new processing methods and technological applications accelerated. The center has now expanded to encompass twenty-five research groups totaling approximately seven hundred employees, and fosters collaborative international research built on the ties established by many researchers who completed some of their graduate work overseas principally in the United States, France, Germany and Japan. The consequences of these subsequent international convergences are covered in the next chapter.

Conclusion

This chapter has shown that the origins of China's rare earth monopoly lie in a historical conjuncture between three processes. Section I discussed how Baotou was the site of territorial ambitions of several powers through the first half of the twentieth century, exercised through the production of geological knowledge, integration campaigns, and international negotiation. Section II argued that contrary to possessing a grand strategy to use its rare earth monopoly to hold the world hostage (e.g. Khosla 2011), the development of China's rare earth base emerged from a broader biogeopolitical policy to tame a border and render a red hinterland out of a historically independent steppe through industrial development and cultural campaigns that were predicated on explicitly raced and gendered regimes of labor and sacrifice. The third section examined the significance of socialist governmentality and atomic aspirations driving the establishment of a military-industrial base on the inland frontier even amidst national and international turmoil, and showed how the nuclear program fit with broader industrial and migration campaigns to stimulate REE research and produce the cultural landscape recognizable today. These geopolitical imperatives laid the foundation for establishing the 'rare earth capital of the world' in China, but this is only part of the story. Chapter three examines the convergence between these historical developments and subsequent global shifts in political economy characterized by Deng Xiaoping's Reforms and the Reagan/Thatcher revolution.

Chapter Three

“Welcome to the Hometown of Rare Earths!”

1980 -2010

Figure 19: After a few days of heavy rain to clear the air, blue skies and this banner welcome visitors to the Bayan Obo Mining District in the northern region of Baotou Municipality in Inner Mongolia Autonomous Region.

The sign reads: “Bayan Obo, the World’s Hometown of Rare Earths Welcomes You. Scientific Development. All Around Innovation. Prosperous People, Strong District. Marching Forward in Unity.” In the background a large specimen of rare earth ore sits atop a marble pedestal. Wind turbines recede to the horizon, where the eastern pit of the mine and the tallest building in the urban district, the new Ministry of Land and Resources building, are visible. Source: Author Photograph 20 September 2013.

Introduction

Chapter two placed China in the world history of rare earth discovery, production, and use by considering the territorial contests that were instrumental to carving Inner Mongolia Autonomous Region, Baotou, and Bayan Obo out of the expanse of the Mongolian Steppe. This chapter completes the task of addressing the apparent paradox of China's near total global dominance of rare earth production despite their relative ubiquity. This global arrangement of production emerged from the convergence between regional mid-20th century developments centered on Baotou with epochal shifts in global political economy characterized by Deng Xiaoping's Reforms and the Reagan/Thatcher Revolution which gave rise to contemporary neoliberalism. It was within this historical framework that rare earth production concentrated in Baotou and Bayan Obo. The cumulative environmental and epidemiological effects of the concentration of rare earth mining and processing in Bayan Obo and Baotou provoked a series of political reevaluations of the role of rare earth elements in China's development, contemporaneous with broader shifts in the global division of labor occurring within the contemporary context of China's rise.

The first section examines rare earth production in the international political economy of the last quarter of the 20th century by tracing shifting industrial geographies through the convergence between the Reagan/Thatcher revolution and Deng Xiaoping's reforms. Broader global political economic shifts of the early 1970s led to the deregulation of capital and the reorganization of production and consumption on a global scale (Fröbel 1981, Bolick 1995, Peet 1999, Jessop 1992, Sprio 1999). This global shift included Deng Xiaoping's state reforms of 1978 which 'opened up' China to foreign investment and accelerated the transition from closed national economy to industrial platform for the world which came to be definitive of the new international division of labor emergent in the late 1980s through the first decade of the 21st century. Rare earth industries in the West transferred portions of their beneficiation and processing chains to China beginning in the 1980s. Although the historic deregulations of the Reagan/Thatcher era are generally treated as separate from Deng's reforms, I argue that both are fundamental to understanding global economic geography produced by the world-historic liberalization of capital of the last quarter of the 20th century, which is essential to understanding the current global geography of rare earth production. The second section examines the environmental effects of the concentration of rare earth production in Bayan Obo and Baotou. The third section discusses how the accumulation of environmental hazards combined with further shifts in the global division of labor to precipitate the 21st-century transformations in China's strategic resource policy and practice.

I. Global Shifts, 1980 - 2000: Deregulation, Reform, and the Rise of China's Rare Earth Monopoly

> 'This issue has the potential to bring down America and greatly undermine its well-being and security, as well as the rest of the world. American prosperity and stability, and the world's strategic balance, may well hang in the balance on the REE issue. If China consolidates its position and maintains a long-term monopoly of REEs, then it will ensure that most high-end and valuable products with REEs will be manufactured eventually in China and, thus, much of the world's wealth will shift to China and be utilized there. China, then, will attain the level of the new—and, possibly, sole—superpower in the world in the coming decades,' (Dobransky 2013, n.p.)

This statement, authored in 2013, describes in the future tense a process that had already happened. Shortly after the 2010 crisis, China's monopoly was cast as an attack on the US defense industry, or an outcome of China's long-term strategy, devised over decades to put the West in a 'stranglehold,' to demonstrate its economic prowess (Anthony 2010, Czarnecki 2010, Dobransky 2013, Martyn 2012). More historically literate interpretations of the rise of China's rare earth monopoly did not begin to emerge until late 2011, which were distinguished by their observation that the transfer of rare earth production to China was at least partially attributable to policy changes in the West (Maginnis 2011, Baltz 2013). Yet many of these tended to miss the mark by pointing to US environmental regulations as the reason that Western firms could no longer compete with China (Rowley 2013, Jasper 2011). In a classic move of neoliberal logic, the problems generated by neoliberal practices on a global scale were to be solved by the enforcement of a difference set of neoliberal rules: if China simply 'played by the rules,' set by the WTO, the crisis never would have happened (USTR 2014a, Bradsher 2012). Regulatory differences are certainly a key part of puzzle, the capacity of firms to leverage regulatory differences across hinterland spaces in the US and China is a historically specific phenomenon which was crucial to the reconfiguration of the geography of the global rare earth frontier between the third and fourth quarters of the 20th century in an era understood as the rise of both neoliberal capitalism and 'globalization.'

The terms globalization and global capitalism are often used interchangeably. What accounts for this elision is the hegemony of neoliberal ideologies and practices that are understood to be behind both processes. Before proceeding, I would like to point out a broader tendency in scholarship on the global changes of the past four decades that have muddled understandings of the origins of China's rare earth monopoly: that of viewing China as an exception to processes of neoliberal globalization while simultaneously viewing neoliberalism as inexorable. What these presumptions obscure is the key role played by China's people and environments in the global rise of neoliberal hegemony, as well as the necessary and conspicuous role of states in producing global neoliberalism.

As Harvey (2005) notes, neoliberalism rose to prominence relatively quickly beginning in the late 1970s from "several epicenters" across China, the US and UK. Harvey's characterization may be read to mean the Deng Xiaoping's reforms were conceptualized as (proto-)neoliberal policies; such an interpretation reads causality backward in time. Rather, it is more precise to say that contemporary global neoliberalism as we know it is impossible to understand without Deng's reforms and their consequences. More precisely still, the position of China's labor and resources in global political economy is constitutive of global neoliberalism. It is nonsensical for a space to be constitutive of global neoliberalism while somehow remaining outside it, even if multiple forms of economic relations in addition to neoliberal practices characterize that particular space.[136] Therefore, China's domestic political economy contains characteristics recognizable as a *variety* of neoliberalism. If we accept this proposition, as many do (Wu 2010a, Ong 2007, Kipnis 2007, Rofel 2007, Nonini 2008), then we must reexamine a basic tenet of many theorizations of neoliberalism: the withdrawal of the state (Strange 1996, Harvey 2005).

[136] Nor are heterodox economic spaces are not peculiar to China, but are also found in other "epicenters" of neoliberalism. See for example White and Williams (2012).

The clear role of an authoritarian state in China's domestic political economy allows us to better recognize the role of the state in neoliberalism more generally.[137]

The policy practices enforced by Deng, Thatcher, Reagan, and subsequent administrations suggests that neoliberalism is more precisely characterized by an anti-democratic reconfiguration of state functions to support a set of transnational interests dependent on generalized precarity. This realignment of state functions is most vividly illustrated by the redistribution of public assets into private hands and the reorientation of police and military actions toward suppressing claims against the mass privations of neoliberal policies. Moving away from 'China as exception' to China's co-constitution with contemporary neoliberalism allows us to see more clearly the relationship of the state to neoliberalism. This is consistent with Foucault's formulation of the basis of neoliberalism: that it requires, from start to finish, people determined to facilitate the colonization of public institutions by the private sector who are positioned such that they can marshal the power of the state to enforce expropriation in an ongoing manner. As Foucault puts it:

> "The market…can only appear if it is produced, and if it is produced by an active governmentality. There will thus be a sort of complete superimposition of market mechanisms, indexed to competition, and governmental policy. Government must accompany the market economy, from start to finish," (Foucault 2010, 121).[138]

Under such a formulation, the paradox of neoliberalism shifts from its character to the reading of it. Many have identified the fundamental paradox of neoliberalism in its framing as an inevitable process and yet dependent on sweeping policy reforms (For a review, see Sparke 2009). The supposed 'inevitability' of neoliberalism is the result of varying yet highly intentional anti-democratic state practices. Most scholarship has readily identified the central role of the state in producing China's market economy, but the dramatic sweep of these policies in the West has been characterized in opposite terms despite the central role of Western governments in inaugurating and enforcing the necessary conditions to establish a global system of production and consumption defined, above all, by unevenness leveraged by footloose capital. This paradoxical reading of global neoliberalism relies on the presence of the state to make sense of it in the context of China while insisting that it is the *absence* of the state that characterizes neoliberalism in other contexts. The result is a tendency to frame neoliberalism as 'self-actualizing' rather than actively produced, and to see it as an unstoppable force penetrating all things as a virus or as irresistible common sense (See, for example, Peck 2002) rather than as an incomplete project that requires periodic authoritarian measures to be violently imposed in an ongoing manner.[139]

A unifying feature of neoliberal practices across diverse contexts is the forced privatization of public goods alongside the forced socialization of risk, pollution, and vulnerability as two complementary strategies to enrich the wealthiest class at the expense of the

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[137] The messiness of the state's involvement in the rare earth sector is a case in point.
[138] This is, of course, a selective, uneven, and contested process.
[139] This paradoxical but nevertheless widespread view conflates the totalizing force and pretensions of neoliberalism with the totality of human life, with the result that even critical appraisals also 'do the work' of maintaining neoliberal hegemony by discounting practices and spaces which neoliberalisms have failed to penetrate (Gibson-Graham 1996).

others. Beginning in the late 1970s, such dynamics across national and international space—driven by state and private actors—were instrumental to the reorganization of the global geography of rare earth production. China's rare earth monopoly was definitively established at the turn of the millennium, yet the foundation for this development rests on the world-historical convergence of two distinct transformations unfolding in different hemispheres: Deng's 1978 economic reforms, and Reagan and Thatcher's deregulations of capital, all of which gathered momentum in the 1980s. It is important to view these two developments as convergences rather than in terms of a 'Chinese exception' to 'global' neoliberalism. As the early post-crisis interpretations show, if we approach the problem of China's rare earth monopoly with the view that China exists in a state of exception to the neoliberal norm, rather than thoroughly embedded in and co-constituted with contemporary globalization, we come up short.

Deng Xiaoping assumed leadership of China after Mao Zedong's death in 1976. In a series of market-oriented reforms initiated in late 1978, Deng ordered the dismantling of rural communes and initiated the 'opening up' of the country to foreign investment. In his early international visits to Southeast Asia, Europe, and the United States to promote this policy change, Deng emphasized that China's central government policy priorities were economic and technological development. Although policies were articulated in Communist rhetoric, they were used to legitimate the re-instatement of the landlord class and the re-domestication of women by decollectivizing commonly held assets and deeding them to male heads of households (Hinton 1990). Without rights to land or community services, the 400 million peasants who were effectively 'liberated' from their rural livelihoods became the 'cheap labor' that attracted foreign direct investment and sub-contracting to China (Muldavin 2000, Erickson 2008) in a contemporary instance of primitive accumulation that was crucial to the development of contemporary global capitalism.

While there is a healthy body of work arguing that primitive accumulation refers exclusively to the first mass expropriation of English peasants during the British Industrial Revolution (See, for example: De Angelis 2001), Sinophone debates on primitive accumulation in light of China's 20th century political economy rest on a different translation and interpretation of Marx's key concept that decouples primitive accumulation from the rise of capitalism. As Day (2013) notes in his review of the Chinese literature on the subject:

> "'In reality, Marx never saw primitive accumulation as an early period of capitalism. He never even used capitalist primitive accumulation…" Under the rubric of primitive accumulation, "all sorts of brutal behavior of a non-capitalist nature" was attributed to capitalism, just as in present day China, much "pernicious behavior" of a non-market nature is being understood as rooted in the market itself," (Qin 1997, 4 – 5 quoted in Day 2013, 63).

The transfer of rural and household capital to urban and industrial centers during the Mao era was described as 'primitive socialist accumulation,' and seen as a positive development in service of socialist industrialization. Wen Tiejun's (2004b) deconstruction of China's modernization project argues that both socialist and capitalist industrialization fundamentally require primitive accumulation in order to emerge in a specific place. This standpoint maintains that China's marketization was not the result of entirely exogenous factors, in the sense of global capitalism 'penetrating' China, but that endogenous transformations—not only Deng's policies but also the 'primitive socialist accumulation' necessary for 1950s industrialization—created the conditions of possibility for capitalist relations to emerge within, as well as extend into, China (Wen 2004a).

The historical development of China's rare earth industry required a comprehensive suite of state policies and market stimuli in order to assume global prominence. In other words, both the Mao era frontier industrialization strategies involving mass expropriation and migration as well as the political economic liberalizations initiated by Deng Xiaoping were essential to positioning Bayan Obo as the rare earth capital of the world, with sufficient cheap labor and state subsidies to undersell firms established elsewhere. But this is only half of the story.

The other half of the story lies in the deregulation of capital in the West initiated by the complementary policies of Margaret Thatcher and Ronald Reagan. Among their hosts of policies, what is most consequential for the rise of China's rare earth industry and its decline in the West was the deregulation of corporate and financial capital in the 1970s and 1980s. This reduction or elimination of government power in a range of industries was enacted under the banner of creating more competition and innovation, but in practice it meant the reduction of corporate taxes and a significant reduction of territorial constraints on corporate and financial operations. By effectively eliminating most corporate standards other than profit maximization, this unleashed corporations in a global rush to maximize profit by lowering labor and environmental compliance costs in a renewed 'race to the bottom,' (Berle 1932) in which states underbid each other to offer lower taxes, environmental regulations, and safety protections in order to attract investment in the hopes of generating employment. These policies, and their immediate consequences for working peoples and environments, continue to be bitterly opposed (Scott 2009, Tsing 2005 inter alia) While Harvey notes that "[t]he spectacular emergence of China as a global economic power after 1980 was in part the unintended consequence of the neoliberal turn in the advanced capitalist world," (Harvey 2005, 121), it is perhaps more cogent to say that globalization as we know it would be unthinkable without China's 1978 reforms, which recast the third largest country in the world as a pollution haven and introduced 400 million newly disempowered laborers into the global market. This shift allowed firms to escape the disciplining of organized labor and environmental regulation in certain western countries and then undersell firms that were slow to follow suit (Muldavin 2003).

China's policies, laborers, and environments have played a key role in the global political economic restructuring resulting from several decades of internationally institutionalized neoliberal prescriptions harnessed by footloose capital on one hand and channeled by China's state-supported development strategies on the other. In other words, key actors in China's state apparatus were "willing partners with global capital in a restructuring process long advocated by Western economists" (Muldavin 2003, 9) and global economic institutions. Under such circumstances, any firm unwilling to leverage the global race to the bottom became a target for corporate takeover or faced bankruptcy. This pressure was vividly illustrated in the textile and manufacturing sectors, where US manufacturing migrated first to Mexico and then, in the face of labor organizing successes, relocated to China. Such industrial mobility was possible because business operations could be disassembled and removed in relatively short order. The situation in the mining sector unfolded differently, due to the fixed nature of the assets, the sheer size of the capital goods, and the logistical and technological impossibility of performing immediate separation processes far off-site.

Despite these obstacles, the geography of the global rare earth industry followed the trajectory of other dirty industrial geographies with the rise of global neoliberalism and emergence of a new international division of labor insofar as extractive industries embarked on a race to the bottom, circling the globe in search of lax environmental regulations and cheaper labor standards. However, this is not to suggest that rare earth firms relocated wholesale to China. While the fixed constraints on mining activities kept US and Europe-based operations running well into the late 1990s, the material peculiarities of rare earths allowed for subcontracting certain portions of the beneficiation process to China beginning in the 1980s. With the aid of state and private actors on both sides of the Pacific, industrial capacity was transferred piecemeal to China as Western firms sought to cut costs associated with the most hazardous aspects of rare earth refining. One particularly vivid illustration of this is the key role played by Edward Nixon, the younger brother of former President Richard Nixon, in transferring various aspects of the beneficiation process from the Mountain Pass mine in Southern California to China, beginning in the 1980s.

Edward Nixon has played an interesting role in the development of US environmental policy as well as the movement of the US rare earth industry to China. A graduate of Duke University's geological sciences program, he reportedly persuaded his brother, President Richard Nixon to establish the Environmental Protection Agency. He was active in the private sector in the late 1960s and early 1970s, occupying leadership roles in consulting firms that claimed to provide environment-related services, but about whose precise operations information is difficult to find. For example, he was the president of Oceanographic Mutual Funds until the SEC opened a 'gross misconduct' investigation against it in 1971. He left because he reportedly 'had nothing to do with it.' He then worked as the vice president of Ecoforum, Inc., which was a Seattle-based firm 'engaged in furnishing environmental information primarily to industrial corporations,' (Lemon 1972). It had been set up as an environmental consultancy by the heir to the Giannini fortune in Los Angeles. The idea was to provide 'help to industrial concerns that had pollution problems,' the company was reportedly never successful, Nixon was never paid, and never approached the government on behalf of environmental concerns (Turner 1973). There are several other nominally environmental or resource-based firms that Nixon was involved in and for which he was reportedly never paid, and for which he reportedly never performed any government outreach. The record of the younger Nixon's activities has been carefully obscured in English-language archives, but sales receipts and other archival materials held in China help recover some of the history.

In 1982, the Mountain Pass mine had just completed a $15 million separation plant to allow a thirty-five percent production increase and was, at the time, responsible for seventy percent of global production (Goldman 2014). As the EPA gathered steam and began to monitor environmental practices in US mines in the late 1970s and early 1980s (Agency 2014), the Unocal-operated mine in California felt the pressure. In the early 1980s, Nixon approached mining executives with a proposal to subcontract some of the beneficiation processes to China as a measure to reduce environmental liabilities in California and to save costs. For a time it was more cost effective to ship tons of minimally processed ore to China rather than ensure environmentally sound practices on US soil. Since production has resumed at the Mountain Pass mine in 2012, this continues to be the case, as export data at the Port of Oakland indicates

(PMSA-WIL 2013). But the subcontracting continued beyond this, driven by the imperative to move ever-greater portions of production offshore in order to reduce costs and increase profits. Over the 1980s, Nixon's firm facilitated the transfer of magnet production to China, setting up joint ventures with Chinese partners in order to produce cheaper rare earth magnets. These relatively early post-Reform joint ventures also provided technology transfer from international firms to Chinese firms, which, combined with the mid-century industrial and scientific foundations laid by Sino-Soviet investment as well as ongoing state support for the industry, contributed to the steady growth of China's rare earth industry. Edward Nixon subsequently founded Great Circle Resources, Inc to help US downstream producers purchase rare earth oxides from China. Thus, Nixon profited from the transfer of production and technology to China, and profited from the resale of cheaper commodities to US firms.

None of this purports to hold a single person responsible for the decline of rare earth mining in the US or its rise in China, but rather to point out the fluidity between state and private sector actors on both sides of the Pacific in leveraging the policy changes in both countries. Nixon found a way to profit from the deregulation of capital on both sides of the process by helping a US firm subcontract the dirtiest aspects of production, by moving higher-technology processes to China to save on costs, and by facilitating the import of cheaper Chinese magnets to the US. Within the context of the deregulation unfolding in both hemispheres, the profit-maximizing behaviors undertaken by executives of the Mountain Pass mine and facilitated by Nixon contributed to the demise of rare earth mining in the West and the rise of China's rare earth monopoly.

However, the movement of rare earth production from the US to China was not simply a story of *de*regulation, but also of *re*regulation. Although Deng's reforms welcomed FDI and created a new workforce vulnerable to the whims of global capital, post-reform China was by no means a free-for-all for international capital. Incoming foreign investment into China is channeled into three categories: Encouraged, Restricted, and Prohibited. As a strategic national resource embedded in the defense sector, rare earth exploration, mining, and processing falls under the Prohibited category. Investment in smelting and separation is restricted to equity or contractual joint ventures. Downstream industries, such as the production of dyes, fiber optic cables, and lithium-ion batteries, are encouraged to set up shop in China (MOFCOM 2012). This strategy encourages the transfer of production capacity and technology to China, while sequestering intelligence on the country's geological endowments, for reasons noted in the previous chapter. Technology transfer is, and has been since the reforms, a clearly stated cornerstone of the joint venture model. But nor is China a 'wild west' of IPR[140] theft. The US – China Business Council explains:

> "Technology is typically licensed to a China-based entity in which the foreign company has an ownership stake. In many cases the foreign company owns one hundred percent of the entity in China; in some cases, the foreign company must form a joint venture with a Chinese partner. In exchange, the company determines the value of the technology to be transferred and negotiates a payment—the technology is rarely 'given' for free," (USCBC 2011, 20).

[140] Intellectual Property Rights

The cost of purchasing exported goods produced with transferred technology is routinely taken into consideration during joint-venture negotiations. In 1985, China's Ministry of Finance, the General Administration of Customs and State Administration of Taxation began offering rebates to Chinese companies and joint ventures for rare earth exports (Chen 2010b), which attracted FDI and incentivized the development of China's rare earth industry through export-oriented growth. At the same time, China's state-owned banks granted subsidized loans to joint ventures and SOEs to promote full employment as a means of maintaining social stability. Through the 1990s, those loans helped expand the mining sector while state investment in rare earth applications research stimulated production and drove down global prices. Meanwhile in the US, troubles were mounting at Mountain Pass.

Beginning in the 1980s, the Unocal mine began piping radioactive wastewater to evaporation ponds 14 miles away at the Ivanpah dry lake, which was just east of US Interstate 15 near Nevada in the Mojave National Preserve. The partially buried pipeline was structurally unsound and tended to rupture during routine cleaning operations to remove the build-up of mineral deposits, spraying the soil and surrounding vegetation with mineral slurry containing toxic amounts of lead as well as uranium, barium, thorium and radium 100 - 200 times above background levels (AP 1998). An investigation by the EPA later found that sixty spills had occurred between 1984 and 1998, and several were unreported. Between 1994 and 1997, seven spills reportedly releasing 350,000 gallons occurred along a stretch of pipeline near the eastern entrance of Mojave National Preserve, near a school and Caltrans (California Transportation) employee housing (Cone 1997). Federal authorities calculate that roughly 600,000 gallons of radioactive wastewater spilled into the desert. In 1998, the mine halted processing operations when the San Bernardino district attorney issued a lawsuit and a clean-up order (Margonelli 2009). The company paid $1.4 million in fines and settlements (Danielski 2009).

Faced with fines for a litany of environmental violations and price pressure from cheaper commodities coming from China, the Mountain Pass mine closed (Goldman 2014, Baltz 2013, Zepf 2013, Bourzac 2011, Coppel 2011, Galyen 2011, Zielinski 2010). This transferred the lion's share of rare earth production to China, with the remaining global supply furnished by sales of national stockpiles in the United States and Russia. By most accounts, the story stops there, concluding that the perfect storm of environmental regulation and cheap Chinese commodities condemned western industry to bankruptcy. Such a discourse attributes causal force to broader market and regulatory mechanisms and acquits specific actors of their key roles in shaping the contemporary geography of the global rare earth frontier. Given the former technological leadership of the US in rare earth processing, the fixed nature of mining and beneficiation assets, as well as the supreme difficulty of working with these elements, it is absurd to explain the transfer of an entire industry by market mechanisms alone. It required multiple exercises of politically-connected economic power, as illustrated by the role of Edward Nixon in transferring parts of the production process to China. Another relative of a powerful DC leader played a key role in transferring the last of US rare earth magnet production to China, in a series of events that has become known as the 'Magnequench Saga,' chronicled by St. Clair and Hamod (2003).

If China was a 'willing partner' to profit maximizing firms seeking to capitalize on China's lax labor and environmental protections, western counterparts knowingly transferred technology and industry to China despite concerns around national security. Magnequench was an Indianapolis-based company specialized in producing neodymium magnets necessary for information and aviation technology as well as the guidance systems of cruise missiles. It began as a subsidiary of General Motors that used Pentagon grants to develop permanent magnet materials which it began manufacturing in 1987 at a facility in Anderson, Indiana. During the downsizing of the 1990s, GM sold Magnequench to the Sextant Group, which was an investment firm owned by Archibald Cox, Jr, son of the Watergate prosecutor who then became CEO. Sextant's primary clients were the San Huan New Materials and the China National Non-Ferrous Metals Import and Export Corporation, which continue to be two major players in China's rare earth trade. In 1998, Cox closed one plant and shipped its assembly line to China. GA Powders, a subsidiary of Magnequench that produced the rare earth oxide powders used in the production of magnets, met a similar fate. The company originated in a Department of Energy Research Group at the Idaho National Engineering and Environmental Laboratory. After Lockheed Martin took over the national laboratory, they sold GA Powders to Magnequench in 1998. In June 2000, Magnequench management closed the Idaho production facilities and moved them to Tianjin, China. In 2003, Cox closed the final Magnequench facility in the US which was the only remaining domestic source of the magnets used in cruise missiles (St. Clair 2003).

Bipartisan members of Congress demanded a review of the takeover by the Congressional Committee on Foreign Investment in the United States (CFIUS) and asked President George W. Bush to intervene on the basis of the Exxon-Florio Amendment to the 1988 Defense Appropriation Act, which requires Presidential review of foreign investments and acquisitions that pose a threat to US national security. No such action was taken. This prompted a review of CFIUS by the Government Accountability Office, which found that most companies did not file until after the acquisitions were complete. When they were required to answer for national security concerns, companies withdrew their applications and CFIUS did not follow up. Members of the US – China Economic Security Review Commission attributed CFIUS inaction to the fact that it is lead by the Treasury, which has conflicting interests with respect to China: because the Treasury funds the US budget deficit, it has relied on China to purchase US debt. This made the department reluctant to alienate China by halting a takeover bid of a US company (Greising 2005). Although it was clear to Pentagon and Cabinet national security advisors that China's firms had targeted Magnequench in order to develop long-range cruise missiles, the sale went ahead.

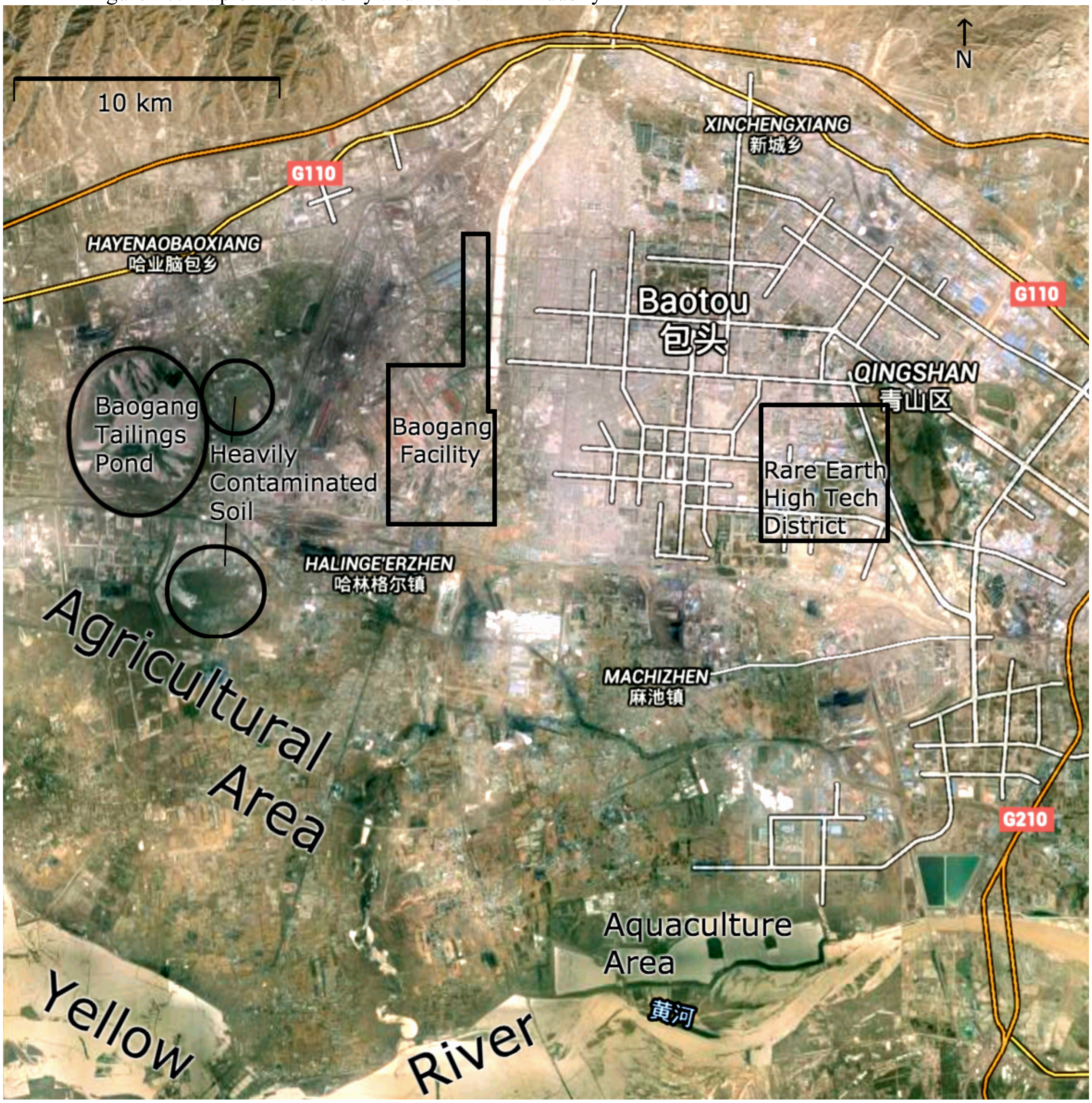
Neither the Nixon nor the Cox vignettes are intended to suggest conspiracy. It is key here to see how Nixon and Cox were working according to particular rationales that, however (un)intentional, had the result of facilitating the rise of China's rare earth monopoly, much in the same way that individual executives in Wall Street firms were pursuing short-term profit but ended up bringing about the 2008 Financial Crisis. Nixon is known as an environmentalist who is credited with persuading President Nixon to issue the executive order establishing the EPA. By all accounts, he was a patriotic capitalist looking to minimize environmental problems of rare earth mining on US soil while maximizing profits from rearranging production.[141] Cox's

[141] This could be read as a demonstration of what happens when environmental concerns are exercised according to a world view characterized by the territorial trap which Agnew (1994, 2010) defines as relying on three obsolete geographical assumptions: (1) states are fixed units of sovereign space that are (2) defined by the polarities of domestic vs. foreign and internal order vs. external anarchy, and (3) function as 'containers' of societies organized according to a coherent set of interests.

illustrious career at the helm of major investment firms, including Barclay's as they took on the assets of the ruined Lehman Brothers following the 2008 crisis, indicates that he was a savvy investor representing the interests of his clients who, in the case of Magnequench and GA Powders, happened to be two of China's state-owned enterprises. It is possible to explain the actions of both sets of actors solely according to profit maximization. Despite their patriotic credentials, they are striking embodiments of the Jeffersonian observation that: "Merchants have no country. The mere spot they stand on does not constitute so strong an attachment as that from which they draw their gains," (Jefferson 1814). It is, in fact, openly acknowledged in the US foreign policy community that "many politicians and corporate executives have transnational interests and cannot argue for more aggressive policies without risking possible severe consequences," (Dobransky 2013).

This is less a story about China threatening US national security than the symbiotic relationships between varieties of neoliberalism: two rapacious political economic ideologies in practice. In the west, the idea that corporate competition measured in greater profitability was the highest ideal of the marketplace (Harvey 2005, Foucault 2010), while defending and enforcing this state of affairs has come to stand in for democratic governance. In China, the idea that economic growth was to be achieved at all human and environmental costs was overseen by a modernizing state (Lin 2009, Qiu 2007, So 2007). China's rare earth monopoly, and western dependence, was one result of this symbiosis. The next section examines the environmental outcomes of this in Bayan Obo and Baotou.

Figure 20: Map of Baotou City and Rare Earth Industry



Source: Google satellite image modified by Nick Bojda, 2015.

II. Radioactive Rivers, Cancer Villages, and Long Tooth Disease

> "With the development of the rare earth industry and the rare earth smelting production processes, the "three wastes" of radioactive material, thorium, and rare earth associated environmental radiation pollution have become increasingly serious. China's rare earth enterprises are compelled to take this seriously," (Wang 2007, 2).[142]

The crisis in Baotou has four dimensions stemming from the unleashing of hazardous materials from their subterranean confines: air, soil, surface water and ground water pollution. The resulting radioactive rivers, cancer villages, acute chronic arsenic toxicity and long tooth disease that constitute an environmental and epidemiological crisis so grave and expansive that addressing it is now viewed as a matter of national security and territorial integrity.[143] There is no shortage of material documenting the intensifying environmental crisis generated within China (Wu 2009, Yang 2005, Smil 1993), and a growing body of literature that demonstrates the embeddedness of localized environmental crisis in broader regional and global networks of production and consumption (Yeh 2009, Muldavin 1996, Economy 2007).

That the environmental conditions of rare earth production only emerged in Western consciousness following the crises in 2010 is not the result of deliberate secrecy on the part of China. To put it bluntly, no one bothered to write about the issue until recently, much less examine the detailed Sinophone research literature on these constitutive issues. This has had the effect of naturalizing the environmental and epidemiological costs to both rare earth production and pollution in China, which obscures the contingency of such hazards and the broader global investment in these destructive practices. This section clarifies the precise nature and origin of the hazards as they emerge in rare earth mining in Bayan Obo and processing in Baotou to explain and contextualize the formation of radioactive rivers and cancer villages as well as the scourges of arsenic toxicity and long tooth disease.

The hazards of rare earth mining and processing begin with geology (Zhou et al. 2002). Recalling the discussion from Chapter one, the conditions under which rare earths are formed are very similar to the necessary conditions for the formation of naturally occurring radioactive materials, which accounts for their frequent coincidence. In the 2003 *People's Republic of China Radioactive Pollution Prevention Law,* rare earth mines are given specific mention as sites containing high levels of radioactive ore concentration (Hu 2003). But neither the stones nor the sands are hazardous themselves. The hazards emerge when the elements are liberated from their earthly confines, dispersed through crushing, transport, and beneficiation processes, and concentrated in local and downstream water sources and soft tissues. In her extensive study on the environmental dynamics of the local rare earth production process, Bai Lina (2004) identified ten points at which radioactive and toxic materials are released into the environment.

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142 "随着稀土工业的发展, 稀土冶炼生产过程中 "三废" 和稀土伴生放射性核素钍对环境辐射污染是比较严重的, 应该引起我国稀土企业高度重视." (Wang 2007, 2)

143 Because the regional environmental issues are now seen by national leadership to generate commercial and security threats, and because addressing environmental concerns also serves broader political and economic objectives, environmental concerns rose to prominence in international discourse in the last five years. The critique that state interventions in China's rare earth sector are driven by more than environmental concerns is valid; this does not negate the severity of environmental and epidemiological harms resulting from rare earth mining and processing in Baotou and Bayan Obo.

Figure 21: Distribution of Thorium in Bayan Obo Iron, Steel, and Rare Earth Production, 2002

Process	Raw Materials and Products Metric Tons per Year	Thorium /%	Total Thorium Metric Tons Per Year
Bayan Obo Ore	88,436,000	0.0364	3219.07
Rare Earth Concentrates	993,000	0.191	189.61
Iron Ore	33,366,000	0.013	433.76
Tailings	54,077,000	0.048	2596.7
Rare Earth Iron Ore Slag	3,690	0.095	0.35
Sinter	74,918,000	0.0057	426.49
Sintering Smoke and Dust	1,078,000	0.0064	6.92
Steel forge	49,672,000	Undetected	Ignored
Smelting slag	20,862,000	0.02	418.42
Smelting dust	111,000	0.004	0.44
Smelting gaseous emissions	746,000	0.01	7.46
Rare earth rich slag	39,470	0.0555	2.19
Rare earth concentrates REO content 50%	7,160	0.191	1.36
Primary rare earth alloy	9,120	0.18	1.64
Baogang smoke and dust	28,000	0.015	0.42
Rare earth alloy slag	121,000	0.0152	1.84
Locally consumed rare earth concentrates	686,000	0.191	130.95
Rare earth processing acid concentrates	598,000	0.184	109.83
Rare earth processing soda concentrates	88,000	0.24	21.12
Exported rare earth concentrates	300,000	0.191	57.3

Source: Bai (2004)

To simplify, there are four primary stages where environmental hazards emerge. The first is the mining process, which generates dusts laden with heavy metals and radioactive materials. Then there is the refining process, where sulfuric or hydrochloric acids are used to separate elements from their parent rock (Hao 2011). The third is the waste management from the primary processing and beneficiation activities which generate slag that contains high levels of radioactivity (Wang et al. 2009)[144], and the fourth concerns disposal of rare-earth containing products (Weber 2012, Gullett et al. 2007). All rare earth elements cause organ damage if inhaled or ingested; several corrode skin; five[145] are so toxic that they must be handled with extreme care to avoid radiation poisoning or combustion (Krebs 2006). Because rare earths tend to coincide with radioactive thorium and uranium, mining is also a radioactive waste management situation (Bai 2001), which is very difficult and expensive to execute effectively.

The ores extracted from Bayan Obo are processed using high-temperature roasting with sulfuric acid. This is actually a thirty-three-step process through which rare earths are ‘cracked’ out of their parent rock through repeated cycles of acid baths, smelting, rinsing and cooling. Every ton of rare earth produced generates approximately one ton of radioactive wastewater; seventy-five cubic meters of acid wastewater; 9,600 to 12,000 cubic meters of waste gas containing radon, hydrofluoric acid, sulfur dioxide, and sulfuric acid; and approximately 8.5 kilos of fluorine (Hurst 2010).

[144] These first three comprise the “Three Wastes” mentioned in Chinese scholarship.
[145] promethium, gadolinium, terbium, thulium, holmium

Because of the chemical similarities between rare earths, uranium, and thorium, separation is extremely difficult and requires high temperatures (above 300 degrees Celsius). The high temperatures convert thorium to a mobile and water-insoluble form, thorium pyrophosphate, which accumulates in the mine tailings and is difficult to recover or reuse. To be used for nuclear fuel, thorium must be purified and converted to thorium nitrate, which is difficult to do with thorium pyrophosphate. Nevertheless, because thorium has the highest melting point of all oxides at 3300 degrees Celsius, it is required for a set of highly specialized but limited industrial applications (Cardarelli 2008)[146]. This is salient for two reasons: one, rare earth processing concentrates thorium in tailings in forms that are especially mobile and also extremely difficult to work with. And two, given the limited applications[147] for thorium, there are few incentives to invest in the development of more efficient techniques to recapture radioactive material. Furthermore, the high cost of thorium storage further discourages initiatives to reprocess the mine tailings in order to separate out the thorium pyrophosphate, since doing so would in essence create another expensive waste management problem distinct from the tailings pond (Xin 2006).

Separating thorium and uranium from the tailings does not eliminate the radioactive threat. As Marie Curie discovered, as much as 85% of the radioactivity remains in the host material after the element is removed (Edwards 1992). Unlike non-radioactive elements, the atoms of radioactive elements are unstable. This means that the atoms explode and give off two types of highly charged particles known as alpha and beta. It is helpful to think of these particles as shrapnel. These are not radioactive rays, they are materials that circulate in water, food, and air. The 'shrapnel' from these explosions rips through material at the microscopic level (such as that of cells, nuclei, and DNA) and randomly breaks or burns chemical bonds. 'Explosion' refers to radioactive decay: thorium disintegrates into uranium, which disintegrates into protactinium, which disintegrates into radium, which disintegrates into radon gas and polonium. Radon gas atoms disintegrate into 'radon daughters', which include another half dozen solid radioactive materials that stick to surfaces such as dust particles and are easily inhaled. The end result is lead.[148] If inhaled, these particles stick to the airways of the lung and increase the risk of developing lung cancer (Agency 1990, Liu 1996). A few micrograms of radium in the body will cause the bones to go soft, teeth to fall out, gums to bleed, and cancers of the bone and soft tissues.[149] The hazard of the tailings is that the bulk of the radioactivity is left behind in the slurry which continues to generate radon gas (Edwards 1992). This finely pulverized powder circulates in the air and water, introduced into the wider environment by wind, rain, leaching, and industrial accidents.

