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Kinetic Landscape and Unalloyed Potential: Rethinking the Extractive Landscape of Michigan's Native Mass Copper Mining Industry

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KINETIC LANDSCAPE AND UNALLOYED POTENTIAL: RETHINKING THE EXTRACTIVE LIFESPAN OF MICHIGAN'S NATIVE MASS COPPER MINING INDUSTRY

By

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PREFACE

This dissertation consists of three, single-authored chapters, two of which have been submitted for publication as journal articles, the third published as a book chapter. Chapter 1 is currently under review in the *Mining History Journal* , while Chapter 3 was published in *IA: The Journal of the Society for Industrial Archeology*. Chapter 2 was the first of 3 chapters and an epilogue written by the author for a recent second edition of Donald Chaput's and Sean M. Gohman's (2015) *The Cliff: America's First Great Copper Mine, Revisited*.

A footnote on the first page of each chapter lists the publishing status and identifies the publication the article/chapter is/will be included in.

All archival figures are courtesy of Michigan Tech Archives and Copper Country Collections, unless otherwise noted.

ACKNOWLEDGEMENTS

I want to first thank my dissertation committee for sticking with me through this long journey. My advisor for nearly ten years, Patrick Martin, took a chance on a guy passing through town in January 2008, gave him a supported MS position, and stood by him as he grumbled and procrastinated his way through a PhD. Pat retired several years ago now, and could have walked away, but he didn't. And I'm forever grateful. You always found ways to support me — sometimes with some pretty weird tasks, frankly — but it made a professional out of me.

Fred Quivik constantly challenged my way of thinking about industrial processes, significance, and integrity. Fred's boundless enthusiasm for expanding research questions, as well as an editor's eye for the written word, pushed me into areas I never would have contemplated on my own. I couldn't follow all of those leads, or always find the right words to fully address his questions, but now I have a back pocket full of ideas, and reasons to keep writing. And like Pat, Fred is retired. But Fred is a patient man, and I did my best to finish before he moved back to Minnesota.

Don Lafreniere came on board a little later in my graduate career, when I had already completed my comprehensive exams and was working on my proposal for this dissertation. Initially approached to assist me with spatial questions I had for version 1.0 of that proposal. Subsequent changes to my research objectives lessened the importance of maps and spatial analysis, but Don's ability to cut to the chase, streamline arguments, and push you to move forward makes him a great person to have on your team, and I appreciated that he was willing to join the team.

Paul White is, simply put, the person who taught me what Industrial Archaeology has been, what it is today, and what it can be in the future. Paul not only taught my introductory course in the discipline, but also my first readings course. While that was during my MS tenure, it was really my first sampling of PhD-level discourse. It was about landscapes, and though it contained a lot of fluffy French philosophizing, I loved it all. Simply put, there is no scholar in the vast field of archaeology that I root for more than Paul.

A few other faculty I'd like to call out for their support over the years are Tim Scarlett, Larry Lankton, and Carol MacLennan. I never took a course with Tim, but he was the faculty of record every year out at Cliff, so I got to witness his enthusiasm for teaching every summer. He pretty much let me lead the way out in the field, for good and bad, but I suppose that's the point. You need to make research design mistakes to learn the correct approach later on when its earning you a paycheck. Larry taught me to care about the Copper Country, how to approach asking questions about it, and (implicitly) what questions were left unanswered. Years ago Larry joked about looking forward to reading my book on the Cliff. Well, here's your chance. Carol's contribution was very simple and indirect, but key. She started a writing group at the exact moment I was ready to chuck it

in. The writing group put me back on track, offered much needed support, and helped focus and finish my writing. Her empathic understanding of the difficulties faced when writing made all the difference for me.

From a professional standpoint, I'd like to thank a few local entities that have helped me in my dissertation research and professional development. First, the Keweenaw Road Commission, owners of the Cliff property, for letting me explore, map, excavate, and stick my nose in their business regarding site use. The Keweenaw National Historical Park and its Advisory Commission have been partners in many projects over the years, some of which have directly informed this dissertation. Through KNHP and the AC, I got to work at the Quincy Smelter, Ft. Wilkins, do a comprehensive survey of mine waste, and of course several years of field work at the Cliff mine. Scott See, Advisory Commission Director and fellow IA grad, was also the first student I spoke to when I visited MTU. So full circle. I am truly grateful for the opportunities to work with the park and the AC and collaborate on ways to tell the story of native copper mining. The Michigan Tech Archives and Copper Country Collections has also been the source of so much of the data I've worked with over the years. Always helpful, always courteous, always understanding of my idiosyncratic ways. The archives is just one of those places you always have a rewarding experience when visiting. So do so.

I've been at Tech for so long and seen so many students pass through The Department of Social Sciences and/or assisted on fieldwork at the Cliff, that it would be fruitless to try and name all of those who helped me complete this degree.* You all were instrumental in keeping me on the positive side of the path. But, I would like to single out two fellow students, without whom I'd have high-tailed it long ago. Dan Trepal, I met you the first night I spent in Houghton, just before leaving for the West Point Foundry field school and the start of my graduate career. You had just defended your MS thesis, you were not happy about your revisions, and you treated me like I was invisible. But that's OK. You've had ten years to make up for it. You're getting close. John Arnold, you began the PhD program before I did, and finished it before I did. If you weren't such a swell guy, that would peeve me. A friend to the non-sequitur and foe to punctuation, Arnold challenged my patience daily, and that's exactly what I deserve. Thanks, you guys, for helping me keep my sanity.

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DEFINITIONS

Mineralogical terms

Native copper: Copper existing in a pure, metallic state. Most mined copper is found chemically bound to other elements, but in the Copper Country, native copper predominates. Native copper in the Copper Country exists in three lodes:

- **Amygdaloid:** This is finely disseminated native copper that filled empty gas-bubble holes that formed within the top portion of lava flows. As the lava cooled, and the gas escaped, minerals—including native copper—filled in.
- **Conglomerate:** This is finely disseminated native copper that filled spaces between rocks and pebble sediment laid down by rivers in between lava flow events. Of the two disseminated copper lodes, conglomerate is historically richer, harder, and more difficult to process.
- **Mass:** When the geology of Lake Superior basin was forming, fractures cut across and between the various layers of lava and hardened sediment. Mineralized water precipitated through these fissures, and as it evaporated, minerals were left behind. In some cases, these fissures were filled with masses native copper, often of incredible size. These were the first targets of organized native copper mining since they required little processing when compared to the more abundant disseminated lodes.

Lake copper: This term is given to the native copper produced in the Lake Superior basin in the nineteenth and twentieth centuries, regardless of lode it derived from. Lake copper was known for its purity, which set it apart from other domestic sources of chemically-bound copper.

Geographic terms

Copper Country: This term describes the *cultural* landscape that formed as a result of decades of mining practice on the Keweenaw Peninsula.

the Keweenaw/Keweenaw Peninsula: This term is used to describe the physical geography of the region where native copper mining occurred. Mining occurred outside the region as well, but Keweenaw is the common term for the entire geographic setting.

Lake Copper district/s: I use the plural form of this term to describe the geographic arrangement of activities that mark the *formative* stage of native-copper mining. There were originally five distinct mining districts: Keweenaw, Portage Lake, Ontonagon, Porcupine Mountains, and Isle Royale, and all followed similar yet separate paths to development owing to location, entrepôts, and mineralogical peculiarities. Over time, these separate districts became a singular district, and I use the singular form to denote the industrial landscape of native-copper mining on the Keweenaw Peninsula.

ABSTRACT

This dissertation examines the extractive landscape and persistent lifespan of native mass copper mining in Michigan's Upper Peninsula. The historic native copper mining industry of Michigan lasted for over a century, though its impacts on the landscape can be broken into two distinct, though overlapping, phases of extractive practice: mass mining and disseminated lode mining. Each mined specific native copper deposits, utilized related but specialized technologies, and relied upon different sources of energy to power its practices. A first, formative phase of mass mining exploited fissures of pure metallic copper using traditional technology and organic sources of fuel. A second phase of disseminated lode mining persisted longer and produced more copper than mass mining using industrial-scale technologies powered by fossil fuel. Lode mining eclipsed then replaced mass mining, though in some cases the practices of lode mining were transferred to mass mining locations in an attempt to prolong their extractive lifespans. This dissertation uses the Cliff mine, the most successful and influential of the formative period's mass copper mines, as a case study in three interrelated papers to explore the lifespan of these unique extractive landscapes: first as a formative landscape, then as a landscape reborn thanks to the technological changes linked to lode mining, and finally as a site for the interpretation of industrial waste residues.

The first chapter adopts a concept of *workscape* to illuminate the unique activities associated with the extraction of mass native copper in Michigan's Keweenaw peninsula, 1845-c.1880. These activities mark the formative stage of what would become the Lake copper district. Mass mining workscapes were the earliest manifestations of potential for the Keweenaw, and they set the stage for lode mining's long and fruitful success. Deciphering these early workscapes relies on the use of two dimensional maps of the period to recreate not only the envisioned potential for the Keweenaw, but how those visions were enacted upon the landscape. The second chapter focuses on twentieth century activities at the Cliff mine to expand the notion of the mining district's lifespan by focusing on the certain, but not sudden, decline and closure of the mine. The chapter concludes that the Cliff's extractive history was not confined to a few decades of financially significant activity in the mid-nineteenth century, but rather that extraction continued on through the twentieth and even into the twenty-first centuries. The methods and intents of that extraction changed over time, but its continued use meant the Cliff mine site endures as a living landscape. The third chapter details a survey of over 350 separate sites of native copper mining waste in Michigan's Copper Country. This work resulted in the development of a classification and scoring rubric designed to identify waste sites of greatest historical significance, authenticity, and integrity. This chapter provides an overview of the survey and its findings, then uses the collective waste of the Cliff mine as a narrative device in the telling of its extractive history. These findings offer insight into understanding and appreciating the residues of extractive practice that in this case, due to the benign nature of the unalloyed copper mined there, pose a lesser threat to the environment compared with most hard rock mining activities.

Introduction

Due to the boom and bust cycles experienced by extractive landscapes of mining, their constructed environments can be a mixture of the ordinary, the anachronistic, the vernacular, the standardized, and the complex. They are inherently technological landscapes defined by networks and systems of artifice and production designed to manipulate and adapt to environmental systems in the pursuit of growth.[1] The technological landscapes of extractive practice are often begun within settings that are traditionally set apart from society, be that in untamed, unordered wilderness, or just on the edge of traditional agrarian pursuits. While ultimately technological, the landscapes of extraction are also natural, and subservient to natural systems.[2]

But those natural systems are (seemingly) only short-lived barriers to notions of constant growth in industrial society. In North America, where an abundance of natural resources often enticed exploitation first, ordered settlement second, the practices of resource extraction set the parameters for the ordered settlement of a natural landscape. The resources targeted, the technologies adopted to exploit them, and the transportation networks necessary to support that exploitation altered and shaped the environment as newly discovered resources improved the exploitation of another in a cycle of increasing industrial organization.[3] After two centuries of expansive activities, North America transitioned from a predominately rural society to an increasingly urban, industrialized, and intensified one.[4]

Humans of this industrial society desired and depended upon a "simplified, regulated, and disciplined nature," and acted to create that. They were not always successful, but the intent alone created something new to history: the *envirotechnical* landscape.[5] Thus, industrialism and the industrial period illuminate our relationship with non-human nature by heightening the severity and interdependence of that relationship. The impacts of mineral extraction are one of the most severe examples of this relationship.[6] Expansions and contractions in organization and footprint create a variety of built environments, while the topographical alterations of activities can last for centuries. Considering the alterations and residues of that evolving, contentious relationship lends a tangibility and scale to understanding industrial activity.

In the case of extractive landscapes, the contentious relationship is seemingly dominated more so by human endeavors than natural systems. In mining especially, the wholesale removal of landforms and ecosystems can be seen as an effective and economical approach to resource extraction. But mining begins at small scales, and only if success is met will that scale ramp up until the resource is either depleted or markets make its extraction overly expensive. Closures are often followed by corporate restructurings, geological studies, calls for reopening operations, and the construction of new infrastructure when markets trend up or technologies improve. The landscape undergoes a series of morphological changes due to these spasms of activity, with each stage of expansion and contraction leaving behind their specific features to be later identified, assessed and perhaps preserved.

The historic native copper mining industry of Michigan's Upper Peninsula lasted for over a century, marked by several periods of growth and contraction. The impacts of these spasms of activity on this landscape can generally be broken into two distinct, but overlapping, phases of extractive practice: mass mining and disseminated lode mining. Each mined specific native copper deposits, utilized related but specialized technologies, and relied upon different sources of energy to power its practices. A first, formative phase of mass mining exploited fissures of pure metallic copper using traditional technology and organic sources of fuel. A second phase of disseminated lode mining persisted longer and produced more copper than mass mining using industrial-scale technologies powered by fossil fuel. Lode mining eclipsed then replaced mass mining, though in many cases the practices of lode mining were transferred to mass mining locations in an attempt to prolong their extractive lifespans. These activities each left behind physical traces: transportation networks, built environments, and industrial waste residues, that help illustrate how humans attempted to regulate and discipline their natural surroundings.

For the last several decades, Industrial Archaeology has positioned itself as a discipline well suited to tackling landscape-scale systems of extraction, production, transportation, and waste creation. While geographers combine social and natural science understandings to spatial aspects of human activities, they lack the tools necessary to identify the remains of those activities and contextualize their significance. The toolkit of Industrial Archaeology: historical research, survey and identification, excavation, assessment, interpretation, and preservation, is designed to properly contextualize the activities of extraction and production within the ecological complexities encapsulated in the envirotechnical landscape. This dissertation examines the specific envirotechnical landscape of native mass copper mining in the *Copper Country* region of Michigan's Upper Peninsula, to explore notions of lifespan and change over time within this context of industrial extraction.

The Copper Country

The story of Michigan's native copper mining industry offers unique insight into the story of America's industrialization. Although it just predated the California Gold Rush, the shine of red metal's place in the American narrative is lost amid the glow of the precious metals found in California, Nevada, and other western states. Yet its place is earned due to the unalloyed nature of its metal, its contributions to the technology of hard rock mining, and the legacy of its evolving ethnic makeup.[7] Initially a collection of small mining districts dotting the northwestern end of Michigan's Upper Peninsula, these copper producing areas gradually coalesced into what is now colloquially termed the Copper Country, a name still used today, even though it refers to events long since passed. The physical remains of those events bear witness to the processes of industrialization that playout out in the Copper Country, three facets of which are analyzed in this dissertation: the changes that industrialization wrought in the settings and practices of work; a transition in the kinds of copper resources that were most effectively

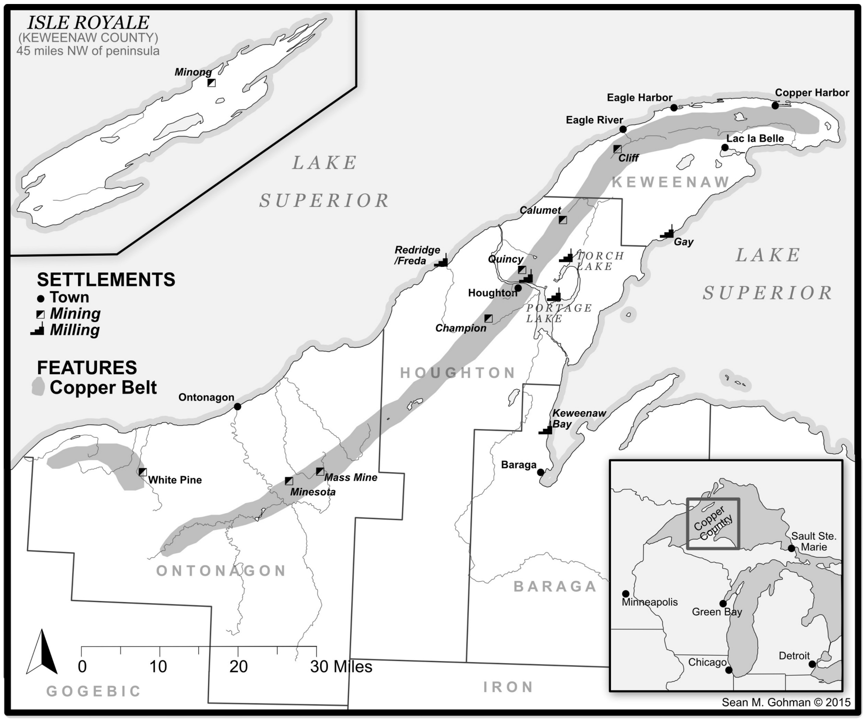


Figure 1. Map of Michigan's Copper Country showing Keweenaw, Houghton, Ontonagon, and Baraga Counties, towns and mining locations of note, and the Copper Belt, the copper-bearing geologic zone that was the primary focus of historical mining. Map by Sean M. Gohman, 2015.

exploited by industrialized mining; and the importance industrial waste plays in the process of industrial mining.

Today, the Copper Country encompasses most of the northwestern portion of Michigan's Upper Peninsula, including the entirety of Keweenaw County (including Isle Royale), the northwest corner of Baraga County, and most of Houghton and Ontonagon Counties (Fig. 1). Originally containing dozens of small industrial communities created for either the mining or milling of copper, today only a handful of population centers remain, now surrounded by a landscape gradually transitioning back to a more natural, although still human-influenced, setting. The mid-nineteenth century population of the Copper Country, initially comprised of mining-experienced northwestern European arrivals, and later nearly replaced by northeastern and southern European novices around the turn of the century, is today still primarily descended from those two waves of immigration. While mining is no longer the way of life in the Copper Country, it is still the defining characteristic of its place within the Upper Peninsula and Michigan.

