THE LIFE OF THE BY-PRODUCT IN THE "GRANTS URANIUM DISTRICT" OF NORTHWESTERN NEW MEXICO

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ABSTRACT

In the "Grants uranium district" of northwestern New Mexico, there is a large-scale high-tech operation underway to monitor and cleanup the uranium mine waste and mill tailings from the U.S. Cold War development of nuclear weapons. This dissertation presents an anthropological study of the expertise involved in cleaning up the by-products of such historic production. Though the focus of the study is on the experts who monitor and manage the mine waste and mill tailings, the dissertation considers the different perspectives on policy, planning, design, and engineering surrounding uranium tailings piles. Through this emphasis on multiple perspectives, the study opens up the kind of "explanatory pluralism" prescribed by Evelyn Fox Keller (2002), in which differences in perspective are "not simply a reflection of differences in epistemological cultures but a positive virtue in itself, representing our best chance of coming to terms with the world around us." The goal of this dissertation is to refine our understanding of the different "stakeholders" involved in cleaning up the mining district, as they deliberate about the possibility of reclaiming abandoned uranium mines, remediating Superfund sites, and restoring the natural and cultural resources of northwestern New Mexico. My thesis is that the possibility of cleaning up the Grants uranium district hinges on the "politics of baselining"—a term I introduce to help articulate my argument about the relationship between three categories of stakeholders. By tracing lines of geochemical evidence through the same groundwater samples, each stakeholder's model imagines a different geological past prior to mining that can be deemed "natural," as the background against which to measure the anthropogenic impact of "man-made" piles of uranium tailings.

CHAPTER 1

INTRODUCTION: THE LIFE OF THE BY-PRODUCT

In the "Grants uranium district" of northwestern New Mexico, there is a large-scale high-tech operation underway to monitor and cleanup the uranium mine waste and mill tailings from the U.S. Cold War development of nuclear weapons. This dissertation presents an anthropological study of the expertise involved in cleaning up the by-products of such historic production. Though the focus is on the experts who monitor and manage the mine waste and mill tailings, I consider different perspectives on the policy, planning, design, and engineering of uranium tailings piles. In this way, I have opened my purview to the kind of "explanatory pluralism" that Evelyn Fox Keller prescribes, which "is not simply a reflection of differences in epistemological cultures but a positive virtue in itself, representing our best chance of coming to terms with the world around us" (2002:300). The goal of this dissertation is to refine our understanding of the different "stakeholders" involved in cleaning up the mining district, as they deliberate about the possibility of reclaiming abandoned uranium mines, remediating Superfund sites, and restoring the natural and cultural resources of northwestern New Mexico.

Stakeholders in local communities, government employees, and transnational mining corporations all have different, often conflicting perspectives regarding appropriate technical applications and outcomes of environmental cleanup, not to mention different terms, values and ideologies. This course of research contributes to critical understandings in environmental anthropology of the triad stakeholder model of analysis that emerged in international development discourse in the 1980s as a tool for managing public deliberations between three categories of actors: "the corporation," "the state," and "the community" (Ballard and Banks 2003; Fortun 2001; Jacka 2015; Kirsch 2014). I offer a fine-grain analysis of the ways diversely

positioned stakeholders analyze the environmental cleanup regime. The analytic concept of the "regime" is used to underscore the systematic and planned way in which the cleanup is calculated, ordered, and executed. I am also drawing on the historian of science Gabrielle Hecht's concept of "technopolitical regimes," which refers to the strategic practices of people and institutions that govern, and the contested nature of their designs and use of technology to achieve particular political outcomes.[1] I take this technopolitical opportunity to place historical and ethnographic accounts of science, technology and engineering in the field of *political ecology*, which combines critical analyses of political economy with ecological sciences.[2]

By studying the possibility of cleaning up former mining districts, I offer an account of the entanglement of technology and politics (Hecht 2009), and the promise and failure of ecological modernization from the perspectives of many different stakeholders (Ferguson 1999;

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[1] Gabrielle Hecht's conception of "technopolitics" refers to the "strategic practice of designing or using technology to enact political goals" (2011:3). Hecht leverages Thomas Hughes's systematic view of technology as "a linked network of artifacts, knowledges, and institutions operating in a coordinated fashion toward a series of specified material goals. Thus the French nuclear program is a technological system whose components include state agencies, private companies, reactors, laboratories, uranium mines, university curricula, factories, and portions of electricity distributed in a network" (2009:16). Hecht amends the Hughesian concepts of "technological system" and "technological style" because these concepts subdue political critique and are not accountable for "purposeful policies." The term "regime" is meant to account for such things. It draws our attention to gradients of power and the political strategies that are missing from Hughesian historical accounts of technology. Consider the technopolitics of nuclear things: "*Radiation* is a physical phenomenon that exists independently of how it is detected or politicized. *Nuclearity* is a *technopolitical* phenomenon that emerges from political and cultural configurations of technical and scientific things, from the social relations where knowledge is produced" (Hecht 2012:15; original emphasis). Hecht's conceptualization of "nuclearity" is preceded by the notion that "for mines to be treated as "nuclear" workplaces in any meaningful scientific, political, or cultural sense, their radiation levels must be detected and recorded using instruments, laboratories, and comparison data" (2012:14). I leverage the concept of technopolitics throughout this dissertation in order to recognize the entanglement of technology and politics in the process of monitoring and cleaning up former mining districts.

[2] Recent scholarship has highlighted productive possibilities between political ecology and science and technology studies (STS) by applying Pierre Bourdieu's field theory to understand the expertise involved in stream restoration (R. Lave 2012). I will identify a different set of interdisciplinary opportunities, tracing courses of theoretical and methodological significance through particular genealogies of *political ecology* (Harvey 2005; Jacka 2015; Lefebvre 1991; N. Smith 1984; Tsing 2005, 2015; West 2006, 2012, 2016; Wolf 1982; and others) and *engineering studies* (Downey 2009; Hughes 2005; Noble 1977; Layton 1971; Wisnioski 2012; and others).

Scott 1998). I consider systems of environmental information as significant sites for political intervention (Fortun 2012), and an important part of the production of nature (Lefebvre 1991; Smith 1984; West 2016). I hope this course of research will contribute to the many cases in which environmental sciences and engineering have been positively improved through the inclusion of diverse stakeholder perspectives and forms of knowledge (Hoover et al. 2015; Scammell 2010).

In Chapter 2, I discuss my methods of ethnographic research, and how my initial fieldwork was situated among the Multicultural Alliance for a Safe Environment (MASE), a regional environmental advocacy organization based in Santa Fe. MASE coordinates the efforts of five local grassroots groups: Eastern Navajo Diné Against Uranium Mining (ENDAUM), Laguna-Acoma Coalition for a Safe Environment (LACSE), Red Water Pond Road Community (RWPRC), Bluewater Valley Downstream Alliance (BVDA), and Post-71 Uranium Workers Committee (Post-71). We also worked in close relation to the Southwest Research and Information Center (SRIC) and New Mexico Environmental Law Center (NMELC). I will discuss how I have extended my ethnographic endeavor to better understand the relationships between all stakeholders at public meetings regarding the limitations and possibilities of cleaning up the Grants mining district.

My thesis is that the possibility of cleaning up the Grants uranium district hinges on the "politics of baselining"—a term I introduce to help articulate my argument about the relationship between three categories of stakeholders. I describe how corporations attempt to limit their environmental liabilities by producing science that establishes baseline data which permit a higher level of contamination in the environment, thereby limiting the extent to which they are obligated to cleanup. This is a strategy of "corporate science" (Kirsch 2014) that I call

"backgrounding." State and federal permitting regimes give the permits that allow for alternative contamination limits (ACLs) and allow companies to pollute up to seemingly arbitrary levels. But government employees are not hopeless "intermediaries"; they are "mediators" that change what passes through (Hull 2012; Latour 2005). Sometimes they offer "political openings" and create spaces for local communities to work together to limit their exposure to environmental health risks, and employ independent scientists who criticize strategies of corporate science and produce forms of "civic science" (Fortun and Fortun 2007), which support lower baseline levels of contamination that register under the maximum contaminant levels (MCLs). By tracing lines of geochemical evidence through the same groundwater samples, each stakeholder's model imagines a different geological past prior to mining that can be deemed "natural," as the background against which to measure the anthropogenic impact of "man-made" piles of uranium tailings.

This chapter begins with a chronological framework that organizes the following overview and clarifies the object of study. However, where the chronology of events fails to explain the making and unmaking of the mining district, I shift toward a *topological or spatial analysis that traces the technopolitical life of the by-product*. This form of analysis cuts across the entire dissertation and can be understood as the organizing metaphor that structures my historical reflections and ethnographic essays. In Chapter 3, I will elaborate on how a conceptualization of the life of the by-product refines our understanding of uranium mill tailings piles and offers unique insight into the cultural production of space, place, and nature in northwestern New Mexico.

1.1 The Grants Uranium District

During the second half of the twentieth century, northwestern New Mexico served as the primary production site for one of the world's largest nuclear arsenals. From 1948 to 2002 the "Grants uranium district" provided roughly half of the total uranium ore accumulated by the United States federal government for the production of nuclear weapons, in addition to becoming a national source for commercial nuclear energy in the 1960s.[3] More than 340 million pounds of uranium oxide (U_3O_8) have been produced from the sandstone uranium deposits of the Jurassic Morrison Formation in northwestern New Mexico, accounting for more than 30 percent of total production in the United States (2017:1).

The geologist William Chenoweth (1985) once described the status of uranium mining in New Mexico, "the acquisition of raw materials," as one of the most underreported aspects of U.S. Cold War history. Despite media that have depicted the exceptionality of the state of nuclear development in New Mexico, the legacy of uranium mining and milling in the region still remains largely obscure. Consider the most prolific yet unheralded radioactive spill in U.S. history, the Church Rock mill spill of July 16th 1979. Although affected workers and local residents commemorate and memorialize the event annually, it does not register at broader scales

[3] See McLemore and Chenoweth (2017). I tend to use the toponym "Grants uranium district," which is the term used among a particular epistemic community, a genealogy of scholars beginning with the work of William Chenoweth and colleagues at the Atomic Energy Commission Raw Materials Division in Grand Junction, Colorado; continuing with the work of Virginia McLemore and colleagues at New Mexico Tech in Socorro. I use the name interchangeably with the "Grants uranium region" (Kelley et al. 1963; Rautman et al. 1980; Turner-Peterson, Santos, and Fishman et al. 1986), "Grants Mining District," and "Grants Mineral Belt," which have been used by federal and state scientists, including the Environmental Protection Agency and regional NGOs (e.g., the Multicultural Alliance for a Safe Environment). All of these different toponyms refer to an area of northwestern New Mexico that extends one hundred miles east-west, from east of Laguna Pueblo to west of Gallup, and twenty-five miles north-south. What makes the region such a fascinating geographical area of study is the many different place-names about which people speak, and the polysemic and polyvalent dimensions of the landscape. From an anthropological perspective, my approach is *emic.* Rather than bounding a geographical area of ethnographic inquiry myself, I am interested in how different interlocutors define the area of inquiry.

of collective memory like the nuclear disasters at Chernobyl, Three Mile Island, and Fukushima Daiichi. Existing literature on the entire cradle-to-grave lifetime of uranium production in New Mexico forgoes consideration of the role of uranium mining in the grand project of "radioactive nation building," and fixes its gaze instead on the technoaesthetics of nuclear weapons (Masco 2006:25; cf. Johnston et al. 2007). Joseph Masco makes an exceptional comment about uranium mining that should not be overlooked:

> Federal management of Pueblo lands produced fundamental changes in Pueblo societies during the twentieth century. In the decades preceding the launch of the Manhattan Project, the eight northern Pueblos, for example, lost title to over 18,000 acres of farmland in U.S. courts, just as their populations began to grow significantly. Unable to live off traditional farming practices for the first time, most of the eastern Pueblos turned to the cash economy for their livelihoods. As Richard Clemmer (1984) has argued, the loss of the subsistence economy encouraged a number of Pueblos to lease their lands for coal and uranium mining, both tying their economic future to the world energy economy and placing their lands (and often bodies) in the hands of corporate mining interests. For the northern Pueblos, the economic crisis led many to search out work at the area's largest employer, what was to become Los Alamos Scientific Laboratory. Thus, one structural effect of U.S. policies toward Pueblo territories in the decades preceding the Manhattan Project was to help foment an economic crisis that coincidentally not only opened up tribal land to uranium mining, but also produced workers for those mining operations and for the construction of Los Alamos. Ultimately, Cold War New Mexico would produce half of the U.S. supply of uranium, providing the raw material for the U.S. nuclear weapons that were being designed at Los Alamos" (Masco 2006:117-118).

The Grants uranium district encompasses large swaths of Indigenous lands, as well as Anglo settler communities and Hispano *allottees*.[4] It overlaps areas of the Navajo Nation (*Dinétah*) and Laguna Pueblo (*Kawaika*), adjacent to Acoma Pueblo (*Haaku*) and Zuni Pueblo (*Shiwinna*), in a region that is considered vitally significant to all 19 Pueblos of New Mexico, as well as recognized tribes of Arizona, Colorado, and Utah. The making of the Grants uranium

[4] The term "allottees" refers primarily to Hispano, but also Native American, land-holders who were granted land under sixteenth, seventeenth, and eighteenth century Spanish land grants and nineteenth century Mexican grants, some of which were incrementally recognized by the U.S. federal government by the middle of the nineteenth century, making the area of northwestern New Mexico into "the checkerboard area"—a mixed distribution of historic land allotments and fragmented private property holders, with large swaths of federal, state, and tribal lands, which looks like a checkerboard on a map.

district constitutes profound cases of environmental injustice, environmental racism, and settler colonialism, which initially occurred under the auspices of the mid-twentieth-century U.S. federal government through the apparatus of the Atomic Energy Commission (AEC).

By the twenty-first century, after a prolonged period of economic decline that began in the late 1970s, all uranium mining and milling in the state had ceased, leaving a legacy of environmental and public health impacts (EPA 2014; Khoury 2013; Shuey and Ronca-Battista et al. 2007). What was once referred to as the "Grants uranium district" and "the Uranium Capital of the World," now encompasses about a thousand abandoned uranium mines and seven massive uranium tailings piles; each of which is associated with expansive groundwater plumes of uranium, radium, selenium, molybdenum, vanadium, and other contaminants (Robinson 1998). "Tailings" are by-products of the milling process that often remain onsite as a matter of industrial procedure. Once the rocks have been crushed, they can be leached in liquid tailings ponds, which help separate the valuable uranium ore from the rock, along with other salvageable heavy metals like molybdenum. Uranium tailings may retain about eighty percent of the initial radioactivity. Situated in context with heavy metals, acids, and other toxic constituents (e.g., lead, zinc, copper, arsenic, cadmium, mercury, selenium, cyanide, polychlorinated biphenyl, and asbestos), tailings pose a range of environmental and human health risks (Ceto & Mahmud 2000:30; Brugge and Goble 2002). A qualitatively thick description of uranium tailings would have to account for their properties as amalgams of heavy metals as well as their "radon daughters," alpha and beta particles and gamma rays. These are not bounded objects of study; they are radiant matter that radiates outward.

In New Mexico, tailings have been amassed into unlined piles near the former uranium mills that once crushed the sandstone and limestone host-rocks for subsequent leaching by

sulfuric acid and carbonate, respectively. The mills themselves have now been crushed and placed in the same piles they produced. At the Bluewater disposal site, for example, the infrastructure of the mill was demolished and dumped in the large tailings pile along with other contaminated equipment onsite, and from other sites. The Bluewater site is named for the water that is known to collect there, between the watersheds of Mt. Taylor and the Zuni Mountains. Hence its previous life as a thriving Mormon agricultural community and part of "The Carrot Capital of the World." Grants has been the self-proclaimed capital of the world twice, for the production of two very different commodities. The tailings piles in the Grants mining district are situated precariously in basins, valleys, alongside rivers, in the course of former arroyos, and on fractures and fault lines above groundwater aquifers—in places where water flows, both above ground and underground. The fact that these tailings rest *unlined* means there are scarce precautionary barriers between radioactive materials and the nearby soil, water, and air. Tailings piles are subject to the same losing battle against erosion that all mountains face, whether made by humans, tectonic plates, volcanoes, glaciers, water, wind, or other geophysical agents. Processes of acid mine drainage, waste water discharge, and ongoing tailings seepage make contaminants from abandoned mines and mill tailings bioavailable through geologic and hydrologic proliferation. Wind-blown particulate matter, radon gas, and ambient gamma radiation are agents of atmospheric proliferation, which are by no means discrete from geologic and hydrologic processes. The high desert environment has inspired its own set of ideal-typical assumptions by scientists and engineers about keeping tailings in dry places, where major sources of water are underground. Yet the erosion-prone landscape of the U.S. Southwest and the fracture flow groundwater system of the Grants region pose their own unique set of challenges for managing tailings piles.

The tailings piles themselves are cultural artifacts and historical features of a peculiar human practice and collective social process. The cascading geophysical and geochemical impacts of the historic mine waste and mill tailings are first a matter of mid twentieth-century industrial modes of production and the U.S. Atomic Energy Commission's (AEC) former policy to "dilute and disperse" so-called low-level radioactive waste (Hagen 1992:117). As the name suggests, the commission was less about regulating industry than commissioning the development of uranium. The AEC Raw Materials Division established a regional office in Grand Junction, Colorado, which became the mid-century, post-war state in the region prior to the federalization of environmental protection in the 1970s. It also housed the archive on uranium ore resources across the Colorado Plateau in the Four Corners area of the United States—an archive only rivaled in depth and breadth by the Anaconda Company library in Grants, New Mexico. The AEC archive now lives in the Geologic Information Center at New Mexico Tech in Socorro;[5] whereas Anaconda's collection became the Anaconda Geological Documents Collection at the University of Wyoming in Laramie.[6]

The AEC was the market for uranium. It was the sole purchaser of the uranium ore from 1948 to 1970. Mid-century AEC projects and programs were the most deterministic factor in making the uranium orebodies in the district valuable economic "resources." In Chapter 4, on the making of the "Grants uranium district," I consider different origin stories about how the district came into existence and ask an epistemological question about how the discipline of geology was applied during the second half of the twentieth century to render the district legible for the

[5] https://geoinfo.nmt.edu/libraries/gic/home.html; accessed October 2, 2018.
[6] https://www.uwyo.edu/ahc/collections/anaconda/; accessed October 2, 2018.

extraction of uranium ore resources.[7] Though the question is *epistemological*—about knowledge itself—it is also *practical*—about the application of knowledge. In cruder terms, this question is not just about science but engineering.[8] By the twenty-first century, how had the geological modes of inquiry and intervention changed in the region? What kinds of geosciences would be applied in cleaning up the former mining district? This course of questioning between the making and unmaking of the "Grants uranium district" juxtaposes geo-logical thought styles and traces epistemological trajectories and plausible applications of the discipline of geology. It highlights the major paradigm shifts, contingencies and disjunctures, that have led to the present technopolitical moment of environmental cleanup.

1.2 The Emergence of an Environmental Cleanup Regime

After congress dismantled the AEC in 1974, a key environmental law was passed: The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, which authorized the Environmental Protection Agency (EPA) to set environmental health standards, including groundwater protection limits; the Nuclear Regulatory Commission (NRC) to license sites; and the Department of Energy (DOE) to provide perpetual care for designated legacy sites. This is essentially the same uranium tailings cleanup regime the United States has today, which is

[7] This question of legibility builds on James Scott's concept of "legibility and manipulability" in his analysis of the "logic behind the failure of some of the great utopian social engineering schemes of the twentieth century" (1998:4).

[8] I address the difficult epistemological question of how to study theories of knowledge by observing the way in which knowledge is applied and information is leveraged in practice. The notion of "the application of knowledge" implies a shift from science to engineering. I find it compelling because it is the central thought in the founding statement of Rensselaer Polytechnic Institute (RPI), the first civil engineering school in the nation. In 1824, Stephen van Rensselaer and Amos Eaton uttered the words that would form the ideological basis for the school: "I am inclined to believe that competent instructors may be produced in the school at Troy, who will be highly useful to the community in the diffusion of a very useful kind of knowledge, with its application to the business of living" (http://rpi.edu/about/history.html, accessed December 18, 2016).

supplemented by state environment departments and influenced, sometimes driven by industry experts and their corporate science. Notice how the federal government stops buying uranium ore from the Grants district in 1970, which coincides with the emergence of the EPA. The legislation introduced by the EPA became the antithesis of the AEC. Stakeholders involved in cleaning up the Grants district have referred to the EPA legislative action of the 1970s as a precedent to strive for today. As the uranium industry in New Mexico began to recede by the 1980s, the mining companies were required to submit plans for reclamation and schedules for closure. Although a number of companies continued to salvage uranium through systems of mine-water recovery, operations subsided considerably throughout the eighties and nineties, and have not returned to "active mining." Until recently.[9]

The remedial action of the eighties and nineties is widely acknowledged as a paradigm of failure made possible by notions of perpetual sacrifice. What happened in practice, in the weeds of the paper trail and off course from the plans and schedules was the discursive promise of "reclamation" by corporations, "remediation" by the state, and the overall failure of "restoration" from the perspectives of local communities, which prompts questions of language and meaning on all sides about what counts as successful environmental cleanup. As much as this work is about the polysemic and polyvalent terms of "cleanup," it is also about how paper trails do not necessarily map onto the geophysical landscape. In other words, there has been significant disjuncture between discourse and practice. Barbara Rose Johnston and Shirley Fiske show the national figures of an alarming story about what was called a "success" and experienced as a failure in remedial attempts to address *the precarious state of the hydrosphere*:

> A 2012 reassessment of groundwater remediation by the National Research Council came to the conclusion that at least 126,000 sites have contamination too complex to achieve

[9] The New Mexico Mining and Minerals Division permit for the Mt. Taylor Uranium Mine to shift from "standby" to "active" will be the topic of Chapter 9.

> restoration within the next 50–100 years, acknowledging that some 10% of sites 'closed' and declared remediation 'successes' were, in fact, still dangerously contaminated and only deemed safe by restrictions on public access, and by making assumptions that science and technology will evolve to effectively address the complex nature of the contamination (2014:4).

There are sites in the Grants district that fit this description about discursive disjuncture and the deferral of cleanup. They are part of the statistical story about how science and technology will evolve effectively and ineffectively, what counts as "successes" for different stakeholders, and what risks and restrictions are placed on the public. It raises questions about the meanings and values of the different, incommensurable terms of "reclamation," "remediation," and "restoration." Contrasting these keywords can open our purview to the governance style of New Mexico, which has been characterized in terms of "permission to pollute." For example, during an interview with Paul Robinson, research director at the Southwest Research and Information Center (SRIC), he contrasted each of the three keywords in order to characterize our state of governance:

> "Restoration" means back the way it was, "remediation" means repair but not restoration, "reclaiming" means re-getting something or trying to pull back some of those uses, so that having a sense for what those words are and not just treating them as synonyms. "Cleanup," what the hell does "cleanup" mean? Is it the opposite of clean down? I mean is it really that hard to identify what these words mean in law and communicate to communities and get performance implemented? So New Mexico has innovative groundwater regulations. We are allowed to pollute up to the standards. No water is protected at the level it occurs. Restoration is not required in New Mexico. So as valuable as those regulations are as a model of state enforcement and international level of groundwater protection program, it fundamentally is a *permission to pollute* (Robinson September 13th 2018).

These are terms of art that guide specific kinds of practices. They have many different meanings and values among the people who use them. By way of establishing some common understanding of what I mean when I use these words in the following chapters, I will offer brief definitions that attempt to capture the way I experienced the terms in use in northwestern New

Mexico: “Restoration” is in the local community’s best interest because it would restore the quality of the site and drinking water to pre- mining and milling conditions. “Remediation” involves permits through state and federal agencies that allow for alternative contamination levels at sites. It involves estimating the “naturally” occurring levels of contamination in the environment based on the constraints of private and public interests, considering “best available technology,” and applying statistical methods to establish the values that guide cleanup in ways that can often appear arbitrary. “Reclamation” means finding alternative use values for the land that are made commensurable with whatever values were sacrificed, even if that just means making it aesthetically pleasing for tourists, or placing a fence around it and calling it a “Wildlife Reserve” or a recreation site, or building a medical waste incinerator plant or a prison complex. These are examples of alternative use-values for the land that have either been proposed or actually developed in and around Grants and Milan. Reclamation is a process of salvaging a sacrificed landscape for an alternative economic life.

Robinson reveals a defining feature of groundwater governance in New Mexico, and identifies a major barrier to cleaning up former mining districts in the state. He recognizes the notion of *permission to pollute* as the guiding principle of the state’s environmental cleanup regime:

> So that is pollute up to a standard as well. It’s not protected at an existing level. So protection of groundwater and restoration of groundwater is very rare to find in any framework there, even though it is the basic concern that communities have as a performance measure. New Mexico and NRC both have criteria for allowing a weakening of the standards above the maximum contaminant levels identified by rules and guidelines and that includes lack of any economic benefit to further treatment, no potential future use, and demonstrating that all reasonable measures were used. So companies make that showing and the agencies don’t hire experts to do an independent evaluation to verify... stakeholders don’t have the means to compete with the models, competing analysis, and as a result alternative standards have been adopted in all cases (Robinson, September 13th 2018).

The notion of "alternative standards" and Robinson's observation that groundwater is "not protected at an existing level" reveal important aspects of the broader environmental health governance of New Mexico. Robinson lists the different ways in which companies can request alternative standards: "no economic benefit," "no potential future use," and "demonstrating that all reasonable measures were used" (or "best available technology"). He also identifies a major power gradient in environmental monitoring whereby companies make the claims, state and federal agencies are unable to hire the expertise to cross-examine the company's claims, and other stakeholders are left powerless, unable to "compete with the models" and make a "competing analysis." For this reason, it bears repeating, "alternative standards have been adopted in all cases." Robinson elaborates on how defining the terms of "cleanup" and the marked contrast between "remediation" and "restoration" define a spectrum of policy and technology approaches:

> So what is set as cleanup, the difference between remediation and restoration, and mitigation or elimination… Those are the words that define a spectrum of policy approaches as well as technology approaches. Looking at New Mexico in the mid 80's, New Mexico had uranium licensing authority, uranium mill licensing authority. The mills had closed pretty much at that time and New Mexico returned its licensing authority to the [Nuclear Regulatory Commission (NRC)] because it didn't have the capacity to effectively regulate. The state has not been forceful in identifying technology or generating technology improvement. You are allowed to pollute up to a standard, in the groundwater regulations, as opposed to protect water as you find it (Robinson, September 13th 2018).

Because *you are allowed to pollute up to a standard*, *as opposed to protect water as you find it,* there is very little driving the improvement of environmental cleanup technologies in New Mexico. Though New Mexico Environment Department and other state apparatuses that govern the environment and public health in New Mexico deferred to NRC for licensing authority of the uranium mill sites, and Environmental Protection Agency to establish the alternative contamination limits (ACLs), the state continues to play an important role in relation to the

federal programs, like Superfund, that are driving environmental cleanup. Robinson's final point was about how ACLs inhibit technological innovation and the growth and diversification of environmental sciences and engineering in the state of New Mexico. Robinson's observation helps take us beyond "the usual scripts of 'economy versus the environment' polemics – a discursive repertoire and politics" that Dana Powell challenges in her work (2015:56). From this standpoint, we can see how stringent environmental regulations can drive economic growth in the environmental sciences, technologies, and engineering sector.

Contingencies of past policy, planning, design, and engineering inhere in the extensive problems associated with the legacy of uranium mining and milling, but it would be misleading to call this a historical problem. History can be leveraged in a numbing way as a means of political anesthesia. This was not an isolated moment, a mistake that happened before there was regulation, a problem we inherited from the past. Though I have met people who prefer to say it was that simple. What is more interesting than the making of the "Grants uranium district" is the way it continues to perpetuate itself, finding new beginnings and alternative political-economic lifecycles. This is a central tendency of the life of the by-product.

Tailings are a matter of the contemporary politics of environmental cleanup that are peculiar to New Mexico. Current "best practices" at designated Title I sites of the Uranium Mill Tailings Radiation Control Act (UMTRCA) establish protocol for dry tailings, placed below-grade, lined on the bottom and covered on top.[10] Whereas southwestern Colorado and southeastern Utah have become subjects of state-of-the-art reclamation techniques and technologies, remediation in New Mexico has become an exemplar of a different kind. One

[10] https://www.energy.gov/sites/prod/files/2014/10/f19/UMTRCA.pdf; accessed October 15, 2018. https://www.nrc.gov/materials/uranium-recovery/regs-guides-comm/title-i-program.html; accessed October 15, 2018.

explanation leveraged to justify Title II UMTRCA sites and the mediocre, run-of-the-mill cleanup regime in New Mexico is the designation of "commingled tailings."

Robinson remarks, "*Commingled* meaning they include tailings from… pre-70 weapons era purchases and post-70 commercial. Comingled between the weapons era and the commercial era." When the U.S. government stopped purchasing uranium for the manufacture of nuclear weapons in the 1970s, the commodity of uranium oxide became a commercial source of nuclear energy, and the by-products commingled. During an interview with my colleague from BVDA, Candace Head-Dylla, I said, "I'm wondering if you could tell me a little about commingled tailings." She responded:

> The entire Homestake [uranium mill tailings] site is classified as what is called commingled tailings because… the uranium that was processed there was used for weapons production, and then after 1971, when it was no longer used for atomic weapons, then they transitioned and the uranium they were selling and processing at that time went into energy production. But because those tailings include both uranium processed for weapons and uranium processed for energy, they're considered "commingled tailings." And because the country benefitted, by the way it is seen by Congress, because the country benefitted from the weapons production, the country is responsible for, I don't know, I think the fifty-fifty was just an arbitrary number. Because I'm sure they didn't go in and measure, I'm sure they didn't stop to record how much uranium was processed for weapons and how much was processed for energy. Although they know that number. I wouldn't hazard to guess but they just decided that the U.S. government would pay for half of the cleanup costs at these sites (Head-Dylla, June 6th 2018).

On another occasion, she remarked, "The tailings at Homestake are 'commingled' and, so far, taxpayers have forked out $90 million on cleanup at the site. This is the taxpayer portion of what has been spent so far with another $55 million currently budgeted. The ramifications of these facts are huge—particularly when you realize how little has been accomplished to date."

The tailings piles in New Mexico include the largest in the United States, and the hydrological engineering methods that have been employed over the last forty years have led to the commingling of tailings in a mucky mess. It is difficult to describe the material quality of

these tailings piles from outside to inner core. They cannot even be characterized monolithically as solid, liquid, or gas. It would be near impossible just to find the bottom of the tailings piles and the beginning of the alluvial aquifer. Each tailings pile is associated with expansive groundwater plumes of uranium and other contaminants that have affected multiple levels of the underground aquifer system. Tailings have been geologically active in relation to these sites for decades, since their *second orogeny*,[11] when men made mountains from the by-product of the original underground ore. It will be difficult to muddle through, hard to work with, and perhaps impossible to cleanup, according to some.

Only within the last decade have comprehensive cleanup plans for the Grants mining district been negotiated. Within the last year, Region 6 of the EPA proposed the San Mateo Creek Basin Superfund site, which could offer federal resources and the scope necessary to clean up a larger portion of the widespread contamination across sites under CERCLA.[12] Also within the last year, the College of Pharmacy at University of New Mexico was awarded a grant to establish the UNM METALS Superfund Research Program Center.[13] The National Science Foundation's Established Program to Stimulate Competitive Research (EPSCoR) at the

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[11] I will elaborate on my conception of "second orogeny" as part of the life of the by-product in Chapter 9. In the meantime, note that the geological concept of "orogenesis" refers to mountain making, and the processes by which "ore" comes to be. For an ethnographic description of different geological ontologies of orogeny see John McPhee's *Annals of the Former World* (1998). Here the concept of second orogeny refers to the anthropogenic process of making mountains of uranium mill tailings. This concept allows geologists and anthropologists to engage in cross-disciplinary discussions about how humans have become a geophysical force on a planetary scale, which offers insight into debates about the Anthropocene and diverse forms of *–cenefication*—the emergence of many different, significantly humanized –cenes. The suffix "-cene" refers to the Cenozoic era of the Geologic Time Scale. "Second" is not just a reference to the by-product as a secondary product; it refers to the concept of "second nature" initiated by Hegel and amended by Marx (N. Smith 1984:33). I have also been thinking about Thomas Hughes's history of a human-built world and the Anglo-American settler perception of technology and engineering as means of "second creation" (2004:10).

[12] CERCLA: Comprehensive Environmental Response, Compensation and Liability Act. https://www.epa.gov/grants-mining-district/san-mateo-creek-basin; accessed September 26, 2018.

[13] https://hsc.unm.edu/college-of-pharmacy/research-and-scholarship/metals/index.html; accessed September 26, 2018.

University of New Mexico, New Mexico Tech, and New Mexico Highlands University developed a component on uranium; they have generated a number of scientific publications on the biogeochemistry and mobility of uranium in New Mexico during the award period (2013-2017).[14] There has been substantial epistemological growth and diversification in regional environmental health sciences on the legacy of uranium mining in the last decade. By the twenty-first century, the former mining district had become a robust area of geophysical and geochemical inquiry.

In this dissertation, I pursue questions about the emergence of such applied sciences and the politics of environmental information. What are the different epistemological styles, the diverse modes of co-producing knowledge? How are they applied and taken up by the present technopolitical cleanup regime? What are the streams of information through which different stakeholders wade, and how do they interpret their way through the sometimes-overwhelming currents of data? Where are the contingencies and disjunctures of information—where data come together, connect, bridge, and traverse; and where data breach, fracture, fissure, and fault? I trace these questions through Chapter 5 and Chapter 6, which analyze two large uranium mill tailings sites; and Chapter 7 and Chapter 8, which address the problem of mine waste and mine water discharge in a basin that encompasses these two sites. In both chapters, we will notice the emergence of an environmental cleanup regime and its contested methods of environmental monitoring, modelling, and engineering.

The recent decade of growth and diversification in environmental sciences and information about the Grants uranium mining district was prompted by new collaborations among MASE, SRIC, and NMELC: an assemblage of advocacy, research, and law that works *for*

[14] https://www.nmepscor.org/science/uranium; accessed September 26, 2018.

the public good. Though the local grassroots efforts of the five core groups of MASE—ENDAUM, LACSE, Post-71, BVDA, and RWPRC—have been underway for nearly half a century, as have the trajectories of SRIC and NMELC, my colleagues acknowledged that they began to cultivate political clout by the beginning of the twenty-first century. Around 2006, they were acknowledged by state and corporate stakeholders as "the community" leg of the triad stakeholder model. My colleagues also recognized that the "multicultural" banner that brings together Native Americans, and Hispano and Anglo settler communities, became a powerful political coordinate that could be leveraged against corporate mining interests.

1.3 Settler Colonialism and "Multiculturalism" in the North American Southwest

Characterized in terms of ecological "sacrifice zones," the geography of uranium mining and milling, and the present policy and practice of environmental cleanup in northwestern New Mexico, constitute profound cases of environmental injustice and environmental racism, as well as deeper impositions of settler colonialism. There is a global human rights crisis associated with mining and resource extraction in general: many of the affected communities are geographically remote, economically depressed, politically "minoritized" (Simpson 2014:18); as well as recognized Indigenous peoples (Ballard and Banks 2003:298; Harvey 2015:249; Johnston et al. 2007:6; Kirsch 2014:5-9; Masco 2007:277). Indigenous lands and labor would bear the brunt of the extraction and primary production process in the Grants uranium district, in addition to bearing an uneven proportion of the legacy of environmental health hazards and inadequate public health services. The trauma of which continues today. There is a symphony of reportage and scholarship reverberating in response to the legacy of uranium mining and milling primarily in Navajo Country, as well as Laguna Pueblo and Acoma Pueblo (Brugge, Benally, Yazzie-

Lewis 2006; Johnston et al. 2007; Lewis, Campden, Shuey, Robinson, Baldwin, Begay 2015; Lorenzo 2017; S. Ortiz 1980; Pasternak 2010; Reno 1981; Voyles 2015).[15]

Thousands of years before it became known by AEC geologists as the "Grants uranium district," before the geological maps and memoirs, before the drills, pumps, and mills, the high desert landscape of northwestern New Mexico was/is/will be known as *Haaku, Kawaika, Shiwinna, Dinétah,* and many other significant Indigenous toponyms. The ruins of the former mining district pervade significant portions of the Navajo Nation (*Dinétah*) and Laguna Pueblo (*Kawaika*), adjacent to Acoma Pueblo (*Haaku*) and Zuni Pueblo (*Shiwinna*), in a region that is considered vitally significant to all 19 Pueblos of New Mexico and recognized tribes of Arizona, Colorado, and Utah.

In Chapter 9, I discuss the contested nature of Mount Taylor as a sacred place and state-designated Traditional Cultural Property (TCP) for five nominating tribes—Acoma, Laguna, Zuni, Hopi, and Navajo—a sacred pilgrimage site for dozens of other Indigenous nations throughout the Southwest region, and, according to economic geological estimates, "a world-class uranium deposit." I will trace this epistemological cataclysm, underscoring the profound constitutive incommensurability between such categories of being in which the land is central and vital (Espeland 1998:29; Raz 1986). The powerful process of commensuration yields where

[15] There is scant record of uranium production in the Pueblo of Acoma. There were forms of exploration conducted, such as airborne radiometric reconnaissance, but economic uranium ore resources could not be located. Though Acoma Pueblo was adjacent to the mining district, labor was recruited from Acoma, as companies hired for work in the uranium mines and at the mills, and everywhere in between (S. Ortiz 1980). Haulers drove truckloads of ore down windy dirt roads and trains carried uncovered shipments of uranium ore from the Jackpile mine to the Bluewater mill; from Laguna Pueblo through Acoma to Bluewater Valley. Note that the prevailing winds tend to carry particulate matter from the mining district southeast toward Acoma, in addition to being downstream from the district. When the population of Grants boomed, Acoma's drinking water was heavily impacted by human waste from the release of municipal sewage into the Rio San José. Acoma's 2006 resolution was drafted in response to the impact of past mining activities on air, land, water, and public health; it aims to protect cultural and natural resources from further degradation from mining, now and into the future.

Indigenous land-based values and meanings refuse to be rendered in terms of geological "resources," as the raw materials for modern industrial development. The refusal to be recognized, apprehended, and incarcerated, categorically and spatially (Simpson 2014), is as important as carefully attending to broader impacts and the possibility of scaling up Indigenous scholarship that is endorsed for non-native audiences. Following the work of the Diné and Laguna scholar June Lorenzo, I will discuss her understanding of how geographies of universal "rights" come into conflict with Indigenous notions of "responsibility" (2017:14). I ask how "multiculturalism" can serve to scale up Indigenous "grounded normativity" (Coulthard 2014) and a sense of responsibility toward the land as a way of displacing utilitarian notions of God-given rights to natural "resources."

I hope this understanding of multiculturalism will nuance the scholarship of settler colonialism, which offers strong reasoning to be critical of the way discourse of "multiculturalism" has been leveraged under neocolonial regimes in order to undermine Indigenous sovereignty (Dunbar-Ortiz 2014:7). Multiculturalism has served in part of the process Audra Simpson calls *homogenizing heterogeneity*, "a multicultural solution to the settlers' Indian problem" (2014:18, 20). Studying these discursive strategies of "multiculturalism" supplements discussions in fields of Native American and Indigenous Studies (NAIS) focused on settler colonialism. "Settler colonialism" is a field of study that accounts for the ways foreign populations displace and dispossess Indigenous peoples of their lands and livelihoods. A fundamental task involved in settler colonial studies is dispelling settler origin stories and founding myths. In many ways, this dissertation is concerned with compiling different origin stories. I consider these stories in relation to the original moment Karl Marx called "primitive

accumulation" (1976:873-940), and how that moment reoccurs through a process David Harvey calls "accumulation by dispossession" (2005:144).

Questions about cataclysmic epistemologies are at the heart of my inquiry into discursive formations of "multiculturalism" in northwestern New Mexico, and the "three-culture myth (Native American, Hispano, and Anglo) that has been at the center of academic and popular discourse about New Mexico for more than a century" (Kosek 2006:58). I am interested in the myths and realities of "the three cultures" of the Southwest (Lamadrid 2003; Sanchez 2014; Rodriguez 2007). How do the different sociocultural roots that tie people to place become reified in the way "Native Americans," "Hispanos," and "Anglos" perceive, conceive, and live in relation to each other? How do such categories of culture congeal even as "people struggling with each other are profoundly and mutually transformed" (Lamadrid 2003:12)?

I seek to understand "multiculturalism" in an emic manner, from the perspectives of my colleagues at the Multicultural Alliance for a Safe Environment (MASE). My colleagues at MASE cite the moment they began to cultivate political clout around 2006 as a situation where Native and non-native collaborators joined forces to address the shared problem of the legacy of uranium mining. I am interested in how "culture," "history," and "archaeology" are discursively leveraged in state political domains against the mining interests that have been influential in the region since the sixteenth century. In what follows, I ask how a conception of the life of the by-product can offer an alternative course of sociocultural analysis, and refine our understanding the relationship between "three cultures" and three categories of stakeholders. By treating the life of the by-product, uranium mill tailings piles, as an ontological and epistemological resource for the emergence of diverse forms of expertise, what possible insights open up about the production of space, place, and nature in northwestern New Mexico?

1.4 The Life of the By-Product

> Besides, what we are pleased to call the riches of a mine, are riches relatively to a distinction which nature does not recognize. The spars and veinstones which are thrown out in the rubbish of our mines, may be as precious in the eyes of nature, as conducive to the great object of her economy, and are certainly as characteristic mineral veins, as the ores of silver or gold, to which we attach so great a value (Playfair 1802; as cited in the third edition of *Ore Deposits*, Park and MacDiarmid 1975:1)

Uranium begins its social life as a by-product. At the end of the eighteenth century, near the mines of Joachimsthal (*Jáchymov*) in Old Saxony (today the Czech Republic), the German chemist Martin Heinrich Klaproth recognized uranium as a by-product from silver mining. In 1789, Klaproth found uranium discarded and piled up in dumps outside the silver mines in Johanngeorgenstadt. It was considered a "refuse by-product of silver mining." The miners gave it the name *pech-blende*, which translates to "bad luck-mineral," because it hampered the silver milling process. This is the etymological origin of the contemporary term "pitchblende." By 1847, a method was developed to use uranium for the yellow coloring of glassware and porcelain. The silver mill in Joachimsthal was converted for this purpose and was renamed *Urangelbfabrik* ("uranium yellow factory"). After radioactivity was discovered by Antoine Henri Becquerel in 1896, Marie and Pierre Curie placed an order for 10 tons of the processed uranium by-product from Urangelbfabrik. In 1898, the Curies discovered radium and polonium from what was once the "discarded processed ore from which uranium had already been extracted, sitting behind the factory, a refuse pile mixed with dirt, leaves, and twigs" (Marshall and Marshall 2008). By the beginning of twentieth century, the factory began processing radium too. The Radium Palace was constructed in 1912 across from the factory and advertised as "the first radon

spa in the world." By 1941, Urangelbfabrik was demolished and the site became a memorial for the Curies. Uranium mining in the district continued until 1964.[16]

Discarded and piled up in dumps—this refuse by-product. Discarded processed ore from which uranium had already been extracted, sitting behind the factory, a refuse pile mixed with dirt, leaves, and twigs. The figure of the pile is a fitting image to illustrate the original moment when the life of the by-product takes place, left behind for waste only to be rediscovered, the by-product of the by-product as it were. This is an optimistic story that prompts us to ask, what economic prospect lies beyond the horizon for these *discarded refuse piles* and the mining district as a whole. In the Grants uranium district of northwestern New Mexico, uranium was first recognized as a by-product of early twentieth-century radium and vanadium mining. In 1942, the Vanadium Corporation of America (VCA) found uranium in the vanadium ore, entered a lease[17] and secretly recovered 44,000 pounds of uranium oxide (U_3O_8) from the Navajo Reservation, which was recovered "via a uranium circuit at the Monticello mill (Utah) for the Manhattan Project 1943-1945" (McLemore 2010:24). Economic geologists (McLemore and Chenoweth 2017) have considered the Grants mining district in five historical periods: "radium boom" (1918-1923); "vanadium production" (1926-1940); "post WWII" (1948-1970); "uranium boom" (1970-1982); "a new uranium boom" (2008-present). Notice the discursive speculation of the so-called "new uranium boom" and what has been called "the nuclear renaissance" that never happened. It is worth noting that "All science involves speculation, and few sciences include as much speculation as geology" (McPhee 1998:133). Fewer yet include as much speculation as economic geology.

[16] This paragraph follows the chronological account of the chemists Marshall and Marshall (2008).
[17] The East Reservation Lease (no. I-149-IND-5705).

Specters of the uranium mining industry again became apparent in the first decade of the twenty-first century. Barbara Rose Johnston remarks on the shifting economic priorities and "the changing value of uranium oxide, which sold in December 2000 for US$7 per pound and six years later sells for US$60 per pound and is expected to continue its rise, prompting exploration and new mining worldwide" (2007:11). Though claim staking proliferated near Grants, the price did not continue to rise; it quickly dropped off the economic radar and has not recovered. I am speaking in general terms about the economic question of uranium oxide and its lifecycle as a commodity, which will be examined in detail in the following chapters. What I want to point out here is how each period of mining reverberates the last boom. In other words, stories of past mining pave the way for the prospect of future mining. The theory of industrial minerals, from an economic geologist's standpoint, envisions a capricious market driven by fickle consumer demands and technological innovation, whereby geologists are called upon, *demanded*, to move the mountains around them, overcome geological barriers, and provide the raw materials for engineers to manufacture a human-built world.

Though consumer demand and technological innovation can be perceived as straight forward lines of progress with the prospect of unlimited growth, the logic of economic geology is actually cyclical. In order to go forward, geologists have to turn around and go backwards, making mining "booms" from the ruins of former mining districts, and the materials of ancient earthly processes. It is a process that reaches backwards through time—surveying geologic archives, talking to old prospectors, going down old roads and visiting former mines, milling through what was left behind, the tailings that have piled up on the landscape. It is a process of going back through the strata of geologic time to extract some ancient material that has been bestowed a new human value. We can see how the logic of spectacular accumulation (Tsing

2005) and salvage accumulation (Tsing 2015) come together in the economic geologists' view of and vision for industrial minerals. Their goal in the geophysical production of nature is to turn rocks into a valuable economic resources called *ores*. "Ores are rocks and minerals that can be recovered at a profit" (Park and MacDiarmid 1975:1). "Mineral resources are the naturally occurring concentrations of material (solid, gas, liquid) in or on the earth's crust that can be extracted economically under current or future economic conditions" (McLemore 1986:3). "The mineral-resource potential of an area is the likelihood or probability that a mineral will occur in sufficient quantities so that it can be extracted economically under current or future conditions" (5). If one were to calculate the costs of cleaning up the former Grants uranium district, the term "ore" would not be applicable to the uranium deposits, because it would not have been possible to mine the uranium profitably without externalizing such expensive costs of production.

By framing the logic of economic geology in its own terms, concepts, chronologies and periodizations, what insights are offered into the production of nature in northwestern New Mexico and the making of the "Grants uranium district"? This prompts a second question about how the application of geologic knowledge has changed course during the contemporary period of "reclamation," "remediation," and "restoration." My fundamental argument here is that the second life of the by-product in the Grants uranium district coheres with the emergence of a technopolitical cleanup regime that utilizes federal and state government funding to monitor and remediate uranium mine waste and mill tailings. The cleanup process is regimented by the protocols of state agencies, which are predominantly influenced by the corporate science of transnational corporations and contested by the civic science of local communities and regional NGOs. By accounting for the emergence and entanglement of different forms of expertise, the collision between their geologic models and analyses, we can test the promise of technology for

the future and the prospect of ecological modernization. Given this course of study, it seems appropriate to write a concluding section that opens up the perceivable possibilities for cleaning up the Grants uranium district, by breaking down the confines of what I recognize as a cycle of "ecological sacrifice and salvation" that emanates from the modernist master narrative of nature and technology.

1.5 Conclusion: The Promise of Ecological Modernization

In August 2014, during my initial ethnographic fieldwork in New Mexico, I attended the National Conference on Mining-Influenced Waters, which was convened in the Grand Ballroom at the Sheraton Albuquerque Uptown Hotel. The U.S. Environmental Protection Agency (EPA) sponsored the conference for an audience of mine-waste professionals that identified variously as, for example, "Senior Environmental Engineer," "Technical Director," "Senior Scientist," "Soil Scientist," "Senior Economic Geologist," "Environmental Manager," and "Regional Administrator." In the Plenary Session, a technical director of the International Network for Acid Prevention (INAP) stated that "Mine waste management is the elephant in the room." Roughly ninety-eight percent of what is mined remains onsite as mine waste—overburden, waste rock, mine water, and tailings—which rests in context along with various chemicals used to extract the valuable ore from the host-rock. These agents are the material by-products of mineral extraction and production that remain onsite as a matter of industrial procedure.[18]

Acid drainage has been characterized as the most alarming problem facing the mining industry today (Ceto & Mahmud 2000:30). In certain cases, it is specified as "acid mine drainage" (AMD) or "acid rock drainage" (ARD). It was the problem the technical director

[18] https://clu-in.org/download/issues/mining/mining-influencedwater/Mining-600-R-15-088.pdf; accessed December 26, 2018.

would define in relation to his role at INAP. Both terms refer to the proliferation of harmful mining agents—a mixture of both naturally occurring and anthropogenic contaminants, which may include lead, zinc, copper, and other heavy metals; arsenic, cadmium, mercury, selenium, and uranium; as well as cyanide, acids, bases, polychlorinated biphenyl (PCB), and asbestos (2000:61). Depending on atmospheric, geologic, and hydrologic conditions, such contaminants may lay dormant onsite for years or decades before reaching water sources and cascading through the environment. It is important to note that anthropogenic conditions not only introduce the threat of acid drainage but also mediate the process, for better or worse.[19] It is through the process of acid drainage that mine waste enters the hydrologic cycle and begins to influence drinking water. Even after the machines of human production have left the mine waste, it continues to be an active agent in changing its environment and those living in it, which then engenders costly corporate liabilities. According to the INAP, "The cost of ARD remediation at orphaned mines in North America alone has been estimated in the tens of billions of U.S. dollars. Individual mines can face post-closure liabilities of tens to hundreds of million dollars for ARD remediation and treatment if the sulfide oxidation process is not properly managed during the mine's life."[20]

During my initial fieldwork, I took a cue from the regional environmental engineers, scientists, and technical experts who were addressing what would become the central concern of my dissertation. Mine waste is the proverbial elephant. This emic approach of identifying a

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[19] For example, the 2015 Gold King Mine wastewater spill in Silverton, Colorado was prompted by the EPA's attempt to remediate a site that was abandoned in 1923, which resulted in the collapse of an earthen dam that had been retaining the contaminated mine water. It yielded the contamination of the Animas and San Juan rivers in southern Colorado, southeastern Utah, northern New Mexico, and the Navajo Nation (see http://www.denverpost.com/news/ci_28781450/house-science-committee-review-gold-king-mine-disaster, accessed October 26, 2015).

[20] See http://www.gardguide.com/index.php?title=Summary, accessed October 26, 2015.

problem, bounding an ethnographic field site, and formulating research questions according to the epistemological purviews of my colleagues has helped structure my dissertation. My thesis about the promise and failure of technology and ecological modernization was inspired by a moment at the Mining-Influenced Waters Conference, which has driven my curiosity about the possibility of cleaning up the Grants mining district. An environmental engineer shared his experience and expertise on groundwater treatment by method of "evapotranspiration and geochemical controls" at arid uranium milling sites. He compared the process of treating groundwater contaminated by uranium to a Starfleet training exercise from Star Trek: "It's like Kobayashi Maru," he said, "It's a no-win situation." Kobayashi Maru premiered in *Star Trek II: Wrath of Khan* (1982), but references are made to it in various episodes. In the simulation, the captain of the Starfleet ship receives a distress signal from a ship called the Kobayashi Maru. Because the ship is in "neutral territory," an uncolonized space of the Starfleet, the captain would risk certain warfare with the Klingons if they attempt to rescue the ship. The training simulation introduces participants to a scenario where failure is designed into the program. It forces trainees to accept sacrifices, while rationalizing the costs and benefits of engagement, the purpose of which is to challenge the moral character of the trainee. It is a double-bind scenario, a situation between a rock and a hard place.

Captain James T. Kirk is the only character to achieve the rescue and evade warfare. He defied the design of the program by questioning the normative categorical imperatives, introducing a difference necessary to change the *status quo* of failed programs. This approach takes the repetitive application of a rule with a healthy sense of skepticism. The trope of Kobayashi Maru indexes the moments when and situations where the easy application of normative ethics falter. This was not the first time I noticed an engineer adopt the metaphor of

Kobayashi Maru. It was often used pessimistically to describe certain failure given the parameters and limitations of the project, as a way of coming to terms with the rationale of "sacrifice zones." In this way, it can be related to the "trolley problem," an ethical exercise in utilitarianism where an engineer must decide whether to let a runaway train kill one person or five people. During my work as a graduate student teaching assistant and co-instructor for courses at Rensselaer Polytechnic Institute, I noticed circumstances where undergraduate engineering students referred to Kobayashi Maru optimistically, in the spirit of Captain Kirk, to suggest possibilities for changing the rules, improving the design, and refusing to accept sacrifices. It is unclear whether and to what extent the environmental engineer at the Mining-Influenced Waters Conference had any optimism in his claim.

In this dissertation, I describe the politics of cleaning up the Grants mining district in terms of normative ethics, by taking account of local conceptions of "good" and "bad" governance, and the relationship between "civic science" (Fortun and Fortun 2007), which is "for the public good," and "corporate science" (Kirsch 2014). Normative conceptions of "good" and "bad" science offer unique insight into the politics of cleaning up the Grants uranium district, but they ultimately fail to capture the dynamics of how technology and politics become entangled through nature and culture, the unintended nature of the by-product, and the geophysical formation of the landscape in northwestern New Mexico. Gabrielle Hecht's (2009) concepts of "technopolitics" and "technopolitical regimes" offer the threads necessary to trace such entanglements; they guide my analysis of the relationship between the different stakeholders involved in the politics of cleanup. A focus on technopolitics shifts our attention from the discursive forms of civic and corporate science involved in environmental monitoring and modelling to projects of environmental engineering and the management of uranium mill

tailings piles. With this turn toward a technopolitical understanding of the life of the by-product, I can account for the unintended dimensions of uranium mining and environmental cleanup.

Timothy Mitchell's sense of "techno-politics" informs my analysis by guiding my attention toward engineering projects as, "a technical body, an alloy that must emerge from a process of manufacture whose ingredients are both human and nonhuman, both intentional and not, and in which the intentional or the human is always somewhat overrun by the unintended. But it is a particular form of manufacturing, a certain way of organizing the amalgam of human and nonhuman, things and ideas, so that the human, the intellectual, the realm if intentions and ideas seems to come first and to control and organize the nonhuman" (Mitchell 2002:42-43). The technopolitical life of the by-product is *the unintended* overrunning *the intended*. In the case of the by-product, the intended is secondary. Intentional forms of human production return to the abandoned refuse pile to salvage what remains. The by-product is an unintended consequence of production that is initially illegible and beyond the grasp of human control. It is the "bad-luck mineral" that gums up the machines. "Just as pollutants are integral products of the production process though not its immediate goal," says Neil Smith, "much of the production of nature is not the deliberate goal of production" (90). Indeed, human action reaches beyond intentional human production in myriad directions. The by-product indicates more than just unintended consequences; it also serves as an index for the differentiated results of the uneven geographical development of the material landscape (Smith 1984:50). In other words, the distribution of the by-product contours topographies of injustice and "landscapes of power" (Powell 2018). Tracing the life of the by-product can illuminate particular standpoints of social justice and areas of political-economic critique. The by-product inheres in the savage process of making "resource

frontiers" that are made legible through forms of "spectacular accumulation" (Tsing 2005). It then becomes a target for what Anna Tsing calls "salvage accumulation" (2015:63).

The by-product ruptures the ideology of "control" and "domination" of nature—the bourgeois "triumphant vision of man's conquest of nature" that Raymond Williams and Neil Smith critique (Smith 1984:47). Then, the ideology returns with new intentions for old materials. My argument here is that the second political-economic life of the by-product has emerged in northwestern New Mexico in the form of an environmental cleanup regime that coheres around the issue of uranium mill tailings and mine waste, and is composed of different epistemological styles of geosciences for environmental monitoring and remediation from universities, civil organizations, government agencies, and corporations. By contesting baseline levels of environmental data, these stakeholders deliberate about appropriate technologies and techniques of environmental monitoring, modelling, and engineering using incommensurable terms of "restoration," "remediation," and "reclamation."

By raising questions about the possibility of cleaning up so-called "sacrifice zones," we can test the promise of ecological modernization. The life of the by-product poses a significant problem for the theory and practice of ecological modernization. Stuart Kirsch describes the "fallacy of ecological modernization theory" as a critique of the assumption "that new technologies can be developed to mitigate ongoing environmental impacts of mining" (Kirsch 2014:195). In response to Arthur Mol's (1995) claim that "the only possible way *out* of the ecological crisis is by going further *into* the process of modernization," Richard York and Eugene A. Rosa pose several challenges that lead to a counter finding in their research: "the most highly modernized nations (as indicated by per capita GDP, urbanization, and economic structure) have the highest environmental impacts" (2003:276; original emphasis). Proponents of

ecological modernization theory "have generally failed to refute the claims from demodernization and political economic perspectives that capitalism and modernization are incompatible with ecological sustainability" (278). I take Kirsch's notion of the *fallacy of ecological modernization theory* to task here by examining the technopolitical life of the by-product at the heart of the promise of cleaning up the Grants uranium district, a place where normative ethics have faulted giving way to "sacrifice zones."

I pose this challenge to the ecomodernism of the Breakthrough Institute and their *Ecomodernist Manifesto*.[21] They refer to the moment humans became a geophysical force on a planetary scale as the moment we would recognize our true potential to *control* nature for the better. Clive Hamilton (2015) critiques this form of ecomodernism as "the theodicy of the 'good' Anthropocene," which poses the old theological argument that, due to the divine nature of God, people are ultimately good; therefore technology must be good too. A generous reading of such an ecomodernist proposition would appreciate the advocacy that paves the way for good technology, but normative notions of "good" and "bad" fail to capture the complexity of how technology and politics become entangled through nature and culture. This manifestation of ecomodernism glaringly omits standpoints of social justice and critiques of political economy. They do not recognize ongoing manifestations of settler colonial exploitation and dispossession, and the uneven geographical development.