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[146] Because its melting point is second only to tungsten and tantalum carbide, it is used in high pressure applications such as petroleum cracking, welding electrodes, carbon-arc lamps, and high-temperature laboratory crucibles for melting refractory metals (Cardarelli 2008, 451).

[147] Shortly after Marie Curie's breakthroughs at the turn of the 20th Century, drug and cosmetic manufacturers added thorium to everything from toothpaste to laxatives under the assumption that something so energetic as radioactive thorium had to be beneficial (O'Carroll 2011). The mania ended a few decades later following the grotesque deaths of prominent proponents of radioactive tonics (Rowland 1994).

[148] For reasons of space, Lead is omitted from this discussion. See Klinger (forthcoming June 2015, Palgrave) for further reference.

[149] Unlike other radioactive elements, radon is gaseous and easily inhaled. It is odorless, colorless, and tasteless. As such, it is generally responsible for the majority of public exposure to ionizing radiation (EPA 1990).

Radioactive rivers and cancer villages

Heavy industry requires water. The industrial geography of Baotou is fundamentally shaped by this imperative. The Bayan Obo mine is located 80 kilometers (50 miles) from the border with Mongolia, and 241 kilometers (150 miles) north of Baotou's iron and rare earth processing industry. The processing industry is built around the state-owned enterprise Baotou Iron and Steel, or Baogang for short. Baogang set up its operations near the abundant waters of the Yellow River, which bends northward through Ordos and Baotou across the Hetao Plain. Most of the heavy industry, and industrial waste, is concentrated in Baotou, far from the site of extraction (See Figure 20). Nevertheless, the cancer mortality rate in the Bayan Obo mining district rose from 107.93 per hundred thousand in 1989 - 1990; three times the national average and five times the average for western China, to 155.7 per hundred thousand in 1997 (Liu 1996, Chen 2010a). In the mining district, the three leading causes of death are cancer, unspecified poisoning and accidents, and infant mortality (Zhang et al. 2001).

The Baogang tailings dam has been growing since the late 1950s to the point where it is the 'world's largest rare earth lake,' containing 200 million tons of radioactive slurry. This thirteen square kilometer lake is located ten kilometers north of the Yellow River and twelve kilometers west of the Baotou city center. Since 2005, the rare earth working group of the State Planning Commission has issued warnings about the structural vulnerabilities of the tailings pond in light of seismic activity and climate variability (Xin 2006). An earthquake or unseasonably heavy rains could cause the tailings lake to burst, the consequences of which officials warn would dwarf even the most alarming river pollution incidents to date, such as the Songhua River incident in 2005. The situation has received considerable domestic media attention over the past fifteen years, and has been the subject of local, regional, and national research initiatives since at least 1975, several of which remain available to the public. While the gravity of the situation may not be translated for non-Sinophone audiences, the issues are nonetheless well known in Chinese academic, official, and popular discourse. As one reporter put it:

> "It is not only about the risk of dam failure. Around the dam, sheep have suffered from long tooth disease, villagers are suffering from cancer, and this once fertile vegetable garden has become a place where seeds do not grow and the water cannot be drunk," (Li 2010).[150]

The Baogang Environmental Monitoring Station released reports showing that the area of the most severe surface contamination[151] in 1998, 2002, and 2006 increased three-fold over the eight-year period, from 4.92 square kilometers (about a kilometer out from the edge of the tailings dam) in 1998 to 15 square kilometers in 2006 (Wang et al. 2009). This is an indicator, first, of the strict delimitation of the areas of investigation under Baogang jurisdiction, and second, of the intensity of contamination generated by wind transport. Of course, the circulation of radioactive residues is not confined to this limited area. Because radon gas is a decay product of uranium and thorium, the tailings lake releases it continuously. It is more dense than air, so it

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[150] "不只是溃坝的危险。在大坝的四周，陆续发生的绵羊长獠牙、村民患癌症、庄稼减产等事件，已经将昔日的"包头菜园子"变成了地不能耕、水不能喝的地方." (Li 2010)

[151] The Environmental Monitoring Station measured U-238, Ra-226, Th-232, and K-40.

travels close to the ground and can cover a thousand kilometers in a couple of days on a steady breeze (Edwards 1992).

The tailings pond does not have any sort of lining to prevent seepage (Wang, Xie, and Chen 2007). It sits at 1045 meters above sea level, while the agricultural villages between the tailings pond and the Yellow River are at 700 – 1000 meters above sea level on sandy soils. Villagers in this area describe the tailings pond as a 'hanging lake'[152] over their heads. Drawn by gravity and larger regional drainage dynamics, contaminated water travels through the sandy subsoil down to the Yellow River at a rate of 300 meters per year. Atop the sandy subsoil is Baotou's declining 'vegetable base,' which historically supplied the city with its produce. The problems with the tailings dam have been documented since the 1970s, when farmers in the surrounding villages noticed decreased yields in the vegetable plots. A 1994 survey found elevated levels of radioactive contamination in vegetables produced downstream (Zhao 1994b), and a 2002 study of village well water released by the environmental monitoring station found that radioactive salts exceeded the safety threshold by a factor of 10 (Xin 2006).

Chinese journalists have coined the phrase 'Cancer Village' to capture the manner in which pollution from rare earth beneficiation has defined death for residents surrounding the tailings ponds. In one small village of seventy-five households, locals reported six cancer deaths a year, and frequent strokes among adults (Liu 2013). In a neighboring village, residents counted the phrase "one in seven" to capture the rate of middle-aged cancer deaths (Wang 2006), when compared to the national average of 2 cancer deaths per 1000 rural inhabitants (Guo et al. 2012).

In early 2004, villagers initiated dialogue with Baogang and the Baotou city government to demand compensation and resettlement. Local officials responded by digging a deep well to provide potable water, but villagers opted not to use it after finding that boiling the water generated a gooey white residue (Ren 2013). Furthermore, the geological profile of the area is such that high levels of arsenic and fluoride are concentrated in hydrothermal deposits, so while deep wells may temporarily escape the surface seepage, they expose users to different hazards. Unsatisfied with local responses, villagers successfully demanded environmental monitoring reports and took them to petition higher levels of government in Hohhot and Beijing. They have had some success reframing the plight of their village as a threat to regional food security and a serious upstream national water supply issue because the pollution contaminating their land is also contaminating the Yellow River, which flows through five provinces after passing by Baotou and supplies water to an estimated 200 million people. Their efforts have helped shape national and international consciousness on the human cost of China's rare earth monopoly (Hilsum 2009, Jeffries 2014). In compensation, Baogang agreed to give five villages surrounding the tailings dam five million yuan [814,000 USD] per year. However, divided equally among the 25,000 inhabitants, this comes to about 200 yuan [32 USD] per person, which is a tiny fraction of the amount needed to relocate from the polluted village. "It's not even enough to buy water," noted one citizen. One newspaper article quoted a villager as saying "Soon our lives will be over, what good is this money? We just want to move away. Not moving means waiting for death," (Hui 2013).

[152] 悬湖 *xuanhu*

Since beginning their campaign ten years ago, villagers have gained better access to health care at the specialized Osteology Hospitals in Baotou city, but doctors reportedly stop short of naming the causes of ailments. One villager interviewed in 2013 reported: 'The doctor told me that the bones of people from my village are different from the bones of people who live in other places. Our bones are weak, they grow strangely, and they break.'[153] If the doctors are hesitant to share the realities of the ailments with their patients, local citizens are well aware of the situation: 'In the dry season we breathe the dust. In the wet season it comes into our water. We eat the pollution in our food. The livestock eats it in the grass, and we eat the livestock. It is very dangerous. Everyone knows the problem, but it is too big to manage'.[154]

Chronic Arsenic Poisoning, Skeletal Fluorosis and Long Tooth Disease

Because of its deadly, uncontrollable character, discourses on radioactive waste contamination tend to crowd out the maladies caused by other toxins proliferated by rare earth mining and processing. Outside of Baotou, where the majority of the processing takes place, arsenic and fluorite are the primary contaminants (Xia and Liu 2004, Yu et al. 2005, Liu et al. 2005, Zhao et al. 2013). Their proliferation in the environment surrounding Bayan Obo and Baotou has profoundly altered the human landscape in this region formerly populated by Mongolian nomadic pastoralists. It is, heartbreakingly enough, often possible to distinguish true natives from migrants by the skin lesions caused by arsenic poisoning, and by the malformed bones and decaying teeth which are symptoms of chronic fluorosis. It is estimated that 40% of the peri-urban and rural inhabitants of the Hetao Plain, or roughly three hundred thousand people, are suffering from arsenical dermatosis (Mao et al. 2010). The social and economic calamities caused by of arsenic in drinking water are considered comparable to second-hand smoke and indoor radon gas (Chowdhury 2006). Chronic arsenic toxicity is implicated in 'cardiovascular, hepatic, renal, gastrointestinal, neurological, reproductive problems and malignancies,' (Mao et al. 2010) and has been demonstrated to hinder the cognitive and intellectual development of children in Baotou (Li et al. 2003).

Arsenic and fluoride are naturally occurring elements that do not become hazardous to humans until they are liberated from their earthly confines and concentrated in soil and drinking water. Arsenic and fluoride enter the human body by ingestion or respiration. Windborne residues from mining activities build up on the surface of the soil and are absorbed by food crops and grazing livestock. As rainwater carries the elements into the soil, these elements can build up in the water of shallow wells. But digging deeper wells is no escape: as wells are bored deeper to escape surface pollution, hydrogeochemical deposits rich in arsenic and fluoride are tapped, sometimes at 200 and 400 meters depth (Wen et al. 2013). Escaping one problem creates another. As with the scholarship on radioactive hazards around the tailings pond, there has been extensive Sinophone research on these issues dating back several decades (Luo 1993, Wang, Kawahara, and Guo 1999).

Fluorosis has serious effects on livestock. Skeletal fluorosis causes certain bones to grow at irregular rates and to soften. In livestock, this causes their teeth grow uncontrollably, soften,

[153] Village resident, male aged 54. Interview by author, September 2013
[154] Village leader, male aged 46, interview by author, September 2013

and fall out, which makes it impossible for the sheep to graze. They eventually starve to death. In the region, extensive cases of irregular tooth growth have been observed since the 1980s, with devastating effects on local pastoralist livelihoods over the following decades. Citing local animal husbandry bureau statistics, an official in the Shadegesumu district[155] noted that the number of sheep in the area declined from 160,000 in 1964 to 16,000 in 1999 (Zhao 1999).

In humans, skeletal fluorosis is a devastating condition, the advanced phases of which are crippling (Tamer et al. 2007). In some cases, it causes the long bones to continue growing. Because the ligaments and muscle tissues remain the same size, they stretch to the point of tearing or snapping. In other cases, an increased fluoride load in the human body causes the bones to become more dense and brittle. This occurs when it binds with calcium ions in the bones to form an insoluble salt that, when cleared from the body, takes away part of the bone matrix. As a result, the early phases resemble arthritis and osteoporosis. As skeletal fluorosis advances, the ligaments of the spine and long bones calcify, hindering movement. Fractures occur easily, and cannot be treated using standard methods because of the brittleness of the bones. Recovery from bone fractures is extremely rare. Other side effects include thyroid damage, ruptures of the stomach lining, and loss of motor control cause by spinal compression (Reddy 2009). There is no particular medicine to counteract fluorosis. The best treatment method is to find a new source of drinking water (Sharma et al. 2013).

Figure 22: Abandoned pastoralist home in foreground; western pit of the Bayan Obo mine in the background.

Source: Photo by Author, 21 September 2013.

[155] Located between Baotou city and Bayan Obo

The high incidence of these ailments over the past three decades has stimulated an emptying out of the grasslands around Bayan Obo and rural to urban migration, which represents neither a clean escape nor a secure livelihood. The landscape surrounding the Bayan Obo mining district is marked with abandoned and crumbling houses formerly occupied by farmers and nomadic pastoralists. The official narrative delivered by the local director of the Land and Resources Bureau in Bayan Obo is that all farmers and herders were resettled and compensated; officially, there is no grazing or agriculture within the mining district. All formerly agropastoral land has been converted to wind energy generation. At first glance, this seems true. It is a desolate landscape, made striking by the hundreds of wind turbines stretching away under an immense sky. Only after traveling twenty kilometers away from the outskirts of Bayan Obo mining district did I encounter an elderly herder, in a village built around a small spring. He boasted that the water was cleaner than anything around for kilometers, 'far better than the pollution they drink in the city,' and that enterprising urban residents periodically approached their community with offers to purchase water or build pipelines to the district. He explained that Bayan Obo used to belong to Mongolian nomads, and that the Bayan Obo mine was once a sacred mountain in local religious lore. Even as the mine expanded, nobody wanted to leave, but, 'first the animals got sick, then the babies, and then everybody else.' Most left because it was that or death.[156]

Figure 23: Wind turbines as seen from the western tailings pond of the Bayan Obo mine. This is not a black and white photograph.

Photo by Author, 21 September 2013.

[156] Rural pastoralist male aged 61, interview by author, September 2013

Yet, from the window of this local director's office in the Land and Resources Bureau over the grasslands outside of the small urban district of Bayan Obo,[157] some herds of sheep and horses were visible among the massive wind turbines. At both legal and illegal mines, hoof prints marked the gritty, sparkling mud accumulating along cracks in waste pipes and around the tailings ponds. Just as villagers around the tailing dam in Baotou had little means to leave, some herding families around Bayan Obo saw no alternative to continuing their lifestyle. The local government attempted to compromise with the few remaining families by implementing a local eco-tourism initiative in 2007, prior to the 2008 Beijing Olympics. Herders received subsidies to build concrete huts around their dwellings, sculpted and painted to look like traditional yurts, which they advertised as an "Authentic Eco-tourism Resort." But there has been no tourist traffic to Bayan Obo, this place known across the country for its fearsome pollution and short life expectancy and the influx of international tourists around the 2008 Olympics did not reach Bayan Obo. Entrepreneurial families have since returned to grazing even though they were aware of the pollution, were acquainted with the ravages of cancer and fluorosis, and periodically paid fines for violating the no-grazing policy. They view sickness as inevitable. Yet those I interviewed stated that they preferred the risk to the life of a day laborer working on the margins of a far-off big city (Klinger 2013b).

This section has focused on environmental and epidemiological effects surrounding production, but has not covered the occupational health and safety issues for people working within the rare earth mining and processing industry. Contemporary data is more difficult to obtain because of heightened sensitivities to 'foreign criticism', but studies from the previous decades published in academic journals provide a window into the human costs of China's rare earth production monopoly. For example, a longitudinal study of female workers in Baotou's smelting facilities found that their rate of pregnancy complications was 22.94% higher than the national average and congenital birth defects at a rate of 20.89% higher than the national average (Liu 1996, Zhao 1994a). The high incidence of cancers along the respiratory tracts of Baogang workers has likewise been researched and reported upon at annual conferences of China's Rare Earth Research Society since 1990 (Li 1990), and has been a core research area of Baogang's internal public health bureau (Wang, Wanping, and Yulang 2002).

The toxicity of the land and water surrounding Bayan Obo and Baotou has been closely monitored by local environmental and public health bureaus for decades (Guo 2009). In the local documents repository at the Baotou Municipal Library, as well as at other provincial and national archives, I found annual reports specific to particular industries, pollutants, and diseases dating back to 1972, and a wealth of academic literature on specific places and cases available in Chinese print journals, many referenced in this section. These academic studies have not been subject to censorship, but neither have they been widely disseminated beyond specialist audiences, nor have they been translated into English. There are three consequences to this.

The first is that there is little general understanding outside of specialized Chinese-speaking audiences (including local inhabitants) about the human cost of rare earth extraction and beneficiation, which precludes substantive dialogue on how to address the catastrophes of Bayan Obo and avoid recreating them elsewhere. The second is that the paucity of material available in translation is mistaken as secrecy, and secrecy is mistaken for a lack of

[157] Visited on 20 September 2013

environmental monitoring, regulation, and remediation in the area. This leads to the third consequence, which is that the billions of renminbi committed by the central government to support dedicated specialists working on these issues, and most importantly; the outcomes of their efforts are simply now known because they are not publicized beyond specialized, Chinese-speaking audiences. Within this is a singular wealth of accumulated knowledge built on four decades observing, documenting, and attempting to manage this dangerous yet necessary enterprise.

This indicates that, contrary to the western perception of China as an unregulated free for all for dirty industry, the situation has been closely monitored. This devastation did not occur because political and industrial leaders were ignorant of the effects, or only recently became aware of the hazards of radioactive waste or mining residues. The priority was, instead, to maximize exploitation of China's hinterland for the greater good, defined as China's economic development and national security, as well as the global market (Chen 2010b, Mancheri 2013). The consequence of this was the reconfiguration of Baotou into a national and global sacrifice zone not through default but by design and according to the interests of principle actors in the global rare earth sector. There are, clearly, limits. Contaminating the water supply on which a fifth of the country depends, and sickening a local population to the point that illness and early death undermine regional economic development (Wang and Baocheng 2011, Yu, Le, and Li 2008) has prompted sweeping changes. Yet the situation remains bleak and warrants dramatic measures. The measures taken in production policy and practice are discussed in the next section.

III. From Peak Production to Strategic Resource Conservation and Regional Development: 2000 – 2010

"Currently, Baogang Company's steel and iron ore production is increasing. But the growing shortage of iron ore and other raw materials increasingly constrains the company's future prospects. This will be the primary problem for future development," (Liu and Liu 2007).[158]

"How to solve the problems of complex use in the beneficiation process as well as remediate the environment? First, change perspective. We must change production priorities and guidelines from "Steel First" to "diversification and environmental protection," (Ma, Gao, and Yu 2009, 90).

This section gives a multiscalar account of the transformations in policy, discourse, and practice that were necessary to reorient the definitive role of rare earth production in China's political economy toward strategic resource conservation and diversified regional development since the beginning of the 21st century. The previous section established that the environmental and epidemiological hazards of rare earth elements have been known for decades, therefore the dramatic shift that has unfolded over the first decade and a half of the 21st century could hardly be explained by a sudden wealth of new information. Rather, the abundance of research on the environmental and epidemiological devastation of rare earth production in Baotou and Bayan Obo indicates that achieving peak production status and attaining a global monopoly was

[158] "当前，包钢（集团）公司钢铁产量的增加和铁矿石资源的日益紧缺，铁矿石原料成了制约公司未来发展的主要问题．" (Liu and Liu 2007)

predicated on the reconfiguration of the region into a 'sacrifice zone' (Fox 1999, Brannstrom 2009, Endres 2012). But what most analyses of sacrifice zones do not account for is what happens 'after,' or when the place in question is revalorized as something other than a pollution haven or extractive frontier.

In recognition of the fact that the tailings lakes cannot be completely sealed (Wang et al. 2009), nor can the contamination be pulled out of the soil or ground water, policy makers have instead focused on reducing the cause of pollution by making efforts to control production, while extending palliative measures such as hospital construction, expanding access to health care, and undertaking extensive economic diversification campaigns. For China's central government policymakers, a straightforward way to rein in the environmental and epidemiological harms of rare earth production is to decelerate the pace of resource exploitation, production, and processing. In a market economy, this must be implemented through a host of complex policy instruments, institutional restructuring, punitive measures and propaganda campaigns. In China's context, this has been accomplished by reframing overarching political and economic development objectives according to these priorities with the effect that in Baotou and Bayan Obo, strategic resource conservation and the dramatic industrial restructuring required is meant to be seen as an inalienable part of ongoing national development and reform.

Just as the exploitation of Bayan Obo's geological endowments was framed as integral to regional industrialization and socialist revolution during the Cold War, the contemporary strategic conservation initiative has been articulated to a comprehensive national and regional development program. The policy measures are sweeping, and organized according to numbered slogans:

> 'The Eleventh Party Congress of Baotou Municipality pointed out the "Three Enhancements" that will be achieved in Baotou. These are: enhance the comprehensive economic strength of the region; enhance urban taste and quality; enhance the material and cultural living standards of urban and rural residents. Thus the Congress promoted the "Five Transformations:" transform the region from an old industrial base to a new industrial base; transform Baotou into a regional center with sophisticated urban functions distinct from other relatively simple industrial cities; transform local structural mechanisms as needed to boost innovation-driven technological development by investing the necessary material resources; transform the development orientation from the sole pursuit of economic growth to give increasing attention to improving people's livelihoods; transform the growth mode from extensive to intensive. These changes will be focused through the "Six Projects Implementation:" Implement industrial restructuring and project upgrades; implement the 'ecological and livable city' construction projects; implement the urban and rural integration development projects; implement the 'scientifically educated city' through human resources development projects; implement projects to protect and improve the people's livelihoods, (Li 2012)"[159]

If these policy measures seem vast and sweeping, it is because they are deliberately formulated to be sufficiently broad so as to be applicable to the operations of entities as diverse

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[159] "包头市第十一次党代会提出:"十二五"包头市将实现"三个提升":提升地区综合经济实力、提升城市品位和素质、提升城乡居民物质文化生活水平;推进"五个转变":即产业定位由老工业基地向现代产业基地转变,城市功能由相对单一的工业城市向区域性中心城市转变,动力机制由主要依靠物质资源投入拉动向科技创新驱动转变,发展取向由更多地追求经济增长速度向更加关注和改善民生转变,增长模式由粗放型增长向集约型增长转变;重点实施好"六大工程"实施产业结构转型升级工程、实施生态宜居城市建设工程、实施城乡统筹一体化发展工程、实施科教兴市和人才强市工程、实施环境综合整治和生态保护工程、实施保障和改善民生工程。" (Li 2012)

as the Ministry of Culture and a State-Owned Enterprise. It is typical of China's political process for the highest policy entities to formulate the ideological framework and policy objectives, and then for the range of policy actors and lower levels of government to interpret the objectives according to local conditions. For example, the environmental protection bureau interpreted these measures in the following way:

> "First is to emphasize pollution reduction by restructuring Baotou's economy in order to reduce emissions and make significant improvement to the economy. This is necessary in order to realize the 'Primary Pollution Controls Plan in the Twelfth Five-Year Plan of Baotou Municipality' and the measures outlined under the 'Baotou Municipality Working Program for Control of Major Pollution Emissions…Second is to eliminate backwards production capacities…third is to strictly control access to the environment…This is important to progress and improvement of the people's livelihoods,'" (Li 2012).

This might seem to be an unrealistically ambitious and comprehensive set of goals to be undertaken in five years' time, and it may even seem unlikely that the declarations of an environmental protection bureau would be realized in industrial restructuring. This is where the discursive properties of rare earth elements prove politically expedient. Reframing them as scarce, strategically necessary, vulnerable to foreign expropriation, serves as an ideological instigate to reorient policy and production practices from maximum output and export to conservation and industrial innovation. The Twelfth Five-year plan provided the ideological pivot:

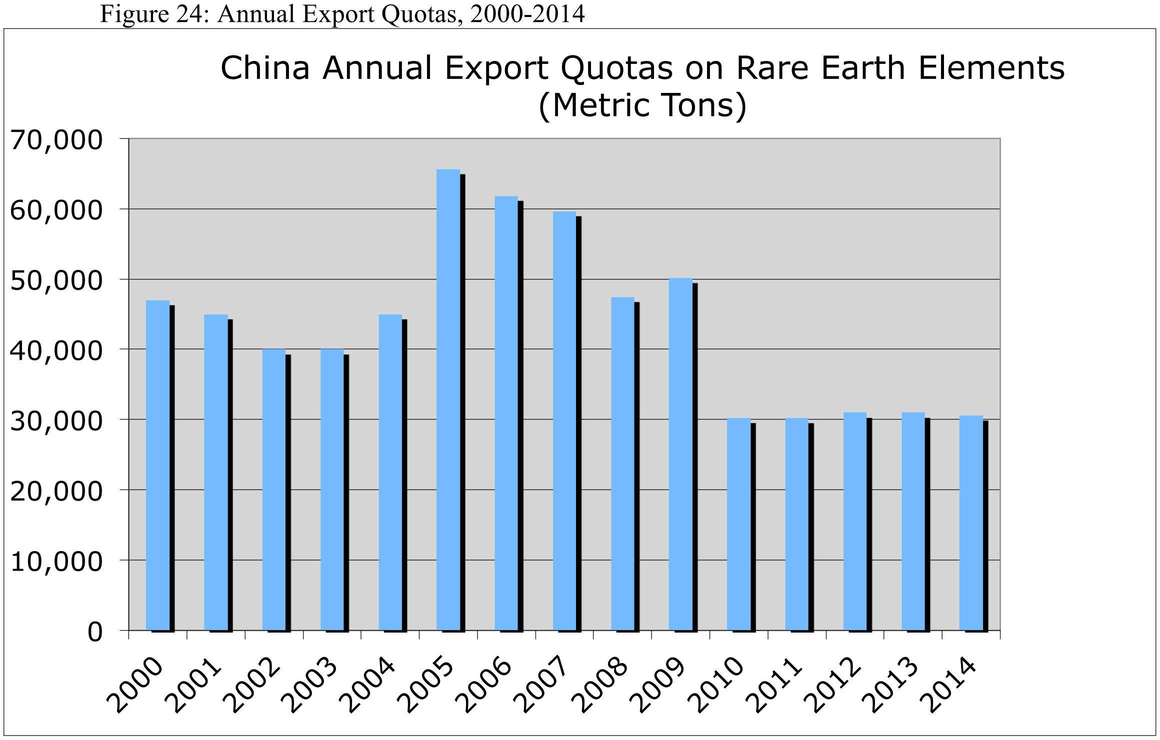
> "Article 28 of the Emerging National Strategic Industries Development Plan very clearly points out that we must consider protecting and strengthening existing rare earth reserves while growing our domestic rare earth industry to be a strategic task of utmost importance," (Li et al. 2012).

There, in plain language, is the articulation of central government strategy to change China's position in the global division of labor, and to transform domestic dominance in rare earth extraction and refining to national dominance in value-added processing. This earliest statement of this intention can be found in the 2003 Policy on Mineral Resources, in China's subsequent white papers on rare earth elements, and countless policy documents. This is hardly a revelation, although considerable Anglophone and Lusophone literature continues to treat it as such. Continuing to upgrade China's production capacity is critical to longer term domestic sustainability, employment, and stability concerns. Put succinctly: "Mining rare earth minerals employs hundreds of people, separating rare earth elements employs thousands of people, producing rare earth end products, however, employs millions of people," (Chen 2010 quoted in Lucius, 2014, 176). It is important to understand these policy slogans as emerging from longer-term dynamics rather than vaingloriously declared irrespective of political economic realities. The ideological legacy of Cold War caricatures of Socialist politics continues to hobble international analyses of China's policies by presuming that official objectives are tone-deaf declarations of an out-of-touch Leninist regime (IBP-USA 2012, CSIS 2013). To the contrary, these policy objectives have been built on more gradual structural changes encouraged by the export tariffs in the previous decade.

In 2003, the central government issued an updated *Policy on Mineral Resources*. In distinction to the previous laws issued in 1986 and 1993, the 2003 policy emphasized the need to promote more technology-intensive mineral exploration and improve environmental oversight. In

January 2004, the export tax rebate initiated by the Ministry of Commerce in 1985 was adjusted from 13% to zero, and the export tax rebate for yttrium and scandium compounds was adjusted from 17% to 5%. As of May 1, 2005, the export tax rebates were abolished. Cancelling the rebates was part of a larger set of shifts in China's economic development strategy around raw materials. The purpose was to discourage exports and increase imports of raw materials while building up domestic beneficiation and components manufacturing capacity. Toward those ends, on November 1, 2006, the Ministry of Commerce announced that 10% tariff on rare earth exports was would take effect on June 1, 2007 (Chen 2010b). The Ministry of Commerce subsequently increased the tariffs to 15 – 25% on all rare earth products except praseodymium, gadolinium, holmium, erbium, thulium, ytterbium and lutetium (Chen 2010b). These tariffs were accompanied by a set of export and production quotas that were announced in 1999 and went into effect in 2000. Most charts begin with the year 2005 in order to show a simple pattern of steadily decreasing quotas. Beginning in 2000 shows the more variable character of the quotas, indicating policy experimentation rather than a draconian imposition of limitations, as it has been so often portrayed in Anglophone discourse. The historical trends help show that quotas are not arbitrarily designated, but determined according to a set of calculations based on supply, market price, strategic and diplomatic considerations.

Figure 24: Annual Export Quotas, 2000-2014



Compiled based on data from (Tse 2011, Korinek and Kim 2009, MOFCOM 2013, 2014). The sudden spike in quotas in 2005 is due to the extension of quotas to include joint ventures. The quota is not the same thing as the total amount exported. Official exports have been lower than the quotas since 2011 (Yoshoika 2012). Because of robust black market activity, actual exports can only be estimated but tend to exceed official exports by 10% - 40%.

Building on the macroeconomic changes precipitated in part by the quotas and tariffs, the next step in the policy strategy was to consolidate production control under Baogang (Guo 2009). In 2006, the central government began a forced consolidation campaign to reduce the number of private industries in the rare earth sector to 20 state or military owned enterprises by 2015. In 2010, the state issued a moratorium on new are earth separation projects in order to reduce production overcapacity. In Baotou, privately owned and operated rare earth firms were directed to merge with or sell out to Baogang, of which thirty remain.

The consolidation policy in the rare earth sector follows a similar process of that in the coal sector, in which private firms were given a deadline to comply with the state mandate to merge with or sell out to a state-owned enterprise. The central government also issued a mandate ordering all illegal mining operations cease. However, key local officials opposed these mandates for the same reasons that central government officials had formulated them: national security and economic stability. As a result, the mine closure and enterprise consolidation policy followed the selective compliance pattern of many other national campaigns, wherein it was most effectively implemented where the results would be visible to visiting officials, which is to say, from the paved roads. Traveling along the highways in Baotou Municipality, dormant processing plants and abandoned workers' housing could be seen. But off the paved road, accessible by dirt tracks leading off behind the hills, small-scale illegal mines were still in operation in late 2013. The claim made by certain local officials refusing to implement the forced closure and consolidation is that the small mines were, above all, *useful* for local employment as well as for various nationalist objectives such as industrial and economic development.

Industrial consolidation in Baotou has been partial for several reasons. The first has to do with inertia inherent in the built environment around Baotou. The city, provincial, and central government devoted significant resources to constructing a 'Rare Earths High-Technology Development Zone' in order to attract private industry from around China and the world, including building up a new residential district with luxury apartments. Their successes had resulted in the establishment of sixty firms specialized in different aspects of the beneficiation and downstream production process. Some firms were private spin-offs of military industries and produced specialized components for advanced naval and weapons applications. With the more specialized firms overseen by individuals with more influential connections, sales and mergers tended to be negotiated over private dinners with terms favorable to the seller. But there remain about thirty nominally independent firms because they have either specialized in a particular aspect of the beneficiation process that Baogang officials judged it too difficult or inefficient to take over, or relatedly, remaining independent firms were owned by current or former military personnel and thoroughly integrated with the local arms industry.

Despite this local compromise, Baogang is still responsible for allocating the raw materials coming from the mine at Bayan Obo. When there is not enough to go around, this is where the 'illegal' mines enter the picture to provision certain private firms with raw materials to keep the machinery running. This arrangement required no small measure of complicity on the part of local actors. Bayan Obo is a closely monitored region, designated a 'strategic area' in a national public safety law in 1991, which officially forbade foreigners and unauthorized outsiders from entering. With the closure and consolidation[160] campaign entering into force in 2009, the local public security bureau received considerable central government money to implement a host of new surveillance measures. As a result, all roads leading into town and those surrounding the mine are monitored by networks of surveillance cameras. Another local official reported that every ore bearing dump truck contains a GPS tracking chip and is monitored by satellite. Since there is only one paved road and one railroad linking Bayan Obo to Baotou, enforcement duties are less onerous than in other, better connecting mining regions in the south of the country. These measures were put into place reportedly to crack down on black market activity, the devastating environmental effects of illegal mining, and to help stabilize the prices and regularize the rare earth economy, all of which are in keeping with near and long term environmental and national security interests.

But some local officials have a different perspective. In their view, the central government mandates are driven by environmental concerns, which carry less weight than the national security imperative to provide the weapons manufacturing industries with a steady supply of raw material. Furthermore, since central government axioms are formulated with the express purpose to be interpreted by lower level government officials according to local conditions, officials supporting the ongoing operations of illegal mines do not necessarily see their activities as contradicting national interests. One official interviewed said that such an arrangement was an appropriate application of the national mandate because keeping the arms industries well supplied was contributing to the fundamental mission of building a mighty nation.[161]

However, there is intense disagreement on the ground as to the best practices. Local officials frustrated by the incomplete closure and consolidation process criticize their complicit comrades as only looking after their own interests by profiteering from 'selling out' China's 'precious natural resources' to foreigners and not caring about the severe environmental problems caused by ongoing illegal mining. One frustrated official in the local bureau of the Ministry of Land and Resources in Bayan Obo characterized his complicit colleagues as possessing a 20th-century industrialist mentality about national security, wherein the production of heavy machinery was the primary measure of national strength. By contrast, 21st-century national security means enacting long-term measures to eliminate threats to the strategic resource supplies—which include 'chaotic' mining—and eliminating environmental destruction by rationalizing production and enforcing environmental protection regulations. In this particular case, this means consolidating production and processing under the umbrella of the state-owned enterprise.

Consolidating rare earth mining and processing into state-owned enterprises has important implications for ongoing environmental regulations. SOEs have their own environmental and public health bureaus, internal to the SOE itself. Because private firms were subject to the monitoring and audits of the local bureaus, the data gathered by the environmental protection bureau and public health bureau included pollution and occupational health and safety

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160 近几年来，通过包头市人民政府对沿四道沙河流域稀土生产企业的整顿、搬迁的决定，目前市区内稀土焙烧、碳沉企业已全部搬迁至九原区钢铁稀土工业园区内，搬迁企业的稀土生产废水全部集中排入包钢尾矿坝 (Guo 2009)

161 Anonymous local official in Bayan Obo Mining District, interview by author, September 2013

data from private firms. Private firms merged with the state-owned enterprise were removed from the jurisdiction of local government offices and became subject to the internal monitoring of the SOE, the findings of which are not shared with local government bureaus nor disclosed to the public. As Baogang assumed a greater share of mining and beneficiation processes, an increasing share of the rare earth industry has been exempted from public monitoring and regulation. The findings from the SOEs internal monitoring offices are reported up the chain of command for SOEs to SASAC instead of to the Ministry of Environmental Protection, Ministry of Land and Resources, and the Ministry of Public Health. This spatial delimitation of monitoring and regulation means that local environmental data does not include SOE data, nor is it legally required to be shared. Furthermore, SOEs are more difficult to petition for redress of grievances as compared to ministries (GJXFJ 2014). This has deepened the knowledge gap between existing 'policy silos' in China's government apparatus. If in fact merging private firms into SOEs has improved environmental regulation, the state has refused to disclose it.

Given the shift in priorities from industrial production above all to strategic resource conservation and environmental remediation, it may be tempting to view the changes in Baotou and Bayan Obo as a vivid enactment of the New Ecological Modernization approach. Blaikie (1999) and Muldavin (2008) characterize this in China as a convergence of 'cornucopians' and 'environmental managers' within the domestic technocratic elite in the belief that the state can, through the effective application of management strategies and technologies, manage environmental harms and overcome natural limits to growth while also benefitting the market (Mol 2006). Western proponents of ecological modernization theory assumed a static global division of labor in which nation states are primary actors. As a result, Mol *et al* failed to take into account how local domestic investment in industrial innovation, particularly the growth of energy efficient technologies, as well as the global dependence on China as supplier of cheap rare earth elements, might force industrial restructuring elsewhere. In Mol's analysis, the incentives to invest in energy efficient technology and environmental cleanup would create new markets for European technologies, resulting in a win-win scenario for Euro-American firms and China's developing regions. But actually, broad developments in China's rare earth sector have undermined the renewable energy sector in other parts of the world at both ends of the commodity chain: upstream users outside of China are vulnerable to shortages and cost fluctuations, while downstream users in Europe and the United States have been outcompeted by rapid development of China's renewable energy technologies industries that have expanded in Baotou.[162] Ecological modernization theory did not account for fundamental differences generated by its specific implementations across global space.

Conclusion

This chapter shows how frontiers are necessarily temporary signifiers: when environmental and epidemiological harms intensify to the point that the damage done by rare

[162] The US and EU have filed WTO complaints against China for providing support to domestic wind turbine manufacturers, (USTR 2011); China has ongoing WTO cases against the US, EU, Australia, Japan, Korea, Russia, and Norway for their anti-dumping duties against solar panels manufactured in China (WTO 2014b); this industrial competition between China and the EU has complicated efforts to collaborate on climate change mitigation (Lema et al. 2011).

earth mining is judged to pose a serious existential threat to stable territorial hegemony, extractive relations change. Since 2005, the National Development and Reform Commission has expressed an explicit intention to trade China's global dominance in rare earth mining for value-added production and advanced research and development (NDRC 2005). While this has met with resistance in areas where the local economy is largely dependent on rare earth extraction and beneficiation, the overall trend is clear. The concentration of rare earth mining and processing in China does not seem to be in anyone's interests: Western commentators have emphasized the strategic and economic vulnerabilities presented by this arrangement, while Chinese commentators have pointed out that securing a stable supply of rare earth elements should be a point of international collaboration, given their relative ubiquity.

Tracing the changing geographies of the global division of labor from approximately 1980 to 2010, this chapter has examined the emergence of China's rare earth monopoly from the perspective of international political economy since the Reagan/Thatcher revolution and Deng Xiaoping's reforms. The first section examined this shifts of global geographies of rare earth mining and beneficiation under emergent forms of neoliberalism, the second section examined the physical effects of this in one key site, and the third traced the domestic political economic responses stimulated by these effects and enabled by broader shifts in the global division of labor. These developments were not, in themselves, sufficient to create the 2010 crisis. The next chapter examines the 2010 events that awoke the world to its dependence on China's rare earths, transformed global resource politics, and precipitated dramatic spatial transformations on the global geography of the rare earth frontier.

Part II:

The 2010 Crisis and Aftermath

The chapter in this section examines several key changes precipitated by the 2010 rare earth crisis. Chapter four critically examines events and debates surrounding the 2010 crisis as well as the responses to China's rare earth production and export quotas across the globe. The sudden price increases occurring in 2009 and 2010—the price of some elements increased 2000% (two-thousand percent)—unleashed waves of prospecting and speculation across the globe aimed at identifying a non-Chinese source of rare earth elements in areas previously considered off limits, such as Greenland, Afghanistan, and California. It was in this context that the world's largest niobium producer, CBMM succeeded in producing high-purity rare earth oxides from its mine tailings in 2012. This was a significant technological breakthrough that could have signaled the beginning of greener rare earth production. But that did little to quell the rush to raise capital and generate political will to open up reserves in impossible places, examined in subsequent chapters.

Chapter Four

The Rude Awakening

Introduction

The previous chapter discussed the global political ecology of China's rare earth dominance and examined shifts in Baotou and Bayan Obo's production policy and practice. These shifts had been underway well before the rude awakening to global dependence on China's rare earth production. This chapter first surveys the 2010 events that awoke the world to China's rare earth dominance and then examines some key aspects of the ongoing spatial transformations precipitated thereby.

Whereas Liggatt (1933), Saleska and Engel (1999), and Newell (2012) *inter alia* contend that hazardous extractive industries tend toward places with lax regulatory frameworks, the post-2010 geography of exploration, speculation, and nascent extractive activities on the global rare earth frontier reveals a much more complex picture. The developments examined herein indicate that the spatial character of the global rare earth frontier is not simply driven by price and regulatory concerns, but also, and often overwhelmingly, by an intersection of transnational territorial ambitions and geopolitical anxieties about China's global influence. As this and subsequent chapters will show, the following three dynamics characterize the contemporary global political economy of rare earth prospecting following the rude awakening of 2010:

(1) An extension of the frontiers of rare earth production to previously off-limits regions such as: designated ecological protection areas in Brazil; nuclear-free zones in Greenland; the heart of the so-called 'war on terror' in Afghanistan; and the robustly-regulated context of California, in the United States;

(2) The cooptation of sovereign development aspirations by transnational extractive interests requiring a significant regulatory offensive in order to exercise resource claims, resulting in the paradoxical weakening of environmental regimes in the name of sustainability under the contemporary contexts of climate change politics and resource nationalism, both of which have demanded a ready supply of more sustainably-produced rare earth elements, and;

(3) A robust strategy to produce rare earths from existing mine wastes—thereby redefining the frontier in terms of sustainability rather than successive exhaustion—and a failure of downstream state and market actors to leverage this breakthrough to shift the global status quo.