The Northwest Territory, of which the Upper Peninsula was a part, was the first far off western frontier of the early Republic. While French and British interests briefly explored the region in the 17th and 18th centuries, America's interest in the peninsula did not occur until the 1820s and '30s, and over the course of those decades that attention focused more

on the potential of its mineral deposits than on its settlement. When the copper mining rush began in 1843, those who arrived here possessed a poor understanding of native copper, and it took nearly two decades for the nascent industry to show real signs of sustained profitability.[8] The rush did not bring with it trains of hopefuls coming overland looking to get rich quick, but instead a small stream of ship-bound adventurers plying the Great Lakes. Steamers and schooners brought Yankees, Cornishmen, Irishmen, and Germans to a peninsula of harsh winters and heavily timbered forests.[9] These (mostly) men spent winters dealing with snow, cold, and physical isolation from the rest of the nation, and spent summers searching for exploitable mineral veins and transforming the peninsula from a formative frontier to a developing industrial landscape.

Initially backed by eastern investment capital from burgeoning industrial cities like Pittsburgh, Philadelphia, Detroit, and the banking center of New York, small exploratory ventures grubbed and blasted exposed mineral veins found on their respective holdings. For the few that found promising signs of future copper wealth—and initially this was almost wholly in the form of pure masses of native copper—by the end of the 1840s, mining camps were set up to develop claims and encourage additional capital investment. For an even lesser number, subsequent success was had, and their temporary camps transitioned into (relatively) permanent mining communities. These activities marked the formative stage of the Copper Country's extractive lifespan, focused on mass copper and fueled by organic sources of energy, namely, wood.

This transformation occurred during a period of change in the way people understood their relationship to the energy potential contained within the land around them. For millennia, humans were tied to the solar-agrarian system of energy. This meant that energy derived from wood, wind, and water, each dependent upon solar radiation for their existence, were all that was readily available (and economically viable) for use as thermal, chemical, and mechanical energy. A mining company's potential for transforming energy towards industrial purposes was thus determined by the availability of these sustainable resources. The changing of the seasons and the difficulty of harnessing that energy put limits on growth. By the nineteenth century, this system was gradually replaced by the fossilized energy system, one unbound from a dependence on the sun for its continued existence. Using coal, existing in a seemingly superabundant and inexhaustible supply, allowed for the expansion of industrious activity and the belief in a new economic paradigm: constant growth.[10] This shift, while allowing for incredible increases in scale of production and global change, also produced unforeseen consequences in the shape of anthropogenic climate change.[11]

From the opening of the districts in the 1840s, through its development in the 1870s and '80s, wood-derived energy was dominant in the Copper County. An extractive landscape dependent upon organic energy sources dictated activities but did not slow down development. During the first two decades of the industry, mass copper was the primary target of mining. While its extraction required considerable manpower and exertion to free it from fissures deep within the earth, mechanical power was utilized primarily for raising the masses, and surrounding waste rock, out of the mine. The nature of mass

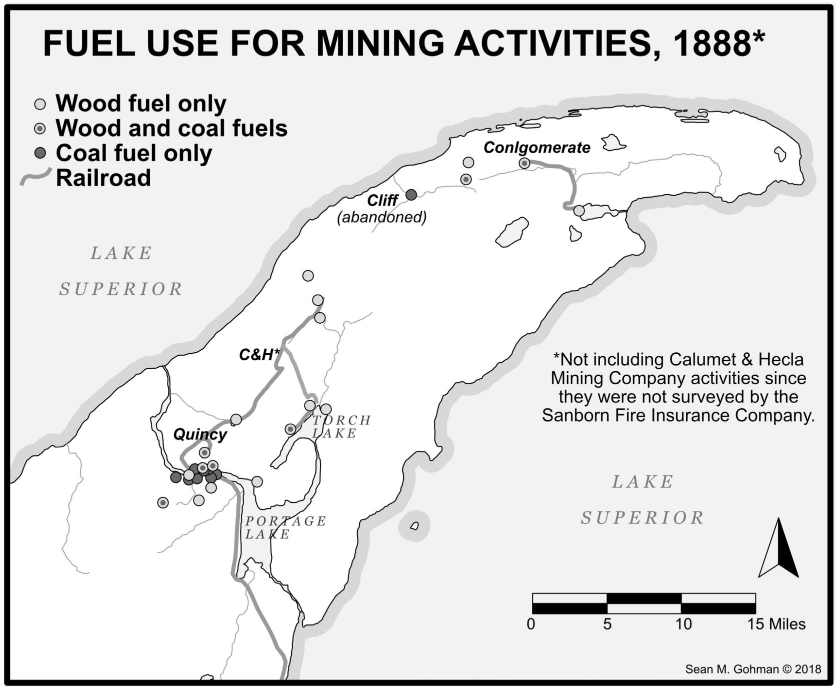
mining practice therefore was metabolically energy intensive, but not necessarily fuel-consumptive for mechanical needs. By the late 1860s, mass copper was replaced by conglomerate and amygdaloid lode copper, which demanded greater quantities of fuel to power drilling, hoisting, and milling machinery. The vast timber stands that fueled mass copper mining were able to supply lode mining as well, for a time, but by the end of the nineteenth century, coal's accessibility and affordability met the region's industrial fuel needs, allowing wood to be saved as building/structural material.

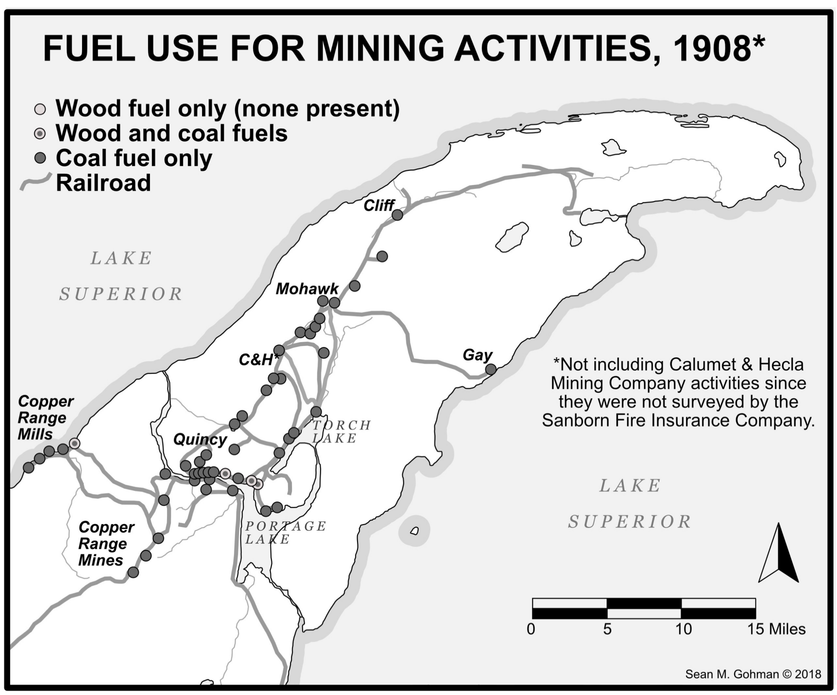
The transition from wood to coal was not sudden. Nationally, coal was already accounting for nearly 60% of industrial consumption by 1870.[12] However, according to data collected from three decades of Sanborn Fire Insurance maps, coal dependency a decade later was only found in 10% of all mining related activities (8% of all industries) in the Copper Country. By 1902, that dependency grew to 73% in mining related industries (60% in all industries), and 92% by 1908. Within a period of less than 25 years (1884-1908), an industry almost entirely dependent upon wood for its energy transitioned into one almost entirely dependent upon coal (Figures 2 and 3).[13]

This is a rapid change that brought with it drastic alterations to the physical landscape of the Copper Country as activities on shorelines intensified in order to accommodate coal delivery and increased copper exports. The shores of inland lakes and Lake Superior were initially staging areas for the delivery of goods and people, both into and out of the Copper Country. Logging enterprises and commercial ventures could also be found, but activities directly related to the mining and production of fissure-bound mass copper were located within close proximity to the mine, which were located inland, sometimes more than 10 miles from shore. The early disseminated lode mines of the Portage Lake district were located atop hillsides surrounding Portage Lake, and their targeted copper resources required significant milling operations, which could be sited on the lakeshore.

Portage Lake was also used by lode mines to more efficiently transport timber fuel to its mining and milling plants, and the infrastructure created to bring wood from the shore to the mine could also reciprocally bring copper-bearing rock to a shore-based mill. As the practices of lode mining grew around the lake, improvements to shipping in the form of dredging and canal building also took place to accommodate increases in copper produced for export from the area. Increases in production eventually strained timber fuel reserves around Portage Lake, but the infrastructure already in place on the shore (trams and narrow-gauge rail) was easily adapted for the delivery of coal. Rail systems radiated outward from Portage Lake, delivering imported coal shipped as ballast on incoming freighters. With finished copper making the outbound journey, this reciprocal arrangement eliminated the transportation difficulties of distance presented by ever-depleting timber reserves. Lode mining and milling activities subsequently expanded, and Portage Lake transformed into a singular, intensified and industrial landscape.

Eventually this intensification expanded to nearby Torch Lake, located 3 miles southeast of the lode mining activities of the Calumet & Hecla Mining Company (C&H), and soon these two lakes became the focus of industrialization in the Copper Country. The Quincy,





Figures 2 and 3. Maps showing locations of industrial fuel usage in 1888 (left) and 1908 (right). The Cliff Mine was already inactive by 1888, but wood-fueled activities in the Keweenaw were relatively equal to those around Portage Lake (where coal complimented wood fuel). Twenty years later however, the focus of activity had dramatically shifted south, and coincided with expansion of rail networks and coal's near total replacement of wood as an industrial fuel. Note Cliff is again active in 1908. Map by Sean M. Gohman, 2018.

Isle Royale, and especially Calumet & Hecla mining companies overtook the lion's share of regional copper production but the close of the 1860s, replacing long-time producers like the Cliff, Minesota [sic], and Copper Falls mines. Within another decade most mass mines, connected to several small entrepôts on Lake Superior's shore rather than the industrially intensified shores of Portage and Torch Lakes, were closed or working at drastically reduced scales. By the turn of the century, most were abandoned altogether.

But the shift to coal also coincided with changes in geological understandings of the Copper Country. Large lode mining operations, working deposits of unknown size, invested heavily in geological and mining engineering research. In the 1840s, mining and geological engineering was in many ways still a vernacular practice, reliant upon on (or under) the ground experience rather than years of education and the scientific method. By the turn of the century and beyond, mining and geological engineering was a fully professional practice, and when combined with the rail infrastructure of coal delivery, created new possibilities for depopulated mass mining areas of the Keweenaw and Ontonagon districts.

Armed with ever-expanding geological knowledge, mining companies like C&H funded small exploratory operations in former locales of mass mining. Supplied by rail and working temporarily diamond drill and exploratory shaft surface plants, these exploratory activities prolonged the extractive lifespans of some of the earliest sites of native copper mining practice. While none were developed beyond that exploratory phase, these failures were attributed to labor strife or outside market forces as much as poor results underground. Regardless, the physical changes brought to these formative landscapes created new possibilities for understanding the lifespan of extractive practices. Here, one can see archaeological evidence for these sites' development, maturity, bust, and restructuring, all created in part by changes in fuel access.

It is important to note, coal *did not cause* the shift in focus from mining mass copper fissures to disseminated copper lodes. This shift was merely inevitable since lode mining practices were far more energy intensive. Access to affordable coal only made the shift more possible and profitable. Before the arrival of coal, the acquisition of fuel was a wholly separate activity from the production of marketable copper. Now, the acquisition of fuel and the export of copper could follow a reciprocal pattern. Coal could be delivered by ship, while marketable smelted copper could be exported on the ship's return trip, making for more efficient shipping costs.

Copper Country Historiography

This shift in energy sourcing can in turn be seen as the formation of an entirely new, industrially scaled endeavor. Coal and intensive lode mining marked the maturation of the Lake Copper district, and for historians of the Copper Country, this mature period receives the most attention. It is easy to see why. The scale of production (working several shafts and transporting copper-bearing rock and fuel to mills and depots miles

away) required a level of organization and management dependent upon documentation, at both the local and national level. Mass mining ventures, working small, tightly clustered mining and milling plants were also well documented, but their size did not require locally-based, complex management structures. Much of the documentation was therefore kept in eastern offices, and the early closure of the mass mines made the survival of those documents less likely. The century-long active lifespans of large lode producers like the Calumet & Hecla and Quincy mining companies left behind thousands of documents, some of which are only just now reaching an age of historical significance. In comparison to a formative period devoted to mass copper mining practice, the mountain of documentary evidence has encouraged repeated historical analysis.

The earliest histories of the native-copper mining era focused on those organizational documents, particularly those dealing with technical innovation and top-down financial decisions. William B. Gates' *Michigan Copper and Boston Dollars: An Economic History of the Michigan Copper Mining Industry* first shown a light on the impact of eastern investment, how mid-nineteenth century centers of financial backing (Pittsburgh the most important, followed by New York, Philadelphia, and Detroit) were supplanted by Boston as the Calumet & Hecla Mining Company, based there, became the dominant producer of Lake Copper, and how decisions in Boston, far removed from the Copper Country, came to dominate the region's economic and, in turn, social development.[14]

C. Harry Benedict's *Red Metal: The Calumet and Hecla Story* was the first narrative history to cover the native copper mining industry, albeit at a company-scale. Again, focused on the activities of Calumet & Hecla, Benedict's history begins more than twenty years after the region's native copper first drew organized attention, and as a result set the temporal stage for most subsequent historical analyses. Benedict followed *Red Metal* with *Lake Superior Milling Practice: A Technical History of a Century of Milling Practice*, which provides a concise history of early milling techniques in the mid-nineteenth century, when milling was merely an additional source of copper to mass mining, not the focus of production. Milling's lessened role at this time is born out in the lack of detail available to Benedict, and he quickly shifted attention to the complexity of technical innovations in the milling and washing of copper-bearing rock that occurred over the late nineteenth and early twentieth centuries as lode mining of disseminated copper became the norm. While it is a thorough discussion of incremental change in industrial processes, it also diminishes the pioneering engineers of milling, who may not have been relied upon to produce all the mine's profits but were still tasked with managing the efficiency of their milling operations.[15]

Bode Morin's *The Legacy of American Copper Smelting: Industrial Heritage versus Environmental Policy*, while ultimately concerned with the conflicts between heritage and environmental policy, devotes considerable attention to technical advancements in copper smelting spurred on by the discovery of native copper in Michigan's Upper Peninsula. Practically speaking, native copper was melted rather than smelted, but efficiently melting large pieces of copper with pieces of quartz and basalt adhering to them still required a few decades of trial and error to perfect. These trials and errors took

place outside the Copper Country, but they aligned with the formative mass copper mining period. *Legacy* handles the primary technical challenge of the period in a similar way to how *Lake Superior Milling Practice* handles the technical challenges posed by the transition to disseminated lode mining.[16]

Following the economic and technological histories of the region, the work of mining and labor conflict received attention, though again, Calumet & Hecla remains at the center of the narrative. Arthur W. Thurner's *Rebels on the Range: the Michigan Copper Miners' Strike of 1913-1914* is first of these labor histories, and deals with the causes and effects of the region's greatest labor dispute. Several other histories of the strike have followed Thurner's work, with varying degrees of bias for or against the strikers, but as of yet no histories have given equal attention to the later labor disputes at the tail end of the industry, or even earlier, short-lived conflicts that arose in the 1860s and '70s.[17]

One author who has placed the give and take between labor and management at the center of his work is Larry D. Lankton, who over the last few decades has authored three books on the Copper Country, two of which are thematically connected to issues of work. His earliest work, *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines* covered the technological side of work during the mature phase of lode copper mining, but its primary narrative focus was on the impact on underground work by the introduction of first the two-man, and later the one-man, drill, and the labor strife that followed in 1913. Lankton's latest work, *Hollowed Ground: Copper Mining and Community Building on Lake Superior, 1840s-1990s* adds social perspectives to the narratives first introduced in *Cradle to Grave*, and documents the decisions companies made over the course of the twentieth century to not only provide housing and services to its workers, but to use those amenities as a means of controlling them. Alison K. Hoagland's *Mine Towns: Buildings for Workers in Michigan's Copper Country* complements *Hollowed Ground*, including discussions of vernacular architecture in the role of company housing in the twentieth century, paternalism, and response to the grievances of labor.[18]

The first history to focus on the formative practices of the mid-nineteenth century is Donald Chaput's *The Cliff: America's First Great Copper Mine*. Chaput devotes the first third of the book to the geographic and geological discoveries that led to the Keweenaw's opening to mining and the Cliff's discovery and success. Chaput's work, though focused on a single entity's rise and fall, manages to also contextualize the story of the Cliff into a larger, region-wide narrative. David J. Krause's *Making of a Mining District: Keweenaw Native Copper 1500-1870* is also concerned with this formative period, but its focus is on the geological debates over the region's unique copper deposits in the 1830s and '40s, not the practice of mass copper mining. It sets the stage for the region's development, but its temporal range falls short of mass mining's heyday in the 1850s and during the Civil War years. Larry D. Lankton's second book, *Beyond the Boundaries: Life and Landscape at the Lake Superior Copper Mines, 1840-1875* does cover the formative period of mass mining, but it approaches it from a social perspective, rather than a technological one. *Beyond the Boundaries* examines the everyday life of reluctant pioneers who shaped a

wilderness into a community, but it spends more time in the home, the store, the church, and the school, than it in the shaft, the mill, and amongst stands of timber.[19]

While the historiography of the Copper Country is substantial, it is incomplete. The widest gap in the region's history is found in the years between the first rush to Lake Superior's southern shore, and the ascendancy of Calumet & Hecla and its lode-mining contemporaries. The documents are harder to come by for this formative period, and less detailed than those of half a century later. But archaeological evidence is abundant, and it can be used to flesh out details in the documents available.