Ecomodernists tend to subscribe to an ideology where the benefits of nuclear technologies, for example, outweigh the costs of uranium mining. The "greater good" of nuclear weapons and electricity are calculated over the externalized costs of production. The by-product is an important point of analysis for this reason. I suspect that projects of ecological

[21] http://www.ecomodernism.org/; accessed December 28, 2018.

modernization will have to account for the life of the by-product—mine waste and mill tailings from the extraction of industrial minerals. The figure of the by-product reveals the sacrifices made in pursuit of "good technology" for the future and the promise of technological salvation. It poses a significant challenge to the theory and practice of ecological modernization by accounting for the externalized costs of production. By describing how such a technopolitical regime for environmental cleanup emerged around issues of mine waste and mill tailings, I hope to contribute to critical anthropological scholarship on "ecological modernization" and "modernization theory" (Ferguson 1999; Fortun 2001; Kirsch 2014; Masco 2006; Scott 1998).

The manifestation of ecomodernism described above is an example of what James Scott calls "high-modernist ideology," which "is best conceived as a strong, one might even say muscle-bound, version of the self-confidence about scientific and technical progress, the expansion of production, the growing satisfaction of human needs, the mastery of nature (including human nature), and, above all, the rational design of social order commensurate with the scientific understanding of natural laws. It originated, of course, in the West, as a by-product of unprecedented progress in science and industry" (1998:4). Scott describes the emergence of scientific forestry in Prussia and Saxony in the late eighteenth century to illustrate his conception of high-modernist ideology and the utilitarian discourse that the displaces "nature" with the term "natural resource." His work on *legibility* has inspired my questions about how the discipline of geology was applied in rendering the Grants uranium district legible for the extraction of uranium ore "resources." It also inspires my questions about how uranium mill tailings piles and mine waste have emerged as objects of geochemical inquiry and subjects of environmental health governance.

By examining the promise of ecological modernization, I can follow up on the claims of Joseph Masco (2006), and Barbara Rose Johnston and Shirley Fiske (2014) about the failure of current technology and the promise of future technology at so-called "sacrifice zones." According to Masco, "Official estimates of the cost of cleaning up the Cold War nuclear complex ranged from $100 to $380 billion at the end of the Cold War, the DOE was forced to admit that some sites were beyond environmental remediation given current technology, and were, thus, de facto national sacrifice zones" (2006:220). Barbara Rose Johnston and Shirley Fiske raise questions about how the promise of remediation is undergirded by "assumptions that science and technology will evolve to effectively address the complex nature of the contamination" (2014:4).

My line of questioning also takes to task the historian Matthew Wisnioski's claim that "the creation of the EPA gave rise to environmental engineering as a new regulatory field at the nexus of government, academe, and industry" (2012:188). The EPA has been a conduit for bringing federal funding into the state of New Mexico, which employs geoscientists and hydrologists with advanced degrees from New Mexico Tech, for example. In his statement about the EPA nexus, Wisnioski does not consider the agency of local communities and NGOs as a significant force for *environmental engineering as a new regulatory field*. In the chapters that follow, I will show how emergent forms of undone civic science can supplement and sometimes drive federal and state technopolitical cleanup regimes in former uranium mining districts. EPA public meetings have become representational spaces that offer "political openings" to intervene in the politics of environmental information, creating new possibilities for environmental cleanup.

CHAPTER 2

METHODOLOGY: AB-USE OF THE STAKEHOLDER MODEL

In this methodological chapter, I consider ethnographic approaches that account for the technopolitical life of the by-product and the making and unmaking of the Grants uranium district. I am interested in the myriad problems associated with mine waste in general and uranium mill tailings piles in particular, how different people come to terms with these issues, and the different meanings and values of those terms. What follows are designs for a sociocultural anthropological study of the expertise involved in monitoring and managing former mining districts. Though the focus is on the experts who monitor and manage the mine waste and mill tailings, I consider many different perspectives on the policy, planning, design, and engineering of uranium mill tailings piles. I am abiding by Evelyn Fox Keller's methodological imperative of "explanatory pluralism," which "is not simply a reflection of differences in epistemological cultures but a positive virtue in itself, representing our best chance of coming to terms with the world around us" (2002:300).[22] This is a cumulative and positive endeavor that pursues a broader understanding of "expertise" and an awareness of diverse epistemological cultures. By examining different forms of explanation and how different lines of thought intersect in particular situations, this approach forces us to think critically about the qualities of

[22] Keller contrasts her terminology of "epistemological culture" from Karen Knorr Cetina's concept of "epistemic culture" (1999) and relates it to Ian Hacking's notion of "style of reasoning" (1994) and Lorraine Datson's "historical epistemology." Keller accounts for the explanations, models, and metaphors of life among biologists. Resisting a reductionist tendency, she seeks to identify the diversity of explanatory goals and the various needs they satisfy. I am obviously moving away from her intended meaning of "epistemological culture" as something that belongs to scientists. Though there is an important point here about how scientists have culture too, "epistemological culture" also belongs to non-scientists; they have knowledge too. I am interested in the relationships between diverse epistemological cultures across taxonomies of "stakeholders." I argue that "expertise" can be understood as broad, diverse, collective, and perhaps more relational than we once thought. The "scientist" label that stands for universal knowledge will be taken to task in particular situations, and in relation to diverse epistemological communities.

"experts" and the meanings and values of "expertise." As I mentioned at the beginning of the first chapter, this course of research contributes to the many cases in which environmental sciences and engineering have been positively improved through the inclusion of diverse stakeholder perspectives and forms of knowledge (Hoover et al. 2015; Scammell 2010).

Though I am interested in *epistemological* questions about knowledge, I offer a *practical* inquiry into the application of geological knowledge—applied geosciences, geochemistry, geophysics, geohydrology, and other earth and planetary sciences that have been used to understand the Grants mining district. I address the epistemological question of how to study knowledge by observing the ways in which knowledge is applied and information is leveraged in practice. What are the diverse epistemological styles, the different modes of co-producing knowledge? How are they applied in the process of cleaning up the Grants district? What are the streams of information through which different stakeholders wade, and how do they interpret their way through the sometimes-overwhelming currents of data? Where are the confluences, contingencies, and disjunctures of information—where data intersect, connect, bridge, and traverse; and where data breach, fracture, fissure, and fault? These are fundamental questions about the politics of environmental information, and the sociocultural interface between science and policy. I will plot these questions in ways that connect the fields of science and technology studies (STS) and political ecology.

By studying the possibility of cleaning up former mining districts, this chapter sketches an ethnographic portrait of the entanglement of technology and politics, and the promise and failure of ecological modernization from the perspectives of many different stakeholders. The joint pursuit of epistemological studies of science and technology combined with critical studies of political ecology can offer pathways to move between analytic scales of environmental

information sciences, the politics of environmental monitoring, modeling, and engineering, and the geophysical production of nature. By attending to how representations of nature map onto the physical, material production of nature, I seek to contribute to an evolving body of scholarship on diverse representational strategies in political ecology (see West 2016).

2.1 MASE and Colleagues

This chapter is about my own peculiar ethnographic project that begins with an internship as a graduate student researcher at the Multicultural Alliance for a Safe Environment (MASE), a regional environmental advocacy organization that coordinates the efforts of five local grassroots groups: Eastern Navajo Diné Against Uranium Mining (ENDAUM), Laguna-Acoma Coalition for a Safe Environment (LACSE), Red Water Pond Road Community (RWPRC), Bluewater Valley Downstream Alliance (BVDA), and Post-71 Uranium Workers Committee (Post-71). These are groups that have emerged in response to the legacy of uranium mining. Their mission is to "restore and protect the natural and cultural environment through respectfully promoting intercultural engagement among communities and institutions."[23] Beginning around 2006, they started organizing across communities under the banner of MASE, developing sophisticated critiques of the logic, discourse, and practice of the technopolitical cleanup regime in the Grants mining district. MASE also works in close collaboration with the Southwest Research and Information Center (SRIC) and New Mexico Environmental Law Center (NMELC), and in relation to various other local, regional, national, and international governmental and nongovernmental organizations. Such a network of *research-advocacy-law* can be conceived as a stratagem of the "politics of space," to use Stuart Kirsch's term, "which links actors in multiple

[23] https://swuraniumimpacts.org/contact/; accessed February 7, 2019.

locations. The resulting networks are comprised of individuals, communities, nongovernmental organizations, experts, lawyers and others. They benefit from the complimentary mobilization of resources, discourses of persuasion, access to power, and forms of leverage deployed by their participants" (2014:188).

By the time I arrived, MASE had already become known by federal and state employees as the "community" leg of their triad stakeholder model in the Grants mining district. My apprenticeship with MASE began over the course of three months—June, July, and August—during the summer of 2014. It was part of a preliminary ethnographic project that I proposed for a two-year graduate colloquium in sociocultural anthropology. I approached my initial work with MASE and colleagues as a form of "apprenticeship in critical ethnographic practice" (Lave 2011). *Apprenticeship* can be a way of inhabiting the spaces between the theoretical and the empirical, aligning with and committing to a particular political and ethical practice, and shifting from abstract commonplace assumptions to critical relational situations.[24]

In my role as a graduate student researcher, I would attend to many different tasks. My main project, however, was to draft a ten-page brief at a tenth-grade reading level that would bring together a fragmented and dispersed body of information regarding the legacy of uranium

[24] In her 1993 Lewis Henry Morgan Lecture, the anthropologist Jean Lave made four key points hewn from nearly a century of debate about ethnographic practice in anthropology. First, ethnography is "critical." It queries commonplace assumptions and commonsense understandings. It also enunciates and amplifies social criticism and social justice from a relational, situational, historical standpoint (2011:10). Second, ethnography works at the relationship between theory and practice. In other words, ethnographers arrive at one theoretical-empirical problematic or another, which changes over the course of long-term engagement (10-11). Third, Lave highlights a "functional positivist paradigm" at the core of the discipline of anthropology (11-12). The commonsense, functional positivist assumptions become the background against which ethnographers can shift to a critical relational standpoint. For example, Lave highlights the friction and transformation that occurs when the common Western categories of "formal" and "informal" education are applied to make sense of the acquisition of mathematical knowledge among Vai and Gola tailors' apprentices. Fourth, by situating oneself relationally to a particular political and ethical practice, the pursuit of fieldwork can be a way of *inhabiting* a changing theoretical-empirical problematic (12-13).

mining in New Mexico. Rough drafts of the brief were edited by my colleagues at MASE and SRIC. Revisions were made regarding keywords and concepts, selection of sites and case studies, narrative style and textual organization. The brief is relevant here because much of that information pervades this text, and the questions raised during that experience have evolved into the research questions of my current ethnographic project. MASE's prioritization of research and information has driven my own inquiry and intervention in the politics of environmental information. The task of compiling environmental information has continued to drive my work through a landscape that is checkered with "data gaps," and scant public health and epidemiological studies. However, the information landscape has changed substantially over the last decade; and, in recent years, one might say there has been a veritable renaissance of "civic science" (Fortun and Fortun 2005), a tremendous growth and diversification of information regarding the Grants mining district that can be considered "for the public good." For example, Region 6 of the EPA has been conducting environmental research at the proposed San Mateo Creek Basin Superfund site in order to initiate the CERCLA process.[25] The College of Pharmacy at University of New Mexico was awarded a grant from the National Institute of Environmental Health Sciences (NIEH) to establish the UNM METALS Superfund Research Program.[26] And, the National Science Foundation's (NSF) Established Program to Stimulate Competitive Research (EPSCoR) at the University of New Mexico, New Mexico Tech, and New Mexico Highlands University has developed a component on uranium that addresses the biogeochemistry and mobility of uranium in New Mexico.[27]

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[25] CERCLA: Comprehensive Environmental Response, Compensation and Liability Act. https://www.epa.gov/grants-mining-district/san-mateo-creek-basin; accessed September 26, 2018.
[26] https://hsc.unm.edu/college-of-pharmacy/research-and-scholarship/metals/index.html; accessed September 26, 2018.
[27] https://www.nmepscor.org/science/uranium; accessed September 26, 2018.

What started as an internship with MASE led to many other opportunities and experiences, which have culminated in this ethnographic project. Over the past four years, MASE has kept me abreast regarding developments in the Grants mining district, and the scheduling and proceedings of public meetings and hearings. In August 2017, I returned to New Mexico to carryout long-term ethnographic fieldwork under the auspices of Rensselaer Polytechnic Institute's Humanities, Arts, and Social Sciences Fellowship. The research portion of which lasted until December 2018. Although the standpoint methodology of apprenticeship in critical ethnographic practice has remained an integral part of my approach, I have extended my ethnographic endeavor to better understand the relationships between stakeholders. My focus has shifted from my own apprenticeship at MASE to public meetings where the whole gamut of stakeholders would come together to discuss the limitations and possibilities of cleaning up the Grants mining district. I supplemented these experiences with interviews, archival research, and with the collection and analysis of corporate, government, and NGO reports, news coverage, and relevant scientific publications.

2.2 Participant-Observation

What I deem "ethnographic" here primarily refers to participation, observation, and documentation at public meetings and hearings held by government employees, in obligation to their various protocols to provide "the public" with information. At these joint-agency multi-stakeholder meetings, I documented my observations with hand-written notes and photographs when permitted. In these situations, I would introduce myself as a doctoral student of science and technology studies from Rensselaer Polytechnic Institute and disclose the purpose of my dissertation research in common language (e.g., "I am studying different perspectives on the

possibility of cleaning up the Grants mining district and the diverse forms of expertise involved in such an undertaking"). Most of the meetings took place at the Cibola County Building in Grants. I would also attend meetings held by MASE at the First United Methodist Church in Grants, the Recreational Center (or "Fun Center") in the Village of Milan, and the Sky City Casino in the Pueblo of Acoma. Additionally, I attended meetings and hearings in Santa Fe, at the Wendell Chino Building and the New Mexico State Capitol Building (the "Roundhouse"). All of the meetings mentioned above were accompanied by digital and/or paper documents containing environmental information about the Grants mining district. Indeed, many meetings coalesced around the public release of new artifacts of environmental information. For this reason, my analysis of such multi-stakeholder meetings accounts for the "graphic artifacts" (Hull 2012) that circulate and mediate the interactions between stakeholders. Finally, in addition to meetings and hearings, I participated in public tours of the Grants district, visiting and even going on top of uranium mill tailings piles.

2.3 Interviews

I collected 22 unstructured and semi-structured interviews with key stakeholders through the process of interlocutor referral ("snowball sampling"). I began by interviewing my closest colleagues at MASE, followed by interviewing the colleagues they recommended. I also requested interviews with various stakeholders at the aforementioned meetings. Unstructured interviews were used to identify questions that could not be known in advance and to identify appropriate courses of questioning given a particular interlocutor's experience and expertise. Interviews were documented by audio-recording and hand-written notes when verified informed consent was received. In addition to interviews, I had informal discussions on a daily basis with

79 people in Grants, Gallup, Milan, Socorro, Santa Fe, and Albuquerque, New Mexico. With permission, I accounted for these discussions in hand-written fieldnotes.

2.4 Archives

I have supplemented my ethnographic fieldwork with archival research in the Geologic Information Center at New Mexico Tech, the Center for Southwest Research and Special Collections at University of New Mexico, Southwest Research and Information Center (SRIC), the collection of the Cibola County Historical Society, and the library at the Grants branch of New Mexico State University (NMSU). The Geologic Information Center is a specialized library and archive that contains geologic data on New Mexico's mining and petroleum industries, including more than 5,000 maps, roughly 5,000 reports and publications, over 2,000 photographs, and about 1,200 theses and dissertations.[28] The Center for Southwest Research and Special Collections contains historical manuscripts, books, recordings, photographs, and other library materials that pertain to New Mexico and the Southwest.[29] At the Center, I was focused on the anthropologist Louise Lamphere and colleagues' Oral Histories Project of San Rafael, San Mateo, and Grants, New Mexico (2006-2010). SRIC is a non-profit educational and scientific organization that publishes an online open-access journal, *Voices from the Earth*, in addition to housing a number of other digital and physical documents that address energy development and resource exploitation in the Southwest.[30] The Cibola County Historical Society allowed me to access their historical sources regarding uranium mining in Grants (e.g., newspaper clippings from the *Grants Daily Beacon*). NMSU Grants Library contains a number of reports and plans

[28] https://geoinfo.nmt.edu/libraries/gic/home.html; accessed February 5, 2019.
[29] https://elibrary.unm.edu/cswr/; accessed February 5, 2019.
[30] http://www.sric.org/; accessed February 5, 2019

on Homestake Mining Company's Grants Reclamation Project, in addition to other regional environmental monitoring and groundwater hydrology reports.[31]

2.5 Ethnographic Refusal

My work with MASE has necessarily involved collaboration with Indigenous peoples of Acoma Pueblo, Laguna Pueblo, and the Navajo Nation. Over the last four years, I have been discussing the possibility of conducting ethnographic research with my Indigenous colleagues. Though I have received verbal and written consent, as well as letters of support to conduct ethnographic fieldwork and interviews in the manner described here, we ultimately decided not to render them as ethnographic research subjects. This decision was made for a number of reasons, foremost because there is a long track-record of unethical conduct of social, behavioral, and biophysical research done by non-native researchers working among Native communities. Moreover, the unethical conduct of research among Indigenous peoples is not a problem relegated to the past; such problems persist. Anthropologists working among communities impacted by mining are particularly vulnerable to having their research leveraged for the purposes of the mining industry against the interest of their Indigenous colleagues (Ballard and Banks 2002; Coumans 2015; Kirsch 2014; also see Jorgenson and Wolf 1970). Even research designed with the best intentions and the best interest of Native interlocutors can be exploited. This decision has been an important factor in my calculations of "ethnographic refusal" (Simpson 2014).

However, given the circumstances, a flat-out refusal to represent the perspectives of Indigenous peoples runs the risk of erasure, perpetuating ignorance of Indigenous political and ethical standpoints, which is a problem that has inspired anthropological research for the better

[31] https://grants.nmsu.edu/library/; accessed February 5, 2019.

part of the twentieth century. A Native colleague once expressed to me, "We don't want you conducting research in a vacuum." For these reasons, I recognize my Indigenous colleagues as advisors, from whom I would request help in re-directing my research questions and compiling my bibliography. I do take account of my Indigenous colleagues' formal public statements and publications regarding the Grants mining district. This is a means of what Gary Downey (2009) calls "scalable scholarship"—careful consideration of the possibilities of scaling up different epistemological standpoints, different ways of knowing the world, which have been marginalized and minoritized by the dominant epistemological paradigm. This task entails citation of Indigenous scholarship that has been endorsed for non-native audiences in order to remind us of what Glen Coulthard calls Indigenous "grounded normativity" (2014:3). I consider this to be a gesture of what Spivak (2012) refers to as "ab-use."

2.6 Situating Critique Outside Corporations and States

Though I have had conversations with many different stakeholders from the community, the state, and the corporation, I did not interview active employees of state agencies or corporations due to the professional risks and hazards entailed in the politically polarized landscape of the Grants mining district. I have however interviewed retired employees of both state agencies and corporations, as well as independent scientists, engineers, and researchers. It is worth noting that such limitations have generated a critical edge in this research; many of the voices represented here offer incisive critiques of the environmental cleanup regime. In this way, I have followed Stuart Kirsch's method of situating critique outside of corporations and states. Kirsch suggests "alternative models for studying corporations by examining how they produce and manipulate science in order to influence their critics and avoid regulation" (2014:12). As for recognizing

one's political-ethical engagements and theoretical-empirical orientations, Kirsch prescribes a "logical extension of the commitment to reciprocity that underlies the practice of anthropology" (11). In his case, the constants that underpin his research are the people with whom he began his work: those affected by pollution. Such relationships would become the ethnographer's locus of reciprocity. Ballard and Banks offer a similar ethics of engagement: "anthropologists must choose between an illusory neutrality, which states and corporations are best positioned to exploit and advocacy on behalf of local communities" (2003:306). It is this form of standpoint methodology (Harding 1993) that fixes my ethnographic approach toward the triad stakeholder model. Situating ethnographic research among communities that have been marginalized and minoritized through mechanisms of dispossession and displacement makes possible the forms of cultural critique for which sociocultural anthropology has become known over the last century (Marcus and Fischer 1986).

2.7 Triad Stakeholder Model of Analysis

In this way, I seek to refine our understanding of the different "stakeholders" involved in cleaning up the Grants mining district, as they deliberate about the possibility of reclaiming abandoned uranium mines, remediating Superfund sites, and restoring the natural and cultural resources of northwestern New Mexico. Stakeholders in local communities, government employees, and transnational mining corporations express different understandings of appropriate technical applications and outcomes of environmental cleanup, as well as different terms, values, and ideologies. This course of study builds on critical scholarship in environmental anthropology of the triad stakeholder model of analysis, which emerged in international development discourse in the 1980s, as a tool for managing public deliberations

between three categories of actors: “the corporation,” “the state,” and “the community” (Ballard and Banks 2003; Fortun 2001; Godoy 1985; Jacka 2015; Kirsch 2014).

“The introduction of local communities as stakeholders,” according to Chris Ballard and Glen Banks, “into the previously binary relationship between states and corporations has led to the widespread adoption by industry analysts of a three-legged or triad stakeholder model” (2003:289). Although Ballard and Banks identify limitations of “the now conventional triad stakeholder model,” they ultimately accept it: “the various institutions that relate to the three central categories—corporation, state, and community—have a persistent presence, demanding that they continue to be treated as fundamental components of any analysis” (290). Using the corporation-state-community triad as a model for analysis is helpful for identifying various social actors according to three different categories, but it limits our ability to think otherwise. It fails to account for the “multi-sited and multi-vocal arena for interaction of exceptional proportions” (289). It fails to grasp a “new global cast of agents and a novel range of interconnected locations” (289). Such distribution of analysis would challenge orthodoxies of ethnographic practice and extend beyond the “conventional lines of anthropological enquiry” (289). This approach can be understood as part of the broader movement Jessica Barnes and Michael Dove notice: “Indeed, over the past few decades many anthropologists have been moving away from studies of individual communities to analyses of the ways in which people, objects, and ideas are interrelated across space and time in an increasingly globalized world” (2015:5; see Fortun 2001; Gupta and Ferguson 1997; Marcus 1995; Tsing 2005; West 2012). Ballard and Banks subscribe to George Marcus’s call for multi-sited ethnography, which places ethnographic practice in complex, “often-unlikely” collaborations, and questions “the romantic ideal of the solitary

scholar" (2003:307). They call for something like the "integrative approach" articulated by Ricardo Godoy in *Mining: Anthropological Perspectives* (1985).[32]

By the twenty-first century, new designs for multi-sited ethnographic research began to flourish among sociocultural anthropologists welcoming new collaborative opportunities and extending the lines of ethnographic inquiry beyond traditional disciplinary boundaries. An outstanding example is Kim Fortun's (2001) experimental ethnographic approach and her expansive analysis of "enunciatory communities," through which she identifies the merits and problems associated with R. E. Freeman's "stakeholder model of management" (1984). Fortun writes:

> Like most pluralist models, the stakeholder model can't seem to tolerate much complexity—or much dissent. I needed a different model. Yet I also needed to better understand how a stakeholder model *could* work. I needed to turn the stakeholder model into a resource, rather than insisting only on its insufficiencies. So I made the decision to rely on a stakeholder model a little differently than usual—miming the model so that I could see its limits—organizing my own thinking around "indigenous categories" to better understand the merits and problems of those categories (2001:11).

The value of the stakeholder model is its recognition of difference; but it is often used to "manage difference" and shape "diversity into consensus" (11). Fortun offers "a new way to account for the emergence of new subject positions" (9). Disasters do not figure easily into

[32] Noticing the paucity of "mineral economics" in the anthropological literature on mining, Godoy proposes an integrative approach that brings together the geologic, economic, social and cultural dimensions of mining. Following Godoy's advice, I attend to the economic geology of the Grants uranium district and the social life of uranium oxide as a commodity. Though I have explored such issues to some extent in the previous chapter, I will focus explicitly on the integration of mineral economic concerns in Chapter 9, which offers an analysis of the New Mexico Mining and Minerals Commission hearing and decision to permit the Mt. Taylor uranium mine to shift from "standby" to "active." During the hearing, economic considerations of minerals became glaringly obvious, even though the Commission deemed any economic consideration to be outside their purview and jurisdiction. The Commission considered economic forecasts to be the sole responsibility of the company. Though economic questions and discourse were unsuccessfully censored from public comments during the hearing, they became the central issue of debate and a major source of contestation, hence a key area of focus in the following chapters.

discrete "units" of analysis; they are not bounded by space and time; they entangle the global and local, past and future. Arriving after the fact, given the disastrous circumstances in Bhopal, India following the explosion of a Union Carbide chemical plant in 1984, Fortun's "own advocacy would become an object of analysis alongside the advocacy of others." By pushing the limits of the stakeholder model, Fortun's account of enunciatory communities turns difference and diversity into a resource rather than a problem. This means more than compiling different modes of analysis. The effects of crosscutting enunciations can be recognized as a "textual organizing device" that takes form from one's own narration being interrupted by the different narrations of others.[33]

Ethnographers do not have complete control over the text. "Ethnography is invaded by heteroglossia" (Clifford 1988:51). The author's voice is refracted by the voices of others and diverse discursive styles. Particular experiences in local places shape our course of analysis; local people interrupt master narratives and particularize the discourse of social and natural sciences. Anna Tsing's remarks about engaging the universal come to mind: "Attention to friction opens the possibility of an *ethnographic* account of global interconnection. Abstract claims about the globe can be studied as they operate in the world. We might thus ask about universals not as truths or lies but as sticky engagements" (2005:6; original emphasis). By

[33] Enunciatory communities arise productively from a problematic distinction between "statements," as out of place and divorced from context, and "enunciations," which clearly connect with and cut across historical-material circumstances and phenomenological moments. Foucault's problematization of the distinction underscores the impact of his nuanced method of discourse analysis (361-362). There are four ways Fortun's analysis of the crosscutting effects of enunciation leverages this aspect of Foucault's work: first, by unsettling the opposition between the particular and the general, and by demonstrating how what was once thought to be unified and isolatable is actually crosscutting; second, by describing the places where discourse becomes an historical effect; third, by showing how enunciation divides and disperses; and fourth, by examining "how enunciation manifests continuity—it is something in which subjects return and begin again. But he also emphasizes *the strategies through which enunciation transforms and even disposes of given ways of speaking*" (362-363; emphasis added).

questioning general "expertise" in particular situations one can attend to how "even so-called general knowledge only has power in specific circumstances" (Lave and Wenger 1991:33). Ethnographic approaches benefit from experiences that change the course of inquiry. This grounded use and "ab-use" of universal models, such as the triad stakeholder model, and the friction that occurs, can expose limitations and possibilities for a broader, more diverse understanding of the people involved in the environmental health governance of the Grants mining district.

I am following Gayatri Spivak's strategy of *ab-use from below*: "A literary pedagogy, choosing texts carefully, can at least prepare another space that makes visible the fault lines in slogans of the European Enlightenment… [T]he remaking of history is a persistent critique, unglamorously chipping away at the binary oppositions and continuities that emerge continuously in the supposed account of the real" (2012:71-72). Spivak proposes a bibliographic strategy of "ab-use" that selects and uses texts carefully in order to foreground the fractures and fissures in the archives and libraries of the Enlightenment.[34]

After almost four decades since its initial conception amid an Orwellian zeitgeist, the late-industrial triad stakeholder model remains a pervasive form of analysis and management. It

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[34] Spivak explains how "ab" means more than "below," the prepositional standpoint to which she refers. According to Spivak, the Latin prefix "ab" indicates:

> both "motion away" and "agency, point of origin," "supporting," as well as "the duties of slaves." It nicely captures the double bind of the postcolonial… regarding the Enlightenment. We want the public sphere gains and the private sphere constraints of the Enlightenment; yet we must also find something relating to "our own history" to counteract the fact that the Enlightenment came, colonizer and colonized alike through colonialism, to support destructive "free trade," and that top-down policy breaches of Enlightenment principles are more rule than exception. This distinguishes our efforts from the best in the modern European attempts to use the European Enlightenment critically, with which we are in sympathy, enough to subvert! But "ab-use" can be a misleading neographism, and come to mean simply "abuse." That should be so far from our intentions that I thought to sacrifice precision and range and simply say "from below" (2012:3-4).

is an important concept for analyzing how human relations are integrated into mining, development, disaster, and other world historical political-economic interconnections. From an emic perspective, my colleagues and interlocutors in New Mexico, stakeholders on all sides, would often organize their field of analysis in these terms. The model can be used to calculate political coordinates that are strategically leveraged by all stakeholders. Among environmental anthropologists, the stakeholder model remains a source of immanent and imminent critique. This form of critique is reluctant to transcend and move beyond the political terms of our interlocutors. The stakeholder model is a concept that carries explanatory force in the social fields in which it operates. Yet it perpetually fails to capture, categorize and spatialize; it is an always-partial process of rendering legible and tangible. Following Ballard and Banks, Jerry Jacka states that the typical triad stakeholder model continues to demand more ethnographic attention, "in order to show how each of these entities is more diverse and factionalized" (2015:23). In what follows, I will *ab-use* the stakeholder model to account for such diversity and factionalism. Like many universal models that have landed up in northwestern New Mexico, they are particularized by that experience. The stakeholder model breaks down through the friction that occurs.

In the process of writing this dissertation, I initially outlined three separate chapters that would compose the body of the ethnography, each addressing the corporation, the state, and the community in their own terms. I have also tried to manage my fieldnotes, interviews, and other ethnographic data using these three categories. In the process of curating the data, I determined that it does not make sense to study the relationship between stakeholders by parsing them into separate chapters. Many of the artifacts described below are relational—they index pathways, interconnections and intercommunications between different stakeholders. They are not discrete

artifacts of any single author or authority. The dense interactive moments I experienced, the situations I describe, that which I deem *ethnographic* below, would be incoherent, disassociated, fragmented, displaced—the family of words Henri Lefebvre despised, the antonyms of the relational. In the following chapters, we will see how anti-relational terms are actually relational terms made possible through epistemological disassociation. The course of research presented here takes account of the relationships between stakeholders. I account for how stakeholders traverse the categorical and spatial capture and separation of "communities," "states," and "corporations," sometimes in surprising ways. I take notice of how individuals and institutions inhabit different categories at different times, leveraging the terms of their own critique (Kirsch 2014)[35] and deploying different rhetorical strategies (West 2016).[36]

Though my research design offers some "symmetry" of analysis between groupings of stakeholders, my analysis is not symmetrical, because ethnography is not symmetrical if it is expected to cross uneven terrain and contour gradients of power. This form of analysis seems appropriate given the situated nature of my research: experience at public meetings and hearings

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[35] According to Stuart Kirsch, "It may not be an exaggeration to claim, as I have heard from parties on both sides of these conflicts, that mining companies and indigenous peoples regard each other as their greatest threat" (Kirsch 2014:8; also see Jacka 2018). "One of the most pressing challenges faced by Indigenous peoples," according to Glen Coulthard (2014:77), quoting Kirsch, is the "speed with which capital now appropriates the terms of its critique" (Kirsch 2007:304).

[36] I am thinking with Paige West's understanding of Foucauldian "discourse" and her attention to "representational strategies" that are *rhetorical*, therefore strategic in nature—directed at bringing about a particular world and certain conditions of possibility. West writes:

> Discourses, following Michel Foucault, are the material and linguistic infrastructures through which knowledge, power relations, and subjectivities are produced over time (Foucault 1975). They constitute the conditions of possibility for being, thinking, and acting, as well as the epistemological systems and processes that interpenetrate them… For Foucault, the episteme, or the accumulation of structures that lay under the production of knowledge, is grounded in a particular time and place and is unconscious and singular (Foucault 1970). In *The Order of Things* he writes, "in any given culture and at any given moment, there is only one episteme that defines the conditions of possibility of all knowledge, whether expressed in a theory or silently invested in a practice" (Foucault 1970:168)… The deployment of these representational strategies today are rhetorical in nature, they are meant to persuade, to motivate, to influence thought and action; that they are not ever fully unconscious" (West 2016:6).

attended by all of the stakeholders involved in the environmental monitoring and cleanup process of the Grants mining district. Therefore, the chapters that follow pivot around moments of interaction between *stakeholders*—a term that is used here to the extent and in the manner of my interlocutors, based on the way they categorize and organize their social relationships. Through investigation of these spaces and places of interaction, I aim to contribute to critical analyses of the stakeholder model in environmental anthropology and make broader claims about the heterogeneous and cross-cutting enunciations of environmental justice in New Mexico.

CHAPTER 3

CONCEPTUAL ROADMAP

In this chapter, I render a conceptual roadmap that guides my analysis of the life of the by-product in the Grants uranium district. I begin by introducing Henri Lefebvre's (1991) *trialectical* theory of the production of space with the metaphor of "crossroads," which refers to a dense point of interaction where particular relationships between nature and culture bound together and proliferate. Though these places have been backgrounded—rendered as spatial and temporal gaps, absolutely empty spaces—such spatial order is undermined by the notion of crossroads. Next, I incorporate Neil Smith's (1984) critique of Lefebvre's ideology of nature through his conception of "the production of nature." The concept offers refrain from the pervasive and befuddling "ideology of nature" as both *universal* and, ironically, *external* to society. It also offers refrain from the transcendentalism and speculative futurism of the ontological turn in anthropology, which promises to go beyond "nature" and "culture," and other political coordinates of our interlocutors (Bessire and Bond 2014). I will show how the concept of production of nature can be used to draw together the fields of political ecology and science and technology studies (STS) in order to understand the social life of uranium as a by-product.

I will examine the revised concepts of the "resource curse" and "accumulation by dispossession" (Harvey 2005; Kirsch 2014), as well as the relationship between capitalism and settler colonialism (Coulthard 2014). These concepts are part of a Marxian critique of political economy—a project of identifying the origins of industrial ideas and programs, and the precise moment in which capitalism began. They can also supplement the more extensive project of accounting for how such moments of accumulation by dispossession reoccur. Following Lewis Mumford, I trace the origins of the sixteenth-century Saxon "animus of the miner" as a peculiar

view of and vision for nature made manifest through world historical political-economic interconnections. Mumford draws our attention to the development of industrial technologies of groundwater discharge and mine dewatering. In my account of the Grants uranium district, I recognize the impacts of such hydraulic technologies on the landscape. According to Mumford, "the animus of the miner's technique is reflected in his treatment of the landscape" (1934:71). I take account of the ongoing environmental impacts from mine water discharge in the Grants uranium district in Chapter 7 and Chapter 8, and how historic exploratory boreholes drilled to identify uranium ore deposits (see Chapter 4) have served as conduits carrying contaminated water discharged on the surface into the groundwater aquifers below.

3.1 The Crossroads

Rather than thinking of the uranium mill tailings piles in isolation, as discrete objects of analysis, consider their *relations*. "Social space contains a great diversity of objects, both natural and social, including the networks and pathways which facilitate the exchange of material things and information. Such 'objects' are thus not only things but also relations" (Lefebvre 1991:77). The philosopher Henri Lefebvre advises us to not simply take an inventory of things in space, offer more than a technical description of the object itself, and pursue a richer account of the relationship between things. Lefebvre's *tri*alectical conception of spatial practice, representations of space, and representational spaces attends to the triadic relationship between what is lived, conceived, and perceived (Harvey 1990; Lefebvre 1991; Smith 1984; West 2006). The trialectical concept of the production of space is not necessarily sequential. The different realms of the perceived-conceived-lived triad occur simultaneously throughout space and time, and there is political agency at every moment and in every situation. This is the result of Lefebvre's

grand project to refine our purview and bring together "mental space" and "real space"; thus, productively undoing a stultifying feature of the European Enlightenment and the capitalist world order.

Lefebvre despised the gaps and distances that separate objects and the Cartesian logic of absolute space. "For space is never empty" (1991:154). He venerates the Japanese notion of *shin-gyo-sho* as an exemplar of an organizing-principle of space that privileges the relational—meeting-places, intersections, crossroads, "mixed" areas between the public and the private realms. "The term *shin-gyo-sho* thus embraces three levels of spatial and temporal, mental and social organization, levels bound together by relationships of reciprocal implication… We do not separate the ordering of space from its form, its genesis from its actuality, the abstract from the concrete, or nature from society. There is no house in Japan without a garden" (Lefebvre 1991:153-154). The Nuevomexicano concept of *querencia*, a community's "deeply rooted sense of place," is used as such a relational metaphor in northern New Mexico (Lamadrid 2003; Sanchez 2014). These conceptions open our purview to epistemological and ontological association (together, in relation). The Acoma scholar Simon Ortiz poetically articulates his ethic of association in relational terms of land-based work:

> The land has worked for us
> to give us life—
> breathe and drink and eat from it
> gratefully—
> and we must work for it to give it life.
> Within this relation of family,
> it is possible to generate life.
> This is the work involved.
> Work is creative then.
> It is what makes for reliance,
> relying upon the relation of land and people.
> The people and the land are reliant
> upon each other (Simon Ortiz 1980:36).

Ortiz describes a political and ethical framework for the relationship between the people and the land. "Work" is the creative process that designates this relationship and makes life possible. The kind of reliance involved in the genesis of vitality suggests that the working relationship between people and earth is one of kinship—*family*. The reproduction of life thus relies on a kind of mutual *work* that supports the people and the land. This discursive metaphor of biological-geological kinship has important implications in academic discussions on the relationship between anthropology, biology, and geology. And it is more than a metaphor. From Ortiz's standpoint, it is important to recognize that the land is alive, figuratively and actually. *Land*, in this sense, enfolds bio-logic and geo-logic. Yet it takes the work of people to give it life, the way "the land has worked for us to give us life." This work reproduces the biological-geological relationship of family. It is this work of making kin that makes life possible.

Donna Haraway has made her central project the task of making *kin*, which "is a wild category that all sorts of people do their best to domesticate" (2016:2). Muddling through her partner Rusten Hogness's proposition of "compost instead of posthuman(ism), as well as humusities instead of humanities" (32), Haraway traces an etymological thread between the people and the land: "From Proto-Germanic and Old English, *guman* later became *human*, but both come soiled with the earth and its critters, rich in humus, humaine, earthly beings as opposed to the gods" (169-170). We are "that worker of and in the soil" (11). The earthly orientation of Haraway's terms and rhetoric is a response to "the forward-looking, sky-gazing Anthropos" and the problem of "the Anthropocene" (53). The ambiguous word "Anthropos" that comes from "he who has the face of a man" has trouble recognizing the face of a "woman" and others, human and not human (183). The problem is the lofty gaze of "man" is not really placed on earth; "he" is looking forward and upward. Thinking of earthly beings, as opposed to star-

gazers, Haraway uses the word "chthonic," which traces to "ancient Greek *Khthonios*, of the earth," to tell stories and draw figures of making kin in the timespace she calls "the Chthulucene" (173). She suggests that the earth does not make itself; it is not "autopoietic." The earth is "sympoietic," meaning "making-with" through relationships that matter (33). Simon Ortiz would call this "work"—the familiar and vital relationship between the people and the land.

What happens in northwestern New Mexico, where such deeply rooted senses of place and values of association encounter transient and transcendental, modern industrial modes of epistemological disassociation (separate and discrete)? Simon Ortiz notices how "since the Mericano, knowledge has been kept in some hidden place and has been used as controlling power" (Ortiz 1980:64). The phenomenon Ortiz describes has catalyzed my archival approach and driven my research in the Geologic Information Center at New Mexico Institute of Mining and Technology. I am reading against the archival grain in order to address what Kim Fortun calls "discursive gaps" (2012). How is local knowledge fragmented and displaced *where the rubber meets the road*, as transnational development lands up in New Mexico?

This is part of the process Anna Tsing calls friction. "Roads are a good image for conceptualizing how friction works: Roads create pathways that make motion easier and more efficient, but in doing so they limit where we go. The ease of travel they facilitate is also a structure of confinement. Friction inflects historical trajectories, enabling, excluding, and particularizing" (Tsing 2005:6). Tsing is interested in the landscape as an object of analysis: "material as well as representational practices of making and maintaining the landscape" (2005:173-174). Roads are also a useful image for contrasting Tsing's concept of "spectacular accumulation," which builds on David Harvey's (2005) notion of "flexible accumulation."

"Spectacular accumulation occurs when investors speculate on a product that may or may not exist" (Tsing 2005:75). To demonstrate this spectacular process, Anna Tsing refers to the Bre-X scandal as an example of how economic speculation for gold can occur in places where gold minerals do not exist. The Bre-X scandal led to reform on the Toronto Stock Exchange and the regulation of professional geology in Canada.[37] Every economic geologist knows: *If you don't have a road, you don't have a mine.* Roads are the material-semiotic infrastructures that allow for and represent the movement of people and raw materials from out-of-the-way-places to the world market.

In her analysis of how fantastic images of indigenous peoples of Papua New Guinea are used to sell coffee, Paige West includes a description of "the historical development of the routes by which coffee travels today" (2012:69). Her ethnographic portrayal is an eloquent response to David Harvey's (1996:285) imperative that combining "political economic with phenomenological approaches to place is as important politically as it is theoretically" (Kirsch 2006:221). West takes seriously the phenomenological "challenge to register a full range of discursive and non-discursive modes of expression through which everyday and poetically heightened senses of place are locally articulated" (Feld and Basso 1996:8). She frames her analysis in Lefebvre's trialectical terms by attending to *the physical routes*, *the social routes*, and *the ideological routes*, offering "an ethnography of the creation of value along circulatory routes" (2012:29; Appadurai 1986), and contributing to "the social analysis of the production of nature" (31). In this way, she cuts through the scale of "development" and reveals the fantasies that obscure the structural relations of dispossession in Papua New Guinea.

[37] National Instrument 43-101: "Standards of Disclosure" requires a "qualified person" engineer or geoscientist with at least five years of experience to sign-off and be liable for claims about geological deposits.

Capital is not a thing; it is a relationship between people and things. Because commodities do not take themselves to the market, the physical infrastructure of roads and highways, and the broader intermodal networks that connect the world marketplace, are perhaps the most concrete and apparent forms of global capitalist development. A study of the production of nature in northwestern New Mexico orients my research toward the roads that lead to the mines. This focus on roads draws from a tradition that takes seriously the relationship between history and anthropology and seeks to understand how global political-economic connections touch ground and change local communities (Wolf 1982). Eric Wolf's broad empirical consideration of world historical, political-economic interconnections prompts anthropologists to think more carefully about how they bound their geographic area of ethnographic inquiry. In this study, I take an emic approach in order to understand how my interlocutors bound their geographic areas of inquiry.

I am interested in the concept of *crossroads* in the Grants mining district, a dense point of interaction where particular relationships between nature and culture bound together and proliferate. Though these places have been rendered as spatial and temporal gaps, absolutely empty spaces, such spatial order is undermined by the notion of crossroads. In particular, I am interested in how the Environmental Protection Agency's (EPA) *Phase II – Ground Water Investigation Report for the San Mateo Creek Basin Legacy Uranium Mines Site, Cibola and McKinley Counties, New Mexico* (October 2018) brings together a basin-wide analysis with "the Crossroads" at the center of the study, the junction between New Mexico State Highway 605 and 509. In the report, the EPA is able to pursue multiple lines of geochemical evidence in order to work their way through spaces that were once articulated as "data gaps." The epistemological centering of the Crossroads would allow the EPA to address 85 mines and four mills. About one-

third of the mines were "wet mines" that had to be dewatered in order to access the orebodies below the water table. The Crossroads allows the EPA to address large quantities of mine water that had been discharged into nearby arroyos, drained into the San Mateo Creek Basin, seeped into the alluvial aquifer and deeper bedrock aquifers, and is now associated with groundwater plumes of uranium and selenium. This will be the topic of Chapter 7 and Chapter 8.

The highway junction was originally engineered for the purpose of accessing uranium mines during the expansive mid-century development and the Robert Moses era of roadbuilding and highway construction for automobiles (Caro 1974; cf. Mumford 1958). Joseph Masco describes how the federal interstate highway system engineered by the Eisenhower administration in 1956 was sold as a way to evacuate cities in the event of a nuclear war (Masco 2006:25). Mid-century roadbuilding was intricately bound together with what Masco calls "radioactive nation building" (2006:25). Once the route of economic uranium ore resources, "the Crossroads" has now become a place of diverse applications of geosciences. This has been an interesting place to shift attention from roads as the material infrastructure that link together commodity chains, to roads that intersect lines of a geochemical inquiry. In this dissertation, I shift attention from the product lifecycle to the life of the by-product.[38] I shift attention from the trucks that once hauled uncovered loads of uranium ore from the mines to the mills, toward the second life of the Crossroads at the center of the recent EPA basin-wide study.

[38] Interest in the product should be directed toward Masco's (2006) analysis of the "technoaesthetic" life of nuclear weapons: Between 1948 and 1970, uranium from the Grants district was used to manufacture one of the world's largest single nuclear arsenals, which is now located underground at Kirtland Air Force Base in Albuquerque, New Mexico. Masco describes the subterranean threat of global nuclear war as a phantasmagoria—a shadowy underground figure that is not necessarily meant to be used as a bomb. It serves as the semiotic threat of global violence and mutual assured destruction that underpins all international negotiations.

3.2 The Production of Nature

"There is no house in Japan without a garden" (Lefebvre 1991:154). It bears repeating Lefebvre's romanticism of the relationship between Japanese culture and nature. By the second half of the twentieth century, scholars of historical particularism began to anxiously grapple with the mass production of commodities and environmental decline driven by global industrial capitalism, which would make Lefebvre's (1991) claim possible: "Nature has disappeared and culture is nowhere to be seen" (1991:97). Mass production introduces an alarming situation in Lefebvre's view: "It is becoming impossible to escape the notion that nature is being murdered by 'anti-nature'—by abstraction, by signs and images, by discourse, as also by labour and its products. Along with God, nature is dying. 'Humanity' is killing both of them—and perhaps committing suicide into the bargain" (71).

The geographer Neil Smith critiques Lefebvre's "ideology of nature," using the term *ideology* in the pejorative sense it inherited from Marx and Engels in *German Ideology* (1845-7), which was unwittingly adopted from Napoleon Bonaparte's negative connotation of the term (Williams 1976:107-111). According to Smith, the "ideology of nature" is a view of and vision for nature that was catalyzed by industrial capitalism. This ideology of nature is befuddled by gaps and fragmentations of knowledge. It poses an essential dualism that perceives-conceives-lives nature as external to social humanity, but also internal because humans have nature too. "Nature," according to Raymond Williams, "is perhaps the most complex word in the [English] language" (1976:164). In his book *Keywords*, he distinguishes "three areas of meaning: (i) the essential quality and character *of* something; (ii) the inherent force which directs either the world or human beings or both; (iii) the material world itself, taken as including or not including

human beings" (164-165). He notes that areas (ii) and (iii) are subject to variable and often opposed meanings.

Questioning the ideology of nature, Smith introduces his conception of "the production of nature" (1984). From a Marxian[39] perspective, production is "a process by which the form of nature is altered" (Smith 1984:53). It is an axiom of the indivisible relationship between "environment" and "society," "nature" and "culture." Smith reminds us that the "relation with nature is a historical product, and even to posit nature as external to society (a primary methodological axiom of positivist "science," for example) is literally absurd since the very act of positing nature requires entering a certain relation with nature" (32). The necessary relation with nature has reciprocal implications. Karl Marx's concept of production is significant because it does not assume the commonplace ideology of nature. The Marxian view "begins with the relation with nature as a unity" and any separation that occurs thereafter is considered an historical product (Smith 1984:48). In this process of the production of so-called "external" nature, human nature is fundamentally and mutually altered. Any attempt to separate, disassociate, and purge "nature" constitutes its own idiosyncratic and reciprocal relation with nature. I take this Marxian view as axiomatic to any approach to science, technology, society, and environment. A serious deficit of "the ontological turn" in anthropology is the transcendental pursuit to go beyond and leave behind the real political coordinates of nature and culture (Bessire and Bond 2014). Notions of "nature" and "culture" remain politically valent, central to the technopolitics of cleaning up the Grants uranium district, and an integral part of state political discourse of environmental health governance in northwestern New Mexico.

[39] I use the term "Marxian" to refer to the academic scholarship of Marx, instead of using the term "Marxism," which refers to the political ideology of Marx (Wolf 1982).

3.3 Hauntology of the Resource Curse

I supplement my understanding of the geophysical production of nature and the life of the by-product with Jacques Derrida's concept of *hauntology*, whereby "Ontology is a conjuration" (Derrida 1994:202). I account for origin stories of the Grants uranium district in terms of so-called primitive accumulation, accumulation by dispossession, settler colonialism, and the Anthropocene because I am curious about what will happen when we conjure them together. Though I am interested in the original moment when they came into being, which is a periodizing gesture to be sure, I am also interested in how such things keep occurring. I am focused on the many different origin stories that people tell, which bear on the current technopolitical moment. From an anthropologically emic perspective, what are the different moments diverse social actors conjure in order to keep at bay? The following passage from Derrida's *Specters of Marx* (1994) illustrates this interest in conjuring:

> Everything begins before it begins. Marx wants to know and make known *where at what precise moment*, at what *instant* the ghost comes on stage, and this is a manner of exorcism, a way of keeping it at bay: before this limit, it was not there, it was powerless (1994:202)… Marx advances that belief in the religious specter thus in the ghost in general, consists in autonomizing a representation (*Vorstellung*) and in forgetting its genesis as well as its real grounding (*reale Grundlage*). To dissipate the factitious autonomy thus engendered in history, one must again take into account the modes of production and techno-economic exchange (1994:215; original emphasis).

These are some of the theoretical underpinnings that hinge together my questions about the making and unmaking of the "Grants uranium district," the moment the geological *epistémé* emerged and anticipated the legacy of uranium mining and the political life of the by-product. This is the moment Karl Marx called "primitive accumulation" (1976:873-940), and the moment David Harvey argues continues to happen through the process of "accumulation by dispossession" (2005:144). Identifying the origins of industrial ideas and programs, or the

precise moment in which capitalism began, is only part of a more extensive project of accounting for how such things reoccur.

In order to account for the new beginnings of accumulation by dispossession, we do not necessarily need to trace product lifecycles all over the world—a task taken seriously in environmental anthropology (Mintz 1985; Tsing 2015; West 2012; Wolf 1982). It is an important task to be sure, to show how "politics is the link between regimes of value and specific flows of commodities" (Appadurai 1986:57). My approach is toward an understanding of the political-economic life of the by-product, as a way of coming to terms with the recursive nature of accumulation by dispossession—the way capitalism keeps finding new beginnings. The life of the by-product indexes the moments when old materials find new beginnings. What was once waste can now be salvaged for a *second economic life*. This geo-logic of finding new beginnings is part of what Anna Tsing calls "salvage accumulation," whereby "Salvage translates violence and pollution into profit" (2015:63). It is also part of the ideology of economic geology and the logic of industrial minerals, which maintains a cyclical view of nature and an eventual return of economic value for all industrial minerals, according to innovation in new technologies and fickle consumer demands. Considering the industrial double-meaning and double-value of uranium-as-by-product in relation to Tsing's concept of salvage accumulation has forced me to abandon a commodity chain analysis of the product lifecycle in order to trace the life of the by-product, which changes the course and form of analysis. Elaborating on this conception, I attend directly to my thesis about the promise and failure of ecological modernization by tracing the life of the by-product as a recursive agent of accumulation by dispossession.

Lefebvre's trialectical analysis of the production of space provides the breadth necessary to bring together science and technology studies (STS) and the field of political ecology, which I

have been discussing in metaphorical terms of crossroads. I draw on both fields together to support my inquiry into systems of environmental information. Environmental information sciences and technologies are significant sites for political intervention (Fortun 2012), and an important part of the production of nature (Lefebvre 1991; Smith 1984). According to West, "The key to the production of nature argument is that it brings together sociocultural constructions of nature with material productions of nature" (2006:28-29). The production of nature is a central concept of political ecology, a field that combines critiques of political economy with ecological sciences (Forsyth 2003; Jacka 2015:4; Vayda and Walters 1999:169). I have articulated a critique of political economy above that will be elaborated. What follows is a description of the ecological sciences side of this project, which focuses on the production of geosciences and hydrology, informatics, and environmental engineering.

Kim Fortun's project of "informating environmentalism" (2009) is one possible way of bringing about difference in the production of nature and bringing together political ecology and STS, displacing "discursive gaps" (Fortun 2012) and tracing attempts to "displace discursive fields" (Spivak 1988). "The informating of the environmental field," Fortun writes:

> deserves critical attention, as does the work of informating writ large. To be informated is to be beset by possibilities for constant re-ordering and re-visualization. When fields of practice are informated, previous latent signification often comes to the surface; discursive gaps—spaces where established analytic and explanatory language fail, spaces where hegemony comes to crisis—can be displaced. Fields of practice that have been informated are thus sites "of the displacement of function between sign systems" (Spivak 1987: 198). They are a place where change happens, sites of transaction between the past, present and future (2012:19).

Fortun identifies environmental information as a significant site for political action. The politics of environmental information systems and the relationship between science and policy are important areas of research in STS, and an understudied area of political ecology. Following EPA threads of evidence through the discursive lacunae, traversing the "data gaps," I attend to

the subjects-in-doubt trying to articulate their way through the "Grants uranium district." How do different stakeholders leverage environmental information in practice? How do such "graphic artifacts" draw our attention "to the associations emerging through the production and circulation of documents" (Hull 2012:21)? This course of research offers a rubric for *informating* through the "resource curse" and documenting the baseline anthropogenic impacts of mining and milling.

Stuart Kirsch articulates the concept of "colliding ecologies," as an "alternative way of conceptualizing what economists call the 'resource curse,' the recognition that developing countries dependent on mining and other forms of natural resource extraction possess slower growth rates than their peers" (2014:18):

> The resource curse not only causes macroeconomic problems at the level of the state, but it also creates microeconomic problems for the peoples most directly affected by mining. Even though new mining projects are routinely promoted on the grounds that they will raise the local standards of living, in practice, the people living in the catchment areas of these projects end up bearing a disproportionate share of their costs—in the form of environmental impacts. Instead of benefiting economically from mining, many of these communities are impoverished by pollution, an example of 'accumulation by dispossession'" (Kirsch 2014:18).

Broader notions of the resource curse have been debated at least since the sixteenth century in Saxony, as a by-product of the emerging science of mineralogy and industry of mining and metallurgy. Lewis Mumford asks us to consider how "the animus of the miner's technique is reflected in his treatment of the landscape" (1934:71). *The animus of the miner* is a formidable exemplar of the proliferation of industrial ideas, values, and attitudes toward nature. It can be considered an analytic concept for understanding the stubborn industrial ideas of sacrifice and salvation. Mumford queries the "rapid advancement in technique in German mines: by the sixteenth century those in Saxony led Europe, and German miners were imported into other countries, like England, to improve their practices. The deepening of the mines, the extension of the operations to new fields, the application of complicated machinery for pumping water,

hauling ore, and ventilating the mine, and the further application of waterpower" (1934:74). He identifies the devastating nature of hydraulic technologies of mining and milling, and refutes Georgious Agricola's (Georg Bauer) "lame reply," responding to a quote selected from the sixteenth-century compendious treatise, *De Re Metallica* (1950 [1556]):

> the strongest argument of the detractors is that the fields are devasted by mining operations, for which reason formerly Italians were warned by law that no one should dig the earth for metals and so injure their very fertile fields, their vineyards, and their olive groves. Also they argue the woods and groves are cut down, for there is need of an endless amount of wood for timbers, machines, and the smelting of metals. And when the woods and groves are felled, then are exterminated the beasts and birds, very many of which furnish a pleasant and agreeable food for man. Further, when the ores are washed, the water which has been used poisons the brooks and streams, and either destroys the fish or drives them away. Therefore the inhabitants of these regions, on account of the devastation of their fields, woods, groves, brooks and rivers, find great difficulty in procuring the necessaries of life, and by reason of the destruction of the timber they are forced to greater expense in erecting buildings. Thus it is said, it is clear to all that there is greater detriment from mining than the value of metals which mining produces (Agricola 1950 [1556]:8; see Mumford 1934:71-72).

Mumford claims that the origins of all industrial ideas, values, and attitudes toward nature can be traced to the nascent scientific mineralogy and industrial mining and metallurgy of sixteenth-century Germany, with the exemplar of *De Re Metallica* (Agricola 1556; Winner 2010).[40] He sets up an organic/inorganic binary whereby the miners that went underground entered an inorganic environment, a hard, dark, and dangerous place devoid of life. When they came back to the surface, they were fundamentally transformed, and their inorganic view of and vision for nature proliferated across the landscape. Geomicrobiologists today would refute Mumford's claim that these underground environments were inorganic, but this is beside the point he was trying to make about the emergence of "the animus of the miner." Mumford draws

[40] Note the Weberian problem of studying the affinity between the Protestant ethic of Benjamin Franklin, for example, and the spirit of capitalism through the notion of "the calling," which ultimately compelled Weber to consider the chemical concept of elective affinity. Of course, there are many different origins for the many different industrial ideas and programs. The Saxon animus of the miner is one place among many whereby the landscape was devastated, sacrificed, transformed.

our attention to the industrial technologies of groundwater discharge and mine dewatering. In my account of the Grants uranium district, I recognize the ongoing impacts of such hydraulic technologies on the landscape. This is the necessary recognition of the *devastation of mining*, which is an integral part of the uneven geographical development of the landscape. "One must admit the devastation of mining, even if one is prepared to justify the end" (Mumford 1934:72).

I recognize the application of such hydraulic technologies that pump water from mines and mills as appendages of the sacrificial "logic of elimination" (Wolfe 2006) inherent in settler colonial structures of dispossession. Patrick Wolfe's concept of logic of elimination refers to a kind of reasoning that proliferates when foreign populations dispossess and displace Indigenous peoples. Because elimination is a structure not just an event, there are reoccurring moments when and situations where elimination occurs, in new and old forms, but always for the sake of land. This idea maps roughly onto David Harvey's elaboration of the Marxian concept of "original" or so-called "primitive" accumulation. With insight from Rosa Luxemburg, Harvey describes the recursive nature of accumulation by dispossession, against the other interpretation of Marx's focus on a single original moment in history where accumulation for accumulation's sake began. I say the idea maps *roughly* because, as Glen Coulthard (2014) notices, the Marxian focus on labor and proletarianization elides the point about Indigenous "elimination" for the sake of the land. Coulthard encourages us to focus on the relationship between *capitalism* and *colonialism.* Such technologies of displacement and dispossession are guided by a sacrificial logic, destroying the land for accumulation's sake in ways that undermine and destabilize Indigenous livelihoods, only to return to the land to salvage what remains.