The first section of this chapter details the 'rude awakening' of 2010, caused by a temporary disruption of exports from China. The second section examines some salient aspects of the subsequent ideological, market and policy responses that have redefined the contemporary geography of the global rare earth frontier. The third section examines a key technological development provoked by the sudden price increase and the demand for a non-Chinese source of more sustainably produced rare earth elements. The upshot is that it is no longer adequate to superimpose the geography of mining and prospecting over the geography of frontiers principally characterized by lax regulatory frameworks. Rather, this chapter shows how economic interests and 'lax regulatory frameworks' are insufficient to explain the spatial transformations precipitated by the recent changes in Bayan Obo. A more complex interaction among economic, geopolitical and environmental concerns articulated with contemporary territorial ambitions, speculative hyperbole, and broader anxieties provoked by China's changing position in global political economy is at work in the spatial transformations of the global rare earth frontier.

I. Trouble Downstream: The 'Embargo' and the 2010 Crisis

In the first decade of the 21st Century, the question of rare earths, of global dependence on China, or of environmental concerns about their production made scarce appearance in international policy or media discourse. As had been the case for much of the twentieth century, rare earth elements remained the domain of specialized chemists, materials scientists, and niche investors. A particular event brought the issues to global attention.

The 'Embargo'

The Senkaku, or Diaoyu Islands lie in disputed waters north of Taiwan and southwest of Okinawa, Japan. These eight uninhabited islands, with a total area of about seven square kilometers, are contested because of their geostrategic location, proximity to important shipping lanes, and abundant fish and petroleum resources. China claims that they have belonged to China since ancient times, Japan claims that they belong to Japan since they were the first to formally survey the islands and erect a sovereignty marker in 1895, and the Taiwanese government varies its claims depending on which party is in power.[163] Tensions had already been periodically simmering between the two countries since the discovery of oil deposits in 1970 and had reached the point of erupting in episodic anti-Japanese demonstrations during the 2000s (CD 2003, Bao 2010).

On September 7, 2010, the Japanese coast guard seized a Chinese fisherman, Zhan Qixiong, who had strayed to close to the sensitive area. Instead of complying with the procedural escort beyond the 15-kilometer range, Mr. Zhan reportedly rammed his boat into approaching coast guard vessels. Although the latter fact has generally been omitted from reporting on the subject, it is important to note that fishing activities around the island had generally proceeded despite the diplomatic dispute: both Chinese and Japanese fishers were entitled to fish in the area. International and Chinese media omitted the fisherman's behavior from their accounts, which conveyed the impression that Japan had detained a hapless fisherman as a unilateral act of escalation. Domestic Chinese media interpreted the detention of Mr. Zhan as an act of war.

In response, according to Anglophone accounts at the time, 'China' halted rare earth exports to Japan. However, this was not an official policy or even a decision taken by national-level policymakers in Beijing. Rather, some military personnel in China's port city of Lianyungang colluded with port workers and local customs officials to retaliate by withholding

[163] The KMT is pro-China and pro-integration, so they are more likely to echo Beijing's utterances about the island. The DDP is pro-Independence and tend to remain silent on the issue in the interest of maintaining smooth relations with what they view as their more developed neighbor (Kao 2014).

shipments. The motivation was 'to teach Japan some humility' by reminding them of their economic dependence on China.[164]

Officials at the Ministry of Commerce publicly denied that any such disruptions had occurred. But contrary to international speculations about complex diplomatic maneuvering (Bradsher and Tabuchi 2010), Beijing issued this denial because they were caught unawares and were only alerted to the issue after the Japanese Customs Authority inquired after the rare earth shipments. Meanwhile, Beijing officials made urgent remonstrations to the local level that went unheeded for several weeks. Central government officials made public statements disavowing any central government strategy to restrict rare earth exports beyond the quotas already in place for nearly a decade. Adding to the confusion, Anglophone analysts that do not differentiate between international declarations and specific local realities cite official statements from Beijing as evidence that the shipping disruption never actually occurred (King and Armstrong 2013).

Local port workers framed their actions as defending China's national interests according to local conditions[165], which is an axiom of China's decentralized authoritarian governance (Xu 2011). In this particular case, local conditions were crucial in informing the action of military and port personnel. Lianyungang is on the coast of the East China Sea, and as such it is one of the more proximate ports to the islands. It is also located north of Nanjing, where a living memory of the Japanese invasion and massacre is cultivated as a matter of public policy (Fogel 2000). Furthermore, Mr. Zhan was detained within a few days of the anniversary of the 1931 full-scale Japanese invasion of Manchuria. Thus Japanese claims to the islands were, in formerly occupied regions of China, interpreted through the historical lens of colonialism and war; seizing a Chinese national in waters that Beijing asserts are its own was framed in domestic Chinese discourses in terms of a brutal history of humiliation suffered under Japanese expansionism. History, memory and geography were crucial to how this issue played out: military and port personnel in Lianyungang saw themselves on the front lines facing off against a contemporary manifestation of Japanese aggression. Central government officials had considerable difficulty persuading local officials and workers in Lianyungang to resume shipments because the latter viewed it as an order to stand down, to surrender to Japan.

As an intermediary step, port officials nominally resumed shipments in early October, but subjected nearly every container bound for Japan to thorough inspections before loading them on ships, which had the effect of delaying shipments further (Yuasa 2010). Even though the fisherman was released on September 24, 2010 (Fackler and Johnson 2010), port workers did not restore normal export activity until late October or mid-November[166], approximately two months after the initial incident (BBC 2010, Bradsher 2010c, b).

Halting shipments was an isolated local decision unrelated to export quotas, industrial consolidation in Baotou, or to any other production control measures. The act nevertheless had serious international consequences. Beijing did not know it was happening, denied it was

[164] Anonymous Military Officials in Lianyungang, interviews by author, September 2013
[165] Anonymous port workers in Lianyungang, interviews by author, September 2013
[166] Newspapers as well as interviewees express conflicting dates; all fall within the timeframe of October 28 and November 24, 2010.

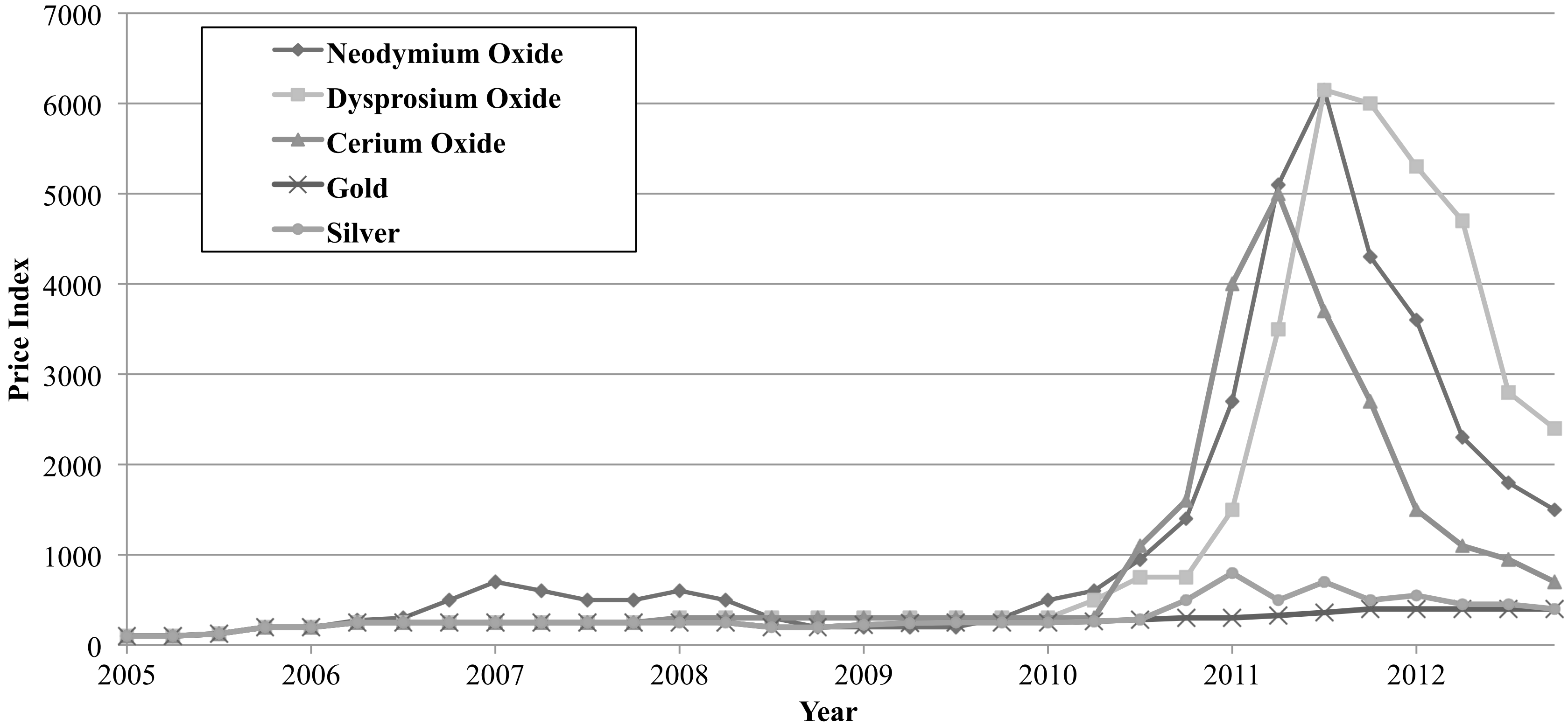
happening once it learned, took steps to resume official shipments from this port in the interests of maintaining stability, and then denied the incident had ever occurred (Areddy, Fickling, and Shirouzu 2010, Richardson and Williams 2010). But the damage had already been done.

The Crisis and the Aftermath

The sudden halt of official exports from China to Japan constituted a significant disruption in the global supply of rare earth elements, given that Japan imported forty percent of all rare earth elements produced (Humphries 2013). This caused prices to increase by as much as 61-fold for some elements in a very short time in the latter months of 2010 (see Figures 25 and 26).

In fact, the 'web of pain' created by the sudden fears of shortage exposed just how diverse the applications of rare earth elements are, and how much of modern life depends on them. Major downstream producers saw their profits cut into by as much as 35% percent between the third and fourth quarter of 2010 (Monahan 2012). Junior firms in the renewable energy sector were particularly hard hit. Rare earth elements are essential for the production of wind turbines and hybrid fuel cell batteries; each two megawatt wind turbine uses roughly eight hundred pounds of neodymium and 130 pounds of dysprosium (Stover 2011), while each hybrid vehicle uses about thirty pounds of rare earth metals (Burnell 2010). Yet they are only one of many inputs; therefore a 2000% price increase was too much for many nascent green technology companies to bear: some analysts claim that fifty-nine renewable energy companies in the US have since filed bankruptcy; others claim that the number is only nine, or three (Lakatos 2014, Stahl 2014, Primack 2014). DOE personnel interviewed in early 2014 did not have precise figures on the number of cleantech bankruptcies related to rare earth price increases.

Figure 25: Comparative Price Index: Selected Rare Earths vs. Gold and Silver, 2005 - 2012



Sources: Bartekova (2014) and Thomson Reuters Datastream (2014).

Figure 26: Annualized Quarterly Volatility for Selected Rare Earth Oxides from late-2010 to mid-2012, USD/kg.

	Q3 2010	**Q4 2010**	**Q1 2011**	**Q2 2011**	**Q3 2011**	**Q4 2011**	**Q1 2012**	**Q2 2012**
Lanthanum	16.37%	**374.47%**	**366.10%**	**348.22%**	**348.71%**	143.07%	140.42%	59.82%
Cerium	20.36%	**439.84%**	**425.33%**	**410.26%**	**412.68%**	139.05%	135.20%	65.63%
Praseodymium	46.15%	61.51%	59.72%	88.99%	94.00%	**108.49%**	**120.27%**	43.22%
Neodymium	37.13%	63.97%	64.58%	97.58%	84.79%	**122.07%**	**138.34%**	73.88%
Samarium	1.47%	**865.67%**	**840.27%**	**808.42%**	**803.10%**	122.45%	117.11%	45.00%
Europium	7.62%	5.85%	3.60%	77.71%	**285.42%**	**296.18%**	**303.59%**	**322.21%**
Terbium	48.30%	44.48%	45.35%	84.52%	**191.66%**	**204.88%**	**211.99%**	**222.02%**
Dysprosium	44.82%	48.99%	45.72%	76.68%	**199.73%**	**199.38%**	**218.60%**	**242.57%**

This table shows how not all rare earth elements were affected equally by the market response to the 2010 disruption. The most dramatic volatilities indicated in bold.
Sources: Bartekova (2014) and Thomson Reuters DataStream (2014).

The story of this broke in the west in an article by New York Times reporter Keith Bradsher, which was followed by a disavowal of the incident in the People's Daily, the English-language edition of Beijing's official mouthpiece (Bradsher 2010a, Qi 2010, Liang 2010). Given that international media and politicians needed to learn very quickly what rare earth elements were, it is perhaps understandable that the initial responses were knee-jerk and ahistorical. Commentators across the ideological spectrum speculated about the possibility of war with China, using Deng Xiaoping's couplet[167] to reason that rare earth elements would become the next oil, and therefore the next cause of global conflict (Chapple 2012, Coppel 2011, Brennan 2012, Dobransky 2013, Krugman 2010, Kudlow 2011).

But denial, even in the face of clear evidence, has proven to be an effective diplomatic strategy (Kellner 2007, Franken 2003, Woodward 2006). Since the position of China's central government was that the issue had never occurred, institutions whose legitimacy draws from taking state power at its word carried the message forward. There were special events in Washington DC that questioned whether the embargo had ever actually happened (Hao 2011, King and Armstrong 2013). These were headed up by renowned experts in international relations who nevertheless did not have a practice of examining the facts on the ground.

One evidence-based analysis was conducted by Alastair Iain Johnston at Harvard University. His analysis was based on import data from Japan's Ministry of Finance, which found that there was little statistical relationship between import figures for rare earth commodities, and import declines at Japan's major ports. Johnston drew this conclusion because a third of the cases examined showed a decline in rare earth imports; in 46 percent of Johnston's observations, rare earth imports to Japan increased from August to September of 2010 (Johnston 2013). Because two thirds of the cases examined do not reveal an irregularity in shipments from China, Johnston concludes that nothing happened. The customs receipts showed that Japan was importing rare earth elements during the time that the alleged embargo was taking place. The import receipts are presented, and accepted, as evidence that the embargo did not actually occur.

Yet all thirty one of the Japanese companies that handled rare earth elements reported stoppage or disruption in rare earth oxide shipments from China (AFP 2010). Furthermore, Johnston did not differentiate between rare earth oxides and rare earth alloys or other downstream products. Rare earth oxides, not alloys, were subjected to the temporary export restrictions. Finally, it is important to note that the legality of rare earths imported from China is almost never noted in recipient ports; black market rare earth elements have exceeded China's production quotas by an average of 40% annually since 2007 (Els 2011, Stanway 2011, CD 2009, Topf 2013). A halt in official exports provided an excellent market opportunity to black market traders who, because of their lesser technological capacities, deal in oxides and not in alloys (Reporter 2012, Bradsher 2010d).

Some further clarification is crucial here. Framing the question in terms of whether an embargo occurred obscures the nature of the event. Strictly speaking, an embargo is an official ban on trade or commercial activity with another country. Nothing that fits this strict definition

[167] The Middle East has Oil, China has Rare Earths.

occurred, but Japan's import receipts are not sufficient evidence to conclude this. The import receipts show only that Japan was importing rare earths from China; it does not indicate anything about the origin or legality of these imports, much less the government's official position on temporarily impeding their flow. Indeed, the black market trade in rare earth elements has been a persistent problem for China's policy makers, while also serving as a necessary pressure valve for international downstream buyers who would otherwise face supply shortages much in the same way that clandestine mining is essential to supplying independent processing firms in Baotou.[168] China's Customs Administration monitors the volume of black market rare earths circulating in the global economy by comparing import data of recipient countries with export data from China. The discrepancy is interpreted as the volume of the illegal rare earths exports. Furthermore, the shipments were halted from the port of Lianyungang, which is one of many seaports that export commodities to Japan. There is no indication, in my field research or available information on the matter that military and civilian personnel at other ports engaged in similar tactics.

Yet, regardless of the actual flow of goods, the market response turned a temporary and by all accounts minor interruption into a full-blown economic and geopolitical crisis. Indeed, the market response during this period supports the contention that, much more so than by material fact, the market is driven by speculation, fear, and fantasy (Eichengreen et al. 1995, Taffler and Tuckett 2007, Carrington 2015), and that such mass subjectivity shapes political thought and action in important ways. The *suggestion* of an embargo was sufficient to drive prices of certain rare earth elements through the roof, despite the lack of investigation into the actuality or the extent of the disruptions in global supply, or the abundance of black market sources. As Tsing (2005) and Tuckett (2011) *inter alia* have demonstrated, the mere suggestion of an impending boom or bust is sufficient to mobilize massive sums of investment capital.

Although the crisis was short-lived, it transformed contemporary global resource geopolitics and unleashed waves of global prospecting, speculation, and investment. In fact, by driving prices to unprecedented highs, the crisis generated a range of opportunities for mining companies in the rest of the world, as well as for researchers hopeful that market incentives would sustain funding for rare earth recycling and greener production R&D. Furthermore, citizens, elected representatives, and prospectors in economically depressed regions of the US and Canada saw the solution to their employment and tax revenue woes in bringing rare earth mining back home, so to speak. The immediate political economic and discursive responses that have been key to reshaping the global rare earth frontier are examined in the next section.

II. Rational Responses? Green Nationalism, Global Exploration and WTO Suits

The economic, policy, and ideological responses to the 2010 crisis were marked by incoherencies and cross-purposes, several of which are discussed in this section. The ideological response in the United States and Brazil was characterized by the emergence of an environmentally-inflected right-wing discourse that has been dubbed 'resource nationalism,' 'neo-extractivism,' and 'green' or 'environmental nationalism,' (Baletti 2012, Margonelli 2009, Hao and Liu 2011). The global market responded to the sudden price increase with an

[168] Examined in the previous chapter

unprecedentedly broad wave of speculation, investment, and exploration driven by the resolve to end dependence on China by opening up new sources on the global rare earth frontier. One analyst found that by mid-2011 there were 429 new projects outside of China and India being developed by 261 different companies in 37 countries (Hatch 2012).[169] However, the defining international policy responses are captured in the WTO suits against China—discussed herein—which have had significant consequences for domestic industrial capacity in developed countries (Laïdi 2014, Fratianni, Savona, and Kirton 2013, Blanchard and Wei 2013, Meléndez-Ortiz, Bellmann, and Mendoza 2012).

The economic, policy, and ideological responses to the supply crisis embody different forms of anxiety associated with growing economic uncertainty in 'developed' countries in general and China's growing global influence in particular. The rare earth crisis amplified fears that had been growing for a decade or more in the Anglophone world. For example, Xie and Page (2010) found that most Americans surveyed after the 2008 Beijing Olympics were primarily anxious about what China's rise might mean for US national security, though the vast majority favored peaceful engagement and cooperation to 'balance' China's influence in global affairs. Economic nationalism in the US periodically flared around the issue of low-cost goods from China—even though they have arguably been important to helping the United States contain inflation—as well as investment from Chinese firms and sovereign wealth funds in firms and development projects in the Americas, even though this has helped create jobs (Hoge and Hoge Jr. 2010). The question of whether China played by the rules of multilateral regimes had been thoroughly debated well before the rare earth dispute (Leal-Arcas 2010, Woods 2008), and China's growing resource acquisitions and influence in the Global South has provoked US and European geopolitical concerns since the early 2000s (Kurlantzick 2008, Klare 2008). Thus what is critical and transformative about the rare earth crisis was not the set of concerns that had been circulating in policy talk and scholarship over the past two decades, but rather how the crisis stimulated a radical redefinition of the frontiers of prospecting and extraction.

The remainder of the dissertation deals primarily with this theme. The remainder of this chapter explores several illustrative cases on the nature of the reconfiguration of the global rare earth frontier, using interviews conducted in Washington DC and Brazil, and examines policy, media, and investment materials in Anglophone and Lusophone literature to identify the emergence of new spatialities of critical resource extraction. These new spatialities are characterized by an extension of the frontiers of rare earth production to previously off-limits regions, such as designated nuclear-free zones in Greenland, the heart of the so-called 'war on terror' in Afghanistan, and the putatively better regulated global north, specifically the Mountain Pass mine in California. While it is consistent with established theories of capitalism and commodity frontiers that circuits of accumulation expand to penetrate new spaces, these theories generally rest on the informed assumption that capitalist expansion tends toward areas that appear unregulated or unclaimed (and are interpellated as the frontier); the prevailing wisdom has been that large-scale mining interests have moved from developed to lesser developed countries and regions in pursuit of lower production costs captured in less regulated contexts. In ideological terms, this has translated into an irreconcilable difference between environmental interests and extractive interests (UNDP 2012, Schroeder 2000), with the idea that there must be a trade-off between one or the other given that mining radically transforms the environment in

[169] The farthest extent of this exploration is the subject of Part III.

which it is carried out. The emergent geography of the global rare earth frontier indicates a different set of dynamics at work.

Green nationalism?

The responses to the rude awakening to China's rare earth monopoly revealed that green nationalism takes many forms. The sudden shortage of these critical materials precipitated a new interest in the commodity chains of green technologies, which had the effect of mainstreaming awareness of environmental degradation in Baotou and Bayan Obo (Hilsum 2009, Jones 2010, Jones 2013a, Parry and Douglas 2011). This information was then used by fossil fuel and nuclear lobbyists to argue against renewable energy generation (Fisher and Fitzsimmons 2013, Stover 2011, Epstein 2014), as well as by national security-minded analysts advocating for developing 'environmentally superior' rare earth production practices closer to home, including green sourcing and recycling (Kennedy 2013, Stoyer 2013). In both cases, toxic practices in China were racially coded (Chen 2011a)[170] as both a 'Chinese' problem and as a 'dirty trick' played by China's central government in order to achieve dominance in rare earth production. Parties in the US typically opposed to clean technologies in favor of the petroleum-dependent status quo reversed their position once it appeared that the possibilities for the US to end fossil fuel dependence might be dictated by China's control of rare earth supplies. Viewed in this light, reviving US rare earth capacity could not happen quickly enough: what was needed was some sort of rare earth-specific 'New Deal:'

> "A few years ago, China showed its power, and cut the supply of rare earths to a trickle. The move sent the United States and other countries scrambling to end their reliance on China…But the crucial element in escaping China's rare-earth rule isn't new mines, it's rebuilding the expertise and infrastructure to process the finicky metals, experts say," (Oskin 2013).

In a curious twist, anti-government, Ayn Rand-quoting congresspersons were authoring legislation demanding an approach that resembles nationalizing industry:

> "It is the sense of Congress that the United States should take any and all actions necessary to ensure the reintroduction of a competitive domestic and ally nation rare earth supply chain, to include the reintroduction of the capacity to conduct mining, refining/processing, alloying and manufacturing operations using domestic and ally nation suppliers to provide a secure source of rare earth materials as a vital component of national security and economic policy,"(2011b).

Given the circumstances, right-wing policymakers found that a federal industrial policy was preferable to the possibility that the US' policy choices would be dictated by China. Even though congress acted relatively quickly to authorize the Department of Energy to establish the *Critical Materials Institute* at Ames National Laboratory in late 2010 (Bauer 2010), commentators bemoaned the long lead-time on policy changes and rare earth projects:

> "That still leaves a long gap when the green revolutions will rely on the economic and political judgment of China's exporters," (Heap 2010).

[170] As Chen (2011a) has noted, the toxic hazards of production are racially and sexually coded within a global geopolitics of sovereign fear over foreign toxins hailing from distant production frontiers.

In the meantime, several Democratic US Senators sought to curb China's rare earth dominance by leveraging multilateral institutions to thwart China's mining investments within China and around the world. In a letter to Treasury Secretary Tim Geithner and Secretary of the US Department of the Interior, Ken Salazar, they:

> "…urged Sec. Geithner to instruct the US representatives to the multilateral banks (including the World Bank entities) to oppose funding for any Chinese financed mining project in China or abroad. They also asked Sec. Salazar to use his authority to block any Chinese funded domestic mining project, until the Chinese end their anticompetitive practices in regards to REEs. US mining law recognizes that foreign investment in mineral exploration and purchase should be prohibited where a foreign country denies reciprocal privileges to US companies, and the Senators urged Secretary Salazar to invoke that power." (Casey et al. 2011, n.p.).

No such action was taken. But this and other requests like it were indicative of a strong sense that China's rare earth monopoly threatened US sovereignty and national security. Anti-China discourses resorted to environmental comparison; the differentiating element between 'us' and 'them' became 'our' Euro-American potential to be 'environmentally superior'; given enough time and resources, the United States could 'beat China' by being greener (Perkowski 2012, Leifert 2010). Heavyweights in the downstream industry such as General Electric and Siemens stoked this sensibility by promising to pay a premium for sustainably-produced non-Chinese rare earth elements, and emergent rare earth companies attracted investors on promises to lead the new green wave:

> "Molycorp CEO Mark Smith plans a different kind of mining in a new age of environmental awareness. 'I don't want to produce another pound of product if we don't do it right environmentally. That's how serious we are,' Smith said. 'We don't want to be just environmentally compliant; we want to be environmentally superior,'" (Kraemer 2010).

This approach was outlined as a 'pillar' of the United States' Department of Energy Critical Materials Strategy:

> "In all cases, extraction, separation and processing should be done in an environmentally sound manner…research into more efficient and environmentally-friendly separation and processing technologies has the potential to boost supply from new and existing sources throughout the world, lowering costs while reducing the environmental impacts of mining and processing," (Energy 2011).

In a prescient investigative piece on the re-emergence of the rare earth industry in the United States, journalist L. Margonelli described the charged climate around rare earth elements as 'nascent green nationalism…a weird amalgam of environmentalism, economics, and national security,' which was not:

> "…predictable. Consider the views of the industry analyst Jack Lifton—by no stretch your standard environmental activist ('I don't give a rat's ass about global warming'). To protect US industry from supply shocks, he has called on the government to mandate the recycling of strategic minerals. A 'bottle bill' for cars, long dismissed as an environmentalist's dream, is just one possible outcome. Another could be a backlash of resource nationalism in supplier nations like China. As green nationalism's potent mix of idealism and fear changes the kinds of cars we drive, it also promises to change the course of globalization," (Margonelli 2009).

Broad declarations such as 'chang[ing] the course of globalization' were typical of the post-crisis rare earths discourse of the time. But there are several ways in which it is true. One salient feature is the changing geography of global rare earth prospecting, which adds new dimensions to our definitions of a 'frontier,' explored below.

Global Exploration: Greenland, Afghanistan, the Americas

Concentration of the production of critical resources in one or two places around the globe is hardly peculiar to rare earth elements. The economic catastrophe that would result from a disruption in boron production, for example, the entire global supply of which comes from Turkey and the southwestern United States (Şebnem, Ayşe, and Işıl 2013, USGS 2014), has not inspired further exploration or investment anywhere, much less in politically or geographically challenging environments. The production of other critical materials for heavy industry and munitions, such as tungsten and antimony, are likewise concentrated in China (Shedd 2014, Carlin Jr. 2013), but nor has this generated political or economic fervor comparable to that surrounding rare earth elements.

Clearly, asymmetry in the global production of critical materials is not, itself, sufficient explanation for the wave of global exploration and prospecting that occurred after the 2010 crisis. Nor, as Chapter one has shown, is the simple presence of rare earth elements sufficient reason for investment and exploration, given their relative ubiquity. Rather, the rare earth crisis provided a vehicle for growing international political anxieties concerning China's rise, which have been effectively leveraged in the case of contemporary rare earth politics by long-standing territorial ambitions and extractive interests particular to each site. The dynamics of contemporary exploration can be explained by three factors: the drive, on the part of state and imperial powers, to discipline historically recalcitrant territories in an exercise of sovereign and biopolitical power; the need to sequester the harmful effects of production away from centers of political accountability; complicated by the desire to contain an aspect of China's growing global influence by developing supplies of these strategic materials outside of China. The strategic imperative with which rare earth elements are imbued is instrumental in generating the political will and necessary capital to pursue environmentally hazardous production in contexts that are well regulated or conflict-ridden. Facilitating rare earth exploration outside of China is an immense political, scientific, and regulatory undertaking, demonstrated by the sweeping measures taken in diverse contexts—from Greenland to Afghanistan to the Americas.

Rare earth mining in Greenland had been indirectly prohibited by a 1984 Danish declaration of all its territories as a nuclear-free zone, which banned mining for radioactive materials. Because of their geological coincidence with uranium and thorium, this foreclosed any possibility of rare earth production in places under the Danish authority, until recently. The imperatives of economic development and the elusive promise of sovereignty to be won by mining revenues triumphed over extant legal regimes prohibiting the production of radioactive materials as well as mining in sensitive regions. In 2009, the Act on Greenland Self-Government gave the territory authority over its natural resources independent of Denmark for the first time in 200 years. In 2010, the Greenland administration began recruiting mining companies to explore the island's mineral potential (Boersma and Foley 2014). China's interest in Greenland's minerals provoked the EU to request preferential treatment in mineral concessions while also recommending that Greenland restrict investment from China. Then-Prime Minister Kuupik Kleist rejected this request, saying that "Greenland is open to investments from the whole world," (Briscoe 2013). In October 2013, Greenland's parliament voted 15 – 14, with two abstentions, to repeal the moratorium against mining radioactive materials (Faris 2014).

As the voting reflects, this was fiercely contested (McGwin 2014, Olsvig 2013). Some view mining as the only hope for diversifying Greenland's economy away from dependence on fishing and subsidies from Denmark; others fear the ecological devastation and social decay that comes with transforming small towns into large scale mining operations dependent on migrant labor (Loewenstein 2014). The fact that foreign firms would be exploiting the resources and would be able to bring in their own laborers has caused further contention (Arctic Journal 2013b, Macalister 2013). But expanding mineral production in Greenland has been framed by domestic and international proponents as an important way to increase the GDP of the territory and integrate it into "the globalized world," which would reduce its dependence on annual subsidies from Denmark (Faris 2014). The promise of sovereignty and a desire to integrate more fully into global circuits of power and accumulation as, it is hoped, an independent state, have trumped concerns to preserve the socioecological fabric of Greenland (Gravgaard 2013, Fletcher 2013, Arctic Journal 2013a). This provoked considerable public debate in Greenland, as citizens grappled with the interpellation of their country as a new global resource frontier, opened up by a retreating ice sheet (Nuttall 2012). In the European Union, Greenland's quest for mining-financed autonomy has drawn considerable interest from Chinese investors, which has raised geopolitical concerns about growing Chinese influence in the region (Desgeorges 2013, Conley 2013). Rejecting EU aspirations to bound Greenland into a hinterland for continental Europe's critical raw materials needs, Kleist pointed out in an early 2013 address to Danish Parliament in Copenhagen that each EU citizen discards an estimated seventeen kilograms of critical raw materials annually, and that continental Europe has its own rare earth reserves valued in the hundreds of billions of dollars (Santos 2013).

In Afghanistan, rare earth deposits received significant media attention in late 2010 amidst the crisis, following several years of relatively unpublicized prospecting funded by the US Agency for International Development (USAID) and undertaken by the USGS and the Afghanistan Geological Survey (AGS) (Peters 2007, Orris and Bliss 2002). These expeditions have published findings of reserves valued in the trillions of dollars, not just of rare earths, but of gold, copper, iron, precious gems and other nonferrous metals (Hansen 2012, Risen 2010).[171] In a special feature in *Scientific American*, these resources were framed as a way to "beat" the Taliban: "vast deposits of rare earth and critical minerals found in Afghanistan by US geologists under military cover could solve world shortages and get the country off opium and out from under Taliban control," (Tucker 2014).

These discoveries, however, are not new. The US and UK coalition forces began supporting geological prospecting operations as early as 2003. Furthermore, much of the data simply needed to be translated from Russian, and small-scale clandestine mining operations continue to provide a modest but important income stream for many groups, not just the Taliban.

[171] U.S. and international press reported $1 trillion in 2010; in 2011 and 2012 Afghan President Hamid Karzai claimed that the assets were worth $3 trillion. In a 2013 meeting with potential Indian investors, Karzai reportedly stated: "Actually it's $30 trillion. The U.S. knocked a zero off to keep our assets a secret." (Mehrotra 2013).

Afghanistan's mineral wealth had been extensively surveyed by outside interests periodically over the past five decades, primarily Soviet (e.g. Abdullah, Chmyriov, and Dronov 1980). The former Soviet Union committed hundreds of billions of dollars to develop extractive infrastructure in Afghanistan, but the projects halted with the Soviet withdrawal in 1989.

The US-led war created, perhaps counterintuitively, more favorable conditions for foreign prospecting in Afghanistan's subsoils, where multiple polities exercise claims to statehood (DiJohn 2010, Goodhand 2005). The presence of international security forces and the explicit mandate of the US Department of Defense to create conditions favorable for international business interests in this geopolitically vital central Asian country have led some key players in the international minerals and narcotics trade to conclude that the US-led occupation is 'a war worth waging,' and to drop the pretense that the occupation is about anything other than economic interests underwritten by the United States military (Chossudovsky 2005, Randall and Owen 2012, Scott 2010).

Figure 27: *Science* story about rare earth elements in Afghanistan

The caption in the top right corner reads: "Making every second count, Robert Tucker liberates a chunk of rare earth minerals from the Khanneshin Volcano Complex." Source: Stone (2014)

Developing Afghanistan's mineral wealth, which includes subcontracting prospecting to the AGS and solidifying regulations favorable to international corporations (DiJohn 2010), is the primary task of the Pentagon's Task Force for Business and Stability Operations (Defense 2011).[172] Since 2012, investors have been openly arguing for an indefinite US military presence in order to secure their assets and to temper the likelihood that China, Russia, and "others" might "cash in" on US and UK sacrifices over the past decade and a half (Mehrotra 2013, Benard 2012, Randall and Owen 2012). Natural resource exploitation is aggressively promoted as a key to national development, but members of Afghan civil society are critical of international efforts to

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172 "By working with the Afghan Geological Survey on an airborne geophysical exploration program, we are taking an important step in preparing the Afghan government to conduct their own mineral exploration efforts," said Emily Scott, director of natural resource development for the TFBSO. "The goal of this training is to enable the Afghan government to give the best information possible to international investors." (PNA 2011)

open up the country's resources and are working hard to cultivate a sense of resource nationalism to improve extant natural resource governance frameworks. According to Ikram Afzali, director of Integrity Watch Afghanistan and co-author of a letter to British Prime Minister David Cameron signed by forty organizations: "We want to develop our natural resources, but from a position of pride and strength, not by lowering our standards and ignoring abuses," (Afzali 2014, Peacebuilding et al. 2014).

In both Afghanistan and Greenland, prospecting has been driven by outside interests aided by a small handful of domestic policy elites that stand to profit financially and politically from facilitating transnational mining concessions. In both contexts, the strategic imperative, the promise of sovereignty, and the tensions surrounding a particularly salient aspect of contemporary China's power have been invoked by domestic and foreign proponents in order to generate political will for mining in the previously unexploited and socioecologically delicate regions.

Speculative hyperbole abounds about these new rare earth frontiers, wherein each site supposedly contains the world's largest deposit. Of Greenland's potential, Greg Barnes, chief geologist for the Australian mining company looking to exploit Greenland's rare earths reports: "It is the world's biggest rare earth deposit, it's probably got 50% of the world's rare earth in it. This is one of the world's top 10 mines eventually we think," (Barnes quoted in Fletcher 2013, n.p.). With respect to Afghanistan, an internal Pentagon memo described the country as the "Saudi Arabia of Lithium," and claimed that the country "could eventually be transformed into one of the most important mining centers in the world," (Mazurkewich and Greenaway 2010). As the 9/11 pretext for invading Afghanistan has faded, the extractive agenda has become more pronounced. Ongoing security concerns are framed as investment opportunities[173]: "The challenge is for an enterprising company to develop this exciting deposit," (Coats 2006).

Despite extremely different regulatory frameworks and development histories, both Greenland and Afghanistan are imagined as global peripheries (Kjeldgaard 2003, Krieckhaus 2006) and some of the latest frontiers for exploration. Each of them, respectively, introduces a new valence into the meaning of a frontier. Indeed, the case of Greenland undoes the relationship between regulatory robustness and hazardous mining activities in the making of commodity frontiers. In the words of Greenland's deputy foreign minister:

> "We are, in mining terms, a frontier country. But we are not a frontier country like frontier countries in Africa or South America. We are something very different – perhaps unique. We have evolved over 300 years a solid legal framework, a well-educated population, rules, democratic institutions and a strong society," (Deputy Foreign Minister Kai Holst Andersen as quoted in CER 2014, n.p.).

Nevertheless, from the perspective of conventional development theory, perhaps it is unsurprising that rare earth mining interests from 'centers of accumulation' in Beijing and Melbourne should target these regions that are imagined to be on the global periphery. But the wave of exploration is not limited to so-called peripheral states. The revival of the rare earth industry in the United States, and ongoing prospecting efforts in both the US and Canada (Machacek and Fold 2014) indicate shifting meanings of center/periphery that defined 20th

[173] A more sympathetic critique might call this 'mission drift.'

century world orders, at least as far as the geography of rare earth mining is concerned. These efforts to bring mining back to areas that had previously exported dirty production to the developing world undermine linear conceptions of development and industrial modernization proposed by Rostow (1960) and advocated by policymakers in the Bretton Woods institutions. In the 20th century understanding of global development, which imagined the United States and Western Europe as advanced states, heavy and hazardous industry such as rare earth mining was something for 'lesser developed' countries positioned 'lower' on the 'ladder' of democratic market development (Johnson, Pecquet, and Taylor 2007, Corbridge 1994, Redclift and Sage 1998).

Indeed, as discussed in the previous chapter, the closure of the Mountain Pass mine in southern California followed the broader contours of the new international division of labor at the end of the 20th century. But contemporary dynamics suggest a qualitative shift in which rare earth interests are not necessarily pursuing lax regulations, but instead are mounting regulatory offensives, as evinced by the tremendous political undertakings to create favorable mining conditions in contexts as diverse as Afghanistan, Greenland, and the US[174] In the US context, the 2010 crisis stimulated questioning as to how such a strategically vital industry was allowed to go overseas, with commentators and policy-makers across the ideological spectrum characterizing federal policy-makers as "feckless…who did nothing while a rogue regime acquired a stranglehold on key materials," (Krugman 2010) and who "dropped the 'rare earth ball,'" (Goldman 2014).

Following the 2010 crisis, private industry actors, as well as a range of elected officials representing regions that had been economically depressed since the closure of mining activities in the latter part of the twentieth century, lobbied hard for the development of some sort of industrial policy to revive rare earth mining and processing in the United States (2011a). The proposals ranged from eliminating mining regulations in the United States (Tanton 2012) to creating federal funds to support the revival of a strategically vital industry (Dillon 2010). Over thirty bills concerning rare earth elements have been introduced to the US Congress since 2010 (Grasso 2013). Although the framing of the bills varies, they share a mandate to revive something resembling a national industrial policy. H.R. 2210 of the 112th Congress, also known as the National Defense Authorization Act for Fiscal Year 2013, contained clauses requiring the Secretary of Defense to assess the rare earth materials supply chain to determine which materials were critical to national security. In the case of a positive finding, the Secretary would have been required to formulate a plan to ensure long-term availability within a three-year timeframe. This resolution also would have mandated the Secretary of Defense to develop a plan to establish a domestic source of neodymium magnets used in defense applications that had only been produced in China (McKeon 2012), following the closure of Magnequench in 2003, as discussed in Chapter three.