Archaeological evidence points to dramatic differences in the built environment, management of resources, transportation networks, and the footprint of activity during this period when compared to the era of lode mining. The formative period of mass copper mining was built upon wood, and the need for this resource shaped the networks and footprint of activities necessary for the successful extraction of copper. It also occurred during a period of relative isolation from national industrial trends, resulting in the use of unique, and sometimes anachronistic practices when compared to other nascent industrial regions. This all led to the creation of a unique and vibrant landscape molded for the successful extraction unalloyed copper.

It is within this temporal gap that this dissertation begins, but also pushes beyond. Another gap in the literature of the Copper Country is the protracted decline of these formative areas, beginning in the 1860s and continuing in some places for almost a century. The death of the native copper mining industry, initiated by the Great Depression and hanging on for another three decades, is well documented, but again that story is told from the perspective of the large producers. What of the outlying areas that were also impacted, though at smaller scales? This dissertation returns to the formative landscapes of mass copper mining to witness their decline, and their later appreciation as potential heritage sites, within the larger context of industry-wide restructuring, as mine waste—and mill tailings specifically—became the new focus of extractive practice in the mid-twentieth century.

This dissertation makes several arguments about mass copper mining's place in the extractive history of the Copper Country: that this unique extractive landscape demands attention due to its physical isolation and a dependence upon organic sources of energy; that when those factors were lessened during the rise of disseminated lode mining and the technological innovations that came with it, the landscapes of mass mining were given new extractive lives; and that it is in the collective wastes of those decade-spanning activities that those activities are best preserved, interpreted, and appreciated. These arguments are built upon the interrelated themes of energy transformation, the lifespans of extraction, industrial archaeology, landscapes of production, the residues of industrial practice, and industrial heritage.

Energy Transformation

Energy, as we conceptualize it today for productive purposes, is only made possible thanks to the structural changes brought about by the industrial revolution. In an organic energy system (OES) — the only system humankind knew of prior to that revolution — heat, food, work, and light were all separate concepts not yet unified under the term, *energy*. The idea that water, wind, nourishment, and motion possessed some essential commonality was foreign to the agrarian mind. Only after industrial activity necessitated the control of these seemingly disparate concepts for similar productive means was *energy* understood as an abstract concept. The nuclear energy of the sun, in the form of electromagnetic radiation, is transformed into either thermal or chemical and metabolic energy by Earth's processes, and humans then further transformed those forms of energy into mechanical power to perform work. All energy harnessed by humans derived from the sun in this linear fashion. Wind and water were merely diverted from their material cycles, while metabolic energy was processed through decomposition or burning. But not all was consumed. Some sources of energy were captured by the earth and fossilized under pressure.[20]

Following the discovery and exploitation of these sequestered reservoirs of fossilized solar energy, the cyclical nature of energy transformation was disrupted. Coal, oil, and gas freed humankind from the cyclical OES. No longer did sites of production face limits to their growth when organic fuel reserves were no longer readily available. Fossil fuels could be brought to the source of production, or vice versa. In either case, sites of production were free to first exhaust nearby organic fuel reserves before switching to (or physically moving toward) far off fossil fuel reserves.[21] In effect, this material shift was also an ideological shift, as organic fuel sources also came to be part and parcel of constant, unlimited growth.[22]

The extractive landscape of Michigan's native copper mining industry provides an opportunity to examine historically, archaeologically, and spatially, one of the most profound shifts in human history: the replacement of sustainable, organic energy systems utilized for the production of goods with finite, fossilized ones. Due to its case-study structure (discussed further below), this dissertation is not directly concerned with this shift on a region-wide scale. It is instead concerned with an extractive landscape shaped for organic energy sources, and the subsequent later impacts a shift to fossilized energy sources had on that landscape. A formative landscape once shaped by and for wood energy adapted and reshaped itself over a generation in order to accommodate coal. Those adaptations then restructured that landscape, extended its extractive lifespan, and dramatically altered the interpretable remains of its constructed environment.

Extractive Lifespans

As an endeavor whose objective is inherently finite, mining is seemingly well-framed by discussions of lifespan. There is a boom. There is a bust. The period of time between

boom and bust is variable, but always inevitable. Initial discovery, the speculative carving up of the landscape (first by claims, later by excavation), and the handful of enterprising success stories are gradually replaced by thorough geological documentation, a consolidation of activities under a handful of large operators, and shareholder profits. Eventually, the veins, lodes, and ores either pinch out or become too expensive to access, leading to closure, a departure of moneyed interests, and a decline of communities designed for little other than supporting a now dormant industry.

However, the cycle of boom and bust is not binary. Often, some areas of a mining district are on the rise, while others are on the decline. Changes in technology or an infusion of investment capital can expose a previously unknown mineral resource, reinvigorate an area of extraction previously believed exhausted or too expensive to target, deem an area obsolete, or dramatically upscale activities and their footprints. The movement of people in response to changes in technology and capital leave behind specific features that can, collectively, be sorted in typological assemblages that inform understandings of those movements. In Richard Francaviglia's *Hard Places*, these assemblages are presented as defining characteristics of an extractive landscape's lifespan, though Francaviglia acknowledges that not all historic mining districts may conform to these assemblages due to their own idiosyncrasies.[23]

An historic mining district generally begins with a formative (camp) stage marked by temporary structures, high transportation costs, primitive technology, and relative isolation. Studies of mining communities may focus on this period due to a "frontier demeanor," but as is seen in the case of the Copper Country, the colorful character of activities is given preference over the visions of potential held by those practical enough to see the district's development through. The ensuing development phase, when camps transition to formalized communities, is marked by improvements in transportation, the switch from primitive to complex technologies, and a gradual urbanization. Following this, a successful mining district will plateau into a mature phase, continued urbanization, and a level of self-sustainability and commercial activity that supports a large population. Maturity eventually gives way to a restructuring phase. This phase can be protracted and punctuated by a series of ups and downs as declining reserves and outside market forces bring alternating periods of hope and despair to a community facing economic decline. Finally, after a period of restructuring, a mining district enters the divestment phase, marked by industry closure and abandonment. A community set up for life after mining may endure, but many do not. The population declines precipitously as the young leave for new opportunities, and the built environment fails into disrepair as historic structures are left unoccupied.[24]

Prior to that decline, mining is an exercise in "digging and dumping."[25] There is little regard to the impact of extractive activities, either on the environment or the people whose lives depend on those activities and are forever changed once those activities end. The temporary nature of early mining may give way to relative permanence once a mining district reaches financial and/or productive stability, but that permanence never overrides the lack of concern consumptive practices of extraction depend upon for and

continued digging and constant growth. The residues of extraction: rock piles, mill tailings, smelter slag, industrial structures, are left behind to tell the story of a particular industry's rise and fall.

For the Copper Country, the relative length of the local native copper mining industry meant each of these phases occurred over many locations in sometimes overlapping periods of time. The formative period, identified in this dissertation as the period of activities focused on the mining of fissure-bound mass copper, lasted roughly three decades in places. Development, defined as a two-pronged transition from mass to disseminated lode mining and from wood to coal as industrial fuel, overlapped the formative period in places by a decade, and continued into the 1890s. The mature phase straddled the turn of the twentieth century, while restructuring impacted the region during from the 1920s into the 1950. Decline and divestment soon followed, bringing an end to over a century of native copper mining.[26]

Landscape Perspectives in Industrial Archaeology

Understanding the lifespan of extractive practice in a specific setting demands considerations of landscape, and this scale of inquiry and analysis has been a mainstay of Industrial Archaeology for decades. Neil Cossons's believed as early as the 1970s that industrial archaeologists should understand artifacts within a landscape context due to the scale of systems of production, and later those systems and the landscape itself were recognized as artifacts themselves.[27] Today, it is accepted, and expected, that landscape perspectives be applied to archaeological studies, regardless of scale, and be it for mitigation, interpretation, or conservation purposes.[28]

The landmark study of Shropshire's Coalbrookdale region in the mid-1980s brought the landscape to the forefront of Industrial Archaeology practice. The complexity of activities occurring in and around Coalbrookdale in the 18th and 19th centuries, one of the cradles of the Industrial Revolution, demanded an archaeological methodology for appropriately documenting the dramatic physical, structural, economical, and social changes the area underwent. Beginning with historical divisions of land ownership, cultural resources were documented within each property, and contextualized with available historical evidence. What became evident were evolving integrated systems designed for iron production at differing scales as markets expanded and contracted, innovative technologies were introduced, and coal/coke replaced organic sources of energy. The landscape was revealed to be not merely the canvas upon which Coalbrookdale's industrial development played out, but a key factor in that development. Its particular geography and resources allowed for these successful developments in iron production and offered a template for how industrial archaeologists could approach similar complex landscapes of production and extraction that appreciates the landscape as an artifact itself.[29]

Archaeological examinations of Cornwall and Wales's productive landscapes offer additional regionally-specific contexts for industrial development.[30] Identification of

historic industries, transportation networks, and locations of resource extraction guide typological cataloging useful for the comparative analysis and site significance assessments integral to heritage management. In recent years, the practical applications of industrial archaeology have been augmented with the asking of larger social questions of landscapes of production and extraction. For instance, the documentation of regional landscapes of water power in the U.K. and U.S. have not only shed light on impacts to industries, but also on the transitions from rural to urban communities undergo through industrialization, as well as the societal changes brought about by industrialization's growth and decline.[31]

Today, digitally representing and analyzing the complex physical and social changes landscapes of production undergo is an additional approach the industrial archaeologist must add to their toolkit. One model for this approach is found in Anne Kelly Knowles historical analysis of American iron production in the first third of the 18th century. Knowles adds technological and economic context to historical geographic information systems (HGIS)-created cartographic interpretations made of mid-nineteenth century iron manufacturer's guides, to illuminate not only the geographic scale of iron production at this time (nearly half a continent), but the challenges this scale presented to the development of this national industry. These challenges meant adopting site and regional-specific technical and organizational solutions in hopes of success. While much larger than the scale of activities examined in the Copper Country, Knowles combining of cartographic data and spatial analysis to historical documentation offers a blueprint for uncovering the visions, intentions and complexities of decades of localized extractive practice.[32]

Locally, the Copper Country Historical Spatial Data Infrastructure(CCHSDI) is another HGIS approach to cataloging, interpreting, and—in a virtual sense—preserving the Copper Country's cultural landscape. Built and maintained at Michigan Technological University, CCHSDI is an ongoing project collecting historic maps, images, archaeological evidence, and stories of the area and then utilizing both university personnel and citizen scientists to extract usable data from those resources in order to make them available to researchers and the greater public (in the form of the Keweenaw Time Traveler website).[33] While still relatively new, as it collects and interprets a greater variety of data, the CCHSDI will recreate the Copper Country in virtual form and offer both static time slices of the physical landscape, as well as illustrate the rapid changes over time of industrialization and the erasure of those changes that accompany deindustrialization that industrial archaeologists are concerned with.[34]

Industrial Heritage and Waste Residues

The heritage of technological landscapes, and specifically post-industrial landscapes, has increasingly turned to the often-forgotten by-products of industrial activity. As a result of CERCLA (Superfund) legislation, many historical industrial sites are the targets of remediation. These and environmental whitewashings often target the waste residues of

industry, and due to perceptions of industrial waste as by-products that lack integrity or historical contexts, arguments for the preservation of waste materials is difficult. Waste landscapes, along with the technologies devised to create, transport, and manage them, can make strong cases for the reevaluation of industrial waste as a culturally significant resource. Fred Quivik (2007) states that the preservation and interpretation of sites related to mining waste in the Butte, Montana, "complement, rather than interfere with," federally funded environmental remediation. Their preservation speaks to the unpleasant truths of industrial practice, and in some cases details the history of industrial management of by-products, long before the advent of the modern environmental movement. By wiping them clean, the uneasy relationship between industry and environment is disrespected, and a more nuanced picture of negotiation and conflict is lost. Beyond broadening the scope of industrial heritage, the work at Butte also strengthens the case for the importance of cultural resources in environmental remediation planning endeavors.[35]

Though left behind and often forgotten, waste residues can represent a variety of historic intentions as well as current heritage themes. Certainly, these residues signify changes in practice and the lifespan of industrial activities.[36] Additionally, they may represent the intentions of industrial actors and the impacts of those intentions on the communities that grow up around them, be they invisible, or the result of visions for potential commodification and/or reuse.[37] That potential may be as challenge to remediation efforts or as serendipitous opportunities for historic preservation.[38] In either case, compelling arguments for the significance of industrial waste residues can, and must, be made.

Today, the most visible remains of the Copper Country's extractive landscape are the over 350 distinct sites of mine waste deposition. Produced over a century by a variety of technologies, these collective industrial residues offer a tangible link to past extractive activities. While shaft rock houses, mill remains, and waste rock-constructed mining buildings can also be found dotting the landscape, they lack the visual impact of scale and ecological change that make mine and mill waste effective resources for a variety of environmental and historical interpretations. The Copper Country presents an excellent opportunity for using the flexible methodologies for studying technological landscapes outlined above.

Structure of the Dissertation

This dissertation follows an integrated article format. This introduction offers an overview of the collection, describes how the three articles fit together to address an overarching research goal, explains how the collection fits within the larger body of scholarship, describes the methods, and summarizes the findings. Following are three chapters (1-3), two of which have been prepared for publication in academic journals. The third (chapter 2) is included in an update/reissue of a previously published book. Each of these article chapters were single-authored. A conclusion follows the three article chapters with a discussion of findings and suggestions for future research.

The first article (Chapter 1), "Unalloyed Potential: Envisioning Mass Copper Workscapes under an Organic Energy System," has been submitted to *The Mining History Journal*. This chapter adopts the concept of *workscape*, defined by Andrews (2008) as a three dimensional "constellation of unruly and ever-unfolding relationships" between animate and inanimate actors, to illuminate the unique activities associated with the extraction of mass native copper in Michigan's Keweenaw peninsula, 1845-c.1880.[39] These activities, while occurring over the course of several decades, in effect mark the formative stage of what became the Lake copper district. The Lake copper industry continued well into the mid-twentieth century, but by the late nineteenth century copper mined from embedded lodes of finely disseminated copper had replaced fissure-bound mass copper. The technologies, fuel, and practice of mining lode copper was far removed from those of mining mass copper, and in many cases the former erased or built over the physical traces of the latter. Mass mining workscapes were the earliest manifestations of potential for the Keweenaw, and they set the stage for lode mining's long and fruitful success. Uncovering these earlier workscapes of fissure-bound mass copper mining, defined by isolation and local organic energy sources, uses two dimensional maps of the period to not only interpret the envisioned potential for the Keweenaw, but examine how that envisioned potential became reality. This paper uses the Cliff Mine, the most successful and thoroughly documented mining enterprise of the mass mining period, as a case study to focus the narrative and provide illustrative examples.

The second article (Chapter 2), "The Cliff in the Twentieth Century," included as Chapter 7 in, *The Cliff" America's First Great Copper Mine, Revisited*. Originally published in 1974, this book gave a detailed overview of the mine's history up to the close of the nineteenth century. With the decision to reissue the work, it was felt by the publishers that the story of the Cliff Mine be brought up to today. By focusing on over a century of activity at the Cliff long after most considered it a forgotten footnote to the Copper Country's industrial beginnings, this chapter expands the notion of the mining district's lifespan by focusing on the certain, but not sudden, decline and closure of the mine. The chapter concludes that the Cliff's extractive history was not confined to a few decades of financially significant activity in the mid-nineteenth century, but rather that extraction continued on through the twentieth and even into the twenty-first centuries. The methods and intents of that extraction changed over time, but its continued use meant the Cliff Mine site endures as a living landscape.[40]

The third article (Chapter 3), "It's Not Time to be Wasted: Identifying, Evaluating, and Appreciating Mine Wastes in Michigan's Copper Country," is in print in *IA: The Journal of the Society for Industrial Archeology*.* Over a century of mining native copper in Michigan's Copper Country has produced several million tons of workable metal and an even greater amount of waste. The remaining rock, tailings, and slag each represent a separate step in the process of hard rock mining, providing tangible links to industrial landscape narratives at both regional and site-specific scales. In 2011, the Keweenaw

* The release date of this volume was actually in 2015, due to delays in the journal's publishing.

National Historical Park's Advisory Commission funded a survey that included over 350 separate sites of copper mine waste, ranging from multi-acre tailings deposits to slag heaps occupying less than 50 sq. ft. This work resulted in the development of a classification and scoring rubric designed to identify waste sites of greatest historical significance, authenticity, and integrity. This chapter provides an overview of the survey and its findings. These findings offer insight into understanding and appreciating the residues of extractive practice that in this case, due to the benign nature of the unalloyed copper mined there, pose a lesser threat to the environment compared with most hard rock mining activities.[41]

Methods

The technological landscapes of industrial processes, be they extractive, transformative, productive, transportation related, or all four, all contain within them evidence for scales of continuity and change that allow for temporally or geographically small studies as well as those concerned with over a century of regional impact like that found in the Copper Country.[42] What these technological landscapes demand are flexible methodologies to support a multitude of approaches to their understanding.[43] Studies in landscape should begin with historic cartographic materials and aerial photographs for comparisons to recent cartographic maps and remotely sensed imagery.[44] Out of these can be created digital maps consisting of polygon, line, and point data. These data may be sufficient for site identification and change over time narratives, but they may be insufficient for rapid assessment and evaluation. Methodologies should therefore include field visits, along with smaller scale collections of data at/within various scales/contexts. Outcomes should result in sub-divided landscapes of defined areas marked by consistent character based on one or more components resulting in the identification of discernable patterns. A successful and adaptable methodology approach toward landscape, may be contracted, expanded, reclassified, and ultimately, more appropriately defined for contemporary purposes.