The animus of the miner and the economic resource curse mark a temporal and spatial threshold where processes of industrialization, modernization, capitalization, and settler

colonization took the world stage. This mode of telling origin stories, calling out the beginning of such things, is a periodizing gesture to be sure, which offers its own peculiar insights into debates about the Anthropocene and the diverse forms of -*cenefication*—the emergence of many different significantly humanized -cenes. The suffix "-cene" refers to the 65 million-year Cenozoic geological era that accounts for the Holocene epoch of human development in relation to the earth. "The Anthropocene" is meant to index the moment humans became a geophysical force on a planetary scale. It opens up areas of anthropological inquiry of global proportions in order to understand the anthropogenic nature of the geophysical landscape. The proliferation and pluralism of such scholarship and the conceptual elaborations of the geological concept have been a source of anxiety for some scholars. I have no interest in a cynical or reductive approach—what Eric Wolf calls "intellectual deforestation" (1989:588). I think "anthropology can be cumulative" (588). I remain open to all the different -cenes. I follow Mumford here by identifying the sixteenth-century Saxon *animus of the miner* as a prolific view of and vision for nature. It is a stubborn ideology that underlies the emergence of scientific mineralogy and industrial mining and metallurgy. It undermines the strata of the Anthropocene. *It is a peculiar albeit pervasive logic, discourse, and practice that rationalizes sacrifices with the prospect of salvation.*

"Mining moves more earth than any other human endeavor" (Kirsch 2014:3). Societies and economies of the twenty-first century can be described in terms of "the mineral age," according to Jerry Jacka, which is made possible by an ideological mindset, a "logic of extractivism" that is so ubiquitous it makes us all complicit (2018:62; Jalbert et al. 2017). I offer an analysis of this extractive epistemological paradigm by tracing the origins of scientific mineralogy and industrial mining and metallurgy, and observing how they took course in

northwestern New Mexico. I hope my observations will contribute to a body of anthropological scholarship on mining and STS scholarship on "the underground" (Ballard and Banks 2003; Godoy 1985; Golub 2014; Jacka 2015; Kirsch 2014; Kinchy et al. 2018; Nash 1979; Smith Rolston 2014; Stewart 1996; Taussig 1980; Tsing 2005; Welker 2014). By taking account of different origin stories—stories of industrialism, modernism, capitalism, and settler colonialism—what insights are gained in respect to the contemporary problem of mine waste and the technopolitical life of the by-product? *The hauntology of the resource curse* refers to conjuring those original moments and the recursive nature by which these old problems persist. *Call them out to keep them at bay*.

3.4 Conclusion

This chapter hinged on a question that is sustained throughout this dissertation: What happens in northwestern New Mexico where deeply rooted senses of place and values of *association* encounter transient and transcendental, modern industrial modes of epistemological *disassociation* (separate and discrete)? The spatial analysis described in this chapter traces the life of the by-product, which offers an alternative political-economic critique and opens up different perspectives on the product lifecycle of uranium oxide as a commodity. This chapter accounted for the emergence of diverse forms of geological expertise involved in making the "Grants uranium district" or "region."

The conceptual roadmap rendered in this chapter draws together the fields of political ecology and science and technology studies (STS) with the metaphor of "the crossroads"—a material space and phenomenological place of dense associations between nature and culture—which will be used in the following chapters to understand how geologic mapping and modelling

clearly connect with the geophysical production of nature, opening up and foreclosing the possibilities of environmental cleanup. Henri Lefebvre's (1991) *trialectical* conception of "the production of space" opens our purview to the relationship between what we perceive, conceive, and live directly—what he calls "representations of space," "representational space," and "spatial practice." These layers of space occur simultaneously and unevenly, and there is political agency in every moment and situation. Given this understanding of the production of nature, we can heed Kim Fortun's (2012) call to examine environmental information systems as significant sites for political action, spaces of intervention into representations of nature. This conceptual roadmap offers a tangible connection between the fields of political ecology and STS by bringing together representations of space (artifacts of environmental sciences; e.g., models, metaphors, explanations, and information) with spatial practice (environmental monitoring and engineering) at representational spaces (public tours, meetings, and hearings).

CHAPTER 4

MAKING THE "GRANTS URANIUM DISTRICT"

This chapter is concerned with the making of the "Grants uranium district," as glimpsed in origin stories about how it came into existence. I will trace the emergence of the district as a discursive formation—a toponym, or place-name—and an area of geologic study. How was the discipline of geology applied in rendering the district legible for the extraction of uranium ore? And how have the dominant forms of geologic investigation and intervention shifted since the initial development of the district toward projects of reclamation and remediation? With this course of inquiry between the making and unmaking of a mining district, I can trace the contingencies and disjunctures between the history of exploration geology, the techniques and technologies used to search for and define uranium deposits (Kelley et al. 1963; Rautman et al. 1980), as the background against which to monitor the promise of contemporary geosciences for monitoring the mine waste and cleaning it up (Blake et al. 2017; Dixon 2015; Schatz 2017). I attend to the geophysical production of the Grants uranium district during the second half of the twentieth century. The following account extends beyond the historical period of 1950 to 2000 in order to consider the earliest reported discovery of uranium in the region in 1913 in the Zuni Mountains (Brown and McLemore 1986:34), among other pre-1950 discoveries.

I pursue these questions through the Geologic Information Center at New Mexico Institute of Mining and Technology (New Mexico Tech, NMT) in Socorro. The Geologic Information Center is a specialized library and archive that contains geologic data on New Mexico's mining and petroleum industries, including thousands of maps, reports, publications, photographs, theses, and dissertations.[41] The center inherited the Atomic Energy Commission

[41] https://geoinfo.nmt.edu/libraries/gic/home.html; accessed February 5, 2019.

(AEC) library from the regional office of the Division of Raw Materials in Grand Junction, Colorado. New Mexico Tech was also once considered a candidate for hosting the Anaconda Company library, but apparently there was not enough room.[42] The geologist William Chenoweth has been instrumental in "informating" geological knowledge regarding uranium resources in New Mexico. I am using Kim Fortun's concept of "informating" to account for "how information technology and culture animates change at multiple scales, sometimes provoking critical change in sign systems. Such shifts enable articulation previously impossible or unrecognizable" (2012:6). The concept is used here to understand the emergence of the "Grants uranium district" through Chenoweth's projects of conducting research, authoring reports, maps and memoirs, and compiling information regarding the historical and geological record of uranium deposits in the U.S. Southwest, which would become the foundation of the Geologic Information Center. A local news report portrays Chenoweth as "the Google of the Colorado Plateau before search engines were even the stuff of dreams."[43] With his encyclopedic and bibliophilic drive, he collaborated with Virginia McLemore and other colleagues at New Mexico Tech in order to curate geologic information, which has found an array of applications in uranium districts throughout the United States and internationally. Through the process of *informating*, the geologic information was compiled to make uranium resources in the Grants district and elsewhere in the world "legible" and "manipulable" (Scott 1998). These terms draw our attention to how the ordered arrangement of minerals offered new possibilities for the production of nature.

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[42] It ultimately became the Anaconda Geological Documents Collection at the University of Wyoming in Laramie: https://www.uwyo.edu/ahc/collections/anaconda/; accessed October 2, 2018.
[43] Accessed October 28, 2015: http://www.gjsentinel.com/portrait/articles/bill-chenoweth-a-lifelong-geologist-hes-spent-his-career-making-miners-safe/.

McLemore and Chenoweth's *Memoir 50C Energy and Mineral Resources of New Mexico: Uranium Resources* was published by the New Mexico Bureau of Geology and Mineral Resources in 2017. It can be used to guide readers through the archive and library that host the information on uranium resources and other industrial minerals of New Mexico. Their work attempts to synthesize the breadth and density of their archival material, and build on their collaborative research on the origins of the uranium deposits and the history of uranium mining in New Mexico. According to McLemore and Chenoweth: "Knowing the source of uranium is important in understanding how the Grants deposits formed, establishing U.S. Geological Survey (USGS) geologic deposit type and geoenvironmental models, and locating additional uranium provinces elsewhere in the world" (2017:29). In addition to compiling models on the origin of uranium, their chronologies and periodizations account for the earliest forms of mining in the Grants district and the successive mining booms, always ending with the prospect of the next mining boom. I attend to their work of making uranium deposits legible and tangible as productive economic resources, demonstrating how geological representations of nature map onto the geophysical production of nature.

This chapter begins by considering the apocryphal story of Paddy Martinez as the Navajo man who discovered the Grants uranium district. I examine how this discourse of "discovery" conceals the exploitation of local knowledge and local resources through the fabrication of fantastic ideas and images. Taking account of many different origin stories, I aim to pluralize our understanding of how the Grants district came into existence, as the baseline against which to measure the historical impacts of uranium mining and milling in northwestern New Mexico. I begin by attending to the "historical background" and the naturalized chronology that is repeated as a matter of fact about how the district came into being. I then examine the politics of the

archive and how settler chronologies are cast over Indigenous topographies in successive attempts to categorize and spatialize Indigenous lands and livelihoods. Situating the dominant historical narrative in a cluster of scholarship on settler colonialism, I will show how it is fractured in places that connect to a deeper history, a past that refuses to recede, which offers ground for many possible futures.

4.1 "Historical Background"

> Social-scientific writing often doubly presupposes this authoritative constitution of reality by taking historical scholarship for granted as background, to be used as a prelude to some variety of synchronic sociological analysis. That strategy obliterates any sense of history as a story or construct. Relegated to the background, history can be presented as facts. The existence of such facts in turn process the existence of the "thing" the facts are about. Thus to begin an ethnographic narrative with historical background becomes a powerful rhetorical device for establishing the reality of the object of one's study (Handler 1985:179-80; cited in Samuels 2004:42)

> Rather than tell history as a chronological procession of events—causes and effects—this approach represents history on principles of simultaneity, juxtaposition, and layering rather than of sequence. Its organizing trope place rather than time. These emplaced juxtapositions are something like being able to look out on the present and see the past, an experience that is partly in keeping with people's experiences of the world. Old things here aren't necessarily removed to make room for the new. They stick around for a while (Samuels 2004:52)

> Sense of the recoverability of the past pervades… ambiguity becomes a resource for expressing history. Unlike the clearly marked highway, the landscape vibrates with contingency… It is easy to get this sense of a past that refuses to recede. History becomes a series of layerings and juxtapositions—ruins etched into the land, hewn out of the rock (Samuels 2004:42)

The apocryphal story of Paddy Martinez is the most frequently told story about the "discovery" of the Grants uranium district.[44] It is a folkloric curiosity, the habit of repeating the story of

[44] I use the term "apocryphal" because there are questions of authenticity and authorship, doubtful origins, as well as questions about what remains hidden by the story. The Greek adjective *apókryphos* means "hidden, concealed, obscure," from the verbal adjective *apokrýptein* which means "to hide (from), keep hidden (from)" (https://www.merriam-webster.com/dictionary/apocrypha, accessed November 25, 2018).

Martinez as though it explains the verifiable moment uranium mining in the region began, as if the "Grants uranium district" came into being overnight in the middle of July 1950, brought about by Paddy Martinez's discovery of uranium in the Todilto limestone near Grants. "Discoveries" such as these are often portrayed as anomalous events, exceptional moments or occasions in time, rather than acknowledging the broader trends from which they occur and reoccur. These snapshots are archived and canonized as historical facts that are part of a naturalized chronology and master narrative about the origin and order of things.

Posthumously inducted into the National Mining Hall of Fame in 1992, after his death in 1969, Martinez was the 80th inductee. On his webpage in the Inductee Database a description begins this way: "This native New Mexican, a Navajo, made the initial discovery of uranium in the San Juan Basin, the most important uranium-producing area in the United States. The region yielded in excess of $25 billion in uranium and contained 60 percent of the known uranium resources in the nation." Martinez was featured in *Time, Life, True West,* and *Reader's Digest* as a "one of a kind" polyglot, "respected and remembered for his contribution to mining and to mankind."[45] From the yellow rock on display at the New Mexico Mining Museum in Grants—with a label that says, "JUST LIKE THE ROCK FOUND BY PADDY MARTINEZ"/ COLLECTED IN 1951 BY THOMAS MONTOYA—to the softball fields that have been named after him, these artifacts and features of the landscape index the fantastic, imaginative, and embellished folklore and lure of uranium mining in northwestern New Mexico. The apocryphal story of Paddy Martinez is a pervasive part of public and academic discourse. The story commenced many of the interviews I conducted with people from the area; it was the prelude to renditions about uranium mining in many of the oral histories I listened to and read; and it could

[45] See http://www.mininghalloffame.org/inductee/martinez, accessed October 21, 2015.

be found in the historical background of almost all of the regional geologic memoirs on uranium resources.

In his book *Fight Back: For the Sake of the People For the Sake of the Land,* Acoma scholar Simon Ortiz questions this historical fiction. He describes the relationship between "discovery" and exploitation, and the making of time over place:

> In the Grants area for years it was popular knowledge that Paddy Martinez, a Navajo Indian, had discovered uranium… But that's not quite true. Grants and the U.S. system could have us believe it was as simple as that: it would reiterate the idea of the Indian bringing his own fate upon his head… There were any number of explorations for uranium since the 1940's in New Mexico… There was knowledge that there were substantial uranium ore bodies in the Southwest, and all they needed was time to a make a "discovery" and a place where there would be no problem in exploiting (1980:64).

Ortiz elaborates in a poem entitled "It Was That Indian," which recognizes the reasoning behind the representation of Martinez as "the one who discovered uranium… that Indian who started that boom." The Kodak color photographs of Martinez authorize his status as a historical marker in the form of a brochure referenced and celebrated by the Chamber of Commerce.

The brochure is like the historical highway marker described by the anthropologist David Samuels (2004). The highway marker denoting Geronimo's Surrender on Arizona's Route 80 commemorates "that historic day, [that] forever ended Indian warfare in the United States" (Samuels 2004:41). Samuels remarks on how such markers indicate the "finality of the past," as though something was here and now it is gone, seemingly unrecoverable (2004:41). Marking the beginning and the end of things, peoples, and places produces a naturalized chronology. Such chronology welcomes the hubris of natural realism by which so-called "historical background" can be presented as a succession of events and series of facts that justify and reify the "chronological ascendancy of Bureau Americans" (52).

Settler time is not only chronological; it is also teleological. Traci Voyles introduces the concept of "progressive teleologies of injustice" to make sense of the fantastic stories of Paddy Martinez (2015:98). Thinking of Ned Blackhawk's analysis of the violence over the land that underlies discourse of "vanishing" Native peoples, Voyles says:

> Origin stories, like Paddy's and like the "vanishing race," are narratives that set a teleology in motion: they seek to explain how we begin to progress, from here to there, as a nation or an industry. These particular origin stories set in motion a teleology that derives from what [Andrea] Smith calls "the logic of genocide"… Teleologies have long been ways in which a kind of "natural" progression—of society, history, knowledge, or even industrialism—is understood to occur. In teleologies of both settler colonialism and industrialism, injustice is a crucial feature of progress" (98).

Elaborating on settler temporalities, Mark Rifkin describes how "asserting a shared modernity or presentness of Natives and non-natives implicitly casts Indigenous peoples as inhabiting the current moment and moving toward a future in ways that treat dominant non-native geographies, intellectual and political categories, periodizations, and conceptions of causality as given—the background against which to register and assess Native being-in-time" (2017:viii). Addressing this problem, Rifkin asks how "to pluralize temporality so as to open possibilities for engaging with Indigenous self-articulations, forms of collective social life, and modes of self-determination beyond their incorporation or translation into settler frames of reference" (ix). Leveraging post-Einsteinian notions of time, he focuses on particular kinds of "temporal knottings," where time is not absolute; it is contingent upon relative motion and frames of reference. Discourse of the Martinez "discovery" is part of a temporal knotting that can only be understood by accounting for other frames of reference.

Such settler temporalities and teleologies, notions of time over space and chronology over topography, obscure the fact that the past is never completely settled. Audra Simpson describes the "interrupted *and* interruptive capacity of that life within settler society. Their

political consciousness and actions upend the perception that colonization, elimination, and settlement are situations of the past" (2014:33). It is "a symptom of the continued colonial requirement that they disappear and a symptom, I would say, of colonialism's ongoing life and simultaneous failure" (33). This is the nature of Indigenous "nested sovereignty" (11). It is absolute power from within and apart from settler society, which offers refrain from settler origin stories and founding myths. Simpson's concept of "scenes of apprehension" (70) calls out that moment when such a peculiar logic emerged with the example of disciplinary anthropology as a form of categorical and spatial incarceration of Indigenous peoples. Considering such moments of apprehension, one can see how the discipline of anthropology is constituted upon the bodies, blood, bones, artifacts, language, and knowledge of Indigenous peoples. Simpson invites anthropologists to investigate "how Indigenous elimination holds hands with disciplinary formation" (2014:67).

The scholarship on settler colonialism discussed above hinges upon Patrick Wolfe's concept of "logic of elimination" (2006). The breadth of the concept and the foresight it offers are critical, providing insight into the kind of reasoning that proliferates when foreign populations settle and dispossess the lands and livelihoods of Indigenous peoples. The concept has been leveraged dynamically to address the pervasiveness of such logic and the subtle and not-so-subtle forms by which it manifests. The breadth of the concept supports analyses of a range of settler colonial forms of elimination: from enslavement and oppression, to frontier homicide, to BIA "Indian Schools," to land granting policies and re-allotment of Native lands, extirpation of local game, devastation of agriculture, livestock reduction, exploration geology and prospecting, exploitation of minerals, contamination and depletion of drinking water, exploitation of labor and unemployment, "Indian stereotyping… as old as colonization of Indian

nations" (Dunbar-Ortiz 1980), to the externalized costs of capitalist production and the by-products of "development" that pile up on Native lands and pose a range of environmental health problems. All of these events are part of a structure that imposes the elimination of diverse forms of Indigenous life. The disciplinary formation of geology in northwestern New Mexico and the emergence of Grants uranium district held hands with a failed program of sociocultural and biophysical elimination of Indigenous peoples of the North American Southwest.

During the second half of the twentieth century, the genesis and development of the science of field geology on the Colorado Plateau was constituted upon the exploitation of Indigenous lands and labor, as well as the appropriation of large swaths of federally allotted lands. Joseph Masco describes how federal management of Pueblo lands in the decades preceding the Manhattan Project led to the loss of title to tens-of-thousands of acres, which decimated the local subsistence economy and traditional farming, just as pueblo populations began to rebound from the previous eras of elimination, displacement and dispossession, forcing them to lease land and provide labor for the mid-century rise to power of the energy industry in New Mexico (2006:117-118). This included uranium as well as coal, oil, and gas development (Needham 2014; Powell 2018).[46] Johnston, Dawson, and Madsen (2007:97-116) account for one dimension of such an energy regime, the legacy of uranium mining and milling, in an attempt to calculate the human costs of uranium production in the context of the Navajo Nation. Enumerating exposures and diseases from scant epidemiological studies they determine that "the Navajo Nation is experiencing a health crisis of epidemic proportions, which many believe to be

[46] Andrew Needham illustrates the twentieth-century American settler view of and vision for "electricity as evidence of new human control over the natural world" and the dispossession-side of how the "uneven distribution of energy had produced a region in which economic prosperity and high quality of life in metropolitan centers required the dual exploitation of people and nature on the Colorado Plateau, creating significant, frequently unrecognized, costs for distant environments and marginalized peoples" (2014:5).

the result of hosting uranium mining and milling operations and the failure of the federal government to protect its citizens" (Johnston et al. 2007:110).

Scholars of Native American studies at the University of New Mexico and other universities in the Southwest have established strong programs of critical inquiry that trace such lines of dispossession and investigate the growth and development of "transnational energy corporations" (Nafziger 1980) and the making of "resource colonies" in the U.S. Southwest (Ortiz, Deloria, Kelley, Hundley, Dunbar Ortiz, Lamphere, Ruffing, Henderson, Boyle, Robbins, and Reno 1979). These studies have laid the foundations for understanding the changing forms of settler colonial exploitation of Indigenous knowledge and resources. I have already discussed the international human rights crisis associated with mining and resource extraction, which has been based largely upon the appropriation of Indigenous lands and livelihoods (Ballard and Banks 2003:298; Harvey 2015:249; Johnston et al. 2007:6; Kirsch 2014:5-9; Masco 2006:277). I also mentioned the scholarship reverberating in response to the legacy of uranium mining and milling primarily in Navajo Country, as well as Laguna Pueblo and Acoma Pueblo (Brugge, Benally, Yazzie-Lewis 2006; Johnston et al. 2007; Lewis, Campden, Shuey, Robinson, Baldwin, Begay 2018; Lorenzo 2017; S. Ortiz 1980; Pasternak 2010; Reno 1981; Voyles 2015). Acknowledging the significance of Native American and Indigenous studies and such critical epistemological standpoints of settler colonialism, I will also portray the impact of the legacy of uranium mining on Hispano and Anglo communities of northwestern New Mexico. These are people who tend to be left out of the accounts mentioned above, yet they have settled, albeit differently, in areas that continue to experience the environmental health impacts from the legacy of uranium mining.

In what follows, I aim to contribute to these clusters of scholarship by attending to the application of geological knowledge in making the Grants uranium district. The disciplinary formation of regional geology in northwestern New Mexico was born amid a slew of mid-century U.S. Atomic Energy Commission-funded science projects that attracted some of the nation's most brilliant scientists and were executed on large swaths of federalized land, which paved the way for radiation research on Indigenous peoples and ecosystems (Hagen 1992; Johnston et al. 2007; Masco 2006). This is one way of shifting the course of questioning away from the problematic narrative that makes a Navajo (*Diné*) man responsible for the origins of the Grants uranium district, which has become an embellished subject among regional settler folklore. This habit of association automatically reproduces the social relations of settler colonialism under a fiction that reiterates "the idea of the Indian bringing his own fate upon his head" (Ortiz 1980:64).

I will not tell the apocryphal story of Paddy Martinez here because it is entirely misleading.[47] This is a standpoint of the kind of ethnographic and political refusal Audra Simpson (2014) prescribes. To repeat the story is to mistake the event, a single moment, as what counts for history, instead of attending to the deep-seated structural features of dispossession that continue to happen to this day. The habit of repeating the story is part of the structure of exploitation it serves to conceal. It is the blame that follows modern industrial "development"—the exploitation of local knowledge and local resources (West 2016). Martinez did not make the initial discovery of uranium in the region, nor did his discovery lead to the development of the largest deposits, which occurred in the sandstone, not the limestone. The reason for the initial proliferation of the Martinez story was the promotion of the event by Atchison, Topeka and

[47] See Voyles (2015) for a composite narrative and discussion of various renditions of the Martinez story, and for her critical analysis of such "progressive teleologies of injustice."

Santa Fe (AT&SF) Railroad—the company that owned the mineral rights to the land on which Martinez found the tyuyamunite ore. News of the "discovery" reverberated when Paddy Martinez and Carol Gunderson lost the litigation with Tom Evans and the AT&SF Railroad for the mineral rights to the land. In this case, the railroad, like the historical highway marker, marks the beginning and end of people, places, and things.

4.2 Chronology Over Topography

In the last two decades of the nineteenth century, news, people, and products began traveling rapidly in and out of the Southwest via the AT&SF Railroad, which was a critical technology for disseminating the lore and lure of New Mexico and the announcement of the Martinez discovery half a century later. Prior to the mid-twentieth century federal highway building, the railroad was the primary carrier of the land-granting policy, power, and Bureau Americans who would enact the fragmentation of the landscape and divide up the "rights to resources." The "checkerboarding" of the Navajo Nation in northwestern New Mexico is the result of a series of land granting policies, like the Morril Land-Grant Act and the Dawes Act set in motion over a century ago, which have commingled with the General Mining Act of 1872 to make mining districts throughout the United States.

"Checkerboarding" refers to the pattern one sees on a map of northwestern New Mexico, variously allotted squares distributed among federal, state, tribal, and private ownership. The lines on the map may correspond with barbwire fences and gates and cattleguards that are traversed by kids on ATVs, equestrians accompanied by their dogs chasing prairie dogs, and cattle roaming in pursuit of greener pastures in the high-desert Southwest. Through its federal right-of-way, the railroad served not only as a form of passage for settlers and products across

the landscape, a venue for capital accumulation, and a mechanism for nation-making, it also salvaged the mineral rights over large swaths of land, and became a target for timber, coal, and steel production everywhere it went. The railroad had become a technology of "the chronological ascendancy of Bureau Americans to dominance" in the U.S. Southwest (Samuels 2004:52). The Martinez story illustrates the how the railroad became a technology for distributing information. Railroads, like all roads, serve as the material conduits of time over space.[48]

The dominant form of settler colonial development and industrialization has been recognized in terms of settler time and temporality cast over Native American space, place, nature, and land (Basso 1996, Deloria 1994, Masco 2006, Ortiz 1969, Fowles 2013). Alfonso Ortiz (1969) remarks that the fundamental difference between Euro-American and Pueblo cosmologies is that Pueblo peoples emphasize an experience of space over time. Vine Deloria prioritizes this contrast as one of great philosophical importance:

> American Indians hold their lands—places—as having the highest possible meaning, and all their statements are made with this reference point in mind. [European] immigrants review the movement of their ancestors across the continent as a steady progression of basically good events and experiences, thereby placing history—time—in the best possible light. When one group is concerned with the philosophical problem of space the other is concerned with the philosophical problem of time, then the statements of either group do not make much sense when transferred from one context to the other without proper consideration of what is taking place (Deloria 1994:63-64).

David Samuels asks, "What happens when we remove chronology as the dominant organizing model for talk about the past" (2004:42)? Following the lifework of Keith Basso,

[48] Note Richard White and colleagues' Spatial History Project, and their consideration of how the railroad shaped the West: https://web.stanford.edu/group/spatialhistory/cgi-bin/site/pub.php?id=29; accessed December 6, 2018. For example, they discuss how rates of travel are an important part of the production of space. Also see Alfred Chandler's analysis of the "revolution of transportation and communication" and how "railroads demanded the creation of the first administrative hierarchies in American business" (1977:81-144). I am also thinking of William Cronon's notion of "railroad time" (1991:74-81). Also consider Simon Ortiz's (1980) account of the development of the railroad as a mode of dispossession in Grants area.

Samuels considers how "place-names shift 'history' from chronology to topography" (2004:45). Rather than repeating the "historical background" as a matter of fact, Samuels uses an organizing metaphor of place instead of time. By referring to Indigenous place-names, Samuels shifts his historical account from historical highway markers that indicate the finality of the past to places that vibrate with contingency and create an enduring sense of a past that permeates everyday life. He accounts for an "iconicity of feeling" (54) among his Apache colleagues of the San Carlos Reservation. This topological form of analysis focuses on the vitality of the land and resurgence of Indigenous ontologies and epistemologies, and their capacity to interrupt settler chronologies. By describing how that *feelingful* sense of the past endures, Samuels shows how phenomenological senses of the past persist in these places, undermining settler origin stories and upending notions of settler time over Native spaces. Here I borrow Samuels' discursive strategy of layering and juxtaposition to provide a more careful consideration of the relationship between chronology and topography in northwestern New Mexico.

This chapter attends to the imposition of settler time over Native spaces by compiling and layering different origin stories about the Grants district. In what follows, I consider how settler colonial technologies of displacement and dispossession have been used to industrialize the natural and cultural spaces and places of Indigenous peoples of the North American Southwest. In Chapter 1, I considered roads as the lines cast through out of the way places as a matter of time over space. In this chapter, I shift from railroads and highways as conduits of time over space to historic exploratory boreholes.

Against this background, I can shift to an account of the exploratory drilling program of the Atomic Energy Commission (AEC), and how borehole drilling technologies became the pervasive mode of exploration for uranium deposits. I argue that innovative geological methods,

like geobotanical sampling, were undermined by drilling that only became more pervasive as the dominant technopolitical paradigm in the 1970s and 1980s, after the decommissioning of the AEC. The application of geological knowledge lost ground to drilling. This phenomenon can be witnessed in the record of borehole logs, which are primarily authored by drill operators, not geologists. According to Chenoweth and Holen, "Exploration in the region has been influenced by the availability of land, rather than by the use of geologic models" (1980:17). Caught amid a burgeoning uranium resource industry and the expansion of the region during the 1960s and 1970s through the exploration programs of large oil companies, Chenoweth and Holen's statement feels a bit overrun by non-geological knowledge. Their perspective captures the industrial application of academic geology, or lack thereof, among the AEC and oil companies that preferred a constellation of borehole logs over any lofty theories about orogenesis. There are artifacts however that suggest the emergence of a robust epistemological paradigm for the application of geological knowledge as early as 1963: two memoirs published by the New Mexico Bureau of Mines and Mineral Resources and one case study published by the Energy and Minerals Division of the American Association of Petroleum Geologists: *Memoir 15: Geology and Technology of the Grants Uranium Region* (Kelley et al. 1963); *Memoir 38 Geology and mineral technology of the Grants uranium region 1979* (Rautman et al. 1980); *A Basin Analysis Case Study: The Morrison Formation Grants Uranium Region New Mexico* (Turner-Peterson, Santos, and Fishman 1986).

The geologic models of the genesis of uranium ore in the Grants district have been applied to identify other uranium ore deposits around the world. "Most of the ore in Grants is in sandstone, as it is in the other uranium districts of the United States. The United States deposits of this type have provided a model for exploration around the world" (Wright 1980:22).

"Knowing the source of uranium is important in understanding how the Grants deposits formed," and for establishing "geologic deposit types" and "geoenvironmental models" that can aid in locating uranium districts elsewhere (McLemore and Chenoweth 2017:29). Before I describe the development and application of geologic models, chronologies and periodizations, I will introduce the origin stories that begin to pluralize our understanding of the Grants uranium district.

4.3 Origin Stories of the "Grants Uranium District"

I was waiting to meet a colleague on the side of the road at one of only two Blake's Lotaburgers left in Grants—not the one by the high school; the one on Santa Fe Avenue, which traces a portion of Old Route 66 and runs parallel to the interstate highway (I-40) and the railroad, braided and interlaced, crisscrossing under and over bridges, making their way east-west through the Rio San José Basin before they dogleg northwest around "G" Mountain and pass through Bluewater Valley in the watersheds between Mt. Taylor and the Zuni Mountains. My colleague offered to let me borrow a collection of oral histories from former uranium miners, which her granddaughter had recorded years ago. The oral histories were once curated and exhibited at the Mining Museum in Grants. She arrived in a white pickup truck. Parked. Stepped down from her truck and handed me the document. She mentioned the boxes of newspaper clippings and other documents her family and friends had been collecting over the last forty years. She said I would be welcome to take a look at the collection at some point. On another occasion, she did connect me with the Cibola County Historical Society to view the boxes of artifacts and information. The stories she shared complicate the folklore of the Martinez story. It is worth considering two

lengthy excerpts from the transcripts that indeed complicate and refine our understanding of the origins of the Grants uranium district.

> My brother, Quimby ("Tink") Farris was a student of geology. He wasn't a geologist, but he read a lot about it. He knew that up in Colorado was the northern outcrop of the San Juan Basin and down here was the southern outcrop… Therefore he felt that uranium could possibly exist on all four outcrops of the San Juan Basin… So they came out here, and he and his wife camped at the San Antonio Pass [about 10 miles northeast of Thoreau]. He stomped around the hills, and actually he walked up on this little outcrop of carnotite and recognized it… He staked three claims…in July of 1945 or '46… I had a garage in Valleo, California, and so he came out there and went to work with me. Of course, we knew about it then; he told us, but we didn't publicize it. We kept it kind of quiet because it was new.
>
> Each year, we would come out here and do the assessment-work on it. He hired a fellow that was here by the name of Alfred Hutton to help him with the assessment work. I used to come back and do the assessment-work part-time… In the meantime, my brother came back and staked two more claims…. The Carnotite #1 and #2, which joined these three and made a total of five [claims]… During those years, before Paddy Martinez, [who] was instrumental in getting it off center because we were keeping it quiet… Alfred Hutton and Volten "Fat" Tietjen had some mining on Section 18 by the Haystack… So they were mining it; they had a little hole, and Alfred had a little one ton truck…
>
> This ore down here was high lime content, and none of the mills could handle it because they were acid leach. So Alfred would load the little truck up and take it up there [to Colorado] and Pete Minoletti, my brother-in-law, would mix it with his ore—it was high grade, but it had too much lime in it. He would mix it with his ore and keep the total content down to less than five percent… They had been doing that for quite some time, several months, and during that time, that is when Paddy Martinez got interested in it. How Fat and Alfred got into it was that Alfred had been working for us and know what to look for. So they got to mining it… This property happened to be on an old Santa Fe Railroad Section that Volten Tietjen had bought the surface from, but evidently the Railroad retained the minerals… Fat claimed they owned it and they took it to court…
>
> So when the news hit the papers that uranium had been discovered here, and that was because of Tom Evans [representing the Santa Fe Railroad], [Carol] Gunderson, and Paddy Martinez, then we had to prepare to either forget it or to get out here. So that's why we moved here. We moved here in July 1952… The whole thing just blew up. We started mining here in 1952, but it wasn't on the property that we had staked [in '45-'46]. It never did materialize to be of any value.
>
> Thoreau was almost as big as Grants at that time. We moved here and Anaconda had already started development. They were working over here in the limestone on Section 9 and Section 34, but they hadn't mined anything. We sub-leased from Anaconda the Andrew's property in 1952 and started mining what they call the Francis Mine. We shipped it to Anaconda, and the AEC put up a buying station in Milan. We shipped it to there and to Anaconda, both. It was Anaconda property so most of the time, if Anaconda would take it, we shipped to them… We started mining the Francis and then the Evelyn

> Mine, and the Alta Mine—three mines on the Andrew's Property. That was the beginning of it. In fact, it was some of the first actual production in the area... It's off to the west [of Ambrosia Lake]; it's on Andrew's property, out of Prewitt… We just closed up everything we had out there [in California] and moved here (Jerry Farris, Grants, NM).
>
> ***
>
> I was born in Grants, in the old Mother Whiteside Hotel. We were living forty miles south of Grants, at the point of the malpais, where Dad [Alton Head] had a little ranch… We moved to Grants in '40… We were the only house on First Street. Dad mined fluorspar [in the Zuni Mountains] during WWII, and that's where we started mining. I helped him out there when I was a kid… We would pick up float and stuff around the top of the ground and put it in the ore pie to help them get more ore. Later we started helping him hand-muck some… Uranium came in about 1950… Otto Jones was a partner with Dad out there in fluorspar for a while… and then he and Mr. Keeney were partners. But Otto Jones was a prospector, a mineralogist kind of guy. He studied all the time and Dad did too. They had mineralogy books and all that they studied… But Otto had read about uranium somewhere… He got interested in uranium, and he found it out there at Haystack. He dug a hole into it, and it was in the limestone… It was a ways up on the hill…
>
> The Colorado School of Mines were down [in Grants] and they were getting ready to go back… So Otto Jones went by [the Yucca Hotel] and he had these samples. He showed [the samples to them] and told them that he thought that they were uranium. Well they got real excited about it… Anyway, Mr. Gunderson and Paddy Martinez got their results back before Otto Jones got his back… Of course, when everybody got excited about uranium, Dad and Mr. Keeney ordered a Geiger counter… Mostly they looked in lime at that time. Everything that had been found was in limestone basically. They weren't too interested in sandstone. Then later in Ambrosia Lake, somebody had got a probe… So they were out in Ambrosia Lake and around. Any hole that they could get into, they probed it to see if it had uranium in it. Out there, where Rio de Oro is, that's where Stella Dysart had drilled an oil well… So that started the Ambrosia Lake [prospecting]—they found out that [uranium] was in sandstone too. It just became a whole new world then. Anaconda came in here with Jack Knaebel… as Knaebel Mining Company. He came and talked to Dad; he wanted to lease outcroppings that dad had found. So they leased to Anaconda, and then he hired Dad to start exploring. That is what they were doing in this picture (Milton Head, Grants, NM).

These two narratives present multiple original claims of uranium discovery quietly staked around Grants prior to 1950. "Of course, we knew about it then… but we didn't publicize it. We kept it kind of quiet because it was new." Paddy Martinez is staged as "instrumental in getting it off center because we were keeping it quiet." They were interested in the limestone outcrops: "everything that had been found was in limestone basically." When they found out that uranium

was in the sandstone too, "It just became a whole new ballgame." Though news of the Martinez discovery led to exploration for limestone uranium deposits, most of the uranium production in New Mexico was produced from sandstone deposits (McLemore and Chenoweth 2017:9).

When Anaconda Copper Mining arrived in January 1951, the company acquired a significant amount of private property and "initiated a diversified, systematic geologic reconnaissance and uranium exploration program" (Wolfe and Carlson 1954). Jack Knaebel with Anaconda Company located uranium in the so-called "Jackpile" sandstone during an airborne survey over Laguna Pueblo:

> The first discovery in this area was in 1951 by aerial radiometric survey which located what was to become the Jackpile-Paguate mine. For many years, this mine was the largest uranium mine in the world. Over 80 million [pounds] of [uranium oxide] have been produced in thirty years of operation and remaining reserves are substantial. The Jackpile-Paguate mine consists of four coalescing open pits, numerous adits, and one decline… Laguna subdistrict (eastern end of Grants uranium district) accounts for 29% of the total pre-1971 uranium production in NM. 45 deposits or occurrences in Morrison Formation (including 31 in the Jackpile sandstone)" (Chenoweth 1988:46).[49]

Technical Memorandum #45 describes the expansive borehole drilling that followed the airborne reconnaissance: "The largest [uranium deposit] was found by rim flying Anaconda planes about a year ago. It has been wagon drilled with dozens of holes, few more than 10 feet in depth, spaced at 4 and 5-foot intervals in rows about 25 feet apart… Development drilling of the Evelyn and Frances properties, as well as 10,600 feet of exploratory drilling between these mines, was conducted by Anaconda with rotary air-drills during August and September of 1953" (N.d.)

[49] The story of how "Jackpile" mine was christened could be considered too vulgar and offensive to be presented here. The story does not appear in any formal publications or other academic or public sources that I am aware of. I took account of two versions of the naming of Jackpile from conversations with people whose identities I will not disclose. Both renditions describe how Jack Knaebel and colleagues discovered uranium during an aerial radiometric survey. When they landed the plane to survey the area by foot, "Jack had to take a crap. That's why they call it Jackpile."

After 1953, borehole drilling only became more pervasive as the dominant technology for uranium exploration in northwestern New Mexico.

Acknowledging the significance of the Jackpile discovery in 1951, McLemore and Chenoweth also indicate a deeper history and a series of more or less important discoveries of uranium mineralization. Undermining the significance of earlier discoveries, they ultimately attribute "the uranium boom" to Martinez: "The initial discovery of uranium mineralization in the Grants uranium district was during the 1920's… however, it was the discovery in 1950 by Paddy Martinez in the Todilto Limestone that started the uranium boom. Paddy Martinez discovered tyuyamunite at what is now known as the Haystack-Section 19 mine" (2017:57). By this point, it should be clear that the habit of blaming Martinez for the boom has little to do with "discovery." It conceals the emerging market in the region in the 1940s, and the story of how uranium oxide became an economic "resource." The narratives presented here account for a backstage glimpse into the mid-century premier of the "Grants uranium district."

In his *History of Exploration*, Paul Melancon claims, "Paddy Martinez, a Navajo Indian prospector, is responsible for the discovery that was to develop the most prolific uranium-producing district in the world. Although his discovery was made in 1950, uranium minerals that were known to occur near Grants had been recognized in the early twenties… and mapped on the outcrop in 1948" (1963:3). Notice the historical amnesia of "re-discovery" and how the mining district begins before it begins. The district is not unique in this regard: many mining districts begin before they begin. There are often a handful of prospectors ahead of the curve, who arrive before the boom, but keep it quiet. According to the economic geologist Vincent Kelley:

> The Grants region experienced phenomenal development, growing from practically nothing in 1951 to a position of great national importance by 1955. There are several stories about the discoveries that culminated the big development of the early fifties. Paddy Martinez, an Indian, is generally credited with bringing the "find" that triggered

> the rush and boom in 1951. However, I am sure that many of the "old timers" in the Grants and Gallup districts were aware of the uranium minerals long before. As one who almost rates the "old timer" tag, I like to recall the winter of 1937 when I often partook of the fine family-style meals at Mrs. Whitesides' cafe in Grants. Mr. Whitesides, a prospector at times, had recently passed away. Mrs. Whitesides often brought samples from her husband's collection for me to see, and on one occasion it was a good-sized, canary-yellow sample which I identified as carnotite and added ironically, "it has no value." Again, about 1950, a very large prospector who came to see me about things in general and some of the old days in particular related how he and others prospected the carnotite beds near Gallup about 1920. It is also reported that federal geologists had examined reported deposits in the Grants district in the early forties. No one really knows who first discovered the Grants uranium, and it is possible that before the white man, the Indians used it locally for pigment. It really is not surprising that such abundant stuff was known by many before 1951 (1963:1).

In their report *Uranium Prospecting and Exploration in New Mexico* (1954), Wolfe and Carlson stage the "re-discovery" of uranium in a familiar way, discounting past discoveries: "In the northwestern portion of the state, the earliest report of the presence of uranium in the Grants area was in 1913. However, it was the "re-discovery" of uranium in the Spring of 1950 by Paddy Martinez, a Navajo Indian, on lands controlled by the Santa Fe Railway that has since led to the present widespread mining development of uranium ores in the Grants vicinity" (1954):

> The Santa Fe Railway, through their subsidiary, Haystack Mountain Development Company, was the first major company to initiate exploration activities in the Grants vicinity. The Program started in December, 1950, consisted first of test pits into the Todilto limestone for the purpose of recording lithology and for ore sampling. Test-pitting was soon replaced by wagon drilling. Half-track mounted wagon drills are still employed by the company in the Haystack pit for ore development and for blast holes (Wolfe and Carlson 1954).

There are glimpses into a deeper history of the Grants mining district with mention of fluorspar mining in the Zuni Mountains and the initial discovery of uranium in the area in 1913 and the 1920s. In spring of 1985, the Bureau of Land Management and what was once called the Bureau of Mines and Mineral Resources (now the Bureau of Geology and Mineral Resources) collaborated in preparing a mineral resource inventory and assessment of northwestern New

Mexico. The report considers the deeper social life of minerals in the Grants mining district of Cibola (once Valencia) County and McKinley County:

> Mining in McKinley County probably began during the early Spanish occupation. Since the late 1800's energy resources have been the most important commodities. Coal, although utilized on a small scale locally prior to 1880, was produced in large quantities since the 1880's when the railroad began operations. Oil and gas production began in 1934 when Red Mountain Mesaverde oil pool was discovered. Uranium was discovered in the Todilto limestone in the late 1940s, but was not mined until 1951. By the mid-1950's, uranium production from sandstone and limestone in the Grants district in Valencia (now Cibola) and McKinley Counties exceeded production from other uranium districts throughout the United States)… Clay, aggregate, crushed and dimension stone, and scoria have been produced periodically since 1913… much of this production directly or indirectly supported energy resources production. Vanadium and molybdenum were produced as by-products of uranium production (Brown and McLemore 1986:34).
>
> The earliest mining of mineral deposits in Cibola County was by Indians for ornamental purposes. Subsequent mining occurred in the late 1800's by settlers and prospectors. Base- and precious-metals were prospected for and perhaps mined. Production of copper, silver, and gold was reported in 1905 (U.S. Geological Survey, 1906). Fluorspar was discovered in 1909 and between 1909 and 1962, over 192,000 tons of fluorspar was produced, mostly during World War II (Williams, 1966). This district is one of the more productive fluorspar districts in New Mexico. Pumice was produced near Grants from 1939 until 1952 (Fig. 14), when U.S. Gypsum Co. purchased property from Pumice Corp. of America. U.S. Gypsum abandoned the pumice operations and opened a perlite quarry. Perlite has been produced intermittently since 1953 (U.S. Bureau of Mines, 1953-1983). Aggregate (including sand and gravel and crushed stone) has been produced at least since 1912 but production figures are not available. Other miscellaneous commodities such as gemstones, Gypsum, mica, vanadium, and molybdenum have been produced periodically, but production has been insignificant (1986:33, 36).

These narratives account for known geologic resources and present timelines of mineral development in the counties that overlap the Grants uranium district. These are "historical background" paragraphs that explain successive waves of mining. With the term "mining" defined broadly, deep histories can be construed if not tortured to make the primeval moment where man and mining co-existed "naturally." It may seem reasonable to think: "The earliest mining of mineral deposits in Cibola County was by Indians for ornamental purposes," but there are contending definitions of the word "mining" and the claims staked around "earliest mining."

Economic geologists have constructed historical periods of mining, metallurgy, and exploration of industrial minerals in ways that naturalize and normalize the relationship between man and mining.

In order to address questions of earliest mining or the moment mining began, these narratives define "mining" broadly enough to account for pre-Columbian Native American relations with minerals. Considering the claim that "Mining began with prehistoric man who wanted to improve their life," Virginia McLemore points out how the important cultural eras are named after the minerals people used during that historical "stage" of development: Stone Age (prior to 4000 B.C.), Bronze Age (4000 to 5000 B.C.), Iron Age (1500 B.C. to 1780 C.E.), Steel Age (1780 to 1945), Nuclear Age (1945 to the present).[50] It is important to qualify the term "mining" from many different perspectives because, for example, Pueblo and Anasazi relations with turquoise minerals from the "prehistoric" Cerrillos mine, along the Turquoise Trail near Santa Fe, were qualitatively different than the AEC and Anaconda Company's relation with Jackpile uranium mine of the Laguna sub-district of the Grants uranium district in orders of magnitude. I will have more to say about contested definitions of the term "mining" and the historical periodizations of economic geologists. Indeed, this will become thematic in the following chapters.

In 1980, the Grand Junction Office of the U.S. Department of Energy (DOE) open filed a technical memorandum that shed considerable light on the early uranium mining history of the eastern-side of the Carrizo Mountains near the northern New Mexico-Arizona state border (Chenoweth 1985). Throughout the 1980s and 1990s, regional geologic memoirs began plotting and coordinating a more complex constellation of facts that highlight the former social life of

[50] https://geoinfo.nmt.edu/staff/mclemore/teaching/imclass/home.html; accessed January 4, 2019. See the "Introduction" hyperlink.

uranium in the Grants uranium district as the by-product of early twentieth-century radium and vanadium production. “These deposits, principally in southwestern Colorado and southeastern Utah, had been mined for radium from about 1910 to 1924, with uranium and vanadium recovered as by-products. Since 1936 the same deposits had been mined for vanadium” (Chenoweth 1988:2). I have already mentioned McLemore and Chenoweth’s (2017) five historical mining periods in the Grants mining district: “radium boom” (1918-1923); “vanadium production” (1926-1940); “post WWII” (1948-1970); “uranium boom” (1970-1982); “a new uranium boom” (2008-present).

Not everybody agrees with this form of historical periodization. One point of contestation is that no uranium mining has actually occurred during the last period. My colleagues at MASE refer to this as “the Nuclear Renaissance that never happened.” The word “boom” appears to be leveraged with the prospect of making a uranium market from the ruins of the former mining district. This is a specter of spectacular accumulation. By tracing the procession of origin stories and the succession of “booms,” it becomes clear how each period of mining reverberates the last one. In other words, past mining paves the way for the prospect of future mining. They would talk to old prospectors and visit old mines, return to abandoned piles with new methods for evaluating and exploiting resources. This is the nature of salvage accumulation and the *secondness* and succession of the social life of the by-product. As field experiences are documented and archived as geologic information, mining districts are rendered increasingly legible in the eyes of the state (Scott 1998) and the eyes of the corporation (Kirsch 2014); yet this form of legibility often fragments local intelligibility (Ortiz 1980). Today, generally speaking, a literature review will take you deeper than a borehole. Movement between the field and the library is necessary for understanding the relationship between the two sites, which are divided

categorically and spatially through the binary conventions of the European Enlightenment, which are inherent in the process of industrialization and modernization. The following historical account of exploration geology describes the techniques and technologies used to search for and define uranium deposits within a broader historical context of the Cold War period, and prior.

Emphasizing the significance of *the acquisition of raw materials* in order to build an atomic bomb, Bill Chenoweth recounts the prospect for uranium during the Manhattan Project: "In 1942 the largest available sources of uranium were the Shinkolobwe Mine in the Belgium Congo (now Zaire), and the Eldorado Mine on Great Bear Lake, Northwest Territories, Canada. In the United States, uranium was known to occur in the carnotite deposits in the Salt Wash Member of the Morrison Formation on the Colorado Plateau" (1988:1). The acquisition of raw materials was originally undertaken by the Army Corps of Engineers who began the development of the Manhattan Engineering District on the Colorado Plateau in the Four Corners region of the United States. McLemore and Chenoweth offer some of the most comprehensive and concise historical accounts of the Grants uranium district, from which one can glean the historical periods of mining prior to the so-called Martinez "discovery."

In 1918, noticing the growing radium market in Colorado, John Wade of Sweetwater, Arizona staked 41 claims on the New Mexico-Arizona state line with illegitimate claims on the Navajo Reservation (McLemore 2010:13). Wade began operating his Carriso Uranium Company (sic.) in the northwestern San Juan Basin (McLemore 2010:24; Chenoweth 1980:5). On June 30th 1919, a congressional act "opened the Navajo Reservation to prospecting and locating mine claims in the same manner as prescribed by the United States Mining Law" (Chenoweth 1985:3). Some uranium development did occur, but the Navajo Nation closed, and it remained restricted from 1927 to 1942 (1985:3). In 1942, the Vanadium Corporation of America (VCA) found

uranium in the vanadium ore, entered a lease[51] and secretly recovered 44,000 pounds of uranium oxide (U_3O_8) from the Navajo Reservation, which was recovered "via a uranium circuit at the Monticello mill (Utah) for the Manhattan Project 1943-1945" (McLemore 2010:24). An estimated 64,000 pounds of uranium oxide was recovered from the vanadium ores mined in Monument Valley and the Carrizo Mountains on Apache and Navajo lands. Geologic investigations were conducted under contract by the Union Mines Development Corporation, which laid the groundwork for the exploration activities of the Atomic Energy Commission, the successor of the Manhattan Engineering District.

By 1947 the U.S. Atomic Energy Commission (AEC) took form, and by the end of the 1950s, it was positioned to govern the world uranium trade (Hecht 2012:58). The uranium composition of the first atomic bomb, the product of the Manhattan Project, was of various origins, both national and international. At the international scale, in 1940, early planners of the Manhattan Project purchased 1,250 tons of high-grade uranium ore that was mined in Shinkolobwe—a town that became a mine in 1921, in what was then the Belgian Congo—and stored it in a warehouse in Staten Island, New York (Hecht 2012:49; Johnston et al. 2007:98). A group of physicists would use some of that uranium ore to replicate the German discovered-Austrian termed "nuclear fission" for the first time in the United States using a cyclotron in Pupin Hall at Columbia University in the City of New York.[52] Within a few years the Americans and the British formed the Combined Development Trust (CDT), which held large uranium supply contracts in South Africa, Australia, and the Belgian Congo; they made separate contracts in Canada (Hecht 2012:50). At the national level, beginning in 1942, the U.S. Army Corps of

[51] The East Reservation Lease (no. I-149-IND-5705).
[52] See http://www.atomicheritage.org/location/manhattan-ny, accessed December 17, 2015.

Engineers would procure uranium not only within the U.S. but also on the Navajo Nation (Chenoweth 1985:4-8).

The Division of Raw Materials of the AEC refers to a U.S. Department of the Interior Geological Survey (Merritt 1951) and a summary report by B. N. Webber (1943) that describes the geologic study of the Morrison Formation carried out during World War II by the Union Mines Development Corporation:

> To evaluate the uranium resources of the Salt Wash Member of the Morrison Formation of the Colorado Plateau, the Army Corps of Engineers, as part of the Manhattan Project, contracted with Union Carbide and Carbon Corporation to create a raw materials appraisal group. This group, known as Union Mines Development Corporation (UMDC) was formed in 1943 and was active through 1946.
>
> Geologic studies and resource estimates for the northern and western Carrizo Mountains are contained in reports by Webber (1943), Eakland (1946), and Harshbarger (1946). All of the known outcrops of uranium/vanadium minerals, prospects, and mines were mapped and described by UMDC geologists. After mapping the mines, UMDC geologists estimated the uranium content of the 6,924 tons of mined vanadium ore at 0.15 percent U3O8 [uranium oxide]. Much of this uranium was later recovered by reprocessing the vanadium tailings at Durango (Chenoweth 1980).

4.4 The Application of Geological Knowledge

By 1951, airborne radiometric reconnaissance had become the broad-brush strokes that would identify uranium deposits on the Colorado Plateau, followed by ground reconnaissance, drilling and probing. In the report, *Airborne Radioactivity Survey in the Vicinity of Grants, McKinley and Valencia Counties, New Mexico* (1951), Frank W. Stead outlines standards for aeromagnetic measurements and radioactivity measurements. Such aerial surveys were often carried out on a Piper PA-18, 135 horsepower Super Cub, equipped with a Mark VI airborne scintillometer for "rim and grid flying" with flight lines spaced at 100-foot intervals, at a height of 50 feet in order to produce a 15-minute, semi-controlled air-photo mosaic with a scale 1:62,500 (Chenoweth 1957:10). Ariel surveys were followed by ground reconnaissance in cases where radioactive

anomalies were identified. Geophysical methods for surface exploration would supplement this endeavor. A focus on "primary structures" and "sedimentary structures" revealed two favorable trends of Salt Wash sandstone outcrops of the Jurassic Morrison Formation: the edges of mesas and "questas" or "cuestas," a ridge with a gentle backslope (Stokes 1953:11). As noted above, carnotite outcrops were the "favorable signs" and observable conditions that led to the claim staking for uranium in 1944 and 1945 by Farris and Hutton and colleagues.

During the first decade of uranium exploration, from 1943 to 1953, basic surface methods would suffice. Once they identified the sandstone and limestone exposures, they would drill holes behind the outcrop to develop the uranium orebody and begin plotting exploratory boreholes to find the extent of the deposits. By 1953, such surface inquiries would be exhausted giving way to "the untested territory" of the underground. Drilling became the pervasive and dominant technology for exploration during the second half of the twentieth century:

> Chief geomorphic fact with regard to the search for uranium has been the production of wide benches, dip slopes, mesa tops, cliffs, and thinly covered flats on or under which the ore-bearing Salt Wash sandstone occurs. Economically this is fortunate since it means greater numbers of ore deposits are exposed or lie within explorable depths than could occur under other processes or stages of erosion. The excellent exposures also provide almost unlimited opportunity for study of gross or detailed composition of ore-bearing rocks… The purpose of this analysis would not be the discovery of new deposits in the exposed outcrops for this phase of activity appears to have been mostly complete with ordinary types of surface prospecting. What is needed are usable guides for subsurface exploration in covered ground and the present investigation therefore aims to direct attention to features by which known surface or subsurface conditions may be projected into unknown territory. In other words, the present study deals not only with favorable signs but also with the projection of observable conditions, favorable or unfavorable, into untested territory (Stokes 1953:7, 13-14).

In 1953, the AEC Division of Raw Materials, Exploration Branch returned to the Carrizo area where the uranium ore was originally recovered for the Manhattan Project to explore the possibility of extending uranium mining operations underground. The field report, *Reconnaissance of the Northwest Carrizo Area, Apache County Arizona* (Hatfield and Maise

1953), accounts for the history of production from 1942 to 1944, when the mines operated for vanadium. Note that it can be difficult to distinguish uranium production from vanadium production because they are closely associated minerals, and, in some reports, "vanadium" was used as a code-word for uranium during World War II. According to Hatfield and Maise (1953), the mines operated for both uranium and vanadium since 1948.

By 1949 and 1950, the U.S. Geological Survey had diamond-drilled 24 exploratory boreholes in the area. The report also benefited from the Shell Oil Company that allowed their "seismic shot holes to be gamma ray logged." After assessing the uranium-vanadium concentration of the deposits located northwest of the Carrizo Mountains, the report prescribes further exploration of the area with "a minimum of 20,000 feet of wagon drilling, logged by gamma ray equipment." The pattern of deposition they noticed called for "exploration by drilling." Geological studies revealing directional trends of the deposits guided the prescribed drilling. "Significant radioactivity has been detected in 14 seismic shot holes, suggesting the presence of buried ore bodies. The expense and nature of the information desired make wagon drilling preferred… Holes spaced in 200 ft. centers should be drilled. In their report, *Geologic Studies and Diamond Drilling in the East Carrizo Area, Apache County, Arizona, and San Juan County, New Mexico* (Masters, Hatfield, Clinton, Dickson, Maise, Roberts 1955), they describe the process by which "primary grid ore holes were offset 25 to 50 feet in order to outline the orebody. At the same time, development drilling behind mineralized outcrops was in progress." They followed the suggestions of W. L. Stokes and D. J. Jones (USGS 1951), who studied the area as early as 1942.

From Grants to Gallup, reconnaissance on the Jurassic Morrison Formation was undertaken by the Denver Exploration Branch of the U.S. Atomic Energy Commission in 1951

and published in March 1952 (Melancon 1963:3). "As exploration depths began to exceed 150 feet, the wagon drill was replaced by the rotary shot-hole drill. A tool that proved to have great versatility, it could drill deeper, faster, and at lower costs; it could be used to cut cores if necessary; and either compressed air or water could be used as a circulating medium to clear the cutting from the hole" (1963:3).

> With the introduction of the rotary drill and deeper drilling became more extensive use of radioactivity logs as a means of determining the tenor of mineralization cut by the drill holes. The first general equipment consisted of a Geiger counter with a long cable; those manufactured by Gordon Babbel were most common. The Geiger tube was raised and lowered in the hole by a hand reel, and readings taken every six inches or one foot at the operator's discretion. An automatic recording device was eventually incorporated into the equipment, but had very limited use in the Grants district before it was replaced by the more sophisticated truck mounted logging equipment (Melancon 1963:3-4).

By 1952, securing uranium resources became a "patriotic duty" with an economic incentive. According to Johnston, Dawson, and Madsen, "The AEC opened offices in Colorado, New Mexico, and Utah, publishing advice on uranium prospecting and offering a $10,000 discovery bonus for high-grade deposits. In the decade that followed, "uranium fever" swept the United States. In 1953 alone, Americans bought thirty-five thousand Geiger counters" (2007:99). Johnston and colleagues found that "By 1958 there were seventy-five hundred reports of uranium finds in the United States, with 850 underground and 200 open-pit mines producing uranium" (2007:99; Brugge and Goble 2002). A sub-office of the AEC Denver Exploration Branch was established in Albuquerque, New Mexico in April 1953, "for rapid reconnaissance and preliminary appraisal." The primary task of the office was "to encourage and assist prospecting activities by individuals and private companies" (Wolfe and Carlson 1954). One report mentions the "commission-trained Indian prospecting" (Gabrecht 1954). By the mid-1950s, they were core-drilling 100,000 feet per month in the vicinity of Grants, and there were "several hundred part-time and professional prospectors in the area, and at least 50 more each

month." A majority of the uranium discoveries have been made by "the part-time non-professional prospector." *Technical Memorandum #45 – Regional Reconnaissance and Prospecting in the Northeast Grants District, New Mexico*, reports on the initial approaches the AEC had carried out to precipitate a more extensive exploration program for uranium:

> 1) radiometric prospecting during the sedimentary and structural reconnaissance to determine favorability of an area; 2) examination of mines and prospects; 3) contacting prospectors, acquainting them with uranium-bearing rocks, and pointing out favorable areas to prospect… It is believed that thirty-two of the persons encountered were encouraged to look for uranium. Perhaps half of them have, or will soon have, Geiger counters. It is suggested that AEC keep in contact with the more active prospectors by visiting them. The Warm Springs area has the best potential of the areas visited for containing a uranium deposit. Three persons are actively prospecting there, and thus the AEC need not spend time duplicating the effort. Contact prospectors rather than waiting for them to contact the AEC office (N.d.).