The failure of the majority of the legislative attempts in the US reveals that competitive pricing remains the sourcing priority for the Department of Defense even insofar as critical materials are concerned. The Secretary of Defense responded to this directive with a report on "the positive changes in rare earth supply chains" precipitated by "global market forces" which

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[174] This is important in order to establish that the dynamics in Brazil, discussed in the next chapter, are not entirely exceptional.

should incentivize the development of "economic and environmentally superior" domestic production capacity (Kennedy 2013). Those within the US mining industry as well as Congressional representatives from both parties characterized the Defense Department standpoint as willful ignorance of the investment required to rebuild US industrial capacity so that it would be on par with China, let alone to develop new, green, superior technologies. Without government life support, it would not be possible to rebuild the US supply chain.[175]

Following the 2010 crisis[176], the Molycorp mine at Mountain Pass mine was revived with a US$1.55 billion investment in order to overhaul production to upgrade the facility and eliminate the causal factors of past environmental disasters. But the promise of Molycorp as a newer, better, greener, and above all more *American* rare earth producer soon deflated as prices continued their downward trend. In 2011 and 2012, Molycorp acquired a number of firms with processing capacities in China and Eastern Europe—places with lower environmental regulations, which indicates that the firm must continue to export the dirtier and more complex aspects of rare earth processing in order to continue to operate in the United States (Gordon, Wilson, and Dickson 2012, Sims 2011). This is not to suggest that by subcontracting the more hazardous aspects of rare earth processing Molycorp has achieved anything that can be called green production status in the US. A surprise inspection by the Environmental Protection Agency in October 2012 found that leaked materials containing lead and iron were present in storm water on the plant site. Investigators also found several containers of hazardous waste that were improperly closed and labeled (Steinberg 2014, Danielski 2014). Since the global price of rare earth elements has fallen, the stock price for Molycorp has fallen from its 2011 high of US$76 per share to less than a dollar in late 2014 (Xu 2014), and Molycorp is currently facing an SEC investigation over its disclosures, a lawsuit related to engineering deficiencies at the Mountain Pass facility, and a class-action lawsuit alleging that former CEO Mark Smith overstated the importance of rare earth elements to shareholders and the public (Elmquist 2012, Pearson 2012, Wayne 2012). These issues have been attributed to the same economic and regulatory forces that led to Molycorp's closure: the challenge of carrying out a hazardous business in a well-regulated context and a volatile market dominated by cheap goods from China. But that, too, is only part of the story. Multilateral policy actions pursued by the Executive branch of the US government worked to restore the global political economy of rare earth elements to the pre-2010 status quo, which was characterized by the inability of US firms to compete with China's rare earth exports.

WTO suits

In China's 2001 Protocol of Accession to the WTO, the country agreed to progressively eliminate all export duties with the exception of a list of products listed in Annex 6 of the protocol. However, the concentration of extractive industries for dozens of critical materials in China posed a set of serious sustainability problems: the environmental degradation caused by expanding mining and basic processing; the threat of domestic resource exhaustion; and the need to address the serious occupational health and safety problems of the mining sector that had

[175] Mr. Green (U.S. federal rare earth researcher and lobbyist), interview by author, January 2013

[176] The mine at Mountain Pass was operated by the Molybdenum Corporation of America, or Molycorp, from 1952 to 1977, at which point it was purchased by Unocal. It belonged to Unocal when it closed in 1999. Chevron acquired it in 2005, and sold the mine back to Molycorp in 2008.

made mining the deadliest job in China, and China the country with the most mining deaths in the world (Mehmood 2009, Areddy 2012). Article XX of the General Agreement on Tariffs and Trade provides that member states can impose exceptional regulations that would otherwise be in violation of WTO rules. Specifically, member states are permitted to restrict the production and trade of commodities when doing so is: "necessary to protect human, animal or plant life or health;" and "relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption," (GATT 1994).

When the crisis hit in 2010, the US, Mexico, and EU were engaged in a raw materials dispute with China concerning other critical materials[177] on which the latter had imposed export duties and quotas in the name of environmental conservation and public health. China successfully defended its practices in the claims brought by the United States and Mexico. This was because the US and Mexico failed to establish "sufficiently clear linkages between the broad range of obligations contained in the provisions of covered agreements allegedly violated by China's export measures," (WTO 2013). However, the panel also found that China's measures were not developing in a WTO-compliant fashion, mainly because the panel found that GATT Article XX could only be used for temporary provisions, and China's measures did not appear to be temporary or to affect domestic production and consumption equally with international trading partners. The panel ordered China to bring its measures into compliance. Following China's appeal, the Appellate body disagreed with the panel's finding that a trade restriction must likewise equally impact domestic industries. Nevertheless, China's General Administration of Customs removed several of the export duties and export quotas on some of the raw materials in question (WTO 2013). Rare earth elements had not been mentioned in the suit.

In March 2012, the US, EU, and Japan brought another suit against China for the same issues pertaining to thirty measures covering 212 commodities related to tungsten, molybdenum, and rare earths. China claimed that the quotas were related to the conservation of exhaustible natural resources and necessary to reduce mining-related pollution. The US, EU, and Japan disagreed, claiming that the restrictions were designed to protect Chinese industries producing downstream goods and to attract more value-added processing technologies to China. In October 2013, the WTO ruled that China failed to provide sufficient evidence that the production and export quotas were necessary for either environmental conservation or national security. Furthermore, the Panel found that conservation provisions under Article XX do not allow members to adopt measures that control the international market for a natural resource. Since China produced 97% of the global supply of rare earth elements, any action to control the rare earth production unavoidably exercised some controlling influence on the global market. Thus the complainants alleged that rigging the global market was the motive behind the rare earth export measures, and the majority of the panel agreed. China's Ministry of Commerce had continued to issue export quotas through 2014 on the basis that the panel did not uphold its obligation to conduct an objective assessment of the matter, and appealed the decision in April 2014 (China 2014). In August 2014, the Appellate body acknowledged various ambiguities between China's Accession Protocol and GATT, but nevertheless upheld the Panel's ruling that China's export quotas were not justified under the conservation provision. It made no mention of the human health provision (WTO 2014a).

[177] Bauxite, coke, fluorspar, magnesium, manganese, silicon carbide, silicon metal, yellow phosphorus and zinc.

Experts, such as Liao Jinqiu (quoted in Tu 2012) note that the environmental costs of rare earth production and processing had not been integrated into the commodity price, which is one reason why China was able to undersell foreign competitors. The solution to the grave environmental and epidemiological situation described in the previous chapter has been to further consolidate and integrate the rare earth industry in order to better control extraction and processing.[178] Officials in the Ministry of Industry and Information Technology found the WTO suits regrettable because, "as a rule, the WTO allows members to take necessary measures to protect resources and environment, and considers it fair if export restraints are accompanied by simultaneous restrictions over domestic production and consumption," (MIIT in Xinhua 2013). The WTO did not agree, and China dropped its export quotas in January 2015.

The effects of a WTO victory against China remain to be seen. In the US, it was hailed as a political victory against China and an economic act of 'shooting oneself in the foot' as far as domestic industry was concerned (Dinwoodie 2013). The United States Trade Representatives argue that the victory supports American businesses, workers, and rule of law because the export restraints artificially increased world prices while artificially lowering prices for Chinese producers. This enabled China to produce downstream products more cheaply while incentivizing US firms to move their operations, jobs, and technologies to China (USTR 2014b). But capital flight had happened three decades ago, and was hardly the central issue in the debate. For firms outside of China, prices and shares dropped with the quotas (Paul 2015). Liberalized exports effectively eliminated the market conditions under which projects outside of China would be economically viable (Matich 2015), yet, as of this writing, the projects examined here are proceeding regardless of market conditions. Some predict that liberalized exports will drive other firms out of business and thereby have the effect of restoring China's monopoly over rare earth elements absent a long-term investment to continue producing these elements outside of China. Others point out that China's export quotas were rarely filled anyway, so this is likely just a symbolic move to signal compliance with multilateral institutions (Wilson 2015). What is significant, however, is that that loss of a clear economic incentive to expand rare earth exploration outside of China requires proponents of exploration elsewhere to make stronger strategic or geopolitical cases in order to maintain the regulatory offensive necessary to continue exploration and mining initiatives on the new frontier.

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[178] Building on the forced consolidation campaign of 2006, the State Council approved in 2014 an additional measure to be taken by China's Ministry of Industry and Information Technology in order to rationalize mining and control sources of mining-related pollution. The measure mandates further consolidation of all mining and processing companies into six large groups, each led by either a state-owned enterprise or a large private domestic firm. At the helm of the Big Six will be revamped Baogang, renamed China North Rare Earths Group. Two other regional groups will be run by state-owned companies—Aluminium Corporation of China (Chinalco) and China Minmetals Corporation. Three groups will be organized under now private firms: Xiamen Tungsten Co., Ltd., China National Nonferrous Metals Industry Guangzhou Corporation, and Ganzhou Rare Earth Group. The objective, "to build up a highly concentrated rare earth industry," (Caijing 2013) is intended to reduce overall exploitation of rare earth resources and facilitate the construction of several vertically integrated military, IT, and renewable energy commodity chains. Industry restructuring has proceeded in fits and starts, as influential heads of private companies and local officials can resist mergers and closures if they judge them to be against local interests. As discussed in Chapter three, consolidation in Baotou has been partial for several reasons, ranging from the inertia of the built environment, to entrenched power relations, to officially-sanctioned clandestine or black market activity judged by certain key local officials to be in the national interest.

The two primary US policy responses—to shore up domestic industry and take action through the WTO—worked at cross-purposes. For the former, the latest legislative failure came in July 2014, when the bipartisan Securing Energy Critical Elements and American Jobs Act lost by nine votes on the basis that it created a government handout and unnecessarily expanded the role of government in this industry. Opponents to this bill argued that the "federal government should open access to the thirteen states where rare earths are known to lie," *instead of* offering subsidies to US industry (Wegmann 2014). The effect of this has been to create a climate more favorable to foreign prospecting interests in the United States (Epley 2014, Gee 2014). This outcome shows that the US federal government is primarily committed to maintaining a global regime of free trade favorable to transnational interests over and beyond domestic resource security and technological competitiveness. Despite anxieties surrounding China's rise, and despite the brief flurry of green nationalism, the prevailing approach was to attempt to restore the pre-2010 status quo in order to maintain a steady, low-cost rare earth supply for large purchasers and military contractors such as General Electric and Lockheed Martin at the expense of domestic producers, primary industries, and of course China's environment. The tension between transnationally-oriented federal policymakers and large purchasers advocating for a restoration of the status quo, and those in the defense, energy, and mining sectors seeking to revive domestic capacity in the US illustrates the conflicts that can emerge from politics organized at different scales.

This is unfortunate, because a phalanx of junior mining companies asserted their competitiveness on the basis of developing more sustainable production practices. In the discourses of green nationalism following the crisis, figuring out how to produce greener rare earths seemed as important as finding non-Chinese sources. As the next section shows, the post-crisis concerns generated some compelling technological consequences that are at once breathtaking in their promise to transform the way rare earth elements are produced, and heartbreaking in the near total practical disinterest in greener rare earth production on the part of downstream industries.

III. Greener Rare Earths: Uncelebrated Breakthroughs in Brazil

For a short time, there was a strong sense that downstream purchasers would pay a premium for non-Chinese rare earths. Furthermore, no one wanted to be seen as stooping to China's level of environmental degradation. The green discourses turned out to be insubstantial, but the idea was powerful enough to stimulate some firms to take unprecedented steps to clean up their operations, as in the case of the Molycorp mine at Mountain Pass, CA, which now spends $2.4 million per year on environmental monitoring and compliance (Margonelli 2009), or to invest in the development of new technologies, as with the case of the Brazilian *Companhia Brasileira de Metalurgia e Mineração* (CBMM—Brazilian Mining and Metallurgy Company) located in Araxá, Minas Gerais, Brazil.

CBMM was established in 1955 following the discovery of niobium-bearing pyrochlore in Minas Gerais. Niobium is a soft, ductile metal used to make iron and steel super alloys, which are lighter, stronger, and require less base metal compared to other alloys. The niobium deposit mined in Araxá was formed by an alkaline magmatic intrusion referred to as chimney. These are carbonatite formations, similar to those that formed the deposit at Bayan Obo, in which columns of magma pressed against the terrestrial crust in repeated cycles of heating and cooling over millions of years. These are essentially volcanoes that never quite happened. Just as the rare earth mine at Bayan Obo is rich in niobium, the niobium mine in Araxá is rich in rare earth elements.

When CBMM was founded, there were few manufacturing processes or markets for the metal, so the primary investors, the *Grupo Moreira Salles*, adopted a long-term mission-like approach that involved developing applications for niobium, sharing technical expertise internationally, and promoting its products to iron and steel industries worldwide. Notably, this company created the global demand for its products—of which it currently supplies 85%—through international diplomatic outreach and research partnerships initiated in the 1970s. CBMM's niobium-based technologies are used in nearly every jet engine, automobile body, hybrid fuel cell battery, suspension bridge and superconductor produced in the last three decades; China, the largest producer and consumer of steel in the world, is entirely dependent on CBMM for its niobium supplies (Ma, Gao, and Yu 2009, 88)[179]. With the dominance of the Mountain Pass mine, and then later China in the global rare earth market, CBMM focused on niobium. Rare earths have been accumulating in their mine tailings since the 1960s.

According to representatives of CBMM, it was China's interference in the global market in 2010 that catalyzed and augmented the velocity of their technological development to deal with accumulating mine tailings. Because separation technologies must be developed specifically for each deposit, the apparent demand for non-Chinese rare earth sources inspired the firm to 'create a new bottom line' in rare earth production in 2011. It is worth quoting at length the head of their rare earths research and development program in order to illustrate the global paradigm shift that might have been:

> 'We believe that the world needs a supplementary source of rare earth elements other than China. What China provoked in the world market, in some senses, is the need for suppliers that don't come from China. This question of China controlling more than 90% of rare earths is not going to happen any longer in the market.
>
> 'I think there will be space for values in the market greater than those attained through the cheap China price. In truth, the China price is illusory, a grand illusion. As soon as you take into account technical recuperation efficiency, which in China is not greater than fifty percent if that, factor in the environmental costs, the social costs, the so-called competitive low-cost will rise to a more normal base price. Today, the base price is very distorted. But Europe, Korea, Japan the United States, they *will* pay a higher value in order to have access to different rare earths players other than China. There is no doubt about this.
>
> 'Do you think that Japan is going to rely on China eternally? Will Europe or the Americas trust in China forever? No. This is the pillar of our strategy. We understand that there exists a real possibility, there exists a real opportunity for new players, and we want to be the primary ones.
>
> 'How do we plan to do this? What is our motive? This is the technological question: through technology. We have developed a technology in-house and a strategy that respects the fact that with China on the scene,

[179] "目前全世界每年消耗量约四万吨五氧化二铌, 生产主要集中在巴西，我国钢铁工业所需的铌铁主要从巴西进口. " (Ma, Gao, and Yu 2009, 88).

> our status for the time being is to be almost everyone's Plan B. But major potential partners have assured us that they are interested in our rare earths. Everything that we are developing is up to the same technological, environmental, and social standards that we maintain with our niobium operations.
>
> 'So we are seizing an opportunity, actually, to improve our niobium production. We don't need to commit environmental or social transgressions in order to seize an isolated market opportunity here and now to make some sales. No. This is not what we are doing. We are going to have a cost, and consequently a price, that would only with great difficulty be equal to China's, but we are going to have a guaranteed supply with the proper social and environmental commitments in order to demonstrate the superiority of our product'.[180]

In a relatively short time, CBMM developed the technology to separate rare earth elements from their existing mine tailings and produced high-purity oxides. In 2012, the company invested US$430 million to expand production facilities to produce three thousand tons of rare earth oxides annually. In 2013, the company invested another USD 24.7 million to double the capacity of rare earth production. The plant uses recycled water from mining operations, produces rare earths in a way that reduces the volume of their mine waste products, and operates under the most stringent international industry standards for environmental and occupational health and safety in a region that is not considered socioecologically sensitive.[181] Therefore the rare earths produced by CBMM are the 'greenest' in the world, and that is not just because the Bayan Obo and Mountain Pass mines set such a dismally low bar for environmental health and safety.

But the CBMM strategists overestimated the values of major purchasers on the global rare earth market, at least for the time being. While their production breakthrough has the clear potential to transform the way rare earths are produced by effectively eliminating the need to open new mining concessions, the WTO victory against China restored the global status quo and removed sustainability and security concerns from the priorities of major consumers and regulators as the guaranteed flow of low-cost rare earth elements from China resumed. This has had a quieting effect on green nationalism in general, and foreclosed for the time being the possibility that recycling and reclamation might displace new mine exploration in favor of greener rare earths. But because rare earth elements are not CBMM's primary business; because they take seriously China's intention to become a net importer[182]; and because they are convinced that global anxiety over China's rise will eventually trump the allure of low prices, CBMM has adopted a long-term approach to the issue and has determined to produce rare earth oxides regardless of global market conditions. In their analysis, the United States, European Union, and Japan WTO victory ensures a return to the global status quo, which means another crisis is imminent. By mining its internal waste frontier, the firm intends to be prepared for the next global shortage.

Conclusion

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[180] Various anonymous personnel at CBMM in Brazil, interview by author, March 2014

[181] CBMM earned an ISO 14001 Environmental Management System Certification in 1997 and an OHSA 18001 Health and Safety Management System Certification in 2002.

[182] Demonstrated by, among other things, the purchase of a 15% retainer of all of CBMM's known deposits in 2011 (Tudor 2011).

Although many of the discourses of green nationalism were framed in antagonistic terms against China, many of the international reactions to the 2010 crisis were actually complementary to the policy objectives of China's export and production quotas. At the annual meeting of the Central Government Economic Working Committee held on 28 December 2010, Yao Jian, a top official in the Ministry of Commerce stated:

> 'To maintain the international rare earth supply is the common responsibility of countries around the world. I hope other countries will further the development of rare earth resources. Countries should find a way to cooperate to open up new resources, as should they strengthen cooperation in energy-saving technologies for global industries, especially high-tech products for superior provision of rare earths,' (Han 2010).[183]

Although uneven and contentious, these aspirations were realized to varying degrees by efforts to open new mining sites and develop greener production practices. A period of greater global awareness of the acute environmental and epidemiological harms of rare earth production stimulated productive criticism of the clean technology supply chain. This inspired many to call for more sustainably produced rare earth elements, and compelled some key players to develop environmentally superior production practices. The restoration of the global political economic status quo has not slowed activities at the Molycorp mine at Mountain Pass, nor the ventures in Greenland or Afghanistan, but did undermine the entrée of more sustainably produced oxides into circulation. While the 2010 price increase created favorable conditions for exploration and investment in new mining initiatives outside of China, the strategic imperative was effectively leveraged by extractivist interests to roll back codified pacifist values in the case of Greenland, or to leverage US military operations in the name of western business in the case of Afghanistan. While the regulatory changes in these circumstances occurred at the expense of local people and environments, the case of CBMM in Brazil presented an alternative scenario. CBMM's breakthrough provided a glimpse of alternative futures of rare earth production. Every ton of rare earths produced currently generates one ton of radioactive waste residue, 2649 cubic feet of acidic wastewater, 423,776 cubic feet of acidic waste gas, and 18.7 pounds of fluorine (Chen 2010b). A future in which no new mines are opened would mean that additional heavy metals and radioactive materials would stay underground instead of contaminating surrounding soils and waters. A production model in which existing mine tailings are reduced would mean that existing sources of heavy metal and radon gas would likewise diminish. Most significantly, this production model would mean that the question of whom must be displaced in the interest of exploiting the minerals beneath their feet would cease to be a part of the mining prospectus.

Had CBMM's practices for creating a 'new bottom line' been anything but ignored, the extractive imperative dividing Greenland's populace between environmental and sovereign integrity, the neoimperial edge of Anglo-American intervention in Afghanistan, and the ongoing contamination of the southern California desert might have diminished significantly. Had major Western purchasers been serious about the commitment to source environmentally superior, non-Chinese rare earth elements, perhaps we would be witnessing a paradigm shift in global rare earth politics. Perhaps global discourse would shift from the importance of opening new mines

[183] "保证国际稀土供应是全球各国共同的责任。希望有稀土资源的其他国家能进一步开发稀土资源，各国也要通过合作寻找新的开采资源，并加强节能环保技术的合作，为全球产业特别是高技术产品提供稀土" (Han et al. 2010)

and whether the risks of radioactive waste were a reasonable price to pay for a greater GDP or for greater national security to making productive use of the wealth of rare earth resources latent in mine tailings across the globe. Perhaps commentators would cease paying lip service to the egregious social and environmental burdens borne by the people of Bayan Obo and Baotou as sustainable production of rare earth elements became a point of international cooperation. Perhaps, for the first time in a century, the flow of radioactive wastewater, toxic gases, and heavy metals into the soils, water, and bodies would begin to slow.

Although the global rare earth frontier extended into areas previously considered 'off-limits,' it has not extended into the waste frontier. This was not simply because industries and purchasers in the global north reneged on their stated commitments to source environmentally friendly rare earth elements should they become available; the driving interests behind the contemporary geography of the global rare earth frontier are not just economic, they are also geopolitical, and, as the next chapters show, entangled with longer-term territorial agendas. Indeed, in Brazil an entirely different set of interests has been at work in order to open up high-risk mining concessions in the extreme northwest of the Brazilian amazon, even amidst CBMM's potentially paradigm-shifting breakthrough.

Part III:

Making New Frontiers: The Amazon and the Moon

The chapters in this section demonstrate the importance of geological knowledge production to territorial conquest in two distinct but illustrative cases: São Gabriel da Cachoeira in the northwestern Brazilian Amazon, and the Moon. Because large-scale rare earth mining is not economically, logistically, or politically feasible in these spaces at present, contests over geological knowledge and the question of entitlements to rare earth rich subsoils have been unfolding in legal debates, controversial prospecting exercises, and small-scale prospecting and extractive activities. Like historic Baotou and Bayan Obo, both sites examined herein have been conjured into frontiers by competing imperial and national powers seeking territorial consolidation and geopolitical advantage; like Baotou, a range of discursive, ideological, and military techniques have been deployed to recast the spaces in question as problems to be solved by extralocal powers. What is distinct about these two cases are the actors, histories, and stakes involved in the material and symbolic struggles over the making these new frontiers.

Chapter Five

From the Heartland to the Head of the Dog

Introduction

> "Madam President…I wish to address another subject that is crucial for the development of our country, a subject that concerns the reaffirmation of our sovereignty especially with respect to scientific and technological autonomy in more advanced areas of innovation. In addition to the gains in basic research in a very new area of technology, our country can benefit economically if we develop the knowledge necessary to transform some rare minerals that we have right here in our territory into the inputs for complex and sophisticated products…I am referring to those which are called 'rare earths'."[184] (Address of Senator Luiz Henrique da Silveira to Plenary Session of the Federal Senate of Brazil, 2013).

In the wake of the 2010 crisis, public and private sector actors sought to 'reglobalize' Brazil's rare earth industry to restore it to pre-WWII importance in global political economy (Lapido-Loureiro 2013). In particular, the state-owned geological research enterprise, *Companhia de Pesquisa dos Recursos Minerais* (CPRM) jointly with *Departamento Nacional de Produção Mineral* (DNPM), received the largest federal budget in their history in order to reinvigorate their mandate to generate basic geological information about the thirteen million square kilometers of Brazilian territory toward the ends of facilitating strategic resource extraction (Jones et al. 2011). In late 2011, the Ministry of Science, Technology and Innovation as well as the Ministry of Mines and Energy held the first seminar on rare earths in Brazil in Rio de Janeiro, in which government geologists declared that Brazil possessed the largest known rare earth reserves of any country in the world (Lima 2012).[185] The objective of the first and subsequent seminars was to disseminate information on domestic rare earth reserves to recruit investors and generate political will to organize a vertically-integrated rare earth production chain in Brazil (Ferraz 2011). In 2012, the Senate established a temporary commission to elaborate a special regulatory code to facilitate domestic rare earth mining (Federal 2013). Framed in official discourse as strategically necessary to Brazil's technological innovation and increased international influence, rare earths are referred to as 'bearers of the future,'[186] (Diniz 2013), as crucial to national defense (Portales 2011), and as an essential ingredient to the national sovereign development of Brazil (Henrique 2013).

Yet, even before the liberalization of China's rare earth exports in January 2015, the Brazilian rare earth frontier displayed a spatial paradox that cannot be accounted for by market pressures alone. From 2011 – 2014, two rare earth frontiers emerged within a broader national developmentalist framework. The first, discussed in the previous chapter, concerned the challenge of procuring rare earth elements from existing, partially separated mine tailings at a

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[184] *"Srª Presidente, trato…de outro assunto crucial para o desenvolvimento do nosso País, um assunto que diz respeito à reafirmação da nossa soberania, que passa pela autonomia científico-tecnológica, sobretudo em áreas de inovação mais avançadas. Além do ganho na pesquisa básica e numa área muito recente da tecnologia, o nosso País poderá beneficiar-se economicamente se desenvolver conhecimentos de ponta para transformar os minerais raros que possui em seu território em insumos para a criação de produtos complexos e sofisticados. Refiro-me às chamadas terras raras."* (Address of Senator Luiz Henrique da Silveira to Plenary Session of the Federal Senate of Brazil, 2013).

[185] As noted, in chapters two and four, each major finds examined in this work are purported to be the largest in the world, so the substance of these claims must be treated with skepticism; it is the *work* such claims do in producing frontier space that must be examined.

[186] *Portadores do futuro*

state-of-the-art production facility situated on well-established infrastructure networks in the Brazilian heartland within a regulatory context favorable to extractive industry. The challenge, in this case, was developing the technological capacity to remake waste sites generated by niobium mining into a new rare earth frontier. With the major technological, regulatory, and infrastructural issues resolved, the remaining challenge for CBMM was to find downstream buyers willing to pay a premium for a sustainably produced, non-Chinese source of rare earth elements. Industry analysts explain the failure of the sustainable rare earths initiative strictly in terms of price competition: if CBMM could beat the China price, then they would dominate the global market.[187]

But there is more to the story. The basic paradox at work in the Brazilian geography of the rare earth frontier is this: given that reportedly abundant, technologically and environmentally superior high-purity rare earth oxides are already under production in Araxá, a site favored with well-developed physical and regulatory infrastructure, there is nevertheless a tremendous push to exploit rare earths and related elements in the inaccessible, legally protected, and politically inhospitable northwestern Brazilian amazon. Paradoxes, as Proctor (1998) notes, cry out for some form of resolution. Indeed, there is a geological basis for interest in the Amazon. Re-examining samples collected in the 1970s, state geologists identified a deposit containing record concentrations of rare earths taken from a sacred hill—Morro dos Seis Lagos[188]—located in Indigenous territory on the border with Colombia and Venezuela, in the ecological park of Morro do Seis Lagos on the eastern edge of the municipality of São Gabriel da Cachoeira (Simões 2011). Geologists claimed that the resources there could supply global demand for the next four hundred years (Lima 2011). However, this case is not one in which CBMM's oxides are simply too expensive, therefore extractive interests are compelled to look elsewhere for cheaper, more accessible alternatives. The infrastructural constraints alone negate this proposition, as illustrated in Figure 28.

[187] CBMM has yet to publish price or production data for its rare earth products, and reportedly has not permitted major investors from Korea and China to conduct technical due diligence, due to the confidentiality surrounding its separation processes. This suggests that it has yet to produce rare earths at a price that can compete with Molycorp, which reported losses of USD 67.2 million for 2013 and USD 99.6 million for 2014 (Molycorp 2015).
[188] Literally: Hill of Six Lakes.

Figure 28: Location of Araxá and Cabeça do Cachorro in Brazil

The map shows that the relative density of Brazil's paved road networks on a national scale. Rendered by Nick Bojda, 2015.

As with the cases of Afghanistan and Greenland discussed in the previous chapter, the debate concerning rare earth mining in Cabeça do Cachorro is about so much more than rare earth elements: longer-term struggles over territory, sovereignty, recognition and geopolitics are (re)enacted through competing claims over the region's mineral resources. Crucially, among domestic stakeholders, including a diverse set of Indigenous activists, the question of mining in Cabeça do Cachorro is not framed in terms of *whether* it should occur,[189] but *by whom* and *under what sorts of political economic conditions*. That such an intense struggle, as detailed in the following pages, is unfolding over the meaning and control over rare earth extraction in this region *despite* the economic and logistical infeasibility of such an enterprise indicates that there is much more at stake than the development of a national rare earth production chain. This is a clear instance in which historical continuities critically shape contemporary debates, changing the meaning of the latter through reenactments and reinterpretations of the former.

This second frontier has garnered considerably greater political interest and international exposure, relative to the understated developments in Araxá, because it builds on long-term

[189] As discussed herein, categorical opposition to mining comes primarily from international advocacy groups and their cosmopolitan counterparts in Brazil.

struggles between: Indigenous populations and the state; intersecting ideologies concerning mineral extraction, profiteering, and sovereignty; border militarization and transnational issues such as clandestine economies and the US-led war on drugs, among others.

Although the continuities are important, there is something fundamentally new about the debates concerning resource extraction in *Cabeça do Cachorro* driven by the prominence of Indigenous mining proponents in legal skirmishes over the fate of Indigenous and environmental protection laws currently prohibiting mining in this region. Indeed, the question of how geological knowledge production and mining relate to territorial contests in the region and contemporary struggles between Indigenous people, international advocates, and the state has not been examined in this literature beyond the familiar framings of Indigenous peoples as victims of violent mining activities imposed by outside actors.[190] The case of São Gabriel da Cachoeira demands a complexified view of Indigenous peoples and mining in the Brazilian Amazon. This chapter reviews colonial history, archival resources, and draws on interviews and observations with this issue at the center, which is essential to identifying toward what ends are actors in Brazil seeking to undo hard-won Indigenous and ecological protection laws to encourage mining in this historically contested border region, especially when there are more easily accessible rare earth oxides being generated elsewhere in the country.

Because São Gabriel da Cachoeira and Seis Lagos are characterized by struggles over *whether* state-sanctioned extraction takes place, and if so, by *whom,*[191] the remainder of this chapter uses rare earths as a lens through which to bring these complex dynamics into focus and more precisely, to illuminate how various (mis)understandings of the issue propagated by a host of actors advancing territorial claims to the region obscure the entangled historical continuities characterizing resource politics within and with respect to this place referred to as 'the end of the world.'[192] The first section examines competing claims to exploration and extractivism in the region. Section II places the contemporary debate in longer-term historical perspective,

[190] There is abundant literature on the historical dynamics between indigenous peoples, mining practices, and the penetration of state and capital into the Amazon region over the course of Brazilian history (e.g. Hecht 2005b, Hecht and Cockburn 1990, Triner 2011, Browder 1997, Cleary 1993, Graulau 2001, Spiegel et al. 2012, Fearnside 2005). Yet scholarship *specifically* on the upper reaches of the Rio Negro had been primarily concerned with indigenous ethnographies and linguistics (Jackson 1983, Fleming 2009, Goldman 1963, Chernela 1983), violence during the periods of rubber extraction (Meira 1996)[190] and religious movements and resistance (Wright and Ismaelillo 1982, Muller 1952). Since the 1980s, scholarship about and emanating from the region has blossomed (Neves 1998, Hill 1996, Vidal 1999, de Oliveira 1995, Chernela 2003, Lasmar 2008). This would not have been possible without the 1989 self-organization of indigenous peoples into a political federation (FOIRN: *Federação dos Organizações Indigenas do Rio Negro)* directed against the 'divide-and-conquer' strategies deployed by state and corporate actors over time. As peoples organized around shared history and counter-truths in the name of indigenous sovereignty and meaningful citizenship rights, indigenous inhabitants exercised political, cultural and economic agency in their definitions of daily life over and against the paternalistic characterizations imposed by the Brazilian state and echoed in earlier academic analyses about the region (FOIRN 2000, Wright 2005, Andrello 2006, Guzmán 2013)[190]. FOIRN has been instrumental to systematizing narratives and scholarship about the region as well as advancing legal issues at state and federal levels of government.

[191] Certain elements characterizing the quest to tame the rare earth frontier in Baotou are recognizable here: longer-term transnational ambitions have surveyed the region with the intention of consolidating territorial power or a broader sphere of influence through capturing the economic and ecumenical riches of this place.

[192] Missionaries, soldiers, federal police officers on temporary assignment, rotating air traffic controllers, and Manaus-based traders, geologists, and politicians used this term. Local Indigenous people and other long-time residents did not.

reviewing the ways in which surveying and geological prospecting has interwoven with successive imperialist and nation-building efforts to rationalize the northwest Amazonian frontier over the past several centuries. Section III analyzes the competing enactments of extractivist, legal, and geopolitical agendas that inform contemporary struggles over the meaning and practice of rare earth mining in São Gabriel da Cachoeira. In each section, the production of geological knowledge figures significantly. Violent struggles over its meaning and circulation unfolding over multiple temporal scales shape the contemporary rare earth debate in crucial ways.

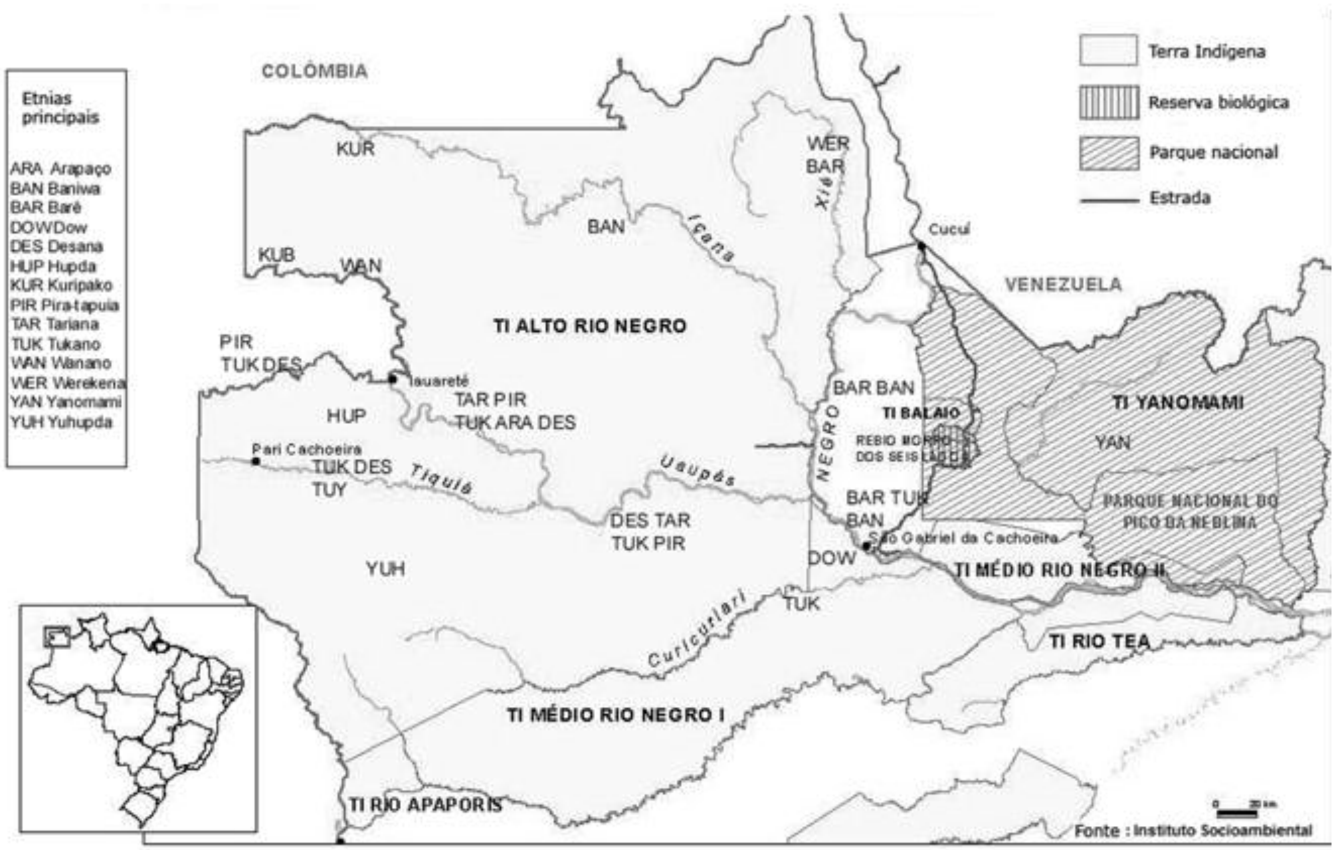
I. Competing Sovereignties: Indigenous Peoples, the State, and NGOs

Since the 1600s, extractive interests colluding with imperial and state powers have endeavored to discipline, rationalize, and exploit the subsoils of this place, situated on the upper reaches of the Rio Negro in a historically contested border region between Brazil, Colombia, and Venezuela marked by episodic violence between Indigenous people, outlaw geologists, police forces and traffickers of various sorts. Ninety-eight percent of the population belongs to one of the twenty-six Indigenous groups[193] possessing pre-Colombian histories to the area extending back at least three thousand years (Neves 1998), the collective land rights of which were legally recognized by the federal government in 1996 with a demarcation of five continuous protection areas totaling approximately 10.6 million hectares.

The region can only be accessed by air or river transport. Although Indigenous and environmental victories in the 1980s and 1990s had deterred many large-scale extractive interests in recent decades, in early 2011 the Brazilian government announced that it would encourage exploration for rare earth deposits in the Amazon. President Dilma Rousseff personally invited *Companhia Vale do Rio Doce* to identify possible production sites (Gozzi 2011), which inspired other companies and enterprising geologists to follow suit. Since then a troubled alliance among military planners, state geologists, small-scale miners, Indigenous activists and federal government officials has coalesced in a struggle to rewrite hard-won state and federal laws categorically prohibiting mining in this socioecologically sensitive region.

[193] A note on usage. Indigenous interlocutors referred to themselves as '*Indios*,' which translates as 'Indian,' and used this interchangeably with '*povos indigenos'* which translates as 'Indigenous peoples'. This chapter likewise adopts the usage of both terms.

Figure 29: Map of *Cabeça do Cachorro,* or São Gabriel da Cachoeira, showing principle ethnicities, Indigenous lands, and conservation areas



Translation of Key: *Etnias Principais:* Principal Ethnicities (only half are shown); *Terra Indigena (TI):* Indigenous Lands; *Reserva Biologica (ResBio):* Biological Reserve; *Parque Nacional:* National Park; *Estrada:* Highway. Source: Ricardo and Ricardo (2006).

At present, an executive order, a constitutional amendment, and several acts of congress would be necessary to repeal the laws currently forbidding mineral exploration and extraction in this sensitive and protected region. Long-standing contests over national sovereignty and Indigenous citizenship rights in São Gabriel da Cachoeira lie at the core of the impetus to exploit rare earth elements in such a challenging context. At stake in these contests is access to and control over geological knowledge of mineral resources and the economic and political spoils to be won by controlling their extraction. In this place where there is a decades-old moratorium on commercial mining activity, a multitude of national, local, and transnational actors pursue rare earth exploitation in order to assert national defense, citizenship entitlements, or basic livelihood security.

This has generated some strange and perilous alliances. At a conference organized by General Vilas Boas, commanding general of *Comando Militar do Amazônia* (CMA, or Amazon Military Command), senior military officers, state planning officials, geologists, *garimpeiros*,[194]

[194] *Garimpeiros*, or 'small-scale', 'artisanal', 'illegal' or 'clandestine' miners are much more visible in the Brazil case relative to the China case for two primary reasons. First, garimpeiros are politically organized and active in

and Indigenous mining proponents assembled at CMA headquarters in Manaus on 26 April 2014 to discuss the subject of rare earths and strategic geopolitics. In an open comment session following a series of lectures on rare earth elements, the entanglement between rare earths and competing sovereignties was laid bare in an exchange between a geologist, an Indigenous garimpeiro, and General Vilas Boas. To start, a senior geologist who had participated in the preliminary geological explorations of Morro dos Seis Lagos during the military dictatorship said the following:

> 'I am here weeping before you because it has been 39 years since I became a geologist…40 years ago, we went up the Rio Negro doing our research, finding the resources that would develop our nation and FUNAI[195] chased behind and said "No, this is Indigenous land." But I have confidence that you, here, who defend our sovereignty [gestures toward audience primarily composed of three and four-star generals], are going to wipe the tears from our eyes that come from seeing so much poverty amidst the riches that we have conditions to develop.'

This inspired a younger geologist, Fred Cruz, to say the following:

> 'After São Gabriel became a biological reserve and Indigenous territory, we had to cease all mineral research activities. But what we have there, I tell you, the greatest niobium deposit in the world, with rare earth concentrations previously unheard of, is a *national patrimony*. It would bring tremendous returns to all of us Brazilians.
>
> 'The demarcation of Indigenous lands and Conservation areas is financed by European and North American and Japanese banks. The Brazilian government is coordinating the process, but all of the money comes from international environmental entities and banks that want to lock up Brazil's resources, because they know that they are not going to fare well if they have to enter into competition with a developed Brazil! We have let this go on for too long! Too long! [Applause]
>
> 'Enough with all of this concern for the Indians! Enough with creating conservation areas! The Indians are not interested in conservation areas; they are interested in mining and development! [Addresses Indigenous activists in the audience] International NGOs are lying to you! They don't want you to know that behind you are tremendous riches! They want you to continue being poor, to continue being simple! The international NGOs are never going to let you grow! They want to keep you stupid, illiterate!
>
> 'They are making Indigenous areas and putting you there like you are some kind of animal and they aren't giving you a single legitimate economic activity. It is a degradation of your very lives! You want to work and develop, but it's prohibited! You can't mine, you can't develop tourism, you can't do anything. Because everything that would be good for you is prohibited. [Applause].'