This dissertation uses just such a flexible approach, relying both on archival evidence and the archaeological record to examine the evolving extractive landscape of native mass copper mining in Michigan's Copper Country. Archival and author-created maps, historic photographs, and documentary sources enhance archaeological findings to focus a multi-faceted lens of technological change, energy transformation, and industrial waste on an era previously viewed as nothing more than an introductory chapter in the story of Michigan native copper. Utilizing an integrated article format, this dissertation provides a historical account of changes on the landscape using archaeological field data to expand upon those narratives. Furthermore, author-created cartographic imagery constructed with these data, as well as data interpreted from archival sources, will help further illustrate the spatial dimensions of those narratives. While not a spatial history in the technical sense, this dissertation is written with recognition of geography's importance and the spatial relationships of production in the interpretation of this body of data, and ultimately, the telling of these stories.

Through several archival and archaeological projects over the last several years, I have collected a plethora of material related to the development of the native copper mining industry. This dissertation provides a conduit to synthesize that material and offer new a new perspective to the area's historiography. The Michigan Technological University Archives and Copper Country Collections (MTU Archives) houses the largest and most comprehensive collection of source material related to the native copper mining industry. Data collected here provides the majority of documentary evidence for the historical narrative chapters. Though it acts as the primary expository tool through which the dissertation is structured, in this case its analytical efficacy is lessened when compared to archaeological field data. However, what cannot be minimized is the importance of historic cartographic resources also found at the MTU Archives.[45]

In spring 2011, the J. Robert Van Pelt and John and Ruanne Opie Library tasked me with surveying the MTU Archives' map collections in order to select a series of maps for a digital storage pilot project. This survey required viewing and recording every map in their holdings and allowed me to amass a large collection of cartographic evidence to support this dissertation's aims. These maps act not only as expository tools, but also analytical tools when understood as interpretations of past activities and intentions. By identifying what is included— and omitted —from these maps, and interpreting the meanings behind those inclusions and omissions, one can see a landscape not just ordered for, but also understood as, a system to support the means of production.

The Cliff Mine

Discovered in 1845 on an exposed, copper-filled fissure vein running through the basalt Greenstone bluff overlooking the west branch of the Eagle River, the location that would be known as the Cliff Mine spent its first few seasons as a typical mining camp of the 1840s (Figure 4). Surface workers cleared the land of trees for fuel and building material, exposing other veins of potential, while miners of Cornish, Irish, and German descent hammered, chiseled, and blasted mass copper and rock (some containing copper, most of it not) underground. Workers lived in log bunkhouses, though a few framed buildings also housed the mine office, mill, and smithy. Power derived almost wholly from muscular effort, either by human laborers or draught animals.[46] The landscape of the Cliff at this time was therefore designed to be adaptable and if need be, temporary. Only with success could the site hope to reshape the landscape for permanent settlement.

After a few seasons of promising exploratory and underground development work, the owners of the mine, the Pittsburgh and Boston Mining Company, looked to transform the Cliff from transitory mining camp to permanent mining community. The first step was to formally incorporate the company in March 1848 with a 30-year charter and $150,000 in raised capital. By the end of that year, the company was able to declare their first dividend, making the Cliff the first profitable native copper mine in region. Much of these early profits were channeled back into the mine's development, first by hiring more

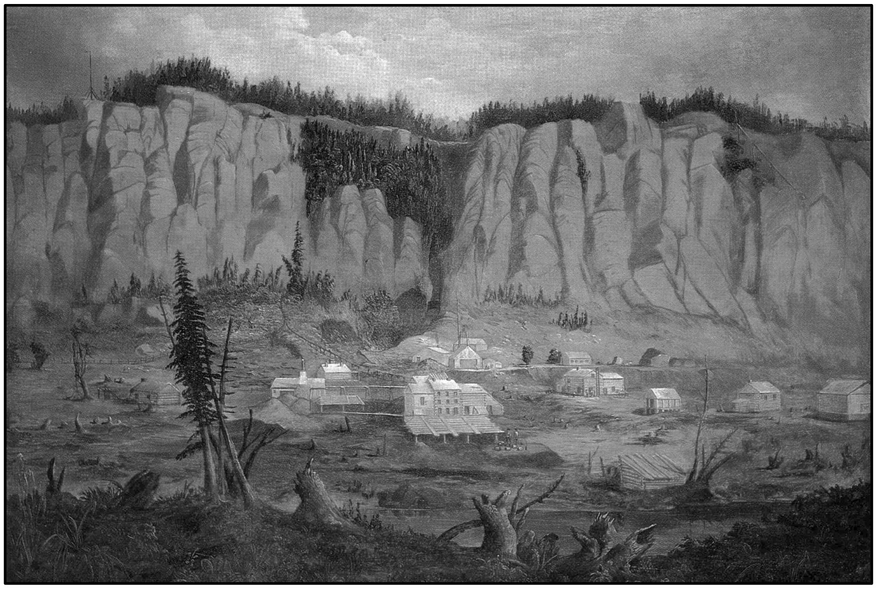


Figure 4. Robert S. Duncanson's, *Cliff Mine, Lake Superior*, 1848.
F. Ward Paine, owner.

employees and housing them in a roughly planned community of Clifton, and second by constructing stone buildings to protect newly purchased steam engines to power the mine's industrial activities.[47] The Cliff's early adoption of steam technology, fueled by plentiful stands of nearby timber, offered a template for other mining ventures in the region, and soon a landscape of disparate mining camps began to coalesce into several interconnected mining communities.

The Cliff Mine continued to expand over the course of the 1850s, sinking new shafts, installing additional steam engines, building more employee housing, and expanding its milling capacities (Figure 5). The community of Clifton grew to over 1,500 residents, becoming a center for commercial activity north of Portage Lake. By the onset of the Civil War, the Cliff was not only the biggest producer in the region, but its biggest employer as well.[48] Working from atop and at the base of the Greenstone bluff, the Cliff's industrial footprint grew to cover several acres, while its underground workings sunk over 1,000 feet. Soon that success was challenged by soaring wartime copper prices, as dozens of new mining ventures sprang up to take advantage of eager investors. Most of these ventures eventually failed, but their shallower depths offered an enticing lure to miners used to descending and ascending several hundred feet of ladders each day and put a strain on the Cliff's ability to keep its workers happy. This development led to the installation of the region's first man-engine, a powered elevator for travelling underground, and though only briefly, again placed the Cliff at the forefront of regional technological practice.[49]

Over the second half of the 1860s, the Cliff remained a major copper producer in the region, but its influence waned as its workings sank deeper and deeper. At the same time, mines located to the south around Portage Lake and working disseminated copper lodes

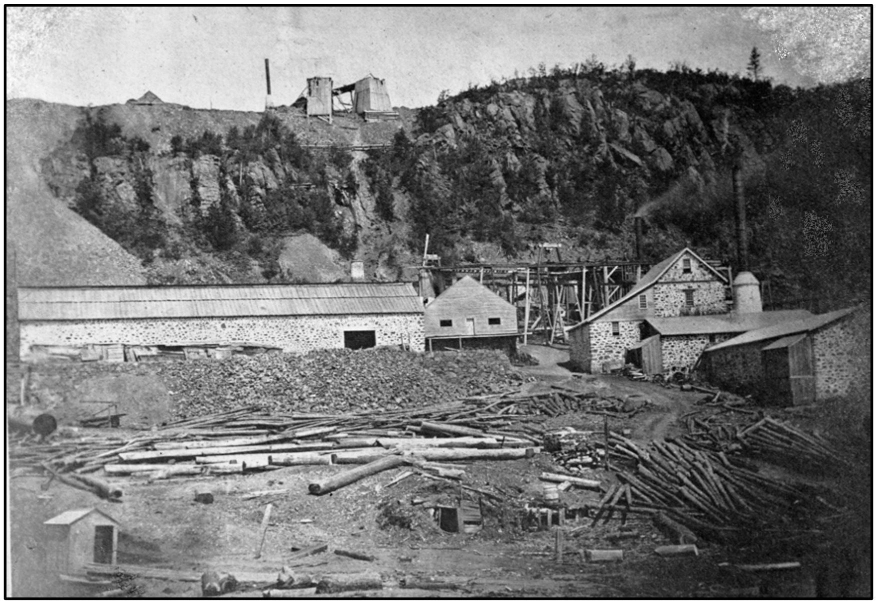


Figure 5. Earliest known photo of the Cliff Mine, taken c.1857. Once profitable, the company's earliest improvements to the Cliff's industrial core were steam engines housed newly built stone buildings. Courtesy Michigan Tech Archives and Copper Country Historical Collections.

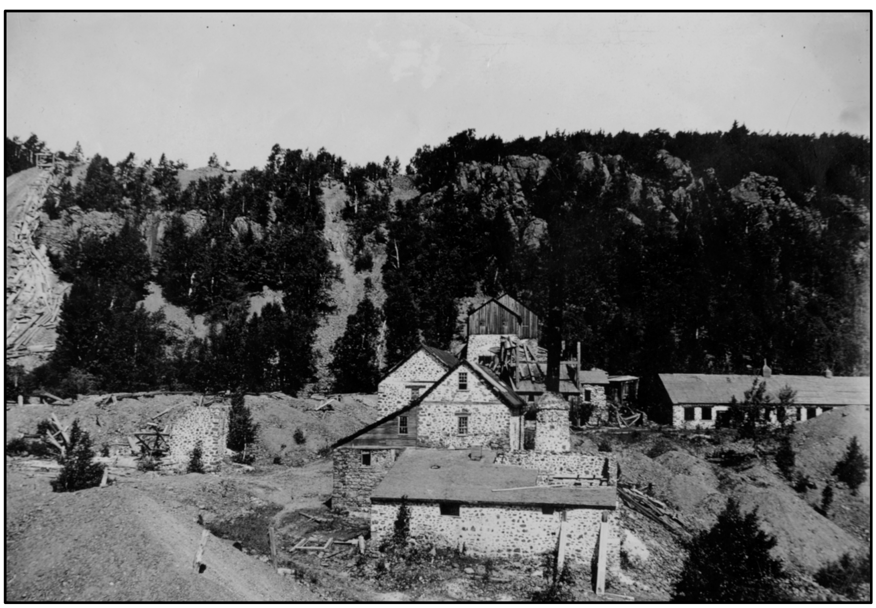


Figure 6. The Cliff's industrial core, c.1890. The same stone buildings from figure 6 soon deteriorated and collapsed after the mine's first closure. Courtesy Michigan Tech Archives and Copper Country Historical Collections.

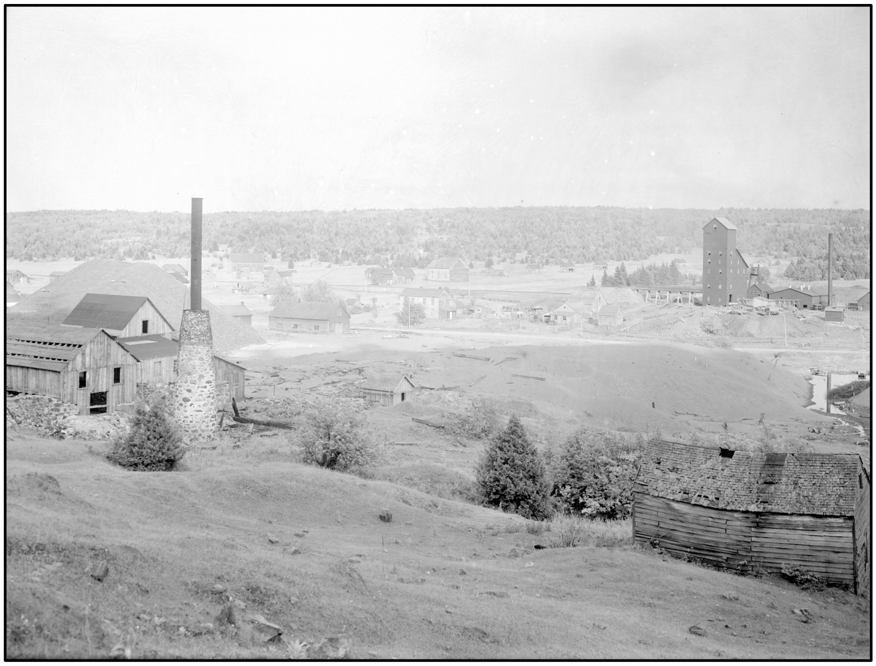


Figure 7. Cliff Mine, c.1908. Stamp mill remains can be seen at left. At right—and on the other side of the mill's tailings deposit—is the Tamarack-run Cliff Copper Company's South Cliff shaft-house and surface plant, located on the Keweenaw Central Railroad line.

existing in conglomerate and amygdaloid deposits began their rise to market dominance. Relying on milled copper rather than mass copper pried from fissures, these lode mines demanded greater volumes of rock and water to extract a marketable product. By 1870, the Cliff, facing greater competition and changes in extractive practice was sold to a new investment group, who in turn immediately downsized operations. Within a decade, the Cliff Mine was closed, and its underground workings allowed to fill with water (Figure 6).[50] The first cycle of boom and bust at the Cliff occurred before the railroad and coal could make it to the mine, but these linked innovations would help to initiate the mine's second act.

With the laying of the Keweenaw Central Railroad in 1906-07, an abandoned Cliff became a new hub on a rail line that connected to Calumet, Portage Lake, and ultimately, the rest of America.[51] Now, the Tamarack Mining Company could supply small teams of diamond drill operators and miners with coal from afar, rather than hiring large crews to harvest timber and create the infrastructure needed to redevelop the mine (Figure 7). Calumet & Hecla Consolidated Mining Company expanded this even further after acquiring the Tamarack company in 1909, first by shuffling equipment and personnel around the Keweenaw through its collection of interconnected mining properties. And second, by using coal-fueled technologies to greatly expand the underground workings of the mine—in just a few years—in the search for paying conglomerate deposits that may have intersected the original vein.[52] Just as changes in practice in the 1870s directed

attention away from the Cliff, now those same practices were refocusing attention toward it.

Redevelopment at the Cliff continued until the early 1930s, though the mine could never again be made into a profitable venture. From 1932 to the late 1950s, the mining property again sat idle, finally dissolving in 1955.[53] Though no longer seen as a site for mined copper, its collective mill tailings were discussed as a potential source of extractable copper. Large tailings deposits along Portage and Torch Lakes were the sites of reprocessing as early as the 1910s, and it was hoped to find efficient ways to reclaim inland, riverside tailings deposits like that of the Cliff as well. In the summers of 1959 and ’60, those tailings were finally trucked to Torch Lake and reprocessed, while the mine shafts were all secured and capped by 1968.[54] That concluded the extractive history—in a mineralogical sense at least—of the Cliff, though through the ensuing years it has been the target of waste rock extraction for road fill, archaeological excavation and inquiry, and environmental remediation. For over a century and a half, the Cliff’s landscape has been shaped by human needs, with changes in technology, fuel, and appreciation informing those activities.

How the Cliff Mine connects to dissertation themes

The connecting theme of this dissertation was to primarily be about energy transformation and its impact on the Copper Country’s development. As this dissertation evolved, other themes emerged that deserved additional emphasis. The concept of landscape, along with technological change brought on by accessibility, were also relevant in each of the chapter’s structures. Each chapter is concerned with the relationship between humans and their extractive practices, and the landscape upon which those practices are enacted. While landscape initially frames and shapes these relationships, each chapter also illustrates how technological accessibility alters those relationships in humanity’s favor. At the Cliff Mine, early adoption of steam engine technology put them at the forefront of early mining practice. Decades later, and after years of inactivity at the mine, coal-fuel and railroads opened he Cliff up to a new era of extractive practice and reconnected it to the industrial activities of Lake Copper district. These two periods of activity created different physical footprints on the site’s landscape, the environmental and historical impacts of which are still being dealt with today

Ultimately, it was the lifespan of a mining district, its cyclical nature of boom and bust, that emerged as the underlying and unifying theme of this dissertation. This chapter explores the mining district’s formation and early development, using the Cliff Mine’s historical and archaeological evidence to give specificity to region-wide trends. This formative period was marked not only by a dependence on wood fuel, but also physical isolation and unique mineral deposits that demanded specific technological and spatial requirements. The Cliff Mine, as the most thoroughly documented site of this formative period, provides the largest diversity of evidence available to examine these factors.

Chapter 2 expands the discussion of a mining district's lifespan by mirroring the formative period of native copper mining discussed in Chapter 1 by focusing on the restructuring and divestment of the Cliff Mine. Chapter 2 focuses on two periods of reorganization at the mine: the exploration and reopening of the Avery and South Cliff shafts over 1906-1913 by the Tamarack and C&H companies, and Calumet & Hecla (C&H) Consolidated Mining Company's 1920's efforts to redevelop the mine in response to the promising findings of a geologic study undertaken in conjunction with the USGS. After these efforts failed, C&H Consolidated spent years debating the merits of reclaiming the Cliff's mill tailings, echoing discussions of mine waste's significance in Chapter 3.

Chapter 3 examines the physical impacts of over a century of extractive practice, specifically the creation and deposition of mine waste. The chapter illustrates how one might appreciate the significance of those impacts from an historical perspective, noting that their scale, morphology, connection to activities and locales of historic importance provide a deeper emotional impact and tangible connection to the past than is generally believed. To make this point, this chapter relies on the collective mine wastes of the Cliff Mine as a narrative device to tell the entirety of the site's history. Together, these chapters tell a complete story of discovery, development, decline, closure, and ultimately, remembrance. The dissertation, and the story of mass mining and the Cliff, concludes with a discussion of its landscapes representing the idea of a living landscape. If these landscapes of extraction are ultimately the result of visions for their potential, is not the continual potential people see in the Cliff: as a place of recreation, mineral collecting, archaeology, environmental remediation, or logging, in effect keeping that landscape alive in the minds of the public?