According to Virginia McLemore and William Chenoweth, "The first economic discovery of uranium in sandstone was made on January 4, 1951, east of Haystack Butte in an area called Poison Canyon… named for the abundance of locoweed" (2017:15). "Locoweed" or "Crazyweed" refers to the plant *Astragalus,* which produces the phytotoxin "swainsonine" when it grows in soils rich in selenium. If consumed by livestock it can cause "locoism," associated with weakness, odd behavior, and paralysis.[53] Recognizing this threat over the centuries, Native American and Hispano pastoralists would avoid these places while grazing their sheep. *Geology of the Poison Canyon Mine* (Mathewson 1953) references a geobotanical survey that focuses on the occurrence of Astragalus and discusses the feasibility of using the method to identify uranium deposits. In her report, *Geobotanical Reconnaissance near Grants, New Mexico* (1953), Helen Cannon recommends "Uranium analysis of trees growing on the Todilto bench and mapping of selenium-indicator plants on the sandstones of the Morrison formation" as a method

[53] https://www.ars.usda.gov/news-events/news/research-news/2010/ars-and-new-mexico-scientists-take-a-long-look-at-livestock-and-locoweed/; accessed December 12, 2018.

for prospecting. Sponsored by the AEC, Cannon also makes a "special acknowledgment" to the Atchison, Topeka, and Santa Fe (AT&SF) Railway "for permission to study the deposits on the railroad property" (1953:2). She discusses how selenium-indicator plants of "the preussii group of Astragalus (milkvetch) and Oryzopsis hymenoides (Indian ricegrass) grow profusely along the base of the outcrop of the carbonaceous ore in the Westwater Canyon sandstone member of the Morrison formation in Poison Canyon" (2). Cannon notes that Atriplex confertifolia (shadscale) also absorbs selenium, and juniper and piñon trees "absorb unusual quantities of uranium." Her report suggests that the occurrence of such plants on the surface of the Morrison Formation and an analysis of the vegetation offer a feasible method for uranium exploration:

> Needles of deep-rooted pinyons or junipers may be sampled by collecting needles from all sides of a tree at certain specified intervals along traverses or on a grid pattern. Wood from the branches or trunk of the trees is a favorable sampling medium. One hundred milligrams of dried wood or needles are needed for an analysis by the fluorimetric method. Thirty samples per day can be collected and charted by a two-man party, and a similar number can be analyzed by a chemist in a centrally located laboratory (1953:7).

The geobotanical method offered supplementary evidence for locating a number of deposits, but its utility was ultimately deemed limited, and it eventually lost explanatory power to other modes of exploration such as airborne reconnaissance and exploratory drilling.

In the beginning, more than any contending or prevailing geologic conceptual model, mid-century auger technology was the most pervasive tool for rendering the district legible and tangible. Drilling exploratory boreholes became the dominant practice. Mystified by the distribution of the uranium ore, one geologist states, "the drill remains a reliable diagnostic tool in ore-finding and following the elusive trend. But the faint tell-tale evidences along the route of travel of the ore solutions and their capriciously deposited offspring always lie buried along their devious routes in their hosts. Therefore, our ore-finding techniques are yet, of necessity, in the trial-and-error stage" (Garbrecht 1954:9-10).

> But we are always groping with some success to find a more scientific way to follow ore, or to find new ore areas away from the rim. Later, we may be more dependent upon other methods for ore-finding. Geophysical methods, therefore, forcibly present themselves as the "chosen instruments" of the future. Depth where scintillometer are no longer effective but drilling is… Recommendations for drilling in several instances where the anomalies found by airborne means… But the use of purely geological principles alone, as well as favorability maps were not prominently in use. In the ultimate analysis, of course, most criteria used bear a geologic relationship… trial-and-error methods are rightly sill in vogue here, as they are elsewhere, and the drilling rig is still a sound diagnostic tool, by the very nature of the things, in the art, if less so in the science, of ore-finding on the Plateau (Garbrecht 1954:9-10).

In March of 1955, Lewis Louthman discovered uranium in the Ambrosia Lake region, which would become the most productive of the eight subdistricts of the Grants uranium district.[54] This is an early exemplar of the "application" of geological knowledge to identify uranium ore bodies, albeit for the sake of drilling. Louthman discovered the Ambrosia Lake trend by examining logs of oil tests at the New Mexico Bureau of Mines and Mineral Resources in order to determine drilling depths to the Morrison Formation. With this information, he began drilling for uranium in Ambrosia Lake area and discovered uranium mineralization in the Westwater Canyon Member of the Morrison Formation by the second drill hole, which led to the development of the Dysart No. 1 mine. "The Ambrosia Lake-Mt Taylor trend is the largest mineralization area in the Grants district and accounts for a substantial portion of the reserves and potential resources in New Mexico" (McLemore 1981). McLemore and Chenoweth describe what followed:

> News of this discovery created a claim-staking and leasing boom in the Ambrosia Lake area. Exploration drilling followed, and several more ore deposits were located. The small operators merged with well-funded companies such as Homestake Mining Company (Homestake), Kerr-McGee, and Philips Petroleum Company to develop mines. On July 5, 1956, the AEC opened an ore buying station in Milan… to provide a market for uranium in central New Mexico (2017:17).

[54] Ambrosia Lake subdistrict production: >211,200,000 lbs U_3O_8, at grade ranging from 0.1-0.5 U_3O_8 percent (McLemore 2010:27).

In 1955, radioactivity logs were made primarily with hand operated equipment. Rautman and colleagues note that the AEC "made a valiant effort to log all the holes for which it had requests with its truck-mounted scintillation equipment, but the volume of work soon surpassed the capacity of the equipment" (1980). By the end of the 1950s, large oil companies began to lead the exploration for and development of uranium deposits. "Kerr-McGee Oil Industries and Phillips Petroleum Company contracted with Century Geophysical Company to make recorded logs of all their drill holes. Electric logs, resistivity and self-potential logs soon were part of the service, since it was found that cuttings from holes drilled with water left something to be desired when they were to be used for detailed lithologic studies. The information obtained has proved most valuable in compiling subsurface geologic maps and, more recently, in mine planning" (1980:4).

By 1956, exploration activity had reached a peak with the pervasive auger technology of drilling rigs:

> More than 200 drilling rigs were in operation in what is now the Ambrosia Lake area. Noncore rotary drills made up the great majority of the operating rigs. Conventional core drills were used only to verify results obtained from natural radioactivity logs of the open holes. Coring with the shot-hole drills soon became perfected, and the core drills could no longer economically compete… It was soon found that ore outlines drawn from such widely spaced drill holes were much too general for proper planning of underground development. Ore sometimes went between weakly mineralized or barren drill holes, and sometimes did not extend from one ore hole to the next. All these factors were responsible for the introduction of long-hole drilling from the underground workings. This drilling is generally done at regular intervals along the advancing sublevel development drifts. Results of the drilling give better definition of known ore, and verify or discount suspected areas of favorability that come to light as the mines develop (Melancon 1963:4-5).

In June of 1956, "exploration drilling by Anaconda, in the area west of Jackpile open pit mine (NMCI0064), made a major discovery (Kittle, 1963). This would be developed into the Paguate open pit mine (NMCI0064), which is adjacent to the Jackpile open pit mine, both of

which are located in the Laguna subdistrict of the Grants uranium district" (McLemore and Chenoweth 2017). Melancon accounts for the breadth of exploration methods driven more by innovation of tools and technology than geosciences:

> The rapid development and practical utilization of new exploration techniques and tools have played an important part in the evolution of the Grants uranium region. Methods used to explore for and define deposits of the district included rim walking with and without radiation detectors, radiometric traverses, geobotanical sampling, airborne radiometric reconnaissance using fixed-wing aircraft and helicopters, test pitting, trenching, rim stripping, wagon drilling, rotary noncore drilling used in conjunction with natural radioactivity and electric logging, and extensive long-hole drilling from underground workings. Each of the methods has been at least partially responsible for the discovery of mineable deposit (1963:3).

In his report, *The Geological Survey's Work on Development of Prospecting Tools, Instruments, and Techniques* (1952), Frank Stead describes:

> The understandable need for speed in the recent search for uranium has tended to retard the more fundamental and theoretical research needed for future progress. Particularly in gamma radiation, we have continually found that satisfactory prediction could not be made on the basis of existing theory, and we have been forced to mark time while new concepts were developed to explain apparently anomalous data. We hope in the future to reach a better balance between the two extremes of the research spectrum, the purely empirical or applied phase and the fundamental or basic phase… With the possible exception of thermal gradients caused by radioactive decay, the standard geophysical methods of exploration do not provide any direct indication of radioactive materials, although they may be used in the determination of geologic structures favorable for the occurrence of uranium ore. For these reasons principle emphasis has been placed on the development of equipment and techniques for rapid field measurement of radioactivity, principally portable survey counters, carborne and airborne equipment, and gamma-ray logging equipment (1952:4).

Between the 1960s and 1970s drilling continued to proliferate. Since the initial publication of *Memoir 15* in 1963, "the impact of well-funded exploration programs has increased knowledge of the region's resources. Records of the Grand Junction DOE office indicate that 63,898 holes totaling 64,631,792 ft have been drilled in the area. Average drilling depths increased from 212 ft in 1964 to a record high of 1,651 ft in 1975" (Rautman et al. 1980:20). According to Chenoweth, "Exploration in the region has been influenced by the

availability of land, rather than by the use of geologic models" (Chenoweth 1980). The development of equipment and techniques for rapid field measurement of radioactivity dominated the first decades of uranium exploration with the auger technology of drill rigs and radioactivity logging equipment. This mode of exploration and development was made possible by the "availability" (i.e., the appropriation) of large swaths of Indigenous lands, as described at the beginning of this chapter.

By the 1970s and 1980s, geological theories, explanations, and models of uranium exploration, mining, and milling experienced tremendous growth and diversification. *Memoir 38: Geology and Mineral Technology of the Grants Uranium Region* (Christopher A. Rautman et al. 1980) is the publication that resulted from a conference that attracted over 800 geologist and other scientists, including people from six foreign countries. Field trips had an overflow crowd of 260 geologists and 46 papers were presented at the 1979 symposium that aimed to build on the canonical *Memoir 15* (Kelley et al. 1963), the *locus classicus* of geological knowledge on the topic of uranium mining in northwestern New Mexico. Though uranium mining in the region subsided considerably by the 1980s, grinding to a halt in 1990, this was the period of most intense scientific research on the Morrison Formation of the "Grants uranium region," a time when geologic models proliferated (Turner-Peterson, Santos, and Fishman 1986). The source of this scientific pursuit was endowed by the National Uranium Resource Evaluation (NURE; 1974-1984), which was implemented by the Grand Junction Office of the U.S. Atomic Energy Commission (and succeeding federal agencies) in order to assess the nation's uranium resources and identify favorable areas of mineralization. The evaluation included geochemical surveys, compilation of quadrangle geologic maps, geophysical surveys, quadrangle assessments for uranium resources, miscellaneous geologic investigations, and drilling projects (McLemore and

Chenoweth 2017:21). NURE was the last comprehensive attempt by the federal government to understand the distribution of the uranium resources in the United States. There are documents from NURE archived in the Geologic Information Center at NMT.

Chenoweth's academic project from the 1980s onward has been to remind Cold War historians of the significance of "the acquisition of raw materials." We can read Chenoweth's work as an academic response to the banalization of uranium mining (Hecht 2012), and how the front end of "the entire cradle-to-grave lifetime of nuclear weapons" (Masco 2006) has been backgrounded as uninteresting refuse piles. By the 1990s, Chenoweth was lamenting a dying industry:

> Low prices, inventory liquidations, and foreign competition continued to plague the domestic uranium industry. As a result, the Secretary of Energy [James Watkins] declared the domestic industry to be non-viable for the sixth straight year. Uranium-exploration expenditures in the United States continued at a very low level. In 1990, an estimated $6 million was spent on uranium, including 1.5 million ft of surface drilling… Uranium produced from solution mining and as the result of the by-product of phosphoric-acid production accounted for about 42% of the total production of the United States. At the end of 1990, two uranium mills were operating in the United States (Chenoweth 1991).

Bill Chenoweth's experiential accounts, memoirs, reports, and other publications stand out as one of the most comprehensive efforts in the application of geology to make the "Grants uranium district" legible for the extraction of uranium ore.[55] One source, *The Daily Sentinel,* a local newspaper out of Grand Junction, Colorado, spins it this way: "Chenoweth was the Google of the Colorado Plateau before search engines were even the stuff of dreams."[56] The report portrays an 82-year-old Chenoweth as "a life-long geologist" that has "spent his career making miners safe." He is, "On so many levels… a national treasure." This was not the first time I

[55] See https://geoinfo.nmt.edu/, accessed April 20, 2016.
[56] Accessed October 28, 2015: http://www.gjsentinel.com/portrait/articles/bill-chenoweth-a-lifelong-geologist-hes-spent-his-career-making-miners-safe/.

heard an eminent geologist referred to as a “treasure” or a “gem.” The report also reveals the process in which Chenoweth became an authority on uranium mining throughout the Colorado Plateau. It begins over half a century ago. After receiving his bachelor of arts in geology from Witchita State University in 1951. He attended a summer field school in 1950, supported by the New Mexico School of Mines in the Zuni Mountains, he took a job in Shiprock, New Mexico that reportedly paid $6.50 a day. “Chenoweth traveled to the Southwest on behalf of the Atomic Energy Commission, then the Energy Department, as a geologist and as a branch chief for both agencies, mapping mines, studying uranium resources and generally keeping his finger on the pulse of the uranium business and the people who ran it.” Such projects would eventually underpin his thesis and the award of a master of science in geology from the University of New Mexico in 1953. Funded by the AEC, Chenoweth’s master’s thesis offers a study of the Morrison Formation in what was Valencia County (now Cibola County), New Mexico. He was employed by the AEC thereafter to work on exploratory drilling projects for uranium on the Navajo Nation in northwestern New Mexico and northeastern Arizona. He lived in Grants, New Mexico, but was transferred to the AEC’s main office in Grand Junction, Colorado in 1964. He was assigned to “study uranium ore deposits in South Dakota and Wyoming. Bill was appointed Chief of Geologic Branch in Grand Junction office in 1970 and was responsible for the activities of AEC geologists in 14 western states” (McLemore and Chenoweth 2017:50).

Chenoweth’s memory of these early experiences, at a time when records were either top secret or scarcely kept, has been called upon where lacunae appear in the official record. By 1990, the U.S. Justice Department would consult Chenoweth’s expertise for the Radiation Exposure Compensation Act (RECA). He “was placed in charge of evaluating the claims of miners, millers and haulers suffering from terminal diseases for compassionate payments from a

government grateful for their Cold War efforts." If there were ever conflict between Chenoweth's story and the stories of claimants, their claims would likely be dismissed. Chenoweth thus stands as a *de facto* gatekeeper by enforcing boundaries against those suffering from the health impacts of uranium exposure seeking compensation from responsible parties.[57]

McLemore and Chenoweth's *Memoir 50C* entitled, "Energy and Mineral Resources of New Mexico: Uranium Resources" was published by the New Mexico Bureau of Geology and Mineral Resources in 2017. Though there is no consensus on the origin of the uranium deposits of the Jurassic Morrison Formation sandstone, they account for the many different models that map the origin of uranium in the district. The "brine-interface model" and "lacrustrine-humate model" build on the earlier models. They also cite numerous isotopic studies that suggest a potential source of uranium from an arc of plutons, calderas, and other volcanic features that were active during the Jurassic Period, and spewed ash into the sky that sedimented into a large briny Cretaceous basins, such as the San Juan Basin where the Grants district is located. They describe the "intimate association" of uranium, vanadium, and humates during "early diagenesis." (31). These models account for the genesis of uranium ore—how it came into existence—which gives insight into how to find more uranium around world. Geologic models of orogeny became ancillary to how they could be actualized in a global market. My argument here is about a process by which geology becomes co-opted for *the application of knowledge* in making uranium ore legible and tangible.

This geological paradigm of applied sciences took ground in northwestern New Mexico through the epistemological emergence of the "Grants uranium district," as a geologic model that makes other uranium mining districts possible around the world. This chapter accounted for the

[57] http://www.post71exposure.org/about.html; accessed November 18, 2016.

emergence of this peculiar thought style, how it took course in New Mexico, and has collided with the situated ontologies and epistemologies of Pueblo and Navajo (Diné) peoples, as well as Anglo and Hispano settler communities. The notion of "time over space" indexes the fundamental problem identified by Vine Deloria and Alfonso Ortiz: an ideology of triumphalism, in which settler time is cast over Indigenous spaces and places.

The geological application of time over space maps onto a broader political-economic landscape. It is part of the problem Karl Marx called the "annihilation of space with time"—a concept elaborated by David Harvey as a "shrinking world" or "space-time compression" (1989). Neil Smith explains: "Capital drives to overcome all spatial barriers to expansion and measure spatial distance by transportation and communication time" (1984:78):

> In short, expansion is fueled by creating a larger number and broader variety of commodities, by selling them on the market and reinvesting part of the profit in a further expansion of the scale of the productive forces. Historically, the earth is transformed into a universal means of production, and no corner is immune from the search for raw material; the land, the sea, the air and the geological substratum are reduced in the eyes of capital to a real or potential means of production, each with a price tag (Smith 1984:78).

We can see how the annihilation of space with time inheres in the logic of economic geology and the making of the Grants uranium district, and how this disciplinary emergence holds hands with Indigenous elimination.

Geology, perhaps more than any other discipline, is fundamentally about transforming space into time. It is a process that reaches backwards through time—surveying geologic archives, talking to old prospectors, going down old roads and visiting former mines, milling through what was left behind, the tailings that have piled up on the landscape. It is a process of going back through the strata of geologic time to extract some ancient material that has been bestowed a new human value. It turns soil sediments and geological strata into Geologic Time Tables. Radiocarbon dating emerged in the 1940s as a method for determining the age of things

containing organic matter by tracing the radioactive isotope of carbon. In 1939, carbon-14 (^{14}C) was isolated using a cyclotron accelerator at the Radiation Laboratory in Berkeley.[58] Accelerator mass spectrometer (AMS) has become the method of choice for its power to separate rare isotopes. This device transforms space into time supplementing geological investigations. Geology is literally and physically a discipline that turns space into time. Even before the emergence of radioactive carbon dating, geology had long been a discipline of time over space.

By asking questions about how the discipline of geology was applied in rendering the "Grants uranium district" legible for the extraction of uranium ore, investigating settler chronologies and periodizations, we can see how exploratory borehole drilling became the dominant technology for identifying, characterizing, and developing uranium orebodies from the 1940s to the 1970s. Though geological and ecological sciences emerged from the Atomic Energy Commission (AEC) and their federally-funded research paradigm into all things nuclear (Hagen 1992), geologic models of ore genesis became applicable in a new way by 1963, as indicated by *Geology and Technology of the Grants Uranium Region* (Kelley et al. 1963). These geologic models were latent initially as AEC invested more heavily in drilling and drill operators, anc citizen and indigenous science, rather than advanced studies of orogeny. *Informating* uranium regions and districts, compiling and archiving geologic information has become a powerful way of knowing the region. Where local knowledge was fragmented and displaced (Ortiz 1980), the accumulation of geologic information took ground, first, in Grand Junction, Colorado and Grants, New Mexico; then, in Socorro, New Mexico and Laramie, Wyoming. The biography of

[58] https://www2.lbl.gov/Science-Articles/Archive/early-years.html; accessed July 16th 2019.

Bill Chenoweth illustrates this story of informating the "Grants uranium district" and the application of geological knowledge.

4.5 Conclusion

This chapter was inspired by Simon Ortiz, the Acoma poet who expressed concern about how Paddy Martinez is represented as the Navajo man who "discovered" uranium, which led to the development of the Grants uranium district and "would reiterate the idea of the Indian bringing his own fate upon his head" (1980:64). Ortiz's observation maps onto Paige West's (2016) theory of dispossession: how the exploitation of local knowledge and local resources is followed by blaming the people who have been exploited. Refusing to tell the "historical background" and the apocryphal stories of "discovery" that make Indigenous peoples responsible for the devastation of the land is a gesture of the kind of "ethnographic refusal" prescribed by Audra Simpson (2014). As an alternative course of study, this chapter traced the question of how the discipline of geology was applied in making the Grants district legible for the extraction of uranium ore through the Geologic Information Center at New Mexico Tech. By tracing how settler colonial chronologies are cast over Indigenous spaces and places, I took account of how the disciplinary formation of geology in the U.S. Southwest held hands with the exploitation of Indigenous peoples, lands, and knowledge by turning local knowledge into geologic information through exploratory borehole drilling and logging.

In Chapter 7 and Chapter 8, I describe how these historic exploratory boreholes have become conduits that carry contaminated surface water into deeper groundwater aquifers. Boreholes have also served as the conduits of settler colonial time over the spaces and places of Indigenous peoples. Though the holes were drilled during the second half of the twentieth

century, they have remained a pervasive problem that haunt the landscape in the twenty-first century. The technopolitics of borehole drilling resides in the era of environmental monitoring and cleanup. Today, boreholes are drilled for the purpose of groundwater monitoring and hydraulic engineering in the former mining district. This chapter accounts for the rediscovery of the successional growth and development of settler colonialism, capitalism, and industrialism; how they happened in the past and keep happening now.

CHAPTER 5

URANIUM TALES PART I: THE HOMESTAKE SITE[59]

In this chapter, I take account of stories about uranium mill tailings piles. I begin by describing the critical analyses of the Bluewater Valley Downstream Alliance (BVDA) and other residents who live near the corporate "reclamation project" of Homestake Mining Company of California, a subsidiary of Barrick Gold Corporation.[60] I introduce the Homestake site through an ethnographic account of a "human rights tour." The tour was organized by the Multicultural Alliance for a Safe Environment (MASE) and led by the core group BVDA as a contribution to the Human Rights Network's (HRN) compilation of cases for their "Shadow Report" for the United Nations (UN) Committee on the Elimination of All Forms of Racial Discrimination (CERD). Though this tour took place during my preliminary ethnographic fieldwork in 2014, I have since toured the site on several other occasions with BVDA and other colleagues from MASE. I also inquired about the site during interviews. I include insights from other visits and quotes from interviews that deepen our understanding of the Homestake tailings piles. With this site, I will demonstrate the technopolitics of environmental monitoring between stakeholders of local communities, transnational mining corporations, and federal and state agencies.

I will introduce Stuart Kirsch's notion of "corporate science" (2014:127-158), which will become a familiar concept in the pages that follow, in order to show how Homestake-Barrick Gold uses science and technology to limit their environmental liabilities and naturalize their industrial impacts through strategies of "backgrounding," "alternative contamination limits"

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[59] I am grateful to the historian of science Luis Campos for suggesting this title that indexes stories of uranium tailings.

[60] Though Homestake Mining Company of California merged with Barrick Gold Corporation in 2001, I use the name "Homestake" emically; it was the most common term used to refer to the site by all stakeholders. See https://www.barrick.com/news/news-details/2001/Barrick-Completes-Merger-with-Homestake/default.aspx; accessed April 24, 2019.

(ACLs), "buyouts," "discharge permits" and other forms of so-called "remediation" and "reclamation." The Homestake site offers unique insight into an active corporate reclamation project that is currently underway and has not yet achieved standards of remediation. Local communities, grassroots organizations, and regional NGOs describe the Homestake reclamation project as a peculiar procedure involving unique methods of hydraulic engineering that are used nowhere else on earth. I hope my account will capture the idiosyncrasies of the cleanup regime and the policy, planning, design, and engineering of their large uranium mill tailings pile.

Considering how such forms of corporate science influence the technopolitics of environmental cleanup, this chapter focuses on the corporate practice of *backgrounding*, which is both a technical application of corporate science, and a concept I want to generalize as a strategy of figure-ground interplay whereby the object of study, the culprit of contamination, uranium mill tailings piles, become obscured, naturalized and normalized. Backgrounding is a strategy of corporate science that hides away important information about the nature of contamination at these sites through epistemological disassociation. I want to conceptualize the term "backgrounding" broadly to understand processes that produce "data gaps" and disjunctures in environmental information. It is a process that naturalizes the impacts of the mining industry and raises the level of contamination that will be accepted under state permitting regimes through alternative contamination limits. Gabrielle Hecht (2012) accounts for a similar process of nuclear exceptionalism and *banalization*. Though my colleagues would often conflate the terms "background" and "baseline," I specify my understanding of *backgrounding* as a corporate strategy used to negotiate the "politics of baselining."

In Chapter 7, I will introduce my conception of the "politics of baselining," which attends to how communities impacted by mining contest the corporate practice of backgrounding, and

the conflation of industrial systems with natural systems. In this chapter, I will show how the concept of the life of the by-product helps us keep track of the environmental impacts of mine waste and mill tailings, which have been backgrounded through various techniques and strategies that inhibit the growth and diversification of environmental information pertaining to the region. My argument here is that applications of geosciences for the public good, for the purpose of identifying the problem and cleaning it up, are compromised by "corporate science" that backgrounds industrial pollution and naturalizes the environmental impacts of mining, leaving gaps and fragments in environmental information that conceal areas of risk to public health.

For this reason, I supplement my ethnographic portrayal of the human rights tour with reports from the Southwest Research and Information Center (SRIC) that weave together fragments and traverse gaps in public environmental information pertaining to the Grants mining district. I recognize this source of information as a form of "undone science"—a term Frickel and colleagues define as "areas of research identified by social movements and other civil society organizations as having potentially broad social benefit that are left unfunded, incomplete, or generally ignored" (2009:2). David Hess (2016) elaborates on how the concept of "undone science" brings together the fields of science and technology studies (STS) and social movement studies (SMS). Hess considers how "mobilized publics" can become a driving force in getting undone science done, which can lead to significant transitions in industries. The concept of undone science is relevant here as it directs our attention to how social movements change industrial technology. In the ethnographic description that follows, notice how critiques of the environmental cleanup regime in the Grants mining district are aimed at political coordinates that map onto Hess's typology, catalyzing the research that traverses fields of undone science,

changing mining and energy industries in complex and dynamic ways, fundamentally altering the technological systems used to manage uranium tailings.

In this chapter, I show how what may emerge as "undone science" can become a contending scientific paradigm that bolsters community and environmental health concerns and drives state and federal environmental cleanup regimes. A colleague from SRIC once referred to this phenomenon of emergence by telling me: "It can be hard to see the forest through the trees," considering how his expertise had recently been undermined in New Mexico Environment Department's (NMED) approval of "alternative abatement standards" for the St. Anthony mine in the Laguna sub-district of the Grants mining district, yet he was simultaneously playing an important role in the manifestation of a multi-million-dollar National Institute of Environmental Health (NIEH) Superfund Research Program at the University of New Mexico.

5.1 The Homestake Mill Tailings Site

On a Tuesday morning, July 29th 2014, a group of us gathered in the parking lot of the Nativo Lodge in Albuquerque, New Mexico. We were bound for Acoma Pueblo (*Aacqu*) and Laguna Pueblo (*Kawaik*), then to Milan, and finally, to the Community of Red Water Pond Road near Church Rock in the southeastern corner of the Navajo Nation (*Dinétah*). MASE arranged a "human rights tour" of the Grants mining district that would be followed by a "tribunal hearing" in Gallup. The coordinator from MASE, Susan Gordon, piloted the eleven-passenger rental van. I was sitting co-pilot. We were accommodating six constituents of a national NGO based in New York City and Atlanta called the Human Rights Network (HRN). They were compiling cases for a "Shadow Report" for the United Nations (UN) Committee on the Elimination of All Forms of Racial Discrimination (CERD), which would be presented later that summer in Geneva. Their

aim was to collect human rights injustice statements in order to substantiate policy claims in an international forum. Their program was also intended to be a form of public education—a collective dialogue in which the exchange of information would go both ways, creating a space where diverse stories of struggle could intersect.

Our itinerary was to visit three sites associated with uranium mining and milling: first, the Jackpile-Paguate mine site, once the largest open-pit uranium mine in the world; second, the Homestake mill site; and third, the Church Rock mill site, which experienced the most prolific yet unheralded radioactive spill in U.S. history.[61] All three sites have been listed on the Environmental Protection Agency's Superfund National Priorities List (NPL).[62] These sites are referred to as "closure sites" in the discourse of mining corporations and "legacy sites" by other stakeholders. It is notable that the corporation uses the word "closure" giving a sense of spatial containment and schedule for a temporal end; whereas the corporation's critics use the word "legacy" to describe the enduring impacts of the site and its ongoing, outward proliferation. Federal and state agencies would use both terms depending on the circumstances. For example, DOE uses both "legacy" and "closure" to describe their Bluewater site. In this chapter, I offer an account of our visit to the Homestake mill site, and the narrative of contamination articulated by our colleagues from the Bluewater Valley Downstream Alliance (BVDA), a core group of MASE.[63] BVDA identifies as "a grassroots group made up largely of residents and property owners directly affected by groundwater pollution and radiation releases from the

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[61] See Leona Morgan's informative itinerary, *Human Rights Network: Tour of Communities Affected by Uranium Legacy* (July 2014).
[62] See http://www2.epa.gov/superfund/superfund-national-priorities-list-npl, accessed October 29, 2015.
[63] I selected the BVDA tour of the Hometake site in order to foreground the peculiar technopolitics of environmental cleanup at this particular location, that is, Homestake's use of corporate science and design of corporate environmental engineering projects involving large-scale technological systems and the political ends they achieve.

Homestake/Barrick Gold Mining Company uranium mill and tailings pile near Milan, NM and by the historic discharges of mining and milling waste from dozens of mines and two other uranium mills in the Ambrosia Lake Mining District northwest of Grants, NM."[64]

We met a colleague from the BVDA in Milan who would be our *de facto* tour guide. She joined us in the van as we continued north on state highway 605 toward the Homestake mill tailings site. The mill was constructed by an early version of United Nuclear-Homestake Partners in 1958, and operated through 1990. At optimal production, it produced 3,500 tons of ore a day. Because the uranium ore processed contained under 0.2% content of uranium oxide, 99.8% of what went through the mill has remained onsite in the form of two uranium mill tailings piles. The "Large Tailings Pile" (LTP) has 23 million tons of tailings; it is one mile in length and 100 feet high. The "Small Tailings Pile" contains roughly 1.5 million tons of tailings. Because uranium mills require a significant amount of water to process the uranium ore, the Homestake mill was situated in the lower San Mateo Creek Basin in between watersheds of Mt. Taylor and the Zuni Mountains. It is also precariously placed in a "one-hundred-year flood plain," which means in a given year there is a one percent chance of a flood occurring.[65]

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[64] https://swuraniumimpacts.org/bvda/; accessed April 19, 2019.
[65] SRIC's *Voices of the Earth* entitled "Homestake's Long History of Contamination" (2010:1). See http://sric.org/voices/2010/v11n1/homestake.pdf; accessed April 21, 2019.

Figure 1. Homestake Large Tailings Pile. Photograph by the author.

5.1.1 Flooding

During the tour, our guide told us how the notion of "one-hundred-year flood plain" could allow one to underestimate the fact that these floods do occur. In her family's collective memory, they could recall three major flooding events in San Mateo Creek Basin within the last eighty years, two in which Homestake's large tailings pile "breached," flooding nearby communities with contaminated water. The other flood occurred prior to uranium mining and milling in the region. During an interview, I asked, "Now what caused the tailings pile to breach? Was this monsoon season in the Grants area?" She said:

> Yes. There was a big rain and they put that tailings pile, that's an unlined tailings pile, right in the middle of a flood plain. So we've been lucky. My dad remembers about, oh gosh I'm trying to think if it was the 40's, where they got enough rain in San Mateo that it came right through the area where the large tailings pile is now and it took out the railroad track down there. They were farming carrots then and he said it took out all of our carrot fields and it even took the train off of the track. It was a big flood. But you know those are hundred-year floods. But they could happen. Homestake Barrick Gold said well we have a ditch around our site. You should stand on top of the tailings pile and look at that ditch. And you think, OK, now I'm thinking about a flood big enough to take out a railroad car, and I'm just not seeing this ditch you got here, channeling all of that

> water around it. Now it is a foolish thing when you stand up and look at it, but I guess people just don't believe those rains will ever come again. But in the 70's, late 70's [1979], they did have a rain, significant enough to breach that tailings pile… and this was really before any cleanup (Head-Dylla, June 6th 2018).

I followed up by asking, "So since the cleanup, do these tailings piles seem more adequately engineered, or are they still just these *ad hoc*, kind of pile it up as it comes along?" She replied,

> Well, no, I definitely think that they're better maintained. Now you have to just remember that you can't go back under and put a liner underneath it. So this is contamination that will drip forever. Susan was recently at a meeting on Legacy Management where they are talking about some new technological innovations and I don't quite understand it yet, where you can maybe, solidify these old unlined ponds. Which would be amazing if they can make it work. But for now, they're all just leaking. Now, we had a huge rain, I'm trying to remember, I think it was about 2009… when did we have that rain that breached the side…? I can't remember if it was around 2009, 2011, sometime in those years, even with the new and improved tailings pile, they ran water off of the line pile, it breached the sides and then it came into what they called a holding area. They called it a holding area because they have dirt mounded up outside of this smaller tailings pile that is lined. But when we go that rain, it was a freak rain, it came right on our site and it just poured from maybe a mile north of us and through the whole area, and so what happened is it did breach off of that small tailings pile and down into, they said, their holding pile. And so I showed the state pictures of the entire area. That entire fenced area being under water, about two inches of water. And it ran all the way into the community. So that the whole road, basically that road where the prairie dogs are now, was under water, the homes, everything was standing in water right there. So I'm like how do you think that water ran right over the tailings pile, right over your mound of dirt, and out into the community? We called the state and told them this had happened. The state [NMED] called Homestake (which they always do) and Homestake said, "No that is not true. It is all maintained within our pond." I then sent the state the pictures of the entire area and finally, [NRC] came out and sampled water and took it back and said oh no they didn't think, they told us they didn't think anything of significance made it into the community. They wouldn't even come out and check it. Their response is just always call the company and the company says nah, not a problem, and that is it. We're done. They say that the samples were not high enough in the larger community to worry about. And you know we always hope that's true (Head-Dylla, June 6th 2018).

I responded, "Well you know what I find just so disturbing too is usually this feel of the rain in the high desert is usually just this great feeling. And to know that there is a tailings pile up the road that is going to flood over when we get heavy rains kind of destroys that—one of the most incredible feelings in the desert, right?"

> Right. And for this whole 30-year process, that we've been involved every time, well more than that but, every time we see those really dark clouds north of us in San Mateo it's just like oh please let it not be a deluge. I mean my husband is from Minnesota. When he first moved out, he went to work at the coal mines, and I told him you know when you see those little clouds and stuff up in the mountains be careful of the dip. And you know, sure enough he hit one of those and stalled out the truck early on. And you know if you are not from around here you, your mind doesn't realize if you are not from around here how flash floods work. And how powerful they can be. So now when you are sitting below this huge tailings pile that you know could breach, yeah it's an eerie feeling (Head-Dylla, June 6th 2018).

A resident of Broadview Acres in Milan, Linda Evers, described her experience of the "breaching" event during an interview. She begins by offering insight into how discourse of "reclamation" can be dangerously misleading:

> When I moved back here, I was under the impression that all of these tailings ponds had been reclaimed because Kerr-McKee, Tronox, Quivira, whatever name they were when I moved back I don't remember exactly. They had a big production going on. They made evaporative tanks across the road, built their own bridge, tore their whole tailings pond down right down to clean dirt then put the liners did an excellent job of reclaiming that tailings pile. So I was under the impression that everything had been reclaimed. I'd been out of state for 12, 15 years. So when I bought my house and I could still see the tailings pond there, I wasn't really worried about it because I assumed, Homestake said, that after their tailings pond busted in 79 as well, that they had… they paid the peoples' water for 10 years because they were going to clean up the water they were going to clean up the land. When I left town that was what the conversation was. So when I came back, I didn't have any reason to think that had not happened especially since the Kerr-McKee site was totally reclaimed. I assumed which was wrong on my part that it had been reclaimed but no that is not the situation at all. It's still not reclaimed. They're still contaminating our water (Evers, September 20, 2018).

This comment points the ambiguity of the word "reclamation" and the expectations it established among residents near tailings piles. Many people in the area held higher expectations for what a "totally reclaimed" site could be, based in some measure on the promises made by the previous environmental monitoring and cleanup regimes. She then told me her version of a tailings "breaching" story.

> I'm standing on my porch one day. We are in the middle of a monsoon storm. I'm watching the water in my yard because I have a basement, of all the things I have a basement, so when the water gets so deep my basement starts flooding. So I'm standing

> out there watching the water build up in my yard and it's a pretty heavy rain and I think, I don't think that tailings pond over there is…. I don't think that is just water running off the side. So I went and got my binoculars and it was water running off the side. The side that faces us had breached and I don't know what water if it was their evaporative pond or what because they tell us stories all the time, but the biggest pond, this whole side had collapsed down and was running water at us. So it runs right to the street in front of my house and the bar ditches on the road then divert it west. So it sits straight north of me. So I'm calling people, asking who do we call that tank that berm is busted it's running crap down our road you know. I got a hold of [BVDA] and those guys and they made some phone calls. I don't know who phone called who or what but they didn't bring equipment out to repair that until the end of the next day. So I can understand not running the equipment out there in the rain. You don't get anywhere in the mud but they could have done something. They could have run a dump truck across the top to try to dump a load to try to stop it. So they let that thing run almost 24 hours. And then they got the equipment out there but by then the next day it wasn't running water down the side. My cousin got a really nice camera for his birthday so we went out and snapped a bunch of pictures of it running down (Evers, September 20, 2018).

5.1.2 Leaking

In addition to the possibility of flooding on the surface, there is a long record of groundwater contamination at the site from the seepage of the tailings. During the course of our tour with MASE, it became clear that one of the most pressing issues is that the tailings piles are *unlined* and have been leaking into the groundwater for over half a century. There is a geologic fault line that rests underneath the Homestake site, which connects the alluvial aquifer with deeper aquifers. Wells used to pump water for the milling process were often situated near faults that connect aquifers so they could pump water from multiple aquifers using one highly productive well. The EPA recognizes the impacts of the two tailings piles on the San Mateo alluvial aquifer, as well as the Upper, Middle, and Lower Chinle aquifers.[66] The Chinle aquifers are the most significant drinking water aquifers in the subdivisions below the tailings piles.

[66]https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0600816#bkground; accessed April 25, 2019.

Voices from the Earth is a quarterly journal edited by SRIC that offers, in their words, "environmental views, news and reviews. Our goal is to tell the true stories of people's courage, dedication and struggles against injustice in order to maintain a clean and healthy environment."[67] In 2010, SRIC published two reports documenting the BVDA's concerns about the Homestake site: "The Long History of Contamination at Homestake" (spring 2010) and "Homestake Revisited: Health Concerns Over Radon" (summer 2010). Whereas the latter focuses on means of atmospheric proliferation from the tailings pile, the radon progeny, the by-product of the by-product; the other report foregrounds the impacts of the tailings pile on groundwater aquifers. According to SRIC, the U.S. Public Health Services first reported groundwater contamination at the site in 1962. They identify an investigation conducted by the EPA in 1975 as the critical point of intervention. During the investigation, the EPA identified selenium as the most significant contaminant at the Homestake site. At a well that belonged to a local resident living in the subdivision downgradient of the tailings piles, they took samples that registered at 340 times the drinking water standard! According to SRIC, "The EPA investigators also found that uranium concentrations in groundwater had reached 25 to 50 times the concentration found in samples of unaffected groundwater" (spring 2010:4). This prompted the EPA to draft the first Groundwater Protection Plans for the area, in collaboration with an early version of the NMED.[68] Homestake refers to the site in their reports as the "Grants Reclamation Project." They acknowledge that their "tailing piles influenced groundwater quality in the alluvial aquifer and shallow bedrock aquifer units immediately below and downgradient from the site" (2018:1).

[67] See http://sric.org/voices/index.php; accessed April 25, 2019.
[68] See http://sric.org/voices/2010/v11n1/homestake.pdf; accessed April 21, 2019.

With the EPA and NMED plans in place, Homestake would attempt to remediate the groundwater. SRIC describes the process of remediation as follows:

> For more than 33 years, Homestake has operated an increasing complex and extensive groundwater extraction and injection system. Operations have included extraction of hundreds of gallons per minute of contaminated groundwater beneath the tailings and in the contaminated groundwater plume downgradient of the tailings. These injection wells were supplemented by injection of relatively clean groundwater at the south end of its property, but not at the downstream end of the contamination plume. Injection wells at this location could have established a "hydrologic barrier" to prevent pollutants from moving downgradient towards to the subdivisions. By 1997, 20 years of clean-up effort had resulted in the extraction of groundwater totaling more than 2.6 billion gallons (more than 8,100 acre-feet), and drainage of more than 270 acre-feet of liquid from the tailings by "toe drains." Despite those efforts, groundwater contamination remained under the tailings and in downstream areas including the subdivision where BVDA residents live (2010:5).

5.1.3 Flushing and Diluting

During the tour of the Homestake site, our guide from the BVDA referred to the remediation process as "flushing and diluting." These have become familiar terms since I first visited the Homestake site in 2014. When government employees would use the word "remediation" during public meetings to describe the Homestake site, BVDA would effectively reframe it in terms of "flushing and diluting." At a time during my research when I was still somewhat naïve about this process of "flushing," I posed the question this way: "Can you tell me a little bit more about the tailings pile itself? How was it engineered? You already mentioned that they are unlined, and they haven't capped them with clay material for example. They are pouring water on top of them so that they drain or at least we think that practice has stopped." My colleague Candace Head-Dylla responded:

> It did. They did that until recently. We finally, and again this is through MASE. This is through working with the EPA. The EPA brought in USGS and they took a look at the remediation process. Well actually, I forget. We do so much, I actually forget. We sent a request to the [NRC]. The NRC is only regulated by the general accounting office. I mean there really is no oversight of the NRC. And so we asked the general accounting if

> they would take a look at how funds were being spent at this site. And, anyway, that request precipitated the USGS coming in and doing an analysis of the remediation at the Homestake site. What the USGS found was that: Why would you be adding water [to] the water you are already trying to clean? You are increasing the volume of water, this isn't done any place else. The tailings need to be dried, not have increased water put on them. And so that is when they stopped the flushing… They were flushing. They were getting all of this uranium down at the bottom and then they were collecting it and treating it. When in fact, when you've got stuff in there in the bottom, that process is not as easy to predict where deposits are going to remain. And so, that is one reason, and this was really smart, that the NRC is making them look at rebound. *Now that they have stopped the flushing, they are getting the heavy rebound, like high numbers of contaminants that are now seeping from various spots* (Head-Dylla, June 6th 2018).

She described the new regulatory approaches that have addressed the emergent issue of "rebound," for example, as *the NRC finally doing their job*. At another point in the interview, she described how the process of flushing was diluting the contaminants with clean water:

> And we always argued that all they were doing was using New Mexico's good water, for a long time they would pull up good water and put it on the large tailings pile to flush the large tailings pile. This was not done any place else in the country as far as we know. This was the only place this was allowed to be done. And because that large tailings pile is unlined basically all they were doing was diluting the contaminants. And then in the beginning they showed some progress because of the huge amount of dilution, it looked like things were getting better when in fact they were just diluting the contaminated water with clean water (Head-Dylla, June 6th 2018).

In SRIC's report on the Homestake site (spring 2010), they describe Homestake's unprecedented approach of flushing:

> By 2000, Homestake staff determined that draining contaminants from the tailings pile "had proven more difficult than anticipated" and began a new tailings management strategy. They began a tailings flushing program which used pumps in wells to inject fluids (rather than extract fluids) into the large tailings pile in an effort to increase the amount of drainage which could remove contaminants from the pile. This unique and unprecedented approach—no comparable examples of tailings flushing have been identified by Homestake staff in their response to questions—has resulted in a small increase in the total amount of contaminants that Homestake has been able to remove from the tailings (Head-Dylla, June 6th 2018).

I have considered the practice of flushing and diluting at the Homestake site as part of the enduring logic of the former Atomic Energy Commission (AEC) policy to "dilute and disperse"

so-called "low-level waste" (Hagen 1992:117). One reason the mills were placed near major hydrological features was the sheer necessity for water to process the uranium ore; but, the fact that large uranium mill tailings piles have remained unlined on top of fault lines that drain into every level of the regional groundwater aquifer system is a matter implicated by the AEC policy to dilute and disperse what they deemed low-level mine waste. Homestake accelerated this logic of dilution and dispersion by flushing their tailings piles—pumping clean water from the San Andres-Glorieta (SAG) aquifer into the large tailings pile, forcing contaminated tailings slurry through the fracture flow aquifer below, increasing the amount of contaminated water, raising the groundwater-level, and depositing "secondary uranium salts" in the "vadose zone" of soils above the aquifers. This is a form of *corporate environmental engineering* that designs and deploys technology in attempts to limit environmental liabilities and conceal the externalized costs of production.

Linda Evers, a resident of Milan once described to me how Homestake's groundwater remediation regime affected the landscape around her house. I asked, "I wonder if you can tell me a little bit about living near these tailings piles. What are some of the things you've seen? Because I've heard some of the stories." She replied:

> I was waiting for a delivery from a FedEx guy here, oh I guess it was last fall, and you know our places out there aren't marked very well, so I come around the corner and here he is off to the side of the road. I thought he was looking for my place, so I stopped and said, "Hey! Are you looking for me? My address is this." He said, "Ya, ya here's your package." I said, "Thanks. You know I appreciate it. Your truck looks like you have flat or something." He pulled off to the side of the road and the whole truck sunk, because one of their well heads was leaking right underground right there. So when he pulled off the edge of the road to check an address, the whole side of his truck sank and he was stuck. And I noticed here from about maybe a month ago, about halfway between that wellhead and my house they had another wet spot that they blocked out. I mean it was on right now. They had loaders. They had people. They dug it up. They replaced it. They repaired it. And nothing was said. Somehow or another they aren't running those wellheads right because they keep oozing water that comes right up to the edge of that

> road and it makes that whole bar ditch soggy and that's happened twice in the last two years so (Evers, September 20, 2018).

I followed up by asking, "Do you think that has to do with the hydrological engineering that they are doing below ground? So if they are pumping water up in certain places it is hitting those wellheads?" She said:

> Or coming up just in a weak spot in the… because there are sink holes… Our land out there is very porous. I was gardening one day and put the sprinkler on and went out in an hour to check on my sprinkler and my sprinkler was hanging in a sinkhole! Where I just planted my corn. So I'm glad it didn't sink while I was planting corn but put water on it. The other thing is their injection process seems to be causing the land to rise in certain places. I mentioned before, I have a basement at my house, but now my house and my basement are separating. So my basement is doing this and my house is doing this. So I have this gash, this wedge-shaped gash between the foundation of my basement and the bottom of my house. Well land doesn't move that much by itself. It's got to be the water injection underneath there. Change in the way the water flows. According to BVDA now, it's not even flowing down the natural underground course. It is a plume. That's just expanding, expanding, expanding. *So I believe that with all my heart because they are causing my house to tear itself apart* (Evers, September 20, 2018).

It is generally recognized by all stakeholders that the groundwater contaminant plume from the Homestake tailings piles has moved downgradient, contaminating private wells used for residential drinking water, gardening, agriculture, and pastoralism. Initially, Homestake gave community members bottled water as an alternative drinking water source. After a 1983 community lawsuit against the company, they came to a settlement and our guide's residence would be "hooked up" to the municipal drinking water system of Milan. It would be paid for by Homestake for up to 10 years, which was the amount of time expected to remediate the site. During a conversation with a resident of Milan, I wrote down his comments about the process in my field notes: *File lawsuit in 82. By spring of 84, Department of Justice sued Homestake and we settled. We were given $5,000 and $6,000 a well if you sold it to Homestake, though they kept assuring us $12,000. They offered to cover water within 10 years. Should've been at least till we*

get the water clean. The Homestake site was added to the EPA National Priorities List (NPL) in 1983 and has been undergoing remediation ever since.

5.2 Alternative Contamination Limits (ACLs)

By 1997, groundwater quality was still far from acceptable by all standards. So, according to SRIC, "Homestake Mining Company sought to ease its cleanup burden by proposing alternative concentration limits. This would weaken groundwater cleanup requirements by raising the concentration of contaminant that would be allowed in groundwater after clean-up" (2010:5). What was reported as "alternative contamination limits" (ACLs) in the EPA's terms, "alternate concentration limits" by NRC, and "alternative abatement standards" in NMED's terms, will be discussed further in Chapter 7 and Chapter 8 on "the politics of baselining." These are key terms that are associated with state and federal policies, and an important part of environmental health governance in New Mexico. MASE and colleagues have referred to this emergent form of governance as "permission to pollute" and "permit to pollute."

ACLs are a phenomenon that only became apparent during my experience on the human rights tour with MASE and colleagues in 2014. ACLs were at the heart of the difference between "remediation" and "restoration" at every site we visited during the tour—from the Jackpile mine site in Laguna Pueblo, to the Homestake mill site in the Anglo communities of Milan, to the Church Rock mill site in the southeastern "checkerboard area" of the Navajo Nation. My colleagues at MASE generally recognize that they themselves did not understand how oppressive ACLs and discharge permits had become until they started working together across communities and across former mill and mine sites under the banner of "multiculturalism" around 2006. SRIC was an important catalyst for making cross-cultural connections and linking these groups across

sites, with whom SRIC had collaborated with since the 1970s. Public meetings facilitated by state and federal agencies were also identified as a place where MASE and colleagues began to work together, as they started recognizing each other's increasingly familiar faces.

SRIC's spring and summer 2010 update for the Homestake site offer some sense of "poetic justice" in response to Homestake's claim that they "would leave the site cleaned up by 2010" through the "combination of groundwater extraction and tailings drain." Demonstrating the significance of repetition in advocacy, SRIC echoes a point that the BVDA would regularly remind government employees. It is important to repeat the point here regarding the EPA's original conclusion for the Homestake site in 1977: "geologic and hydrologic conditions are not suitable for land disposal of milling wastes in that sandy soils and a relatively shallow water table are present" (SRIC 2010).

5.3 Remediation

According to the EPA's recent estimates, "The contaminant plume has receded back almost three-quarters of a mile into the site boundaries of [Homestake] by injecting fresh water downgradient of the site. Nearly 4.5 billion gallons of contaminated water have been removed and 540 million gallons of treated water have been injected into the aquifer."[69] Yet it remains unclear how the plume is moving through fractures in the groundwater system below and how it has been deposited through "groundwater mounding" in the soils above. This process will be discussed further in Chapter 7, where I will introduce the hydrologist Dr. Myer's hypothesis and the "faulted graben" model.

[69]https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0600816#bkground; accessed April 25, 2019.

The EPA currently identifies the primary contaminants of concern in the groundwater at the Homestake site as "uranium, selenium, radium-226 + radium-228, thorium-230, chromium, molybdenum, vanadium, sulfate, chloride, nitrate, and total dissolved solids (TDS) (Hydro-Engineering 2006). Radium-226 was the primary contaminant of concern present in the soil."[70] They describe the current groundwater remediation regime at Homestake as follows:

> Early this year Homestake began construction of a 200 gallon per minute (gpm) capacity zeolite-based uranium water treatment system on top of the Large Tailings Pile. The proposed 1,200 gpm system is designed to supplement the existing 300 gpm pilot treatment system currently being operated at the site. Together, the total treatment capacity of the system is expected to be able to treat contaminated groundwater at a rate of up to 1,500 gpm. Homestake expects to complete the current system to utilize the full capacity construction and commission by end of this summer. Homestake currently operates a 600 gpm capacity Reverse Osmosis (RO) groundwater treatment system. Due to operational issues the system is not running at full capacity. Homestake is upgrading and build an additional 600 gpm system. This will allow Homestake to treat 1,200 gpm of groundwater by the RO system. Construction of the new building to house the additional 600 gpm is complete. System electrical and plumbing work is currently in progress. Homestake expects to have the new 600 gpm RO system in operation next year.[71]

During an interview with Paul Robinson, research director at SRIC, he defined the terms of "cleanup" and contrasted "remediation" with "restoration" to show the spectrum of policy and technology approaches that hinge on the difference between those terms: "People often want to see their water restored and the state will only allow remediation. And now they have the alternate abatement standards which allow very high levels in contaminant plumes. So New Mexico is not a place where you see some of the better technology, though there is extensive technology used at each site, and there are improvements from conditions at each site resulting from the technology" (September 13th 2018). Though Robinson offers refrain that there is extensive technology used at each site to improve conditions, he shows how the major

[70]https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.Cleanup&id=0600816#bkground; accessed April 25, 2019.
[71] See https://semspub.epa.gov/work/06/9610078.pdf; accessed April 25, 2019.

“innovations” were not in technologies for environmental cleanup; they were in the state and federal groundwater permitting programs and guidelines for remediation.

It is important to emphasize how technological “innovations” in the Homestake “remediation system” really work. My colleague would often use the word “innovative” to underscore that these were new ideas to deceive rather than actually achieve cleanup. Flushing was the prevailing example. It seemed that each new innovation at the site systematically achieved something other than cleanup. These were innovations aimed at limiting corporation’s environmental liabilities. With each new innovation the question became what could they possibly conceal with a new technique or technology. BVDA has developed a healthy sense of skepticism for the promise of pilot projects and other innovations at the Homestake site.

During the tour, my colleague from the BVDA described the long track record of misleading and deceptive information and failed projects of remediation. We parked the van at the northeast corner of the Homestake site. I stepped out to take a photo of the pile (see figure 1). The “closure manager” of the Homestake site pulled up in his pickup truck shortly thereafter. He asked us if we would like to join him in his office so he could explain the work they were doing at the site. I was intrigued by his invitation, even if all he had to offer was a heavily scripted narrative supplemented by corporate brochures of environmental technologies. HRN, BVDA, and MASE did not see how what he would say could possibly add to the conversations we were having on this human rights tour. Our guide from BVDA told us that the closure manager lived in Albuquerque and she already knew what he had to say. She mentioned that she often has one-way interactions where Homestake updates the community about the site. She was tired of hearing their version of the story because she had a different experience. One of the HRN “expert witnesses” on the tour took over the conversation. She was a well-known civil rights

lawyer from New York City. She told the manager about the purpose of our human rights tour and said she was shocked by the stories she had just heard from BVDA about the site and the infringements on international human rights. She described it in terms of "cultural genocide." This interaction was brief; we were on a rigid schedule and had other sites to visit. As we left, he gave us a few of his business cards in case we wanted to hear Homestake's side of the story.

Our guide from BVDA also expressed distrust in the state and federal government employees and their statements of containment and control. My colleagues at BVDA would often tell them, "I don't care about your sympathy. We don't need you to feel sorry for us. Just do your job." She made her point by saying that every time they were told it was contained, the contamination had spread to another part of the aquifer system. "They said contamination would never go beyond the alluvial aquifer. They said it will never make it into the Upper Chinle. It did. They said it would never seep into the Middle Chinle and it did. They said it would never contaminate the Lower Chinle and it did." The promise of innovation has also been met with criticism due to a long track record of failed remediation technologies. The zeolite absorption system that was recently installed as part of a "pilot project" was not operating as expected. Their Reverse Osmosis (RO) system was also underperforming. Our guide from the BVDA said that she would like to see an RO facility twice the size of their current system. Homestake has promised numbers as high as 1,600 gallons per minute (gpm), but their system rarely operated above 600 gpm. They simply have not been able to pump and treat enough groundwater to effectively remediate the groundwater plume.

The Homestake remediation system necessarily involves the discharge of a significant amount of produced water. Water from the contaminant plume beneath the tailings pile is collected and processed through a remediation system that uses RO and other pilot projects. The

water is required to be treated up to accepted water quality standards before it can legally be released into the environment. NMED regulates this through discharge permits. Discharge permits are an important point of political contestation for MASE. According to my colleague at the BVDA, Homestake has developed innovative techniques for discharging water. BVDA caught Homestake illegally discharging water into an arroyo that runs through the community behind a cluster of houses in Broadview Acres. They use water "canons" that spray treated but contaminated water high into the air to facilitate the evaporation process; they had also illegally irrigated fallow fields.

Figure 2. Fallow field adjacent to the residential subdivision of Murray Acres. Photograph by the author.

5.4 Discharge Permits

During an interview with a colleague from BVDA, Candace Head-Dylla, I said, "I want to just step back a little bit and talk about the field, the sort of barren site with the sand dunes, where Homestake was discharging water. Now I understand that water discharge is a big issue for these

corporations during the cleanup process. Can you talk about the politics of discharging water and the way you have seen that play out?"

> So this is where New Mexico was an agreement state, and then wasn't an agreement state. So where we are right now, so while New Mexico Environment Department was in charge and they basically did not have the resources or the time to do anything but perfunctory regulations. Then they turned it back over to the NRC and the same thing. NRC, I don't think they had the will, they certainly didn't spend the resources and time to come out to the field. And at that point NRC then was in charge of the sites, but New Mexico [Environment Department] was still in charge of discharge permits. So if they want to run a reverse osmosis plant to clean the water which is what they need to do then that has to be discharged somewhere into evaporation ponds or wherever they want to discharge it. And [NMED] still is in charge of that process. So basically, they still control a certain amount of the remedial process because they control the discharge permit. In addition, they also through the Office of the State Engineer, give permission to drill more wells for this collection-injection system (Head-Dylla, June 6th 2018).

At this point, she regretted that MASE did not take better advantage of the political opportunity Ron Curry opened up at NMED. She expressed that they really could have made an impact and improved the remediation system at Homestake had they contested the issue of discharge permits:

> So New Mexico has always controlled these discharge permits and frankly, except under when Ron Curry who was under Richardson at the New Mexico Environment Department, other than that New Mexico Environment Department has let Homestake propose whatever they wanted and they rubber stamped it. And the only time there was ever any serious scrutiny was like I said when Ron Curry was in charge of the Environment Department. At that point though, had we been better organized, and had the MASE organization behind us when he was Secretary of the Environment Department of New Mexico, we could have done really well. Because there was a political opening there that we did not take advantage of because we weren't organized well enough and we didn't have the funding. And we didn't understand the process (Head-Dylla, June 6th 2018).