Brazil. Several whom I interviewed had cultivated allies in state and federal offices; interviewees in government office also referred me to garimpeiros because in their judgment, the garimpeiro perspective needed greater exposure. Second, and by contrast, small-scale or clandestine mining activity was subject to public condemnation and closure campaigns in China. Several officials interviewed in China expressed the sentiment that small-scale mining was irrational and evidence of backwardness. Furthermore, because Baotou and Bayan Obo are securitized areas, there was heightened sensitivity to speaking to foreigners. Even local officials actively supporting the clandestine mining activity stated that there was no possible way for a westerner to speak to small-scale miners without consequences. Since the 'consequences' would be most acutely felt by those in an already precarious position—the worst I would suffer would perhaps be interrogation and an order to leave—I judged it unethical to pursue this line of inquiry further in China.

[195] *Fundação Nacional do Indio*, the federal organ responsible for defending the rights and interests of Indigenous people.

In response to this, Lukas, an Indigenous *garimpeiro* took the floor and introduced himself as a member of the Tukano people, a military veteran, and the organizer of a small mining cooperative:

> 'Folks, when I hear you talking about how the world is not letting *us* develop, it is very hurtful. *We* are as *Brazilian* as you. Our condition is not the fault of the world.
>
> 'We are the most mineral rich country in the world, and we don't have our own affairs organized. We are dependent on China! This is pathetic, folks. Today: no, it should have been done yesterday; the law that permits us to mine on Indigenous lands must be regularized. But it is not the world. It is we Brazilians who make the laws. These laws need to be changed, and we are the ones to change it.
>
> 'People go out claiming to represent the Indians. They say Indians don't want *garimpagem* [small-scale mining], they say Indians are puppeteered by politicians; politicians say Indians are puppeteered by NGOs. And when this country doesn't have progress people blame the Indian. They say: the Indian is interfering with our development. The Indian is not interfering with anything. The Indian wants progress! The Indian wants to help secure the frontier!
>
> '[…]I have formed a cooperative because I have hope in Brazil. We hope to obtain a concession to have a small mining operation in my region so that we Indigenous people, ourselves, can bring minerals to augment the economy of the country, which we need so badly. So I hope you will understand me when I say that the NGOs are hindering us in our efforts to move forward. Expel the NGOs from our lands! We want progress [Standing ovation].'

Next came General Vilas Boas' closing remarks, in which he projected a map showing the richest reserves of rare earths and other high value mineral commodities in the Amazonian region. He then super-imposed a map indicating Indigenous lands and conservation areas, which covered many of the largest deposits (See Figures 30a and 30b). 'It would seem that Indians really like minerals,' he said, which provoked laughter. He continued:

> 'You know, I made this same joke at a presentation in São Paulo and somebody denounced me to the Public Ministry for disrespecting Indians. I hope you will forgive me; I made such an ironic statement because the Indians, you, my Indigenous brothers, are tools. You are tools being used in this process that Fred characterized very well. Mining is the basis of sovereignty, yet we are preoccupied with human rights questions about things that happened forty years ago, and in the meantime, we have completely incapacitated ourselves from enacting concrete solutions to our problems.'

No one had mentioned human rights or the military dictatorship during the conference, so the General's unprovoked reference is a telling indication of the ideological continuities underlying military concerns toward the Amazon.[196] Furthermore, the exchange indicates how perilous the Indigenous mining position becomes in the face of competing territorial agendas. The General's response to Lukas shows that despite a declaration of loyalty, a claim to military fraternity, and a condemnation of NGOs, the Indigenous are seen as obstacles to agendas of militarized extractivism. Indigenous control over mining in Indigenous lands does not satisfy the Military's vision of sovereign control over the Amazon. Only the domination of Amazonian socionatures through large-scale capitalist penetration will suffice. So long as Indigenous

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[196] The National Truth Commission recently determined that at least 8,350 indigenous people were exterminated as a matter of state policy during the military dictatorship, with an incalculably greater number affected, disappeared, or unaccounted for (Ricardo et al. 2014).

counterparts propose anything other than acquiescence, they are seen as tools of International NGOs.

Figure 30(a): Slide from widely circulated presentation showing some subsoil resources in the Amazon. The slides from the 26 April 2014 event were not available for broader circulation; these convey the same idea.

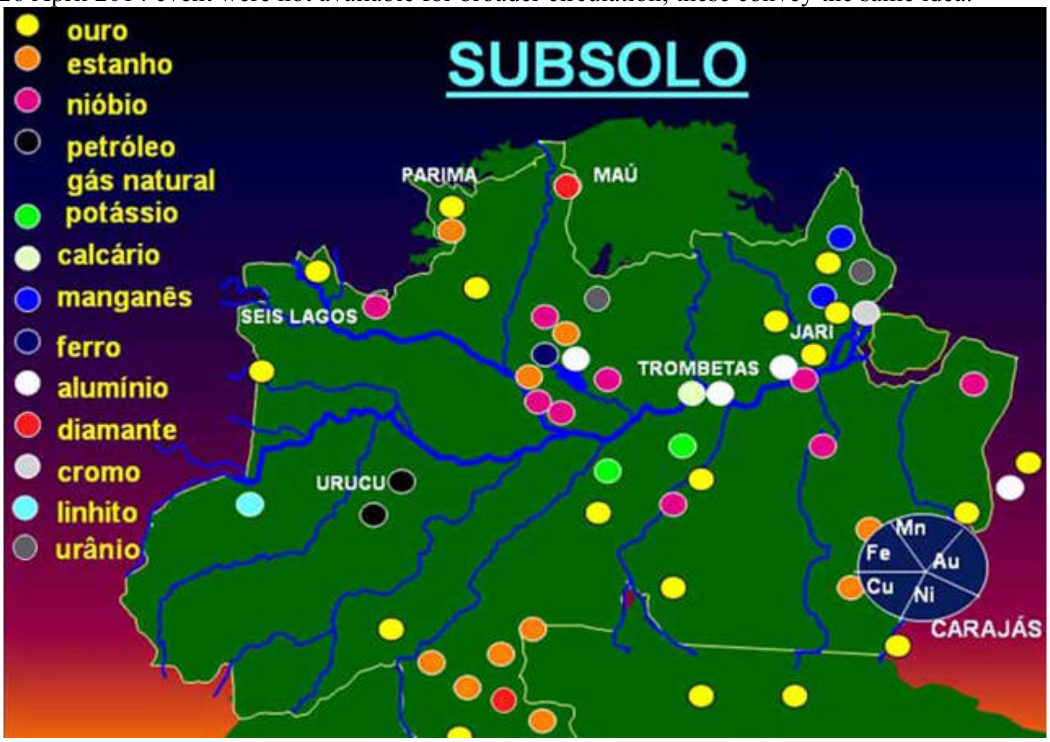
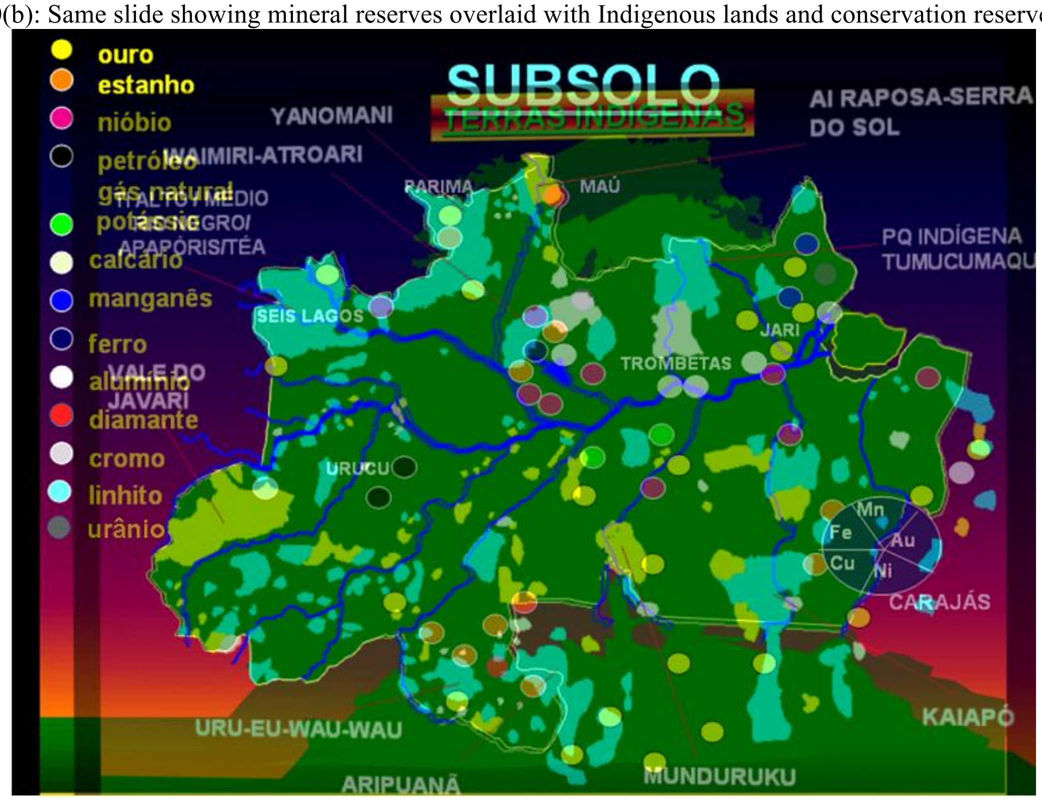


Figure 30(b): Same slide showing mineral reserves overlaid with Indigenous lands and conservation reserves.



Source: Rempel (2011).

There is a way in which international environmental and indigenous rights campaigns on one hand, and Indigeneity scholarship on the other, align with the General's dismissal of Indigenous claims to mine within their own territory, on their own terms, for their own economic gain. The relationship between people and nature in Indigeneity discourse too often frames Indigenous agency in terms of a 'more balanced' relation to nature that has not entirely let go of the 'noble savage' tropes (Redford and Stearman 1993) and as a result allows no space for the figure of the Indigenous miner. With remarkably few notable exceptions (Graulau 2001, Lahiri-Dutt 2011), mining does not even enter into consideration as a legitimate economic activity for Indigenous peoples: not in the international conservation movements, not in the majority of literature on Indigeneity, and not in the perspective of the Brazilian military.[197]

Exiled from transnational advocacy networks, but not recognized as being wholly Brazilian: the exchange between Lukas and General Vilas Boas indicates the limits of agency contemporary researchers had attributed to contemporary Indigeneity. Guzmán *inter alia* had noted that Indigeneity "is always negotiated, selected, and performed—not in the sense of disingenuous fabrication or pretending to be something one is not but rather…by constituting the very identity that one claims," (Guzmán 2013, 50). But when it comes to mineral resources, Indigenous claims to Brazilian identity are dismissed when accompanied by the hope of securing an Indigenous claim to the land. It is perilous, as Li (2000) points out, for people to adopt the category of Indigeneity as it circulates globally insofar as the term conjures very narrow and uncompromising ideas on appropriate behavior between Indigenous peoples and the environment:

> "…Candidates for the tribal slot who are found deficient according to the environmental standards expected of them must also beware…they are in in an ambiguous position which, rather than allowing them room for maneuver, may instead restrict their scope, and make it difficult to isolate opponents and identify allies and arenas for action," (Li 2000, 170 - 171).

Furthermore, whether Indigenous people in São Gabriel da Cachoeira actually identify with notions of Indigeneity circulating globally and in domestic Brazilian discourse is a question seldom asked of Indigenous activists in the region. Constrained by this intense duality of mining as destruction wrought by outsiders counterposed to the image of Indigenous people as environmental stewards[198], with virtually no recognition of the differentiation between corporate and *garimpeiro* mining activities in international conservation discourse, Indigenous mining proponents find themselves in an impossible position. Branded as "coopted Indians"[199] by cosmopolitan environmental activists, these Indigenous rights advocates find themselves forced into an impossible space of silence on the matter of basic citizenship and usufruct rights: "Who knew that geological knowledge, in these times, could suffocate you?"[200,201] Under such

[197] This exclusion of mineral extraction from 'permitted' extractive activity is vividly illustrated in the *Integrated Conservation and Development Projects* in the Amazon in the 1980s and 1990s. For a description of the failures of extractive reserves in the Amazon, which were intended to achieved conservation and development objectives through the sustainable extraction of non-timber forest products, see Dove (2006).
[198] For an examination of the concept of the "ecologically noble savage," see (Silva 2012)
[199] *Índios cooptados*
[200] Sr. Domingos (FUNAI staff, São Gabriel da Cachoeira), interview by author, April 2014

conditions, geological knowledge production has been separated from its silent, reassuring place among the working cosmological whole held by peoples of the Upper Rio Negro (Cabalzar 2010), to become a site that is fraught with past traumas and present impossibilities.

In the view that emerged from this concentrated gathering of diverse mining interests, conservation and Indigenous protections are an injury to Brazilian sovereignty insofar as they constrict the extractivist reach of the state. The relationship between centralized Lusophone power and the Amazonian frontier has changed little over the past centuries: Indigenous entitlements to the land are a hindrance that would be best dealt with by the imposition of large-scale mining activities and the obliteration of extant socionatures. Not even an Indigenous investment in the extractive effort, expressed directly to military officials and state geologists in the name of national development and frontier security, could shift this perspective.

Vertical Territory, Legal Ambiguity, and Citizenship Rights

As it currently stands, Indigenous people are legally entitled to the use of everything above forty centimeters depth (to allow for cultivation) contained within their federally recognized lands. Everything beneath forty centimeters is reserved as property of the federal government and part of the Patrimony of the Union. Legally, nothing can be extracted from below this depth without paying royalties to the federal government. But, the process for legalizing extraction is prohibitively expensive, and *garimpeiros* face the risk of being violently displaced by large-scale mining companies should they register their holdings.[202] Many rare earth deposits on Indigenous lands in *Cabeça do Cachorro* are found at, or very close to, the surface of riverbanks and streambeds. Since 'mining' these types of deposits requires little to no digging, it is actually ambiguous as to whether this form of mineral extraction taking place on Indigenous lands could fall under the usufruct rights that Indigenous peoples have to the top forty centimeters of their soil.

The legal designation of vertical land rights and the incidence of rare earth elements on some Indigenous lands in *Cabeça do Cachorro* has generated some confusion as illustrated by the ordeal suffered by a local leader in the Indigenous rights movements, Domingos Barreto. In early 2011, Mr. Barreto noticed bluish green stones and clays at the mouth of a riverside cave within his lands. He sent a sample to a geologist friend in Manaus for analysis, which confirmed an unusually high concentration of rare earths. This geologist subsequently informed a buyer who quoted a price that was noticeably higher than what Mr. Barreto recalled his other acquaintances ever receiving for their mineral shipments. This was in 2011, when the global rare earth price was still quite high, although Mr. Barreto was unaware of the reasons at the time. He arranged to fill an 11-foot boat with a few tonnes of this raw material and transport it to Manaus to sell. He, his friends, and his family joined in the effort to gather the rocks and clays to fill the boat:

> "There was nothing clandestine about this. My friends and family gathered and loaded rock in the plain light of day, and I took the boat down river, stopping in the city [of São Gabriel] for lunch. I secured the boat on the beach in front of the federal police post and when we returned from lunch the federal police

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[201] *Quem sabia que conhecimento geologico, hoje em dia, sera suficiente se-afogar?*
[202] Haroldo (retired garimpeiro), interviews by author, April 2014

> asked me: 'Mister, is this your boat?' I said yes. They asked me: "Where is your fiscal note for these materials?" And I said: "Fiscal Note? What fiscal note? This is from my land." The Police said: "You robbed these resources from Indigenous lands?" And I said, "Robbed, what's this? I am from that land, I found these rocks, and my relatives helped me gather them." The police informed me that removing minerals from Indigenous lands was a crime. They seized my boat, arrested me, and sent me to jail in Manaus, where I was charged with illegal clandestine mining and environmental crimes. I was sentenced to six months in jail and assessed a fine for picking up stones on my land. Now I, a fighter [for Indigenous rights], invested in the reform of the legal system of our country, and the father of two young daughters, must return to Manaus several times each year to report to the Justice. I conducted my business in the plain light of day, and now I am a criminal." [203]

Mr. Barreto and his family had planned to use the money from mineral sales to purchase a computer for his daughters and to take care of medical expenses needed by some elder community members. In a region where social relations are as yet largely non-monetized, certain essential goods and services nevertheless require cash. Exchanging a boatload of rocks for a good price seemed to be an entirely legitimate means to acquire currency. Mr. Barreto was not the first to experience this. A newspaper report from the turn of the millennium reported a similar affair, in which a member of the *garimpeiro* cooperative *Cooperíndio* was intercepted by the federal police in Manaus with a boatload of amethyst and tantalite (Brasil 2001). The cooperative has since politicized its activities, deploying white Brazilian *garimpeiros* to engage with allies in the DNPM and pro-mining interests in the Amazonian military command in an effort to shape national mining policy to protect smallholder interests.[204]

At stake in this debate over who mines in what way is the longer-standing question of citizenship, which is played out over who has the right to explore and exploit Brazil's subterranean resources. The sense that an unknown entity could take the earth from beneath one's feet is a chronic source of insecurity among Indigenous interlocutors, which is cited in ongoing struggles for fuller citizenship rights within Brazil. Currently, only wealthy prospectors and established firms can afford to comply with the law as it is written, which suggests that the law was written with only a specific citizenry in mind.

Indigenous proponents of mining, as well as white garimpeiros I interviewed in 2014, have identified two primary issues they understand to inform the state's rationale for branding their activities illegal, but which could be remedied with legalization, regularization and prioritization of small-scale mining activity. First, the nature of their mining, and the perils of the permitting process means that *garimpeiros* are not conducting mining in a way that allows the state to collect royalties. Second, the clandestine nature of their activities means that they cannot organize investment or other programs to implement environmentally superior technologies. *Garimpeiros* interviewed expressed a firm desire to formalize their operations in order to reduce the danger that plagues their currently lawless trade. As noted above, Indigenous peoples had already established a system for permitting, taxing and regulating white *garimpeiros* participating in small-scale mining activities on their lands, but the federal government condemned this practice as illegal and ordered the military and federal police to forcibly halt this system.

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[203] Sr. Domingos (FUNAI staff, São Gabriel da Cachoeira), interview by author, April 2014
[204] Geologist in Manaus, interview by author, April 2014

Garimpeiros are cast as the ongoing villains in Amazonian conservation and Indigenous politics. They are condemned for destroying the environment, invading Indigenous lands, and for wreaking murderous havoc wherever they go (Hoefle 2013, MacMillan 1995, Slater 1994, Guimarães 2010, D'incão 1994). But that characterization is too simple. It does not allow for the possibility of cooperation among Indigenous and *garimpeiro*; it racially codifies mining activity by presuming that only whites conduct mining on Indigenous lands, and that Indigenous people are opposed to mining. Such a characterization forecloses the possibility that Indigenous people might also be *garimpeiros*, engaged in mining on their own volition as part of their own livelihood practice on their own lands.

Because Indigenous people are not allowed to engage in any mining on their lands for economic gain, except that which is designated 'traditional' and used solely for ceremonial jewelry, Indigenous mining proponents argue that the law is designed to keep them in a state of nature and does not allow them to advance or live as modern citizens of Brazil. FOIRN[205] in particular has been at the forefront of condemning the current legal regime as primitivist, classist, and racist insofar as it only makes it possible for those who can afford the up-front permitting costs to comply with the law while criminalizing the rest, regardless of how necessary small-scale mining might be for livelihood security.[206] But because proposed revisions to the federal mining code would make mining impossible for all but major corporations (Coêlho 2013), Indigenous mining proponents and white politicized *garimpeiros* are engaged together in a multi-pronged fight against corporate interests in the Brazilian Senate to legalize *and* grant statutory protection to small-scale mining operations on Indigenous territory. Only then, they argue, will they rise from their status as criminals at worst and second-class citizens at best (Coêlho 2013).

The struggle represents a claim to citizenship and belonging outside of the categories ascribed to Indigenous and extractive interests; the claim for greater autonomy over Indigenous lands is actually a claim to belonging to the Brazilian nation. André Baniwa, elected deputy mayor of São Gabriel da Cachoeira expresses it thus: "Being Indian means knowing one's own culture, traditions, and maintaining one's identity without failing to know the Brazilian state [and] the culture and tradition of the nation," (Baniwa 2009 quoted in Guzmán 2013, 50). The struggle over the mining code, as it unfolds between Indigenous leaders and the state, is characterized at its heart by a demand on the part of Indigenous *garimpeiros* to participate in national development through small-scale mining on one's own lands under the terms of one's choosing. Interviewees were adamant that mining be permitted according to terms agreed upon by communities that understand the implications of different types of mining activities (Farias 2013a).[207] [208]

One Tukano member, João Paulo Barreto, has had a small-scale mining project that he began in 2013 to promote as a model for a sustainable development policy:

> 'The activity would seek profits, not from the point of view of the capitalist world but from the measure of sustainability using traditional techniques and Indigenous conceptions and taking into account the

[205] *Federação dos Organizações Indigenas do Rio Negro* (Federation of Indigenous Organizations of the Rio Negro).
[206] FOIRN representative and founding member, interview by author, April 2014
[207] Sr. Domingos (FUNAI staff, São Gabriel da Cachoeira), interview by author, April 2014
[208] FOIRN representative and founding member, interview by author, April 2014

relationship with nature. We do not want the presence of large companies and large corporations doing the work,'[209] (Farias 2013a).

However, both environmentalists and their political opponents in the Senate have misapprehended this sentiment. On one hand, certain politicians pointed to the favorable disposition of some Indigenous toward mining activity in poor faith in order to justify the liberalization of mining on Indigenous lands under Senator Romero Jucá's PL 1610, in exactly the terms Indigenous activists oppose. On the other hand, the international environmental conservation community is vehemently opposed to changing the mining code on Indigenous lands under any terms whatsoever. In their global campaigns to pressure the Brazilian Senate from approving pro-corporate, anti-Indigenous mining measures, big international NGOs have exclusively privileged a simplified narrative of Indigenous interests.

In a 2014 tour sponsored by Survival International, the renown Yanomami shaman Davi Kopenawa spoke to diverse audiences around the world to generate international opposition to permitting mining on Indigenous Lands (Bayer 2014).[210] This international campaign, although rightly positioned against corporate mining interests, furthers the racial codification of mining insofar as the problem is framed in terms of white miners invading pristine Indigenous lands populated by people who have no interest in mineral exploitation. While it is true that capitalist mining is understood as a degradation of the land and a violation of the Indigenous cosmos (Kopenawa and Albert 2013), small scale mining is not understood in these same terms (Hinton, Viega, and Beinhoff 2003, Graulau 2003).[211] Unfortunately, the international campaign traffics in the primitivist vision of Indigenous peoples that activists and inhabitants in *Cabeça do Cachorro* have been fighting against.

The current success of the international campaigns comes at the expense of the more nuanced proposals intended to give Indigenous people better control over their lands, such as those advanced by FOIRN and local activists. This has generated intense resentment against international NGOs among Indigenous interviewees and mining proponents, but the antipathy goes both ways. Environmental activists dismiss Indigenous pro-mining arguments as not representative of the *real* concerns of the community, suggesting that Indigenous garimpeiros have been tainted by greed or brainwashed by military propaganda despite the fact that many of the mining proponents interviewed have been involved in the Indigenous struggles since the bloody days of the 1970s and 1980s.[212]

While international NGOs position Indigenous mining proponents as coopted by corporate and military interests, federal policy makers and military officials dismiss Indigenous mining proponents of the sort referenced above as indistinguishable from the traitors whom have

[209] 'A atividade visaria lucro, mas não do ponto de vista do mundo capitalista e sim no patamar da sustentabilidade, com uso de técnicas artesanais e concepções indígenas e levando em conta a relação com a natureza. Não queremos a presença de grandes empresas e grandes corporações fazendo o trabalho' (Barretto quoted in Farias, 2013, n.p.)
[210] On the same days in which I was conducting interviews with Indigenous people in Cabeça do Cachorro, hearing heartfelt accounts such as Mr. Barreto's as well as sophisticated legal arguments for the statutory protection for Indigenous mining operations on Indigenous lands, Davi was visiting San Francisco to raise awareness and funds to pressure the Brazilian government to maintain the mining moratorium on Indigneous lands.
[211] Sr. Domingos (FUNAI staff, São Gabriel da Cachoeira), interview by author, April 2014.
[212] Three anonymous Indigenous veterans of land demarcation struggle, group interview by author, April 2014

aligned themselves with international NGOs. Under the latter framing, both NGOS and Indigenous mining proponents demanding special protections against outside interests are accused of stalling Brazilian national progress by locking up the Amazon in conservation reserves and Indigenous lands. Thus Indigenous mining proponents find themselves doubly exiled in political discourse on the matter: from their transnational communities composed of Indigenous activists and international NGOs; and from the position of recognized citizenry of Brazil. This troubled relationship between Indigenous inhabitants and competing territorial orders has an extensive history, examined in the next section.

II: Amazonian Frontier: Geology, Imperialism, and Nation-building in São Gabriel da Cachoeira, 1639 - 1975

The antecedents to the April 2014 encounter at CMA extend back through several centuries of extra-local efforts to territorialize the region regardless of in situ governance structures or extant political economies. From imperial conquest to modernist nation-building projects, geological prospecting has been a key tool through which multiple extra-local powers have sought to discipline the northwest Amazonian frontier into a resource hinterland. Histories of surveying and exploring São Gabriel da Cachoeira, several of which are examined in this section, periodize the rotating cast of hegemons with territorial and extractivist designs on the region.

Europeans first explored the upper reaches of the Rio Negro in the expedition of Pedro Teixeira in 1639 as part of a mandate by the Portuguese crown to consolidate its control over the Amazon. Teixeira's expedition to the upper reaches of the Rio Negro consisted of forty-five canoes, seventy soldiers, twelve hundred archers and conscripted Indigenous rowers (Miranda 2007). Along the way, Teixeira's expedition fought Dutch and English interests that had set up forts on the Amazon river and seized control over their Indigenous slave trade operations for Portuguese interests (Salvador 1627). The Spanish Jesuit Cristóbal de Acuña accompanied Teixeira in hopes of finding Indians to catechize to expand the territorial scope of their missionary activities. Acuña also served as the expedition's chronicler, noting the abundance of precious stones visible along the rivers and on the surface of the soil entirely disregarded by native inhabitants who apparently had no idea of their value (Acuña 1641). The capturing of souls preceded the extraction of stones in the territorialization of the upper reaches of the Rio Negro, although participants in the expedition expressed enthusiasm about both (Herzog 2015).

In 1690, the Portuguese crown sent Carmelite missionaries to convert the Indians and solidify control over Amazonian frontier regions disputed with Spain. Their territorial strategy was typical of religious settlements of the time and crucial to state formation in frontier regions (Chernela 2014): where they went, missionaries set up a convent, a farm, and a village. Established in São Gabriel in 1695, this represented the first Portuguese settlement on the upper reaches of the Rio Negro. In order to sustain themselves, the Carmelites expropriated land and labor from the Indigenous inhabitants and descended to enslaving, buying and selling Indigenous peoples with riverine slave traders (Hemming 1978).

For half a century, Spanish forts remained further to the north, where the Orinoco connects with the Rio Negro via the Casiquiare waterway. However, the 1750 Treaty of Madrid divided South America between Spanish and Portuguese powers; Portugal ceded part of the Rio de La Plata and much of present day Argentina in exchange for control over a greater portion of the Amazon. To enforce the treaty, in 1761 the governor of the Captaincy of São José do Rio Negro at Barcelos[213] organized several defensive patrols of the upper reaches of the Rio Negro. The expeditions identified that the drainage of the Orinoco into the Rio Negro provided a fluvial passage between the Amazon and the Caribbean Atlantic and hoped to develop a trade route to move timber, gold and silver from this inland frontier to Europe. Representatives of the Barcelos Captaincy made the case up the chain of command to the Office of the Secretary of State for Marine and Overseas Affairs of the Portuguese Imperium[214] that improper defense of this region could jeopardize Portuguese control over the deep jungle (Bernardo e Mello 1763). This fear of losing control over the Amazon struck a chord among extra-local administrators charged with maintaining order over an immense and dynamic region that resonates through to the present.

The Office for Marine and Overseas Affairs responded by providing financing and man-power for a construction expedition, enlisting the services of German Military Engineer Phillip Sturm with instructions to attend to the solicitations of the Captain of Barcelos (Nabuco, Sampaio, and Rodriguez 1903). Sturm recommended the construction of two forts, one in present day São Gabriel da Cachoeira, and another upstream to mark the northern extreme of the Portuguese dominion near Cucuí, called the Forte de São José de Marabitanas. From this fort, Portuguese soldiers could expel Spanish settlements and defend against possible incursions via the Orinoco (Santos 2008). Portuguese officials were convinced that Marabitanas would be the first part of the Amazonian frontier to be attacked by competing colonial powers (D'Almada 1785); therefore maintaining a military presence was necessary. However, there is no record of any such invasion and the original fort is now in ruins.[215] But because of the enduring anxiety among the Brazilian military that the Orinoco connection to the Caribbean Atlantic poses a national security threat (Brito 2013), it is now the site of the Fifth Rio Negro Frontier Command and the Fifth Special Border Platoon under the CMA.

Despite the territorial anxieties, non-Iberian powers did not explore the Orinoco - Rio Negro - Amazon River network until the 20th Century when the outbreak of WWII severely threatened US rubber supplies. With the caesura of relations with Germany, it became clear that US chemical companies had no idea how to produce synthetic rubber, while Japanese imperialist designs on Southeast Asia threatened US supplies from Malaysia (Dean 1987). Meanwhile, trading routes from the Amazon river delta and the Atlantic were being "severely harassed by

[213] Located downstream of São Gabriel da Cachoeira toward Manaus

[214] The Barcelos capitão conveyed their findings to the Governor and Captain-General of the State of Grand-Para and Maranhão Manuel Bernardo de Melo e Castro. This was a colonial Portuguese state from 1621 – 1772 which covered an immense territory now divided into the states of Amazonas, Maranhão, Pará, Tocantins, Roraima, Rondônia, and Acre. With the separation of Maranhão in 1772, the state was renamed *Estado de Grão-Pará e Rio Negro* which existed from 1772 - 1823. Governor Bernardo de Melo then sent this news with a map created by Phillip Sturm to the preceding governor, Francisco Xavier Furtado de Mendonça, who then occupied the office of the Secretary of State for Marine and Overseas Affairs.

[215] In the Cabanagem rebellion of 1835 – 1840, it was a political prison for captured rebels (Harris 2010, Oliveira 1968), and during the Federalist Revolution in 1893 in the southernmost state of Rio Grande do Sul, the President Marechal Floriano Peixoto banished leading revolutionaries to Marabitanas (Oliveira 1968, Reis 1942).

submarine attacks," (Engineers 1943, 1) which threatened US supplies not just of rubber, but also of chicle, mica, and other essential wartime goods supplied by Brazil (Pecora et al. 1950, USGS 1942 - 1947).[216] The US Army Corps of Engineers cooperated with the governments of Venezuela, Colombia, and Brazil in order to survey the 1,842 mile long Orinoco-Casiquiare-Negro Waterway with the purpose of identifying alternative shipping routes and "to further the understanding and development of that region by the sovereign governments," (Engineers 1943, 1).

The survey team, composed entirely of US military personnel, conducted hydrographic and climatological surveying, aerial photography, and mapping of the route from the Caribbean to São Gabriel da Cachoeira. The final recommendations stated that "this report and maps be published and distributed to…interested officials and agencies of the several participating governments, for their information and study [and that] copies of the report and maps be placed in the hands of all officials and agencies resident in and adjacent to the region, so that the maps and physical data may be available immediately to residents and students of the region," (Engineers 1943, 297). Of São Gabriel's mineral wealth, the Army Corps of Engineers report noted that "the natural resources of the region are considerable, but, because of its comparative remoteness, not easy of development," (Engineers 1943, 30).

[216] Two US firms, the Chicle Development Company and the Rubber Development Corporation established operations in São Gabriel da Cachoeira with the intention of taking over extensive rubber tapping networks to supply the US rubber market via the Rio Negro-Casiquiare-Orinoco waterway. Despite the massive investment and resettlement programs, no amount of US public funds could overcome the deleterious effect of South American leaf blight that had driven rubber production to Southeast Asia decades ago, nor were they able to disrupt the established networks of the local rubber barons. The extractivist initiative failed at an enormously high cost: in June 1945 an audit of the Brazilian office of the Rubber Development Corporation found that costs exceeded income by $9.1 million dollars during the War, while Brazil's Federal Congress estimated that 17,000 to 20,000 rubber tappers resettled to work in RDC's groves remained unaccounted for (Dean 1987, 104).

Figure 31: Map of 1842 mile Orinoco – Casiquiare – Negro waterway connecting Manaus to the Caribbean

Source: Original figure by Spike Hamson, adapted by author.

This report was instrumental in providing baseline data for the first systematic geological survey of the region, which was undertaken by the military dictatorship (1964 – 1985). Abundant deposits of ferrous and non-ferrous metal deposits were hypothesized in the 1960s when a group of geologists participating in the preliminary border surveys of the geological reconnaissance project RADAM-BRASIL observed a “chimney-like” hill protruding out of the northwestern Amazonian landscape outside of the city of São Gabriel da Cachoeira, which was later identified as the Morro dos Seis Lagos deposit (Corrêa, Costa, and Oliveira 1968). In 1973, on the calculation that local resources could sustain a regional industrialization project, the 21st Engineering and Construction Company of the Brazilian Army and the Battalion of the Caicó Highway were relocated to São Gabriel (Brasileiro 2006). This relocation occurred contemporaneously with the notorious military assault on Communist guerrillas in Araguaia (Vecchi 2014, Portela and Neto 2002), so anti-communist industrialization defined the dictatorship’s approach to *Cabeça do Cachorro.* As part of its relocation agenda, the Brazilian army trained a troop of Indigenous mercenaries in the upper reaches of the Rio Negro in case communist guerrillas should occupy the region and interfere with plans to build an industrial mining hinterland to fuel Brazil’s development (Ricci 2014). It was in service of a rightist nation-building agenda that DNPM conducted the RADAM geological survey of Morro dos Seis Lagos and São Gabriel da Cachoeira in 1975.

The RADAM survey of the Amazon was organized across ten ministries and spearheaded by the Brazilian Air Force. It *officially* took place between 1970 and 1985, during which the entire Brazilian territory was surveyed with aerial radar and mapped with over 38,000 logged flying hours (Souza and Cavedon 1984)[217]. The first phase (1970 – 1975) covered 54% of the national territory, comprised primarily of the Amazonian frontier and parts of neighboring countries (Momsen Jr. 1979). It later expanded to cover all of Brazil in the second and third phases: 1975 – 1980 and 1980 – 1985, respectively (Archela and Archela 2008). This was a project of unprecedented scope, the radar technology of which allowed Brazilian surveyors to collect their first imagery unaffected by cloud cover (Momsen Jr. 1979). The Seis Lagos carbonatite complex was recognized in 1975 after geologists published a report on the radioactive anomaly detected on the site (Hassano, Biondi, and Javaroni 1975). That year, CPRM conducted a preliminary phase of geophysical and geochemical exploration that consisted of drilling four samples between 110 and 255 meters depth. The samples were only partially analyzed at the time.[218]

Clearly, the drive to exploit the region long precedes the identification of rare earth elements. The histories of São Gabriel da Cachoeira from the 1600s to the third quarter of the 20th century show successive attempts on the part of imperial and state actors at surveying and rationalizing the region through the production of cartographic and geological knowledge undertaken in service of various imperial, colonial, and nation-building projects. These bodies of knowledge about the Amazonian frontier have been generated and deployed by Imperial Portuguese as well as military actors from the US and Brazil in order to somehow rationalize and capitalize on the region's resources in order to address broader territorial and geopolitical insecurities. The histories of the production of these bodies of knowledge is also a history of multiple forms of brutality and subjugation visited upon Indigenous peoples whom, at best, were framed as spiritual and labor resources in multiple territorial orders and at worst, as obstacles to

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217 RADAM-BRASIL created the largest geophysical database in Latin America at the time, and continues to be the basis from which nationalist development projects draw: "Amongst innumerable contributions of RADAM-BRASIL Project to the knowledge of Brazil's natural resources in the of geology the following are relevant: identification of various granitic bodies subject to enclose mineralizations of tin, tungsten, gold, niobium and tantalum in the States of Pará, Amazonas and Rondônia and in the federal territory of Roraima; *discovery of the Seis Lagos carbonatite rock, north-west of the State of Amazonas, one of the biggest world reserves of niobium and rare earth elements;* detection of several lignite levels in the State of Amazonas. In the field of vegetation definition of resources and exploitation of timber; definition of Amazonian phytoclimates and forest inventory; and firewood phytomass survey in the savanna region. The soil survey constitutes a unique source, at regional level, capable of expressing Amazonian reality in terms of survey and its results. It follows that about 33 millions hectares have soils with medium to high fertility and good physical characteristics for plant development, situated in the area of the Carajás Project in the State of Pará and also in the States of Acre, Rondônia and Mato Grosso. About 22 millions hectares have soils with medium to high fertility in low lands of Amazonian rivers and its tributaries. In the field of geomorphology 140 sites were detected as capable of generating hydroelectric power stations and power lines in Amazonian and central-western regions, some being utilized by Eletronorte, such as Balbina (State of Amazonas) and Cachoeira Porteira (State of Pará). In the field of potential use of land, besides utilization classification, several areas were proposed for environment protection such as forest parks, biological reserves and ecological stations." (Souza and Cavedon 1984, emphasis added).

218 One of the veteran geologists interviewed reported that after they completed their initial reconnaissance of the radioactive anomaly at Morro dos Seis Lagos, U.S. spy planes based in Panama conducted clandestine geological reconnaissance of the place. According to the story, Brazilian mapping of the amazon rainforest apparently aroused the distrust of the U.S. with respect to Brazil's reportedly peaceful (Various 1947 - 1989) nuclear ambitions (Cruz 2014)It is not the truth of the account that is informative, rather, it is the sense among Brazil's geologists, reflected in military policy, media, popular culture, and conspiracy theory that the country's Amazonian resources are coveted by the United States, which also resents Brazilian progress and development in the region. This theme will be further examined in the next section.

development and colonial civilization. Indigenous struggles for federal recognition of their claims to the lands they occupy and the resources beneath their feet began to generate significant results in the 1980s in ways that are consequential to contemporary contests over *whom* is entitled to local rare earth resources, discussed in the next section.

III. Contested Hinterland: Extractivism, Geopolitics, and Militarism, 1976-2014

> 'The question of geological mapping of Brasil is far from being resolved. What is clear, however, is that Brazilian geology is still unknown compared to other mining nations. This represents an excellent opportunity for businesses especially focused on exploration, in search of potential activities in frontier regions such as the amazon…' (Jones et al. 2011, 10).[219]

In 1985, ten years after the RADAM-BRASIL survey of São Gabriel da Cachoeira, state geologists calculated that Morro dos Seis Lagos contained a reserve of 81 billion tonnes of niobium at 2.898% concentration, which was fourteen times the known global reserves at the time (Justo and Souza 1986). The deposit was also found to possess remarkably high concentrations of rare earth elements as well as vanadium, beryllium and zirconium (Radambrasil 1976). In this period preceding the proliferation of rare earth-based information and military technologies, did not stimulate much practical interest (Rossini 2012). After the successful demarcation of Indigenous lands 1987 and biological reserves in 1990[220], all further geological research was halted. Knowledge about the extent of the mineral wealth in the region is a very recent phenomenon, emerging after the 2010 crisis awoke Brazilian researchers to the importance of rare earth elements.

The RADAM-BRASIL samples were taken out of storage for further analysis in the immediate aftermath of the rare earth supply crisis. In December 2010, a joint research group between the Federal University of Rio Grande do Sul and the National Council of Research on the Mineralogy and Geochemistry of Mineral Deposits re-opened investigations into the Seis Lagos deposits. This initiative was overseen by CPRM doctoral fellow Mateus Marcili Santos Silva, who had participated in large-scale hydrographic mapping initiatives and was therefore able to gain access to samples through his colleagues at CPRM. But the project was dealt an unexpected setback when Silva died in a car accident in July 2011 (N.A. 2011) and did not resume until nearly a year later.

Ongoing analyses carried out by members of this research group using the samples that were made available to the late Mr. Silva have found concentrations of heavy rare earth elements between 5 and 10% (Giovannini 2013), which is exceptional compared to other sites which

[219] '*A questão do mapeamento geológico do Brasil está longe de ser resolvida. O que está claro, porém, é a que a geologia brasileira ainda é desconhecida, compa- rando-a com outras nações minerado- ras. Isto representa uma excelente opor- tunidade para as empresas com um foco na exploração, em busca de ativos nas regiões de fronteira como a Amazônia...'* (Jones et al. 2011, 10).
[220] Created with Decree-Law 12.836 of 1990

successfully garnered investment based on concentrations of 0.9 – 2.2%[221]. In addition to the resources at Morro dos Seis Lagos, there is an abundance of rare earth elements, coltan, vanadium, and other elements now considered 'strategic' or 'critical' present in alluvial deposits and clays on Indigenous lands elsewhere in *Cabeça do Cachorro*. One sample collected from a riverbank by an Indigenous interlocutor[222] revealed record concentrations of the less common heavy rare earth elements at 22%.