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UNALLOYED POTENTIAL: ENVISIONING MASS COPPER WORKSCAPES UNDER AN ORGANIC ENERGY SYSTEM

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Abstract

This paper adopts the concept of *workscape*, defined by Andrews (2010) as a three dimensional "constellation of unruly and ever-unfolding relationships" between animate and inanimate actors, to illuminate the unique activities associated with the extraction of mass native copper in Michigan's Keweenaw peninsula, 1845-c.1880. These activities, while occurring over the course of several decades, in effect mark the formative stage of what would become the Lake copper district. The Lake copper industry continued well into the mid-twentieth century, but by the late nineteenth century copper mined from deposits of finely disseminated copper such as the Calumet conglomerate lode had replaced fissure-bound mass copper. The technologies, fuel, and practice of mining lode copper was far removed from those of mining mass copper, and in many cases the former erased or built over the physical traces of the latter. Mass mining workscapes were the earliest manifestations of potential for the Keweenaw, and while they were replaced, they set the stage for lode mining's long and fruitful success. Uncovering these earlier workscapes of mass mining, defined by isolation and local organic energy sources, relies on the use of two dimensional maps of the period to recreate not only the envisioned potential for the Keweenaw, but how that envisioned potential became reality. This paper uses the Cliff Mine, the most successful and thoroughly documented mining enterprise of the mass mining period, as a case study to focus the narrative and provide illustrative examples.

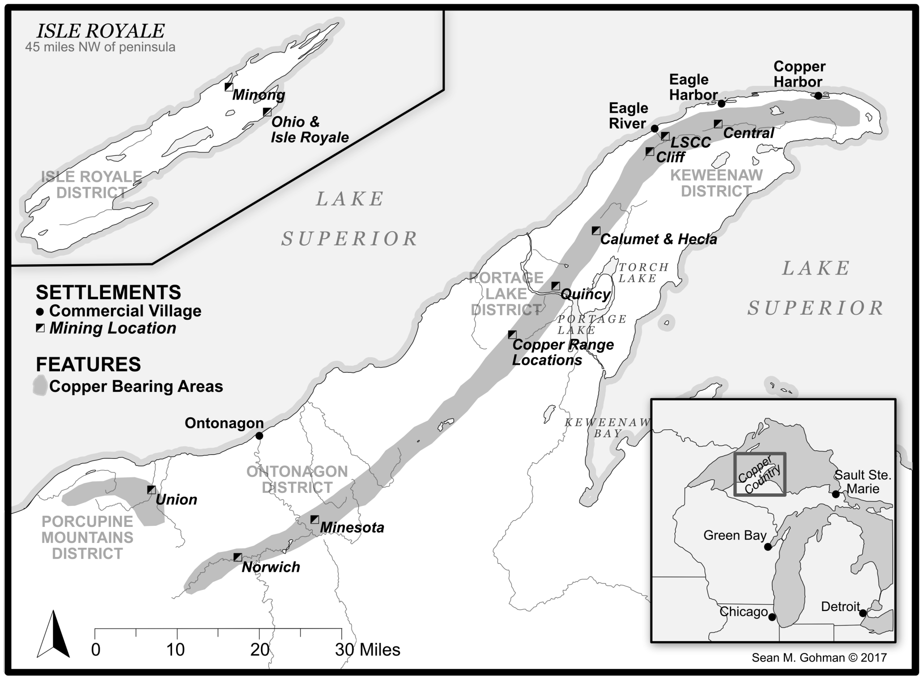

Figure 1. Map of Michigan's Copper Country showing the various early mining districts of Keweenaw, Portage Lake, Ontonagon, Porcupine Mountains, and Isle Royale. Map by Sean M. Gohman, 2017.

Introduction: Michigan's Native-Copper Mining Industry

The story of Michigan's native-copper industry's beginnings is well known as a prelude to the larger non-ferrous mining booms of the western states. Seven years before the 1848 discovery of gold at Sutter's Mill, the publication of Douglass Houghton's *Copper Report* initiated a mad scramble of speculation and prospecting in the upper reaches of the newly created state of Michigan. By the end of the decade, the Lake Copper districts were populated by dozens of exploratory operations working seams of mass copper often visible at the surface and continuing underground for hundreds or even thousands of feet.[1] Most of these ventures failed, and the challenges of transportation in a region accessible only half the year made it a difficult place for the industry to establish any semblance of self-sufficiency. Labor, equipment, and facilities for smelting mined copper were supplied by eastern states. The only useful abundant resource — besides copper — available locally was the virgin stands of timber that fueled and sheltered the struggling industry.[2]

For two decades mining companies rose and fell, and while a few endured and even made profits over the next two decades, the native-copper industry did not experience sustained, exponential growth until the late 1860s. A war-time spike in demand, combined with a shift in focus away from mining masses of copper found in fissures to newly discovered embedded deposits of finely disseminated copper that intersected those

fissures — and heretofore identified as *lodes* for purposes of distinction — requiring more rigorous processing, pushed exploration and technological innovation. The Calumet & Hecla Mining Company (C&H), established in 1865 and sited on the largest of these lodes, first turned a profit in 1869. It quickly became the largest copper producer in the world and initiated the transformation of the Lake Copper districts into a singular, cultural landscape colloquially called the Copper Country. (Fig. 1) A decades-old cultural landscape dotted with islands of industrious activity transitioned into an urbanizing melting pot of multiethnic labor and intensified extraction and production.

Most histories of the Copper Country focus their attention with activities surrounding the establishment of Calumet & Hecla and, to a lesser extent, its primary rivals, the Quincy and Copper Range companies. It is easy to see why. The profits made by these companies dwarf those of earlier mass mines, making the early successes nearly invisible.[3] Further, the consolidation of efforts under the aegis of only a few big players produced a treasure trove of historical records as these companies juggled dozens of operations and thousands of employees, whereas the earlier mass mining period is recorded in terse stockholder reports, brief newspaper accounts, and little else.[4] Discussions of mass mining are often presented as table-setting in a larger context of either C&H and its contemporaries' success, their paternalist management of life and work, or the capital investment and technological advancements that drove those successes.[5] The histories that have tackled the earlier two-decade-long era have narrowed their focus on either the muddled and contentious geological debates about the nature of the region's copper, the first-hand accounts of those pioneers who first explored and settled in the region, or the rise and fall of an early mining venture.[6]

It is not that this earlier era is ignored, but that it is treated as merely the "formative" stage in the long lifespan of this mining district. It is with the lode mining era that the Lake Copper districts coalesce into a unified district and enter into a progression that Francaviglia describes as stages of development, maturation, restructuring, and finally divestment.[7] However, labeling the era of mass mining as formative does not weaken its importance. In *Gambling on Ore* (2013), Kent Curtis frames the development of Montana's copper mining industry as one emerging not from the discovery of copper deposits under Butte c.1882, but as an outgrowth of earlier eras of gold and silver mining practice. The success of Montana's copper industry was laid upon a foundation of silver and gold, and in a similar fashion, the Keweenaw Peninsula's lode mines, working finely disseminated native copper found in embedded strata, were built upon a foundation of mass native copper mined from fissures crossing those strata.[8]

Copper-bearing lodes dwarfed the reserves of fissure-bound mass copper, and the exhaustion of mass copper reserves would have dramatically quickened with the technologies utilized by their lode mining descendants. But those technologies—coal fuel, steam stamps, and pneumatic drills, to name a few—were non-existent in the 1840s and 50s. The technological limitations of an era marked by isolation, a relatively homogenous labor force, and most importantly, a dependence on organic sources of energy, help to define it. Before the Lake Copper districts became the Copper Country,

they were landscapes of potential. Geologists, engineers, and miners had to transform possibilities into realities. Unfortunately, those realities are difficult to uncover since the features and practice of formative periods tend to be ephemeral, poorly recorded, or replaced by later development. Yet with the aid of archival maps and archaeological data, we can visualize these realities. We can see a collection of interconnected industrial *workscapes* designed to exploit an unparalleled, and unalloyed, opportunity.

The Cliff Mine, the first operator to profitably mine native copper in Michigan, offers the best collection of archeological and archival data covering the formative mass-mining period. As the region's first profitable venture, the Cliff set precedents in technology and extractive practice emulated by its contemporaries and later giants like Calumet & Hecla. Its early and prolonged success meant it was also the most thoroughly documented mine of the time, both above and below ground. While that documentation pales in comparison to later successful ventures, the Cliff provides the best window into the workscapes of mass-mining.

Organic Energy, Isolation, and Workscapes

America's economy was almost wholly agrarian in 1800, with manufacturing accounting for only 3% of the domestic workforce. An organic (agrarian) energy system dictated productivity.[9] Wood fuel was primarily used for home heating and cooking. What little industrial activity there was relied instead on wind and water to power it. The fossilized organic energy in coal was little realized outside Pennsylvania. Bituminous seams were noted there as early as the 1750s, and Philadelphia supported a small anthracite market in the 1810s, but even by 1820, sales of coal were still marginal and localized. Over the next 30 years, America's industrial revolution proceeded slowly, limited by the difficulties of overland transportation and a lack of a national marketplace. As transportation networks improved thanks to river-plying steamboats and canal systems, access to energy sources diversified.[10]

From 1850 to 1870, total energy usage in the country nearly doubled while manufacturing accounted for a third of the national economy. The use of wood and coal-fueled stationary steam engines comprised more than a third of industrial energy consumption, but neither could overtake water's primacy. Over those twenty years, and thanks to rail and falling coal prices, coal overtook all other (organic) sources of energy, and relegated wood to the residential market. Fuel is only as good as the cost of transport, and with a nationalizing industrial economy, wood was simply too local to be cost effective.[11] Coal freed industry from the cyclical nature of organic energy systems and bolstered an economic belief in constant growth.[12] Wood may be the "fuel of civilization," but "coal is the fuel of industrialization."[13]

For the Lake Copper districts of the mid-nineteenth century, the productive landscape took decades to catch up to national trends. Distance and a lack of year-round transportation networks cut off the region from eastern markets. Coal was practically

unavailable, and therefore the region was dependent on an organic energy system (OES). But coal's promise of constant growth influenced visions for the Keweenaw's future. With enough local development and success, the demand, supply, and transportation networks necessary to make coal economical would come, eventually. But for now, the infrastructure to support an isolated extractive industry reliant upon an OES, viewed sustainably or as an exhaustible supply, fueled the visions for the Keweenaw's landscape.[14]

Isolation is a "defining characteristic" of mining districts.[15] Heightened resource demands, a potential for incredible wealth creation, and morphologically transformative practices of extraction set mining apart from society, not just physically, but metaphorically. During the eighteenth and early nineteenth centuries, mines and mills were not seen as *of* a community. The artifice of industrial activities removed from it humanity's traditional relationship to the land. As artifice overtook husbandry in the national economy during the mid-nineteenth century, humanity's relationship with the land adjusted as communities accepted artifice's place within them.[16] These metaphorical isolating factors are exaggerated when combined with a literal isolation of distance, environmental extremes, or transportation bottlenecks. On the Keweenaw Peninsula, this resulted in a distinctive setting of isolation.[17] Distance separated the peninsula from a rapidly industrializing East. Regional rail connections were decades away, and harsh seasons — frozen winters and wet springs — made overland travel time consuming and difficult. Much like the canal systems of the Mid-Atlantic and Ohio River Valleys, the Great Lakes acted as the thoroughfares of commercial traffic, though again, winters made them navigable for only half of the year. Along with winter's hazards, Lake Superior's connection to neighboring Lake Huron was a mile-long stretch of rapids on the St. Marys River that had to be portaged. Locally, other isolating factors came into play. Early mining activities concentrated at the extreme ends of the Keweenaw, with 60 miles of virgin forests and Portage Lake, which cuts through the heart of the peninsula, acting as natural barriers to land travel. Footpaths and "Indian Trails" ran the length and breadth of the region, but formal roadways were company affairs cut *from* harbors *to* individual mining locations, often avoiding other mines altogether.[18] These literal and metaphorical isolating factors influenced the creation of a uniquely specific geography of industrial practice.[19]

Geographies of industry constantly change in response to shifts in energy sourcing, raw materials availability, workforce composition, and technological innovation. These changes are difficult to encapsulate within a static two-dimensional landscape setting, since they constitute what Thomas Andrews calls a "constellation of unruly and ever-unfolding relationships" between animate and inanimate actors. Ecological processes, laborers, other organisms, air, and even language instead create a fluid "workscape," where the "boundaries between nature and culture melt away." Andrews applies this notion of workscape to the intimate confines of Colorado's coal mines to contextualize the Great Coalfield War of 1913-14. In these "subterranean crucibles of industrial struggle," Andrews examines a conflict between exploited colliers working in dangerous conditions and corporate interests demanding cheap and plentiful coal to fuel Colorado's

industrialization.[20]

Sixty years earlier than the events in Colorado, the Keweenaw Peninsula was also home to a mining-related struggle that can be contextualized through an examination of workscape. However, at that time the Keweenaw was populated with vast stands of virgin pine and mixed-hardwoods, and American industry was still powered primarily by wind, water, and muscle; not coal. Local labor issues, while not explicitly addressed in the existing sources from the time, centered on capital's need for experienced laborers and laborers' many options in a speculative and rapidly developing extractive landscape. The intimacy of Andrew's colliery workscapes is harder to replicate in the Lake Copper districts of the 1840s and '50s due to the paucity of sources devoted to work, but by expanding the scale of workscape to the wider surrounding environment of the OES-fueled mass-copper mining period, a different struggle comes into view. While it is difficult to view workscape's role in Lake Copper labor conflicts, one can still witness a contest between humans (laborers, engineers, investors) and raw materials (timber, copper) played out in that period's unique workscapes of extractive practice.

Ordering the Land for Extractive Means

Prior to the onset of the copper rush to the region, Lake Superior's southern shore was poorly understood, and this allowed for several possible visions for its future.[21] A handful of expeditions in the late eighteenth and early nineteenth centuries noted the region's mineral potential, but the unique occurrence of large fissures of native copper flummoxed geologists, leading to debates over how much attention mining interests should give them.[22] Veins of copper crisscrossed the landscape, and were accessible but difficult to remove. Were these fissure-bound veins merely entry points into larger lodes of embedded copper ores, or the primary extractable copper form in the region? For the adventurers, prospectors, and speculators who arrived in the early 1840s, it was immaterial. They envisioned a landscape of metallic wealth lining the ground, and they quickly staked claims and secured financial backing to exploit it, regardless of how one might extract it.

At the outset of the mining rush to the Keweenaw, the War Department, then in charge of the nation's mineral resources, had very specific (and ineffective) visions for what the mineral lands should become. Using a system designed for the lead districts of the Upper Mississippi, begun in the early nineteenth century, when mining's footprint was small-scale and poorly financed, the War Department set up a leasing model.[23] Following precedents set by European practice, mining interests could lease mineral lands — up to a total of nine years — for the privilege of developing them at their own expense, and paying royalties on any lead, copper, silver, or iron they extracted. Any improvements made to leased lands then would revert to the War Department at a lease's end.[24] However, leases were poorly recorded and claims were often made sight unseen, which resulted in boundary disputes, double claims, and leases sited over lakes or far from copper reserves.[25] It was hardly a recipe for success.

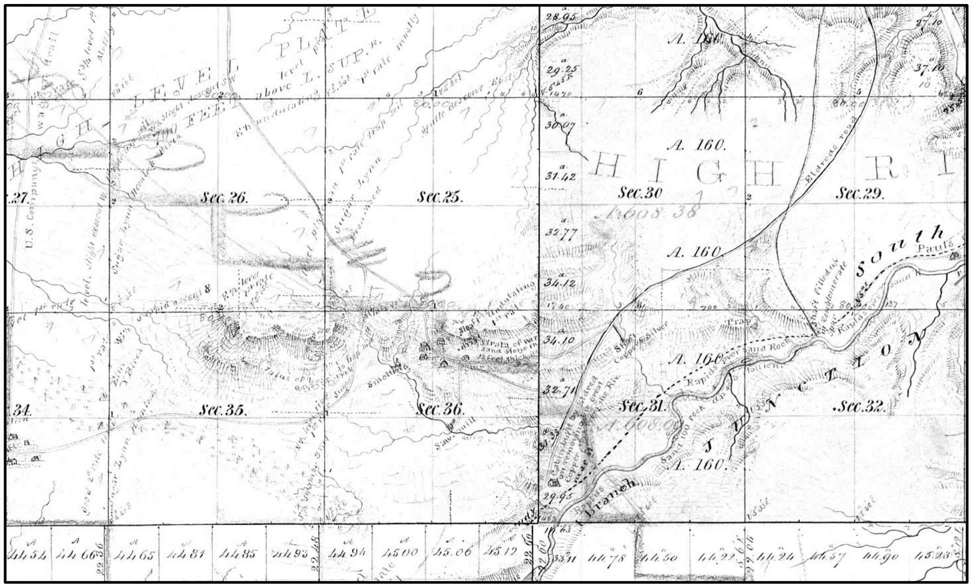

Figure 2. A detailed portion of the linear survey of Township 50N, Range 40W, made in spring of 1847. Cabins, roads, a sawmill, and even an early smelting furnace are documented along with streams, hills, swamps, and tree species. Courtesy Bureau of Land Management's General Land Office Records. https://glorecords.blm.gov/default.aspx.