In my colleague's terms, "the state" often refers to NMED. With discharge permits, the state has allowed Homestake to discharge contaminated water through various means. By calling it "injectate" rather than "by-product material," NMED permitted Homestake to discharge water

outside the Homestake site boundaries, for example. BVDA contacted NRC and prompted them to intervene. Here is how she tells the story of the discharge permits:

> So discharge permits, they allowed, the State allowed, well we don't know what all Homestake Barrick Gold has discharged illegally, we caught them, the only time New Mexico has issued them a violation, one of our members caught them discharging contaminated water out of a pipe behind his house into an arroyo. We don't know how long they had been doing that. We don't know if they have done that in other places that we didn't catch them at. But we called that into the state and they did send somebody out to check it out and they did issue them a violation and made them stop. And this was at the same time that they were allowing them to use contaminated water to irrigate land with a, you've seen those big pivot sprinklers, so they irrigated…. I can't remember how many acres they irrigated between Homestake and Bluewater. They irrigated about 25 acres right next to Murray Acre with polluted water. So it was contaminated water and they were raising hay in both spots because one of their managers, I can't remember his name, but it was a Homestake manager, and he had been a farmer and he wanted to make nice with the community and get in good by talking farming with them and so he said we are going to use some of this water to do some farming experimentation and you are going to like what you see and da, da, da. Well, what happened was over time, the irrigation the 25 acres closer to our community, it just got more and more TDS, like dissolved solids looked like sulfates and things, sodium and things on top. You could see the white crustiness. So all of those contaminants began to have an impact. And they were selling this hay to feed cows to anybody in the area. Apparently, they did an analysis of that or they say they did, and we've seen the presentation on that and it was so miniscule that nobody was affected through feeding this hay to the cows. That is what they told us. They had the reports on file. It was absolutely not a problem. But over time it basically killed their hay fields. And then when the NRC came in and saw what was happening… they were like you can't do this. *This is by-product material… New Mexico Environment Department gave it a name. The name they gave it was "injectate." They called it injectate and they called it, they named it. They didn't call it by-product material. And when the NRC came in they were like "no." This is by-product material and you can't just discharge that outside the site.* So that is why the NRC now, and because of all of that, they've made the company, they, would have issued monetary fines but, instead they've made the company go through, you've seen that paperwork, this whole process of understanding where their problems were, how they made these mistakes and how they are going to correct them in the future. So by undergoing that process, they've saved themselves from these fines. For a company like Homestake Barrick Gold, they are not insurmountable. But it is more of a PR problem if they get these violations posted by the NRC (Head-Dylla, June 6th 2018).

Regarding the problem of public relations (PR), I asked about some of the recent developments at the site. The community of Murray Acres was invited to a meeting hosted by Barrick Gold's Corporate Social Responsibility (CSR) team. My colleague from the BVDA was frustrated by

the process of organizing the meeting because they contacted her to request phone numbers and other means of contacting community members. After I attended the CSR meeting, I wondered what prairie dogs had to do with corporate social responsibility. I asked my colleague. She responded:

> So what happened was New Mexico Environment Department handles the discharge permits at the site and Homestake wanted to irrigate the land that they owned right next to Murray Acres and then between our community and the old Bluewater legacy site. They owned some land over there. And they owned land next to our community and they wanted to use what they call "impacted water" which means contaminated water to irrigate those plots of land. And the state let them do it and the NRC didn't…. the NRC should have stopped it. It was against the corrective action plan, against their permit. But the NRC did not stop them, so they used contaminated water to water those areas. And in the process, they destroyed the land. I mean even what they were irrigating hard, it began to just not grow well, etc. And so it also destroyed the natural vegetation that might have come back on that land. It didn't come back. So it just became a dust bowl. And one of those dust bowls is right next to our irrigation district and so when the dirt blows, if you go out into the community which I think you have been, you will see piles of dirt almost as high as a fence post along the road. And it blows dirt into everybody's driveways and into their homes. So you are constantly shoveling out this sand. And when you get areas like that then you get prairie dogs that come in because they love that kind of area and so we've got not only these dust bowls, but you have these large prairie dog infestations. Which, you know, I don't mind prairie dogs out in the country but when you are trying to farm, they just take your water. And you can't get water on the fields. And that has been the issue. And they have said that well, the NRC and rightfully so for the first time ever in the last three years the NRC has actually done its job. And so they're saying we need to see before you put any more water on these areas, we need to see what damage has been done to this point. So they are making them document that before they go in and reseed, well they have reseeded, well before they go in and water these areas any further (Head-Dylla, June 6th 2018).

Curious about how the NRC has *actually done its job* and the way that has affected the practice of wastewater discharge at the site, I asked about the technique Homestake uses to evaporate by spraying contaminated water into the air.

> With this new better oversight by NRC, they've made them put, oh I'm trying to think of what they are called, but when the winds get too high, they now have control mechanisms that stop the evaporation. So they clean water and then the water off of that process goes into what are now lined evaporation ponds and the idea is that you will evaporate eventually everything off and be left with just the contaminant solids that are left in the bottom of these ponds. And then you can cover them up and dispose of them in that way.

> Well in the process, to increase the evaporation, they bring that water up into the air. So this is… contaminated water basically. And for years before… the NRC got serious about regulation, they would spray that water just as high and as hard as they could because, yes they had machines that shot it into the air. And the machines that they used were like those they use on ski slopes for snow-making sending water into the air. And in the mornings our winds are very interesting at that site. During the day they sweep into the community from the south and the west but at night, they drop back down off Mount Taylor and the direction moves back into the valley from the other side. So in the morning, they would start those evaporation sprayers really early. And you could get up and see the mist, the contamination mist, over the whole community. I have pictures. I've sent all of the regulators multiple pictures of this. Mist lying on the valley. The people closest to the site had a film, a substance, on their vehicles, on their equipment. Where that came and settled on everything. So this is what people lived with. And then of course, now that the NRC has come in and gotten serious. They said no, you can't spray that into the air when the winds are high or when they are sweeping back into the community. You've got to wait until that sweep back happens and then when the winds get high you have to stop the spraying." Well, that's new. That didn't happen before. So you can imagine all the people that lived closest. But see they *buyout* (Head-Dylla, June 6th 2018).

5.5 Buyouts

My colleague elaborated on the problem of corporate "buyout" and its implications for their community:

> This is the other problem. As Homestake buys out the properties, these people go various places and never think about why they have lung cancer, kidney cancer, liver. They just think it is their bad luck, right. And don't tie it back to this. We need to get a history of who has lived there, where they are now. I mean this is the kind of thing that the company needs to do if they are serious about social responsibility. So that those people can have their health care cost covered if that's what happens to them down the road. Some of the people, like tin the same way there was a big tailings spill out at Church Rock, in two years, right at that same time, that large tailings pile breached for us too. Now it wasn't as big of a breach, but it ran right down into the Murray Acres community. Right across from the property where these people are now long gone. But they had tailings run right over their ground. They ran right through the community. That's documented with the New Mexico Environment Department. And we're seeing, you know nobody ever came out and sampled soil. They never did anything. So [the family] that used to live right where the tailings ran right across the road and into his yard, they are gone now. You don't know… and plus his road was one first and most contaminated... They couldn't drink their water. They had to haul water. Before the company was required to bring us bottled water back in the 70's. [Another family was] already drinking bottled water because their wells were so bad. So that family had their

> kids and everyone in the family drink the water. *They lived in the remains of the tailings spill and what has happened to them, nobody knows. Because they got bought out long ago. And nothing is there now. So it is all forgotten and no one is remembered there* (Head-Dylla, June 6th 2018).

Her last sentences capture the double-bind of "buyouts" for local communities in relation to the tailings pile. If the people leave their community near the tailings pile they can limit their exposure to radon, gamma radiation, soil and groundwater contamination, and looming floods and breaches of the tailings pile by selling property to Homestake that would otherwise be difficult to sell. On the other hand, when communities lose residents, they lose memories of how the mill tailings have impacted the area over the last half-century.

This corporate strategy of "buyouts" threatens the way local places are "re-membered," to use Kathleen Stewart's term: "These hills—at once occupied, encompassed, exploited, betrayed, and deserted—become a place where the effects of capitalism and modernization pile up on the landscape as the detritus of history, and where the story of "America" grows dense and unforgettable in re-membered ruins and pieced-together fragments" (1996:4). The political power of the community diminishes in the eyes of the state and the corporation when people die or move somewhere else. Epidemiological tracks and traces of diseases are fractured as residents' bodies become dissociated with the site and they lose contact with their former community. In addition to Homestake's general strategy of, as one resident said, "push it under the rug and hope these people will go away and die," buyouts are an important step for Homestake in their goal to "remediate" the site so that DOE Legacy Management will one day take over. A colleague once mentioned to me that Legacy Management will not accept sites that have residential communities living on or near the site. When Homestake acquires the properties they also acquire the water rights; they demolish the houses, discontinue farming and gardening, and employ the wells into their groundwater monitoring and engineering regime. One recent

concern of the BVDA is that if they cease using the water at properties in irrigation districts, which require holders to periodically put the water to use, they could lose their water rights. The community shares one well in the San Andres-Glorieta aquifer, which is below the alluvial and Chinle aquifers.

> Basically Barrick Gold came not to the BVDA, interestingly enough, but to Murray Acres, so was in the community. The Murray Acres irrigation district is a separate entity. And it's like an acequia, like a water quality cooperative, for an irrigation. That's a very small community. I'm trying to think of how many families. It used to be about 30 families but now it's probably closer to 15 or 20, maybe closer to 15, because Homestake bought out a lot of the property. They came and asked for a Murray Acres meeting. So we invited Murray Acres folks and they wanted to hear what our specific issues were. They are slightly different than the rest of the communities. Because we have, the water cooperative, owns together as a community a San Andres-Glorieta aquifer well. It is a deep well that pumps high volume. And we take turns watering with that well. We turn it on and you track your time and then we all pay a portion of the pumping bill, the electricity bill, and any varying repairs on the well and things like that. So there is a secretary that you call up and say that you need the well. That's how we irrigate. We take turns. And there's a valve system. You go and you turn certain places off and turn your row on and that is how you get your water. It's an underground pipe. That is part of what is being litigated right now, our rights to that water. So Murray Acres as an irrigation district, has to keep a certain number of acres under production or we can lose our water right, our right to have that irrigation well through this litigation. So one of the things that has happened that Homestake wanted to talk about Barrick Gold, Homestake-Barrick Gold is we have been hammering them because they keep buying property in the irrigation district. And then they just let the land go fallow. And that is over time if they do enough of that we will lose our irrigation rights (Head-Dylla, June 6th 2018).

Notice my colleague's persistence in keeping the name Barrick Gold associated with the Homestake site. She wants us to remember that a company with a 8.374 billion USD revenue in 2017 has been responsible for the Homestake remediation project since 2001.[72] She is responding to the way employees of Barrick Gold Corporation wear Homestake t-shirts during corporate social responsibility meetings with communities. They did not associate the Homestake site with Barrick Gold Corporation. My colleague from the BVDA found it ironic

[72] https://www.barrick.com/English/investors/annual-report/default.aspx; accessed April 29, 2019.

that John Ruggie, the author of "Guiding Principles on Business and Human Rights," is a special advisor for Barrick's Corporate Social Responsibility Advisory Board. She wondered if the form of "social responsibility" she had experienced of corporate buyouts, illegal discharge of impacted water, flushing and diluting the tailings abided by the Ruggie principles.

5.6 Backgrounding

During the human rights tour, our guide from BVDA told us that they are exposed to 18 times the standard limit set by the EPA for radon. Exposure to radon is the focus of SRIC's summer 2010 report on health concerns at the Homestake site.[73] In the report, they discuss their "analysis of nearly 40 years of outdoor radon levels in the San Mateo Creek drainage basin northwest of Grants, New Mexico—contained in two reports prepared by SRIC staff under EPA's Technical Assistance Services to Community (TASC) program." They recognize this as "the first attempt to compile and analyze radon and radon progeny monitoring data to address community concerns about the potential impacts of the Homestake tailings operations on local health." In the report, they show how Homestake's "choice of monitor locations for background radon levels influences calculations of the maximum radiation doses to residents who live near the [Homestake] facility." In their studies they found that the calculated doses to residents would exceed the NRC's limit of 100 millirems per year (mrem/y) if the "average historic background concentration" of about 0.5 picocuries per liter (pCi/l) were used to calculate the doses, "rather than a much higher level derived from one of Homestake's air monitoring stations that may be influenced by radon releases from nearby abandoned uranium mines."

[73] See "Homestake Revisited: Health Concerns Over Radon" (2010), in the SRIC quarterly journal *Voices from the Earth.* http://www.sric.org/voices/2010/v11n2/Homestake_radon_summer_2010.pdf; accessed April 22, 2019.

SRIC addressed the question of background at the Homestake site by investigating these misleading comparisons to abnormally high background. Driving their analysis is a review and evaluation conducted by the U.S. Army Corps of Engineers of Homestake's groundwater remediation system (February 2010) that was left in draft form. It identified that "the single highest ambient radon concentration measured at the Homestake property boundary was recorded at a monitor station that is used by Homestake as the background location for radioactive air particulate sampling." In other words, Homestake strategically situated their background monitoring device in the location producing the highest amounts of radiation. SRIC discusses the process by which Homestake used this high background level as the basis in their calculations of total effective dose equivalent (TEDE) for the local community. SRIC shows how Homestake frequently used average radon levels of more than 1 pCi/l-air as "the background concentration in its calculations of radiation doses to the public." Homestake has eight perimeter monitor stations that account for levels of "airborne radon, airborne particulates of uranium, thorium and radium, and direct gamma radiation." SRIC describes the process by which Homestake collects "background radon level from monitor station HMC-16, which is located about 2.5 miles northwest of the LTP where radon levels averaged 1.16 pCi/l-air from 1999 to 2009, and in the second half of 2009 spiked to 2.5 pCi/l-air." SRIC concludes, "Because the dose from each of these contributors is reduced by the background level for each category, calculation is particularly sensitive to background levels of radioactive materials, especially radon." Higher background levels of radon can be used by Homestake to lower their calculations for radiation doses to the public. In this case, Homestake demonstrates what Stuart Kirsch calls "corporate science"; one aspect of which is to use "strategic comparisons to natural or background rates" and conflate natural with industrial systems (2014:140). The corporate practice of *backgrounding*

aims to hide away the "radon progeny" of the uranium tailings piles, the by-product of the by-product, by establishing high background levels that drown out the figure in the foreground, the contaminants of concern, our object of study, the environmental impact of industry.

The "undone science" that SRIC has been getting done traces the history of radon data collection at the Homestake site. They begin to notice "abnormally high" ambient radon levels of 2 pCi/l-air or higher since EPA's original study in November 1975 (Eadie et al, 1976; as cited in SRIC 2010). SRIC used these historical studies to assert a different background level of radon for the site:

> The question of what levels of radon accurately reflect background, or "normal," was first addressed nearly 40 years ago in a study conducted by the New Mexico Environmental Institute (NMEI) for Gulf Mineral Resources, which was proposing construction of the Mount Taylor Mine next to the village of San Mateo, New Mexico. The NMEI (1974) study is notable because it was conducted during all four seasons of the year in 1972–1973, at three ground-level monitor stations in the valley and on the side of the mountain near the proposed mine site, and by aircraft that recorded ambient radon levels at different elevations above the land. (The airborne portion of the study documented, for the first time, the effects of winter temperature inversions that hold radon close to the land surface). The study calculated an average outdoor radon level of 0.19 pCi/l-air, with a maximum of 0.58 pCi/-air, in an area that had not had previous uranium development.

Using historical sources of data that account for levels of radon prior to the impacts of the uranium mining and milling industry, SRIC identifies an average outdoor background of 0.19 pCi/l-air that is orders of magnitude lower than 1 and 2 used by Homestake. I will have more to say about the emergent forms of "civic science" (Fortun and Fortun 2007) in the following chapter, and the faults and fractures in the facts of corporate science. The civic science and undone science that SRIC demonstrates above uses a breadth of historical and contemporary data that scrutinize corporate science and traverse gaps and fragments of environmental information. Despite a colleague's comment that "there is no *pro bono* science the way there is *pro bono* law," the term "civic science" is used here because SRIC's research is established on a basis for

the public good. Where corporations have backgrounded their industrial impacts, I suggest we look for the undone civic science that emerges by *muddling through* the limited means at hand and *milling around* the by-product of the by-product—in this case, the "radon progeny" that Homestake backgrounded.

Mike Fortun and Herbert Bernstein (1998) cite Evelyn Fox Keller's riff on "muddling through," which was originally conceived by Charles Lindblom (1959):

> Just because we are finite beings, located, situated, embodied, we can, and can only, muddle through…. Scientists muddle through with staggering success. Only their success is rather different than they imagine. It depends not on any possibility of translating thought into action, but on the conjoining practices of a colluding community of common language speakers. Our task…is to make sense of the successes of science in terms of the particular linguistic and material conventions that scientists have forged for their own sorts of muddling through (1992:181).

Her statement inspired their book, *Muddling Through: Pursuing Science and Truth in the 21st Century* (M. Fortun and Bernstein 1998). In response to the historical narratives of what Robert Westman calls "Vulgar Triumphalism" in the sciences, Mike Fortun and Herbert Bernstein elaborate on how to "muddle through" the sciences as though "we are living "after the fact," in a world in which science can no longer be regarded as the oracle of those cultural and material reforms necessary to a just society. This world demands a kind of literacy that makes sense of the sciences not in terms of infinity and transcendence, but of finitude and location" (1998:x). Muddling through refers to the situated nature of the sciences like all human and non-human endeavors. Their book is about "politics (not policy) and culture—that is, about how the sciences are made through arduous and diverse political processes. [It] is about how the sciences affect politics not only through technological invention but by generating the images and metaphors we apply to every situation and phenomenon we encounter, and by providing the blueprints we use

to make crucial decisions. The connections between the sciences and democratic pluralism need to be revitalized, through both new concepts and innovative social forms" (1998:x-xi).

I use the term "milling around" as a method, a descriptive technique, a mode of inquiry and intervention that embraces the reality of muddling through by, well, milling around. The term can be used to describe the kind of undone science that SRIC has been getting done for more than 45 years: milling around uranium mill tailings piles and abandoned mines, collecting empirical data onsite, sorting through government information and corporate documents, sorting through historical data and emergent academic sciences at universities. Chris Shuey, a researcher at SRIC, has a photo of the tailings pond dam that collapsed during the Church Rock mill spill of July 16th 1979. He took the photo while collecting environmental and public health data nearby the UNC uranium mining and milling operations. The way he captured this moment is iconic of what I mean by *milling around.*

5.7 Conclusion

In this chapter, I have started an ethnographic description of the emergence of different epistemic formations and how they come into conflict. I have accounted for different stakeholder positions, albeit unevenly and asymmetrically, given the conditions of my ethnographic fieldwork, the uneven topography, the limitations of "public" knowledge vis-à-vis "private" interests, and the gradients of power that contour the infrastructures of accumulation by dispossession. I will continue to expand my cumulative account of different stakeholder perspectives, which are compiled throughout the following chapters. Tracing the emergence of different explanatory forces working for and against environmental cleanup is the first step in my analysis. The second step is to account for how such discursive formations collide. I have attended to how MASE, and

BVDA in particular, have come to terms with the uranium mill tailings piles at the Homestake site by highlighting the keywords they use to describe the site, and the unbounded and cascading effects of contamination: "unlined piles," "flooding," "leaking," "flushing," "diluting," "groundwater mounding," "rebounding," "spraying," and other forms of "illegal discharge."

By adopting the vocabulary of my interlocutors who live among the local community, worked in the mines and at the mills, and participated in the environmental cleanup process, I have characterized the emergent kinds of corporate environmental sciences and engineering in the Grants Mining District. These critical analytic terms are used to understand the corporate discourse and practice of *backgrounding*. In this chapter, I use the term "backgrounding" specifically to articulate how Homestake situated their background monitoring device in a location that was generating the highest levels of radiation. Backgrounding involves "strategic comparisons to natural or background rates" in ways that defer critique (Kirsch 2014:140). Backgrounding is a strategy of corporate science and engineering that naturalizes the impacts of the mining industry and raises the level of contamination that will be accepted under state permitting regimes through alternative contamination limits. Backgrounding can also be conceived broadly to understand processes that produce "data gaps" and fractures in environmental information. Thinking of how Homestake has flushed and diluted contamination from the tailings pile into the fractured groundwater aquifer below, "backgrounding" could also be called "undergrounding."

Backgrounding and undergrounding are related to the banalization Gabrielle Hecht (2012:8) describes whereby nuclear things are rendered uninteresting. Think about how uranium mill tailings piles figure into the landscape as part of the scenic background, something you would not necessarily notice as unnatural if you were driving by on Interstate 40. Steve Feld's

conception of "figure-ground interplays," can be used to describe the dialectical relationship between the foregrounding of local communities and backgrounding of transnational corporations, "in which one sense surfaces in the midst of another that recedes, in which positions of dominance and subordination commingle" (1996:93).

I portrayed the undone science of SRIC as an alternative model for "studying corporations by examining how they produce and manipulate science in order to influence their critics and avoid regulation" (Kirsch 2014:12). MASE and colleagues have pushed back on such manifestations of corporate science through a civic discourse and practice of *foregrounding*, which brings to the surface what corporations have forced underground, figuratively and actually. In response to corporate backgrounding, I cite SRIC's program of undone science and their critique of how Homestake used this exceptionally high background level in their calculations of total effective dose equivalent for radon in the local community. I have also accounted for how MASE and colleagues understand state and federal policies that give companies permission to pollute through "discharge permits" and "alternative contamination limits (ACLs)." During public meetings, BVDA would subvert the term "remediation," effectively reframing it in terms of "flushing and diluting." Critically creative modes of push-back were employed by MASE and colleagues through epistemological association, which allowed them to plot fragments of environmental data across a broader world of political coordinates and historical data-points. The next chapter will account for uranium tales of the Bluewater mill tailings site. Unlike the Homestake site, the Bluewater site has been "successfully remediated," and is now under the long-term stewardship of the Department of Energy Legacy Management. Different epistemic entanglements are brought into our purview through my description of this site, which offers another layer of stakeholder analysis.

CHAPTER 6

URANIUM TALES PART II: THE BLUEWATER SITE

In this chapter, I consider the Bluewater Uranium Mill Tailings site, which can be juxtaposed with the Homestake site: Whereas remediation is underway at Homestake, Bluewater has been "successfully remediated" by the vestige of Anaconda Company, Atlantic Richfield Company (ARCO). The Department of Energy (DOE) Office of Legacy Management inherited the site in 1997.[74] I will investigate their task of "monitoring in perpetuity" through an ethnographic description of a tour of the Bluewater site given by DOE Legacy Management at the request of the BVDA. I supplement my description of this event with insights from a second public tour of the site that I attended. I will analyze the DOE's narrative for the site and their monitoring, modelling, and visualizing of the large tailings "disposal cell" and its expansive groundwater plume of uranium. The tour given by DOE Legacy Management in an attempt to demonstrate that the site is safe by taking the public on top of the disposal cell (see figure 7 and figure 8). Although there is a groundwater contaminant plume of uranium and other contaminants moving off-site, which is a major concern of stakeholders residing downgradient of the disposal cell, Legacy Management wanted us to know that even though they are not taking any remedial action regarding the plume, they are doing their job because, due to alternative contamination limits that were accepted, the site remains in compliance.

6.1 The Bluewater Mill Tailings Site

On April 20th 2018, the Department of Energy (DOE) Legacy Management (LM) facilitated a tour of the Bluewater "disposal cell" at a site they are tasked with monitoring and managing. The

[74] https://www.lm.doe.gov/bluewater/Sites.aspx; accessed May 24, 2019.

tour was given at the request of the Bluewater Valley Downstream Alliance (BVDA). The DOE was accompanied by their colleagues from the Nuclear Regulatory Commission (NRC) who licensed and permitted the Bluewater site. The federal law that designates responsibility for the site is the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978. The Bluewater "disposal site" is authorized as a Title II UMTRCA site because it was licensed by the NRC when UMTRCA was enacted. Under Title II jurisdiction, "long-term custody of the site" becomes the responsibility of either the federal government or the "host-state." The DOE assumed responsibility when the state of New Mexico declined to be the "long-term custodian" of the site. Under Title II, the licensee was deemed responsible for "remedial action." The original operator, Anaconda Copper Company, became a subsidiary of the oil company ARCO in 1977, so ARCO inherited the environmental liability. The mill was decommissioned in 1989 and "reclamation" began in 1991. NRC approved the request in 1996 and the DOE inherited the site from ARCO in 1997. The terms "reclamation" and "remedial action" were applied loosely in this case, as other means were sought to lessen the cleanup burden:

> Active treatment by pumping contaminated groundwater from the aquifers in 1989 produced no significant reduction in concentrations of molybdenum, selenium, and uranium. Consequently, in 1990, ARCO applied to NRC for alternate concentration limits (ACLs). ACLs may be adopted when established maximum concentration limits are unattainable, providing the ACLs do not pose a present or potential future hazard to human health or the environment.[75]

Paul Robinson of SRIC remarked about his experience in cases of ACLs in New Mexico:

> There was a period in the early 80's when the standards and regulations related to the uranium mill tailings radiation control act were being adopted, and the National Mining Association had challenged the NRC's proposed standard, EPA standard, that NRC would implement, so EPA set the standards. And the Environmental Defense Fund and we [SRIC] had intervened saying they were too high. And this was the EPA, had set the 20 picocurie per square meter admission standard. Natural background is typically in the one picocurie per square meter admission rate for radon. And ore is in the up to 1000 or

[75] https://www.lm.doe.gov/bluewater/Sites.aspx; accessed April 30, 2019.

> 1500 so industry wanted to have the 20 set at 200 and we thought a 100% increase, 1 to 2, was allowing major pollution, rather than 20 times normal. And the EPA did. That proceeding resulted in the standard being set where it is. Left where EPA had set it, so as a compromise. So what is set as cleanup, the difference between remediation and restoration, and mitigation or elimination… Those are the words that define a spectrum of policy approaches as well as technology approaches (Robinson September 13th 2018).

There are two uranium mill tailings piles on the site: the smaller 1.3-million-ton tailings pile is left over from the original carbonate-leach mill that processed no more than 300 tons of uranium ore a day from the limestone deposits between 1953 to 1958; there is also a PCB cell and asbestos cell onsite; and, the large tailings pile (see figure 3) is the by-product material of an acid-leach mill that was constructed in 1957 to process the sandstone uranium ore from Anaconda's Jackpile-Paguate Mine in Laguna Pueblo. The ore was hauled by train and by truck from the mouth of the mine to mill. The mill reached peak production in 1978 at 6,000 tons of ore a day. By 1982 all milling at the site ceased. According to Paul Robinson, "New Mexico has the gold, silver and bronze medals for mill tailings size, and these commingled piles are 20 million ton plus" (September 13th 2018). The Bluewater large tailings pile is the "gold medal." It contains an estimated 23 million tons of tailings and other contaminated materials. It is 354 acres around the base and about 250 acres on the surface. The DOE calculates the total activity of 11,200 curies of radium-226 that is contained by 4 to 12 inches of "riprap" erosion protection layer and 1.7 to 2.6 feet of low-permeability radon barrier beneath that. For the riprap, they used crushed basalt quarried at the Homestake site. Though they are capped on top, underneath, the uranium mill tailings piles are *unlined*. The DOE coordinates a "groundwater monitoring network" that consists of 19 wells within the site boundary. The main contaminants of concern are molybdenum, selenium, and uranium, though they have also monitored for other

constituents; for example, polychlorinated biphenyl (PCB) monitoring was conducted from 1997 to 2017.[76]

Figure 3. The Bluewater Large Tailings Pile. Photograph by the author.

6.2 Local Experience and Expertise

Prior to the DOE tour of the Bluewater site, I met a local resident at the Kiva Café and Gas Station in Milan for breakfast, to talk about his experience as a mining engineer and his family history in the area that dates back to 1910. The way I was introduced to him was serendipitous. When I expressed my interest in a collection of oral histories from Grants, Milan, and San Rafael to the anthropologist who had compiled them, Louise Lamphere, she put me in touch with one of her former interviewees and neighbor, Toby Michael. During a conversation with Toby, he called Larry Carver and set up a meeting for us. When I met him, I told him about my research

[76] https://www.lm.doe.gov/bluewater/Sites.aspx; accessed April 30, 2019.

on the history of the Grants uranium district and the politics and technology involved in cleaning it up. He asked me where I started with Toby. I said, "We started with his junior or senior year in 1957 or 1958 and his work at the family grocery store, but then got to talking about the cleanup issues." Larry launched into a succinct historical background that I wrote down in my notebook with his permission:

> So in 1951, after WWII, Paddy Martinez overheard a conversation about the rock. He went to Haystack Mountain and took the rock to the Gunderson store. He then took them to where he found the rock on AT&SF railroad land. Anaconda put up the first mill in 1951 (that ARCO bought later). It was a carbonate-leach mill for the for the limestone deposits. From 1955-1956, they constructed the much bigger acid-leach mill for the newly discovered sandstone deposits. The sandstone deposits were discovered during an aerial fly-over in which Jack Knaebel, General Manager at Anaconda went to the site and had to take a crap; so they named it "Jackpile." There was a lot of drilling companies; who ever found viable ore bodies were given $4,000 or $5,000. Mt. Taylor deposit was developed by 1970s. Oil companies started coming in by mid-50s: Phillips in 55; Kerr McGee in 56. Anaconda built housing in Bluewater 40s and 50s. They built two hotels. Prior to 40s and 50s 2,500 people would increase to 5,000 but they'd leave in July because they were summertime agricultural labors. But Anaconda stayed (fieldnotes April 20th 2018).

After telling the broader historical background, he situated his family history:

> My dad arrived here in 1910. With 7 brothers and 1 sister he moved to Gallup and back to Grants. The cows are still the same; they are a mainstay of the landscape, and forest products. In the 50s there were 15,000 acres under cultivation; today 5,000 acres. All the flat level ground that we would drive through on the DOE tour was used for cultivation. The Mormons cultivated the land. I don't want to say they were clannish, but… The property was bought up for mills. From 51 to 56, around the Ambrosia Lake area mining companies started buying land and water rights. I worked for many of the companies: UNC at St. Anthony... You could quit a job by noon and by four have a job with a second company. Albert Fitch, I was friends with his children. He hired me for a summer job, 8-hour graveyard shifts hired in 57. I was a few years older than Toby. Then left them for a daylight job, 6 days a week. I spent time in the military. During summer of 1968 I got my degree in management and minor in economics at NMSU in Las Cruces. That's the best school in New Mexico. It's an agricultural school like Texas A&M. I was a surface level employee, worked in warehouse, worked on the tailings, paper work five days a week. (fieldnotes April 20th 2018).

Carver then described to me how the tailings piles were made. He was professionally involved in that labor:

> We would pump and slurry out 10" pipeline, which went into a pipe that circled a berm with thousands of 2" holes filled with wooden pegs. I'd have to go and move the pegs out. No one thought about the pond being unlined. It was the cheap method. We would recover mill solution with an acid leach blend that made the piles. To cleanup spills at Anaconda we used clean water on uranium pile leach. At Homestake they used water with sodium leach carbonate to clean up. Our recovery was about 85%. And it was a sodium bicarbonate discharge (fieldnotes April 20th 2018).

He offered a recap on the environmental and public health studies that followed the first public notification of groundwater contamination:

> I've been to a thousand meetings about Homestake since 1975, when they first found problems in the alluvial aquifer at 24 parts per million of uranium and selenium and arsenic. They would sample your well if you had a garden. People would grow lettuce and cabbage. Dr. Love from UCLA took hair samples and finger nail samples to trace high levels of selenium. One family experienced high concentration with uranium. EPA was not involved till later on. AEC, then NRC, was the lead agency. NMEID (now NMED) in Santa Fe came on the scene in 1960. And NM Health Department took samples of contaminated alluvial aquifer. It was by their good grace that they let us know. By 1978, there were periodic meetings. We discussed injection, dilution, collection. From 70 to 85, Homestake had a Canadian hydrologist and environmental guy. In 1977 the well manager of Homestake discussed groundwater issues and they moved him to a different mine. 2001, first EPA five-year report, followed by 2006 and 2011. USGS has been playing a role in the last 10 years. EPA did a bunch of drilling at the far end of Ambrosia lake. Their "background" doesn't meet reality because upstream, that's all mine dewatering; it curves through the sand and disappears, with summer rainfall (fieldnotes April 20th 2018).

Carver then offered insight on how and where the mills and the tailings were sited and situated in places where companies could accumulate water rights: "At Section 27, there was a big farm for growing potatoes, and the NRC maps show "San Mateo Wash," and they put their piles right in the middle." They went to the State Engineer and started to buy water rights to have 3,000 acre-feet for pumping. Mining companies bought water rights. He then mentioned other perspectives about where to move the tailings piles: "Why not pump it back into Ambrosia? Why not slurry it back. They say trucking it would create more deaths. Haul it back and put in a barrier wall. But, if in the future if they have mining… They take the answer and make the facts fit the answer. Milton says dig a hole and place it in the shale."

He began to tell me about the agency battle between NRC and EPA involving Ron Curry, which had been underway since 2000, when one of the DOE scientists announced to the people dining at the Kiva Café that the tour of the Bluewater site would be meeting on the patio outside. By about 12:30 PM, Larry and I finished our conversation and he got up to say hello to a few of his friends eating lunch at a table across the way. After the DOE scientist came into the Kiva Café to announce that the Bluewater tour would be meeting outside, I walked outside and introduced myself to the DOE and NRC scientists, many of whom had advanced degrees in geohydrology and other geosciences. When I explained my dissertation research, one of the agents told me how, after receiving his MS degree in hydrogeology, he had to delay his PhD because he was recruited to work for the NRC. There were also two agents from the Office of Environmental Justice from DOE headquarters in D.C. One of the DOE scientists asked me where BVDA and colleagues were. I told her that an email circulated saying the meeting time was 1:00 PM. She was noticeably flustered by this. "We won't have time to go on top of the cell," she said. The tour was scheduled to begin at 12:15 PM, but BVDA and others did not arrive until 1:00 PM. BVDA requested the tour from DOE after they reportedly gave a tour for Acoma Pueblo. They said the BVDA would get the same tour and info as Acoma. Harry Garcia a local state representative came out and asked about the tour and why he and others had no idea about it. He said he was in the café eating a burger and he heard about the tour. They tried to explain how the BVDA requested the tour. Someone from BVDA said, "Don't blame it on us." One of the NRC agents tried to settle things down, he said, "What's the best way to reach you all, do you have a local newspaper?" Harry responded: "No. We live in the tenth century. Of course we have a newspaper. Put it on the radio or public newspaper. You're trying to get that Superfund in here, we didn't know about it."

After the altercation, DOE decided to have the safety meeting near the curb, away from the entrance of the café and away from Harry. We moved about ten feet over. I wrote down their statement during the "safety meeting" in my field notes:

> We're going to the Anaconda site. We call it the "Bluewater disposal site." It's a DOE site. There's no risk of radiological hazard. This is a pre-job safety meeting. We'll drive in on two-track to the disposal site and get on the cell, but we may not have time to get on the cell now. Watch your step on natural rock surfaces. Watch for insects, snakes, coyotes, and badgers. Although it's been dry out there so there's not risk of insects. Number one accident is slips, trips and falls. There are no radiological hazards out there; it's contained and safe. We have good cell phone coverage out there. The nearest emergency room… the sheriff is still the best person to call. Job safety analysis. Watch driving, we could scrape bottom. Don't park over dry vegetation—fire hazard. No smoking. There's no weather hazard other than wind. [It was windy]. There are animal burrows onsite. There's no water hazard; everything is dry out there right now. We'll take 122 to main access to Anaconda, pass under a railroad bridge and go through the gate and lock the gate behind us. This time of year we worry with wind (fieldnotes April 20th 2018).

Figure 4. Larry Carver, local resident of Milan and former mining engineer, pointing at the volcanic peak El Tintero beyond the large tailings pile at the Bluewater site. Photograph by the author.

We dispersed into different cars and caravanned to the Bluewater site. I joined Larry and John Boomer in Larry's truck (see figure 4). We drove northwest from the Kiva Café in Milan on NM-122 alongside I-40 and the railroad, following the caravan. Larry pointed out a former farm that was mostly carrots, but also cabbage and turnips. He told us Anaconda bought up all that land and all the water rights. "We've gone from 15,000 acres farming to 5,000 acres." His dad lived in Gallup in 1885 and moved to his ranch in Grants in 1910. "My dad came out here to trap mustangs and poison prairie dogs up near Mount Taylor and he'd take this road," which was now gated. It was a dirt road in 53 to 60s, and was paved, but now its dirt again. He told us about his ranch in Murray Acres near the Homestake site. As people get elderly and die, he said, Homestake buys up the properties. They buy 30 acres of that here and there and eventually: "The map shows how Homestake surrounds us. We're a little island."

Larry told us that the land on either side of us was farmland that was bought up by Homestake. He told us which people sold which plots and when. He said that Homestake property extends from the roads 334 to 605 and up to and around the 509. They bought up all the property. "We live in an island surrounded by Homestake property," he said. They had the mile radius around the mill. We drove by a large empty dirt lot with sand dunes along its fence line and prairie dogs burrowing throughout the site. That's where the windblown stuff came from. That it was an extremely windy day added to this effect. Larry said that Homestake plans to gas the prairie dogs and plant on top to control the erosion. We drove by a man in a truck wearing a cowboy hat. Larry waived and told us that he owns Ambrosia estates and leases properties in the area. He was one of few landholders left. This is all Homestake. He pointed to Murray Acres and Broadview Acres, and to a property was abandoned because it is in a flood zone.

Boomer told us about the time EPA "brought in the baby buggy and GPS" and mapped his land. When they used their Geiger counter, "it lit up like a Christmas tree." He pointed out and described how they "use that spot in Bluewater Village as background. Using that background… supporting industry—pipes and all along the chain link fence. He said: "It took three years to get them out here and three minutes to clean it up. They came out in full hazmat suits. They requested that I clear the land in advance so they could scrape the soil clean. I had hired a guy to clear the brush from the land, and he handled the brush with his bare hands." Boomer hadn't been living in Grants all that long, maybe 10 or 15 years. He's an artist that works with stone; said he used the igneous tuff to sculpt. "Inhaling the rock may not be healthy, but neither is working with wood."

Larry told me how the water drainage from Lobo Canyon was used for the mill at the Bluewater site, which also goes to Tri-State Generation and Trans, and Escalante Power Plant. This drainage is the same water source that Toby Michael mentioned to me during our conversation. Toby said early on (circa 1940) the USGS didn't know about it and couldn't locate it. He told me that a former property owner found the hidden body of groundwater by using a diviner rod. As we got closer to the Bluewater site, we noticed smoke from the fire in the Zuni Mountains, he said New Mexico Tech decided to do an experimental controlled burn on the windiest day of the year and it got out of control. We arrived at the Homestake site and parked on the side of the two-track dirt road. They locked the gate behind us. Larry noticed that the DOE and NRC vehicles parked directly over the dry vegetation. We stepped outside of our vehicles and gathered around the DOE scientists, facing east with Mount Taylor in the background. They had poster boards of maps and aerial images (see figure 5).

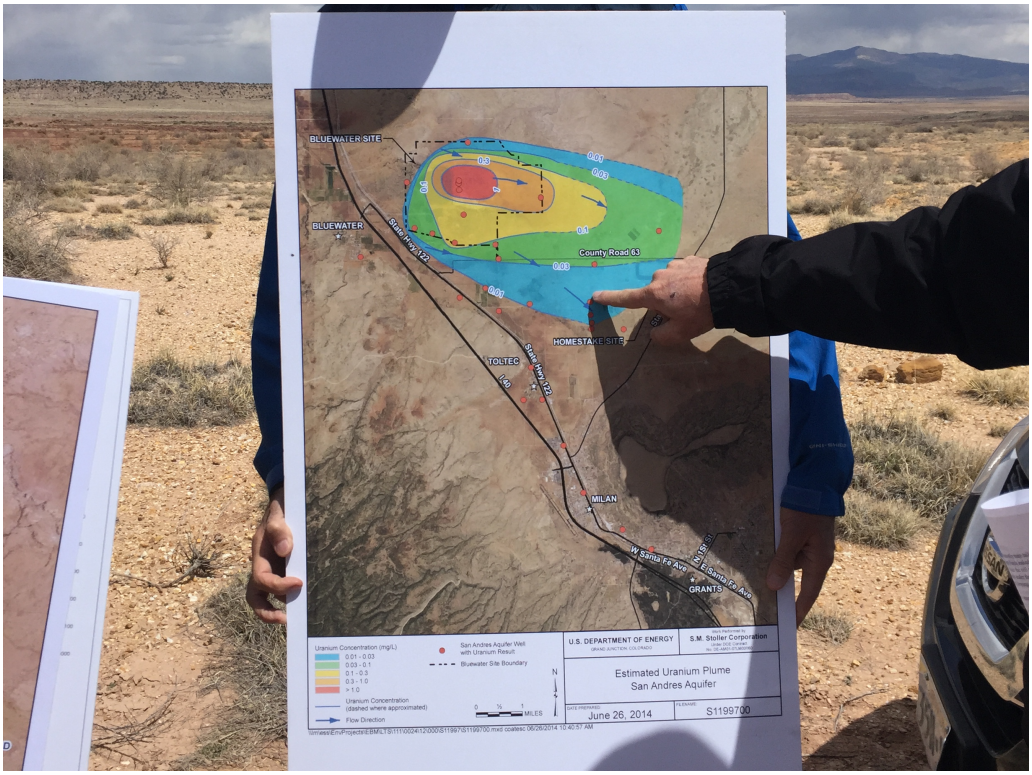

Figure 5. Visualizing the uranium plume from the Bluewater large uranium tailings pile. Mount Taylor in the Background. Photograph by the author.

6.3 Visualizing the Groundwater Plume of Uranium

They acknowledged their backdrop, Mount Taylor and the Homestake site in the distance to the east. One of the Legacy Management "support contractors" told us we were standing on San Andres limestone. There is no San Andres groundwater aquifer here because it is at surface level at "San Andres hill," where we were standing. "We don't have the Chinle aquifers here and there is no San Andres-Glorieta (SAG) aquifer here." He referred to the San Andres limestone and Glorieta sandstone formations as "a sandy limestone and a limey sandstone." In other places it hosts the main groundwater water supply for Grants and Bluewater Valley. Down from the San Andres limestone hill there is an ancestral river valley. He told us the Bluewater disposal cell is located in a "paleochannel confluence zone" here in the watershed of Mount Taylor. There used to be a canyon here, he said—"we call them ancestrals." This is "the Ancestral Rio San José."

The alluvial aquifer is silts, sands, clays, and gravels deposited by a river and buried under more than a hundred feet of basalt lava flow called "Bluewater basalt" from El Tintero of the Zuni-Bandera volcanic field. "In geologic time there would have been a valley here, an old ancestral riverbed." One of the DOE scientists, Dick Johnson, referred to it as a dirty laundry basket with the old stuff on the bottom and the new stuff on the top. The uranium tailings pile was situated on top of the Bluewater basalt in the middle of the watershed for the Rio San José.

They have a SAG well that pumps 1,000 gallons per minute. They also drilled wells and sent cameras down to investigate the fractures and joints. "It is so full of fractures as it gets down." There are two faults that intersect underneath the large tailings pile: the Ambrosia Lake fault and the East-West fault. These faults have posed major problems for managing the uranium plume that is moving through the alluvial and San Andres-Glorieta aquifer underneath the large "disposal cell," and migrating in the direction of Homestake site. There is a groundwater plume of uranium leaving the site at 0.44 milligrams per liter, which is above the EPA's maximum contaminant level of 0.03 milligrams per liter for uranium. Because the NRC accepted "alternate concentration limits" of 0.5 milligrams per liter in 1996, the DOE is achieving their professional task of monitoring and managing the site. "The site is still performing as they said it would. It is meeting site specific standards." "This has been fully reclaimed so you can eat and drink on site." Due to ACLs, it was considered a fully "remediated" and "reclaimed" site in the 1990s. Groundwater is their major focus. Despite the achievement of remediation and reclamation, there are two uranium plumes in the alluvial aquifer and the SAG.

A colleague from the BVDA asked: "Is it safe to say they should've never put the pile here?" Johnson responded, "This is a perfect storm. It's the worst place to put one. Geologically speaking, I'd never put it here." Nonetheless, "this is the site we inherited." The first operation

milled limestone ore, the first formation they mined in the early 50s. They dumped tailings directly on the basalt lava flows. Seemed like a great place to dump without the water issue. They didn't know about the lower aquifer. The alluvial aquifer is 120 feet below the surface. Its proximity to Jackpile Mine and the water are what made this a great site for the mill. They built a soil dike based on how much ore was being processed and they'd just fill against the bank and raise dike as they needed to. They put in clay dikes and pumped in the slushy, slurry material. It was not lined. Regarding the structure of the main tailings cell, the DOE estimated that the materials in the cell were 90% consolidated from their calculations of how the materials have settled. They called it "settlement monitoring." They were noticing differential settlement where the slimes were. And they noticed quite a few depressions on the north end of the cell. "Unfortunately we're not doing annual settlement monitoring." There's more than just tailings in the cell; there's also the contaminated lava materials and contaminated building material. Later, Larry showed us where the Anaconda golf course once was. Boomer asked if they played on the lava beds and dirt, and Larry said yes. He pointed out where the offices used to be, which were now inside the tailings cell. He pointed out the old pool and bowling alley, company residence onsite near the mill, the trailer park—they all rest in the tailings cell now. The major concern about the depression is the potential for damage to the clay radon barrier. They last took radon samples on the cell in 2016 and assured us that the ponding depressions are not affecting the radon levels. The other problem is the cell cover was designed to shed precipitation runoff over the north edge of the cover. All the runoff is collecting as ponds and not spilling over. Because most of the settlement has occurred on north end, there is potential for erosion as spill over the north edge occurs. For this reason, DOE has pumped water from the "areas of depressions."

Monsoon season and after major storms is when they have problems. “We get the water from the pond and pour it in there. Use a camera to monitor water from the wells. There’s a problem from the compaction of the clay, which has grown over time.” They are concerned about how big it could be if water eroded away, if gullies get deeper and extend over the cell. They have been siphoning temporarily to get water off the cell, but there is a potential for erosion to occur, but it’s going at slower rates and the radon barrier is still doing its job. The cell has collected 20 acres and 70 million gallons of water on top just from precipitation. That’s why the tailings water settled into the sands, minerals, and clays. Water is gradually coming out. We do have a weather station out here. The clay material tailings is settling and going down.

At Bluewater they have found that vegetation does not increase the pathway for radon. “We haven’t seen anything with deep roots grow on or around the cell. We’ve noticed Salt Brush and Rabbit Shrubs, and we treat the Salt Cedar in shallow areas. If we find plants that have roots that go down 10 or 15 feet, if they were on the cell, we’d remove them, but we haven’t noticed any. We collect radon samples twice a year and the radon cap is doing its job and water is not degrading the site, except for the ponding on the main tailings cell. We do alluvial inspections and physical protection of roads and wells.” I asked about the monitoring device on top of the tailings. He said that receives data from the number of telemetry stations that look at the relation between precipitation and water level and transmit to headquarters in Grand Junction, Colorado for continuous monitoring. They told us that they saw a whole heard of elk this morning. This prompted a conversation of all the animals they have encountered on the site: Golden eagles, elk, coyote, and rattle snakes. We have badgers and roadrunners. “I haven’t seen any, but I’m sure there are bobcats out there.” I asked about prairie dogs: He had not seen any prairie dogs. He thought this was a good thing because they would be a problem on the site that they would have

to take care of. They have to mitigate salt cedar and prairie dogs, and anything else that can penetrate 10 to 15 feet through the riprap and clay barrier of the cell.

As early as 1959, Anaconda realized there might be a groundwater problem. “When you have faults that are crossing, it’s a great place to pump water from a well.” It was the water that made this such a great mill site in the first place. Anaconda had four production wells that could pump 3,000 gallons a minute all day long. Pumping water from wells in the SAG pulled contamination from the mill tailings along the intersecting faults. When fluids precipitated back into the tailings piles they drained through those same faults. “It’s like there’s an ore body under this site several hundred feet deep that didn’t used to be here.” The SAG wells operated by ARCO for the milling process also pulled contamination down the faults. The DOE determined the evaporation rate and estimated that 5.7 billion gallons of water have seeped through the cell. They noted that water no longer infiltrates the cell. The DOE LM thesis was that the uranium, selenium, and molybdenum plume in the groundwater were “essentially stable.” In 1995 the standard was 0.5 milligrams per liter. In 2004 it was changed to 0.03 milligrams per liter. So the site is in compliance with the old standards, but it’s above today’s standards. According to one scientist, “the plume has been stable since the late 1980s. What’s changed is the background to .03 milligrams per liter, which the Bluewater plume now exceeds in proportions demonstrated on the chart (see figure 5). Their “compliance strategy” for groundwater remediation was to have ARCO meet the standard of “as low as reasonably achievable.” Contrary to the notion that the heavy metal plume is “essentially stable,” a colleague from SRIC said “Everything else in nature moves, but these heavy metals stay in place? These must be some well-behaved heavy metals. It’s almost a policy of agencies now that contaminants don’t move.”

In the 50s, when Anaconda recognized there was an issue, there was no EPA. By 1960, the USGS drilled a well into the SAG aquifer. They piped the contaminated water into a well and ARCO memorialized the well. From 1960 to 1977, they piped and gravity fed the water. For 17 years they piped the water to a well downstream and contamination kept coming back in. They put a synthetically lined pond on the surface over the Chinle materials and put contaminated material into the cells. They drilled 55 or 56 wells and pumped it dry. From 1960 to 1977 they injected wastewater into the Yeso groundwater formation below the SAG as an "alternative means of disposal." "A lot of mining operations re-use the water." They also built seven lined evaporation ponds and it just evaporated away. To better dewater the tailings piles, they installed wells in sand and evaporated it away. DOE used "band drainage" to dry the cell. "Band drains" act like a wick material that just wicked the water out. Through the process of "wicking" they took up millions of gallons of water and the carbonate tailings cell totally dried out. They implemented a similar wicking process to dry out the larger acid-leach cell. "We just can't get all the water out of the clay."

Figure 6. "BLUEWATER, NEW MEXICO." Photograph by the author.

6.4 "Do Your Job"

The "disposal site" is 3,330 acres. There is a plume of uranium, molybdenum, and selenium in the alluvial aquifer and SAG leaving the site. "This is relatively fast-moving water below ground that makes its way to Acoma in 25 years." Following the "ancestral channel," the water moves underground and it does not daylight until the other side of Grants in the Rio San José. The plume has migrated beyond the site boundaries and the DOE has not yet defined the leading edge of the groundwater plume. According to one hydrogeologist, the heavy metal plume had reached a state of "dynamic stability." "It has been locked in place now for twenty years." There are NRC & ARCO maps that show three consecutive years where the shape of the plume has not changed. "It's stabilized at that shape." "The plume has been stable for 20 years now." We're getting that water but it's being diluted with freshwater coming from. "Water from the Bluewater site has already reached Acoma, but it's so diluted it's not even noticeable." The question was

what is diluting the water. Was Homestake diluting or maybe watershed from Mt. Taylor springs? One DOE scientist offered the metaphor of the wet sponge. If you put die in the water, when it passes through a sponge, there is less die that passes through. As it trails away there is less and less. The BVDA appreciated her sponge concept. In the Rio San José downstream from the site they had not noticed impacts from the heavy metal plume. By the time water from the site reaches Grants, Laguna, and Acoma it does not have a trace of high uranium, selenium, and molybdenum. She offered the concept of a sponge to describe some phenomena in the geohydrology that was absorbing or immobilizing the heavy metals. The sponge metaphor can be misleading because it is not necessarily a porous, sponge-like sandstone and limestone aquifer. The fact that it is a "fracture flow aquifer" tells us more about the behavior or groundwater. It is not being absorbed by a sponge; it is moving through fractures. They have not found the leading edge of the contaminant plume, nor did they intend to. It is hard to say how the water behaves when it breaches the boundaries of the site. From the DOE's standpoint, they are meeting their criteria for the site and no further work is required. The NRC has since demanded action from the DOE and told them that it is their responsibility to find the leading edge of the groundwater plume.

Because the tour was running late, the DOE scientists said we would be unable to go on top of the large disposal cell as they had planned. They resolved that we could drive to "the memorial stone" (see figure 6) and observe the pile from about 25 to 30 feet away. On another occasion, however, we did go on top of the large disposal cell (see figure 7 and figure 8). At the end of the tour, the DOE and NRC tried to open a conversation with the BVDA about public outreach. BVDA said, "You need to do your own outreach. We are just one group. As it turns out, this concerns more people in the community." The DOE replied: "We'll do a better job.

We'll do it more often. There are 17 of us or more. We have a unique opportunity for early warning and early announcement, so this is a good time to be involved. Maybe we could get BVDA to deliver the info to the community." BVDA said: "We work with LACSE, RWPRC, ENDAUM, MASE, and we try to support others work, but I'm not going to take responsibility for delivering a message to the larger community. We do appreciate you being here. But you should do your job. In the past BVDA has had an uneasy relationship with NRC. We appreciated the NRC now because they are doing their job. It's not about coming in here and telling us we feel your pain, but more importantly, just do your job." If the plume is moving, who's going to remediate? My colleagues at MASE didn't understand why DOE LM couldn't cleanup, remedial action is part of its mission statement and the objectives outlined on its website. Folks from the BVDA stated that "Our irrigation well is much higher in Total Dissolved Solids (TDS) within the SAG." "Our community well increased in sulfates." "Can we add TDS, sulfates to the study or is that above your pay grade?" BVDA considered TDS an indicator that the mill tailings have impacted groundwater. The DOE responded: I think the data is already being collected. It's in the Gems database that the DOE put together where you can find all the data that they collected. Uranium is the only constituent above drinking water standards so that's our primary concern.

Figure 7. Ascending the large tailings pile at the Bluewater site. Photograph by the author.

Figure 8. On top of the large tailings pile at the Bluewater site. Mount Taylor in the background. Photograph by the author.

6.5 On the Subterranean Hydraulic Relationship Between Bluewater and Homestake

After the tour, Larry, Boomer and I got back into Larry's truck. I asked Larry if it was possible that something could be stopping the plume, and he suggested that "G" Mountain ("East Grants Ridge") could provide a sufficient barrier. On our drive back we went the other direction from the Bluewater mill tailings site to lead the NRC past the Homestake tailings pile at the request of the BVDA, to show them how close the community is to the pile and show them the windblown dust accumulating across fence lines and the wind-erosion prone lands owned by Homestake. That it was such a windy day really contributed to the sense of how wind moves materials around out here. Recall the control burn in the Zuni Mountains that was out of control on the day of our tour. When he dropped me off at my car, Larry asked me if I had learned enough about the issues here. I responded by saying yes, more than I thought. But that I hoped to get together again soon. He told me, at one of the DOE sampling wells, acid had eaten away at the stainless steel 3,000 feet deep in the well. A consulting geochemist once told the DOE, "Your wells are crap. They are not properly constructed." It can be hard to clean up their data. He said, "it's like trying to read in a snowstorm."

On the relationship between Bluewater and Homestake: Since Barrick Gold acquired Homestake in 2001, they began pumping more water from the SAG for their remediation process, which has pulled the heavy metal plume at Bluewater through the fracture flow aquifer system and into the SAG toward Homestake. He told us Homestake pumps 500 acre-feet of water a year from the SAG, and it is moving the plume from Bluewater toward Homestake. "Homestake wants out so bad. They have achieved almost negative results at the site, the value of which is about half-paid by U.S. taxpayers. Homestake has made big efforts to get out. Six hundred wells, it is the largest remediation well complex in the NRC system."

During a geochemistry workshop led by the geochemist Earle Dixon that will be discussed in further detail in the next two chapters, he sketched the Bluewater site in relation to the Homestake site on a white poster with a marker. He drew a line through a large circle to represent one of the faults that cuts through the large tailings pile at Bluewater and its associated groundwater plume in the Permian San Andres (PSA). He plotted a few wells on the map, noting an area of "bad wells" near well 951R by Homestake, which is east of well 951 near Bluewater. There are fractures in the limestone, not pores, but big cracks. This is a "fracture flow system." The way Homestake treats the water they pump up is like "running a washing machine to let the water out." The heavy use of SAG water for the Homestake remediation startled the DOE; they said, stop pumping, that uranium plume is coming from the Bluewater site. "Quit pumping on it, the water wants to flow that way anyway." That uranium is coming from well 951 at Bluewater to 951R at Homestake. He drew arrows on the poster that show the direction in the groundwater plume at Bluewater, and arrows that point toward Homestake to indicate the direction in which the plume has moved following Homestake's accelerated pumping from the San Andres-Glorieta.

He remarked that figure 63 in the DOE 2014 report show the plume 4 miles out. That's when NMED said stop pumping. Well 951 is now impacted and two deep wells in the San Andres. They can only fix their problem at Homestake with San Andres water, but when they use that water it pulls the Bluewater plume closer to their site. Bluewater has pretty good water, he remarked. There's a well that connects to groundwater that is 8,000 years old. He can tell when the groundwater was born through age dating water isotopes can be used to fingerprint water. San Juan Basin to the northwest is where groundwater is trying to go toward Farmington. Municipal wells are out of the path of Bluewater plume. The DOE does not want plumes on the

list. During his work in Nevada, studying each underground explosion, 285 detonations below the water table register as plumes in geochemical investigations, but the DOE would not let them use the word "plume." Their term of art was "corrective action units." DOE headquarters would have a heart attack if you used the term plume, he said. Instead of using the term during a workshop with the public, he drew the shape of the plume. He did that in Nevada and that is how he lost his job. "I was fired because I was too smart and my science was too good." "You can't call them plumes so I drew an image of them." You can't cleanup the test site because that's where the waste is going. Like the Nevada test sites, the Bluewater "disposal cell" has also become a target for waste from other sites that would be managed by the DOE Legacy Management.

6.6 Conclusion

This chapter offered an ethnographic description of how the Department of Energy Legacy Management monitors-in-perpetuity uranium mill tailings piles that have been "successfully remediated." Through my description, I have added another layer of stakeholder analysis. By serendipity, I began with an account of the experiences and expertise of Larry Carver, a former uranium mining and remediation engineer, and resident of the Village of Milan, located near the Homestake site. As we drove from Homestake to Bluewater, he described how Homestake turned community residences into corporate property through buyouts, and turned farm land into tailings piles. Lands that were once cultivated for carrots, turnips, cabbage, and potatoes by Mormon communities and other Anglo and Hispano settlers were turned into piles of uranium tailings about a hundred feet high, which produce groundwater plumes of uranium, selenium, and molybdenum. Larry's narrative accounts for how mining corporations and big oil companies

bought up the water rights in the region, which effectively turned agricultural families and communities into mining company towns.

This situation is iconic of the archetypal battle between local communities and transnational mining companies, as pastoral and agricultural families and communities of North America were turned into corporate mining towns that would boom and bust and leave the landscape devastated. The words "resource curse" and "Dutch disease" come to mind, which index how mining displaces farming, and how mineral extraction is at odds with just about every other form of economic development in so-called "developing countries" around the world. In Chapter 3, I theorize moments like these with the concept of "hauntology of the resource curse"—a course of study that calls out the emergence and residence of "the animus the miner" (Mumford 1934:71), which underlies the genesis and development of scientific mineralogy and industrial mining and metallurgy. This course of study identifies the devastation of mining upon the landscape.