Although mineral prospecting is expressly forbidden in Indigenous territory as well as ecological protection zones, which comprise 98% of the land in São Gabriel da Cachoeira, the original text of the current Mining Code, Decree-Law 227, entered into force in February of 1967, does not contain any provisions against mining or exploring on Indigenous lands. It does, however, set forth a definition of *garimpagem*[223] and describe a legal process for regulating and permitting the activities of *garimpeiros* (República 1967). Further controlling access to the region's mineral wealth is a 1979 law that placed matters of mineral exploration in frontier regions under the jurisdiction of the National Defense Council. This means that mining activities "in areas indispensible to the security of national territory, especially in the frontier regions and with respect to activities related to the preservation and exploitation of natural resources of any type," cannot proceed without military approval. This law was enshrined in the Constitution of 1988 along with a moratorium on activities intending to occupy, fragment, or exploit Indigenous lands or their mineral wealth, unless specifically decreed by Congress on a case by case basis (Brasileiro 1988, Articles 231 and 232).

But nothing in the Constitution or related laws expressly prohibited DNPM from issuing mining concessions in Indigenous lands so long as applicants followed the proper permitting procedures. Furthermore, the moratorium did not nullify existing mining concessions in the region, rather it placed them in a state of suspension until such time that the mining code may be revised to permit mining on Indigenous lands. Such a proposal came in 1996 in the form of PL 1610, authored by Senator Romero Jucá. Under discussion for nearly two decades, this law would overturn the mining moratorium in Indigenous lands, allow prospecting firms the same rights of exploration as permitted on non-protected lands, without providing a process for Indigenous inhabitants to contest or modify mining concessions on their territories. Banking on the success of 1610, the number of mining concessions acquired in São Gabriel da Cachoeira increased from thirty-six before the ratification of the constitution to four hundred and one in 2005 (Ricardo 2013).

Fiercely contested, this proposal had all but stalled in Congress. But it was revived in June of 2013, when President Dilma Rousseff sent a mandate to Congress to formulate a new mining code that would be:

[221] Mountain Pass, for example, has rare earth concentrations between 2 – 3% (Olson 1954).
[222] Which I sent to a third party laboratory for independent analysis.
[223] small-scale mining

'…favorable to business and to productive investments that would strengthen a new cycle of development in our country, but all with gains for society, for workers, and for the environment,' (President of the Republic Dilma Rousseff quoted in Bustamente 2013, *inter alia*).[224]

This became Legal Project 5807 of 2013, and was anxiously awaited by the mining sector, which had hoped that the charged geopolitical climate surrounding rare earth elements would facilitate lifting the moratorium against mining on Indigenous lands (Bustamente et al. 2013). It was advocated with urgency among business and mining interests in the Congress who claimed that the nation was at a critical point to determine its future development. Industry was quick to buy influence among politicians. For example, mining companies contributed at least R$1.8 million to the re-election campaign of the Legal Project's sponsor, Senator Leonardo Quintão, which had comprised 37% of his entire 2013 campaign budget (Souza 2014). Efforts to force through the bill on the pretext of national urgency failed, however, as the price of rare earth elements stabilized and allegations of bribery and corruption surfaced (ISA 2013a). As of this writing, the law has yet to be finalized.

In the meantime, some DNPM and CPRM geologists have taken a proactive stance on exploiting the mineral riches of Cabeça do Cachorro. By problematizing it as the least-known geological region of Brazil (Santos 2003), the scientific and economic potential of which remains hindered by Indigenous and international NGO efforts to keep the region undeveloped, geologists have found a welcoming audience among elites of the CMA, who take care to include the most outspoken among state and Indigenous mining proponents in high-profile military events across the country.[225] Re-opening Indigenous lands to large-scale mining operations would enable the military to revive its agenda of industrialization-driven consolidation of northwest Amazonian frontier. The current prohibitions on mining combined with the sophistication with which Indigenous people defend their constitutional rights over their lands has had the effect of intensifying the allure of *Cabeça do Cachorro* despite the availability of rare earth resources elsewhere in the country because of the way in which contemporary exercises of Indigenous agency stimulate painful recollections among veteran state planners[226] failed regional development initiatives of decades past.

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[224] *"…criar um marco legal favorável aos negócios, aos investimentos produtivos fortalecendo um novo ciclo de desenvolvimento de nosso país, mas tudo isso com ganhos para a sociedade, para os trabalhadores e para o meio ambiente…"* (President of the Republic Dilma Rousseff quoted in Bustamente 2013, *inter alia*).

[225] During my first visit to Cabeça do Cachorro, the Manaus-based geologist Fred Cruz called to inform me that the Brigadier General of the Amazonian Military Command had invited him to travel with them on their military transport plane to witness the changing of command at the military base in São Gabriel. As a friend of the geologist, and as a 'geographer, non-anthropologist,' with expertise in rare earths, I was invited to witness the celebrations. Subsequently, the Brigadier General requested that I brief officials in CMA in order to educate them about rare earth elements, the global situation, and my observations in China. At a special conference organized at their headquarters in Manaus, sixty (60) three and four star generals assembled. Notably, they had invited politicized garimpeiros, colleagues of Mr. Cruz, and Indigenous proponents of mining, who, in the final hour of the conference, gave extensive commentary on the 'interference' of NGOs in resource-based development in Indigenous territory presented in the first section of this chapter. A fuller account of this conference is reported in 'Agency, Conspiracy, and Complexity in Amazonian Neo-extractivism' an article under preparation for submission to *Journal of Political Ecology.*

[226] As illustrated in Section I.

Extractivism, Life and Death

The current disputes over rare earth mining in Cabeça do Cachorro are essentially struggles between mining as characterized by Mumford (1934, 1967), Braudel (1985), and Merchant (1990), in which industrial mining heralds the catastrophic penetration of capitalism into human communities, bringing war, death, and the death of nature; counterposed to that which such approaches seek to delegitimize: small-scale, family mining operations that complement other livelihood activities to provide a supplemental income to other subsistence activities drawn from the land and regional trade (Graulau 2003, Lahiri-Dutt 2011). Both forms of mining, of course, are motivated by profits. In the latter, mining is one family or community enterprise of many in which children, women, and men participate. It is extremely difficult to extract surplus value from such an arrangement, and so it is vilified. In Cabeça do Cachorro,[227] however, it has proven difficult for industrial mining interests to access geological riches without relying upon or expropriating the knowledge of family and community mining activities. Given the territorial contests and multitude of mining interests in the region, geological knowledge has been a matter of mortal consequence.

Wright (2005) was among the first in the social sciences to examine the intersection of Indigeneity, territorial integrity, and the politics of geological knowledge production in the upper reaches of the Rio Negro. Drawing on extensive fieldwork among the Baniwa, Wright demonstrated how the divulgation of geological secrets undermined Indigenous territorial rights while an alliance between missionaries, mercenaries and mining companies facilitated unprecedented military penetration into this region between 1980 and 1990. Because the events of this decade shape contemporary regional rare earth politics in important ways, they are related in detail here.[228]

In late 1979, a group of Baniwa was heading over the border along the *Serra dos Porcos* to participate in Colombian gold mining when they discovered gold within their own lands. They informed people in their communities. News traveled up and down river, and Indigenous peoples from Colombia, Venezuela, and as far away as Guiana came to mine gold. In the first years, there were no whites, only Indigenous *garimpeiros*. By 1983, traders came to São Gabriel da Cachoeira to exchange goods for gold, and white *garimpeiros* joined the operations. Indigenous peoples set up a permitting system which controlled the number of white *garimpeiros* allowed and collected a small tax on their findings.[229]

By 1984 the upper reaches of the Rio Negro was the site of one of the most intense searches for gold in the history of the Amazon. As Hecht and Cockburn (1990) have noted, large-scale enterprises follow garimpeiros and depend on them to assume a significant portion of the risks involved in identifying promising new deposits. Private firms began sending agents and requesting licenses from the DNPM. Two of which—*Paranapanema* and *Goldmazon*—conspired with the Governor of Amazonas to help state surveillance efforts in exchange for

[227] As others have noted elsewhere (Hecht and Cockburn 1990, Graulau 2001, Albert 1992).
[228] Unless otherwise cited, the events related in the next three paragraphs are drawn from Wright's ethnographic records.
[229] Sr. Domingos (FUNAI staff, São Gabriel da Cachoeira), interview by author, April 2014

controlling the mining activities in the region, a tributary to the Rio Negro. The 'New Tribes Mission', which had established infrastructure in the region to support the evangelical activities headed up by the American Sophie Müller, offered mining bosses the use of their remote landing strips and basic supplies.

Then tensions came to a head. In early 1985, representatives of the mining companies recruited Baniwa to carry heavy machinery, gasoline and other supplies through thirty kilometers of jungle from the river to the primary mining site in the *Serra dos Porcos*, to clear forest and to set up camp. It was not clear to the Indigenous porters that the representatives were from large mining companies intending to expel *garimpeiros* or would attempt to expropriate the mine. When the Baniwa demanded payment, mining personnel threatened them with violence and ordered them to leave. In response, a group of sixty leaders from nearby villages prepared for war. In full battle regalia and armed with arrows and rifles, the Indigenous leaders surrounded the miners and offered them the options of leaving immediately, or staying and fighting. The corporate miners left immediately, leaving the operations to the Indigenous.

The mining companies retaliated by conspiring with corrupt personnel working for FUNAI to hire mercenaries to go after the Indigenous leaders and intimidate them into signing agreements opening their lands to outside mining interests. Alarmed at this, representatives from 54 communities got together and wrote a letter to the President of FUNAI in Brasília, Nelson Marabuto[230]. They demanded the recognition of their rights to their lands; the removal of all outside mining interests with the clarification that in the future, these communities intended to work the gold and other mineral resources on their own lands. They made the explicit proviso that they would mine according to their own terms and with full discretion over technical assistance, production, and profits.

Indigenous peoples leveraged different forms of resistance, from armed to political, to regain control over their subterranean resources. They traveled to Manaus and Brasília to petition higher levels of government to recognize their land claims and expel mining companies. They held local meetings with mining representatives, community members, and government personnel. Many of these official efforts were fruitless in the short term as government and industry continued to "dribble the ball"[231] in terms of who was responsible for what in Indigenous territory. In late 1985, FUNAI President Álvaro Villas Boas sent a working group to research the mining and conflict situation and propose a series of measures to alleviate the tensions. As it turned out, the group lacked any authority to implement its recommendations. One of the few concrete legislative changes that emerged was a territorial assertion on the part of the federal government, stating definitively that the *Serra dos Porcos* was within Brazilian territory and that Colombians were prohibited from mining in Brazil. Colombians were not the problem, as far as the locals were concerned, so this did little to address the daily concerns of Indigenous peoples dealing with the ongoing intrusion of mining companies onto their land. Erasing Indigenous concerns, the federal government interpreted the conflict through the lens of

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[230] FUNAI had five presidents during that contentious year: Nelson Marabuto (9/1984 – 4/1985); Ayrton Carneiro de Almeida (4/1985); Gerson da Silva Alves (4/1985 – 9/1985); Álvaro Villas Boas (9/1985 – 11/1985); Apoena Meirelles (11/1985 – 5/1986).

[231] An expression akin to "play hot potato" or "pass the buck" in the sense that two or more parties attempt to buy time and avoid taking responsibility for an issue by claiming that responsibility lies with the other party.

geopolitical interests rather than a dispute among different groups of Brazilian citizens. Episodic violence flared between Indigenous people and corporate miners in a circumstance that both sides described as war.

Post-Dictatorship Militarization, Surveillance, and Subject-Formation

Meanwhile, with the end of the dictatorship in sight, the Brazilian military had been developing a program—*Projeto Calha Norte* (PCN, or the Northern Trench Project)—to militarize the Amazonian frontier following the failures of the massive integration projects of the 1960s and 1970s. Under the twin banners of development and sovereignty,[232,233] it was conceived with the motivation of providing a justification and operating budget to maintain a military presence in São Gabriel da Cachoeira despite growing evidence of military abuses of Indigenous peoples (Ricardo and Ricardo 1990, ISA 2001). This project—submitted to President José Sarney in June of 1985—proposed to better integrate the region into Brazil, rationalize the local economy, and assimilate Indigenous people into the Brazilian population, which—it was hoped—would eventually reduce the need for Indigenous areas.

The proposal sat unaddressed for months. Then, on 6 November 1985, the international press exploded with news of a siege by the Colombian Armed Movement M-19 on the Colombian Supreme Court in Bogotá. Although the attack had taken place roughly a thousand kilometers away from São Gabriel da Cachoeira, and although the M-19 movement claimed less than two thousand members who were overwhelmingly based in urban areas in Colombia, military personnel capitalized on popular fears of jungle guerrillas elsewhere in Brazil. A propaganda campaign cynically mixed accounts of Indigenous attacks on corporate mining personnel and broader cultural anxieties about attacks on Brazilian territory by circulating rumors that guerillas were building up an arsenal on the border in order to invade and capture Brazilian gold (Hayes 1986). The propaganda worked. President Sarney approved the project in December 1985.[234] In collusion with representatives from the United States' Drug Enforcement Administration, the military determined that the upper reaches of the Rio Negro would serve as a 'test case' for their Amazonian occupation, surveillance and assimilation program.[235, 236]

The *Programa Calha Norte* remains active, but after 2003 its primary orientation shifted from sovereignty to developmentalism. The development axis now receives the majority of budget; in March 2014 the Head of Finances for PCN, Brigadier Dias, reported 1800 separate development projects, including the construction of six universities in the neighboring province of Roraima. Although PCN does not have an explicit mandate related to natural resource

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232 Brigadier Dias (Ministry of Defense in Brasília), interview by author, March 2014

233 "I don't work with *security*. I support *sovereignty* through the construction of infrastructure. In the amazon there is no private sector to build the things that are needed. So we build them to help develop the region." Brigadier Dias, interview by author, March 2014.

234 It became formalized into a federal program in 1996.

235 At the time the DEA documented much higher incidences of coca and marijuana plantations in Acre and just outside of Manaus. This makes sense for market and logistical reasons. Given this, it is unclear what was being 'tested' in the upper reaches of the Rio Negro.

236 Anonymous retired US intelligence official, interview by author, May 2014

extraction, 'the best result of the program is the rapidity with which we are able to execute logistical projects because of our military approach. This will ensure the regularization of economic activity on our frontier.'[237]

Since 2010, the budget had increased precipitously, from R$ 250 million per year to R$ 770 million in 2013. [238] Brigadier Dias attributes this to 'the growing confidence Senators have in our initiative' as well as 'growing awareness of the need to protect São Gabriel da Cachoeira's resources from Colombian and Venezuelan outlaw miners by integrating the region into Brazil.' Here again, the extractivist threat is internationalized at the expense of Indigenous claims to frontier resources. Dias emphatically denied any knowledge of any PCN activity related to mining or industrialization interests in São Gabriel da Cachoeira, but then could not name any other activities in the region despite having made reference to the 'very many, indeed' that he had authorized during his tenure.

Wright (2005) proposed that the 1985 threat of Colombian guerilla invasion represented a pretext to intensify state control over a frontier region that was more integrated with the mineral, cocaine, rubber and contraband markets in Colombia compared with the rest of Brazil. Indeed, guerilla attacks on Brazilian territory never materialized. This is not surprising, given the reliance of FARC in particular on supply shipments from São Gabriel da Cachoeira (Brasil 2003), the extensive economic ties between Indigenous groups on both sides of the border, and the sophisticated trading relations between Indigenous miners and cocaine producers seeking alternative routes for their goods.[239] Aside from two alleged planned supply raids on Brazilian army bases in 2004, which also never materialized[240], guerilla leaders have made it very clear that they do not wish to engage in armed conflict with the Brazilian military, but neither does the Brazilian Ministry of Defense wish to appear that it is lagging on the offensive against FARC lest the US military decide that its needs to increase its presence in the region (Filho 2006).

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[237] Brigadier Dias (Ministry of Defense in Brasília), interview by author, March 2014

[238] From US$99.5 million to US$295 million

[239] An intriguing trans-border trade dynamic has been generated by the friction emerging from two very different legal regimes that place different premiums on different black market commodities. In Brazil, there is a tremendous effort on the part of the military and the federal police to control clandestine mining, while efforts to control cocaine trafficking are less systematic. In Colombia, decades of the War on Drugs have compromised or closed major transport routes for cocaine. So people between Colombia and Brazil have set up sophisticated exchange and reciprocity networks to transport cocaine through Brazil to external markets, and likewise to transport minerals through Colombia to outside buyers. The relations are deeper than simply economic, however. Certain Indigenous groups maintain kin relations across the borders. Lack of health services in São Gabriel, aggravated by embezzlement of funds intended to provide services through the ministry of heath provoked a health-related exodus of Indigenous people seeking medical care in Colombia. In part of the fight against FARC, the Colombian Ministry of Sanitation stopped delivering medical supplies and fuel to these frontier clinics in 2001 (Ricardo and Ricardo 2006)

[240] "According to the Amazon Military Command, for two months in mid-2004 the FARC planned assaults on Brazilian Army positions along the 1,600-kilometer border between the two countries. The guerrilla group sought to obtain weapons, ammunition, food and medical supplies. The military in Querari, a platoon on the border considered the most tense, was reinforced by 40 men trained in jungle warfare. It was the last potentially aggressive movement of the guerrillas recorded by the Brazilian military intelligence network in the area of Brazil. At that time, satellite photos of the Ministry of Defense showed the marks of a camp through lower woods in an area customarily used by the guerrillas. Analysts of Amazon Military Command in Manaus believe that the FARC were gathering a column with about 160 men and women in Jurupari," (Silva 2013, 31 - 32).

In general, Brazilian military officials are uncomfortable with the enduring US military presence in Colombia (Marques 2007) since this represents a major imperial power fortifying its military resources near Brazil's Amazon. This has compelled the military to formulate offensives on the region in order to enclose possible spaces in which the US military might decide to intervene. In one such case, the CMA has reframed the fluid transborder economies as a violation of Brazil's sovereignty and has undertaken joint training exercises with the air forces of Colombia, Peru, and Venezuela. To simulate illicit trafficking, they deployed small airplanes to fly at low altitude along the border of Brazil and the participating neighbor states. They practiced radar detection and mid-air interceptions (Marques 2007). Yet the practical motives of these exercises are unclear, given that the majority of the merchandise is moved in small quantities, boat by boat, in an 'ant-like'[241] fashion up and down river. Both military and federal police interlocutors in São Gabriel da Cachoeira professed a fundamental incapacity to monitor small-scale riverine movements on a regular basis.[242, 243]

The most recent military project with an explicit natural resources mandate is known as *SIVAM* (*Sistema de Vigilância dos Amazonas;* Amazonian Surveillance System). This was conceived during the Presidency of Fernando Henrique Cardoso (1995 – 2003) and came online in 2002. One of the principle objectives is to monitor and collect data about natural resources in the Amazon in order to further the modernization task of completing an inventory of national riches (Nascimento and Sá 2008). Using a combination of ground and aerial radar, this 'system of systems' was built to monitor drug trafficking; illegal mining, ranching and deforestation; agrarian conflicts; and invasions on Indigenous lands. Four firms supply the technology: Raytheon from the United States, MacDonald Dettwiler from Canada, and the Brazilian firms ATECH and Embraer. At just over USD 1.4 billion, this was the world's largest environmental monitoring system and the Brazil's largest ever defense procurement deal (Perlo-Freeman 2004), for which the US Export-Import Bank provided ninety-seven percent of the financing at 8.5 percent interest (Martin n.d., Guzmán 2013).

Implementing SIVAM necessitated a re-militarization of the Amazonian frontier in the name of surveillance, which reached beyond the developmentalist ends of the PCN. In 2004, the Brazilian army relocated the First Strategic Brigade of Niterói in Rio de Janeiro to São Gabriel da Cachoeira. This was presented as part of a new orientation of the Brazilian military in response to poorly-defined 'new' international pressures (Filho and Vaz 1997, Messias da Costa 2013), but in fact the re-militarization of *Cabeça do Cachorro* does not seem to reflect any profoundly new thinking about the Amazon in general or the upper reaches of the Rio Negro in particular. Marques (2007) has found that it is more accurate to describe the military as reviving its foundational strategies to address what has long been perceived to be the greatest national vulnerability.

However, the need to defend the Amazon has caught hold of the Brazilian popular imagination with particular intensity in this contemporary era of neo-extractivism. Once thought

[241] *formigando*–to my knowledge, there is no rare earth separation in São Gabriel. That is carried out by downstream buyers in Manaus and Colombia. Local activity consists of extraction and transport.
[242] Officer Antunes, Federal Police Officer, interview by author, April 2014
[243] Commanding Marshal Roberval of Federal Police Post of São Gabriel da Cachoeira, interview by author, April 2014

to be a punishment, posts in the Amazon are now among the most sought after among military officers (Marques 2007). If anything has changed about the older feelings toward the Amazon, it is a sense of morally and technologically empowered purpose emerging out of several years of broader national political economic ascendancy. Furthermore, the contemporary attitude of the military and the federal police toward Indigenous inhabitants has changed little from the colonial era. Indigenous people are still discursively framed as the counterpoint of civilized Brazilians, lacking the initiative to work, improve themselves, or practice good hygiene (Marques 2007, Castro 2003).[244] In these discourses, Indigenous people do not count as a living presence on the Amazonian frontier, as illustrated by the military strategy to 'vivify' the frontier with military colonies:

> "Thanks to the *Programa Calha Norte* there has been an accentuated vivification on the frontier zone, based in the presence and deployments of the Special Frontier Platoons. If it weren't for the PCN, what would we have in this Amazonian vastness? [...] For the strategists, the Special Frontier Platoons are today little points of "national civilization" holding our frontier together, with the hope that in the future they will transform themselves into human agglomerations, small towns, small cities, municipalities, like for example what occurred…in São Gabriel da Cachoeira, which today is a thriving city in the Upper Rio Negro with approximately forty thousand inhabitants…" (Nascimento and Sá 2008, 41).[245]

But, what *has* changed about these antiquated attitudes is that they must reckon with the fact that Indigenous polities are now well organized on the regional, national, and international scale. Chastened by the now well-publicized disgraces of the colonial and mid-century extermination practices in the name of greater geopolitical control over the Amazon (Ricardo et al. 2014), the Brazilian military has been compelled to change its approach from one of necropolitics (Mbembe and Meintjes 2003) and secrecy to one of "100% transparent"[246] biopolitics (Foucault 2007). Because large-scale extractivism remains the prevailing interest outside of *Cabeça do Cachorro*, this obliged the military to undertake an extensive pedagogical campaign of subject formation in an effort to discredit and vilify small-scale mining operations. Switching its politics from necro- to bio- further obliged the military to reconfigure its pedagogies of difference between civilized Brazilian and Indigenous Other. In order to recodify legitimate and illegitimate extractive activity in terms of enlightened patriots and environmental criminals traitorous to Brazil, corporate mining interests were codified as "us:" legitimate and law-abiding, while *garimpeiros* were codified as "them:" outlaw others bent on destroying Brazil's natural wealth.

To do this, the SIVAM Social Communications Advisory Team developed the mascot of a young, light-skinned Indigenous boy wearing athletic shorts and a Yanomami-esque haircut named Sivamzinho (Little SIVAM). According to Guzmán (2013), the promotional materials

[244] Officer Antunes, Federal Police Officer, interview by author, April 2014

[245] "*Graças ao Programa Calha Norte houve uma acentuada vivificação da faixa de fronteira, com base na presença e na atuação dos Pelotões Especiais de Fronteira (PEF). Não fosse o Calha Norte, que iríamos ter nessa vastidão amazônica? Teríamos Tabatinga, Ipiranga, Vila Bittencourt, depois Cucuí e chegaríamos a Clevelândia do Norte, que já existiam e têm suas origens em fortificações militares. Para os estrategistas, os PEF são hoje, pequenos pontos da "civilização nacional" junto a nossa fronteira, com a esperança de que no futuro se transformem em aglomerados humanos, pequenas vilas, pequenas cidades, municípios, a exemplo do ocorrido com Tabatinga, que há dez, doze anos, era uma colônia militar, e como São Gabriel da Cachoeira, que hoje é uma pujante cidade no Alto Rio Negro com cerca de 40 mil habitantes,"* (Nascimento and Sá 2008, 41).

[246] Brigadeiro Dias (Ministry of Defense in Brasília), interview by author, March 2014

provided the following explanation: "This nice little Indian is Sivamzinho, mascot of the SIVAM project. He's the number one friend of the children of the Amazon." Over a million pieces of pedagogical materials, such as pencils, rulers, posters, calendars, and notebooks, were distributed to schools in the amazon, particularly those sites targeted for the construction of SIVAM infrastructure, and a further five hundred thousand notebooks distributed in Amazonian schools showed Sivamzinho raising the Brazilian flag and singing the national anthem.

This is another case, like that examined in Inner Mongolia, wherein the biopolitical and the geopolitical intersect in the formation of desirable frontier subjects. The military developed a pedagogical project to generate proper affect toward the world's largest environmental surveillance and law enforcement regime. The biopolitical agenda can be seen in the campaign objective to "generate a legion of Sivamzinhos" by connecting with Indigenous children's "love of the land" and "spirit of adventure," across the Amazonian frontier (SIVAM 2008 quoted in Guzmán 2013, 111 – 112). The geopolitical stakes lie in the imperative to convert Indigenous people into assimilated citizens to whom the Brazilian state could then sub-contract the project of rationalizing the Amazonian frontier into a national hinterland, notably through efforts to eliminate small-scale resource exploitation in the interest of eventual industrialization. Toward this end, a series of comics depicted Sivamzinho reporting wrongdoers such as *garimpeiros* and Anglo-European poachers—note the configuration of otherness—to the federal police, and then speaking directly to the reader about his love of the Amazon and his resolve to fight against those who destroy it. There are no comics in which Sivamzinho vilifies mining companies, military bases, or missionaries.

However brazen the attempt to erase the history in which mining industries, with significant assistance from the military, violently displaced Indigenous *garimpeiro* mining activities, this campaign nevertheless succeeded at generating tremendous ambiguities among Indigenous interlocutors concerning their claim to legitimate rare earth mining on their territories. The air of illegality ascribed to small-scale production mixed with the anguish generated by memories of the violence of the 1980s weighs heavily on the psyche of Indigenous mining activists interviewed in São Gabriel, whom, as already noted, are doubly exiled from transnational environmental conservation communities on one hand and from the Brazilian national community on the other by virtue of their desire to mine their own lands. Thus framed, interlocutors expressed a moral conflict between their convictions as to their rights to engage in mining activities on their own lands according to their own terms and their deep moral commitments to preserving the environment.[247]

[247] The conditions of impossibility in which Indigenous mining proponents find themselves calls into question the depth of the critiques of the 'noble savage' in academic and other discourses. If we are serious about deconstructing fixed notions that equate Indigenous people with partial and problematic notions of wilderness stewardship, then we need to be prepared to recognize critical instances of agency as exercised by indigenous people even if such actions upset established epistemological arrangements between 'indigenous people' and 'mining.' As this Chapter shows, such an epistemological arrangement serves state, corporate, and military interventions *contra* local needs and desires for resource-based economic agency.

Conclusion

> "I repeat, Madam President, rare earths are a matter of national sovereignty, whether to provide advances in knowledge, whether for the multiplicity of its uses, including in the defense and oil industry. Therefore, we need a strategic policy to foster its production and prioritize entrepreneurial boldness to process deposits into products that are capable of nourishing the most advanced industries existing in the world today. This is a crucial issue for the future of our country," (Address of Senator Luiz Henrique da Silveira to Plenary Session of the Federal Senate of Brazil, 2013).

This chapter argued that the paradoxes currently characterizing rare earth exploration in Brazil cannot be explained by a simple economic calculus. Long-standing contests over sovereignty and citizenship rights form the heart of the impetus to exploit rare earth elements in the challenging context of the Northwestern Amazon despite the ongoing production of more sustainably produced rare earth oxides in the heartland. This suggests that despite the discourses of neo-extractivism in Brazil in the context of rising BRICS hegemony, strategic resource concerns continue to be powerfully shaped by (post)colonial desires to control the Amazonian frontier.

Although the actual scale of resource extraction at the time of this writing is miniscule—ant-like, in local parlance—the stakes are nevertheless very high. In this place where there is a decades-old moratorium on commercial mining activity, a multitude of national, local, and transnational actors have undertaken regulatory offensives in order to legitimate their particular vision of the ideal political economic conditions of rare earth exploitation. At stake in these multiple regulatory offensives to change existing indigenous and environmental protection laws is how access to and control over geological knowledge of mineral resources is defined. These definitions then determine whether rare earth extraction translates into greater geopolitical control as envisioned by the military, or greater citizenship rights and fuller participation in the Brazilian economy as envisioned by *garimpeiros* and Indigenous activists. In this case in which long-standing territorial anxieties intersect with resurgent resource nationalism, the actual feasibility of rare earth exploitation in such a place is secondary to the ways in which multiple actors imagine it might support various territorial agendas.

The dreams of rare earth elements, the dreams of power and sovereignty imparted by control over their extraction has entangled with ongoing struggles over the meaning of place and entitlements to geological patrimony. Generals, investors, geologists, environmentalists and Indigenous conceive of rare earth elements of *Cabeça do Cachorro* as essential to their visions of the future—however they may differ. Because of this, there is also the recognition that regardless of how rare earth elements are extracted, whomever captures authority over their extraction stands to gain tremendously. Given this, it is possible to see how findings on the high geological incidence of rare earth elements in the region intensified competing territorial contests in the upper reaches of the Rio Negro. This chapter has shown some of the material and meaningful consequences of such dreams; this feature is especially salient in the next chapter.

Chapter Six

Rarer Earth: Extraglobal Extraction

Introduction

As of this writing, no one is actively mining the Moon. At least six national space programs and fifty private firms are intent on figuring out how to do so. The fictions of rare earth scarcity emerging from the 2010 crisis gave lunar mining proponents something specific around which to reframe their cause by invoking the necessity and the apparent scarcity of rare earth elements. Trafficking in fictions, fears, and erroneous assertions made in the face of established facts concerning both international legal conventions and the global rare earth supply, lunar mining proponents have made progress in pulling their cause from the fringes to the mainstream of political discourse and public consciousness.

On 2 February 2015, the UK-based Institute of Physics published an article reporting that with "an abundance of rare-earth elements hidden below its surface, the Moon is a rich ground for mining," (Corfield 2015, n.p.). A few days earlier, *Astrobiology Magazine* ran a story entitled "Earth's moon may not be critical to life," reporting on a five-year-old scientific paper that challenged the theory that the Moon was essential to stabilizing Earth's orbit (Cooper 2015, Lissauer, Barnes, and Chambers 2011). Television and Internet news programs ran stories in January 2015 with the provocative titles, "Is mining the Moon economically feasible?" citing an analysis completed by Cornell professor of astrophysics Ian Crawford and published in *Progress in Physical Geography.* Crawford concluded that the concentrations of rare earth and platinum group elements "might become of economic interest in the longer term," (David 2015, Crawford 2015). Also in January 2015, the *International Business Times*, The *Diplomat*, and many other news sources reported China's plan to mine the Moon for rare earths and to "colonize" it with a lunar base by 2030 (Mortier and Finnis 2015, Osborne 2015, Lang 2015). As with other points along the global rare earth frontier, speculative hyperbole abounds with respect to the Moon. In a BBC interview on the occasion of the successful landing of the China's lunar rover *Jade Rabbit* in 2013, China Academy of Sciences Professor Ouyang Ziyuan stated "the Moon is full of resources – mainly rare earth elements, titanium, and uranium, which the Earth is really short of, and these resources can be used without limitation," (Rincon 2013, 2).

The question of mining the Moon emerged among a specialized group of space engineers, military brass, legal experts and space mavens when the first lunar rock samples were brought back to Earth in 1969 (Wakita, Rey, and Schmitt 1971). But it was not until the 2010 crisis that the possibility garnered greater commercial, political, and popular attention. Promising to capture the niobium, yttrium, and dysprosium "desperately needed on Earth," (ME 2013, n.p.), start-up space mining companies collected billions in investment and government technology-transfer contracts. Indeed, the fiction of rare earth scarcity remains operative, especially in the latest space race. As with the previous chapter, rare earth elements serve as a lens through which to examine the complex array of actors and interests comprising the contemporary race to territorialize the Moon. The politics of geological knowledge production—or more precisely, selenological knowledge production—are constitutive of the multiple approaches to lunar resources examined herein.

Recalling the discussion on the geological formation of rare earth elements from Chapter One, the rare earths found in the KREEP[248] deposits (Shervais and McGee 1999) formed in the

[248] KREEP: K = Potassium, REE = Rare Earth Elements, and P = Phosphorus

lower-gravity context of the Moon as magmas cooled after a Mars-sized object cataclysmically collided with Earth. Immense quantities of debris from the crust and mantle were sent flying into space. Some escaped Earth's gravitational pull, other debris fell back down to Earth, but just enough broke free that it gathered its own mass and gravity yet did not escape the pull of Earth. Spinning through space, glowing molten from the heat of the collision, this material eventually consolidated into the Moon. Still liquefied from the power of the collision, the lower gravity of the Moon left an ocean of magma trapped between the mantle and the crust. This lunar magma cooled very gradually, resulting in the formation of higher concentrated deposits of rare earth elements than typically found on Earth (Heiken, Vaniman, and French 1991). Although there are many minerals on the Moon that could hypothetically serve various Earth-bound endeavors (Taylor and Jakes 1974, Lucey, Taylor, and Malaret 1995, Taylor and Kulcinski 1999), at this current technological moment rare earths are the only ones that could feasibly be brought back from the Moon because they are sufficiently useful and sometimes valuable enough in small quantities. That is why they have been the target of the high-profile Google Lunar X prize—also known as *Moon 2.0*—which will reward the first two private companies to place a robot on the Moon with $30 million (Foundation 2015), and why they featured in the data gathering mission successfully undertaken by China's Jade Rabbit lunar rover in 2013 (Rincon 2013).

This chapter focuses exclusively on the political economy and political ecology of the race to mine rare earths on the Moon. Such a pointed focus would not be possible without the conceptual groundwork laid by the growing body of scholarship engaging the broader theory and significance of contemporary human engagement with outer space. Geographers have argued that outer space is an extension of earthy geographies (Macdonald 2007) co-constituted with the human and biophysical materialities of daily life on Earth (Beery 2011), and is therefore within the sphere of quotidian activity (Klinger and Sayre unpublished). Our familiarity with the cosmos is arguably manifest in our tendencies to explain it in terms of Earth-based metaphors (Lane 2010) and the language of place-making (Messeri 2011); not to mention our increasing reliance on "uplinking and downlinking" (Thrift 2005) with outer space-based technologies, or their importance to contemporary global militarism (Paglen 2008, Gregory 2006b). It is therefore hardly an alien space of transcendence or exception, but is co-extensive with Earth-bound political economies and in fact has been since the Cold War (Gorman and O'Leary 2007). Beery (2011) argued that outer space is not 'the final frontier' of scientific exploration, but rather the latest site of penetration by techno-capitalist markets. Several have written about the privatization of space exploration, particularly in the United States (Solomon 2012, Secretary 2010, Reinstein 1999, Martin 2014).

Theoretically and conceptually, most contemporary social scientists frame outer space in terms of physical extremes (Valentine, Olson, and Battaglia 2009) or as something penetrated or conquered by the tendential expansion of technology, capital and empire (Messeri 2011, Dickens 2007, Paglen 2008). A handful of geographers have explored how outer space is produced and understood, and by whom (Macdonald 2007, Lane 2010, Beery 2012). Parks and Schwoch (2012) as well as Warf (2012) argue that satellites reinscribe power relations on Earth. Cultural anthropologists have examined the sociality of space exploration among space workers (Battaglia 2012, Messeri 2011, Hoeppe 2012), and through human engagements with technology (Vertesi 2012). Organizational theorists propose models for off-Earth colonies (Dudley-Flores and Gangale 2012, Maruyama 1984), and military strategists argue that space control and colonization is both a patriotic and a civilizational necessity (Dolman 2002, Halle 1980) especially as space becomes increasingly “congested, competitive, and contested,” (Harrison 2013). The broader question of capital accumulation on ‘the final frontier’ has been examined by political ecologists (Olson 2012), political economists (Beery 2011, Rathman 1998), sociologists (Dickens 2007) and anthropologists (Valentine 2012). While legal scholars have pondered the statutory possibilities for private property regimes and mining concessions on the Moon (Jr. and N. 1998, Guner 2004, Coffey 2009), social scientists have yet to engage the politics of extension of extractive frontiers beyond our atmosphere.

“Our nearest neighbor” (Cave 1944), the Moon, is the first stop on the race to conquer off-Earth *el dorados*. “Only two days away,” the untouched “lunar treasure chest” is reportedly packed with the resources “desperately needed on Earth” and necessary to fuel human expansion into outer space (Clark 2004, Day 2009). “Our offshore island,” (Ostini 2011) as it has been called, is therefore hardly a space of exception (Blanco and del Valle 2014) insofar as the political economy and political ecology of natural resources are concerned, and especially with respect to expanding circuits of accumulation (Robinson 2004) and the corresponding ambit of resource geopolitics (Le Billon 2004). Nevertheless, the sheer immensity of outer space as well as the relative newness of the expansion of mineral frontiers beyond our atmosphere challenges established global frameworks that have always considered the space beyond our atmosphere to be beyond global concerns. A careful consideration of the earthly philosophies reveals that humanity has had an abiding concern with the cosmos (Jammer 1954); the challenge has been to *recognize* the relationship between global processes, contemporary life, and outer space (Cosgrove 2005) rather than to construct entirely new and different epistemologies. In this sense, I argue that three premises are essential to guide our thinking about mining the Moon:

> (1) Outer space is not an undifferentiated immensity, but a historically produced terrain of more and less valuable spaces;
> (2) A critical political economy of natural resources, emphasizing processes of enclosure, accumulation, production and distribution, is essential to understanding the latest space race, and;
> (3) The contemporary production of outer space is coextensive with Earth-bound resource geopolitics. Outer space is, in fact, an extended battleground for ongoing struggles over resource production and consumption; state-capital relations; and the future of socioecological relations here on Earth, with all of which rare earth elements are inextricably intertwined.

As this chapter demonstrates, the Moon is not so exceptional. Geopolitics have figured significantly in the space race from the end of WWII to date (Gorman and O'Leary 2007). What is new is its relevance to global resource geopolitics and the preponderance of public and private sector actors jockeying to be the first ones to *exploit* the Moon in the name of the greater good. As such it is another point the global rare earth frontier that has emerged not because of actual rare earth scarcity or the economic feasibility of mining this particular place, but because there is much to be gained by territorializing this place that, in fact, has very little to do with the value of actual rare earth deposits. Were scarcity actually the issue, it would be much more reasonable to pursue more robust recycling practices since currently less than 1% of all rare earths consumed are subsequently recycled. That the tremendous, high-profile investment and regulatory offensives to enable private sector lunar mining have been proceeding despite economic, legal, and technological constraints indicates that there is much more at stake than assuaging terrestrial resource scarcity.

As the latest *el dorado,* the Moon is vulnerable to enclosure much in the same way that commons around the globe have been. Section I introduces the private sector actors, means, and justifications for pursuing rare earth mining on the Moon as well as the legal context in which the race to mine the Moon is currently unfolding. Section II analyzes the political economy and political ecology of the private sector space race, highlighting the role of surplus capital and territoriality in the latest race to the Moon. The third section examines the deep connections between the space programs in China and the US; the politics surrounding the launch of China's Jade Rabbit lunar rover in 2013; the debates within China concerning the best approach to lunar resources, and the geopolitical dynamics generated thereby.[249]

I. Mining Rare Earths on the Moon: Who, How, and Why?

> "Most of the elements that are rare on Earth are believed to have originated from space, and are largely on the surface of the Moon. Reaching for the Moon in a new paradigm of commercial economic endeavor is key to unlocking knowledge and resources that will help propel us into our future as a space faring species," (Kohlenberg 2015, n.p.).

This quote, taken from the promotional materials of *Moon Express*, a prominent firm in the race to mine the Moon and contender for the Google Lunar X Prize, conveys confused geology and inaccurately describes the incidence of lunar resources in relation to Earth. As the lack of scientific precision or factual discretion over public pronouncements suggests, the latest race to the Moon differs fundamentally from those in the past simply because of the preponderance of the private sector. In the first lunar race in the 1960s, it was unthinkable that rocket launches would be subject to market competition, or that Moon rovers would be developed by small teams working in start-up offices. After all, the first lunar race was characterized by herculean efforts of global superpowers carried out under top-secret conditions. The contemporary situation is characterized by some crucial differences. This section examines who the primary actors are in the private-sector race to mine the Moon, the legal context in which they are working, and how they attempt to negotiate the technological, economic, and legal hurdles to lunar mining.