The new state of Michigan, admitted to the Union in 1837, envisioned the mineral lands as a potential engine for its own economic development. Following procedures set down by the Land Ordinance of 1785, a survey of the state began in 1845 to encourage settlement. The survey identified valuable resources, stamped Michigan's claim to those resources, and influenced visions for the new state's potential. Recognizing that Michigan's linear survey loosened the War Department's hold on the mineral lands, Congress passed legislation in early 1847 to end the leasing system and sell the lands outright. But bypassing Michigan's own designs, Congress demanded its own federal geological survey to inform those sales.[26]

Linear Surveys as Early Visions for the Lake Copper districts

While the geological survey served as the official ordering of the mineral lands, the earlier linear surveys were more influential to the region's development. Their accurate creation and mapping of townships not only cleared up boundary disputes, they provided the first thorough accounting of the Keweenaw's topography. Hills, lakes, swamps, rivers, streams, and timber stands were all accurately mapped, along with the locations of settlements, mining concerns, and pathways, whether wagon roads or "Indian Trails."[27] Additionally, within surveyors' notes were assessments of the potential of rivers and timber stands as sources of motive power and/or board lumber. Now prospective investors could see, in two-dimensional form, what they might acquire. (Fig. 2)

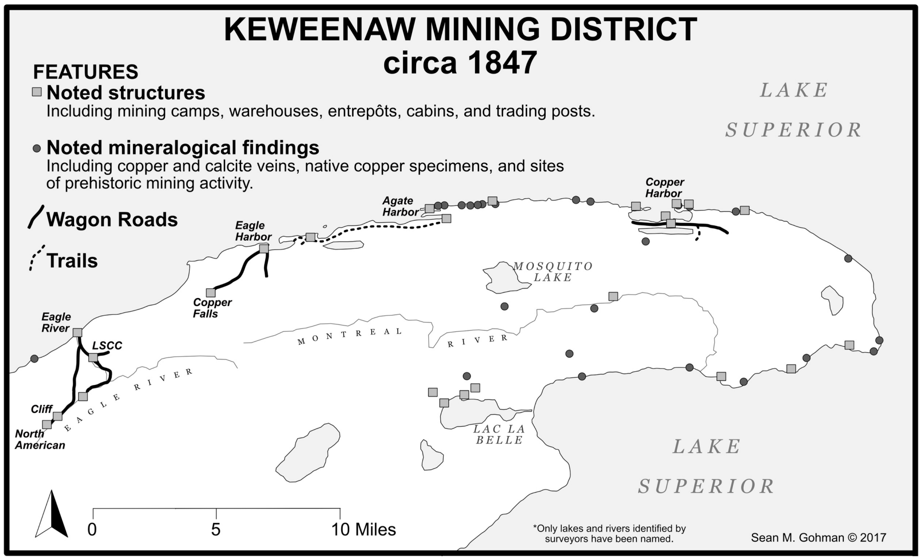

Figure 3. Map of Keweenaw district c.1847, created by tracing historic linear surveys. In the Keweenaw, activities were based near the shore, and connected by short wagon roads. Map by Sean M. Gohman, 2017.

Today, making sense of a wide-ranging dataset of hand-drawn sketch maps is eased with the aid of Geographic Information System (GIS) software. Scholars have used GIS to show clear visualizations at varying scales can transform disparate datasets into singular interpretations, whether decades-spanning national perspectives on industrial production, or as a platform for building databases of architectural, genealogical, or environmental data.[28] By scanning, georeferencing, and then tracing natural and cultural details of roughly 100 individual township surveys into a GIS database, the handwritten scrawls of dozens of individual documents are transformed into singular maps of the natural and cultural landscape from which, we can begin to interpret early visions for the Keweenaw Peninsula.[29]

To the north of Portage Lake, a natural divider between the northern and southern portions of the region, a sugar maple-yellow birch forest was common, while sugar maple-hemlock forests predominated in the south. South of the Ontonagon River were large stands of paper birch and "ironwood."[30] For early mining efforts relying on wood fuel, sugar maple, birch, and ironwood were all excellent sources of thermal energy with high BTU output, and their numbers meant most ventures were well positioned to fuel their extractive activities.[31]

Overlaying the natural landscape of the mid-1840s Keweenaw Peninsula was a cultural landscape of early copper exploration. Mineralized veins, the first target for mineral prospection, intersected the shoreline. Wagon roads followed rivers from harbors (often of dubious quality) to isolated mining camps located along a raised ridge of copper-bearing basalt that formed the spine of the peninsula. At the peninsula's northern end, cabins occupied by fur traders and claim-holders dotted the shore and interior. (Fig. 3) To

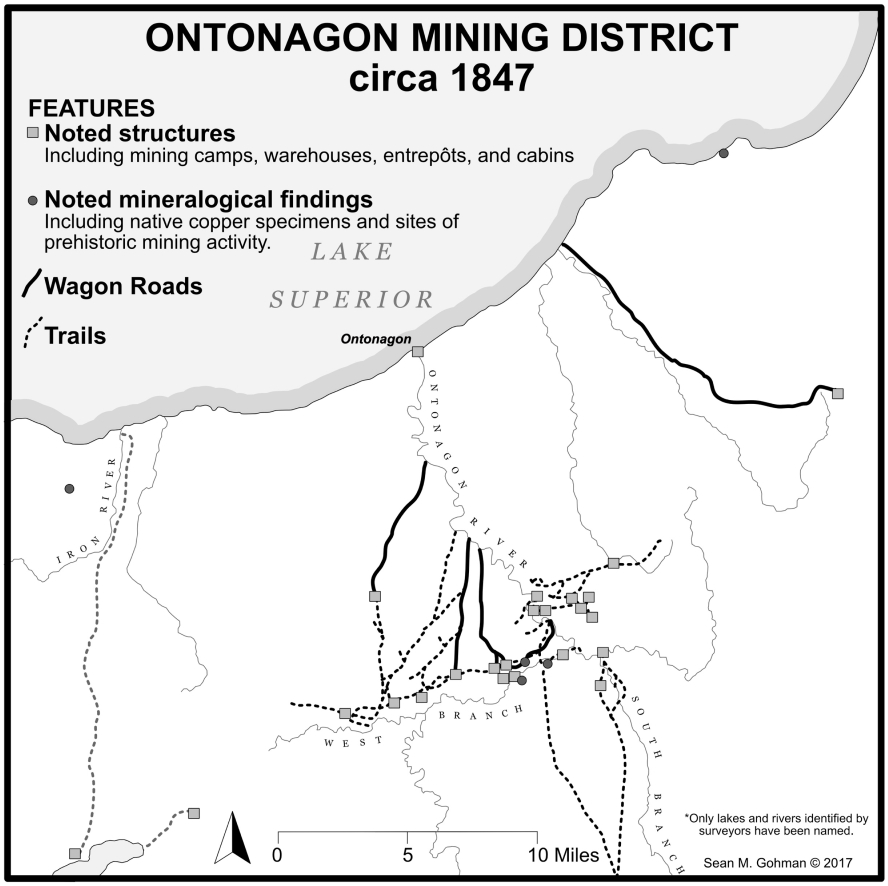

Figure 4. Map of Ontonagon district c.1847, created by tracing historic linear surveys. In the Ontonagon area, activities were based far into the interior, and a mix of footpath, wagon road, and river travel connected the camps to the shore. Map by Sean M. Gohman, 2017.

the southwest, along the Ontonagon River and its tributaries, a network of roads, trails, and river landings connected several separate mining ventures into a 10-mile long landscape of extractive activity. (Fig. 4) As for Native American presence, trails led south to Wisconsin, while sugar camps, gardens, burial grounds, and two missions (Catholic and Episcopal) populated the shoreline of Keweenaw Bay.

The Copper Country's OES-Fueled Workscapes

The interpretations extracted from the maps of the region's natural and cultural landscape in the 1840s offer the physical backdrop upon which the OES workscapes of native copper mining formed. Once land sales replaced the problematic leasing system, mining camps sited on fissure veins increased investment, developed infrastructure, and in some cases quickly grew into vibrant industrial communities. The transition from prospecting to full-scale, intensive mining of fissure veins required resource-specific methods and

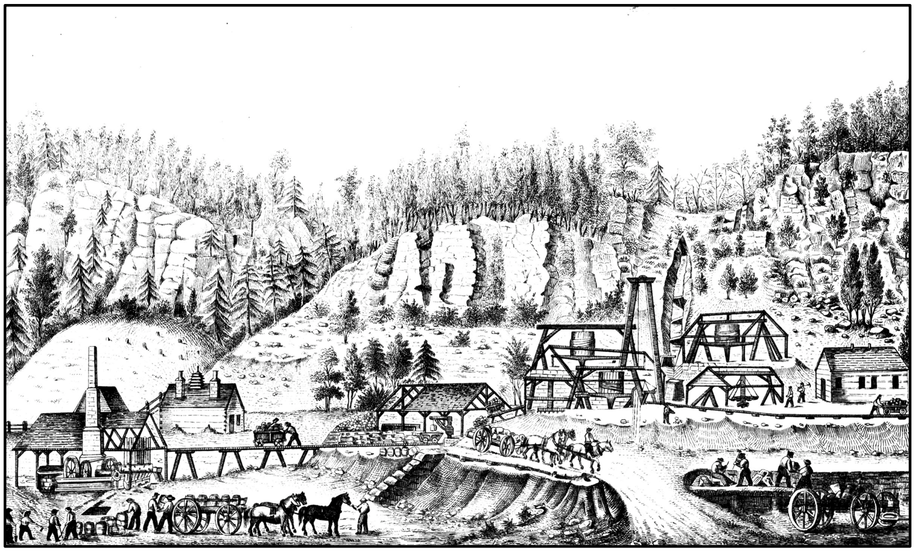

Figure 5. Sketch of the Cliff Mine, c.1849. Muscle powers activities at this time. Note the horse whims and capstans (at mid right). Men push carts and load horse-drawn wagons. Some machinery is present, such as the crane at the kiln house (at center) and a small engine running a rudimentary stamp mill (at left). Courtesy of Michigan Tech Archives and Copper Country Collections.

technologies driven by organic sources of energy. Initially, mining interests believed wood and water would power the mechanical needs of the industry, but by the end of the 1840s, mining interests discovered that wood was the only viable option to ease human and animal effort. Muscle power in the mining of mass copper derived from both humans and draft animals. Oxen and horses drafted wagons at the mines and plows on company farms. Horses also turned whims, large winding drums that raised and lowered material in the mine shaft, while a smaller version of the whim, the capstan, was powered by human laborers. (Fig. 5) Surface laborers also provided all efforts in construction, including carpentry, masonry, and landscaping.

Underground laborers were mainly Cornish, German, and Irish immigrants, with the former occupying the higher skilled positions. Miners descended a series of ladders to reach the poorly ventilated working level lighted only by candle. Three-man teams hammered drill holes into rock adhering to the vein, filled those holes with explosive black powder charges, and detonated the charges to access the vein and its associated masses of copper. When the smoke cleared, some men used forged iron chisels to cut copper masses into workable pieces, while others hand-separated stamp work (rock with mass copper adhering to it and requiring mechanical crushing) from waste rock.[32] The cramped nature of, and poor circulation within, underground workings made it difficult for animal power to assist in the removal of waste rock and mass copper. Shafts and horizontal drifts/levels followed the copper vein, a practice that often resulted in irregular communication from end to end, level to level. When drifting provided enough uniformity for carts to travel on tracked tramways, carts were pushed by trammers, not pulled by horses. [33] (Fig. 6)

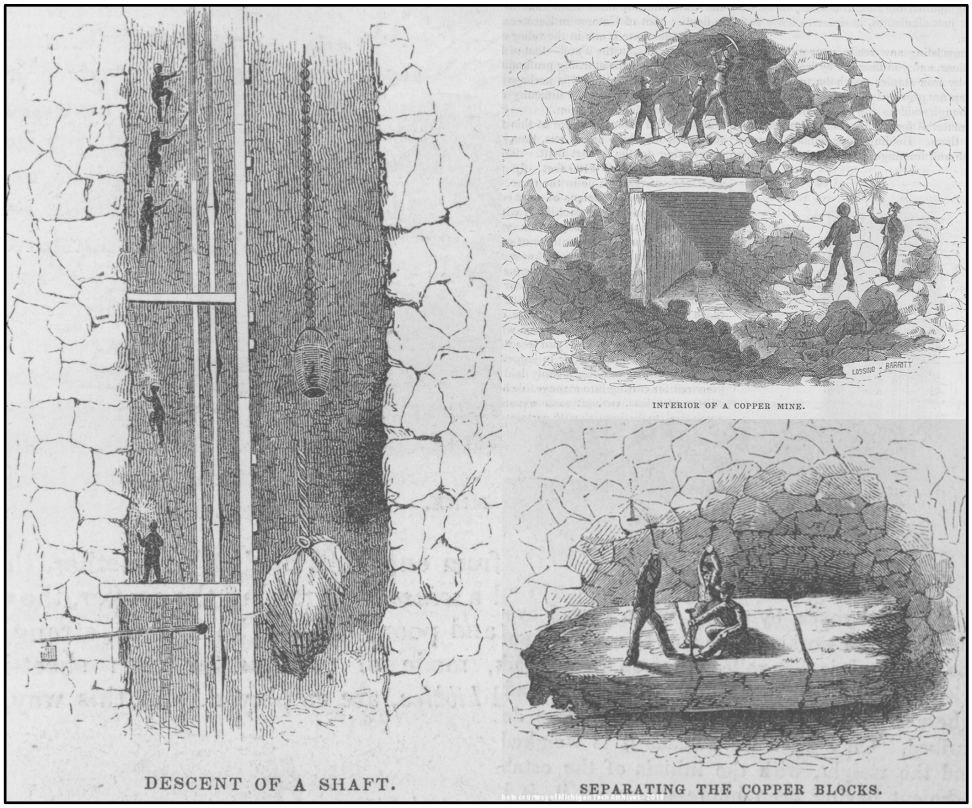

Figure 6. Sketches of work, above and below ground, at the Cliff Mine, c.1852, found in Clarke's "Notes from the Copper Country" in *Harper's New Monthly Magazine*. At left: descending a mine by ladder as a copper mass is raised in the shaft. At top right: drilling and excavating drifts. Bottom right: cutting up a copper mass. Courtesy of Michigan Tech Archives and Copper Country Collections.

At the shaft's intersection with a working level, laborers loaded waste rock, stamp work, and tools into *kibbles*, large buckets hoisted by chain or rope. Back on the surface, waste rock was trammed to ever-growing *poor rock* piles, often located just yards from the shaft. Stamp work was taken to timber-filled kilns and roasted to make it brittle. Once calcined, the stamp work was crushed and washed at the mill either by hand or mechanical means. The stamps were simple pestle and mortar affairs. A cam shaft's rotation, powered by water or steam, lifted and then dropped a series of wooden pestles — with cast iron stamp heads — into a mortar filled with calcined stamp work. A flush of water in the mortar pushed the crushed mixture through an iron punch-plate sieve and into a series of troughs and hand jigs to agitate and separate bits of copper mineral from rock. The copper was barreled, while tailings collected alongside the mill for later reprocessing or pushed out onto a nearby riverbank. At the kiln and mill, the use of wood and water primarily eased physical effort and the drain on caloric energy, rather than power mechanisms.[34]

Winter halted shipping for up to half the year, and when spring arrivals finally landed in the Keweenaw, they witnessed runoff-engorged rivers discharging into the lake. For

easterners accustomed to water-powered textile and sawmills, this sight was believed advantageous to the area's development. However as spring turned to summer and fall, those discharges reduced considerably.[35] A few mining concerns invested in water power regardless, and though these efforts failed, their attempts at harnessing water power offer insight into mining companies' struggles with transforming energy and their early visions for the landscape.

Discounting sawmills, early applications of water power in mining camps focused on the lifting of gravity stamp mills for processing stamp work.[36] The earliest instance of water-powered milling took place on the Eagle River at the Lake Superior Copper Company (LSCC) works, the first organized, incorporated mining operation on the peninsula. Begun in 1844 on several copper (and notably, silver) veins aligned with the river and exposed at a natural fall, the LSCC's location offered a best-case scenario for testing water's efficacy as mechanical power supply. Encouraging results led to the erection of a 90 ft.-long mill building housing a 15 ft.-diameter, 10-ft. wide overshot wheel. The wheel lifted twenty-four stamps, each weighing 200 lbs., twelve inches before they dropped to strike stamp work in an iron mortar, while a further nine stamps and a pair of 500 lb. crushing wheels handled silver ores. The thoroughly stamped/crushed material was then "washed" by hand jigs and sieves, resulting in a process that eased human metabolic effort while not replacing it. Unfortunately, the mill proved inefficient and it, along with the LSCC Mine itself, ceased operations in 1847.[37]

Accommodating Steam's Potential

Other companies joined the LSCC in failing to harness water power, and by the close of the decade companies understood that "there was too much uncertainty connected to the use of water."[38] With water power proven to be unreliable, mining companies instead tried importing steam engine technology, fueled by the surrounding forests, to meet their mechanical needs. While coal was increasingly common in eastern industries, distance and transportation bottlenecks posed by the Great Lakes precluded its use in the districts. The surrounding forests already supplied trees for building material and heating fuel, and those needs quickly depleted immediately adjacent stands, but timber's regional abundance made for a more accessible, and acceptable, fuel choice. Boilers, steam engines, and stamping apparatus were all shipped in from eastern foundries, and required considerable investments of capital, time, and maintenance. Transporting coal along with new technologies, when readily available fuel supplies were found in abundance, pushed the risk of costly investment too far.[39]

As a result, an expansion of wood dependence for extraction, beneficiation, and construction needs widened the geographical scope of mining companies' interests in accessible timber. Mining companies had to look beyond their immediate surroundings and tackle the management of their land holdings for two extractive purposes: mining and logging. Due to the large stands of sugar maple and birch, most mining operations were well positioned to acquire affordable fuel provided they could access and transport it

back to the mine location.