In this chapter, I have described an entanglement of explanatory forces working for and against environmental cleanup. I observed how "alternate concentration limits" (ACLs) set by the NRC have enabled Legacy Management to refrain from all remedial action. Recall that a DOE scientist referred to the site as "a perfect storm," "the worst place to put a tailings pile." He identified the intersecting fault lines underneath the large tailings pile. Nevertheless, it is the site they inherited, and it meets the site-specific standards. The DOE scientists could safely say they were doing their jobs. From the perspective of the local community, the federal government fell short of their civic duty to keep the public safe. Because the NRC accepted ACLs of 0.5 milligrams per liter in 1996, despite the fact that the EPA now considers 0.03 milligrams per liter to be the maximum contaminant level for uranium, this perfect storm is proliferating within the

confines of the law. I considered the BVDA's enunciation to "do your job" as a discursive force against a *neoliberalized* state that is incapacitated and compromised to such a degree that the NGO*ification*, grassroots fundraising, and undone science-funding have become the drivers of an undercurrent of civic sciences and engineering that destabilize and transform industry standards. This observation lines up with David Harvey's (2005) theory that as the neoliberalized state recedes, NGOs emerge as political forces to be reckoned with. In the following chapters, it will become clear how NGO-sponsored independent science is driving the environmental cleanup regime despite the dominant presence of corporate science that backgrounds industrial impacts and produces data gaps and fractures in environmental information.

The broader process in play at Bluewater and Homestake was one that turned lands farmed by local communities, into private lands used to mine and mill uranium, into federal lands where the federal government will one day inherit all nuclear things and landscapes, and make them off-limits to the public. The performative act of the DOE tours of the site offer a glimpse into an alternative public use, an opportunity for DOE scientists to disseminate their environmental monitoring data. These moments led to massive transformations in what Henri Lefebvre (1991) would call "representations of space" (environmental monitoring data) and "representational spaces" (the Bluewater site), opening up new possibilities for "spatial practice" (environmental cleanup). In these spaces and places, land and water, surface and underground, are integrally bound together. There is an understory that progresses through this chapter about the subterranean hydraulic relationship between the Bluewater site and the Homestake site. These sites are not separate or discrete. Though there are epistemic formations of disassociation in play, they are met with other ways of knowing that recognize the relationship between the large uranium mill tailings piles. Homestake (Barrick Gold Corporation) pumps a significant

amount of groundwater from the San Andres Glorieta aquifer for their remediation process, which involves reinjecting the water into their underground hydraulic flow regime. This is pulling a groundwater plume of uranium and other contaminants from the Bluewater site toward the Homestake site. Notice how the push-and-pull of discursive forces map onto the push-and-pull of hydraulic forces. There is a figure-ground interplay that occurs through situated experiences with local expertise where what was once backgrounded and undergrounded emerges into clear view and in monolithic proportions.

CHAPTER 7

THE POLITICS OF BASELINING IN THE GRANTS MINING DISTRICT PART I

This chapter offers a description of the epistemological centering of "the Crossroads" of the San Mateo Creek Basin in the Ambrosia Lake sub-district of the Grants Mining District.[77] The basin-wide model, with the Crossroads at the center, is an analytical tool designed by Region 6 of the Environmental Protection Agency (EPA) to better understand and address the widespread contamination in the district. The problem at the center of the EPA's environmental study is the process by which water discharged from "wet mines" has dispersed contamination throughout the basin, seeped through soils and sediments, and contaminated multiple groundwater aquifers. The mining industry pumped billions of gallons of mine water in order to extract and process the uranium ore deposited below the water table, and released the water into Arroyo del Puerto and San Mateo Creek, which confluence before draining into the Rio San José. Over time, the contamination infiltrated underground aquifers through seepage and fault lines, as well as boreholes from historic exploratory drilling and underground mine workings, which have served as conduits that connect different aquifer systems. This has become thematic in the EPA's narrative of contamination for the site. The genesis of the basin-wide model is derived from New Mexico Environment Department's (NMED) *Preliminary Assessment Report: San Mateo Creek Legacy Uranium Sites* (March 2008), conducted under the auspices of CERCLA, a policy that authorizes the federal government program called "Superfund," which funds the cleanup of contaminated sites.[78]

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[77] In this chapter, I use the EPA and NMED toponym "Grant Mining District," instead of "Grants uranium district," which is the term used by an epistemic tradition of geology at New Mexico Tech (See McLemore and Chenoweth 2017). This shift in terms abides by my emic approach, which attends to the terms by which my interlocutors bound their fields of analysis.

[78]https://www.epa.gov/superfund; accessed February 9, 2019.

7.1 The San Mateo Creek Basin Superfund Proposal

On January 23rd and 25th 2018, Region 6 of the Environmental Protection Agency (EPA) presented their proposal for the 321-square mile San Mateo Creek Basin Superfund site to the McKinley and Cibola County Commissions of New Mexico. On both occasions, they presented their proposal remotely. Due to the federal government shutdown they were unable to make travel arrangements from their regional headquarters in Dallas, Texas to Gallup and Grants. Regulators from the Ground Water Quality Bureau of New Mexico Environment Department (NMED) were there in person, including the manager of the Superfund Oversight Section and the program manager of the Mining Environmental Compliance Section. They did not, however, participate in the January 23rd presentation to the McKinley County Commission. Connected by telephone, amplified through a speaker, with slides projected on a wall in front of the commissioners, the EPA Region 6 National Priorities List Coordinator from the Office of Land and Emergency Management began the roughly twenty-minute presentation. Before beginning, she noted that this was basically the same information they had recently presented to the Pueblos of Acoma and Laguna, and the same information they would be presenting to the Cibola County Commission in Grants in two days. The EPA had already received a letter of approval for the Superfund site from the State of New Mexico on January 12th 2018. Acoma and Laguna also approved listing the site.

7.1.1 Phase I

Phase I Ground Water Investigation conducted by the EPA is the primary study that undergirds their Superfund proposal. They finished groundwater sampling for Phase I in 2016 and expected

to finish Phase II in 2018, both of which have been supported by site and well monitoring that has been underway since 2008. During this period of study, they found a number of private wells that tested beyond the EPA maximum contaminant level (MCL) for uranium and other contaminants. Municipal water sources are apparently not in exceedance, but they may be impacted in the future. The goal of their groundwater investigation is to document contamination in the shallow aquifer and document the migration of contaminants into deeper aquifers. The EPA's narrative of contamination accounts for the process in which groundwater and mine water were discharged on the surface, infiltrated soils and sediment, and significantly re-saturated portions of the upper alluvial aquifer and the bedrock aquifers underneath. This has led to the degradation of groundwater quality. Eighty billion gallons were pumped from the groundwater aquifers between 1956 and 1982 and released into unlined ponds and arroyos on the surface. Additionally, there are four uranium legacy mill sites within the basin that have seeped into shallow alluvial aquifers, which are in direct contact with multiple deeper aquifers. Underground mine workings connect over large areas and thousands of exploratory boreholes have served as conduits throughout different aquifer formations.

The coordinator suggested that moving forward with the Superfund designation and registering the site on the National Priorities List (NPL) could help address the widespread impact of groundwater contamination. There are several reasons why the NPL Superfund would be the preferred program for cleaning up the site. First, there is no other state or federal program that can address such widespread contamination across public and private lands, and across state, federal, tribal, historic allotments and other jurisdictions. Second, a basin-wide analysis would offer a comprehensive analytical framework for understanding the complexity of contamination. Finally, it would allow multiple stakeholders to participate in both the investigation and cleanup.

However, it would use large public funds to pay for the externalized costs of corporate production driven by private interests. A colleague once said that the EPA NPL would be "a big hammer, but you need muscle, and you got to have the hammer above their heads," referring to the potentially responsible parties (PRPs).

The NPL coordinator introduced her colleague, the community involvement coordinator, as they shifted to the second half of the presentation, which underscored their work on building strong community relations. They wanted to go beyond just notifying the public, and requested active input from communities, tribes, and other stakeholders. They will start by doing "community interviews" to find the best way to communicate with the public. After the NPL Proposal, before the Final Rule, there is a 50-day public comment period. Once the CERCLA process begins, there are 24 specified steps that involve public comments. At the time of the meeting, the EPA was in the Site Assessment Phase. They had completed the Site Discovery, Preliminary Assessment (PA), and Site Inspection (SI) and were in the process of Hazard Ranking System (HRS) Scoring. After which came the NPL Listing Process, then the Remedial Phase. Their presentation lasted less than 20 minutes. At the end, the commissioners were affirmative and eager to address this longstanding problem. They had one pressing question: How long will it take to get the site on the list? The NPL is only updated twice a year. The NPL coordinator hoped the listing would occur in the spring, but more likely the fall.

Following the McKinley County Commissioners meeting, I sent an e-mail to my colleagues at MASE to update them on the proceedings. They did not attend the meeting in Gallup because their primary interests were in the proceedings of the Cibola County Commission and the meeting in Grants that would follow on January 25th. It is interesting to compare what I

experienced in Gallup that morning with what we would experience in Grants the following Thursday evening.

Figure 9. A median on Santa Fe Avenue in Grants "Proudly Sponsored By HOMESTAKE." Photograph by the author.

On my drive from Albuquerque, I picked up two of my colleagues near McCartys shortly after 5:00 P.M. As we arrived in Grants, one of my colleagues remarked that, even though she lived in the Grants mining district, she would be perceived as an outsider in Grants, which is a company town. To her point, there are signs in the landscaped median between the roads on Santa Fe Avenue that say, "Proudly Sponsored By HOMESTAKE". When we arrived, just after 6:00 P.M., the Cibola County Commissioners meeting was already underway. It started an hour earlier than we anticipated. Why did the e-mail that circulated among MASE say 6:00 P.M.? They started the EPA presentation at 5:45 P.M. The NPL coordinator was finishing the first half of the presentation as we found our seats. Then, the system failed. The EPA was disconnected before they could deliver the second part of the presentation—ironically, the part of the presentation about developing strong community relations and good channels of communication.

The room was packed, and folks were not happy. Managers from NMED were there in-person and tried to address the concerns of the commission and the public audience to no avail. The commissioners tabled the issue until someone from the EPA could be in the room to answer questions. A friend from Grants later revealed that the residents who attended the commissioners meeting were there for a different issue, and many of them were unaware that the Superfund proposal was on the county commission's agenda.

In late February, the Cibola County Commission voted against the Superfund designation. The municipality of Grants and the Village of Milan also publicly announced their position against the listing. In an interview with a resident from the area, Candace Head-Dylla, I asked, "Can you say just a little bit about why you think Grants would not want this site to be listed as a Superfund site, if you feel like that is something that you are comfortable discussing?" She replied:

> I can tell you exactly why. It's because Grants has decided that they will do anything. Historically, when the uranium boom happened, there were families, some old families… a number of historically wealthy families who made small fortunes on the uranium boom. They had gas companies, local businesses, they had land that they leased, I mean, they threw up trailer parks, they put in hotels. They made money off of the boom. A lot of those families are still in the area. And then other families that were around then and saw what those families were doing have said to themselves, "Oh, if we get another uranium boom, I'm going to do that. I'm going to do that if it comes back, I'm going to do just what they did and I'll get rich too." So there are some old and fairly influential families, and people who have been there a long time who think all we need is just one more boom. Even if it just lasts ten years, I know exactly how to do it. I know exactly how I'll get rich. And so in their minds, uranium is still coming back because that is the way it happened in the past. You know when I was growing up, it was a boom and a bust, and a boom and a bust. And the people who took advantage during the boom, they did, they made really good money. And they think it can happen one more time. It's almost like magical thinking. It's going to happen again, just like it suddenly happened in the past and I'm ready. And those families have stuck around. They have influence. They have money. And those that don't have money that are waiting to make money are supporting the people that have been around a long time. So it is a bit of magical thinking and they think it will happen again.
>
> You got to remember, Grants was "the Uranium Capital of the World." It was so big and things happened. It looked like a different place. There were people from all over

> the world who lived there. I went to school with kids from everywhere, from Canada, from Germany from, I can't even tell you the kinds of people I met because of that industry. So they think that it is coming back and they'll do anything for that. But Homestake has been very nice over the last... they got smart in the last about ten years, and they started giving money to every little baseball team and school organizations. And they were small pots of money. But in an economically depressed area, they were important pots of money. So they developed, they fostered, this loyalty to them.
>
> And when it wasn't uranium mining, it was the coal mining. The coal mining supported the town. So in their minds, mining is good. Anything that has to do with mining is good. Mining will save us and we need to support them in every way. Now, why they wouldn't want to clean up a contaminated area? Well I think they were told, and I know this for a fact from talking to people. They were told that this cleanup was going to hold people that mined back in that time accountable and they would be required to pay for some of the cleanup… there was a rumor that went around town that they were going to have to be responsible for some of the cleanup. So that was a problem too. Some people got scared about that. And they just didn't want to do anything that would be bad for mining. Now the public reason they gave was that it would hurt tourism, because they were trying to get more hikers, bikers, etcetera into the area, and if we had a Superfund, a huge Superfund site, it would hurt the tourism. Now that doesn't jive with the fact that just a few months later they voted to bring in an oil refinery. So I mean how does that not hurt that same segment of tourism? You know it doesn't make sense (Head-Dylla, June 6th 2018).

When presented with the notion that a huge Superfund site would hurt real estate, a geochemist running a workshop for MASE asked whether the Grants chlorinated solvent plume, which is listed on the NPL, had made an impact.[79] He also raised this comment during a public meeting. The folks in the room from Grants didn't seem to know about this NPL site in their own town. In addition to the chlorinated solvent plume, the Homestake site in Milan is listed with the second lowest site score (34.21 out of 50), the United Nuclear Corporation site in Church Rock is listed with the lowest site score (30.36), and the Jackpile-Paguate site in Laguna Pueblo is also listed among the 16 sites in New Mexico on the National Priorities List.[80]

What interests me about the explanation offered above is that it illustrates how "cleanup" can be understood within the cyclical purview of industrial minerals: *It was a boom and a bust,*

[79] https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0605144; accessed February 11, 2019.
[80] https://www.epa.gov/superfund/national-priorities-list-npl-sites-state#NM; accessed February 11, 2019.

and a boom and a bust. All we need is just one more boom. They think it can happen one more time. It's almost like magical thinking. It's going to happen again, just like it suddenly happened in the past and I'm ready. So they think that it is coming back and they'll do anything for that. Notice how the Superfund designation disrupts that cyclical logic by which uranium mining will come back. From this perspective, "cleanup" cuts through space and time; it is a lace of obligation that could hold individuals and institutions accountable and responsible: *This cleanup was going to hold people that mined back in that time accountable. They were going to have to be responsible for some of the cleanup. Some people got scared about that.* There is a statue of a bull in the Cibola County Commission Chamber. I once asked my colleague if the bull indicated their optimism for a bullish market and their expectations that mining would come back, and prices of uranium oxide would go up. He said it would be more fitting if they had a statue of an ostrich with its head in the sand.

During an interview, I asked my colleague, "do you foresee that designation going through despite resistance from the municipality of Grants itself, and can you say a little about that?" The interviewee replied:

> Yes, I do. I think it will go through, because it is not supposed to be a political decision. Even though we know it often times is. But I think this contamination, fortunately, the San Mateo Basin includes areas far outside those municipal, I mean they talked to Grants, Milan and the county, but a lot of that is in McKinley County and some of that is closer to Navajo. So I think the political considerations are far greater than just those three entities. And EPA, regardless, I mean even in this bad administration, cannot just say, "Oh well the community doesn't want it." Because it wouldn't be good for us so we are going to just ignore contamination. I mean, EPA as bad as they can be, they can't do that. It completely flies in their face for the reason for being. So yes, I think it will go through. MASE has definitely supported it. We sent a letter to that effect (Head-Dylla, June 6th 2018).

At a meeting following this series of responses to the NPL, a resident asked an EPA coordinator, "What would slow you down with the NPL? Is it purely bureaucratic or is it

political as well? We know industry has gone to elected officials. Republican State Representative Pierce sent a letter about San Mateo Creek to encourage you to pay attention to mining companies' interests. Would an NPL site prevent future mining activities?" He responded that "the Mt. Taylor Mine is now operational. Roca Honda is in the process of getting permitted as well. Companies are taking quite extensive studies. The Mt. Taylor Uranium Mine will need a water treatment plant because the mines have flooded. But we do have a Governors' letter in support of NPL. The EPA administration under Andrew Wheeler has been cognizant of state-level decision-making and working in collaboration with the state. But we're also following CERCLA and EPA Office of Management and Budget (OMB) bureaucracies, for the benefit of the community. None of us know how the gears turn in DC." What he implied about the Mt. Taylor Uranium Mine returning to operational is that it had not necessarily impeded the Superfund process, nor was the mine impacted by the Superfund proposal. In fact, the mining companies are now conducting much more extensive environmental studies and groundwater investigations, albeit to limit environmental liabilities. This is interesting because the Mt. Taylor Uranium Mine is located within the EPA Superfund area of interest.

7.1.2 Phase II

Thursday, October 18th 2018, the U.S. EPA Region 6 facilitated two meetings: One for MASE and colleagues in the morning and afternoon, and one for residents in the evening. Both meetings were held at the Cibola County Building on High Street, along the Rio San José Riverwalk, across from the Mining Museum and the old Mother Whiteside Memorial Library. The reason for having the meetings was the public release of their *Phase II Ground Water Investigation Report for the San Mateo Creek Basin Legacy Uranium Mines Site, Cibola and McKinley*

Counties, New Mexico. At the meetings, they circulated compact discs (CDs) of the electronic report. They had given a similar briefing for the Pueblo of Laguna on Tuesday and the Pueblo of Acoma on Wednesday. It was led by the EPA Superfund site coordinator Kevin Shade, and the project manager Mark Purcell. They began with an update: the site was not included on the list in September as the NPL coordinator had hoped. However, necessary bureaucratic negotiations were underway. The EPA has begun consultation with other federal agencies regarding the listing. They've had joint meetings with the NRC and DOE about what it means to have Uranium Mill Tailings Radiation Control Act (UMTRCA) and CERCLA operating in the same area.

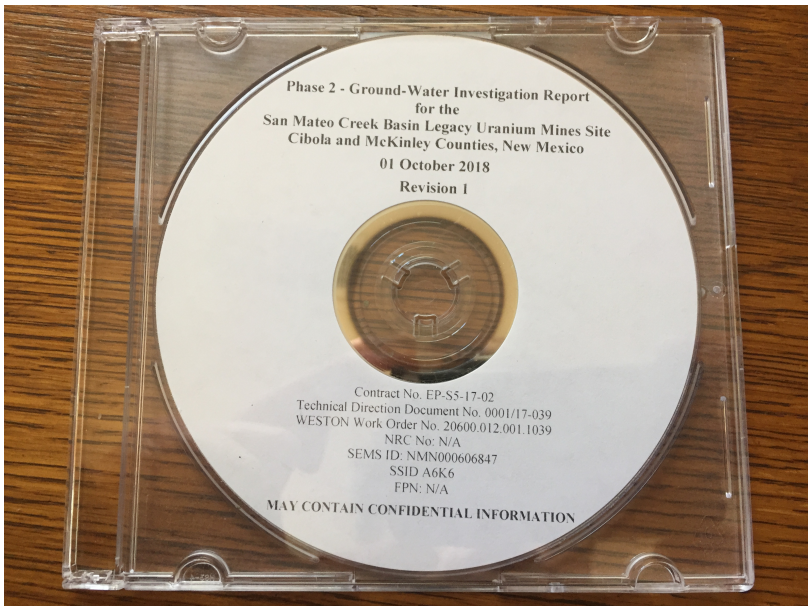

Figure 10. A compact disc (CD) of EPA Region 6 *Phase 2-Ground-Water Investigation Report for the San Mateo Creek Basin Legacy Uranium Mines Site* (October 2018).

Colleagues at MASE moved the conversation along; they were concerned about whether the EPA had identified the potentially responsible parties (PRPs). After sending a general letter to 10 companies, EPA had engaged four viable PRPs: Hecla Limited, Homestake (Barrick Gold), United Nuclear Corporation, and Rio Algom (BHP Billiton). In other cases, they couldn't find the owners, or next of kin if the owners were deceased:

> Others don't feel liable. Corporations fight amongst themselves. A company will sue a company. It's happening at the Jackpile Mine; Atlantic Richfield feels a Laguna construction company is partly responsible. A company can also come back and sue government. If we have PRPs that will do the work, we go with that over other "enforcement paths." By not signing up, those companies have some liabilities (fieldnotes October 18th 2018).

There is also the widely acknowledged corporate strategy of dividing "assets" from "liabilities," leaving "empty shells of corporations" unviable. The Tronox settlement has become a model for federal response to such corporate strategies. The EPA describes it as "the largest recovery relating to governmental environmental claims and liabilities." "On December 13, 2013, the Bankruptcy Court announced its decision in the fraudulent conveyance lawsuit and found the defendants (Kerr-McGee Corporation and certain other subsidiaries of Anadarko Petroleum Corporation) liable for damages between approximately $5.2 billion and $14.2 billion."[81] "Fraudulent conveyance," also known as "fraudulent transfer," means to avoid debt by transferring money to another company.

The EPA Region 6 coordinator Kevin Shade noted that the Church Rock site in the Grants Mining District would be kept separate from their demarcation of the San Mateo Creek Basin Superfund site. Region 6 is deemed the "South Central" region, serving Arkansas, Louisiana, New Mexico, Oklahoma, Texas, and 66 Native American Tribes.[82] Because Church Rock is in the eastern checkerboard area of the Navajo Nation, under Navajo Nation EPA and EPA Region 9 jurisdiction, it is accounted for under the Tronox Incorporated bankruptcy settlement, in which the Navajo Nation received over forty million dollars to cleanup abandoned uranium mines.[83] Tronox Limited is the successor of Kerr McGee Corporation, which operated

[81] https://www.epa.gov/enforcement/case-summary-tronox-incorporated-bankruptcy-settlement; accessed March 9, 2019.
[82] https://www.epa.gov/aboutepa/epa-region-6-south-central; accessed March 26, 2019.
[83] https://www.epa.gov/navajo-nation-uranium-cleanup/tronox-abandoned-uranium-mines; accessed February 10, 2019.

in the Navajo Nation and at other sites across the US. Tronox resolved to settle its environmental liabilities in February 2011. In 2015, they were deemed responsible for 54 abandoned mines for which the EPA recovered $900 million. Thirty-four of the mines covered by the Tronox settlement are on Navajo allotments or on the Reservation, and 20 are on private property. For whatever reason, the state of New Mexico didn't put their foot in the door; the state did not put a claim in. A resident of the Village of Milan interrupted, "What was the reason given to you lower down in the food-chain about why New Mexico missed millions of dollars of cleanup funds?" The EPA Grants Mining District coordinator responded that $900 million is a drop in the bucket when you consider the number of sites and the soil sampling and other environmental monitoring involved. It's a question of how to allocate money and appropriate enforcement actions. Their goal is to focus resources where they are most needed. The Grants Mining District coordinator pieced together a puzzle of sites throughout the district and the various funding mechanisms that support the environmental monitoring and remediation. The San Mateo Creek Basin and the basin-wide groundwater model were the crux, at the center of the Grants Mining District, in the Ambrosia Lake sub-district between the southeastern sub-district of Laguna and the northwestern sub-district of Church Rock-Crownpoint.

The Grants Mining District, New Mexico 2015-2020 Five-Year Plan: Assess and Address Health and Environmental Impacts of Uranium Mining and Milling (2015), drafted by EPA Region 6, displays a pie chart that offers a breakdown of allocation strategies for 97 uranium mines in the district. They designate four categories based on the entities "that should be" responsible for addressing the legacy mines and their impacts: mines associated with Jackpile-Paguate (16%); mines with PRPs (38%); mines covered by the Tronox Settlement (11%); and, "orphan mines" without responsible parties (34%) (2015:11). Shade told us that with these

allocation strategies the Tronox fund can last longer and go further at the sites where it has been allocated. He also mentioned an additional resource, the Superfund Research Center at the University of New Mexico and their Metal Exposure and Toxicity Assessment on Tribal Lands (METALs) program. Non-native community members who live in the Grants district expressed concern that Anglo and Hispano communities living near former mines and mill sites would be left out of the study focused on tribal lands.

Kevin Shade replied that there are other funds too. He discussed the Defense-Related Uranium Mine (DRUM) fund. In 2014, Congress asked the Department of Energy (DOE) to collaborate with state Abandoned Mine Lands (AML) programs, and enumerate the number of abandoned uranium mines across the nation, to calculate the numbers and grapple with the problem through the verification and validation (V&V) program, which includes:

> Exchanging information with other federal agencies and state governments to improve the quality of mine-specific data. Performing field inventories to document the condition of the mines. Conducting gamma surveys, soil sampling, and water sampling (as applicable), and collecting multiple lines of evidence to help evaluate hazards posed by the mines. Producing mine reports that offer inventory results as well as evaluations of physical hazards and potential chemical and radiological risks.[84]

They begin by surveying the state AML literature. If the literature says there was a mine, they would validate whether it was actually there and map the features and compile a report. If the literature says there is an open shaft with water 30 feet below the surface, or other hazardous conditions were observed, they would do the site assessment and justify additional funding to remediate hazards. In New Mexico, more than half (n=113) of the DRUM mines they've identified are in the Grants Mining District; 101 are outside the district. They hope to have the verification and validation fieldwork done by the end of next year (2019). My colleagues at

[84] https://www.energy.gov/lm/defense-related-uranium-mines-program; accessed February 20, 2019.

MASE were surprised to hear about the DOE DRUM program; they were previously unaware of this source of funding. The Abandoned Uranium Mines Working Group (AUMWG) is a manifestation of the DRUM program, which is a consortium of federal agencies working together to understand and address the nation's 4,225 defense related sites produced between 1947 and 1970. The consortium includes the DOE, Department of Agriculture, Department of Interior, and EPA. They consider the AUMWG to be a model of the "one government" approach, which is vaguely characterized as a strategy whereby each agency operates within its own mission, yet in coordination with other agencies. For example, DOE, Bureau of Land Management (BLM), and U.S. Forest Service (USFS) have been collaborating through the verification and validation program in order to address the risks to public health on federal public lands where 2,500 mines are located.[85] The "one government" approach refers to the exchange of information on mine-specific data that connect agencies with specific obligations regarding specific dimensions of the mine and its relationship to environment and society. The extent to which DRUM and AML data are open to the public is limited. A state geologist involved in the AML work once expressed dismay to me that her archaeologist colleague did not want the mines to be on any public database; she believed that knowledge about mines and minerals should be in the public domain.

The environmental monitoring of the magnitude called for in these programs of federal research is not cheap. At joint-agency multi-stakeholder meetings, when community members asked about the shortcomings and limitations of environmental research and information, particularly the "data gaps" that leave community members exposed to health risks, the response was almost always scarce resources and limited funds for further research and remediation. A

[85] https://www.energy.gov/lm/articles/working-group-addresses-abandoned-uranium-mines; accessed February 15, 2019.

former state geoscientist once pointed out that the highest paid federal government positions for scientists were in the DOE. He gave the example of a hydrologist in the Office of Legacy Management who made a starting annual salary of $119,744 in 2016. Drilling one monitoring well costs about $100,000. There are also high costs to send samples to be processed in out-of-state labs. These costs add up. Yet expensive environmental monitoring must take place before cleanup can occur.

Despite economic limitations, government employees often abide by strict protocol that center around "the community" and aim to protect public health. There is a clear civic discourse in the Superfund program, which has dozens of specified moments where government employees are obligated to share necessary information and receive public input. At the discursive level, "the community" is front and center. The EPA Five-Year Plan for the Grants Mining District has been updated twice based on four community meetings. The last of the five objectives of the current plan is to "communicate and coordinate with communities" (3). Their goals under the category of "Communication" are to "Clearly communicate ongoing and planned actions/activities" and "Provide information the community needs" (7). In this chapter, we will see how these stated goals of community relations map onto the experiences of local communities.

The basin-wide Superfund site was considered the next piece of the puzzle for funding the cleanup of abandoned uranium mine lands. Mill tailings piles dropped out of the discussion. In some cases, the coordinator and colleagues refused to discuss the environmental impacts of mill tailings piles because, in this study, they were focused on the mine waste, not the mill waste. They wanted to bracket the mill tailings conversations for another time. For the EPA, a conversation about the tailings piles would be a conversation involving the DOE and the Nuclear

Regulatory Commission (NRC). MASE and colleagues found it difficult to fathom a basin-wide analysis that doesn't seriously consider the impact of four uranium tailings piles on groundwater and how they interact with mine water upgradient of the Homestake Uranium Mill Tailings site. The EPA states that there are four uranium mill tailings piles in the basin that have also seeped into the alluvial aquifers and the deeper aquifers in the basin, but they do not consider the tailings piles as objects of analysis. In fact, they completely omit the mill tailings sites during their 2009 and 2011 airborne fly-overs with a Lidar screening tool called Airborne Spectral Photometric Environmental Collection Technology (ASPECT). A colleague from MASE asked why they didn't fly over the mill sites. "Is there a reason for that?" The coordinator didn't know. He wasn't involved in making that decision. Upon viewing the ASPECT images, the mill sites are glaring omissions. Perhaps the most obvious explanation for this omission is that the mill sites are under various jurisdictions of Uranium Mill Tailings Radiation Control Act (UMTRCA), Department of Energy Legacy Management (DOE LM), Nuclear Regulatory Commission (NRC), and New Mexico Environment Department (NMED); and, one of the four mill sites in the basin is already on the EPA National Priorities List. The other reason is Homestake Mining Company, one of the PRPs responsible for a tailings pile, is in the process of remediation; therefore, they are abiding by federal EPA NPL cleanup protocol. The basin-wide model does not bear the responsibility of calling out these point sources of groundwater contamination. The model accounts for the general dispersion of contamination from *mines*, not mills.

They did fly over the Jackpile-Paguate mine to take Lidar samples in order to better understand how contamination spread. The mine had not previously been subject to ASPECT or other fly-over sampling, with the exception of the airborne scintillator reconnaissance of the era of exploration of course. They noticed two "hot spots"; one around the mine and one by a

retention pond. The purpose of the fly-overs was to understand the impact to the whole area and check whether there were residents living nearby. At the Johnny M. mine, for example, they detected a hotspot and located residents. They assessed 900 residential structures and have taken removal actions on 130 structures. He gave the example of someone using a contaminated segment of pipe from the old mine to support a beam in the house. Part of the EPA messaging at the public meeting was to encourage residents who suspected radioactive materials had been incorporated into their house to contact the Grants Field Office & Ambrosia Lake Outreach Center, which is located at 825 Santa Fe Avenue in the old insurance agency office. It has a "For Sale" sign on the front door. There is a federal "on-scene coordinator" that is supposed to occupy the office during business hours, but he is often "in the field." They circulated his contact information, phone number and email.

7.1.3 Public Health Assessment (PHA)

A colleague from MASE inquired about the process for adding a public health assessment (PHA) for the site. "What's the trigger for the PHA in the San Mateo Creek Basin Superfund proposal? Will the whole basin become subject to the Agency for Toxic Substances and Disease Registry (ATSDR) process?" The coordinator responded that ATSDR does not gather their own data. They utilize the data from the "community interviews" conducted by EPA community involvement coordinator. Then they make an individual determination based on the data available in order to determine the risk. My colleague was concerned that the most recent five-year plan does not mention the *Human Health Risk Assessment, Homestake Mining Co. Site, Cibola County, New Mexico* by Dr. Ghassan Khoury (2013) from the Risk and Site Assessment Section EPA Region 6, which was left in "draft" form. "We have a pretty good idea of the

diseases associated with uranium mining," she said. In an interview, she pointed to a major gap in epidemiological and human health research and information in the district, and gave an explanation for how such a void of data could occur:

> There really haven't been any comprehensive health assessments done in the Grants mining district. So nobody can really truly say there will be no negative health impacts. There was a draft human health risk assessment done by EPA in the Grants mining district in 2013. It hasn't been finalized but there is a health risk—a greater health risk. And it mentions the greater risk that residents in the Grants mining district, especially around Homestake mill site, their exposures are much greater than the general population. So that was the only definitive study and it hasn't been quote, "finalized." I noticed that that's another technique that federal agencies use when they don't really want to come out with some negative information on the corporations. They tend to leave it in draft form. Whether it makes a difference or not, I still like to cite it, because it was the last scientific study that was done. It did come up with some findings (Anonymous, December 1, 2018).

I asked, "So what would you attribute that apparent lack of health studies to? Is there just not funding to do that?"

> It would've stopped the mining. From day one, it would've stopped the mining. And that's why we say… the federal government, there's documentation that's been uncovered that says from day one, they knew that there would be exposure to people that worked either in the nuclear weapons industry or even in the uranium mining industry. There would be additional radiological exposures. But people say, the workers themselves say they were never actually cautioned or told. Yeah, I believed it would've stopped, and even if they did it now it would've stopped this second wave that some people want to see. It will stop. Just like fracking with oil and gas, communities that live where fracking takes place are now saying they've had health effects; they have groundwater contamination; they do not want to see fracking in their communities. Well the same things have happened, uranium mining and nuclear weapons testing, you name everything within the nuclear fuel-chain. So that's why I believe that industry is making sure that we never get the comprehensive health studies we're requesting (Anonymous, December 1, 2018).

I documented her enunciation for comprehensive public health assessment at the EPA public meeting in October 2018 in my fieldnotes:

> We need a RECA [Radiation Exposure Compensation Act] type program for the people who have lived with the legacy of uranium mining. Three out of five family members are now dead; their children played in tailings ponds. You need to administer something along the same lines as RECA for these residents. The coordinator replied that it would

be up to Congress as to who could do that, submit a piece of EPA legislation (October 18th 2018).

7.1.4 Sole Source Aquifer (SSA)

A colleague from Laguna-Acoma Coalition for a Safe Environment (LACSE) reiterated the importance of the sole source aquifer (SSA) designation. She followed up on a request she made a few years ago to include sampling from wells in the San Andres-Glorieta (SAG) groundwater aquifer in the five-year plan, which is omitted in a number of studies that focus on the alluvial aquifer. She raised this concern at almost every public meeting I attended: "Why aren't you monitoring the San Andres-Glorieta? You need to be looking at the SAG." During the Phase II meeting with MASE and colleagues, she petitioned the Grants Mining District coordinator about the possibility of designating the SAG as a "sole source aquifer" (SSA) under the authorization of the Safe Drinking Water Act of 1974. SSA is defined by the EPA as an aquifer that "supplies at least 50 percent of the drinking water for its service area" and "there are no reasonably available alternative drinking water sources should the aquifer become contaminated."[86] The coordinator responded that there is a guidance docket online about how a community can request that. He circulated the contact info of his colleague in the Sole Source Aquifer Program Area in the Safe Drinking Water Branch and the director of Water Division. So far, MASE has been unsuccessful at acquiring SSA designation for the SAG, which would entail demarcating the recharge areas for a groundwater aquifer that has many different points of recharge throughout the state of New Mexico. This would take a tremendous amount of work across communities at

[86] https://www.epa.gov/dwssa/overview-drinking-water-sole-source-aquifer-program#What_Is_SSA; accessed February 20, 2019.

recharge points throughout the state, not to mention regional hydrological expertise to delineate the water body.

7.2 The Crossroads

The "San Mateo Creek Basin" emerged as a site of inquiry in NMED's preliminary assessment report entitled, *San Mateo Creek Legacy Uranium Sites* (March 2008). The two-phase basin-wide study was authorized by CERCLA to establish a "Hazard Ranking System" and "Superfund Chemical Data Matrix" for the site, in addition to determining whether threats exist to human health and the environment. They were responding to public concerns about the widespread impact of legacy uranium mines and mills and the degradation of groundwater quality throughout the basin. They also noticed that "groundwater in the alluvial aquifer upgradient of the Homestake Mining Company Mill Superfund site was found to contain uranium and other contaminants at concentrations above federal and state drinking water standards" (EPA 2015:9). From 2009 to 2012, under Cooperative Agreement with the EPA, NMED conducted Phase I and Phase II of the site inspection (SI) and groundwater investigation in the San Mateo Creek Basin. In their results they found "elevated concentrations of constituents in 31 of the 32 wells sampled with respect to health-based or aesthetic (color, odor, or taste) drinking water standards. The one well with water quality that did not exceed drinking water standards is not located in an area that was mined or where milling operations were located. All well owners were notified by letter of the analytical results" (2015:9). Though they found contamination in private wells, they said it had not affected municipal sources, but the EPA feared such sources could be impacted in the future.

In 2013, EPA initiated a multi-phase groundwater investigation as part of an "extended site inspection" (ESI), with the help of NMED and the U.S. Geological Survey (USGS). Building on NMED's Phase I and Phase II SIs, they aim to characterize "the nature and extent of contamination in the alluvial aquifer."

> Most importantly, the investigation was crafted to determine background water quality in the alluvial aquifer in the basin, i.e., groundwater that has not been impacted by legacy mining and milling activities. Therefore, beginning in the fall of 2014 and continuing into early 2015, a field team conducted seismic surveys and drilled numerous boreholes. Despite an extensive amount of drilling, background alluvial groundwater was not found within the San Mateo Creek Basin. However, five boreholes were completed as monitoring wells in an attempt to address data gaps within the basin. A total of 20 groundwater samples were collected from the new monitoring wells, and from municipal supplies and private wells for analysis. An interim report summarizing the groundwater quality will be completed and shared in the spring of 2016 documenting the results (2015:9).

The most recent five-year plan (2015-2020) lists two primary goals: first, "to build a conceptual site model by 2018 that can be used as a tool to understand impacts of legacy uranium mining and milling on the surface and groundwater systems in the San Mateo Creek Basin and to identify the current and potential future risks to human health"; and second, "Communicate with and provide information to residents regarding groundwater quality especially from private wells with detected uranium and other constituents at concentrations that exceed federal and state drinking water standards. Information about the risks and potential mitigation practices will be provided." They also note the potential challenge of "natural contamination."

> Since the San Mateo Creek Basin contains uranium-bearing rock formations from which groundwater is accessed by private water wells, it is challenging to determine if groundwater containing constituents that exceed federal and state water quality standards are due to natural conditions and/or has been impacted by legacy mining and milling operations. Additional analyses will be performed on groundwater samples to attempt to forensically distinguish mining and milling impacts from natural conditions (2015:10).

At the October 18th 2018 community meetings, the U.S. EPA Region 6 debuted the conceptual site model they promised, which had been a decade in the making. They gave an

overview of the *Phase II Ground Water Investigation Report for the San Mateo Creek Basin Legacy Uranium Mines Site, Cibola and McKinley Counties, New Mexico* (2018). It is worth citing the EPA's statement of the problem from an appendix describing the history and detailed activities of the previous five-year plans, because this story has remained at the center of their environmental studies and groundwater investigations: "The discharge of an estimated 80 billion gallons of mine water from these wet mines re-saturated the alluvial sediments in the basin on a massive scale, with water levels being raised over 50 feet in some places of the basin. This *massive slug of mine water* has been draining out of the basin alluvium and recharging the underlying bedrock aquifers that sub crop against the alluvium for over 50 years" (2015:A-1; emphasis added).

They also grappled with the problem of "background" or "baseline." The project manager began his presentation of the conceptual site model by describing how they are continually upgrading equipment. In some cases, these upgrades produce data that are apples and oranges. They are too different to compare. There can be unreliable connections between historical and contemporary data as science and technology change over time. The quality of a monitoring well can also change over time. But their work aims to mitigate these issues. They've done surface sampling in neighborhoods. They just did a Lidar fly-over of the United Nuclear Corporation (UNC) site in Church Rock. When they identified hotspots during fly-overs, they would go back and do "snail trails" with a buggy and camera scan. According to the project manager, "Background is the problem." Their focus on hydrological, water quality, and geochemistry analysis is part of an ongoing process to establish "background." I wrote down the following statement in my fieldnotes:

> Phillips, Rio Algom, Bluewater and Homestake—we don't study those mills, but we do provide a summary. Our focus is on mine discharge liquid and geochemical lines of

> evidence. In our study, we can "finger print mine water discharge." We call it "forensic fingerprinting." We tried to use background. We punched boreholes all over the place but couldn't find water. Someone from the audience asked whether they had drilled at the confluence of the San Mateo Creek and Arroyo del Puerto. He responded that that's the only place they found water. The dry borehole drillings were located north of the confluence, upgradient. We drilled a number of monitoring wells; we used historical data, and private and livestock wells, and industry monitoring wells. There is a world of data points. The historical data plays an important role too, but there's no data from the 1950s before the discharge. Their earliest historical data are from the 1960s (October 18th 2018).

A colleague from the Bluewater Valley Downstream Alliance (BVDA) asked the project manager to point his laser pointer at the "Sand Curve," near "the Crossroads," which he used to distinguish the "upper basin" from the "lower basin." On the map, the different colors correspond with the location of groundwater plumes of uranium and selenium and the different aquifers with which they are associated. The project manager used his laser pointer to outline the "y" shape confluence of San Mateo Creek and Arroyo del Puerto. Two state highways come to a junction, tracing the "y" shape creek beds. This is referred to as "the Crossroads," which can be misleading. It is not an "x" on the map; it is a "y". It refers to the junction of two New Mexico State Roads north of Interstate 40 (I-40) where one road terminates. It does not cross through. The 36.5-mile-long state highway 509 has a northern terminus at Navajo Route 9 and a southern terminus at state highway 605. Highway 605 extends 22.2 miles, from Route 66 at the Village of Milan to where the state road maintenance ends at the Village of San Mateo. It forms a "y" shape north of Grants where one leg goes east toward Mt. Taylor and the Mt. Taylor uranium mine and the other goes northwest toward Ambrosia Lake and the Ambrosia Lake uranium mines.

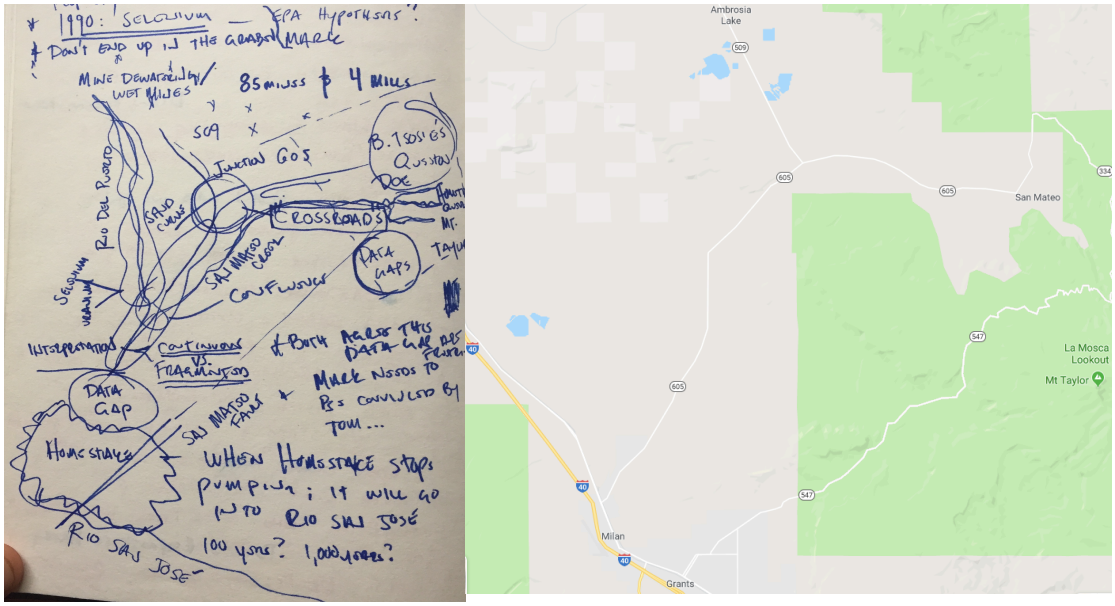

Figure 11. The "y" on the map. The author's fieldnotes (left); Google Maps (right).

The Crossroads intersect with the "Sand Curve" of the San Mateo Creek north of its confluence with Arroyo del Puerto. In the upper basin, at the Crossroads where the "y" splits, the Village of San Mateo is in the east San Mateo Creek floodplain. Throughout the basin there has been a major "hydraulic impact." And there's been a "dramatic hydraulic response" to this massive slug of mine water in the alluvial and Dakota sandstone aquifers. According to the project manager, their study investigates the major ion chemistry. "Certain waters have a signature." They looked at water types in the discharge area and could determine what looked like mine water. In 1958 wet mines start discharging in the upper basin and that is what their data suggests. By measuring the "vertical saturation thickness," they can tell when the increased saturation from mine-water discharge began and ended. There is a livestock well from the 1950s at the Crossroads, but they don't have many wells that are good for sampling, and less that have any water in them. What they know is that the alluvium has saturation.

My colleague from the BVDA took the pointer to show him, "There may be a data gap, but there are wells here." Mark Purcell, the project manager, responded, "There are data gaps.

This is a limited study that's really based on a scattering of private wells and monitoring wells." He noted that they don't have access to certain Homestake wells for example, again they don't really want to look at Homestake. At this point, colleagues from MASE became weary of the EPA's tendency to say the tailings piles were not a part of the discussion, when they themselves would go on to reference the impacts of tailings piles. Purcell continued, "We put in dry holes and dry borings. There were pockets of residual saturation that were dry with over 50 vertical feet of saturation. He then pointed out the "hydraulic connection" of the alluvium in San Mateo Creek. At Rio Algom they have 30 to 35 wells and only two have water. In the early 1980s, the state of New Mexico began to regulate mine water discharge. Most mine water discharge in the basin stops in the early eighties. "We put in 10 to 15 borings to find water and we couldn't. It's draining down into bedrock formations." In 1976 and 1977, there would've been a massive slug of mine water discharge sitting in the Crossroads; but now it's moved and drained down into some of the bedrock and through the basin all the way down to Homestake.

The San Mateo fault cuts through the Crossroads area, runs almost parallel to highway 605, and rests under the Homestake tailings pile. The mine water has made quite an impact on this faulted area. The project supervisor suggested that there is also a second fault line parallel to the San Mateo fault, and that there is a "graben" dropping down between the two faults that is partly the result of geophysical processes, but also the result of a *hydraulic impact* on the bedrock. He acknowledged this as a significant finding. A colleague from MASE asked what he meant by the term "graben." He explained the geophysical term as a displaced mass of land forced downward between to faults. And the geophysical groundwater structure is not porous; it is not going to behave like a pore flow aquifer system. It is a "fracture flow aquifer," though it is scarcely recognized in such stark terms. He reminded us that Phase II of the groundwater

investigation does not answer the question of whether the impact is "natural" or the result of mining discharge coming down or tailings piles.

At well DW 30 they were registering selenium at over 700 parts per billion. Note that the EPA MCL for selenium is 50 parts per billion (or .05 milligrams per liter). The state (NMED) put that well in. "The infamous well at Homestake," well DD, is ten-times to a hundred-times higher. Homestake has a different interpretation about whether the massive slug of mine water has arrived at their site. They do not acknowledge a connection between the mine water impact and their site. They also have a different interpretation about the number faults and the faulted graben model. Homestake has provided geochemical evidence in their white paper (Ulrich, Gillow, and Byer 2018) that suggests that the tailings pile has not impacted the area upgradient, north of the pile. Whereas the project manager noticed continuity between the mine water drainage in San Mateo Creek Basin and the Homestake mill tailings site downgradient, at the bottom of the basin, before the water drains into the Rio San José. He explained that the difference between his interpretation and Homestake's remained in an unresolved "data gap."

Seven hundred parts per billion. He asked, "where did this high pocket of selenium concentration come from?" By 1990, the mine water discharge on the surface begins recharging the groundwater below; that's the selenium increase. Purcell offered a gloss of their application of ion chemistry. They can determine water type and compare mine discharge water types. In this case, marked by selenium, uranium, total dissolved solids (TDS), and sulfur isotope ratio, which are particularly good "fingerprint sources." They then use a "trilinear diagram" of cation and anion ratios. "This tells you what the water type is." In Ambrosia Lake west and east of the Crossroads, they identified Ambrosia Lake mine water. They took their samples and plotted

them on the diamond (the trilinear diagram) and they do match. “They match the mine water samples exactly in wells all the way down to Homestake.”

They do not draw a line saying “impact” or “not impact.” Each individual line of evidence is not conclusive in itself. *But together…* Sulfate in groundwater from pyrite occurring in the mines can be estimated with a sulfur isotope ratio, which gives a unique fingerprint for uranium ore. Westwater Canyon Member pyrite oxidized and moved through the canyon as sulfur. The sulfur isotope in the sample matches the pyrite. The problem is not being able to account for key wells that would suggest whether Homestake has influenced a “mound” of water to push north, upgradient from the tailings pile. These are difficulties within the faulted graben. This was the outstanding “data gap.” Mark Purcell was referring to an alternative conceptual flow model that can only be proven by addressing the roughly one-square-mile “data gap” in which a groundwater mound under the Homestake tailings pile is hypothesized to have “reversed the gradient and caused [uranium] advection to the northeast” (Myers 2015). The Myers hypothesis highlights the hydraulic impact from the Homestake tailings pile and suggests that the groundwater plume from the pile has reversed the flow of water to the northeast of the pile. Purcell nodded to the hypothesis and its role in making the faulted graben; but again, none of these lines of evidence alone are conclusive. He concluded, “We both agree the data gaps are frustrating.”

For 20 to 25 years, mine water has been running down Arroyo del Puerto down into Westwater Canyon. The alluvial aquifer is *likely* impacted by mine drainage water (MDW) in both the upper and lower basin. The Dakota and Morrison formations are *likely* impacted at the Crossroads area. All this water is sitting north of the Homestake site and will move south. Maybe in a hundred years or a thousand years, *it will move south*, into the Rio San José and down. At

the Homestake site there are at least two faults, and there could be more. In addition to the faulting, it's fractured and busted up. There is an "anticlinal fold" and there are large "data gaps." He noted that the USGS is just guessing about the second fault. The tilt of strata is changing. In terms of structural geology, he described the "syncline" of the landscape as an asymmetrical bowl. "How fast that water moves through the media underground we don't know."

A colleague from MASE asked if that information is in the current five-year plan. The project manager responded promptly: Section 3, Part A, "The Evolution of Mine Water" goes into the underground workings, not just ore-bearing but other formations. They dewatered the Westwater Canyon Member to mine, but the Dakota formation has also drained. Going into underground workings, when old stopes, the voids left from removing the ore deposits, are flooded they can recover uranium from the water. They spray the walls with a coding that leaches before more water is released into underground workings; it oxidizes, and they pump it up. According to the EPA "national pollutant discharge elimination system" (NPDES), they now have to acquire a federal permit and treat the water. At the Roca Honda uranium mine, they are asking what to do with the water after treatment: "sell it or pipe it back in?"

"What is the background from all the aquifers?" someone from MASE inquired. "You can't use San Mateo, you can't use the village of Milan. Can you find background waters near Homestake? What do you clean it up to if it's above drinking water standards? Where do we find background? You shouldn't test wells that industry has impacted." Industry wells would not be a good indicator of background prior to impact from mining. He responded, "I don't like their wells either." There will be two technical papers published in journals by the USGS, which will be used by the EPA to help determine background. "We value Tom Myers and Ann Maest," he

said, MASE and BVDA's independent expert consultants. "The DD well, that's not a good well. We looked for a fingerprint of mine water from the north. At the Homestake NPL, we don't know what was natural coming in to their site. I'm not convinced by Dr. Meyers." The BVDA enunciated, "We don't care much about the alluvial aquifer. We care most about the Chinle aquifer. Get background from there." She frequently reminded federal employees that nobody in the area drilled into the alluvial aquifer for drinking water; it has always been considered foul water. They would go into the aquifers below: the upper, middle, and lower Chinle. The project manager responded, "there were a couple wells I didn't like. We need to do that." She advised him to look at that line between "Sand Curve" and that they need a well at the foot of the north-side of the tailings. "More data are needed. Are we going to get that?" "Yeah," he said, "we would like to see more. There are key locations where a well or two would really help. We can't find a fingerprint there. They are mucked up from Homestake pumping."

After the EPA's first presentation of Phase II, I went to a late lunch with two of my colleagues from MASE at the Chinese buffet down the way on Santa Fe Avenue. We were talking about the geological term graben. They'd never heard that term before, one of whom has extensive hydrological experience and expertise in the region. I recalled that a portion of Albuquerque, between the Rio Grande Rift and the Sandia Mountains is considered a graben. I voiced a theoretical concern out loud about how geology can be used as a metaphor for organizing a historical text, or how it can be thought of as more than a metaphor, considering the environmental and social determinisms of the uranium orebody itself as a historical agent. One of my colleagues responded, "Don't end up in the graben." We laughed.

By the second meeting with the broader community, on the evening of October 18th 2018, the EPA coordinator, Kevin Shade, and project manager, Mark Purcell, were noticeably tired

from the previous meeting with MASE. They were less diligent about spelling out their acronyms and defining their key terms of operation. A colleague from MASE asked them to explain to the audience what they meant by "NPL" for example. Soon after, someone from the audience interrupted and said, "Normal people don't have a clue of what you're talking about. We don't have a clue of what he's talking about." At this point, they slowed down their presentation and tried to speak broadly and more clearly. This proved difficult because the EPA was also trying to reveal several significant findings of their research to scientists and community liaisons from DOE, NRC, NMED, and Homestake (Barrick Gold Corporation), who were also present. I wrote the Grants Mining District coordinator's statement in my fieldnotes:

> Rio San José Drainage Basin is the larger basin that San Mateo Creek drains into. A lot of the mines in the area are wet mines, in the Crossroads area near 605 and 509. At this site, we can address 85 mines and four former mills. We picked this area because there are a lot of mines. Discharge occurred from 1958-1970s into Arroyo del Puerto and other arroyos and drainages. There is a historic aerial photograph that shows surface water. They turned an ephemeral arroyo into a perennial creek. Arroyo del Puerto confluences with San Mateo Creek. At the Sand Curve, people who grew up in the area remember seeing water there (October 18, 2018).

Figure 12. "CROSSROADS AREA". Photograph by the author.

Shade and Purcell gave a recap of the Superfund study, and then slipped into a dense discussion about major ions and plotting the percentages of positive cations and negative anions of sodium, calcium, magnesium, potassium, bicarbonate, nitrate, and chloride on trilinear diagrams to determine types of water.

> Phase I began in 2016, but scoping began in 2012. Part A presents "the meat of the report" and reports on all four mills. The "groundwater corrective actions" taken by Homestake are an interesting read. There is a Homestake NPL at the bottom of the drainage. In 1977 Homestake began injecting water through and around the tailings pile to "manipulate the groundwater flow regimes." When we noticed alluvial saturation in the drainage we put in new wells for geochemical analysis: three in the Village of San Mateo to get background, and at Junction 605 and 509, the Crossroads. There are very few wells at the tributary drainage below the Crossroads. Our wells include private domestic wells, private livestock wells, industry monitoring wells, state monitoring wells, EPA monitoring and borings, and DOE monitoring wells. The data were pulled into a USGS study that got us right to the north doorstep of Homestake (October 18th 2018).

After describing the four threads of geochemical evidence—uranium, selenium, total dissolved solids (TDS), and sulfur isotope ratio—he iterated that it is not one line of evidence but taken together we can make suggestions.

Now he faced an assault of questions, not from the community members, some of whom genuinely did not know what he was talking about, but from DOE and Homestake scientists: "On your map, how many of those were data points from 1960s? What number of wells?" Purcell responded that they shot seismic on drainage and put mostly dry boreholes in. He estimated about three wells. A DOE scientist followed up: "What wells were actually there?" In 1968, Purcell said, the New Mexico Department of Health put a well in, the citation is Chavez. Again from the DOE, "Looking at San Mateo, how is saturation occurring?" The DOE question was to what extent they are investigating San Mateo Creek near the Mt. Taylor Uranium Mine. Indeed, the northeastern part of the map near the upper San Mateo Creek in the foothills of Mt. Taylor is also peppered with data gaps. In fact, the only reason they drilled in this eastern part of the upper

basin was to establish background in wells at the Village of San Mateo. This question from the DOE made clear that EPA's main line of culpability was being drawn to the northwest, up Arroyo del Puerto, to the wet mines at Ambrosia Lake. That is where they believe the pocket of high selenium is coming from. They have very little to say about the upper San Mateo Creek north of the Crossroads where the Mt. Taylor Uranium Mine is located, most likely because the Mt. Taylor Uranium Mine is known to have discharged water by pipe to the other side of the mountain into the Rio Puerco.

To the part of the question about how saturation is occurring, he replied, it is clear that billions of gallons of water have drained through this system. A consultant fires a follow-up question: "There weren't data points. Where did you get that information to lead to your conclusion on saturation?" Purcell responds: "We had a hard time getting access near San Mateo. There are big tracks of land we don't have access to. We put in about 10 to 12 boreholes along Arroyo del Puerto. These were dry bores. And we put wells along the creek. There was a quick response in saturation level of the alluvium. We can tell from water levels from 1957 that there was a dramatic water-level change in the Dakota formation from 1957 to 1977-1978. There was a 50-foot rise in water levels attributable to mine water discharge."

Another question was posed, "Which faults are supported by USGS?" He said, "We are interpreting the second fault that sets up the graben. A steep, synclinal fault." "What are your concentration intervals for uranium?" He shows how the levels of uranium over 700 parts per billion are represented in the darker red on the map, which reaches down the basin to the "front door of Homestake." But here, at this point, "It's a big data gap. It's been a data gap for a long time. It's very frustrating." There is the interpretation that says the uranium plume doesn't connect with Homestake. I wrote in my notes: *two interpretations: continuous v. fragmented.* I

elaborate on these two contrasting thought styles in terms of ontological and epistemological "association" and "dissociation" in Chapter 9. "We won't make that interpretation either," Purcell said. Though they stated the promise of tracing multiple geochemical lines of evidence together, the EPA does not draw the line of "impact." After refining our understanding of contamination in the basin, they re-mystified the problem by saying: "It could be natural."

At well R, they had a high reading of selenium. They asked, "Where is the selenium coming from?" Shade and Purcell weren't quite sure but they had an idea. "Why does selenium go up at well R in 1990?" They plotted the number of ellipticals that fan out and can be suggestive of impact around the different lines of geochemical evidence. The project manager underscored the other significant finding: mine discharge water (MDW) remains a major threat. When Homestake turns off its pumps, it will go down into Rio San José Basin—a hundred years, a thousand years? I found this statement striking. It took a moment for it to settle. I wrote in the theoretical margins of my fieldnotes: *Talk about a gift-poison pharmakon: remedy and poison. Homestake pumping at the bottom of the basin is the only thing stopping the growing uranium and selenium plumes from releasing into Rio San José. Of course, the Homestake mill plume is a darker shade of red on the map.*

A colleague from MASE asked, "Where do we not see areas of impact?" Purcell replied, "We have no signature of mine water discharge in the alluvium of the lower basin, we don't see it." He indicated that it would have seeped through the alluvium before it entered the lower basin. In 1967, the USGS discovered a fault. "We know very little about that fault."