For many in the contemporary space race, commercialization is the *only* feasible way to return to the Moon (Eckert 2005, Bakhtian 2009, Peek 2014).[250] In the early 2000s, NASA began to programmatically pursue sub-contracting arrangements amidst threats to its operating budget and growing right-wing hostility toward certain government expenditures. It employed three broad strategies to facilitate private companies' participation. These included holding

[249] The broader epistemological significance of the extension of the global rare earth frontier to outer space is the subject of the article *Extraglobal Scale (Klinger and Sayre unpublished)*

[250] Vice President of Government Relations for Planetary Resources, interview by author, January 2014

competitions around a particular space-faring challenge and offering large cash prizes; supporting a broad institutional framework that privileges these firms by providing infrastructure, liability indemnification, and favorable tax policies, and; offering specific development and demonstration contracts in order to generate market certainty (Culver 2007). While this approach is meant to foster private-sector investment in the space program, it also means that subsequent profits from this immense public outlay remain in the private domain, only available to public programs for a price. This is positively framed as a public-private partnership, which at best allows the government to "achieve certain forms of basic infrastructural maintenance" while opening up the private sector to "new streams of revenue and profit," (Beery 2012, 25). Plainly stated, NASA acts as a patron to private groups of specialists, providing them to with the necessary technological, financial, and political capital to develop technologies and services for which NASA later becomes a customer.

Large giveaways of public funds tend to be the first items eliminated in times of budget cutting, and a $20 Million NASA contest to stimulate private sector lunar exploration capabilities was cut in 2006. Head of the X Prize foundation Peter Diamandis pitched a joint sponsorship to Google Co-founders, to which they agreed. The $30 million Google Lunar X Prize (announced in 2007) emerged out of this context. Had NASA sponsored it, the prize would have only been available to teams from the United States. When Google and the X Prize foundation took it over, they made the contest global and added funds for a second place prize (Koman 2007). Reportedly, however, NASA intended to expand and internationalize the competition by encouraging the European Space Agency and the Japanese Space Agency to offer similar prizes within their jurisdictions.

The current private sector front-runner in the race to mine the Moon, Moon Express, explains it this way: "The opportunity is simply driven by technology. What used to require the unlimited budgets of a superpower are now within reach of a private enterprise...we are going back often, and spending orders of magnitude less to do it," (ME 2015, n.p.). The company proposes to build a "lunar railroad" that "will provide cost-effective exploration and development of Earth's eighth continent." (ME 2013, n.p.). There are several other companies intent on mining lunar resources such as Helium-3 and platinum group metals[251]; however Moon Express is the only one that publicly declares its intention to extract rare earth elements.

There are two primary ideas about what to do with rare earths that are mined from the Moon. The first, by Moon Express, is to robotically process ores and bring partially separated elements back to Earth.[252] The second, by a company interviewed on conditions of anonymity, involves a plan to 3-D print processed minerals into a perforated spheriodal shape composed of

[251] Planetary Resources intends to mine platinum group metals, principally on asteroids. Shackleton Energy Company plans to mine water and convert it into rocket fuel in the form of hydrogen and oxygen. This will essentially be a lunar gas station. Investor Richard Branson, of Virgin fame, reasons that if humanity is to explore the solar system, it needs to do so independent of Earth's resources. Although these initiatives are very important to the larger picture of the contemporary space race, they are nevertheless very different processes from the proposed rare earth mining on the moon, so they are not discussed in this Chapter.
[252] But first, they must land a rover and traverse a distance of five hundred meters, thereby claiming the Google Lunar X Prize, and then broadcast imagery back to earth in order to 'prove the concept' that a company of fifty employees can successfully land on the moon. "Once we accomplish that, then the second or third mission can involve bringing things back from the moon," (Jain quoted in Caminiti 2014).

about seven hundred kilograms of refined mineral to be 'stored' in Earth orbit until it is profitable to introduce them into the global market.

In the first approach, rare earths are intended to be brought back to Earth regardless of market conditions. Perhaps this explains Moon Express' stated commitment to mining rare earth elements on the Moon despite the 2015 liberalization of China's exports. From a business standpoint, Moon Express is not currently concerned about needing to make a return on its lunar mining business. In the near term, it expects to profit from providing transportation service to 'paying customers' who want to set up their own operations—scientific or commercial—on the Moon.[253] In theory, alleviating resource scarcities while moving some of the dirtiest mining enterprises off Earth is an attractive proposal, endorsed by Vatican planetary scientist Brother G.J. Consalmango (Lamb 2010), who has lectured extensively on the ethical considerations of expanded space exploration. Yet if there really are immense reserves of these minerals that can be brought back to Earth, the sudden influx of outer space resources into the global economy could cause commodity prices to crash and create massive unemployment:

> "On the one hand, it's great. You've now taken all of this dirty industry off the surface of the Earth. On the other hand, you've put a whole lot of people out of work. If you've got a robot doing the mining, why not another robot doing the manufacturing? And now you've just put all of China out of work. What are the ethical implications of this kind of major shift?" (Consalmango quoted in Lamb 2010).

According to Moon Express, introducing lunar resources into the global market is intended to deliberately disrupt the global resource economy as we know it, but for the better. The idea, heavily influenced by regular annual immersions in gift economies such as those that coalesce at Burning Man[254], is to innovate our way out of resource scarcity so that a new economy becomes possible: "Once you take away the mind-set of scarcity and replace it with a mind-set of abundance, amazing things can happen here on Earth…The ability to access the resources of the Moon can change the equation dramatically," (Jain quoted in Caminiti 2014). At this point the idea is no more specific than that; basically, it is not their job to worry about the 'after,' they are focused on 'getting humanity to that point.'[255]

The second approach intends to leverage scarcity rather than abundance. It involves a strategy to act as gate-keeper to the 'infinite' resources of outer space by withholding processed minerals from Earth until prices increase enough for lunar goods to be sold at a profit. One lawyer working for the anonymous firm explained that keeping resources in processed form in

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[253] As Moon Express co-founder Bob Richards stated in the San Jose Mercury post: 'The goal is "to build out a transportation business that we think is profitable by itself for scientific and commercial payloads, but also to really start exploring the moon from an entrepreneurial perspective, which has never been done before…It could be $15 (billion) to $20 billion of infrastructure you'd have to put in place to actually economically liberate that wealth," Richards said. "But those kinds of numbers, although big to a startup like us, are not big to existing mining concerns on Earth. Those are the prices of a typical mine, or even an offshore oil platform. If the resources are there, then the economics are there to liberate them."' (Swift 2012)

[254] This is an annual week-long festival that began as a celebration of radical self-expression and situationist art on Baker Beach in San Francisco in the 1980s and migrated to the Black Rock desert of Nevada. The ten principles of the gathering are: radical inclusion, gifting, decommodification, radical self-reliance, radical self-expression, communal effort, civic responsibility, leaving no trace, participation, and immediacy (Burningman.org 2015).
[255] Anonymous NewSpace Industries investor, interview by author, August 2012

Earth orbit would effectively be the same as keeping them locked in a vault on Earth; they could be 'kicked' down[256] and retrieved only at the firm's discretion without breaking any current global trade agreements. The world that fits their vision is one in which humanity has laid such waste to Earth's endowments (or stimulated such runaway inflation) that minerals will cost in excess of $100,000/kg. Even allowing for promised technological improvements that reduce transport costs by an order of magnitude, a $10,000/kg commodity price is hardly anything to aspire to (Jayanthu, Tripathi, and Sandeep 2011). When questioned on this point, a common rebuttal offered by lunar mining advocates is that the vast majority of the resources will eventually only be used in space: to build solar arrays to beam energy back to Earth, to provide building materials for bases and fuel for transport vehicles to enable humanity to access to the mineral bounty of the solar system (Dudley-Flores 2013). In this endeavor, publicly-funded space agencies such as NASA will be "both partner and customer" in "establishing a new paradigm of public-private exploration of the Moon," (ME 2015).

How to conceptualize and regulate exploitation in Outer Space

Legal scholars, astrobiologists, venture capitalists and geographers (Heim 1991, Stone 2007, Helmreich 2009, PR 2012) have employed oceanic metaphors to conceptualize human ideas of, and activities within, the 'complex, four dimensional materiality' (Steinberg 2013) of outer space. Macdonald (2007) proposed considering outer space in terms of the 'recent rediscovery of the sea…not as an undifferentiated emptiness between the land, but as a culturally configured site of knowledge and power.' Outer space mining is not so different from the deep ocean insofar as both are relatively unexplored, pose steep technological and capital barriers to entry, and beckon to capital's expansionist tendencies (Steinberg 2013, Valentine 2012) with an abundance of rare earth elements (Kato et al. 2011, Amah et al. 2012, Jeandel et al. 2013) that might be amassed if only the technological and political obstacles to accessing them could be overcome.

The analogy between outer space and the deep ocean has commercial, legal, and political implications. Many of the legal notes concerning outer space rely on conventions governing the seas and deep seabed (Guner 2004, Heim 1991, Sadeh 2011). Space entrepreneurs and legal scholars draw parallels with the Law of the Sea, but with opposite motivations. Entrepreneurs and their spokespeople tend to conceive of international waters as a free-for-all, wherein "no one really owns the water but any company or country can mine the resources… there is a strong legal precedent and consensus of 'finders keepers' for resources that are liberated through private investment, and the same will be true for the Moon," (Jain quoted in Hennigan 2011). Judging by the frequency with which this sentiment has been repeated by the press and certain politicians over the past few years, it has proven to be a compelling fiction that has helped produce new forms of knowledge around the collective patrimony of Earth's resources.

However, neither resource extraction nor maritime salvage law are governed by the principle of 'finders keepers;' the attempt to construct a parallel between what is actually an archaic, medieval maritime law and contemporary conventions concerning lunar resources is at

[256] The perforated spheroidal shape was conceived in order to limit the amount of element lost to burn-off upon re-entry through Earth's atmosphere to 7 – 10%.

best uninformed and at worst deliberately misleading. In fact, there are a number of internationally agreed-upon rules for ocean exploration. Accessible resources on the ocean floor, outside of special economic zones pertaining to sovereign states, are regulated by the *International Seabed Authority,* to which 159 countries are party, including the US, China, and EU member states. The Authority sets limits on the area of land that can be explored, requires contractors to report on their activities, and most significantly, to relinquish their areas of exploration back to the Authority after eight years (ISA 2013b). While certain space entrepreneurs claim that the legal constraints do not matter because what they are doing is ostensibly for "the benefit of all humanity,"[257] (ME 2013) other scientific and legal experts see the urgent need for a regime governing the proper conduct and use of mining and private exploration technologies in outer space (Reilly II 2013, Salter and Leeson 2014).

These various viewpoints boil down to a difference between the principles of "first rights" and *res communis*[258] (Laver 1986). Proponents of the former are most vocal in Anglophone discourse, arguing that *res communis* is ultimately impracticable because it cannot be enforced (Landry 2013, Hickman 2012), or is "antithetical to the economic development of outer space resources" (Fountain 2003, 1753) because it "fails to create an adequate incentive for space exploration and colonization," (Gruner 2005, 306). Indeed, some fear that it threatens any sort of human progress in outer space: "If humanity hands control of the exploitation of space over to an international political body in an effort to use space development as a wealth-redistribution mechanism, the entire project is likely to fall on its face and there won't be any wealth to redistribute," (Reinstein 1999, 98). Proponents of *res communis* argue that, like Antarctica and the Deep Sea, agreements built around this principle will ensure that such areas are only used for peaceful purposes while guaranteeing their long-term preservation (Heim 1991, Riederer 2014). Furthermore, without a system of checks on the first space-faring nations, global wealth and power inequalities will simply be reproduced in the space age (Reinstein 1999, Frakes 2003, Raclin 1986), therefore it is morally imperative to consider the interests of non-space-faring states when formulating space property law. The current treaties in force require collective action and fairness rather than competition and "first rights."

The primary legal document governing the behavior of states in outer space is the 1967 United Nations' *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (hereafter OST). Signed by 167 countries, this treaty represents a Cold War-era 'gentlemen's agreement' between the United States and Soviet Union to not place weapons of mass destruction in Earth orbit or on the Moon. At the time, the extension of armed conflict into Outer Space would have bankrupted both countries. The OST frames outer space as the "common heritage of all mankind [sic]" and prohibits assertions of national sovereignty "by means of use or occupation, or by any other means," (UN 1967, II). Although the OST has no explicit clauses governing private capital, it includes the following stipulation:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities

[257] Anonymous NewSpace Industries investor, interview by author, August 2012
[258] or the principle of the common heritage of all humanity

> are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty (UN 1967, VI).

Significantly, built on the mutual distrust between the US and USSR, the subsequent paragraph charges Parties to the OST to:

> …inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively (UN 1967, XI).

It is because of this provision to make all findings public that private space enterprises have sufficient selenological data at their disposal. Without decades of publicly disseminated research, it would be impossible to express confidence that they will encounter sufficiently rich deposits of the elements they seek. Selenological knowledge comprises part of the common heritage, therefore the obligation to collaborate in exploration of all types is enshrined in Article I:

> Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

Interlocutors in the U.S. have pointed to this passage in isolation to suggest that it is not necessarily obligatory for private sector firms to share mineral resources captured for economic gain. Furthermore, the fact that the OST explicitly mentions State Parties in this provision has been leveraged by the private space industry to argue that this treaty does not apply to them. But their attempts at the language of exception land them in the language of colonialism: Executive Chairman of Google, Eric Schmidt, and key investor in private sector space industries stated: "the pursuit of resources drove the discovery of America and opened the west. The same drivers still hold true for opening the space frontier," (PR 2012). It has been established that the American West was governed by prior land use customs that settlers refused to recognize or honor (Grinde and Johansen 1995, inter alia); the latest race to mine the Moon is, as demonstrated in the previous section, characterized by a consistent mis-recognition of existing legal conventions. Others likewise argue that exploiting the Moon is fundamentally different than previous resource-driven waves of human expansionism. The late Indian political journalist and filmmaker S Balasubramanian, commenting on the initiative of his compatriot Naveen Jain explained:

> "It is not the same as the colonization of The Gold Coast (Ghana) by the Portuguese and British, subjugating the native residents, or of the D R Congo by the Belgians for diamonds…Moon is just as free and uninhabited as the Antarctic (just a bit further away), and several countries have pitched their tents and hurled their flags in the latter," (Balasubramanian 2011).

This perspective incorrectly assumes that the brutalities and injustices of (post)colonial extractive regimes are confined to the area in which extraction occurs. Resisting such a palimpsestic narrative (Spivak 1988), other states, particularly those whose space programs were not as advanced as the US' or Russia's, saw quite clearly how unregulated space exploration would reproduce colonial relations. Spearheaded by Ecuador, which had been frustrated over the lack of recognition of its sovereign claims to the orbital space above national air space (Beery 2011), several developing countries worked through the UN (1979) to draft the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (hereafter "Moon Treaty").[259] The Moon Treaty strengthened and clarified measures related to lunar resource extraction from the perspective of social progress, development, and equality among all states. The Moon Treaty expresses a commitment to allow all countries to benefit from any space exploration "irrespective of their degree of economic or scientific development," with "due regard paid to the interests of present and future generations as well as the need to promote higher standards of living conditions in accordance with the Charter of the United Nations," (UN 1979, IV.2) In particular, it reinforces the 'common heritage' principle by declaring the that the Moon shall be used exclusively for peaceful purposes, for "promoting international cooperation and mutual understanding…as wide[ly] as possible," (UN 1979, IV.3).

With sixteen Party States, excluding major space-faring powers, many Anglophone commentators have called it a 'dead' treaty. However, it only required five signatories in order to enter into force in international law, which occurred in 1984. In recent years, three new developments indicate that the treaty is assuming greater prominence. Austria, the fifth country to ratify the Moon Agreement, passed domestic legislation in 2011 to attract private sector satellite companies to set up shop within its borders as part of a strategy to help the country achieve space exploration (Listner 2011). Turkey's accession in 2012 suggested a growing strength in numbers around egalitarian use of lunar resources (Turkey 2012, Beldavs 2013). In both the US and in Canada, private citizens have sued multiple levels of government to have their private claims to lunar property recognized (Daly 2012, Jaggard 2009, Sablotne 2012). Courts have thus far dismissed the cases as 'frivolous' and characterized the litigants as 'paranoid,' however these cases raise an interesting issue: these private claims could have been summarily dismissed with a reference to the Moon Treaty, however if the courts of non-signatory States were to comment in any way on existing conventions, that would set a legal precedent, which would provide signatories with significant leverage over non-Party states (Listner 2012).

With respect to the production and the dissemination of selenological knowledge, the Moon Treaty further stipulates that because all states have an equal right to conduct research on celestial bodies, any samples obtained during research activities be made available to all countries and scientific communities for research. But what is especially germane to lunar mining advocates is expansion of the OST statement, that "the Moon and its natural resources are the common heritage of mankind [sic]," (UN 1979, XI.1). The Moon Treaty defines this to mean that:

> Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental

[259] "The Moon Treaty was negotiated in the context of the North-South divide marked by the poverty of developing countries that had votes in the UN and the increasing power of multinational corporations to control economic resources. Space advocacy constituencies in the US saw the Moon Treaty as a power grab by poor developing countries to claim space resources through the power of UN bureaucracies that they did not have the technical means to reach on their own," (Beldavs 2013)

> organization, national organization or non-governmental entity of any natural person. The placement of personnel, space vehicles, equipment, facilities, stations and installation on or below the surface of the Moon, including structures connected with its surface or subsurface, shall not create a right of ownership over the surface or the subsurface of the Moon or any areas thereof (UN 1979, XI.3).

Of further relevance is the injunction to share. In order that each Party to the Agreement may be assured that the activities of other Parties in the exploration and use of the Moon are compatible with treaty provisions:

> … all space vehicles, equipment, facilities, stations and installations on the Moon shall be open to other States Parties. Such States Parties shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited. In pursuance of this article, any State Party may act on its own behalf or with the full or partial assistance of any other State Party or through appropriate international procedures within the framework of the United Nations and in accordance with the Charter (UN 1979, XV.1).

Paragraph five of the same Article charges signatories to:

> …hereby undertake to establish an international régime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible.

In anticipation that eventual exploitation would occur, Article II Paragraph 7 explicitly outlines the structure and purpose of the regime. It is to enforce:

> (a) The orderly and safe development of the natural resources of the Moon;
> (b) The rational management of those resources;
> (c) The expansion of opportunities in the use of those resources;
> (d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries, as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration.

In direct contradiction to this treaty, on 3 February 2015, the United States Federal Aviation Administration issued a memorandum coordinated with the Departments of State, Defense, Commerce and NASA to the effect that they would support U.S. companies' claims to lunar territory through their existing protocols for licensing space launches. Reportedly in order to help businesses protect their assets, the permit would allow for private companies to set up a "habitat on the Moon, and expect to have exclusive rights to that territory – as well as related areas that might be tapped for mining, exploration, and other activities," (Klotz 2015). The reliance of the private sector on the state to secure their actions on the Moon keeps global space politics concentrated at the level of the nation-state, indicating some important continuities with Cold War-era space race. Despite the hedging around government action, and despite the very clear conditions set forth in current international law, private space industries claim that "It's a very wild west kind of mentality and approach right now," and that they do "not see anything, including the Outer Space Treaty, as being a barrier to our initial operations on the Moon," including "the right to bring stuff off the Moon and call it ours," (Thorton and Richards quoted in Klotz 2015).

The CEO and Co-Founder of Moon Express, software billionaire Naveen Jain, claims that his company will offer more "democratic" access to the Moon: "Now that we're shifting from U.S. government-sponsored space exploration to privately funded expeditions, it's important to look at how the resources of the Moon could benefit everyone," (Jain quoted in Caminiti 2014). How, precisely, a private lunar mining venture will overcome technological constraints, capital requirements, and its own profit-maximizing imperatives to make good on their claims to 'benefit all humanity' as opposed to 'paying customers' is a question met with silence in the media and in personal interviews. In that silence, we are forced to acknowledge that the hubbub around *mining* the Moon is a pretext for, or a distraction from, a variety of dissonant agendas broadly concerned with the enclosure of lunar territory. As examined in the next section, these agendas are as simple as providing a few billionaires with a potentially lucrative 'sink' for their current surplus capital (Bort 2014); as dystopic as the desire to maintain national military hegemony at any cost (CM022 2013, Honkova 2013, Dolman 2002); and as cynical as to provide a distraction from intensifying inequalities and injustices at home (UN 2014).

II. Political Economy, Political Ecology, and the State in Outer Space

One outcome of the spectacular growth of inequality in recent years has been the creation of greater numbers of billionaire capitalists (Bagchi and Svenjar 2014). Billionaire capitalists need somewhere to put their money to avoid a crisis of accumulation[260] (Harvey 2005). Building on Harvey's (2003) work, sociologists Dickens and Ormrod (2007) elaborated the concept of the "outer spatial fix" to capture the process through which capital seeks to overcome periodic crisis by drawing new raw materials, territories, and markets into the capitalist system. In the same way that capitalist societies resort to imperialism to alleviate crises of over/under accumulation, an elite group of spectacularly wealthy financiers, industrialists, and entrepreneurs are using private space mining companies as a "sink" (Harvey 2006) for their surplus capital, drawing together dot-com billionaires, heirs to private fortunes, idealistic young engineers and seasoned NASA professionals to "ignite a new industrial age" (Dolman 2002) beyond Earth. Extreme privilege combined with the cultural capital surrounding space-related endeavors generates a kind of evangelical zeal that manifests in the near-complete inability of space investors to handle deeper questions about their projects. Anyone critical is simply lacking vision, is not bold enough, or does not understand the importance of space exploration.

But one need not forfeit their love of space exploration in order to pose some urgently important questions about where all of this is heading, and if mining rare earth elements on the Moon actually has anything to do with making life better for everyone. After all, what are we to make of an endeavor that insists on propagating fictions of lawlessness and resource exhaustion in order to advance its agenda? It is a strange approach: to predicate the success of space-faring enterprise—which is perhaps the most iconic example of advanced human capabilities—on the incapacity of humans to figure out how to live responsibly on Earth. While these endeavors

[260] Moscow venture capitalist Ilya Glubovich reportedly began "chasing down" space startups in Russia in 2013, saying "I want to give you money. Where are things right now?" (Bort 2014)

promise fundamental transformations in how resources are produced and consumed, they are betting on the durability of the current unsustainable political economic status quo.

Only loosely regulated and currently free from clearly enforceable social and environmental accountability requirements (Listner 2012), the Moon seems to represent the ultimate terrain of capitalist freedom (Brennan and Vecchi 2011). Framing it as the common heritage of all humankind intensifies rather than attenuates this appeal: Tsing (2005) explored the ways in which the 'global,' when conceived as an abstract totality belonging to no one, functions to recast spaces, whatever their history, as underutilized 'commons' eligible for enclosure and de facto privatization. Beery (2011) argues, similarly, that while the explicit prohibition on claims of national sovereignty placed important limits on a Cold War-era imperialist turn in the space race, enshrining outer space as belonging to everyone was tantamount to decreeing that it belongs to none, which left it vulnerable to processes of enclosure, primitive accumulation, and rapacious exploitation that have characterized the fates of commons across the globe as they have been incorporated into expanding circuits of capital.

In light of these developments, a political economy and political ecology of lunar mining is not as strange as one might initially expect. Like the political economy of natural resources on Earth, the political economy of outer space hinges on questions of property rights, financing and legal mechanisms, the (post)colonial politics of labor and reproduction, and broader ethical questions such as distribution of decision-making power, risk, and vulnerability. An especially salient feature of private sector space mining companies is the continuation of Cold War-era race and gender politics of space exploration to the present. The demographics of the emergent private sector space companies are considerably more homogenous than those of NASA, for example, which has made considerable progress correcting racist and misogynistic hiring practices in the past two decades.[261] The production of outer space is also raced and sexed insofar as the question of *who* is vested with the decision-making power to determine *how* outer space is explored *for the benefit of whom* is inseparable from contemporary power relations which privilege some and foreclose life chances for others on the basis of race, gender, and class.

The political ecology of lunar mining turns on the materiality of rare earth production and consumption as well as their discursive framing under competing extractive regimes and territorial agendas. Other geographers have shown how the latest space race is historically intertwined with processes of enclosure (Beery 2011, Parks and Schwoch 2012) imperialism (Paglen 2008), and colonialism (e.g. Dolman 2002, Autry 2011). Especially salient is the colonial frontier imaginary: the case for mining the Moon is predicated on discourses of over-regulation and resource scarcity *here* in contrast to regulatory freedom and unclaimed, 'infinite' (Larson 2014) resources *there*. Behind these discourses of potentially infinite resources lies a fundamental geographical principle: some are closer than others. Therefore outer space has a real estate: some sites, routes, and resources are more valuable than others, particularly those close to Earth. The Moon is closest to Earth and therefore most valuable. One legal scholar notes:

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[261] 2013 was the first year in which women formed half of the newly selected astronaut candidates. A third of NASA civilian employees are women. The disparity grows with specialization: of the 11,429 scientists and engineers employed by NASA, only 2,570 are women (NASA, 2012). These numbers reflect differences in opportunities to pursue advanced STEM degrees which continue to cleave along lines of race, class, and gender in the US (Burke and Mattis, 2007).

> "Space may be vast, but many of the most valuable resources—especially those convenient to Earth—are limited. Our Moon is one example. It may be one of the most promising sites for mining, energy capture, and spaceship refueling, but a limited amount of usable land exists, with an even more limited quantity of usable water…in truth, every resource is limited. The question, then, is who, if anyone, should have the rights to the riches or space?" (Reinstein 1999, 64 - 65)

Claims to the Moon date back several centuries. One German claims that his family has owned the Moon since 1756, when the Prussian King Frederick the Great granted his ancestor the Moon as a token of gratitude (CNN 2000); a Chicago man registered ownership of the Moon with the Recorder of Deeds and Titles of Cook County, Illinois in 1949 (SI 1949); and in recent years a few entrepreneurs have become millionaires by selling lunar real estate in single-acre parcels (Davidson 2007). Regardless of existing legal conventions explicitly prohibiting the appropriation of any part of outer space to the exclusion of others, in practice the current race is driven by visions of the economic and geopolitical power to be gained by being the first to capture off-Earth resources.

Despite the recent push to mine the Moon, a tremendous amount of political capital is still needed to actualize it in such a way that does not lead to international conflict. Thus far the most widely deployed narrative is that of rare earth scarcity, which has been critically deconstructed in other chapters. Some scarcity narratives are nefarious, predicting species self-destruction through environmental holocaust or nuclear war (Oneill 2000); others revive Malthusian paranoia, warning that we are headed for population-induced disaster if we fail to tap off-Earth resources (Guner 2004 *inter alia*). The imagined socio-ecological futures under which lunar mining makes political economic sense leverages potent environmental, military, and elite economic anxieties that a growing human population will eventually lead to resource exhaustion. This framing then sets up a moral imperative to find and acquire those "resources desperately needed on Earth," (Day 2009) lest we meet our demise in population-induced starvation (Guner 2004) and the accompanying general breakdown of civilization from which we could only be saved by a military takeover to ensure the transition of "those most capably endowed" humans to colonies off the planet (Dolman 2002). No matter what environmental conservation efforts we make now, we are "only prolonging the ecological endgame for life on Earth," (Autry 2011, 2).

Another, less common variation of the environmental apocalypse narrative argues for developing the capacity to mine in outer space to be prepared for the eventual planetary 'fortress conservation,' (cf. Neumann 1998). Moving dirty industry "off-world" will be necessary once environmental crisis reaches such a point that the global economy is "locked-down" in the name of environmental protection (Lamb 2010). In both framings, investors and private space advocates conflate the infinite expanse of the cosmos with infinite possibilities of accumulation that will be enhanced, rather than threatened, by forfeiture of Earth's biosphere. The only real solution is to formulate an "exit strategy" (Valentine, 2012) to offload humans from the planet (Oneill, 2000). Whomever is in place to facilitate this process will profit enormously. This dystopic fantasy would not be worth out attentions were it not for the significant minority of scholars, policymakers, and billionaires betting on the inevitability of environmental apocalypse as an impetus to lunar exploitation and militarization. However, the apocalyptic socio-ecological imaginaries required to legitimate lunar exploitation clash with the cornucopian promise ready to be enjoyed with today's technologies; progress narratives envisioning human evolution in space do not cohere with the incapacity of humanity to avoid fouling Earth beyond repair. This indicates that the various pushes to mine the Moon do not form a coherent story, which Couldry (2012) and Sparke (2009) have shown is productive for, rather than contradictory to, the expansion of neoliberal logic. Conspicuous among their arguments is a marked inability to see beyond the current global political economic status quo; lending further weight to Žižek's (2012, 1) observation that: "it seems easier to imagine the 'end of the world' rather than a far more modest change in the mode of production, as if liberal capitalism is the 'real' that will somehow survive even under conditions of ecological catastrophe."

Whither the state?

Advocates of privatized space exploitation have a schizophrenic relationship to the state. Civilian space exploration is denigrated as too slow, (Wingo, Spudis, and Woodcock 2009) and bogged down in bureaucracy, which inhibits the fantastic innovation potential building in the private sector (Jones 2013b) where the *true* public resides (Day 2009). Such claims ignore the pivotal role of the state in assuming risk and reducing the barriers to entry by transferring technology, expertise, and millions of dollars of public wealth. These private initiatives rely heavily on the legitimacy, technology, personnel, and legal indemnity conferred by association with NASA and other government agencies, yet private industry seems unable to argue for its activities without mischaracterizing the role of its public benefactor.

What seems clear is that the private sector interlocutors are betting on maximum possible support and minimal regulatory intervention from the public sector, which effectively translates into massive transfers of public wealth while reducing oversight mechanisms concerning the use of that wealth. Leyshon and Thrift (2007) *inter alia* have written extensively on the relationship between the 'retreat of the state' and the financialization of everything under contemporary neoliberalism; the commercialization of lunar resources is one logical outcome of such processes. But this is not a case simply of *de*regulation, but also of *re*regulation. The truth is that, without government space programs acting "as both partner and customer" (ME 2015) to emerging private sector, this commercialization of space would not be possible. The proliferation of commercial space agencies represents not a 'retreat' of the state per se, but rather a reconfiguration of state functions to support a program of redistributing public assets into the private sector. Indeed, the most vociferous political, public, and legal opinion holds that the private sector should lead the way, that "the government should focus on its role as enabler," (Whitehorn 2005). This, overwhelmingly, has been compatible with the approach of the US government since the end of the Cold War (Congress, 1998). The recent memoranda released by the FAA affirms that the US Government is prepared to put its authority behind territorial claims made by the private sector to lunar resources; the dismantling of international law requires an assertion of national state power to actualize. As of this writing, this is the first official declaration of such intent made by any national government.

State-funded space programs remain the preponderant force in the race to mine rare earths on the Moon. For example, in October 2014 the Russian Federal Space Agency jointly unveiled a \$2.5 billion plan with the Russian Academy of Sciences and the Sternberg Astronomical Institute to resume lunar exploration in 2016 with the purpose of bringing unprocessed lunar rocks back to Earth for resource extraction as well as extensive scientific analysis (Jamasmie 2014). Vladislav Shevchenko, Sternberg Institute's head of the Department of Lunar and Planetary Research stated: "We think that the lunar surface contains enough rare earth metal. On Earth, reserves of cerium, lanthanum, neodymium, praseodymium and other metals that are primarily used in the manufacture of high-tech products have dwindled. China currently has the monopoly on this market," (Shevchenko quoted in Ter-Ghazaryan 2014). In Russia's case, promoting lunar mining of rare earths is pitched as a strategy to recruit the nascent domestic commercial space sector by enhancing the economic appeal of developing a manned lunar base (Blosser 2014) in a bid to encourage the growth of a commercial space sector in Russia. In fact, NASA, the European Space Agency, and the Indian Space Research Organization have all announced plans to pursue lunar mining in collaboration with the private sector.

But the materialities of mining are such that it is not possible to extract rare earths while upholding the provisions of the OST. Therefore state promotion of the private sector in pursuit of lunar mining closely resembles the case reviewed in Brazil, in the previous chapter, wherein the private sector executes the territorial agenda of the state, even if of questionable legality, with the force and backing of the central government. In the case of the Moon, the stakes of the state investment in private sector investment are different. Under the terms of the treaty—to which all state actors advancing space mining are party—any mineral they extract from the Moon would have to be distributed in a way that is 'to the benefit of all peoples' on Earth. States would not be able to pursue lunar mining without fundamentally changing the global political economy of resource production and consumption—the terms of the OST have made it thus. Any state doing otherwise would clearly be operating in conditions of impunity. But by insisting on a false premise of legal ambiguity at best and 'chaos' at worst (Whittington 2013), private sector actors can 'do the dirty work' of the state,[262] until such time that the law changes or other Parties acquiesce to violation as the new norm. However, this public-private collusion to recast lunar space as one of exception is not the only approach to accessing lunar resources. With the successful landing of its lunar rover in 2013, China's National Space Agency is the most advanced in the race to mine rare earths on the Moon.

III. The Jade Rabbit: Intrigue, Selenological Exploration, and Geopolitics

In 2003, China became the third country to successfully send a human into space, but its space program shares its origins with the establishment of military-industrial rare earth production in the context of mid-20th century Cold War global politics. Although a government bureau, state-owned enterprises, and specialized domestic firms are all engaged in China's space program, domestic and international discourse unambiguously frames exploration as a national endeavor. The Ministry of Industry and Information Technology[263] is responsible for China's National Space Administration[264]. The array of entities developing China's space program are jointly overseen by CNSA and the state-owned enterprise China Aerospace Corporation, both of which are subordinate to the State Administration for Science, Technology and Industry for

[262] This dynamic has been examined with respect to defense contractors working in contemporary U.S. militarism (Gregory 2006a, Alexandra, Baker, and Caparini 2008, Menkhaus 2003)

[263] which also overseas China's rare earth sector

[264]国家航天局, literally the National Astronautics Bureau.

National Defense.[265] CNSA has active agreements with over a dozen countries and several multilateral space exploration organizations.

Intrigue

Because of the essential role of rare earth alloys in space and missile defense technologies, the hinterland industrialization, rare earth research, atomic aspirations and national space program were closely intertwined in the PRC's founding policy, scientific, and military institutions. Like China's rare earth sector, the country's space program was fundamentally shaped by Cold War politics. The antecedents for China's contemporary space program date back to the height of Sino-Soviet cooperation, with the establishment of the Fifth Academy of the National Defense Ministry in 1956.

The State Council appointed Qian Xuesen as the first director of the Fifth Academy, who had been a founding member of the Jet Propulsion Laboratory (JPL) of the California Institute of Technology in 1936. During WWII, Qian advised the Allied Powers on ballistic-missile guidance technology (Wines 2009). At the end of WWII, he was granted the temporary rank of lieutenant colonel in the US Army to debrief Nazi scientists, including Werner von Braun, [266] was part of the team that analyzed Germany's V-2 rocket facilities and recovered some three million pages, or 1500 tonnes, or technical papers. In these papers, he found that his theories of supersonic flow had already been tested and confirmed in German wind tunnels during the war. Such facilities had not been developed in the United States at that time. From his interviews and research, Qian published *Survey of the Development of Liquid Rockets in Germany and Their Future Prospects* and an 800-page manual on jet propulsion, known as the 'classified technical bible' for post-WWII aircraft and rocket development (Wade 2008). All of this paved the way for space vehicle development in the US.

Qian pioneered US rocket technology as the Robert H. Goddard Professor and head of the Daniel and Florence Guggenheim Jet Propulsion Center, by spearheading the technological breakthroughs that helped the United States transition from propeller to jet-powered aircraft. He was part of a small group of experimental rocket scientists known as the Suicide Squad (Noland 2009). But during the second red scare, he was accused of having communist sympathies and placed under a delayed deportation order in 1950 (Technology 2011). Stripped of his security clearance with no further career prospects in McCarthyist America, he decided not to fight deportation and to return to China despite the interventions of his colleagues and administrative superiors at Caltech. He was unable to leave, however, and was held under house arrest for five years until the US and China brokered a prisoner exchange (Noland 2009).[267] In 1955, Qian was released in exchange for eleven US airmen captured during the Korean War (AP 1955). To avoid charges of espionage, he deliberately left behind all of his research notes and papers (Wines

[265] The State Council appoints its administrators. The Eighth national People's Congress established it in its current form in 1993 in order to fulfill the country's mandate to cooperate internationally in scientific research and technological development.
[266] "No one then knew that the father of the future U.S. space program was being quizzed by the father of the future Chinese space program," (Perret and Asker 2007).
[267] "I do not plan to come back," Qian told reporters. "I have no reason to come back. . . . I plan to do my best to help the Chinese people build up the nation to where they can live with dignity and happiness." (Noland 2009)

2009).[268] Qian oversaw the launch of the first Chinese R-2 Missile in 1960, founded the Space Flight Medical Research Center in 1968 to prepare for manned space flights, launched China's first satellite in 1970,[269] and developed in 1972 the Long March rockets used in all subsequent spaceflights (Wade 2008). He was credited with helping China develop intercontinental ballistic missiles, China's first several satellites, the technology that paved the way for China to put a person in space in 2003 and launch its lunar orbital program in 2007 (Marble 2010). The space programs of both China and the United States are deeply indebted to Qian Xuesen's work.

Selenological Exploration

Although geochemical analysis of lunar rock and meteorite samples containing rare earth elements were first published in Chinese scientific journals in 1986 (Zhang 1986), China's selenological activities entered a new era with the successful deployment of the Jade Rabbit lunar rover.[270] The mission objective was to achieve China's first soft landing and surface exploration, gather selenological data, and provide a basis, through technological demonstration, upon which to develop key technologies for future missions, including a rock sample return mission in 2017 (O'Neill 2013). The Jade Rabbit carried twenty kilograms of instruments intended to "achieve lunar shallow structure profiling, long period observation of astronomical variable-source brightness, Earth plasma detection and other scientific tasks," (Sun, Jia, and Zhang 2013, 2708). These included ground-penetrating radar and spectrometers in order to inspect the composition of the soil and the lunar crust. Composed primarily of new, exclusively Chinese technologies,[271] the Jade Rabbit mission was explicitly framed not as a bid to join the 'lunar landing club' but to advance scientific exploration and human knowledge about a relatively unexplored area of the Moon. Toward that end, CNSA and the European Space Agency signed a mutual support agreement which allows the two agencies to use each other's findings and technological infrastructure (Xiong 2013).

The Jade Rabbit was launched on 1 December 2013 aboard Long March 3B rockets. It achieved lunar orbit on 6 December, and landed on 14 December (Xinhua 2013a). It transmitted images of the lunar surface back to Beijing command center on 15 December before embarking on a three month natural resources survey, which was cut short due to technical failures (Xinhua 2013b). As of the time of this writing, the Jade Rabbit's findings have not been published.

Geopolitics

Meanwhile, three discourses have since emerged in China concerning rare earths on the Moon. Just as there are debates concerning our future in outer space in Anglophone literature,

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[268] When his close friend and colleague, Frank Marble, tried to return the two file-cabinets' worth of papers and notes to Qian in 1981, Qian reportedly said "Frank, American students need them much more than Chinese students," (Marble 2010).

[269] As discussed in Chapter two, the imperative to develop the domestic rare earth metallurgical technology to support China's missile programs stimulated investment in China's rare earths sector.

[270] Jointly developed by the Shanghai Aerospace System Engineering Institute and the Beijing Institute of Spacecraft System Engineering, the project began in 2002 and was completed in May 2010 (Xinhua 2008).

[271] China's rare earth news wires reported that over a thousand of the components of the Jade Rabbit rover were composed of domestic rare earth alloy technology that had been developed specifically for the space program (SHRE 2014).

there are likewise debates in China over whether to pursue scientific lunar exploration under the terms of the OST; to develop mining capability for eventual extraction; or to exploit the Moon as quickly as possible in order to capture geopolitical advantage. In the first discourse, Sinophone scientific literature emphasizes the importance of rare earth exploration on the lunar surface because differentiations among certain concentrated arrangements of rare earths tell an as yet poorly understood story of the formation of the Moon (Guo et al. 2014). Furthermore, the leading scientific authority on lunar resources in China, Dr. Ouyang Ziyuan, emphasized that the purpose of selenological exploration is "not only for the meaningful understanding of the Moon itself, but also to help understand and explore other planets in the solar system, particularly the formation and evolution of the Earth," (Ouyang and Liu 2014, 5). At present, this is the discourse that is translated to other languages and propagated internationally. In an effort to avoid any diplomatic tension over China's advances, the central government has repeatedly framed its pursuit of outer space exploration in the spirit of international cooperation. As one piece in *Xinhua* stated:

> Space exploration is the cause of mankind, not just "the patent" of a certain country. China will share the achievements of its lunar exploration with the whole world and use them to benefit humanity […] all data […] will be open to the whole world. China's lunar exploration provides an opportunity for countries dedicated to peaceful use of outer space to advance space technology together (Xiong 2013, n.p.).