Acquiring wood fuel required a whole different form of work than that of mining. Timbermen were often French-Canadian laborers familiar with northern forests but unaccustomed and/or unwilling to work underground. Wagons traversed ungraded, rutted roadways that constituted little more than linear clearings radiating outward from camp. Transporting logs across the uneven ground in spring and summer months proved difficult and time consuming, though in winter, one to two feet of fresh snow made for easier sledding. *Swampers* cleared the roads, *choppers* felled the trees, *barkers* smoothed the logs for easy dragging, and *sawyers* "bucked" the logs into manageable pieces.[40] Long sections were placed alongside mine openings for underground support materials, while cordwood was either stored in sheds beside boiler rooms or stacked into pyres for the roasting of stamp work. Logging for the mines stripped the surrounding landscape, and companies quickly set about transforming these denuded "wood lots" into agricultural fields.[41]

As mining companies turned to the utilization of steam technology, industrial structures were modified to accommodate them. Engines and their adjoining boilers required a level of protection and maintenance unnecessary at an exploratory camp. Timber-framed, clapboard (or sometimes log) structures already susceptible to fire were not a reliable choice for housing expensive and, in the case of boilers, potentially explosive technologies.[42] Stone masonry, using waste rock from the mine, soon replaced clapboard siding, though timber framing still offered flexibility and roominess for rapidly changing industrial practices. Masonry structures also signified a growing permanence to the region's industrial activity as the region transitioned from a cultural landscape of mining camps to mining communities.

Most companies began their trials with steam technology using small, portable engines that could meet a variety of needs. Transporting and installing a large piece of equipment was an expensive affair, and portability was advantageous for outfits in the early stages of prospecting.[43] A demonstration of profitable mining by someone—anyone—was necessary to encourage companies to take on the expensive gamble of purchasing a stationary engine. Not until the end of the 1840s did a company make that gamble, but by doing so it initiated a flurry of engine importation, a reduction of the region's isolating factors, and dramatic changes in practice. Lankton states in *Cradle to Grave* (1991), "Nowhere in America did the steam engine bring more change than at the Lake Superior copper mines."[44]

The Cliff Mine and the Adoption of Steam

Sited on an copper-filled fissure exposed at the base of 200-foot ridge, the Pittsburgh and Boston Mining Company's (P&BMC) Cliff Mine became the first incorporated mining concern to declare a shareholder dividend at the close of 1848, the first of twenty profitable years for the company.[45] The following year, the company arranged for the

purchase, delivery, and installation of a large steam engine to tackle the mine's hoisting and pumping duties, formerly handled by whims and capstans.[46] This was the first of several engines in the Lake Copper districts designed by the Cornish engineer, Nicholas Vivian, and erected by Vivian's cousin and fellow Cornishman, Joseph W.V. Rawlings.[47]

This low-pressure "winding" engine had a vertically oriented piston, with a "walking-beam" exiting the back of the structure, similar in design to — but smaller than — those common in Cornwall. This was the first engine of its kind in the Lake Copper districts, and its "splendid manner" of operation became the "model for mining engines in [the] region." At a time when most mining companies started with $100,000 in capital, the engine's cost of $15,000 was a substantial investment. Its immediate success however, convinced the P&BMC to purchase a second, nearly identical engine from Vivian the following year to handle stamping duties, though for the reduced price of $8,000.[48]

As the provider of equipment to the districts' most successful operator, Vivian and Rawlings' reputations spread quickly and their engines became a common site in the Lake Copper districts. By the close of 1854, Vivian had contracted seven more engines in the districts, and Rawlings crisscrossed the peninsula to oversee their installation.[49] But with the opening of a lock canal on the St. Mary's River in May 1855, Vivian's influence diminished. Now ships moved freely between Lakes Superior and Huron, reducing shipping costs and encouraging mining companies not only to invest in new technologies, but to use a wider array of suppliers. A year and a half later, 48 engines of varying size and purpose populated the districts, more than doubling the number present prior to the lock's opening. Captain Paull of the Garden City Mine captured the region's embrace of steam in his 1857 report to shareholders. "When we can mine by steam, break rock by steam, stamp by steam, and wash by steam we shall have a model mine."[50] The locks marked a new stage in the region's development as companies looked to adopt steam power for all their mechanical needs.

Mining Maps as Windows into Mass Mining Workscapes

Just as linear surveys of the mid-1840s illustrate the early visions for the Keweenaw, mining maps of the 1850s and 60s offer views of how those visions became reality in the creation of the Lake Copper districts' workscapes. Whether crudely made with a compass or more accurately with optical instruments, the plan maps, landscape sketches, and underground plans and profiles of the era provide two-dimensional clues to the three-dimensional relationships between energy sources, mining, milling, and transportation that defined the workscapes of the mass mining.[51] Plan maps of mining locations were a common inclusion in company shareholder reports, and highlighted where companies spent money aboveground. They also illustrate mass mining's compact footprint. (Fig. 7) At a larger scale, land-holdings maps juxtapose the compactness of surface work with the far-reaching procurement of timber fuel. (Fig. 8) Underground, surveyors usually created section views of shafts and levels to show the extent of work though occasionally, plan views were produced to capture the vein-chasing crookedness of excavations.

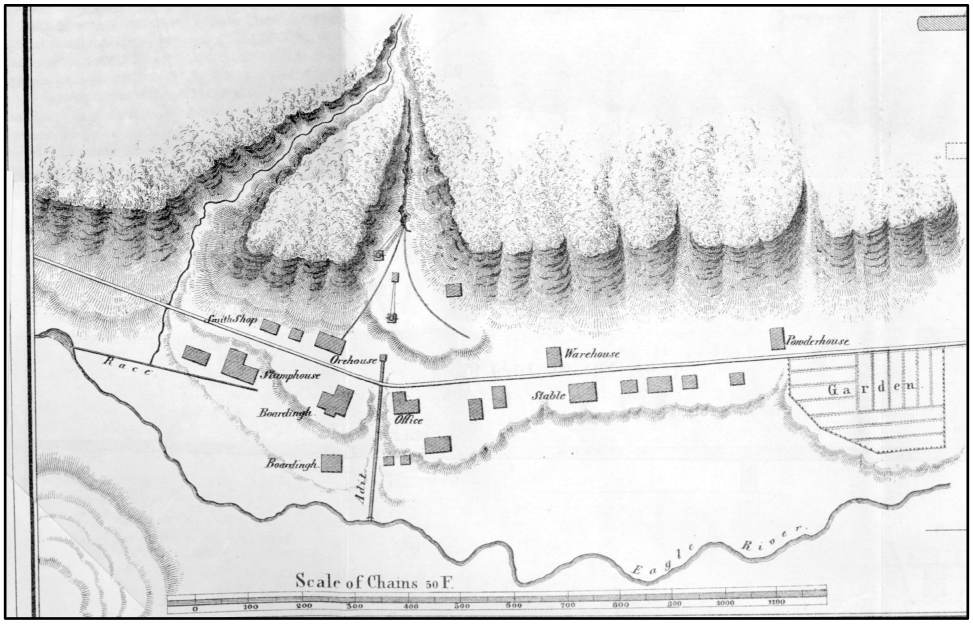

Figure 7. Sam W. Hill's, *Topographical and Underground Plan of the Cliff Mine Situated on Keweenaw Point*, for Charles T. Jackson, U.S. Geologist, 1847. Courtesy of Michigan Tech Archives and Copper Country Collections.

The Rise of Portage Lake and Lode Mining

As mass mining activities intensified in the Keweenaw and Ontonagon districts, the 1856 discovery of the Pewabic Lode, a rich embedded deposit of disseminated copper located in the Portage Lake district, initiated a shift in the region's fortunes.[52] Up to that point, Portage Lake attracted little attention compared to the Ontonagon and Keweenaw districts, but now it—and by extension the lode mines clustered there—was poised to become the hub of the Lake Copper industry. A centralized location on a protected harbor offered a location for ancillary industries to meet the needs of a rapidly interconnecting collection of mining interests. By 1860, a smelter and foundry were each established at Portage Lake, and they soon necessitated the funding of road systems to further connect the region's mining communities.[53] The Mineral Range State Road, authorized by the Michigan Legislature in 1861, connected Copper Harbor at the northern tip of the Keweenaw Peninsula, through Portage Lake 45 miles distant, and then a further 50 miles southwest to the harbor and commercial village of Ontonagon.[54] Two years later, the Military Road, designed to connect Fort Hayward in the Wisconsin Territory to Fort Wilkins in Copper Harbor, was also completed. At the same time, local mining interests and the federal government began to dredge the entry to Portage Lake, easing access to its mines and burgeoning commercial development. Together, the roads and dredging eliminated many of the isolating factors that had defined the Lake Copper districts' early development.[55] (Fig .9)

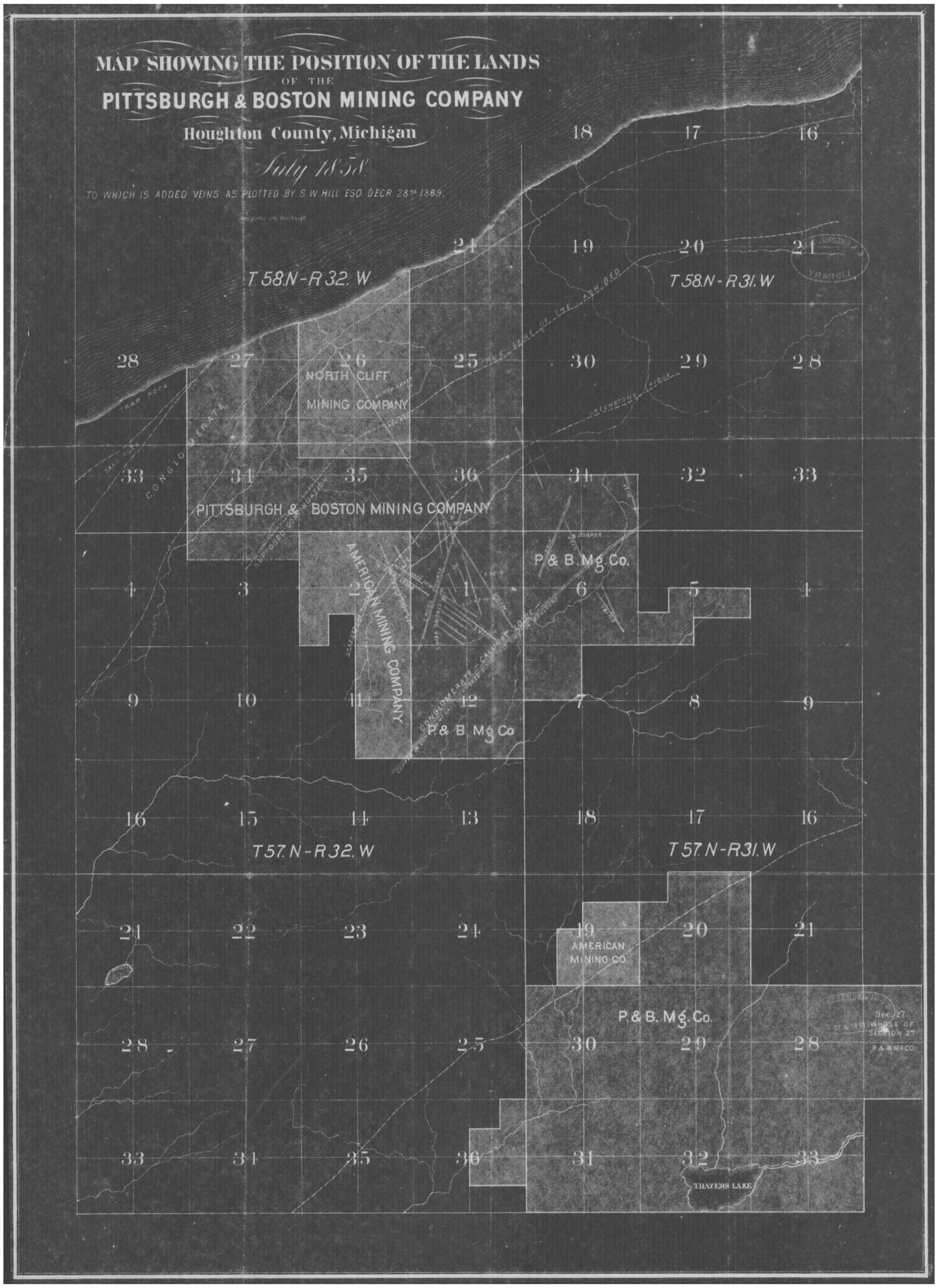

Figure 8. Map of the Position of the Lands of the Pittsburgh & Boston Mining Company, July 1858. In the north are the mineral lands of the Cliff Mine and it's ancillary ventures, the North Cliff and American locations. To the south are the P&BMC's timber lands, the source of fuel for activities in the company's mineral lands. Courtesy of Michigan Tech Archives and Copper Country Collections.

Figure 9. Detail from *Map to Accompany the Cross Sections of the Portage Lake District, in Geological Survey of Michigan,* 1873. Portage Lake's shoreline quickly developed as lode mines sent their copper rock to mills on the shoreline. Courtesy of Michigan Tech Archives and Copper Country Collections.

The lode mines of Portage Lake depended on the efficient transportation of large volumes of stamp work, rather than fissure-bound mass copper. Lode miners still encountered mass copper, but it was now viewed a time-consuming roadblock to productivity, not a desired objective. Miners removed entire strata of copper-bearing rock, dramatically increasing the amount of material raised to the surface.[56] Mass mining's irregular warrens of ladders and kibbles were replaced with lode mining's straight and true shafts and drifts lined with tracks for guiding trams, skips, and man cars. Workforces enlarged to handle the increases in production, and skilled Cornish were gradually replaced by unskilled Finns, Italians, Slavs, and others. Mills, once located on streams and rivers close to a company's mines, now moved to lakeshores and abundant sources of water. They enlarged as well, processing larger volumes of material per day, and depositing tailings that encroached on shipping lanes. Steamers plied these shipping lanes thanks to the dredging of Portage Lake's entry. Initially this was to pick up marketable copper smelted in both company and privately-owned facilities, but over time ships delivered coal as well, beginning the industry's shift from organic to mineral energy dependence.

The End of the OES Workscapes of Mass Mining

The shift to lode mining dramatically reduced mass mining's share of Lake copper production. Several mass mines continued well into the 1860s, though their influence and production numbers waned considerably. Smaller producers consolidated and reorganized to keep working, while the two biggest names in mass mining underwent drastic changes as well. The P&BMC sold the Cliff after a poor showing in 1870, and that same year the Minesota [sic] Mine shut down operations altogether.[57] In some cases mass mines attempted the transition to mining intersecting lodes, though these endeavors proved too expensive. Closures continued into the 1870s and 80s, and by 1890 only the Central Mining Company still mined a paying vein with technology, fuel, and practice directly linked to practice forty years prior. But by 1898, the Central shut down as well, marking the end of an era.[58]

The demands of lode mining put a strain on organic fuel sources as well. Increases in extraction, hoisting, transportation, milling and smelting also depleted the supply of timber. By 1870, coal was the dominant source of energy for industrial purposes in America, and the Lake Copper district began to restructure itself to take advantage of its cheap cost and efficient use. This restructuring was not immediate. It took nearly three decades for coal to overtake wood as the primary fuel source for the local mining industry after coal's introduction in the early 1880s, but by then the practice of mining and the region's connection to the rest of the United States were wholly different from the mass mining era.[59]

Underground, hammers, hand-drills, and chisels were replaced by pneumatic drills. Gone too were ladders and kibbles. Miners and materials now descended/ascended the shaft on man and rock cars. At the surface, mills once located on rivers and streams close to shafts were now sited on large bodies of water often miles from extractive activities. Near to the mills were smelters and coal docks, one producing finished copper while the other handled the delivery of fuel. Coal made its way to the mills, smelters, and mines via rail, and though timber was still a sought-after resource, it was primarily for building and underground structural supports, not as an industrial fuel. The early mass mining areas transitioned to agricultural and timber lands, while the once ignored central part of the peninsula became the heart of industrial and commercial activity.

Conclusion

Concurrent with the change in fuel from wood to coal came the end of mass mining practice. The lode-mining era of native-copper mining overlaps the mass mining era by a few decades. This overlap constitutes the industry's developmental stage as the Lake Copper districts transitioned from a formative stage of mass mining in several loosely connected areas of activity, to a mature stage of intensification, industrial scale extraction, and a coalescence of those areas into a singular mining district. Mass-mining practice, marked by isolation, a unique occurrence of large masses of native copper never

encountered before, and wood fuel, defines the formative stage of native-copper mining.

While this paper is focused on the mass mining as the formative stage in a larger story of copper mining argument, an argument could also be made that the mass mining period is itself a distinct mining industry from the lode mining period, possessing its own life cycle. Could it be both, depending on the approach? Were the activities of mass mining more conducive to an organic and labor-intensive regime? Further, could the activities of the lode mining period continue and succeed under an organic energy system, or are its industrialized methods too energy-intensive? Regardless of the answers, there is much to be explored in this still poorly recorded period of mining practice.

The gradual replacement of mass mining by lode mining does not lessen its significance, but it does make it clear that understanding this significance is best approached through the specific workscapes created out of its envisioned potential. When the potential changed, from organic-fueled mass mining to mineral-fueled lode mining, the workscapes had to change as well. The opening of the Soo Locks, the dredging of Portage Lake's entry, and the cutting of state and military roads mitigated the isolation of the Lake Copper districts. The unique deposits of fissure-bound mass copper were depleting or found only at depths too expensive for profitable mining when compared to newer and shallower lode mines. The rise of ancillary industries provided equipment and expertise previously expensive and risky to acquire. The one-time loosely connected districts were coalescing into a unified Lake Copper district thanks to industrial-scale systems made possibly by the transition to coal. The islands of mining activities were transitioning into an interconnected community soon to be known as the Copper Country.