The person from the audience who voiced his concern earlier in the meeting about the legibility of the presentation interrupted. He said, he didn't like how they were "imposing this super site on us, cramming it down our throats." A colleague from BVDA said not everyone

thinks the Superfund is an imposition. “If it does become a super site how much will it devalue our property.” Someone said, “we’ll tell you at Bluewater.” A geochemist who consulted the EPA on the Phase II groundwater model spoke up. His name was Earle Dixon. He had 10 years of experience working on the site. He asked whether the Superfund chlorinated solvent plume in downtown Grants had impacted property values. He then raised concerns about the presentation of the lines of geochemical evidence. “It’s hard to agree with these slides. You’re trying to qualify this stuff about major ions and the uniqueness of sulfur isotopes, but based on the presentation, it’s hard to agree.” The project manager said he left the slides that go into geochemical detail out of the presentation. He flipped through to find the geochemistry slides. Dixon said the sulfur isotope is the most persuasive line of evidence. “I’m intrigued but wanted to see more geochemistry.”

7.3 Conclusion

In this chapter, I began my account of the politics of baselining through an ethnographic portrayal of the public meetings in which the EPA unveiled their San Mateo Creek Basin Superfund proposal. By describing the EPA’s explanatory model of the basin, with the Crossroads at the center, and how it took course at public meetings, we can understand the explanations that are working for environmental cleanup, and what explanatory forces work against the cleanup. How do such discursive formations emerge and where do they collide? The emic concept of “the Crossroads” revealed a “y”-shaped basin in which “wet mines” and their by-products seeped through soils and sediments, and drained through historic exploratory boreholes and mine workings, into every level of the regional groundwater aquifer system. This “massive slug of mine water,” a uranium and selenium plume, is making its way downgradient to

the Homestake mill tailings site, or perhaps it is already there, and beyond, down the Rio San José Basin. Because there is a roughly one-square-mile "data gap" upgradient of the site, north of Hometake's large tailings pile, it is not yet possible to determine the leading edge of the plume. EPA and Homestake disagree about whether the plume is continuous with or fragmented from the Homestake site. This "very frustrating data gap" prevents the EPA from confirming their hypothesis about the "faulted graben"—the fractured environment underground where the intersecting plumes of the mine water and the Homestake tailings piles confluence and drain into deeper parts of the aquifer system. The faulted graben model was derived from a 1967 USGS discovery of a second geological fault at the site. The "data gap" also leaves the science funded by MASE and BVDA inconclusive. The EPA would not take a position on whether the faulted graben is "natural" or "man-made." Only Dr. Myers' hypothesis infers that Homestake reversed the groundwater flow north of the large tailings pile through hydraulic fracturing—a point of contention that remains unresolved due to the data gap.

At another scale of analysis, this situation illustrates two different standpoints of epistemological association and disassociation. According to the corporate science of Homestake (Barrick Gold Corporation), the site is bounded and discrete from the fracture flow environment in which it is situated, and the groundwater flow regimes are under control. On the other hand, the EPA officially notices the connections made by historic exploratory boreholes and the abundant ways by which water makes its way through sandstone and limestone that has been blasted and busted up by the mining industry, and possibly the hydraulic impacts of Homestake's groundwater remediation system; but, again, the EPA does not say whether the fracture event was anthropogenic or "natural."

CHAPTER 8

THE POLITICS OF BASELINING IN THE GRANTS MINING DISTRICT PART II

Despite over a decade of Superfund research that lays out multiple lines of geochemical evidence of the impacts of mining, the EPA's decision about what background level of contamination will be accepted for the site has been reduced to an October 2016 "split-sample event." It was referred to as a "snapshot" and "split-sample" event because, at that moment, the U.S. Geological Survey (USGS) was contracted by EPA Region 6 and the consultant Arcadis was contracted by Homestake (Barrick Gold Corporation) to cross-examine a single point of analysis, a one-time groundwater sample. This is the moment that underlies the EPA's baseline determination for the site.

"Baseline" refers to environmental data that infer the "natural" levels of uranium, for example, at a particular site prior to the impacts from mining. My colleagues use the term "background" to mean the same thing. They must *infer* at sites where scarce environmental data exist prior to mining. In the process of determining baseline, the EPA can amend the "maximum contaminant levels" (MCLs) and set "alternative contamination limits" (ACLs), based on what they determine to be the "naturally" occurring levels of uranium prior to mining. This is part of *the politics of baselining*, in which mining corporations seek to limit their environmental liabilities by drawing a baseline that allows for a higher level of contamination in the environment, thereby limiting the extent to which they are obligated to cleanup. Whereas local communities work together to limit their exposure to environmental risks and hazards by advocating for lower levels of contamination that register under MCLs.

In this chapter, I examine how the politics of baselining are negotiated through the diametrically opposed forces of "civic science" and "corporate science." Stuart Kirsch's term

"corporate science" accounts for the ways corporations use science to defer criticism (2014:12). Kirsch encourages us to study "corporations by examining how they produce and manipulate science in order to influence their critics and avoid regulation" (12). The term "civic science" on the other hand, refers to "how science can be fashioned to serve the public good" (Fortun and Fortun 2007:44). Kim Fortun and Mike Fortun elaborate on their term and describe how the "civicness" refers to their interlocutors' "ability to create an applied science that undergirded regulations protecting public health through the scientific definition of environmental and biological risk" (Fortun and Fortun 2007:45).

In the Grants Mining District, the October 2016 split-sample event resulted in a publication by the USGS and a white paper by Arcadis and Homestake, which introduce different groundwater models for the site and different understandings of the proliferation of contamination. These are models that understate the impacts of large tailings piles on groundwater and describe "natural" processes by which uranium was deposited in the alluvium. The split-sample event was prompted by a discovery one year prior, when the Multicultural Alliance for a Safe Environment (MASE) funded a study on behalf of their core group, Bluewater Valley Downstream Alliance (BVDA), entitled *Conceptual Flow and Transport Model Uranium Plume near the Homestake Millsite Milan, NM* (2015). Authored by the hydrogeologist Tom Myers, it serves as an alternative groundwater model that raises questions about the conclusions drawn by the other models and foregrounds the impacts of uranium mill tailings on groundwater. By tracing lines of geochemical evidence through the same groundwater samples, each explanatory model imagines a different geological past prior to mining that can be deemed "natural," as the background against which to measure the anthropogenic impact of "man-made" piles of uranium tailings.

In May 2018, BVDA hired Dr. Myers and the aqueous geochemist Ann Maest to draft a memorandum that points out missing data in the USGS "groundwater fate and transport conceptual model." I close the chapter by describing a meeting in which Dr. Myers and Dr. Maest were invited by BVDA to call in from Reno, Nevada and Boulder, Colorado respectively, and vet the USGS and their publication at Senator Martin Heinrich's office in downtown Albuquerque. Through investigation of the politics of baselining and by examining these different groundwater models as they are leveraged in public meetings, I will portray the emergent forms of environmental health sciences and governance in the Grants Mining District.

8.1 MASE Face-to-Face

On October 20th 2018, following the meetings about the EPA's Phase II report, MASE held their quarter annual face-to-face meeting at the First United Methodist Church in Grants. At the beginning, a member of the BVDA reflected on conversations that ensued from the meetings: "The EPA wants us to align with them. They're going to be under tremendous pressure from industry." She reported on her conversation with the EPA project manager: "He wants our experts to beef up his report, and to hire them to do the geochemistry." This is an example of how extra-state, independent scientists hired by non-governmental agencies (NGOs) can supplement and drive the environmental sciences of federal and state government employees. However, she seemed more concerned that in addition to her state and federal taxpayer dollars that support the environmental cleanup regime, she had to hire the help of independent experts too. She then expressed her anxieties about the USGS publication and what it will purport as baseline: "We're going to lose the background on the alluvium, but the battle is over the Chinle aquifers. We have to have good background in the Chinles. If we lose the Chinles, we'll be

powerless. All that impact from the mining industry will become background." She said that she would like to allocate funds to support Dr. Myers and Dr. Maest to look into it. She told MASE and colleagues in a previous meeting that "we can't let USGS use their background against us. We can't let them use it against us. We want our specialists to review the USGS before they publish their results. The big issue now is with the EPA record of decision (ROD). They have never done a ROD on water at the site. They are going to reach a record of decision when EPA does their separate Superfund site. ROD has legal ramifications."[87] She was surprised that in all of their counter research on the Homestake NPL, they did not notice that the EPA failed to establish a ROD for water at their site. This raised the stakes for setting background and catalyzed further contestation of the USGS publication.

She closed her statement by referring to a documentary about Lois Gibbs. She told us how they kidnapped EPA employees at Love Canal. She asked me if I knew anything about Love Canal, presumably because I was enrolled in graduate studies in upstate New York and was studying issues pertaining to contamination and toxicity. I responded that it was the situation that brought about CERCLA. Someone asked me what the acronym "CERCLA" meant. I said it's basically a federally funded comprehensive environmental response to contaminated sites. A colleague looked it up on her iPhone. She spelled out C-E-R-C-L-A, Comprehensive Environmental Response, Compensation, and Liability Act. My colleagues from MASE often responded critically to the superfluous usage of acronyms. Indeed, the assault of acronyms one experiences at public stakeholder meetings hosted by state and federal agents can be overwhelming. During my apprenticeship with MASE in 2014, it took me over a month before I understood a common core of about 100 acronyms and the entities they could conceal if you did

[87] https://www.epa.gov/superfund/record-decision-rod-guidance; accessed April 9, 2019.

not live in the same world of acronyms as an EPA coordinator for example. The concealment of a noun by use of an obscure acronym fractures sentences and entire presentations. MASE had been responding to a track-record in which the acronyms leveraged by state and federal agents interfered in communications with "the public" and obscured critical pieces of environmental information. Our colleague from the BVDA finished her point and paraphrased Gibbs' slogan: "Let's make Superfund super again." She explained how the slogan is a response to eroding federal funding for Superfund, and calls for more attention to be given to it.

Another colleague revisited her sobering concern about making the SAG a sole source aquifer. I wrote down her statement in my fieldnotes:

> The EPA is realizing that they've cut off all the other sources. They should be setting a hydraulic barrier. It's coming from the north. Moving to the west of our site. Where are the hydraulic barriers for both those plumes. There are none at Bluewater. At Bluewater they're not looking at the SAG. Everybody's hoping there's an alternative source and there's not. Maybe we can ask the visiting geochemist to help us with the sole-source designation (October 20th 2018).

The geochemist Earle Dixon was expected to visit the MASE meeting—the same person who consulted the EPA on the San Mateo Creek Basin Superfund proposal, and the same person who raised concerns at the meeting about presenting a more convincing case for the threads of geochemical evidence. He arrived just before I updated MASE about my research. I circulated paper copies of the first draft of my first chapter of my dissertation and offered a brief overview. I had become accustomed to the shorthand expression of "the politics of environmental cleanup" as a succinct way of describing my research to others. When presenting this statement to people who had deep experience and expertise in what I was calling "cleanup"—what they would call "remediation," "reclamation," and/or "restoration"—they would often problematize, complicate, and refine the term. Aware of the limitations of what was sometimes used as an etic term, depending on who I was talking to, I appreciated the dialogue about terminology "cleanup" often

opened up, and how it hinged around the problem of *permission to pollute*. I took note of the visiting geochemist's response:

> "Cleanup" is an Anglo term in which everything is linear. Shoot for a value and put up a fence. It is not about how to bring the spiritual world into balance. It doesn't address fundamental questions about "can we heal the land." Questions about "healing the land" are different. It's never been done before. But I suppose it's possible with the right power of medicine men. The questions are about values, and where values object to be exploited. You can't live on a planet that's being destroyed. We're dealing with a massive contrast in value systems (fieldnotes, October 20th 2018).

He said people often ask the question, "Why was uranium mining focused on Native American lands?" The government needed large swaths of federal lands to explore for and mine uranium. The federalization of pueblo lands in New Mexico was part of the mid-twentieth-century federal expansion. Dixon alluded to the frontier discourse of the 1940s and 1950s: "Go out west." "They used Native lands and federal lands to do their dirty work." He said public health officials were threatened with their careers to prevent them from calling out the dirty work, similar to the way state and federal scientists are currently compromised by their jobs.

Dixon related his statement about the massive contrast in value systems to his research. He was fired from Bureau of Land Management (BLM) "for doing too good of science." Dixon also noted that the DOE recently eliminated its geochemist positions. He acknowledged that he is among about ten people who know the most about the Grants Mining District. Reflecting on the public meeting held by the EPA a few days earlier, he questioned the process of delivering information to the public. He expressed that a one-way dialogue on a Thursday evening does not suffice, no matter how much you water down the presentation. They need to go out and run workshops over the course of a couple weeks and teach the technical terms; don't simplify them. Indeed, this is why our colleague invited Dixon to run a workshop for MASE on the EPA Superfund proposal and their groundwater modeling. He was there to breakdown the way

geochemistry had been applied at the proposed Superfund site. Instead of a slideshow, there were white posters clipped on an easel, and a box of multiple color markers. He set up his laptop on the table in front of him and gazed into the screen. Then he stood up and addressed us (Figure 5).

Figure 13. "Poor man's plume chasing." The geochemistry workshop for MASE and colleagues. Photograph by the author.

8.2 "Poor Man's Plume Chasing"

He explained to us that when state environment departments set background in historically "mining-friendly states" like New Mexico, they neglected to account for water at the point of discharge and avoided water quality standards that would be "too stringent" and "could shut mining down." New Mexico's groundwater policies have clearly changed over time. Consider the policies that undergird the Ground Water Quality Bureau at NMED and establish their role "to protect the environmental quality of New Mexico's groundwater resources as mandated by the Water Quality Act and the New Mexico Ground and Surface Water Protection Regulations

(20.6 NMAC), and to identify, investigate, and clean-up contaminated sites which pose significant risks to human health and the environment."[88] The EPA is involved in monitoring discharge through the "national pollutant discharge elimination system" (NPDES), which is a "permit program" that addresses "water pollution by regulating point sources that discharge pollutants to waters of the United States."[89] Despite such changes in policy and the emergence of new forms of regulation such as permitting programs, the discharge of polluted waters remains a problem in northwestern New Mexico. Indeed, discharge permits have remained a significant point of contestation for MASE.

MASE and colleagues have referred to this emergent form of governance as "permit to pollute"—a prolific term that I have also heard outside of the MASE meetings. I once asked a colleague about how she would characterize the governance style of the state of New Mexico. She said everything under the current governor (Susana Martinez) is to be approved—"approve, approve, approve"—with regard to mining, as well as oil and gas development. She said she questions whether the state even has the capacity to decline permits to industry. The practice of *backgrounding* is an important part of permitting pollution. Backgrounding prevails as an enduring form of friendship between New Mexico and the mining industry. Backgrounding is part of the politics of baselining whereby the "natural" background levels of contamination are inferred by using contaminated samples that have been impacted by industry, thus conflating natural systems with industrial systems, both rhetorically and actually. The term implies a kind of figure-ground interplay where the object of study recedes out of clear view into the background. The figure, in this case, is culpable mine water and mill tailings drainage that has

[88] https://www.env.nm.gov/gwqb/; accessed April 4, 2019.
[89] https://www.epa.gov/npdes; accessed April 4, 2019.

actually been forced underground through faults, fractures, and fissures. A resident of Milan described Homestake's general strategy as "push it under the rug and hope these people will go away and die."

In the last decades of uranium mining in New Mexico, most of the mining companies moved from the ore to the stopes, allowing mines to flood but recovering uranium from mine water. This is a process known as "mine water recovery." Over the last few decades, mining companies in the United States have shifted to the related process of "in-situ leaching." The geochemist referred to it as the "poor man's way" to mine. He described *the poor man's way of in-situ mining* to demonstrate how mining has influenced groundwater and weaved together the geochemical threads of evidence that would underpin the EPA's San Mateo Creek Basin Superfund site. They drop the pH level by acidizing the groundwater. The pyrite in the ore starts to oxidize. Underground rust is exacerbated producing iron sulfide from sulfuric acid (H_2SO^4) blasting, which makes more surface area available for leaching. He used the term "efflorescence" to describe the salty white crust that forms on the rocks as they breakdown. They wash down into mine water leaving a lot of sulfate. Sulfur is the main culprit of total dissolved solids (TDS). The original or "native" water quality in the area near Grants had low levels of TDS. The TDS of the Morrison formation was low, less than 500 mg/L. "You could drink that water." It had TDS of 300 mg/L or lower in some places. "It hadn't been all jacked up by mining operations yet."

Even though there was no account of background prior to mining, there are some sophisticated forms of analysis that can be done to determine background. Dixon offered an account of his experience searching for background with the EPA. "You can't do background in the Morrison formation water. It has been impacted by mining and milling." They sought to determine background upstream. With the advice of a former mining engineer from Milan, they

determined that the spring monsoon water from Mt. Taylor would be good background. They tried to collect samples from the Village of San Mateo. It looked like the background was contaminated from the San Mateo Uranium Mine. They plotted things up to see what they look like. When the USGS was employed by EPA, "they didn't know what they were doing up there." This wasn't the first time I heard someone mention that the USGS sampling and analysis was aloof, ignorant of the particularities and idiosyncrasies of local geohydrology and geopolitics. Indeed, that is part of the USGS mission as a third-party reviewer.

Using the different colored markers, he mapped out the San Mateo Creek Basin in relation to Mount Taylor. He marked the mines that were once above the water table, which were "dry" prior to mining. And then he marked the "wet mines," which accounted for about one-third of all the mines. He drew a line through the creek that shows where the fault cuts through to Homestake and the "near field" background well by the tailings pile. They were getting poor lab results because the sulfate is an interference. It was an interference with reading uranium during the NMED studies in 2008 and 2009. Dixon began developing his analysis of the influence of sulfate and rendering that research in terms legible for his colleagues in state and federal agencies who were less well versed in geochemistry. "Isotopes are like DNA," he said. "They will tell you more about where the water is from and the history of these wet mines." He asked the federal and state cleanup regime, "Why not consider isotopes?" The EPA project manager Purcell was inferring the saturation in the alluvium, but he was not drawing the connections. He also had trouble getting permission to test near the Village of San Mateo because "most people don't trust the federal government out here."

Earle Dixon explained that the high levels of TDS found in the groundwater around Grants are not naturally occurring; it is man caused. TDS has increased due to the practice of

evaporation at the Homestake sites. He mentioned the "canons and sprayers" they use as part of the evaporation process. He then described the process of "wicking" at the Bluewater site. Both processes are discussed in detail in Chapter 5 and Chapter 6. The method of "evapotranspiration" by wicking has increased TDS in groundwater. However, apparently they were not comfortable enough with Earle's "science fiction." They are not geochemists after all. They could not get onboard with his "discussions and conclusions" section.

He elaborated on how the biggest culprit of TDS is sulfur. "The USGS couldn't figure it out. They don't want to be caught in the crosshairs." He noted that all of the state and federal scientists are compromised by their jobs. USGS did a more focused study on the balance of positive cations and negative anions for sodium (Na), magnesium (Mg), calcium (Ca), potassium (K); bicarbonate (HCO_3-), chloride (Cl-), and nitrate (NO_3-). Dixon posed the question, "Why is the chloride so high?" Thirty milligrams per liter is natural. It was much greater. He described the process by which barium chloride ($BaCl_2$) was added to get radium out of the water. In 1975, during the initiation of an EPA discharge program, "the Feds came in to *floc* the water." He described how flocculant ("floc") is used to clean "poo water." It is a "clarifying agent" that can suspend solids from liquid. In the Grants district, they used flocculant to lower the level of radium in the water. They were adding chloride as they treated.

Dixon summarized his initial geochemical findings: the groundwater samples have high TDS, high sulfate, and high chloride. He highlighted a key moment responsible for such unique characteristics of the groundwater. It was the moment the Feds enforced the treatment of water with barium chloride and came in to floc the water. "You can't prove it statistically, but I'll hang my hat on that." The water is trying to remain electrically neutral. We couldn't do a pH test because it buffered too quickly. Mine water discharge impacted "native" groundwaters, in

addition to the impact from the flocculent. Sulfate and chloride are really good indicators of this process. A colleague from BVDA raised the concern I reported above: "Our wells were never in the alluvial. We're interested in the Chinle." The Chinle aquifer is a depositional environment where evaporation salts (sodium chloride; NaCl) occur. Salt water is natural in the environment from the evaporation of water. The Chinle above Homestake is not impacted by this. He said the Chinle is "pretty tight"—meaning impermeable. He traced a 50-year history of TDS, sulfate, and chloride in the groundwater through historic and contemporary samples. Through these lines of evidence, he extrapolates, they can distinguish between the geochemical histories of a coal burning power plant in the area and the discharge of the Johnny M. mine, for example.

"We use major ions" and determine the "water type." Water coming out of the mine is high in sodium, carbonate, calcium, sulfate. He noticed these culprits in a 2011 sample of San Mateo springs. "We see different water types at different locations. We see a different chemical history." He accounted for "mixing and mixed ion water." Wells in the Morrison Formation were high in sulfur. At Section 35 mine we see calcium, sodium, and sulfate from the pyrite. High TDS with lots of sulfate from the oxidized pyrite that had been exposed to the atmosphere through mining activities. Anyone from Grants could identify the familiar image of "efflorescent crust," the white crust on the rocks in a mine ditch. When they pump water from the wet mines, they would retain the water and circulate it through six separate million-gallon ponds where it would sit with the flocculent before being discharged into Arroyo del Puerto. The USGS did not support those findings because "it wasn't quantitative enough." Sitting in the creek you can see the efflorescent crust, which is a clear indication that the culpable water had been evaporated. For the USGS, "the slopes of the lines didn't quite line up." "Those trilinear diagrams are innocuous." USGS is careful not to produce science that would hinder their work with the

industries that support them. He cited a USGS report that articulates the fear of the looming threat of cuts in funding. The limitations of the USGS's research trajectory in the San Mateo Creek Basin served as the background against which the geochemist would present his style of thinking and course of questioning.

"Poor man's plume chasing" is the name Dixon gave his paradigm of geochemical inquiry and intervention. He called it "forensic geochemical investigation." It is a "fingerprint" you can run through a chemical database. It is a way to determine "natural" water from the mixed waters of mining without drilling more expensive boreholes. He referred to the work of M. L. Jensen entitled "Sulfur Isotopes and Biogenic Origin of Uraniferous Deposits of the Grants and Laguna Districts." It was published in *Memoir 15: Geology and Technology of the Grants Uranium Region* (1963). He characterized the memoir as a "celebration of uranium mining." What did Jensen do? In the 1950s and 1960s, he developed a method of exploration for uranium by discovering its association with a ubiquity of pyrite (FeS_2) iron sulfide. The sulfur in that pyrite is unique. They identified "light sulfur" with two of four stable sulfur isotopes (^{32}S and ^{34}S) of the twenty-four total known isotopes of sulfur. Jensen sampled ore. Most of the ore was "light" in sulfur. Looking at Jensen's report and our samples, they selected the "light sulfur" as a tracer that is ubiquitous in the uranium ore body and quite different from other sources of sulfur. At the Village of San Mateo and in the west facing slopes of Mt. Taylor, for example, there is high sulfur, but it has a "heavy" signature. He attributed the heavy sulfur to the oil refinery near Gallup and the prevailing southeast winds that would bring its emissions toward Mt. Taylor. "Jensen wrote a paper in 1963 that was used to explore for uranium. We're using that same concept to fingerprint the water."

The geochemist elaborated on Jensen's stories of ore genesis.[90] It was a sulfur of biogenic origin that could be associated with the ash fallout of the Jurassic arc of plutons. Light sulfur is linked with sulfate in the water during the Jurassic period when sulfur in the atmosphere was light. In 1958, this information was classified, as was the discussion about where the light sulfur came from. Pyrite (FeS_2) iron sulfide would have been trying to escape as gas. It was light and trying to get into the atmosphere but was trapped in the uranium ore bodies. These "reservoirs of light sulfur gas" are part of the "geochemical evolution" of the groundwater in relation to the sandstone uranium ore of the Grants mineral belt. Pyrite (FeS_2) with light sulfur is different than what is found in other mines. At the copper mines in Nevada, where they made their own acid on site, the sulfur melts forming sulfuric acid, which is a heavy sulfur.

As he finished up the workshop, MASE sought Dixon's advice about designating the San Andres-Glorieta a sole source aquifer. He responded that he believed that it was used for water across the state. He said he would be happy to help, but also encouraged them to ask the EPA Grants Mining District coordinator about what you will get out of a sole source designation. He considered the possibilities. If you put a moratorium on the San Andres-Glorieta aquifer it would entail more monitoring and more fingerprinting. The EPA has power to enforce but they need resources. They need to write more laws that say not to pollute. He reminded us of a precedent set by the EPA when they wrote the Uranium Mill Tailings Radiation Control Act (UMTRCA)

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[90] It is worth quoting Jensen's introduction about his paradigm of scientific study, which highlights the emergent technologies that made it possible:

> Although field geology is the foundation of mineral genesis studies, many other "tools: have been of prime assistance in aiding the student of ore genesis. None of these "tools" will ever be a panacea to the study, but some of them have provided significant information, especially when correlated with field data. The mass spectrometer is one tool that has provided further light on the origin of certain mineral deposits by determinations of variations in stable sulfur isotopic abundances which bear on the genesis of sandstone-type uranium deposits (Jensen 1963:182).

in the 1970s. The EPA cannot however require that uranium mill tailings be moved. Everything radioactive will belong to the Feds. But they won't accept tailings piles that have people living near them. DOE will never take the site unless congress takes action. They ultimately make the legacy sites that they inherit off-limits forever.

He articulated his theory about background in the San Mateo Creek Basin. Rain events come in and recharge to 300 mg/L TDS. At the Crossroads it's trying to get to 300. Natural recharge is low TDS whereas mine water is high in TDS. Homestake data has so much noise. Our sampling cannot verify their data. Technology in labs is better and there is less noise, but there is noise in the data that can't be pulled out. The EPA has not refined their data; they just plot it all. They don't account for "spectral interference." It's like trying to read in a snowstorm. He described how radium and selenium move radically different, and suggested that some of the selenium could come from Poison Canyon. "Part of the managers weakness is he's not a geochemist."

Dixon then stated his position against the Superfund listing and elaborated on a grander plan. He noted how the Navajo Nation hired six or seven lawyers to acquire funds from the Tronox settlement while the state of New Mexico did nothing. His plan was to litigate requirements for mining companies to build a multi-million-dollar trust fund up-front that draws interest and they cannot control it. This would entail a radically different relationship between the state of New Mexico and extractive industries from what we noticed above. He suggested that NPL may not be the best course of action. EPA NPL is "a big hammer, but you need muscle." "You got to have the hammer above their head." "The San Andres-Glorieta aquifer needs to be better protected period, or you will have hard water like Gallup, with TDS that clogs up the kidneys." He remarked, "You have a case against the federal government period." He also

told MASE that he would be willing to make the sole source designation for the San Andres-Glorieta his next project.

8.3 The Politics of Environmental Cleanup

In the spring of 2017, before I left New York to go back to New Mexico to undertake my dissertation fieldwork, the former NMED secretary and EPA Region 6 administrator Ron Curry had retired. Just a few weeks after cleaning out his Dallas office at the EPA, he did an interview with *The New Mexico Political Report* in response to the Trump administration's plan to cut thousands of jobs and billions of dollars from the EPA. Curry cited New Mexico's income from the EPA last year, which was $36 million, $18 million of which went to NMED. The report claims that EPA has been *the* driving force to cleanup Superfund sites in the Grants Mining District. According to Curry, "Our emphasis was on how the community was being impacted cumulatively in the long-term, and the job is not over—there's still a heck of a lot to do out there… I know the community is concerned that efforts will be stopped out there, and we certainly tried to put as much emphasis as we could while we were in a position to do so."[91] Ron Curry was a key organizer of the National Conference of Mining Influenced Waters that I attended in Albuquerque during the summer of 2014. The conference brought together the region's experts on mine waste to share ideas about the vast environmental cleanup challenges in New Mexico and across the nation.

The subsequent NMED secretary Ryan Flynn acknowledged that cleaning up the legacy of uranium mining in New Mexico would be the foremost project of NMED in the twenty-first

[91] http://nmpoliticalreport.com/198145/former-epa-appointee-nmed-secretary-comes-home-en/; accessed September 26, 2018. I am thankful that Kim Fortun sent me this news report and asked me if this was significant to my nascent research. I hope this paragraph offers one possible response.

century. But shortly after leaving NMED to join the New Mexico Oil and Gas Association, Flynn was given his second "Toxic Turkey" award by the New Mexico Environmental Law Center (NMELC), which draws public attention to people who have endangered New Mexico's environment. The point here is about how pervasive the question of cleanup had become; even toxic turkeys could get onboard, or say they were onboard, with cleaning up the environment. This was an issue that was receiving bi-partisan support. Though cleanup is considered bureaucratic, *it is not supposed to be political*. After all, we have a governor's letter in support of the San Mateo Creek Basin Superfund NPL. We have a letter in support of NPL from the "approve approve approve" governor Susana Martinez and her "permit to pollute" regime. Additionally, environmentalists and technocrats alike found commensurability in the promise of environmental cleanup. Yet Curry leaves us with some skepticism about an emergent political regime. They certainly tried while they could, but his forecast for the changing political tides was accurate when it came to the termination of his position at the EPA.

During an interview with a colleague from the BVDA, I asked, "Did you ever have any conversations with Ron Curry?" She responded:

> Ron Curry was the best. Ron was the absolute best. He has some background with our site. He actually, he's the person that got this process started allowing our expert, our technical expert, to interact with the EPA folks and take a second look at the background that had been set at the site. Which we have always contended was not correct, not appropriate, and Ron Curry is the person that finally opened that process up and got a foot in the door so that we could have that conversation with the EPA (Head-Dylla, June 6th 2018).

I asked, "Could you tell me a little bit about that process?"

> Yes. It is very interesting because for a long time we were just believing we were on our own and the way we put up any defense at all because within our group we had my dad who was a former mining engineer, and we had [another] former mining engineer, and they had both managed large uranium projects and been part of the uranium mining industry. They understood the area in detail and they had really good technical expertise that we could draw on.

So every time the new action plan came out or some new permitting process. We would rely on their expertise and we would send in our comments. And over about a ten-year process of doing that, and trying to engage democratically and write letters to the president. I have file boxes, files of letters, to presidents, to senators, to congressmen, and all the way back to Domenici and Bingaman. I can't even remember all of the different congressmen we have written to. We engaged the democratic process like you can't believe. We wrote to all of our local representatives, we just were crazy with the letter writing. And we would send return receipts and we would send all of these comments in. And it was like we were just ignored. Completely ignored.

And so finally in about 2005 or so, Chris Shuey called and he said, we were talking and I was home for a visit and we were talking about how we just weren't getting anywhere because, SRIC, Southwest Research and Information Center would always weigh in on our side. And also provide comments and stuff but we were just getting ignored. And Chris was saying well one thing is you just don't have the money it takes and we should get organized. They were working a lot with ENDAUM then. We should get you guys in with ENDAUM and maybe Linda's Post 71 group and we ought to get an organization going and you could apply for funding. And so he and I wrote some stuff up then and during that vacation, he really got the ball rolling and got these groups together and they formed the Multicultural Alliance for a Safe Environment. We got LACSE, the Laguna-Acoma Coalition on board. We got the Red Water Pond Road because Chris had been working with them. We got ENDAUM, we got [Post-71].

All of us got together and then the really critical point was we were able to attract Nadine Padilla… Well Nadine was an unbelievable organizer. She is now at NM Environmental Law Center. She went back and got her law degree. But Nadine was unbelievable. She had this network of young people and she had this way about her that I can't really describe. She inspired confidence. She leads without dominating. She lets everybody have their say so that when she is moving forward, it is with everyone's consent and cooperation. And she really put MASE on the map and she started getting the funding together. And I don't think any of us, any of us old folks who had been doing the community organizing up to that point, had any idea that we might qualify for this kind funding. But she had the vision and the connections and the network and she put it together and it was awesome. I really credit her with getting MASE going.

Then once we got this funding, we said well part of the problem is we… really don't have the technical expertise that these folks can't ignore. They just seemed able to ignore everything, I mean… nothing [we] were writing seemed to make a difference. So we said can we raise some money and get some technical experts who have the degrees behind them that really can't be ignored by the regulators. So that is what we did. And that is how we brought Tom Myers on board. And then one of my friends up in Colorado… [with the] working group of Sierra Club told us about Ann Maest and she then came on board on the other side. So that Tom's work. So the way it worked was that Ron Curry gave us a political opening. MASE gave us the funding to hire Tom. Tom was wise enough to come out and pick the brains of our local experts… He spent several days with [us], and he really got a good, deep understanding of the area from an insider view from people who had both technical expertise and an historical background and so he was able to do a report and because of his background and because of the opening Ron Curry made, it all came together, they couldn't really ignore it. And now they still can't

> ignore it because we have those experts that really can't be pushed aside any longer. And that is a result of the MASE organization (Head-Dylla, June 6th 2018).

I followed up by asking, "What was the political opening that Ron Curry opened? What did that look like?" She said:

> Before Ron Curry, basically, he made the people in the field sit down and listen to our technical experts present their reports. And it became clear to them that there had been mistakes that were made. The process was not right. They didn't have all the information. But with him being both in the meetings in our homes where he brought those field people and they saw that he was interested and that he was serious about it. And it was him sitting on video conferencing, him… giving me their phone numbers so that when we weren't getting the cooperation we needed, I would call him up and I would say, "Here is the deal. Here is what is happening." And I don't know what they did, but they made calls and we kept getting access and cooperation (Head-Dylla, June 6th 2018).

The Myers report is an artifact of that "political opening." Prepared for the BVDA with funding from MASE, *Conceptual Flow and Transport Model Uranium Plume near the Homestake Millsite Milan, NM* (Myers 2015) introduces a "conceptual flow model" (CFM) for the lower San Mateo Creek Basin. His hypothesis suggests that uranium seeping from the Homestake tailings pile is "the exclusive cause" of the uranium plume "at, downgradient of, and to the near upgradient" of the tailings pile. Uranium from mine water discharge near the Crossroads area has reached the lower basin, but it has remained upstream of the tailings pile. The general groundwater flow from the Bluewater site has prevented uranium upstream from reaching the Homestake plume. The model has implications for establishing background and the general politics of baselining. It also points out two significant areas of scientific ignorance at the site that can only be addressed by sampling in areas that have long been deemed frustrating "data gaps." First, the problem of "groundwater mounding" has moved contaminants not just to the south, downgradient of the site, but also to the north, east, and west of the large tailings pile. The second area of ignorance is the ongoing contamination of secondary uranium/vanadium salts that

have been deposited in the soils through Homestake's application of "tailings slurry" in a process MASE and colleagues refer to as "flushing the tailings."

It is important to emphasize the situated nature of Dr. Myers' research. *Tom was wise enough to come out and pick the brains of our local experts. He really got a good, deep understanding of the area from an insider view, from people who had both technical expertise and an historical background, and so he was able to do a report and because of his background and because of the opening Ron Curry made, it all came together, they couldn't really ignore it. And now they still can't ignore it because we have those experts that really can't be pushed aside any longer. And that is a result of the MASE organization.* This form of situated science that draws from local technical expertise, insider knowledge, and the historical background of the area can be sharply juxtaposed with the aloof science that underpins the forthcoming USGS publication, which was contracted by the EPA in order to help establish background in the lower San Mateo Creek Basin.

On June 14, 2018, my colleagues from the BVDA wrote to the MASE listserv offering an update after a meeting that morning with USGS at Senator Martin Heinrich's office in downtown Albuquerque.[92] BVDA asked me to share my observations, since I was invited to observe and take notes. Usually by request, I would circulate my empirical observations, theoretical interpretations, and some degree of polemical tone with my colleagues at MASE. If there was one aspect of my academic work that MASE found valuable, it would be the fieldnotes I collected and circulated from public meetings. I also found it to be a useful rhetorical exercise to find out what modes of explanation MASE valued the most. In my response below, notice how

[92] Though senator Heinrich facilitated the space and the audience of "field representatives," he was not present.

contrasting conceptions about the relationship between "science" and "politics" converged in the discourse of USGS and BVDA during the meeting.

> The USGS publication, which will supply the baseline data for [EPA] to determine background at the site, is a significant target for scientific *and* political inquiry and intervention. The USGS circulated a paper handout at the beginning of the meeting about how 'Fundamental Science Practices' (FSP) govern their work as third-party reviewers, 'someone that doesn't have a stake at the site.' They don't regulate or manage natural resources; they just study them. Their goal is objectivity, scientific rigor, and non-biased science. They stick to the science and do not make recommendations, and their products are viewed without outside influences, as if that were possible. The USGS folks seemed very uncomfortable when their science was framed in broader political terms. If we know anything about politics, we know that even an *a*political standpoint is a political standpoint. The very separation of 'science' from 'politics' can be interpreted as a process that undermines democracy. Consider the [USGS] comments: *This is not the right forum to debate the science. I don't feel it's appropriate to have elected officials judge the science. So far the meeting is not going well. It's supposed to be a discussion. We need to cool this down. This is not the right forum for scientific debate, the right forum is the Scientific Integrity Office. His folks tell us this shouldn't be a debate. I'm a scientist not a political person*. These comments effectively remove a key piece of science-policy from public discussion. Such strong anti-democratic comments from USGS were elicited by [BVDA's] comment about how a USGS scientist's body language was rejecting Tom's science. I guess body language is subjective enough to remind USGS that they're in political territory, despite circulating handouts to suppress the political itch (the author's personal communication, June 14, 2018).

The USGS arrived with an understanding of the relationship between "science" and "politics" as one of oil and water. Discrete. The two do not mix. The impermeability the USGS scientists articulated was one where "politics" had no place in "science." Such purged conceptions of science are particularly vulnerable to political schemes and stratagems. For example, what the USGS was perceiving as a blind sample, the BVDA was perceiving as a sample collected from a contaminated well that the mining corporation Homestake both impacted and selected for background. Though the USGS claimed that they are not the ones making decisions about background, the BVDA would not let them elide responsibility for producing the baseline data that would undergird the EPA's determination of "natural background" levels of uranium in their water. The BVDA remarked, "We've been beaten up by

these reports, that's why we brought our own experts in." Dr. Myers and Dr. Maest were invited by BVDA to call in from Reno, Nevada and Boulder, Colorado respectively. They vetted the USGS publication and what it would purport as baseline by identifying the limitations of their data and outstanding uncertainties. The constraints of the study revealed the political coordinates that oriented USGS application of science: During this "one-shot deal," they collected samples from "the infamous Homestake well," DD, which the mining corporation Homestake selected for their contractors, Arcadis, and the USGS to cross-analyze. My response continues:

> Despite the USGS posture of rigor and objectivity, there is uncertainty and major limitations of their October 2016 'snapshot' samples. Ann suggested that they would need more data across time and space to make a reasonable baseline assessment. [USGS] agreed that there's never enough data, and that she'd like to consider sediments in the area. Tom added that further study not be limited to the top six feet of sedimentation, but 10-50 feet down. I also appreciated Tom's amendment to the 'natural-regional flow' model to consider mounding and the history of discharge and dewatering in the upper basin. USGS said they would include a limitations section in their publication. After Ann commented on the limitations of the data, [a scientist from USGS] reminded us that she was not involved in the initial research design. She was just given the data and picked the analytical models. BVDA and colleagues posed a question earlier in the meeting, 'Who does the selecting? Homestake is diligent in not allowing certain areas to be tested. You got to pick from the litter, but the litter may be cold before you got it' (the author's personal communication, June 14, 2018).

When the USGS scientist mentioned that they collected split-samples from well DD and DD2, Dr. Maest responded that there seems to be something odd going on there. She objected to using DD and DD2 as background. NRC used DD to determine background, "but we still do not know why concentrations are higher there." A hydrologist from NMED mentioned that one of the reasons the EPA hired USGS was to address two outstanding "data gaps" that had been discussed off-and-on for 25 years. The USGS was supposed to get those gaps filled and provide a piece of the information to get background. Dr. Myers told them they would need a few new wells constructed a little over a mile north of the tailings pile, upgradient from the wells to see how signatures change and what is happening with uranium salts. The strong recommendation of

his conceptual flow model is to fill in the space using isotopes and geochemistry. He was hoping the USGS would reveal these data gaps. Surprised by the "political opening," Dr. Maest remarked on the circumstances: "This is weird, I'm not sure if I'm allowed to ask questions." She asked about whether they have noticed a mining influence in the Chinle aquifer. The USGS scientists said there was not clear evidence, but it is more in the alluvium. BVDA said, "you don't have any Chinle wells upstream of the Homestake site. You could set background at a Chinle well in a clean area upstream. There are wells up there, cow watering wells."

Dr. Maest mentioned some of the geochemistry that would be involved in distinguishing contamination from Homestake, Bluewater, and Ambrosia lake—the geochemical threads of evidence like alkaline, acid, sulfur isotope of pyrite in the area, and high sulfate in general. "There's a lot of sulfate in the area." Dr. Maest encouraged the scientist to consider more spatial and temporal variability: collect more sources upgradient and consider temporal sedimentation in the alluvium. "You can't do spatial analyses without more monitoring points. There is data from the 1980s from these same wells that is better than EPA data that would buoy up your report." She encouraged the USGS to use more historical data points in order to understand spatial and temporal data points. She asked the USGS about their funding model. "If funding is limited, you may have to look outside the budgetary scope. Maybe funding for your study should come from a different source. It may have to be addressed in a separate study. More information is needed."

What we noticed here was how unaccountable "science" displaces responsibility for making political decisions about background. Who is responsible for making the decision about background? The USGS just supplies the science; they don't make recommendations. "I'm not the one deciding." "This paper shouldn't make the decision." Once it is published it is going to be used by the EPA. "Science" was used as a rhetorical strategy by the USGS and the EPA, in

good faith, to deal with contentious decisions. They leveraged "science" as a discursive technique to displace the accountability of individuals and institutions of the key decisions they are supposed to make. We noticed how they were employing science that was ignorant of local and regional geology and politics, displacing responsibility, and fracturing any local social relations by introducing "new faces"—agents who apparently don't make any of the important decisions. In my message to MASE and colleagues, I emphasized the BVDA's concern about how "new faces" were introduced as a way of keeping local, insider, historical knowledge of the site separate from the displaced production of scientific information and political decision making:

> They commented on the problem of 'new faces' at agencies inheriting old problems, like the way DOE LM inherited 'a perfect storm' at Bluewater. BVDA recounted the time when Homestake manager… told him that he was brought in for one reason: to spend as little money as possible and keep people quiet, reclamation-wise. There's a theme of bringing new people in who lack a broader understanding of the situation and personal relations with the community: *new faces inheriting old problems*. As Ann noted about the USGS publication, using a 'principal component analysis' means *they don't know what's going on*. Recall that the EPA project manager said the *USGS is just guessing* (the author's personal communication, June 14, 2018).

In an interview with a colleague from the BVDA, I said: "Well, we've talked about this before but the turnover of whether it is NRC agents or DOE agents or any state interface that you deal with it seems like these people turnover in a matter of years. Is that right?" She responded,

> NRC that's true. Sai Appaji with the EPA has been on that project for I think that has been his entire career almost. In DOE there has been some turnover, there's been two people who have been fairly consistent with us the whole time. The truth is with the DOE, we have had very little contact with the DOE Legacy Management side within the last couple of years. For a long time, they basically said that site has nothing and never will have anything to do with your site and you don't need to worry about it. And so we really didn't have much interface with them through the years. DOE is fairly new and I don't know about the turnover on that project. The NRC big turnover, lots of turnover and EPA quite a bit of turnover higher up like with each new president we would get new directors, regional directors, etcetera, but Sai has been pretty consistent in the project. *Unfortunately, he never makes any of the important decisions*. We get to talk to him a lot, but we never get any important decisions. *Those usually come from the Region 6 director*

> *and that turnover is every time you get a new administration* (Head-Dylla, June 6th 2018).

At the October 2018 EPA meeting, the project manager told us that Sai moved to a position in Boulder, Colorado.

I concluded my message to MASE and colleagues by saying: "Sai (EPA) agreed with the basin-wide analysis, and suggested that the USGS paper would be an important piece of the puzzle, but not the ultimate source of information to determine background. It is certainly one important piece of work. I think the publication remains an important site of political action and I really appreciate Tom's and Ann's vetting of the project under the auspices of BVDA." It is unclear what the meeting will have achieved. There were some doubts about the effectiveness of the BVDA's strategy of having their independent experts vet the USGS publication in a "political" space in front of a "political" audience. Someone described the strategy as "going straight for the jugular." One apparent result from the meeting was that the USGS said they "could include a limitations section in their publication." It is unclear whether they actually *would* include it. The USGS was noticeably rattled by the experience. It is hard to tell what was more unsettling, the way "politics" had been flagrantly cast through the USGS science, or how BVDA's skepticism was supported by better science.

A former mining engineer and resident from the Village of Milan said, "We boil inside because we've been fed a pile of manure. If [her dad] were still healthy he'd come in here and pound the table. Since you are funding-limited and data-limited, how can you come up with a reasonable report?" BVDA proposed to improve the product before more people die. "They've taken our land away and devalued our property. They buy the land and stop farming; if Murray Acres doesn't farm, we lose our water rights. They are buying people out for pennies on the dollar." Homestake Mining Company (acquired by Barrick Gold Corporation) hired their

"corporate social responsibility" (CSR) team to come in here; they told us farming would be a liability." "Eventually we all die; time is of the essence. We need some creative solutions. How do we get this multi-billion-dollar company to serve a democracy? Tic-toc, people are dying." She recognized Senator Heinrich's and Senator Udall's field representatives and suggested they collaborate and work together. She requested the USGS "share information with what they've got and share that data for everyone else." Agencies need to find funding to do that. The BVDA left the USGS with a two-part proposition: One, work with our experts to better understand the wells in this area, and when drilling new wells; and two, we need to get outside of Homestake and get upstream in the Chinle for background.

8.4 Homestake's White Paper

In September 2018, Homestake published a white paper, which was prepared by their consultants Arcadis. Following the publication of *Evaluation of Water Quality in Regard to Site Background Standards at the Grants Reclamation Project,* they held a conference call with interested stakeholders to announce the release of their conceptual site model, which asserts their interpretation in light of Dr. Myers' hypothesis. However, it focuses exclusively on the upper alluvial aquifer and the depositional environment of the surface soils; not the Chinle aquifer. Here is how they summarize what catalyzed the October 2016 split-sample event and how their research ensued:

> In 2016, the EPA began to investigate the Site Background Standards for the Grants Reclamation Project due to the anomalously high concentration (0.2 milligrams per liter [mg/L]) of dissolved uranium detected in site background well DD. *Well DD is a key location used in the calculation of the Site Background Standards, and the natural occurrence of uranium here has been questioned by stakeholder groups and regulatory agencies*. The USEPA and the United States Geologic Survey (USGS) conducted a groundwater and geophysics investigation in 2016, which was completed in parallel by [Homestake] via split-sampling and resulted in the generation of two parallel

> groundwater quality datasets. In 2018, two soil borings were completed in the immediate vicinity of site wells DD and DD2. Subsurface soil samples were collected for laboratory analysis and detailed borehole geophysics were also performed (2018:1; emphasis added).

During the conference call, they described the USGS split-sampling event (2016 SSE) in terms of "quality control." They utilized geochemistry, lithology, and geophysics to respond to the recent concern about the area upgradient of the Homestake site in the lower San Mateo Creek Basin. Their study investigates the interplay of groundwater geochemistry and soil geochemistry north of the Homestake facility. In the white paper, their primary goal is to develop a counter conceptual site model (CSM), which attempts to refute the Myers hypothesis that the large tailings pile has impacted groundwater to the north of the site. Their CSM describes "local naturally occurring mineral sources of uranium to groundwater upgradient of the Grants Reclamation Project." They determined that the heterogenous alluvial sediments upstream from the site are naturally occurring. Note that their focus is on the alluvial aquifer, not the Chinle. They noticed how geological variation in the depositional environment of the alluvium with lenses of sand, clay, and gravel is reflected in the heterogeneity of the water. The depositional environment is affecting water heterogeneity. San Mateo Creek and Lobo Creek drainages come off Mt. Taylor, allegedly bringing sediments of naturally eroded sandstone bearing uranium.

Using data from 2016 and 2018 and historical data, they assessed different recharge affects in groundwater. However, the historic boring logs just say gravel, as the wells were drilled by a driller not a geologist using a mud rotary drill. What they saw drilling out there in 2017 was "high conductivity sands and gravels, and low conductivity clays." "This is not a homogenous system. This is a natural system." They use their study to claim that their upgradient wells were not affected by the large tailings pile. Apparently, the water did not have the right chemical forensic indicators of the large tailings pile. Note that the other interpretation

is that it is difficult to get a geochemical fingerprint there because Homestake has mucked up the water through their "hydraulic flow regime." They challenge the assumption that groundwater necessarily needs to be consistent. "There is a lot of heterogeneity in that upgradient trend." The Homestake white paper is quite literally and geoscientifically a shallow response to the Myer hypothesis. Whereas Myers suggests drilling 50 feet deep to look at the vadose zone where there are secondary deposits of uranium salts from pumping slurry through the uranium tailings pile, Homestake takes a superficial look at the alluvium. The white paper also ignores the BVDA's enunciation to collect background below the fractured alluvium in the Chinle aquifer upgradient of the site.

8.5 Civic Science and Corporate Science

What we experienced during the conference call with Homestake was a manifestation of "corporate science" that conceals "evidence of their environmental impacts. This includes efforts to naturalize impacts through misleading comparisons of natural and industrial systems. They make systematic measurement errors by ignoring background rates and presenting averages that conceal significant variations" (Kirsch 2014:128). Stuart Kirsch remarks that "One of the rhetorical strategies employed by mining companies to defend themselves from criticism is to invoke comparisons that "naturalize" their environmental impacts" (140). He discusses how mining corporations "make inappropriate comparisons between natural and industrial systems" (139) and employ the "use of the rhetoric of nature to downplay the responsibility of mining companies for their environmental impacts" (140). The politics of baselining and the corporate strategy of backgrounding refer not just to rhetoric that conflates natural systems with industrial systems; these terms also speak to the geophysical integration of industrial systems into nature,

as the natural background against which to measure ongoing and future impacts. The EPA's hypothesis that there is a faulted graben beneath the Homestake tailings pile illustrates how thoroughly the mining industry has integrated natural and industrial systems in ways that have befuddled federal scientists at EPA and USGS. The graben is the result of a massive hydraulic impact that could be caused by the mining industry, or it could be "natural."

We can understand the work of Dr. Myers and Dr. Maest as an emergent form of "civic science," or science for the public good. Kim Fortun and Mike Fortun elaborate on their concept of civic science by showing how their analysis can be considered in Michel Foucault's terms in two ways:

> In one, we are interested in the enunciation of "good science" within toxicology today, with enunciation understood as an emergent effect of crosscutting forces on the subject. What counts as "good science," we argue, is a historical effect, produced by a tangle of social, political, technological, and biomaterial forces. In another dimension, we are interested in what toxicological scientists themselves understand as worthy of care and ethical attention, following Foucault's elaboration of how the object or focus of ethical care shifts in different times and places. Foucault described how ethical concern fixates on particular dimensions of everyday life (Fortun and Fortun 2005:44).

Myers and Maest's situated science and their enunciation for more data points across space and time before any accurate baseline assessment can be made is what counts as "good science" in this case. In this chapter, we have experienced enunciations of forensic geochemistry that can fingerprint culpable mine water. Within the purview of civic science, we can also consider Earle Dixon's articulation that his "science is too good." His science was so good he lost his job. Recall how he articulated his version of "good science" as part of a major contrast in value systems and his proposal for "poor man's plume chasing."

8.6 Conclusion

This chapter illustrates the politics of baselining by tracing the emergence and entanglements of different epistemic formations, as articulated at public meetings and supplemented by the circulation of artifacts of environmental information. Each epistemological standpoint conjures a different geological past that can be deemed "natural" and prior to the impacts of the uranium mining industry. At this analytical scale, the politics of baselining refers to a triadic relationship between local communities, government employees, and transnational corporations. It indexes a peculiar dynamic between such stakeholders that is generalizable nonetheless, whereby transnational corporations naturalize industrial impacts by producing *corporate science* that supports higher baseline levels of contamination in the environment; whereas local communities work together to employ independent experts who have been fired or retired from state agencies in order to produce *undone civic science* that supports lower levels of contamination in the environment. These two categories of stakeholders negotiate the technopolitics of environmental cleanup through state and federal agencies that attenuate the discursive force of each stakeholder. State and federal employees hosted the public meetings that brought together stakeholders, creating representational spaces for corporate and community interventions into the politics of environmental information.

Federal employees of the EPA, DOE, and NRC recognized that their research was compromised by the emergent political regime of Donald Trump; many lost their jobs, and those who remained were pessimistic about the kind of environmental cleanup the federal government could support. They recognized a rhythm where every time there was a Republican upheaval of a Democratic administration, they would lose their jobs. State employees of NMED recognized that their work was compromised by a "mining friendly state" and a "permission to pollute" governor, Susana Martinez. They cannot just deny permits; they are expected to coach

corporations through the permitting process. On the other hand, my colleagues at MASE recognized the "political openings" made by state (NMED) and federal (EPA) agents like Ron Curry, who opened up the spaces for intervention in environmental information and opened up the possibilities of environmental cleanup. Curry allowed Dr. Myers' "conceptual flow model" to contend with the dominant paradigm of corporate science. According to the BVDA, Curry created the space to bring together civic science and corporate science. Dr. Myer's *Conceptual Flow and Transport Model Uranium Plume near the Homestake Millsite Milan, NM* (2015) is an artifact of the "political opening" made possible by Ron Curry. It interrupted the narrative that naturalized industrial impacts. The report foregrounds the environmental information that Homestake has backgrounded.

The challenge articulated by BVDA is to be better prepared to recognize "political openings" in time to mobilize around the moments that establish baseline, for example. BVDA has become savvy at reigning in the political spaces that open up, even forcing these spaces open. Though he was unable to be there, New Mexico State Senator Martin Heinrich allowed BVDA to use his office space and borrow his field representative for a cross-examination of the USGS publication that will purport the baseline standards for the Homestake site on behalf of EPA Region 6. In this chapter, I characterized the USGS science as "aloof" because, in their non-stakeholder uninterested third-party role, they collected a one-time "snapshot sample" from well DD, "the infamous Homestake well" that had been impacted by Homestake's uranium tailings piles and possibly the mine water discharged into the basin upgradient. Dr. Myers' conceptual flow model and the supplementary research of Dr. Maest reveal a world of historical data-points that span a broader range of spatial and temporal variability. Situated within a broader political spectrum, a broader field of data collection and analysis, the USGS science was

noticeably unsettled. The broader understanding offered by Dr. Myers and Dr. Maest established a position from which to point out the significant limitations of such a narrow-minded study. Homestake (Barrick Gold Corporation) and their consultant Arcadis published a white paper based on the split-sample event with the USGS and EPA, which concludes that the heterogeneous alluvial material containing uranium that runs through their site has naturally eroded from Mount Taylor. Predictably, the corporate stakeholder again tried to naturalize the by-products of their industrial systems.

This chapter also offered an ethnographic description of a geochemistry workshop at the MASE quarter-annual face-to-face meeting in Grants in order to add another layer to my stakeholder analysis of the ongoing politics of baselining. In addition to the work of Dr. Myers and Dr. Maest, I discussed Earle Dixon's proposed method of "poor man's plume chasing," as an alternative course of study to the aloof science of the USGS. Dixon's research empowers the efforts of MASE and colleagues to enunciate for a more robust cleanup; whereas the USGS report threatens to disempower the BVDA and their call for restoration. The sheer physical extent of the contamination in the Grants district is disempowering. Despite such gradients of power, MASE and colleagues have cultivated new forms of undone civic science that are now driving the environmental cleanup regime into spaces and places that have been backgrounded by corporate science.

CHAPTER 9

MAKING MOUNTAINS

In this chapter, I discuss the contested nature of Mount Taylor as a sacred Native American space and place—lands that are central and vital for diverse forms of Indigenous life—and what economic geologists have referred to as "a world-class uranium deposit." Mount Taylor is a religious pilgrimage site and state designated Traditional Cultural Property (TCP) for five nominating tribes: Acoma Pueblo (*Haaku*), Laguna Pueblo (*Kawaika*), Zuni Pueblo (*Shiwinna*), the Hopi Tribe (*Hopílavayi*), and the Navajo Nation (*Dinétah*). It is considered vitally significant by all 19 Pueblos of New Mexico and recognized tribes of Arizona, Colorado, and Utah. Despite the designation that has been upheld by the state, the mountain is surrounded by former and prospective uranium mines. What follows is an ethnographic account of a public hearing regarding a permit that would allow the Mt. Taylor Uranium Mine to return to active. Nestled against a sacred mesa of the Mount Taylor TCP, the mine would operate on private property under the auspices of a company called Rio Grande Resources, a subsidiary of General Atomics. I will first show how the mountain, the surrounding mesas, and the underground uranium orebodies were made legible in the eyes of the corporation as a prospective economic "resource" through state permitting regimes. I will then examine how the Multicultural Alliance for a Safe Environment (MASE) and their colleagues responded to the logic of economic geology and the geophysical production of nature by petitioning against the decision of the New Mexico Mining and Minerals Division to permit a uranium mine adjacent to the Mount Taylor TCP to "return to active."

9.1 Second Orogeny

This chapter is about making mountains. It is organized by the geological concept of "orogeny," which is derived from Ancient Greek *óros* meaning "mountain, high ground" and *geneia*, "creation, birth." *Orogeny* refers to the formation of mountains. As a technical term in structural geology, it refers to the process in which the earth's crust folds and deforms making mountain ranges.[93] I am thinking more broadly about the concept of orogeny, true to its etymology as the genesis of mountains and orebodies, in order to account for the diverse human and nonhuman processes by which they are made. I want to adopt the geological concept as an anthropological concept that guides our attention toward different ontological, epistemological, and practical human associations with minerals and mountains. My conception of "orogeny" goes beyond the traditional understanding in structural geology to highlight the anthropogenic forces that make mountains. I hope this broader conception of "orogeny" will help geologists and anthropologists engage in cross-disciplinary discussions about fractures in geologic time, and a rupture between the Holocene and the Anthropocene. I hope it will supplement discussions about how humans have become a geophysical force on a planetary scale, which expands the anthropologist's areas of expertise in order to study the anthropogenic nature of earth.

From the purview of economic geology and the study of industrial minerals, "ore" can only be said to occur if it can be exploited for a profit. The genesis of uranium ore depends not on the existence of minerals per se, but the speculation of making money. Disciplinary perspectives in geology regarding the genesis of uranium ore in the sandstone and limestone host-rocks near Grants yield to their secondary "discovery" as valuable economic "resources." Consider the potential source of uranium from the Jurassic arc of plutons and calderas, which once spewed ash into the sky that sedimented in a large briny Cretaceous lake that formed the

[93] https://www.merriam-webster.com/dictionary/orogeny; accessed June 5, 2019.