In the second discourse, domestic state media frames rare earth mining on the Moon as a *possibility*, reasoning that although China's rare earth magnets industry is in its infancy, eventually the country's efforts to meet growing market demand and identify new resources will require China to exploit lunar rare earths *if* there are not other breakthroughs in the meantime that would render such a mining expedition unnecessary (CEIN 2013).[272] This discourse most closely resembles the realist sentiment expressed by planetary scientists in Anglophone literature whom are nevertheless committed to 'keep an open mind' to the possibility of lunar exploitation (Crawford 2015). The third and most bellicose discourse maintains that mining critical materials on the Moon is a sure way for China to overcome the measures that the US and Japan have allegedly taken in order to undermine and contain China's rise:

> 'The rich…rare earth, uranium and thorium resources on the Moon can ease China's energy crisis, maintain the status of China as a rare earth power, and facilitate the rapid development of China's aerospace technology…China now has "first-strike capability" on lunar mineral development,'[273] (CM022 2013, n.p.).

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[272] "稀土钕铁硼是朝阳产业，将有越来越多的行业对其保持旺盛需求，中国正在加紧探索新的资源产地，尽力满足日益扩大的市场需求，促进我国经济持续、稳健的发展。预计在未来某一天，我们也将用上来自月球的稀土资源. " (CEIN 2013).

[273]"美国试图通过对中国实施能源及粮食的围堵以达到扼制中国发展的目的。对于粮食，中国可以通过自力更生的办法加以解决，但对于能源，在没有外援的情况下中国是无法通过自身的努力加以解决的，这就为美日的围堵创造了条件，而中国探月工程的成功，有望使这个问题迎刃而解，因为月球上富含氦-3 和太阳能等潜在能源及钛、稀土、铀和钍等矿产资源，不仅可以缓解中国的能源危机，而且可保持中国稀土大国的地位经久不衰, 从中国高速发展的航天技术水平来看, 中国在矿产开发和能源利用等方面具有在月球上先下手为强的可能. "(CM022 2013, n.p.).

Observers in the Anglophone world have interpreted China's lunar exploration in geopolitical terms, framing the science as secondary. Reflecting broader US anxieties over losing supremacy in a global geopolitical order, the Chair of NASA's Lunar Exploration Analysis Group commented:

> "[China's] lunar exploration, while trying to do some science, is more focused on the geopolitical theatre. They are demonstrating that they have the technical capability of doing the most sophisticated deep-space activities. They have a program, and they can keep to the schedule and accomplish mission goals on time," while "the United States has been floundering around for decades, trying to figure out what to do," (Plescia quoted in David 2014).

Building on longer term colonial and post-war struggles between globalized territorial orders, this is a struggle over who gets to act in the name of the greater good: whose activities are recognized as science and whose activities are construed as trespass. Rather than review the immense array of paranoid, racist, saber-rattling discourses that proliferated in Anglophone literature following the deployment of the Jade Rabbit, suffice it to say that the fixation on China's achievements in space exploration as threat to the United States or the European Union serves to shift the debate from substantive questions on *whom* should undertake lunar exploration *toward what ends*—concerns which are in fact shared across Anglophone and Sinophone discourses—to a narrowly focused one of 'how can we beat China?'(Whittington 2013). This generates a "by any means necessary" (Tadjeh 2014, n.p.) approach that leaves private sector, and in fact illegal, approaches uninterrogated. For example, billionaire space entrepreneur Robert Bigelow has successfully ignited a territorial race between the US and China, stating:

> "The big danger here isn't a fear of private enterprise owning and maximizing profitable benefit from the Moon," he said. "The big worry is America is asleep and does nothing, while China comes along, lands people on the Moon, and decides, 'We might as well start surveying and laying claim, because who is going to stop us?'" (Bigelow quoted in Wells 2013).

Bigelow's discourse got results. The 3 February 2015 FAA memo declaring US Federal Government support for private claims to the Moon was in fact addressed to him (Chang 2015). The soundest geopolitical analysis on China's lunar activities to date comes from Greg Kulacki, the head of the China program at the Union of Concerned Scientists. Because China's central government values its satellites and prizes outer space research as a measure of national progress, it is implausible that China's space program would undertake an activity to provoke an attack on its space assets. Basically, those whom have attempted to characterize China's advances in outer space as an asymmetric space warfare strategy, generally in an effort to justify greater military expenditures in the United States (e.g. Cheng 2011a) have fundamentally misread China's intentions. According to Kulacki, "the strategic objective of China's space policy is not to exploit asymmetry between China and the United States, but to end it," (Kulacki 2014, 11). While the drive to capture resources and occupy a leadership position in lunar exploration is certainly a driving motivation of China's space program, it is extremely unlikely that China would make a lunar land grab, given the likelihood of serious international conflict that would result.

Indeed, the form and purpose of lunar exploration is a matter of ongoing debate among states, private sector actors, and civilian scientists across the globe. Private space advocates whom insist that legal conventions governing outer space do not exist are opening a Pandora's box that the 1967 OST was explicitly designed to keep closed. By interpellating outer space as a new 'wild west,' they have helped revive the weaponization of outer space. Although Russia and China have submitted several drafts of a new *Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force Against Outer Space Objects*, the United States' UN delegate has voted against it every time, calling it a "diplomatic ploy to gain military advantage," (Hu 2014). Insisting that there are no rules eventually makes it so.

Conclusion

This chapter has argued that what is new about the political economy and political ecology of lunar rare earth politics is the relevance of 'our nearest neighbor' to global resource geopolitics as well as the preponderance of private and public sector actors competing to lay claim to lunar territory and minerals. Because rare earth mining on the Moon is as yet a prospective possibility, the discursive, ideological, and legal project of rendering a legally protected and collectively held place into a 'wild west' frontier for accumulation and enclosure is especially vivid. By reviewing the way in which private sector actors discursively frame their activities in an effort to negate basic facts of contemporary legal regimes and actual abundance of global rare earth resources, this chapter has demonstrated the complicated role that the race to mine rare earths on the Moon plays in contemporary struggles over the definition of human activity in outer space. These debates range from scientific and humanistic to aggressively militaristic in both Anglophone and Sinophone literature.

Although doomsday scenarios generated by China's monopoly have proven useful to generate broader public support for lunar mining, these venture capitalists, military enthusiasts, and space futurists have overlooked the fact that rather than going to the Moon, we could simply implement proven rare earth recycling techniques here on Earth (Meyer 2011). This would pre-empt many of the scarcity scenarios lunar mining purports to resolve. If rare earth scarcity were really the issue, a massive untapped frontier is much closer than the Moon: currently, less than 1% of all REEs are recycled (Molycorp 2013). Even now, the fiction that rare earths are not only rare but dwindling (Corfield 2015) remains productive.

Part IV:

Conclusion and Appendix

Conclusion

The previous chapters have presented the historical and empirical production of each of the sites, examining in particular the intersection of geological, political economic, and (post/neo)colonial rationalities in the (de/re)territorializations of Baotou, São Gabriel da Cachoeira, and the Moon on the global rare earth frontier. Recalling that rare earth elements are both material and discursive phenomena, this work has been concerned with the frontier as defined by the mined and to-be-mined: particularly how and why, from amongst the hundreds of places endowed with rare earth deposits, have the sites examined herein emerged? As shown, the geophysical, geopolitical, fictive and discursive properties of rare earth elements are all essential to understanding the emergence of the frontier cases examined herein. Chapter one defined rare earths and advanced a world-historical analysis of their entanglements with global politics following their discoveries. Chapters two and three showed how they 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-urbanization project was essential for laying the foundation on which China's monopoly later emerged. Chapter four analyzed the 2010 crisis and its aftermath by identifying the ways in which a sudden shock to the global market drew unprecedented attention to transformations in extractive policy and practice in Baotou and Bayan Obo, which then precipitated dramatic spatial transformations in other parts of the world. Chapter five discussed 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 six showed how fictions about rare earth scarcity continue to be productively mobilized as a justification to revive the space race beyond the bounds of existing international law mandating peaceful and collectivist uses of lunar resources.

Theories of the frontier in practice

This concluding chapter discusses several key ways in which the three sites enrich our notions of 'the frontier' as an operative spatial category and potent geographical imaginary. 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 no 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. Various efforts to impose borders ranged from genocidal to civilizing 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 extra-local actors.

Importantly, these spaces are not as empty as territorial powers would claim. All three spaces are occupied — if not with people, then with transnationally held meanings anathema to enclosure for large-scale mining. But they are also far from 'centers of calculation' (Latour 1987). This feature explains 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 two and five 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. Furthermore, if we take the idea of frontiers as epistemological constructions seriously, then where the frontier is said to lie is a very clear spatial indication of power's idea of its own limits. The cases show that there is an obverse side to this dynamic, wherein inhabitants within the frontier region (as in Greenland and São Gabriel da Cachoeira) sought to leverage the imposition of the frontier signifier as a way to gain greater recognition, in the global economy, or as legitimate citizens, respectively.

It is important to note that although the ascribed marginalities of these places is fundamental to the reconfiguration of these spaces into sites of exploration extraction along the global rare earth frontier, such marginality is not given *a priori*; the marginality of these frontier spaces was *produced* through territorial exercises of imperial, colonial, and state powers over time. Then, as now, rare earth prospecting and mining has always proceeded in accordance with multiple systems of domination. Furthermore, as examined in Chapter four, Baotou, São Gabriel da Cachoeira and the Moon are not the only sites at which geological knowledge, national development, and speculative hyperbole are invoked in efforts to enforce an extractive regime, which, after even the most basic analysis, makes very little economic sense. But within their distinctive attributes, Baotou, São Gabriel da Cachoeira, and the Moon convey a fuller picture of the workings of global political economy and political ecology than hemispheric constraints or 'center-periphery' models might otherwise allow. This is particularly significant for understanding how extractive geographies are produced on a global scale — in the case of the global rare earth frontier, sites are identified and brought into production for reasons entangled with, yet for all practical purposes only marginally related to, local geology.

Thus the geography and history of geological prospecting on a global scale serves as a spatial transcript of contests among aspiring hegemons. While 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 has been an act of power, and contests over its meaning have defined struggles between local and extralocal interests over the last several decades. 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 WWII, and later under the military dictatorship before such activities were outlawed in the 1980s and 1990s. Importantly, localized geological knowledge production continued despite changing legal regimes. As indicated by the ongoing struggles of indigenous *garimpeiros* on one hand and the continued conferral of mining permits by DNPM, the criminalization of activities essential to the production of geological knowledge was not enough to stop them. As for the production of selenological knowledge, the geopolitical anxieties circulating in Anglophone discourse surrounding the Jade Rabbit mission show that, in addition to political motivations that may undergird prospecting efforts, the very act of scientific exploration can be politicized by one party insisting on framing the other party's activities as trespass, regardless of the fact that such activities are entirely in compliance with existing international treaties.

This indicates that invocation of 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. Perhaps this is why, following the failure of decades of national integration and infrastructure construction campaigns in Cabeça do Cachorro, President Figueiredo designated portions of the region with considerable geological wealth as Biological Reserves: if large-scale state capitalist interests 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. 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-20th century conservationism and state custodialism reign.

But as with any reigning power, political economies at the level of everyday life are much more complex. The frontier must be enacted, and a person's idea about what that means differs according to their positionality. In São Gabriel da Cachoeira, this is especially visible in the brutal policing and draconian penalization of small-scale indigenous miners despite corporate dependence on *garimpeiro* activity, and broad support on the part of certain state actors in support of small-scale mining. In Baotou, as noted in Chapter three, 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 and priorities. This helps explain the 'elasticity' of frontier spaces, where local actors maintain an apparently looser relationship to law and order by selectively reinterpreting and incorporating broader political changes into everyday practice (Weizmann 2007).

While this dynamic can be particularly pronounced in frontier spaces, the fact that comparable negotiations with legal regimes occur among differing frontier subjectivities in two places with radically different levels of state presence and surveillance indicates that normative visions formulated by extra-local interests and codified into law contradict too starkly with local values and political economies for compliance to be possible, *even* when local 'lawbreakers' identify their actions strongly with the state. In the case of São Gabriel, enacting the state's solution to the frontier problem would mean the erasure of contemporary indigenous economic agency and basic recognition of the realities of local livelihood necessity. In the cases in which local officials around Baotou and Bayan Obo sanction clandestine mining, enacting the national mandate to consolidate production is understood to mean undermining local livelihoods and national security. Eliminating the employment of those in the now illegal or black-market mines would leave national defense industries malnourished when output from the Bayan Obo mine fails to keep defense industries operating at capacity. In both cases, illegality occurs because compliance would mean capitulating to hunger in some form—bodily or industrial—so compliance is untenable. From the standpoint of the policies concerned, however, such evisceration is the point so long as it generates the desired subordination of frontier people and places to a territorial order conceived and codified somewhere else.

In the case of the Moon, multiple actors within the state and private sector are working actively to produce 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 non-existent legal regimes. 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 <u>not</u> prevail, certain actors work to make it so. This may be because — as in the case of São Gabriel or Baotou — local livelihood necessities cannot be reconciled with existing policies. But looking at the same situation from the perspective of a large-scale mining interest,[274] 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 131 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 is gradually producing the "wild west" conditions so desired. Although the particular context might be new, disavowal of extant conventions governing land and resource use has been fundamental to colonial and capitalist expropriation for centuries.

In the three primary cases examined herein, illegality happens for different reasons. In the case of Baotou, local interpretations of national interest mean supporting black market or clandestine mining activities. In São Gabriel, local economic necessity in a context of legal impossibility compels indigenous actors to risk fines and imprisonment in order to get some much-needed cash. With respect to the Moon, private sector actors have leveraged geopolitical anxieties surrounding China's growing international influence to force an abdication of international institutions by the US. But it is important to remember that just as frontiers do not exist *a priori,* nor does the law. Both must be enacted — forcefully brought into being by a host of institutions, campaigns, negotiations, seductions, brutalities, and disciplinary measures.

But unlike the law, the frontier is enacted so that it can be subsumed or destroyed. Before it is enacted, it must be conceived to render the space in question, first and foremost, as a problem, threat, or opportunity. Then, depending on the problematization, labor, technology, capital and institutions are marshaled to enforce concrete manifestations of desirable frontier subjectivities as part of solving the problems ore seizing the opportunities as interpellated by extra-local power. As the cases show, this project hardly proceeds in a straightforward manner as frontier aspirations entangle with everyday life on the local level. Lefebvrian spatial theory describes this process through the dialectical entanglement of three different types of space —

[274] recall that SOEs, like other international firms, are driven by profitability concerns

conceived, perceived, and lived.[275] The first is the imagined space constructed by extra-local powers, planners, surveyors, investors and engineers. The production of geological knowledge is crucial to substantiating conceived space on the rare earth frontier insofar as it engenders a 'vertical' (Braun 2000) notion of territory that can be discreetly parceled, deeded and bargained over quite independently of actual lived histories and local political economies established on the terrestrial surface. Furthermore, to impose a border in fluid spaces governed by mobile polities or belonging to all humankind, one must first imagine space as something that can sensibly be divided by invisible lines. Conceived space exists in idealized abstraction, but nevertheless in relation to real space—what Lefebvre calls actual physical space—as it is perceived, generated, and used by people who materially engage it. This is intimately linked to the third type of space, which is *lived* — that is to say, space that is used and through that use imbued with symbolism and meaning. Broadly, the tensions between legality and illegality emerge from conflicts between conceived space on one hand and perceived and lived space on the other. But more precisely, as the preceding paragraphs have discussed, multiple meanings, interpretations, and material practices emerge from the array of positionalities engaged in the (un)making and (re)definition of frontier space.

The (un)making of the rare earth frontier

While Baotou, São Gabriel da Cachoeira, and the Moon do in fact represent some extremes of the political economy of rare earth elements, 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 it is too toxic 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 relevant in the push to rationalize lands that had historically eluded centralized state power. In essence, the securitization and crisis narratives surrounding REEs helped the states involved resolve their own frontier problems[276], which comprised longer term historical dynamics common across all three sites, the contemporary manifestations of which featured new social and geopolitical meanings ascribed to rare earth elements.

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. This has two valences: material (referring to the actual resources, industries, and commodities) and meaningful (referring to ideas about territory, geopolitics, and vulnerability). The strange geography of the rare earth frontier is 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 (Gustke 2011, Jeffries 2014, BBC 2011), 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 a complex and hazardous beneficiation process. Processing high quality rare earths by themselves has proven to be risky

[275] *l'espace conçu*, *l'espace perçu*, and *l'espace vécu*. See Figure 4 in introduction.
[276] Often at the expense of *in situ* socionatures, as these three cases demonstrate.

business — not just because of the environmental and epidemiological hazards, but because despite their importance and proliferation, the global market is decidedly small.

As a result, firms specializing exclusively in rare earth oxides have not fared well. Baotou emerged as the rare earth capitol 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 sub-contracting and deindustrialization in the west following world-historical political economic shifts resulting from the Reagan/Thatcher 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 its development of reclaimed rare earth oxides with its booming niobium monopoly. The Mountain Pass mine in California, which specializes exclusively in rare earth production, re-opened in 2012 under the since discredited pretense that it was leading the way in repatriating environmentally-superior rare earth production, but it has relied on the same subcontracting practices that precipitated its demise — it ships 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 rare earth mining must be bound up with other industrial and territorial endeavors.

In addition to the untapped deposits and abundant rare earths overlooked as waste in mine tailings across the globe, less than 1%[277] 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 EU, Verrax (2015) identified the following issues. 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 are uniform in their negative response to the prospect of paying premiums for recycled elements, whose qualities have not yet been demonstrated. These are all technical constraints, but there is also a serious organizational constraint, which is the lack of a waste collection system for either industrial or individual rare earth technologies: how to systematize the collection of nuclear submarine propulsion systems on one hand, and broken ear buds on the other? And of course, rare earth recycling is a very toxic process, currently concentrated in China and Vietnam. As a result, the possible geographies of rare earth recycling are shaped by a tension similar to that which shapes the geographies of exploration and extraction. The strategic necessity demands a secure supply, while the toxicities generated by their extraction and processing must somehow be confined,

[277] What is <1% composed of? Primarily: rare earth scraps from magnet production, lamp phosphors, and nickel-metal hydride batteries.

complicated by the fact that in the case of rare earth recycling how much *more* recycled elements would cost is a daunting unknown. Hence rare earth recycling garnered the most interest when there seemed to be a host of compelling needs that trumped market and IPR constraints. When recycling rare earths meant 'beating China' or possibly getting rich by generating a new source of REEs, policymakers, green researchers, and industry lobbyists in the US, Japan, and EU agitated for government-sponsored recycling programs. As the force of these claims drained away, rare earth recycling became something of a joke among Anglophone analysts. Importantly, the period of greatest promise occurred when more sustainable rare earth production meant something quite apart from the actual use, circulation, and immediate material need for rare earth elements.

And so it has been with the sites on the global rare earth frontier emergent after 2010. The races to mine the places examined in the text have advanced so far because rare earth mining in Afghanistan, Greenland, the Brazilian Amazon and the Moon is less about rare earths *per se* than with what the establishment of extractive regimes could potentially mean in terms of recognition, geopolitical power, and territorial sovereignty in a shifting global division of labor, and within that, acute anxiety over China's growing global influence.

What had previously been obscured in nation-state based, unrelational, single-site commentaries on the contemporary rare earth issue[278] is illuminated by a critical geographical approach using world-historical analysis, encompassing and reciprocal comparison, and the fine-grained multilingual data is gathered from archival research and interviews. Processes unfolding in vastly different spaces, according to multiple temporalities and animated by contesting narratives reaching back centuries are constitutive of the global rare earth frontier. Although there are distinctive attributes of the *rare earth* frontier, examining the visions, destruction, and hazards involved in acquiring these elements on which the best and worst of any possible future depends, we can see with a sharper glint of clarity how frontier space is (un)made, and how sacrifice zones can congeal around geological knowledge, territorial contest, and dreams of sovereignty. These cases show that sacrifice zones are not unilaterally imposed from the top-down, but are 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.

Particularly in São Gabriel da Cachoeira, as well as in Greenland, local mining proponents feel strongly, if somewhat naively, that the geopolitical and economic spoils of rare earth extraction[279] will outweigh the potential hazards simply because they intend to do mining their own way, on their own terms. This is where the racialization of toxic rare earth production as a distinctly Chinese problem obscures the fact that there is no way to isolate the dangers from the extraction of rare earths; as detailed in Chapters one and three, highly toxic and radioactive elements geologically coincide with rare earth elements, many of which are themselves hazardous to living tissues. Nor can rare earth separation take place without generating tons of

[278] Or others, which sought to compare rare earth production in the US with rare earth production in China embodied, as McMichael put it, "*a priori* assumptions" of the "global configuration" at the time "as a historical given, rather than a historical moment," (1992b) As this work has shown, 'the' global configuration is imagined radically differently depending on one's historically informed standpoint, which is always composed of intersections of place, race, class, and gender.
[279] Namely, deeper integration into global economies, greater control over local destinies, and broader recognition of local importance.

pollutants, both in the form of industrial acids and the liberation of lead, arsenic, fluoride, uranium, and thorium in the form of waste products. While these localist sentiments in São Gabriel da Cachoeira and Greenland — along with CBMM's uncelebrated breakthrough, multiple failed legislative initiatives in the US, and even industry and production controls in China — indicate diverse desires to make rare earth production more just and sustainable, there is at the time of this writing insufficient market and policy support for enacting environmentally superior practices.

Furthermore, Baotou is unique because the tremendous investment in building a regional integrated military-urban-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 technology industries. This is complimented by a 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 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 policymakers 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. 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, 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 whom are studying China's western development model in order to apply it to the Amazon and 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.[280] [281] This would require massive infrastructure investment, annihilation of *in situ* socionatures, 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. In

[280] China Academy of Sciences Delegation to Brazil, interview by author, March 2013
[281] China Academy of Sciences Public Health, ground water, and soil researchers, interview by author, August 2013

Brazil in 2014, 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.

Finally, something must be said for the fact that so much fiction surrounds the production of new rare earth frontiers. It is tempting to conclude that the myths of absolute scarcity, or that ideas of 'dwindling' rare earths persist 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 concern for the truth." Advocates for mining the Moon, Greenland, the Amazon, the ocean floor, and Afghanistan cling to the claim that rare earth elements are 'dwindling'; that 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—all of which have been characterized as possibly being the largest deposits in the world. This is simply not true, but it is not enough to simply name the untruth. Rather, this dissertation has shown the 'work' done by discourses surrounding rare earth elements, and how these discourses intersect with longer-term territorial and geopolitical anxieties composed of sovereign aspirations and uncertainty in the face of China's growing global influence.

The role of fiction surrounding rare earth elements in the abovementioned contexts would seem to distinguish them from the case of Bayan Obo, Baotou, Inner Mongolia. But the fictions surrounding the São Gabriel da Cachoeira and the Moon stops at the subsoil, where minable deposits of rare earth elements do actually exist. This requires a different way of looking at the situation. Although the magnitude of actual deposits may be grossly overstated, they are not entirely false. 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 and transformative about the 2010 rare earth crisis is the way in which it stimulated a radical redefinition 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.

Appendix

Methods

This methodological toolkit for this research consisted of multi-scalar interviews and archival research to support a world-historical analysis and critical encompassing comparison among the sites examined herein. Interviewees were selected on the basis of their relevance to or experience with frontier (un)making processes identified in each of the three sites. This meant that I interviewed national, state, and local officials, members of international policy, research, and investment circles, as well as laborers, activists, village elders and other citizens. I made a point of engaging institutions taking a leading role in shaping local, national, and global rare earth politics in the US, Brazil, and China, such as those charged with geological survey, national security, ethnic affairs, and environmental protection. I conducted my interviews in local languages and in a semi-structured manner; where appropriate I employed snowball sampling in order to identify other interviewees. The overarching objective of the interviews was to ascertain the ideas and practices involved in shaping the current geography of the global rare earth frontier on local and global scales.

As discussed in the introduction, this research started with the contention that much of what drives the production of the global rare earth frontier operates in the epistemological gaps of political economies, political ecologies and postcolonial theories that drew their ordering logic from the Cold War vision of a world thrice divided. Although Cold War geographies of extractive territoriality cast long shadows over the contemporary production of these particular places, it has long since been identified that Cold War structurings of the world presumed a static division of global space according to which all other life processes were subordinate—while relevant, this could neither describe nor comprise 'the' global situation, because in fact there are many situations that vary according to positionality and subjectivity. Rather than presuming a fixed global structure at the outset of this work, I instead followed McMichael's (1990) lead of viewing structures as formed through historical relations. From such a perspective, it is necessary to compare processes across space and across time in order to identify the historical formation of specific phenomena and the world-historical processes with which they are co-constituted. Pomeranz' (2000) work on elucidating *The Great Divergence* between two ends of the Eurasian land mass just before the industrial revolution is a key example of this approach, in which no single case is upheld as the norm against which others are measured. When examined in this way, illustrative differences *and* similarities emerge that allow us to understand the relationship of places presumed to be mutually alien—Inner Mongolia, the Amazon, and the Moon, for example—within a world-historical process.

Archives

Such an inquiry requires a fine-grained historical analysis. In addition to interviews, I conducted extensive archival research in the US, China, Brazil, and Berlin in order to understand the histories of the key sites before and leading up to their (re)configuration as points along the global rare earth frontier. In the US, I consulted the USGS records held at the National Archives and Records Administration in Bethesda, Maryland; the Central and East Asian and Latin American maps collections at the Library of Congress in Washington, DC; and made extensive use of the library databases and online collections at the Doe Library and the C.V. Starr East

Asian Library, as well as the special collections procured through the Bancroft Library at the University of California, Berkeley. In Berlin, I made use of the loan capabilities of the WZB to examine historical survey maps of the Inner Mongolia Autonomous Region.

In China, I consulted the microfiche, online scientific research databases (CNKI) and regional books collections at the National Library in Beijing; and the personal and institutional archives of researchers at the China Academy of Social Sciences Institute for Chinese Borderland History and Geography; the local newspapers and periodical collections at the Inner Mongolia Autonomous Region Library in Hohhot for periods between 1947 – 1970; and revolutionary documents collections that archival staff permitted me to see for ninety minutes at a time at the Inner Mongolia Autonomous Region Archive in Hohhot, IMAR. The Baotou Municipal Library contained a wealth of local documents deposited from local bureaus and industries dating back to the early 1970s, and the staff at the local Environmental Protection Bureau selectively opened contemporary archives to the extent they deemed prudent in order to answer my questions about more recent local issues and transformations, and the local Ministry of Land and Resources office in Bayan Obo allowed me to consult its annals and past local development plans.

In Brazil, I examined the historical scholarship on the Brazilian Amazon held at the National Library in Rio de Janeiro. I consulted the Senate Archives as well as the documents collections at the *Instituto Socioambiental* in Brasília, the historical documents collections at the Public Library of Manaus, and the local records and documents collection at the *Instituto Socioambiental* and Federal Police post in São Gabriel da Cachoeira. The Public Archives in Manaus were under renovation during my research visit.

Research Considerations

There are several limitations to this study, most of which derive from the choice to forfeit an extensive ethnographic commitment to the sites studied in favor of working out, in practical terms, a transnational research project that intends to show a way out of ossified notions of global order and difference—fixed in Area Studies disciplines, for example—generally segregated between 'east' and 'west' as well as the 'global north' and 'global south.' As I pointed out in the Introduction, claims of exceptional agency in the making of global history are conspicuous features of both Anglophone and Sinophone political economic and historical geographic literature, while the tendency to folklorize or fossilize Latin American (pre)colonial history is likewise conspicuous in both linguistic canons. In order to carry out this research in a way that did not reinscribe teleological narratives of longue-durée global change with fixed arrangements of power and agency across global space, I relied heavily on a critical geographic and transnational feminist approach, which demand careful attention to local productions of space through the practices of everyday life. Through this approach, the multiple and particular hegemonies relevant in different places to different actors were brought to light in contradistinction to the prevailing analyses of global rare earth dynamics that rely on geological determinism and speculative hyperbole at the expense of actual interests and operative geographical imaginaries. What a fine-grained approach with attention to difference reveals is that these places are not mutually unintelligible, but rather share important characteristics recognizable as different forms of a frontier process.

By pointing to the shared historical attributes involved in (re)configuring the sites studied as part of the global rare earth frontier, the aim was to draw careful attention to similarities and differences, as well as the temporal and technological relationalities among the sites, in order to demystify how extractive and territorial power *works* on a global scale. By working within the local languages and literatures of each of these sites over a period of four years, as well as cultivating relationships of trust built on a decade of research, life, and engagement with Brazil and China, I endeavored to balance the trade-off between breadth and depth. However, in comparison to my own pre-Graduate School experience conducting extensive rural ethnographies in China, the difference between relocating wholesale for an uninterrupted year or more to one place versus structuring my research according to six to twelve-week fieldwork stints unfolding over four years is apparent in three key ways.

First, I eschewed extensive household surveys in favor of targeted multiscalar interviews and repeated escorted site visits with a range of interlocutors. While the strength of this approach lies in capturing multiple narratives of a given place from a range of positionalities, the weakness lies in the fact that I did not generate a codifiable body of work (as would be the result of standardized surveys, for example) that could be analyzed with various social science analytics software. This limits in some ways the claims that I can make about the extent of the similarities and differences of the three sites. This would be a compelling project for further research in order to analyze the extent to which frontier interpellation uses shared rhetoric, for example. The question of how different concepts travel across languages and global spaces, and how those traveling concepts intersect with power to generate specific spatial transformations has been an enduring topic of interest for me since acquiring my fluencies in Mandarin and Portuguese over a decade ago. However, I have found that there is little theoretical or empirical work to date examining this question in the context of specific political economic issues. This dissertation, with a different methodological focus, could have taken up that question.

Second, while one of my strengths as a researcher is my linguistic and cultural facility in Brazil and China, the fact that I did not need to rely on a translator to conduct interviews, particularly in sensitive contexts were interviewees requested not to be recorded, affected the quality of some of my interview notes. The pacing of a translated interview is considerably slower and more modulated than a direct interview, which allows the interviewer time to write more immediate complete notes and to gather thoughts between translations. Working in third and fourth[282] languages in the context of a direct interview meant that I was often taking notes in shorthand to aid the subsequent write-up process later that day or week. The quality of the dialogue captured noticeably differs between recorded and non-recorded interviews. In this work, I have quoted only those statements that I possess in their entirety. Although I am proud of the perspectives represented, one cannot avoid a sense of some precious things having gotten lost. Furthermore, the burden-of-proof to demonstrate the merits of conducting a study that engages *both* China *and* Brazil *as well as* the Moon required considerable historical and archival work. As a result, many of the rich ethnographic and interview findings are not shared in this present work.

[282] And sometimes fifth, when communicating in the local dialect in China

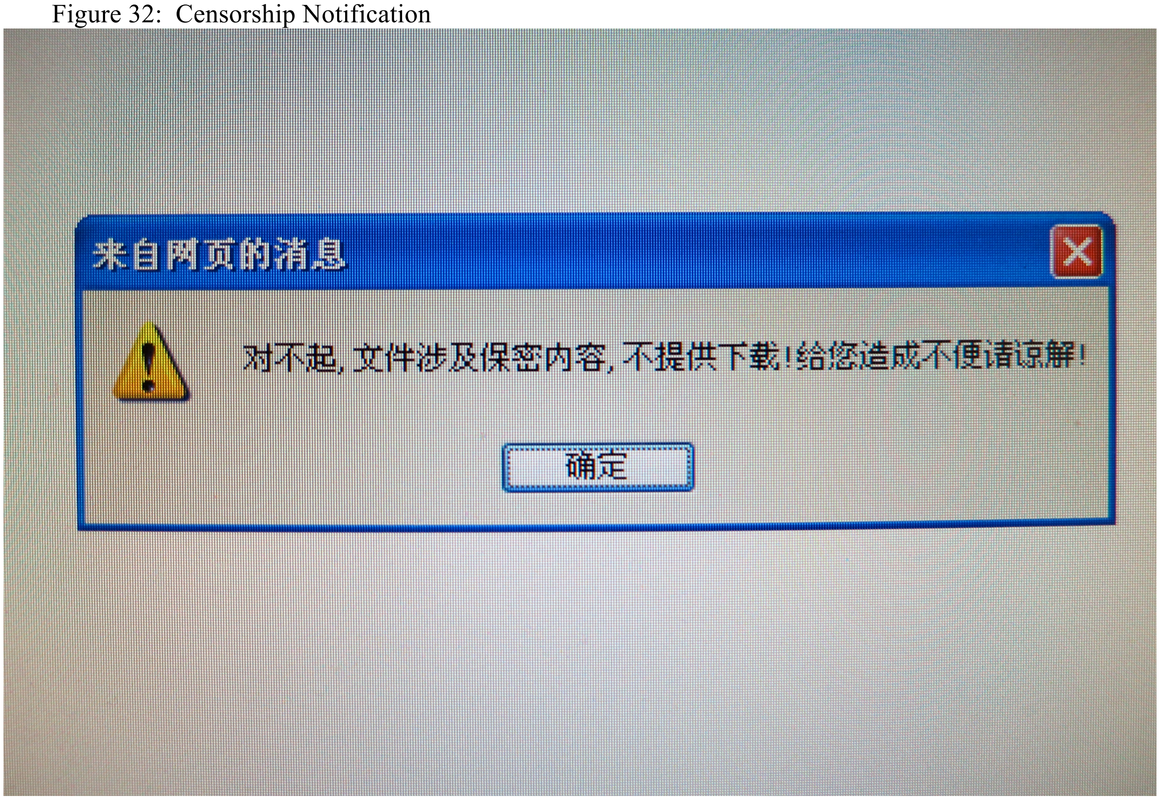
Third, there is a justifiable fatigue among certain policy-makers and activists in dealing with international researchers inquiring about social and environmental issues for the purposes of their own scholarship which will not be published in local languages for quite some time, if at all, in addition to an array of (real and perceived) security concerns involved with working in frontier regions. In light of this, I found the practice of multiple returns—as opposed to one long uninterrupted field stint—to be productive for building trust over time as well as for demonstrating sensitivity to security concerns and the workaday constraints shaping the lives of busy people. This allowed me multiple opportunities to approach situations that at first may have been impossible, whether for reasons of political censorship, social turmoil, or suspicions concerning whether I was *actually* an academic researcher and not an undercover journalist or spy. Local counterparts later expressed appreciation that I did not push certain issues when times were difficult, yet maintained an engagement with them and the issues with which they were worked over several years.

In terms of safety and security issues, three points must be made. First, despite the elasticity of law and order that characterizes frontier regions, it is not as though public safety and bodily autonomy are guaranteed in urban metropolises. The consistent, low-level alarmism I encountered in response to my proposed field sites had the effect of construing the San Francisco Bay Area, or Beijing, or Rio de Janeiro as the *safe* and *orderly* opposites of Baotou, Bayan Obo, and São Gabriel da Cachoeira. This response was as unexamined as it was predictable. Such attitudes, although largely well intentioned, have the effect of erasing the everyday perils involved in moving through urban spaces as someone gendered female, as though threats of violence and bodily harm only become salient facts of life out on the frontier. This is patently false. Although I am privileged by my race in US, Brazilian, and Chinese contexts, my gender provokes certain problems and hazards that are consistently present at home and abroad, and must always be navigated in context-specific ways.

Second, the integrity of my contacts and interviewees, especially those in securitized regions, is something that extends far beyond the actual time I spend in the field. By choosing to talk to an outsider who is also a conspicuous US citizen, local contacts risk increased scrutiny and interrogation should someone later decide to view their engagements with me in a suspicious light. I took care to avoid this eventuality by gaining appropriate permissions and letters of introduction from relevant national and local institutions before initiating interviews, and took the added precaution of meeting first with officials and power brokers to mitigate possible misunderstandings on the part of national and local authority figures. I also prepared copies of my research abstract and a list of key questions in local languages, which I circulated in addition to relevant documentation from the University of California, Berkeley. Because everyone I met received the same paperwork, this helped to establish my credibility and lower any possible stakes that might otherwise be involved in meeting with an outsider. As a further precaution, I assigned a pseudonym to every interviewee cited in the text.

Third, conducting in-depth research into issues deemed to be of critical national significance in the US, China, and Brazil presented its own unique set of challenges and opportunities. In many ways, this project was an informal education in how censorship works in multiple contexts. In China, where censorship is openly discussed and practiced as a matter of everyday state functions, I found that it actually became clear quite quickly what information would and would not be available. Censorship tended to be applied to thematic areas of public discourse as opposed to specific issues engaged by specialized audiences. This meant that although things such as 'radioactive waste' are generally considered too sensitive for newspaper articles, specialized academic research into specific aspects of the problem as manifest in particular places is freely accessible in libraries and academic databases. But censorship is also a dynamic practice that changes over time. In the event that a particular article or book was deemed too sensitive to be downloaded at the time I sought it, library databases alerted the researcher with a dialogue box apologizing for the inconvenience. The author, title, and publication information of the censored work was still available, thereby allowing me to identify which work was deemed to be secret, and whether any such research on my topic existed in the first place. Since part of my purpose was to review the extent of Sinophone literature on environment and development issues in Baotou related to the rare earth industry, this occasional dead-end proved only to be a minor hindrance.

Figure 32: Censorship Notification



The dialogue box reads: "Webpage Notification: Sorry, the article contains secret contents and is not available for download! Please forgive any inconvenience this brings you!" Source: author photograph 28 March 2013.

Censorship works very differently in the contexts of the US and Brazil. In the US, where censorship is largely not talked about, it nevertheless shapes knowledge and action in important ways. Whether people fear lawsuits, or whether it is a function of the generalized paranoia precipitated by post-9/11 mass domestic surveillance practices, self-censorship is a conspicuous feature of engagement with industry actors in the United States. Because this affective posturing forms part of the Anglophone common sense concerning rare earth elements in the US—particularly among those lines of thought that entangle the importance of rare earths to national security with vaguely stated fears of emergent Chinese power and unexamined assumptions as to actual scarcity of rare earths—it was an instructive practice to encounter and observe. In Brazil, I encountered a refreshingly open practice with respect to information concerning the issues researched herein. I was invited into back offices of government bureaus, where civil servants literally opened their files for me to peruse; granted day-long tours of industrial sites; and was given archival materials to take back to my hotel to peruse on my own time after hours.

Figure 33: Public education poster informing Brazilian citizens of their rights to information from government entities.

The poster reads: "Information is your right! You need to know." From the campaign to pass Article 19, the Law on Access to Information, which succeeded in 2011. Source: UNESCO/Artigo 19 Brasil.

These differences are accounted for by different political and cultural attitudes concerning the power of information. In China, information is explicitly controlled as a matter of state policy; therefore in a certain sense, one knows where one stands, although under such conditions ground-level functionaries can sometimes adopt an overzealous approach when dealing with foreign scholars just to err on the side of caution.[283] In the US, political discourse and culture has a deep affinity with paranoid rhetoric (Hofstadter 2012); although this has its roots in the 'red scares' of the Cold War era, the habit was manifest in the way in which rare earths were discursively cast during and after the 2010 crisis. This affect was conspicuous among industry actors, certain elected representatives and media commentators—not necessarily among federal policy-makers for reasons discussed in Chapter four. In Brazil, 'freedom of information' is considered a basic citizenship right and a pillar of national security in the post-dictatorship era that was further codified in a 2011 federal law. This reflects a very democratic notion of national

[283] In one instance in local archives in Inner Mongolia, this entailed the receptionist fabricating an entirely different set of requirements for me to satisfy once he saw that I had complied with all rules posted on the archive's website. These fabricated requirements involved getting letters of permission from a sub-office of a local bureau that—because these rules were made up on the spot—had no experience providing such a service. The put-upon officials in this particular local bureau made a phone call on my behalf, interrogated the receptionist as to why they directed a foreign researcher to their office, and resolved matters.

security, oriented toward preventing domestic abuses of power instead of against perceived foreign military threats. There is an ongoing public education campaign to remind private citizens and public servants of this entitlement, and I found it to be productively manifest in the process of my research.

Areas for Further Research

Despite these various limitations and negotiations, the findings presented in this work have several implications for future research. Chief among the epistemological questions to be further researched and elaborated are the implications of examining global political economy 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. Secondarily, 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.

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 this year. 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 to identify possible practices that could inform the production of less devastating future practices 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 Central Government's 'go west' 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 interviews and dialogues 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 also brought benefits to the host communities. Women were instrumental in maintaining this system. 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 approach the question of how certain indigenous groups in *Cabeça do Cachorro* 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 intersection and co-production of Silicon Valley techtopias, narratives of socioecological 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—indeed Lefebvre rhapsodized the Carnival as containing the seeds for more promising alternative futures—my findings among nascent private sector space mining firms suggest that, in fact, the utopian experiments inform apocalyptic commonsensibilities in a strikingly 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. 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, and whether the fiction of rare earths as rare will remain operative in agendas to territorialize the places examined in this work.

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