San Juan Basin where Mount Taylor and the Grants uranium district are located. Geological theories of the magmatic origins of Mount Taylor as a "super volcano" and a "strata volcano," and the "early diagenesis" and the "intimate association" of uranium, vanadium, and humates in the sandstone of the Jurassic Morrison Formation (McLemore and Chenoweth 2017:31) are only significant to the extent that they can make uranium districts legible and exploitable. This knowledge becomes ancillary to the process of making it a geologic resource, which marks the political-economic life of the orebody. It only comes into existence for a profit. If it cannot be exploited or salvaged for a return on investments, it does not qualify in terms of "ore," "resource," and "reserve" and uranium districts and provinces cannot be made. This is part of the process I call "second orogeny" (Figure 14). It is a view of and vision for nature that materializes in the form of uranium mill tailings piles, for example. These are anthropogenic mountains made from the by-product of the original uranium ore deposits.

Figure 14. An image of "second orogeny." The Bluewater large uranium mill tailings pile in the foreground and Mount Taylor in the background. Photograph by the author.

"Second" is a nod to Hegel's theory of "second nature," which introduces a useful distinction between "first nature," as a primary world of things existing outside of society, and "second nature," as society itself taking shape in the form of the state, the law, and the economy through a manifestation of reason and the realization of an "objective Spirit" (see Menke 2013; Schmidt 1971; Smith 1984). Through ethical education and enculturation, "the spirit" is realized and certain habits are acquired that seem natural. But this realization turns out to be a "misapprehension" of nature that accepts social norms as natural laws. This is the "lapse" that inheres in the production of second nature (Menke 2013:48). Neil Smith notices how Hegel's ideology of nature poses a problematic conceptual dualism of nature as "external," existing outside of society, and "universal" (N. Smith 1984:11, 33). But, with the concept of the "lapse," Hegel actually accounts for rather than succumbs to the process of "universalization"—taking

social habits as natural phenomena and treating historical contingencies as universal laws. We can salvage Hegel's theory of second nature as an anthropological-genealogical critique, which traces such *misapprehensions of nature*. Christoph Menke marks this moment in Hegel's work as, "the beginning of a materialist revision—and not a materialist reduction" (2013:43). A focus on "secondness" and the political-economic life of the by-product draws our attention to both the ideological and material thresholds between "first" and "second" nature and the enduring forms of displacement and the succession of accumulation by dispossession. One of the driving questions regarding environmental cleanup in the Grants uranium district is where to draw the line between "natural" and anthropogenic forms of uranium in the environment (i.e., how to characterize the environment pre-mining and post-mining). I call this the politics of baselining. This question invites a logic of primary and secondary succession, which prompts us to ask where it begins and how it reoccurs.

"Second" is also a reference to the historian of technology Thomas Hughes's understanding of the Anglo-American settler perception of technology and engineering as means of "second creation" (2004:10). From this perspective, technology is a tool used to return to some Edenic fantasy. We can understand the promise of this fantastic technological style as a symptom of what Severin Fowles calls the "myth of eternal return," which is characterized by the two modernist master narratives of "rupture" and "return" (2013:22). According to Fowles: "Modernist histories promote an ideology of progress by providing us with ironic accounts of a future return to human origins in which something natural—that is, something essential and unchanging—is recovered" (Fowles 2013:22). Despite straight-forward linear discourse of progress and modernization, Fowles reveals how the ideology of progress is actually looking backwards at a fantasy of restoring something "natural" and locating "a future return to human

origins" (22). In my analysis of the making and unmaking of the Grants uranium district, I account for the succession of sacrifice then salvation, where a rupture from our human origins occurs, followed by a forward-looking promise to recover something "natural" and "original" about ourselves. The myth of eternal return inheres in what I term the "logic of sacrifice and salvation," which underlies the manifestation of the Grants uranium district.

9.2 The Sacred Nature of Mount Taylor

The epistemic regime described above is at odds with the ontologies and epistemologies of Indigenous peoples of the U.S. Southwest. Native scholars and non-native colleagues have published important insights into sacred places in direct response to resource extraction, modern industrial "development," and uranium mining in particular.

The whole landscape is considered sacred: "the land and everything on it are alive, permeated by a life essence of mingled air, light, and moisture" (Kelley and Francis 1994:20). The geological features of the land are recognized as powerful anthropomorphic "inner forms" of immortal Holy People (1994:10). Mount Taylor is known in Diné as *Tsoodził* meaning both "bringer of life" and "taker of life." It is one of the six sacred mountains, and one of four that mark the cardinal directions and the outer world of Dinétah, marking the southern extent. It both bounds and orients the sacred space and place of Dinétah. Klara Kelley and Harris Francis describe the "four sacred mountains and how they figure in the stories of emergence, Blessingway ceremonial repertoire, and a multitude of natural sources of power that make them symbols of the organization of the natural world, the Navajo people and their territory. If mountains in general are among the most powerful types of places, these mountains are the most powerful mountains" (1994:196). But the mountains cannot be isolated and evaluated as more

significant or "sacred" than other places; they only become sacred through their interrelations with "the whole land" (Kelley and Francis 1994:42). Though the mountain cannot be dichotomized into categories of "secular" and "sacred," discourse of sacred nature has long been leveraged against settler forms of "development."

Mount Taylor is known as *Tsibiina* to Laguna Pueblo, *Dewankwi Kyabachu Yalanne* to Zuni Pueblo, and *Tsiipiya* to the Hopi Tribe (Lorenzo 2017:1). The mountain is of original significance for the Pueblo of Acoma, marking the sacred cardinal direction to the north, orienting the pueblo world. It is known as *Kaweshtima* or *Kawetsima* in the Keres or Keresan language meaning "a place of snow."[94] Acoma's history of association with the mountain can be traced to the beginning of time itself. It was the first mountain formed by two sisters who shaped the earth, placed specific plants and animals from their baskets, and breathed life into them (SRIC 2008). Old Acoma, the Sky City, has a reputation as "the oldest continuously inhabited community in North America."[95] The routes to Old Acoma traverse through a pantheon of megalithic proportions, where the sandstone bluffs and every other geological feature of the landscape seem to gesture toward Kaweshtima, the clouds and the sky respiring from the mountains themselves. The mountain's relationship to the clouds can offer a reliable forecast for changing patterns in weather, seasons, and other powerful forces. Mount Taylor is the primary watershed for the Rio San José and other surface and groundwater sources of Acoma. As such, the mountain actually brings water to the high desert landscape. A panoramic view of sacred Mount Taylor to the north is a reminder that you are home to people of Acoma. Mount Taylor is

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[94] See *Voices from the Earth* (Summer 2008:6-7). In the article, SRIC describes the emergence of the Traditional Cultural Property (TCP) and the processes involved in listing the mountain under Historic Preservation. They describe the agency of Mount Taylor in terms of "commanding" and the deterministic features of the mountain.
[95] http://www.acomaskycity.org/main.html?pgid=11; accessed June 20, 2019.

the eminent feature of the landscape and an icon of greater Pueblo and Tribal social relations. The visibility of the mountain from great distances is an important part of what makes it a sacred pilgrimage site throughout the Southwest region. There are common elements of belief held among Navajo and the Pueblos of Acoma, Laguna, and Zuni about "mountains as territorial boundary markers, and trails across the region. Much closer to Puebloan villages are rock-pile shrines, which look like the Navajo trail shrines but symbolize Pueblo boundary mountains" (Kelley and Francis 1994:208).

With this glimpse into Acoma and Diné ontologies and epistemologies of Mount Taylor, we can glean enough to understand how the second orogeny of the Grants uranium district undermines Mount Taylor's relationship to *the whole land*. What I describe here is how Indigenous and "multicultural" forms of ontological and epistemological *association*—meaning "together" and "in relation"—collide with forms of ontological and epistemological *disassociation*—meaning "separate" and "discrete." What happens in northwestern New Mexico, where deeply rooted senses of place and values of association encounter transient and transcendental, modern industrial modes of disassociation? This chapter traces this cataclysm between conflicting ways of understanding and evaluating the landscape and its geological features, underscoring how categories of being in which the land is central and vital are constitutively incommensurable with utilitarian forms of commensuration that make "resources" exploitable (Espeland 1998:29; Raz 1986).[96]

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[96] "Commensuration," according to Espeland, is an old but powerful idea:

> Plato believed, as Karl Marx and Max Weber, and Georg Simmel would believe much later, that commensuration was a mode of perceiving the world that changed those who used it. Commensuration improves self-control by structuring our choices in ways that make it obvious what we should do. By deliberately eliminating the heterogeneity of our values, we temper our emotions and attachments by removing motives for irrational behavior. A general concept of value allows us to frame choices as being between more or less of the same quantity, which

The field of environmental anthropology is rich with ethnographic accounts of this process that can be described in terms of "ontological dissonance" (Jacka 2015), "colliding ecologies" (Kirsch 2014), "friction" (Tsing 2005), and "dispossession" (West 2016). Dana Powell and Andrew Curley introduce the term "ontology of difference" in the context of their work in the Navajo Nation to underscore that the political question is not about appropriate technologies of "development," but fundamentally different and incommensurable ways of knowing and being in the world: "One of the central points of friction generating non-governmental forms of political action is the question of what modes of "development" are most appropriate… This political debate over the question of "development" is perhaps more a problem of differing, and possibly incommensurate ontologies and epistemologies than it is a disagreement over specific development technologies" (Powell & Curley 2009:109; also see Powell 2018). The powerful process of commensuration yields where Indigenous land-based values and meanings refuse to be rendered in terms of geologic "resources," as the raw materials for modern industrial development. The political refusal to be recognized, apprehended, and incarcerated, categorically and spatially (Simpson 2014), is as important as carefully attending to broader impacts and the possibility of scaling up Indigenous scholarship that is endorsed for non-native audiences. Following the work of the Laguna and Diné scholar June Lorenzo (2017), I will describe how universal rights-based geographies come into conflict with Indigenous notions of "responsibility" regarding Mount Taylor.

> changes our investment in things. Commensuration makes us more stable, less passionate (Espeland 1998:27).

Thinking of Marx's critique of capital, Weber's "iron cage" of rationality, and Simmel's sociology of comprehensibility, Wendy Espeland describes how commensuration changes "our relations to what we value, to alter the way we invest in things and people" (1998:28). She calls for more pluralistic modes of valuing contra rational choice theory and modern utility theory, where commensuration is considered "the only way to overcome conflicting and complex ethical concerns" (1998:27).

I pursue MASE and colleagues' questions of how discourse of "multiculturalism" can serve to scale up forms of Indigenous "grounded normativity" (Coulthard 2014) as a political and ethical sense of responsibility for the land. This is one way of displacing the utilitarian notions of God-given rights to natural "resources." "Multiculturalism" has served as a way of inviting non-native colleagues to recognize and take responsibility for the vital relations between the people and the land, and the sacred nature of lived experiences in these places. This understanding of multiculturalism can nuance scholarship of settler colonialism, which is critical of the way discourse of "multiculturalism" has been used to undermine Indigenous sovereignty and enact forms of neocolonialism (Coulthard 2014; Dunbar-Ortiz 2014; Simpson 2014). It is important to stay with this troublesome keyword precisely because it is such a messy term to muddle through (Haraway 2016). This is one possible response to the problem Bessire and Bond identify with regards to the ontological turn in anthropology, and how it defers critique by transcending the real political coordinates of our interlocutors—going beyond the keywords of "nature" and "culture" for example (2014:441; cf. Latour 2004). This form of "speculative futurism" elides the kinds of "response-ability" Donna Haraway proposes as a capacity to respond to "a comic faith in technofixes, whether secular or religious" (2016:3).

The polyvalent and polysemic qualities of multiculturalism in northwestern New Mexico have opened up spaces for political action among my colleagues at MASE, who began to organize across grassroots groups around 2006, after becoming associated with each other at public meetings about the legacy of uranium mining held by the Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED). "Multiculturalism" nuanced their recognition in the eyes of the state and the eyes of the corporation as "the

community," and it has bolstered the emergent discourse of "environmental injustice" (Gilbert 2014).

It was recognized among my colleagues at MASE that "multiculturalism" and collaborations between Native and non-native groups began to register in powerful ways among state and corporate stakeholders. Working together across sites and communities that were once disparate and fragmented, MASE and colleagues would negotiate what Stuart Kirsch calls the "politics of space" on a scale that registered with the corporation and the state, and their stakeholder vision of "the community." Although "multiculturalism" was a discourse cohering diverse forms of political action, Indigenous representations of space were the dominant gestures of contestation against the mining industry. As we will see in the following account of the hearing regarding the Mt. Taylor Uranium Mine, "resurgent Indigenous politics" were the driving counter force (Coulthard 2014:116). Kirsch notices how "mining companies and indigenous peoples regard each other as their greatest threat" (2014:8). For this reason, he uses a dialectical framework to understand the relationship between mining corporations and their indigenous critics. I retain this dialectical understanding of the relationship between Indigenous peoples and the mining industry, but I acknowledge a more complex story (see Curley 2019).

9.3 The Mt. Taylor "Zombie Mine"

On May 7th and 8th of 2018, I attended a public hearing at the Wendell Chino Building on St. Francis Drive in Santa Fe, New Mexico. It was convened by the state Mining Commission to deliberate about a permit revision (13-2) made in late December 2017, which would allow the Mt. Taylor Uranium Mine in the Grants district to change its status from "standby" to "operating." The New Mexico Environmental Law Center (NMELC) petitioned the action on

behalf of two regional environmental advocacy organizations: Multicultural Alliance for a Safe Environment (MASE) and Amigos Bravos. They petitioned the decision on the grounds that the mine has not produced uranium in almost three decades and is unlikely to produce in the foreseeable future, given the depressed market for uranium oxide and a dismal economic forecast for the commodity.[97] The petitioners characterized it as "a classic zombie mine scenario."

I found out about the hearing from a flyer I had received from my colleagues at MASE with a headline that read: "Zombie mine plans would leave it half-dead with zero cleanup." The body of the text explained:

> The Multicultural Alliance for a Safe Environment and Amigos Bravos have filed an appeal to a permit issued by the New Mexico Mining Commission that would allow the Mt. Taylor Uranium Mine to return to "active" status, even though its own expert said it wouldn't produce any uranium. The mine has not produced any uranium since 1990 and has been avoiding cleanup while under "standby" status. When the mine is in active or standby status, cleanup requirements are put on hold. It is time to kill this Zombie Mine and demand cleanup now! This is simply a game to avoid having to start reclamation. By playing, the State is failing in its duties to protect groundwater for future generations. We all stand to lose. Your input has impact! Join us to demand a safer New Mexico! All regional Tribes including the 19 Pueblos have declared the land around Mt. Taylor unsuitable for mining activities due to its widespread cultural significance as a sacred site and the unique value of the area's hydrologic resources (May 2018).

MASE enunciated their comments in "support of strong reclamation." MASE and colleagues willfully overlooked the possibility of the mine returning to an active process of mining and milling. From their perspective, because the mine has been inactive for 28 years and on standby for 19 years, in a mining district that had been declining since the 1980s and closed in the 1990s, both the standby period and the return to active without a feasible market were interpreted as a strategy to avoid cleaning up the mine waste. The strategy was identified by the petitioners and public commenters as "the pink elephant in the room." Yet the commissioners

[97] See https://www.iaea.org/newscenter/pressreleases/new-edition-of-red-book-uranium-report-is-published; accessed June 20, 2019.

refused the responsibility to hear economic analyses under the pretense that the New Mexico Mining Act of 1993, which established the commission, does not include economic provisions. Though the petitioners contested that the terms "saleable" and "usable" commodity flag an economic imperative in the Mining Act, the motion was sustained on the grounds that economic considerations of mining are made by the mining company, not the commission. The decision by the commission not to consider "economic" statements effectively blocked the expert testimony of Dr. Thomas Power, "an expert in resource and regional economics." Dr. Power was prevented from testifying on behalf of the petitioners "that it is highly unlikely that RGR will be able to actually produce uranium economically within the next ten years in the future, and the market may not support RGR producing minerals indefinitely." Dr. Power was not allowed to "testify that the market for uranium has been depressed since the late 1980s and consequently, uranium production in the United States has declined substantially. Moreover, the economic contribution of uranium mining to communities in New Mexico and nationwide have likewise declined."[98]

The mining company that received the permit is a subsidiary of General Atomics called Rio Grande Resources (RGR). The corporation's lawyer delivered their response to the petition. He summarized the petitioner's position that the Mining and Minerals Division director made an "Orwellian decision" and got the law wrong. In this way, he portrayed the petitioners' position as irrationally dystopian. He delivered the corporate response to the petition with a derisive tone: "He [the director] should have recognized that this is essentially a zombie mine with no hope of being brought back to life. Do we need a doctor to apply a stethoscope to see if it's alive? The

[98] I am supplementing my notes from the hearing with public information from New Mexico Mining and Minerals Division website: http://www.emnrd.state.nm.us/MMD/NMMC/documents/SignedMinutes_2018-05-07.pdf; accessed June 20, 2019. This quote is from the Petitioner's Notice of Intent to Present Technical Testimony.

director does not declare a mine dead on arrival." He summarized the basic position of the petitioners as a misinterpretation of the terms "mining" and "exploration." The company's definition of "mining" includes exploration and other activities that are not directly related to the production of minerals. From the perspective of the mining company, "mining" does not mean narrowly the extraction and production of minerals. RGR's broad definition of mining allows for significant leeway in activities that could be considered for a mine to return to active. Their definition or lack thereof dilutes the political valence of economic critique.

With the terms broadly conceived, it became apparent that the director of the Mining and Minerals Division is guided by vague definitions of key operational terms, which allow absolute discretion of the director and no apparent limits on the amount of time an operator can remain in the planning and scheduling phase of development. What is the threshold at which regulation and enforcement would occur? What is the trigger for enforcing closure and reclamation? These were the prevailing questions among the petitioners and the commissioners who voted in favor of rescinding the permit. Jim Kuipers was allowed to testify as an expert witness for the petitioners, "as a professional engineer and expert in mine design, mine development and production, temporary cessation of mining operations, reclamation and closure, and engineering economics," though he had to withhold his experience regarding "economics." He testified that "with the exception of exploration, none of the activities RGR proposes for 're-activation' are activities that are contemplated by the Mining Act's definition of 'mining.'" Mr. Kuipers testified further that "the Director's and RGR's interpretation of 'mining' and their interpretation of the Mining Act's requirements for standby and active mining are inconsistent with generally accepted mining practices."

All RGR needed for the license to operate was a schedule—a schedule of engineering construction tasks that may or may not lead to the extraction of minerals. Following the hearing, during an interview with Paul Robinson, research director at Southwest Research and Information Center (SRIC), I asked him what to make of the Mount Taylor Uranium Mine "return to active." Part of his response was that "the actual getting into production and producing ore is what constitutes mining." He said, "They are not on an accelerated time frame, it's just that there is a hope of mining. So the idea that there is a possibility that mining could happen, as opposed to mining likely to happen, that is what the state has accepted as mining. So there is a schedule, and being able to meet that schedule would indicate whether they are making progress, but the state would not agree to holding the company to that schedule, to those milestones, as I understand it." Robinson said, "I've met Dr. Kuhn [the mining engineer of the Mt. Taylor Uranium Mine] and I appreciate that he can develop a schedule for the various steps. That is an engineering construction scheduling task as opposed to any commitment to mine or indication that there is likely to be ore daylighting at the end of the process." Their definition of mining without producing minerals was accepted by the state because the company produced a schedule that "could" lead to mining—the actual extraction of minerals.

Authorized by the Mining Act of 1993, the commission consists of seven voting members as stipulated by 69.36.6 NMSA:

> (1) the Director of the Bureau of Geology and Mineral Resources of the New Mexico Institute of Mining and Technology or his designee; (2) the Secretary of Environment or his designee; (3) the State Engineer or his designee; (4) the Commissioner of Public Lands or his designee; (5) the Director of the Department of Game and Fish or his designee; and (6) two members of the public and an alternate for each, all to be appointed by the Governor with the advice and consent of the Senate.[99]

[99] http://www.emnrd.state.nm.us/MMD/NMMC/nmminingcommission.html; accessed June 20, 2019.

On July 2nd, the New Mexico Mining and Minerals Commission voted to uphold the director's decision and declined the petitioners' request to rescind the decision to permit the Mt. Taylor Uranium Mine to "return to active." Rio Grande Resources counts the mining permit (CI002RE) from the Mining and Minerals Division among seven permits already in place for the Mt. Taylor uranium mine to operate. But more permits will be required, including Nuclear Regulatory Commission (NRC) permits that require climatic data (Robinson 2019). In the meantime, the cleanup process for the mine site remains suspended, with scarce precautionary barriers to prevent the mine waste from cascading into the San Mateo Creek Basin, the Rio San José Basin, and the high desert ecology of northwestern New Mexico. With the term "mining" defined broadly, by limiting the economic discourse of the petitioners, and suspending the economic considerations of the commission, Mount Taylor became a viable economic resource.

What sort of "anti-economics machine" was this? James Ferguson (1994) noticed a kind of "anti-politics machine" in international development discourse that sought to depoliticize "development" with economic terms. What we noticed here was how "development" took precedence by erasing economic critique of uranium oxide as a low-value commodity of global exchange. What was the dominant discourse that displaced this economic critique? It was the economic speculation that mining "could" happen, not that mining "will" happen. Though the public had to refrain from economic concerns, the commissioners kept talking about the economic prospect of uranium. The coordinator of MASE, Susan Gordon, called out this phenomenon and delivered a public comment that included the main points of economic analysis from the Dr. Power testimony that the commission did not allow. Though the lawyer for RGR protested, the commission would not allow him to intervene. Gordon enunciated the economic

critique. Even though the commission refused to consider the pessimistic economic analyses in their decision, economic discourse had clearly become dominant.

Commissioner Virginia McLemore was in the role stipulated by the Mining Act as Director of the Bureau of Geology and Mineral Resources of the New Mexico Institute of Mining and Technology. After voting to uphold the director's decision, permitting the license to operate, she explained that she has been teaching the next generation mining engineers that "mining is a cycle that goes from exploration to development to operations to closure to reclamation to a post-mine land use that is sustainable in the future." "At any time, because of economics, that cycle can cease, and the mine may cease production, either temporarily or even forever."[100] I was one of Professor McLemore's students. Visiting from Rensselaer Polytechnic Institute, I audited her course, "Geology and Economics of Industrial Minerals," at New Mexico Tech during the spring of 2018. I cite some of the coursework in Chapter 4 in order to illustrate the logic of economic geology and the study of industrial minerals. From Dr. McLemore's standpoint, it is important to understand the political-economic lifecycle of industrial minerals.

In the description above, we are presented with two diametrical points of view: On the one hand, the bullish optimism of the company and the majority of commission and their rule of thumb that the cyclical demand for all industrial minerals meant the demand for uranium could return; on the other hand, the petitioners had completely excluded that possibility. Despite the elimination of economic terms from the vocabulary of the petitioners, the company and the commission continued to raise economic arguments about the fate of the uranium market. I positioned myself at the hearing by authoring and submitting the following written public

[100] See https://nmelc.org/2018/08/03/mining-commission-issues-final-order-approving-mt-taylor-permit/; accessed June 19, 2019.

comment, which highlights the precarious relationship between the Mt. Taylor Uranium Mine and the EPA's proposed San Mateo Creek Basin Superfund site, as well as the Rio San José Basin; its precarious relationship with Anglo and Hispano community stakeholders in Grants, Milan, and San Mateo; its precarious relationship with Indigenous community stakeholders; and the Mount Taylor Traditional Cultural Property (see Figure 15).

Dear Chair and Commissioners,

Thank you for considering my public comment regarding Permit Revision 13-2 to Permit No. CI002RE. My name for the record is Thomas A. De Pree. I am a Ph.D. student at Rensselaer Polytechnic Institute (RPI) and I am a resident of Albuquerque, New Mexico. I was recently awarded the two-year RPI HASS Fellowship to undertake my dissertation research on the history of uranium mining in northwestern New Mexico and various technoscientific approaches to environmental monitoring and ecological restoration. In the letter that follows, I will make four brief comments based on my experience in the Grants uranium district. I hope the Mining Commission of New Mexico will find my comments pertinent to the matter at hand: The inquiry and perhaps intervention into the Mining and Minerals Division director's decision to permit the Mt. Taylor uranium mine to transfer from "standby status" to "operating status."

First, I hope the commissioners will consider that the Mt. Taylor mine project site is located within the proposed area of interest for a Superfund site and candidate for the National Priorities List. On January 23rd and 25th of 2018, Region 6 of the Environmental Protection Agency (EPA) presented their proposal for the 321-square mile San Mateo Creek Basin Superfund site within the Rio San José drainage basin to the McKinley and Cibola County Commission. According to the EPA, there are four uranium legacy mill sites within the basin, underground workings that connect over large areas, and thousands of exploratory boreholes that serve as conduits throughout different aquifer formations. Historic mine water discharge and mill tailing liquids have seeped into soils and significantly re-saturated portions of the alluvial and underlying bedrock aquifers. Has the subsidiary of General Atomics, Rio Grande Resources (RGR), demonstrated that they are prepared for the problem raised by the EPA about the site? Though RGR has responded to the increase in molybdenum and selenium with the proposed MoSe system, are they going to be responsible for addressing an increase of residual effects from other sites managed by the Department of Energy Office of Legacy Management and Homestake-Barrick Gold Corporation? How will the proposed Mt. Taylor mine project affect the EPA's CERCLA investigations and Superfund remedial processes?

Second, community stakeholders from Grants and Milan, New Mexico have voiced interest at the Mining Commission hearing in bringing uranium mining jobs back to an economically depressed region. These stakeholders will be disappointed if the high-tech operation for the unique and complicated Mt. Taylor mine recruits a majority of their employees from Colorado School of Mines. These community stakeholders expect a robust training program at the New Mexico State University branch in Grants that awards academic and professional degrees and certifications in relevant sciences and engineering for their jobs at the Mt. Taylor mine. In 2016, there were 9,298 residents in Grants and 3,234 residents of Milan. How will the roughly 600 RGR jobs benefit the state and counties that bear the uranium ore resources and allocate taxpayer money toward the safe and responsible development of useful and salable minerals?

Third, as representatives of the State of New Mexico on an international stage, please consider carefully the comments of the Laguna-Acoma Coalition for a Safe Environment

(LACSE) and their human rights concerns about extracting and processing hazardous materials on private property nested within a state-designated Traditional Cultural Property (TCP), amid the sacred mesas of Acoma, Laguna, Diné, Zuni, and Hopi peoples, who additionally have the support of all the pueblos of New Mexico and the international Indigenous community. Because the proposed Mt. Taylor mine is surrounded by the TCP, it is also surrounded by the United Nation Declaration on the Rights of Indigenous Peoples. This raises the stakes and expectation that the harmful constituents produced onsite will indeed be contained onsite, which will require constant vigilance given the problems outlined in my first comment. Furthermore, despite the current designation of the site as private property, uranium processing would occur on the original ancestral homelands of the people, in a place where cultural, historical, and natural resources have already been greatly impacted. The bottom line is underscored in the EPA's narrative of contamination in the region, which describes the real possibility that the region's undesignated sole source aquifer, the San Andres-Glorieta (SAG), could become greatly affected. Because the aquifer sustains one of the oldest continuously inhabited communities in the United States, Acoma, your responsibility for the Mt. Taylor uranium mine's return to "operating status" bears a weight of historical and international proportions.

My final comment is one of gratitude. I have only a dim recognition of the double binds, the rock and the hard place, within which the commission and the division operate. I wish you the best of luck in deliberating whether the director of MMD abused his discretion by permitting "operating status" for a project that rests at the political heart of the State of New Mexico.

Warm regards,

Thomas A. De Pree

Figure 15. The author's letter to the New Mexico Mining and Minerals Commission regarding the Mt. Taylor Uranium Mine's permit to return to active.

Whatever the economic prospect of uranium oxide as a commodity, there were other issues at stake during the hearing that do not divide easily into "economics," "politics," or "religion." The issues were raised by public commenters about the relationship between Mt. Taylor Uranium Mine and the Mount Taylor Traditional Cultural Property. I took note of the constellation of political coordinates that MASE, Amigos Bravos, and New Mexico Environmental Law Center (NMELC) plotted against the uranium mining industry and presented verbally to the Mining Commission during the hearing and through written public comments: historical, cultural, and archaeological protection; a holistic view of sacred nature rather than the commonplace piecemeal view of secular nature; environmental racism and environmental injustice; international rights of Indigenous peoples; and the Mount Taylor Traditional Cultural

Property. These are political coordinates and discursive strategies that were deployed against the mining industry, albeit unsuccessfully, at least in persuading this commission this time.

9.4 The Mount Taylor "Traditional Cultural Property"

During the Mt. Taylor Uranium Mine hearing, the Laguna-Acoma Coalition for a Safe Environment (LACSE), a core group of MASE, reminded the commission through individual public comments that, in 2009, Mount Taylor was designated a Traditional Cultural Property (TCP) on the New Mexico List of Historic Places. The designation was sought in 2008, in direct response to "a new wave of uranium development activities" (*Voices from the Earth* 2008). On December 13th 2006, prior to the designation of the TCP, "The Acoma Cultural Province" came into being, which signaled Acoma's capacity to expand "cultural" sovereignty across their greater ancestral landscape. Because the proposed Mt. Taylor Uranium Mine threatens to undermine Section No. 5 through 7 and Section No. 9 and 10 of the Acoma resolution (TC-NOV-22-06-Vb), which garnered the support of the All Indian Pueblo Council,[101] Five Nominating Tribes submitted an Emergency Petition supporting the listing of Mount Taylor as a

[101] See Section No. 5 through 7 and No. 9 and 10:

> **Section No. 5**: The protection of Acoma's cultural and natural resources for use by the Acoma community is an essential part of the Pueblo's duty to protect the health, safety and welfare of the community and its cultural preservation now and into the future; and
> **Section No. 6**: Past mining activities in the region have detrimentally affected air, land, water and the public health; and
> **Section No. 7**: The issuance of uranium and coal mining, milling, and other development permits upstream of Acoma threatens further degradation and impairment to Acoma's water and cultural resources within the Acoma Culture Province, as well as other natural resources within Acoma's exterior boundaries…
> **Section No. 9**: Affording the greatest protection to the Rio San José watershed and the public health necessitates a *responsibility* to protect the sacredness of significant cultural landscapes which serve as places of worship and spiritual landmarks; and
> **Section No. 10**: Acoma's right to unimpaired access to these areas to continue traditional cultural practices, existing from time immemorial will assure maximum protection of sacred sites and their pristine ecology within the Acoma Culture Province, as well as the Rio San Jose watershed (2006; emphasis added).

TCP and included important cultural and historical information to translate and demonstrate the value of the mountain in a capitalistic, modern secular, settler colonial legal system.

Petuuche Gilbert of Acoma reminded the commissioners about the proximity of the Mt. Taylor Uranium Mine in relation to the sacred space of Mount Taylor and the Cibola National Forest. He asked them to acknowledge two documents: The United Nations Declaration on the Rights of Indigenous Peoples and the American Declaration on the Rights of Indigenous Peoples. Gilbert echoed something I first heard at a U.S. Human Rights Network "tribunal hearing" at the Gallup Community Services Center in New Mexico during my initial fieldwork in 2014. At the tribunal hearing, Petuuche Gilbert gave a human rights statement on behalf of the U.N. Indigenous World Association and the Laguna-Acoma Coalition for a Safe Environment, a core group of the Multicultural Alliance for a Safe Environment:

> I will talk about *environmental racism* perpetrated by governments to satisfy the energy needs of the country. My view is that a rich country goes into under developed countries and into rural communities where useful natural resources are located and mine them while advocating prosperity via economic development. Such actions occur where minority populations are powerless to overcome the majority richer populace. As a result rural areas are devastated and attempts made to try and reclaim the land. At one time these actions meant to satisfy the energy needs of America while ruining land for generations of people was called national sacrifice areas. This, in my mind, is *environmental racism*. The government's response to cleaning up historic uranium mining and milling waste and permitting new uranium mines violates Articles 1, 2 and 5 of the Convention on the Elimination of All Forms of Racial Discrimination (Gilbert, July 22nd 2014; emphasis added).

After the tribunal hearing, the U.S. Human Rights Network submitted their report in Geneva to the U.N. Committee on the Elimination of All Forms of Racial Discrimination (CERD). One of their recommendations aligns closely with Petuuche Gilbert's statement.

> While welcoming the acknowledgment by the State party that low income and minority communities are exposed to an unacceptable amount of pollution, as well as the initiatives taken to address the issue, the Committee is concerned that individuals belonging to racial and ethnic minorities as well as indigenous peoples continue to be disproportionately affected by the negative health impact of pollution caused by the

> extractive and manufacturing industries. It also reiterates its previous concern regarding the adverse effects of economic activities related to the exploitation of natural resources in countries outside the United States by transnational corporations registered in the State party on the rights to land, health, environment and the way of life of indigenous peoples and minority groups living in these regions (Human Rights Network 2014).

While human rights and social justice were major political coordinates leveraged by MASE and colleagues, "history," "archaeology," and "culture" also became significant points of discussion. During the hearing, a legal advisor delivered the Pueblo of Acoma's official response that the approval of the Mt. Taylor Uranium Mine be compliant with the protection of historic and cultural designations under the New Mexico Cultural Properties Act.

The company assured the commission that, though the mine is named after Mt. Taylor, it is on private property on the other side of the TCP boundary. One of the commissioners, Virginia McLemore, pointed out that the mine would operate adjacent to one of the designated sacred mesas. The TCP is surrounded by private property, land grants, and various forms of state, federal, and tribal lands. It is significant that the Mt. Taylor Uranium Mine would operate among the sacred mesas in places of intertribal access to the mountain. Although the "wet mine" would pump mine water discharge by pipe into the Rio Puerco, on the other side of the mountain, it would also treat and "produce water" onsite and attempt to sell it for industrial purposes. RGR did not see how the mine site, which is located in the watershed area that drains into the San Mateo Creek Basin and the Rio San José, would impact surface and groundwater sources. They promised to keep contaminated water and other materials onsite. RGR perceived a bounded and discrete "site," and a process by which hazardous materials from processing the uranium ore would be contained and treated onsite, right down to washing the tires on the trucks that would haul the uranium ore. This is what I call "epistemological disassociation"—a peculiar thought style that considers the mine site as separate and discrete from the landscape in which it is

embedded and the people who inhabit it. This epistemic regime fragments and displaces local knowledge, discourse, and practice (Ortiz 1980); it produces "data gaps" and fractures in environmental information. It can be contrasted with "epistemological association," which recognizes how the whole land is sacred through its interrelations with humans and nonhumans.

At the hearing, the petitioners and public commenters gave voice to the relationship between the mine site and everything around it. June Lorenzo commented at the hearing that "Mount Taylor is not the kind of sacred site you can fence-in in a little circle." Even if they are operating on private land, they are operating in relation to the TCP. "The entire landscape is the aboriginal territory of Indigenous Peoples in the region" (Lorenzo 2017:1). The whole land is sacred to all the Indigenous peoples of the Southwest. Kelley and Francis mark this difference as the "piecemeal" perspective versus the "holistic" view (1994:42). "There are qualitative differences among places" but, "one cannot isolate a particular place as being more significant ('sacred') than another; places each draw their particular distinct significant qualities from their interrelations, from how each functions in the overall system ('the whole land') that sustains the Navajo people and way of life" (Kelley and Francis 1994:42). June Lorenzo shows how articulating the common understanding of interrelationship and interdependence of all Indigenous peoples and Mother Earth, can serve as a gesture of Vizenor's "postIndian warrior" simulations of "survivance," rather than a form of "neocolonial essentializing impositions" (Lorenzo 2017:3):

> Thus, for most Indigenous Peoples our epistemologies, which connect us to "place," tell us that the Earth – our Mother – is a living being, that we must always be respectful, and mindful of where we came from, and that continued relationship is central to a peaceful and just world. For example, the Preamble of the Universal Declaration of the Rights of Mother Earth (2010) issued by Indigenous Peoples from every continent gathered in Bolivia, states that 'we are all part of Mother Earth, an indivisible, living community of interrelated and interdependent beings with a common destiny' (2017:3).

The TCP fails to comprehend the expansiveness, interconnectedness, and totality of the original ancestral homelands of Indigenous peoples of the Southwest. The Mt. Taylor Uranium Mine is situated precariously in a watershed area of Mount Taylor—a mountain that actually brings water to the high desert landscape, which then flows into the San Mateo Creek Basin and the Rio San José Basin before reaching Acoma and Laguna. One of the primary medias of interconnectedness is water, represented by *katsina* spirits who take the form of clouds, rain, moisture, and lightning bolts. Severin Fowles describes Pueblo peoples' "engagement with a set of nonhuman beings known as the katsina," which are most significant as, "the bringers of rain and ecological prosperity. At a conceptual level, they are so closely linked with rainfall that the words used to refer to katsina are the same as those used to refer to clouds, cloud people, and storm clouds" (Fowles 2012:202-203).

Mount Taylor is a sacred pilgrimage site for 30 Native American tribes who trace the relationship between the clouds and the mountain by visiting Mount Taylor, thus enacting these powerful forms of interconnectedness. The mountains permeability for sacred movements of Indigenous peoples is often unacknowledged in the management of the surrounding landscape. For example, according to an article in *Voices from the Earth*: "While certain activities of Nominating Tribes have been cut short due to fencing in the area (at least one sacred trail for Zuni Pueblo has been blocked by fencing, making pilgrimages quite difficult, if not impossible) many activities are still being performed just as they have been since before recorded history" (2008:6). The fence that blocks sacred pathways is an icon of conflicting spatial practices and the private property that inhibits access to sacred Indigenous spaces and places. Examples of the interconnectedness of mountains and Pueblo and Diné (Navajo) peoples abound as exemplars of epistemological and ontological association; whereas barbwire fences indicate a spatial practice

of disassociation. It is important to note that forms of disassociation are in fact their own peculiar forms of association. The Latin prefix dis- meaning "apart," "asunder," "away;" it can also refer to an inherent "privative, negative, or reversing force."[102] It has a "privative" force that creates an "the absence of a quality."[103] In the previous chapters, I described how transnational mining corporations have applied such knowledge of disassociation, which produces fractures and fissures in environmental information—"data gaps." This is a peculiar thought style that backgrounds the impacts of industry, discursively and geophysically conflating industrial systems with "nature." A "dis" without the hyphen is an insult: "to find fault with."[104] This is the fault we find within epistemological dissociation, which is a disrespectful and irresponsible form of association.

[102] https://www.dictionary.com/browse/dis-; accessed July 5th 2019.
[103] https://www.merriam-webster.com/dictionary/privative; accessed July 11th 2019.
[104] https://www.merriam-webster.com/dictionary/dis; accessed July 11th, 2019.

Figure 16. A mural commissioned by MASE that reads, "HONOR THE PEOPLE PROTECT MOUNT TAYLOR" in East Downtown Albuquerque, New Mexico. Photograph by the author.

9.5 Sacred-Secular-Politics-Economics-Religion-Archaeology-Culture-History

With his conception of "Pueblo doings," Severin Fowles describes how the settler orthodox legal purview fails to apprehend the interrelationship between "politics," "economics," and "religion," as well as what is deemed "secular" and "sacred" among Pueblo peoples:

> Most often, an appeal is made to the way Pueblo commitments to specific places are like other people's religious commitments to sacred things. Occasionally, ancestral sites are portrayed as akin to the foci of nationalistic or capitalistic commitments as well. None of these translations are made insincerely, but none are fully adequate either, precisely because Pueblo doings continue to be neither religion nor politics, nor economics. As Curtis Francisco of Laguna Pueblo put it during the protests to prevent uranium mining on Mount Taylor (a key focus of his tribe's doings), "We don't look at [Mt. Taylor] just as a shrine. We look at it as life itself" (quoted in Linthicum 2008). "Shrine"—the language of religion—now proves too weak when confronting capitalist forces of secular modernity; and in the search for a meaningful translation, the Pueblos increasingly have no recourse but to evoke "life itself," although such statements do little more than signal the complete breakdown of translation. Certainly, they are illegible from an orthodox legal standpoint. What we are seeing in all these shifting references, however, are

> indigenous efforts to find discursive leverage within a dominant society that is still unwilling to accept Native American alterity in its own terms (Fowles 2013:250).

June Lorenzo (2017) remarks on this complete breakdown of translation and the failure of religious claims in U.S. courts, noting that Indigenous claims of religion are not taken as seriously as Judeo-Christian forms. She proceeds to ask:

> How can Indigenous Peoples secure protection of sacred areas in a manner authentic to who they are, based on their responsibility? In the case of Mt. Taylor, the five tribes opted to seek a TCP designation rather than litigate their "American" rights to freedom of religion. Thus, rather than asserting a right, they worked on designation of the TCP as a way of inviting state and public entities to join them in efforts to protect a sacred cultural landscape for future generations of Native and non-Native people (Lorenzo 2017).

Thinking with the Mt. Taylor TCP, Lorenzo critiques Ed Soja's conception of spatial justice and encourages us to move from a rights-based approach to a focus on *responsibility* in ways that call non-native individuals and institutions to respond in kind. Shifting from discourse of "religion" and translating the significance of the mountain, Lorenzo and colleagues refer to the political coordinates of "history," "archaeology," and "culture," which are leveraged in response to settler forms of "development" and uranium mining in particular. These terms wield a particular political valence in state and federal legal settings. Tracy Voyles describes how the Mt. Taylor TCP was articulated as "an historical text":

> In the process of this counter-mapping of the mountain, the nominating tribes focused not just on the importance of these different indigenous toponyms but also the *meaning* of "land," "property," and "landscape" within the apparatus of state and federal protection policy. The application, then, did not necessarily define the mountain as "property" of the Navajo and Pueblo peoples. Rather it defined the TCP area on the mountain as "an *historical text* for each Nominating Tribe" (emphasis added), "communicating much about where the people come from, how they came to be who they are today, and what their continuing obligations are to the natural and cultural environment of their homelands." This notion that the mountain functions as a "historical text" emphasized that there is knowledge inhered in the geography of the land itself and the historical integrity of the mountain resides in its role recording (and constructing) tribal life and past much the way westerners presume that books and archives record (and construct) theirs (Voyles 2015:206).

What does the Mt. Taylor Uranium Mine's permit to return to "active" suggest about the historical text strategy for the TCP? This situation gives us insight into how "history" can be treated when looking ahead at the economic prospect of mining. The positive and cumulative view of Mount Taylor contra the negative or reductive view of Mt. Taylor are negotiated through the geophysical production of nature, which is driven by the conflicting ideological orientations of *rights* contra *responsibility*—the "right" to develop natural resources and the "responsibility" to maintain Mother Earth. Lorenzo's proposition of Indigenous *responsibility* raises questions about progressive notions of universal *rights*:

> How can Indigenous Peoples secure protection of sacred areas in a manner authentic to who they are, based on their responsibility? In the case of Mt. Taylor, the five tribes opted to seek a TCP designation rather than litigate their "American" rights to freedom of religion. Thus, rather than asserting a right, they worked on designation of the TCP as a way of inviting state and public entities to join them in efforts to protect a sacred cultural landscape for future generations of Native and non-Native people (Lorenzo 2017).

June Lorenzo encourages us to move from a rights-based approach to a focus on *responsibility*. How does Mount Taylor's status as a universal human right obstruct Indigenous responsibility? How has Mount Taylor become an icon of "multiculturalism," which can be conceived in ways that upscale Indigenous grounded normativity and senses of responsibility, and displace God-given rights to resources? Judeo-Christian notions of God-given rights to salvage the earth are incommensurable with notions of Indigenous responsibility to maintain Mother Earth. June Lorenzo shows how the Mount Taylor TCP was leveraged as an exemplar of Indigenous responsibility that invites non-native colleagues to reciprocate in kind. Her discourse of "multiculturalism" serves to "scale up" (Downey 2009) notions of Indigenous responsibility and broaden the impact of what Glen Sean Coulthard calls "grounded normativity," by which he means, "the modality of Indigenous land-connected practices and longstanding experiential knowledge that inform and structure our ethical engagements with the world and our

relationships with human and nonhuman others over time" (2014:13). I hope this understanding of multiculturalism will nuance the scholarship of settler colonialism, which offers strong reasoning to be critical of the way discourse of "multiculturalism" has been leveraged to undermine Indigenous sovereignty through cultural recognition (Coulthard 2014; Dunbar-Ortiz 2014; Simpson 2014).

Lorenzo adopts the concept of "spatial justice," amending urban-centric universal rights discourse, to "articulate what Indigenous Peoples want while they/we in turn can contribute a lived-out dimension to spatial justice regarding protection of sacred lands" (2017:15). She cautions us against using "spatial justice to secularize what Indigenous people view as an ontological and epistemological conversation. Indigenous efforts to protect sacred places cannot focus solely on secular domestic preservation values or international human rights, but must always focus on the sacred relationship and concomitant responsibility to protect, rooted in Indigenous epistemologies" (Lorenzo 2017:15). We must resist the secularizing habits in which naturalized human rights are taken as an excuse to sacrifice and salvage sacred Native spaces and places.

Traci Voyles contours the gradients of power at Mount Taylor to show how conflicting representations of space between Indigenous peoples, Anglo and Hispano settlers, and transnational mining corporations map onto the uneven geophysical production of the mountain:

> This description illustrates the stark differences between industrial and indigenous perspectives on the mountain and its role in human life. The language used by the company, like language used in industrial geology as a whole, describes landscapes in terms of relationships between mineral deposits… geologic time… and potential yield of minerals… This kind of discursive framing maps the uranium industry *into* the very geography and history of the mountain; just so, the industry inserts itself into the past of the region as well as its future… This kind of mapping, steeped as it is in the seeming objectivity of scientific discourse and geologic time, is afforded more power than "other" (particularly Native or Nuevomexicano) maps of the mountain that premise its immediate relevance to the culture, religion, or economy of local populations, as reflected by the

> statement by Nuevomexicano land grantee Horacio Marquez, that 'Gulf knows more about my land than I do' (Voyles 2015:206).

The uranium mining industry inserts itself into the past and the future through its own peculiar "second orogeny"—a concept that illustrates the different epistemological and ontological associations and disassociations with mountains and minerals.

Through the geophysical production of nature, sacred lands are rendered legible and ancient Indigenous geologic archives are turned into modern industrial geologic archives. They use the information from the archives to extract the orebodies. They take the valuable uranium ore and other salvageable industrial minerals, leaving the bodies in piles of uranium mill tailings. They begin by translating naturally occurring uranium into the language of industrial minerals, which turns rocks into economic "resources" through geologic models and exploratory drilling. Thinking of exploratory drilling, I take Lewis Mumford to task and consider how "the animus of the miner's technique is reflected in his treatment of the landscape" (1934:71). *The animus of the miner* refers to the proliferation of industrial ideas, values, and attitudes toward nature. It has taken form over the course of five centuries and inheres in the logic of economic geology, discourse of industrial minerals, and their associated drilling programs that relentlessly penetrate Mother Earth.

Exploratory drilling offers a visceral image of what Fred Ho notices, "The ultimate destructive hubris is the supremacy of humanity, as argued for in human endowment for technology, social complexity and abstract thinking, a feature so deeply ingrained in Eurocentric thought. Humanity over her Mother—Mother Earth. To make one's mother the ultimate commodity as slave and prostitute" (2013:17). Consider Neil Smith's remark, "It is a commonplace… that nature is often envisioned as female. As complex and as sodden with metaphor as the concept of nature is, probably no metaphor is as prevalent or as deep-seated as

the femininity of nature. It is striking that the treatment of women in capitalist society parallels the treatment of nature" (1984:26).

These sexist relations with nature can be subverted through certain Diné epistemologies and ontologies. For example, Mount Taylor:

> Tsoodził, is a female mountain. She is a "bringer of life" as well as a "taker of life." She is known to have rebelled previously by cutting off her turquoise dress and shaving one side of her head to show her rebellious nature. This type of rebellion by Tsoodził translates to the loss of natural resources provided by the sacred mountain, which are necessary to sustain life, both human and non-human. To extract minerals from her is to disturb her and the deity, *Tl'iish Tsoh*, Big Snake, who guards her. Continued ground disturbing activities cause her to rebel and destroy all in her path" (SRIC 2008:7). "If insulted, the mountains will no longer respond to the ceremonial requests of the Diné and wreak havoc upon the earth (2008:7).

Diné ontological and epistemological associations with Mount Taylor stand fundamentally at odds with the extraction of minerals and the settler disassociations, and their triumphalist pursuit of time over space. The cataclysms between mining and Indigenous peoples are perhaps best understood through the image of historic exploratory boreholes that are drilled as conduits of settler time over Native spaces.

The Grants uranium district is adjacent to Chaco Canyon, a United Nations Educational, Scientific, Cultural Organization (UNESCO) World Heritage site. The ninth- through thirteenth-century Ancestral Puebloan (*Anasazi*) masonic architecture is among the most prolific archaeology in the world. Greater Chaco accounts for a regional system of over a hundred ancient Great Houses spread throughout the North American Southwest, ranging north toward Mesa Verde, west toward Canyon de Chelly, east toward the pueblos of the Rio Grande Valley, and south toward Acoma Pueblo, with Chaco at the center (Lekson 2006:32). There is a stark contrast in the landscape between the ancient architecture, which is an expression of the millennia of resilient Indigenous lifestyles that have survived and thrive today, despite the

persistent settler colonial "logic of elimination" (Wolfe 2007), and the modern industrial features of the landscape: the man-made[105] mountains of uranium tailings and their associated boreholes, which were formed over the course of a few decades.

Chaco Canyon is located northeast of the northernmost Church Rock subdistrict. In 1978, a contractor of the Department of Energy "drilled 15 holes 4,200 to 5,200 feet-deep" in order to determine the feasibility of extending the Grants uranium district and making a "Chaco Canyon subdistrict" (McLemore and Chenoweth 2017:19). "Two holes in the Chaco Canyon area encountered significant mineralization in the Westwater Canyon Member at depths exceeding 4,000 ft, proving that uranium mineralization is found at depth in the San Juan Basin, although these deeper deposits are not currently economical" (2017:19). From the exploratory boreholes and uranium mill tailings to the Ancestral Puebloan Great Houses and kivas, sharply juxtaposed, these material features of the landscape mark the settler colonial imaginary of "frontiers in out-of-the-way-places" creates a situation where Indigenous peoples are perpetually burdened by settler technologies of displacement and dispossession.

9.6 Conclusion

I will conclude this chapter by encouraging critical scholars of settler colonialism to attend to different modes of "scalable scholarship"—careful attention to different theories of knowledge, diverse epistemological styles that have been marginalized and minoritized, and how they can displace the dominant epistemological paradigm (Downey 2009)—in combination with strategies of political and ethnographic refusal. I take up this task of scalable scholarship as an opportunity to cite models of critical Indigenous scholarship, which are endorsed for non-Native

[105] Although women did eventually secure work in the mines, at mills, and hauling ore by the 1970s, these piles were largely made by men.

audiences. Given the disastrous implications of the Anthropocene and the necessary devastation of the land that mining entails, Indigenous models of grounded normativity offer refrain from the ecological sacrifice and salvation that ruptures all the way down, undermining the promise of ecological modernization.

Models of Indigenous grounded normativity have already inspired one of the most important ideas of non-native, Anglo-Saxon, European-American, so-called "Western" paradigms of thought about political economy. Lewis Henry Morgan's portrayal of "primitive communism" and "Pueblo primitive communism" in the U.S. Southwest was taken by Karl Marx and Friedrich Engels as a model of other possible social relations before, beyond, and nested within capitalism:

> Eleventh-century Chaco impacts the twenty-first century (and our lives today) through the nineteenth-century works of Lewis Henry Morgan…. Morgan made the Southwest and, in particular, Chaco Canyon the prime ur-commune, the source of 'primitive communism' from whence came all other forms of communes in ancient North America… Morgan, of course, profoundly influenced Marx and Engels and the theoretical development of Marxism…. Within both anthropology and the larger world of ideas, the pervasive view of Pueblo societies, past and present, is egalitarian, governmentless, and communal. Chaco and the Pueblos were exceptions that proved the rule. Chaco justified our hopes for communal utopia, despite disasters in Russia and China…. If we are to credit Marxism as a political program, we must first believe that human nature will allow communism. The record of modern Marxist states is not good. Primitive communism is the proof, the warrant, that the program is still possible (Lekson 2006:38-39).

Regardless of the actual social arrangements at Chaco (hierarchical and stratified or ahierarchical and unstratified, political or religious), the idea that ancient and contemporary Pueblo societies are an exemplar of life beyond, before, and nested within capitalism has already profoundly inspired us with the prospect of an alternative political program. Though Lekson focuses on Marx's and Engels' drive toward a communist political program, archaeological ideal-types of Chaco and contemporary Pueblo societies provide models of other possible social relations

beyond capitalism. What I am proposing here is a bibliographic strategy that borrows the style of citation Gayatri Spivak (2012) calls “ab-use from below.” Going against the grain of the colonial archive and chipping away at the befuddling binaries of the European Enlightenment. The task that takes place after the text and after the fact is to contribute to the many ways in which environmental sciences and engineering can be positively improved through “explanatory pluralism” (Keller 2002:300), and the inclusion of diverse stakeholder perspectives and forms of knowledge (Hoover et al. 2015; Scammell 2010).

CHAPTER 10

CONCLUSION

I have argued here that the technopolitical life of the by-product has emerged in northwestern New Mexico in the form of an environmental cleanup regime that coordinates around issues of uranium mill tailings and mine waste. It is composed of different epistemological styles of geosciences for environmental monitoring and engineering from universities, civil organizations, government agencies, and corporations. By contesting baseline levels of environmental data, these stakeholders deliberate about appropriate technologies and techniques of environmental monitoring, modelling, and engineering using incommensurable terms of "restoration," "remediation," and "reclamation."

Permission to pollute is the guiding principle of this environmental cleanup regime; "alternative standards have been adopted in all cases" (Robinson, September 13th 2018). Recall how Paul Robinson contrasts the terms of "remediation" and "restoration" to show the spectrum of policy and technology approaches: "So New Mexico is not a place where you see some of the better technology, though there is extensive technology used" (September 13th 2018). The implication was that the major "innovations" in environmental cleanup were happening in the policy sector, not the science, technology, and engineering sectors; the changes were in the state and federal groundwater permitting programs and guidelines for remediation.

My thesis is that the possibility of cleaning up the Grants uranium district revolves around the "politics of baselining," which refers to the relationship between three categories of stakeholders. It describes how corporations attempt to limit their environmental liabilities by producing science that establishes baseline data which permit a higher level of contamination in the environment, thereby limiting the extent to which they are obligated to cleanup. This is a

strategy of "corporate science" (Kirsch 2014). I use the term "backgrounding" to describe the form of figure-ground interplay (Feld 1996) in which the object of study and the subject of governance (e.g., uranium mill tailings piles) recede into the visual background of the landscape and the literal background of the environmental data. State and federal permitting regimes give the permits that allow for alternative contamination limits (ACLs) and allow companies to pollute. Government employees also create "political openings" and make spaces for local communities to work together to limit their exposure to environmental health risks. Regional NGOs and local communities can then employ independent scientists who criticize strategies of corporate science and produce forms of "civic science" (Fortun and Fortun 2007) that support lower baseline levels of contamination that register under the maximum contaminant levels (MCLs).

These entangled scientific discourses are fundamentally about claims of "nature" and what can be deemed "natural." It is ironic that such claims of "naturalness" are so thoroughly anthropogenic (made by humans). The practice of "baselining," or defining a "nature" prior to industrial impact, is ubiquitous in the field of environmental regulation; and it is "crisscrossed by technical, political, and ethical issues" (Ureta 2017). These claims to "nature" also calculate the limitations and possibilities of technology for the future and the promise and failure of ecological modernization. These are real political coordinates among stakeholders and they are leveraged in negotiating the politics of baselining. *Is it possible to clean up the Grants mining district?* This pragmatic question prompts further questions about the meaning of "cleanup" and what alternative standards have been accepted.

At this level of analysis, I have considered the different meanings and values of the keywords employed by different stakeholders. The questions were not just about "remediation,"

and the protocol of state and federal agencies: Can the standards be met? Or can we establish alternative standards that can be met? The questions raised by community stakeholders where about "restoration": Can we heal the land, restore local knowledge, balance Mother Earth, and bring things back into place? There were also questions about "reclamation": What use-values can we pull back? Transnational mining corporations are now asking questions that go beyond government permits to pollute, in search of a "social license to operate." "Reclamation" is about how to salvage the land in ways that would justify discourse of "sustainable mining." "Reclamation" and "remediation" entail various degrees of sacrificing the local values of "restoration."

In each chapter, I have explored the push and pull of explanatory forces working for and against environmental cleanup. Using the different terms, concepts, models, and metaphors of different stakeholders, I attempted to pluralize our understanding of the diverse forms of expertise involved in cleaning up the Grants uranium district. Ethnographic accounts of the emergence and entanglement of different stakeholder perspectives are compiled throughout the dissertation in a way that reads cumulatively and unevenly across the chapters. Notice how each ethnographic account can only be partial given the situated nature of the research, and the views and visions that interoperate in particular circumstances. This is one way of keeping track of the different epistemic formations and their explanatory force in action.

At another level of analysis, the structure of governance that has coalesced around these issues of environmental cleanup is unable to keep pace with the unintended by-products, the cascading effects of mine waste and mill tailings, and the ongoing industrial impacts upon the landscape. This is indicative of the raw material agency that undermines the promise of "restoration." The sheer pervasiveness of contamination is working against the community and

the promise of cleaning up the mine waste. The “data gaps” produced by corporate science can impede the alacrity with which state and community stakeholders can intervene. Conversely, through local forms of epistemological association and relational knowledge, “data gaps” and supposedly discrete mine and mill “sites” can be conceived in relation to the broader landscape in which they are situated.

There are different historical narrations of place-making that play into the politics of baselining. History combines with modes of measuring and regulating in forceful ways. This is perhaps most obvious in Chapter 9, where I contrast forms of epistemological association and disassociation using the concept of “second orogeny.” I demonstrated how an Indigenous and multicultural ethic of responsibility guides knowledge of interrelationships that make “the whole land” sacred. Mount Taylor has become an icon for scaling up Indigenous and multicultural relations of responsibility (see figure 16). Discourse of “multiculturalism” was used to organize diverse civic groups and push back against industrial mining interests.

This form of ontological and epistemological association is incommensurable with the “development” of late industrial “sites” that are discursively bounded and discrete. These “sites” remain an integral part of the geophysical landscape in which they are embedded. The Mt. Taylor Uranium Mine site is located in an important watershed for the entire region. It is one recharge point among many for the San Andres-Glorieta (SAG) aquifer, which is an important source of groundwater for the entire state of New Mexico. Corporate strategies attempt to limit environmental liabilities by disassociating themselves, the site, the mine waste, and mill tailings from broader environmental and social relations; but the gesture of epistemological dissociation is in fact its own peculiar form of association.

Though the dialectical understanding of relationship between corporations and their critics inheres in my ethnographic approach to public multi-stakeholder meetings, I suspend the notion of corporate villains, Indigenous victims, and a dysfunctional bureaucracy, in order to account for diverse forms of agency, the emergence and collision of powerful forms of discourse, and how stakeholders reign in "political openings" that come about in surprising ways. This ethnographic approach prompts a refusal to conclude, and a refusal to foreclose the many different possibilities for cleaning up former mining districts.

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