Notes

[1] I use the term, Lake Copper districts as a descriptor for the geographic arrangement of activities that mark the formative stage of native-copper mining. Five distinct geographical districts: Keweenaw, Portage Lake, Ontonagon, Porcupine Mountains, and Isle Royale, all followed similar yet separate paths to development owing to location, entrepôts, and mineralogical peculiarities. Over time, these separate districts became a singular district, and I use these terms specifically to denote the industrial landscape of native-copper mining in the Keweenaw Peninsula. I use the term, Copper Country, to describe the cultural landscape that formed as a result of decades of mining practice. To describe the physical geography, I use the term Keweenaw, or Keweenaw Peninsula.

[2] Douglass Houghton, *Geological Reports of Douglass Houghton*, ed. George N. Fuller (Lansing: Michigan Historical Commission, 1928). Houghton made four annual reports between 1837-1840, but it was that final report that became the impetus for the ensuing copper rush that followed. Michigan entered the Union in 1837, and while it was given nominal control over the Upper Peninsula at that time, it was not until the 1842 Treaty of LaPointe, made with the local Ojibwe peoples, that the area was ceded to the United States.

[3] Calumet and Hecla paid out an estimated $75 million in dividends to its shareholders, while the Cliff Mine, the first native copper mine to make a profit in the region, paid out $2.5 million over its lifespan. Figures taken from B.S. Butler and W.S. Burbank, *The Copper Deposits of Michigan* (US Geological Survey, Professional Paper 144, 1929).

[4] The Michigan Technological University Archives and Copper Country Historical Collections is the premier repository of print, graphic, and manuscript resources related to Michigan native-copper mining era.

[5] The earliest histories of the native-copper mining era were focused on technical breakthroughs and the business side of things. William B. Gates' *Michigan Copper and Boston Dollars: An Economic History of the Michigan Copper Mining Industry* (Cambridge: Harvard University Press, 1951) first shown a light on the impact of eastern investment, specifically from the Boston-based owners of Calumet and Hecla on the development of native-copper mining. Prior to Boston's emergence as the primary source of investment capital in the region in the 1860s, Pittsburgh, and to a lesser extent New York, Philadelphia, and Detroit were the loci of capital backing. C. Harry Benedict's *Red Metal: The Calumet and Hecla Story* (Ann Arbor: University of Michigan Press, 1952) was the first narrative history to cover the Copper Country's mining activity, albeit at a single entity-scale, and starting over twenty years after the Lake Copper Districts first drew attention. Benedict followed this with *Lake Superior Milling Practice: A Technical History of a Century of Milling Practice* (Houghton: Michigan College of Mining and Technical Press, 1955), which provided a concise history of early milling techniques in the mid-nineteenth century before focusing on the complexity of technical innovations in milling and washing ores that occurred over the late nineteenth and early twentieth centuries. Several labor-focused histories of the region have also been written, with the strike of 1913-1914 being the focus. Arthur W. Thurner's *Rebels on the Range: the Michigan Copper Miners' Strike of 1913-1914* (Lake Linden: John H. Forster Press, 1984) being the earliest. Larry D. Lankton has written three books on the Copper County over the last few decades. His earliest work, *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines* (New York: Oxford University Press, 1991) covered the technological side, but focused primarily on the impact of the one-man drill on underground work, and the resulting labor strife that followed its adoption, while his latest work, *Hollowed Ground: Copper Mining and Community Building on Lake Superior, 1840s-1990s* (Detroit: Wayne State University Press, 2010) follows up on the social perspectives of *Beyond the Boundaries*, only within the timeframe of the late-nineteenth and twentieth century. Finally, Alison K. Hoagland's *Mine Towns: Buildings for Workers in Michigan's Copper Country* (Minneapolis: University of Minnesota Press, 2010) rounds out the list with a history focused on the vernacular architecture of the Copper Country at its productive height, but not the built environment of its beginnings.

[6] The first history to focus on the activities of the mid-nineteenth century is Donald Chaput's *The Cliff: America's First Great Copper Mine* (Kalamazoo: Sequoia Press, 1971). Chaput devotes the first third of the book to the activities that led to the Cliff's discovery and success, and always weaves the single-entity focus through a larger, region-wide narrative. David J. Krause's *Making of a Mining District: Keweenaw Native Copper 1500-1870* (Detroit: Wayne State University Press, 1992) is also concerned with this period, but focuses on the geological debates over the region's unique copper deposits. Larry D. Lankton's *Beyond the Boundaries: Life and Landscape at the Lake Superior Copper Mines, 1840-1875* (New York: Oxford University Press, 1997) covering the period of this paper's focus from a social perspective, rather than a technological one.

[7] Richard Francaviglia, *Hard Places: Reading the Landscape of America's Historic Mining Districts* (Iowa City: University of Iowa Press, 1991), 150-162. These five stages of a mining district are described in detail in a section on seriation in the chapter, "Interpreting the Landscape."

[8] Kent A. Curtis, *Gambling on Ore: The Nature of Metal Making in the United States 1860-1910* (Boulder: University Press of Colorado, 2013). Curtis begins his look at how America transformed into a "mining nation" in the 1880s by following small-scale placer gold mining in western Montana. While mostly unsuccessful, nearly two decades of mineral prospection in the search for gold, and later lode silver, opened geological understandings of the region and paved the way for a future, highly successful copper mining industry.

[9] Rolf Peter Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Cambridge: The White Horse Press, 2001) 19-27. Sieferle uses the term, "agrarian solar energy system" to describe the cyclical nature of solar-radiation derived energy transformation. For the paper, I use organic energy system (OES) to denote the same process.

[10] David A. Tillman, *Wood as an Energy Resource* (New York: Academic Press, 1978), 4-6; Barbara Freese, *Coal: A Human History* (Cambridge: Perseus Publishing, 2003), 106-113; Christopher F. Jones, *Routes of Power: Energy and Modern America* (Cambridge: Harvard University Press, 2014). Jones' work details the importance of access — canals, pipelines, wires, etc. — in the transmission of energy for productive purposes in the Mid-Atlantic between 1820-1930. Improvements in access to coal, oil, and electricity led to an intensification of the region and a dependency on fossil fuels still felt today.

[11] Tillman, *Wood as an Energy Resource*, 9-14. Sam H. Schurr and Bruce C. Netschert, *Energy in the American Economy, 1850-1975* (Baltimore: John Hopkins University Press, 1960).

[12] Sieferle, *The Subterranean Forest*, 181-202; E.A. Wrigley, *Energy and the English Industrial Revolution* (Cambridge: Cambridge University Press, 2010), 10-52. Sieferle points out in his chapter, "Perceptions of Fossil Energy," that in early industrializing Britain and Germany, the depletion of wood-fuel timber was seen as a foreshadowing of the end times. The discovery and economical use of coal as a substitute for wood, was seen by some as a "providential" gift from God. Wrigley deftly compares England's economy fueled by "fungible" wood to its later transition under "consumptible" coal as one of "constraint" versus one of "escape."

[13] Tillman, *Wood as an Energy Resource*, 1.

[14] *Superior Miner* Jan. 24, 1857. Captain Paull's editorial in 1857 noted that coal would replace wood as a fuel for steam engines eventually, but due to cost and distance, it would require prolonged success in the Lake Copper industry to mitigate those difficulties; *Lake Superior Miner*, Mar. 6, 1858. Within a year of Paull's editorial, coal was being shipped to the Marquette iron district as ballast, and fetched $2.00 a ton for the district's iron furnaces.

[15] Francaviglia, *Hard Places*, 67.

[16] John R. Stilgoe. *Common Landscape of America, 1580-1845* (New Haven: Yale University Press, 1982). Stilgoe believes that urban life, and with it the artifice of the industrial cityscape, challenged the primacy of natural landscape, and eventually replaced it.

[17] Gates, *Michigan Copper and Boston Dollars*. Though in this case wealth was almost wholly transferred to shareholders in Eastern states.

[18] Benedict, *Lake Superior Milling Practice*, 11; *Lake Superior Journal*, Jul. 9, 1853. The Minesota Mining Co. cut a 12 mile wagon road from Ontonagon to its mine, while the Norwich, 5 miles west of the Minesota, shortly thereafter constructed their own 18-mile long road to Ontonagon.

[19] Larry Lankton, *Beyond the Boundaries*, 3-47. Lankton details the isolating factors of the region from a social history perspective in the chapters, "Water, Woods, and Winter: A Special Sense of Place," and "Heaving up Jonah: The Travail of Travel."

[20] Thomas Andrews, *Killing for Coal: America's Deadliest Labor War* (Cambridge: Harvard University Press, 2010), 125. As much labor history as environmental history, Andrews' work demonstrates the impact technological change has in social movements, and how work itself is a product of human-environment interplay.

[21] Elliot West, *Contested Plains: Indians, Goldseekers, and the Rush to the Colorado* (Lawrence: University Press of Kansas, 1998), 33-58. Social, environmental, and military history converge in a story of competing visions for the plains and eastern Rockies. Native Americans, miners, farmers, and ranchers all saw the frontier landscape as a land of differing possibilities, and each competed to make those visions a reality.

[22] Krause, *Making of a Mining District,* 149-193. Krause's book is the seminal work covering the debates over Michigan's native copper. Krause offers a thorough look at the players involved, their personalities, their methods, and their findings, to clarify a confusing, and at times tragic tale. Even as late as the 1920s, geologists were still debating the nature of fissure-bound copper.

[23] Patrick A. Pospicek, "The Rise and Fall of Frontier Urbanization in the American Midwest: Galena, Illinois, 1820-1870" (dissertation, Purdue University, 2013), 51-90. Pospicek's discussion of the Federal Leasing system details the systems origins as well as the discontent felt by mining interests in the Upper Mississippi lead districts towards that system's flaws.

[24] U.S. Congress, Senate Document 160, 29th Congress, 1st Session, Feb. 24, 1846. This document provides a detailed explanation of the permit-lease system, as well as the issues surrounding its implementation and eventual termination. The permit holder was entitled to make a claim of up to nine square miles (later reduced to one to satisfy a growing demand for permits). The Mineral Land Agency offices were based at Copper Harbor on the north end of the Keweenaw Peninsula, at the mouth of the Ontonagon River, and at the Chocolay River in the Marquette iron district.

[25] *Lake Superior Journal*, Oct. 9, 1847. One dispute occurred at the Cliff Mine. The prosperous vein that crossed their property was struck at the base of the 200-ft. Greenstone ridge, just a few hundred feet from their lease neighbor to the south, the North American Mining Co. To develop their find, the Pittsburgh and Boston Mining Company (owners of the Cliff) built several timber-frame structures under the shadow of the Greenstone, including boarding houses, a stamp mill, ore house, and office. Unfortunately, these were found to sit on the North American lease. Luckily for the owners of the Cliff, a court order moved the lease boundary south to accommodate their improvements, rather than awarding their efforts to the North American's ownership group.

[26] Krause, Making of a Mining District, 176-193. And, J.W. Foster and J.D. Whitney, *Report on the Geology and Topography of a Portion of the Lake Superior Land District, in the State of Michigan: Part I. Copper Lands* (Washington, 1850). Washington D.C., after deciding to sell the mineral lands, did not want to lose control over those sales to Michigan, and the resulting federal geological survey replaced the earlier linear surveys of Houghton, et al., which themselves contained significant amounts of information regarding geological and mineralogical matters. Led by Charles T. Jackson, the survey of 1847-48 was a "fiasco" beset by arguments, accusations, and outright slander. After two field seasons and a further two years of acrimony between the aggrieved parties, Jackson's assistants, Foster and Whitney, finally published what would be, for the next 30 years, the definitive work on the Copper Country's geology.

[27] Each town and range section was hand drawn with notations based on field notes. Camps and communities were marked by small cabins, wagon roads with solid lines, and trails with dotted lines. Today, digital copies of individual maps and notes can be found via the Bureau of Land Management's General Land Records website: https://glorecords.blm.gov/default.aspx accessed 10-11-2017.

[28] Anne Kelly Knowles, *Mastering Iron: The Struggle to Modernize an American Industry, 1800-1868* (Chicago: University of Chicago Press, 2013). Knowles, with the aid of cartographer Chester Harvey, interprets the history of nineteenth century iron production in America through a variety of simple, yet clear maps to illuminate the geographic expansion of the industry.

[29] The author referenced 117 individual plats covering all of Ontonagon, Houghton, and Keweenaw counties (including Isle Royale). A portion of Baraga County sited around Keweenaw Bay, an important settlement of Ojibwa peoples, was also included. In total, over 800,000 acres of surveyed land constituted the created mosaic of 1840s Copper Country. Referencing was accomplished using both section corner placements and topographical features. The surveyors of the time were excellent at recording their positions accurately, with few discrepancies between aligning historical and present-day locations.

[30] Albert, Dennis A., Patrick J. Comer, and Helen Enander, *Atlas of early Michigan's forests, grasslands, and wetlands: an interpretation of the 1816-1856 General Land Office surveys*. (East Lansing: Michigan State University Press, 2008). The maps created in the 1990s were eventually published in this large-format atlas. In addition to the GLO surveys, researchers overlaid a variety of topographic, county, and statewide information including modern features, soils information, forest types, and expert fieldwork. The atlas presents each forest, wetland, or prairie type identified on the GLO maps with an accompanying photograph, description, and map showing statewide distribution.

[31] Sugar maple-yellow birch forests also possessed balsam, ash, elm, basswood, white cedar, and hemlock. Sugar maple-hemlock forests were nearly identical in species distribution, with hemlock replacing yellow birch in numbers. Ironwood is a common descriptor of tree species around North America. In the Copper Country, ironwood was used to describe *Ostrya virginiana*, or American Hornbeam, a species of birch. Sugar maple (*Acer saccharum*), paper and yellow birch (*Betula papyrifera* and *Betula alleghaniensis*), and ironwood possess some of the highest BTU values for hardwoods in North America, making for excellent fuel sources.

[32] Foster and Whitney, *Report on the Geology and Topography*, 182. Stamp work was later defined "as rock containing disseminated native copper" found in the Lake Superior region in the Rossiter W. Raymond, "Glossary," in *Transactions of the American Institute of Mining Engineers*, Vol. 9 (New York: AIME, 1881).

[33] *Lake Superior Journal*, Jul. 9, 1853; Robert E. Clarke, "Notes from the Copper Country," Harper's New Monthly Magazine, March-April 1853, 443-448, 577-588. Poor air circulation in cramped underground workings could lead to what was described by the article's author as "a fever analogous to the ship fever." Clarke's trip to the Lake Copper districts over the summer and fall of 1852 provided the best description of the travel to, the landscape, the work, and the people who constituted the mass mining industry, and gave readers across the nation a first-hand account of America's first mining rush.

[34] Ibid; Foster and Whitney, *Report on the Geology and Topography*, 183. At that time (c.1852), Clarke stated that the Cliff possessed the finest stamping facilities in the Lake Copper districts, and offered a model for other mining companies to follow.

[35] Forrest Shepherd, *Geological Survey of the Mineral Lands on the Southern Shore of Lake Superior: Belonging to the Pittsburgh and Boston Copper Harbor Mining Company* (Pittsburgh: George Parkin, 1846) 12; Benedict, *Lake Superior Milling Practice*, 11. The Pittsburgh and Boston Copper Harbor Mining Company, holders of several mining leases and eventual owners of the profitable Cliff Mine, noted their Copper Harbor lease location as possessing "depressions sufficient to form lakes and valuable reservoirs for creating water powers," and a one half mile-long stream falling "one hundred and fifty feet, affording the finest opportunity for water power by means of an overshot wheel."

[36] Charles T. *Jackson, Report on the Geological and Mineralogical Survey of the Mineral Lands of the United States in the State of Michigan, Made under the Authority of an Act of Congress Approved March 1, 1847, Entitled* (Washington: Printed for the Senate, 1849), 714-752. In some cases, water-powered sawmills operated in tandem with a stamp mill, but a few standalone sawmills were also mentioned in early reports. The Cushman location, possessed both a smelting furnace and sawmill in 1847. At the Union Mine, work focused on a seam of copper-bearing red clay exposed on the Union River. A log dam was constructed and a wheel pit blasted out of the trap/basalt bedrock. The pit, roughly 5 x 8 feet in dimension with a drop of ~5 feet, most likely held a breast-shot wheel that powered hoisting drums over two shafts sunk on either side of the river. Unfortunately, the masses encountered early on quickly ran out, and with it the only attempt to use water power for hoisting purposes.

[37] Charles T. Jackson. *A Report to the Trustees of Lake Superior Copper Company* (Boston: Beals and Greene, 1845) 8-9. Charles E. Wright, *Annual Report of the Commissioner of Mineral Statistics of the State of Michigan for 1880* (Lansing: W.S. George & C0., 1881) 37. Jackson's report is the first of its kind in the Copper Country: a report issued to shareholders informing them of how their investment capital was being spent. Shareholder reports are the primary source for technical information on the earliest years of the native-copper mining industry. Local newspaper accounts from the time survive, and often contain technical information, but the shareholder reports are often more detailed to the point that newspapers often reprinted them in their entirety.

[38] North-West Mining Company of Michigan, *First Annual Report of the Board of Directors, and the Statements of the Treasurer* (Philadelphia: John C. Clark, 1849). Wright, *Annual Report*, 44. Lake Superior Miner, Jan. 31, 1857. In a few cases, companies were still attempting to use water power well into the 1850s. Miner editor George Emerson identified water-powered mills operating at the Douglass Houghton and Adventure mines, though in both cases, steam power replaced water power as soon as it was affordable to do so.

[39] The British Thermal Unit, BTU, is the amount of heat required to raise the temp of water one degree Fahrenheit. Anthracite coal's BTU value is 28,000,000 per ton (28.0), while the average BTU rating of dried wood (consisting primarily of sugar maple and birch) is 22,000,000 (22.0). Additionally, considering combustion value, one ton of coal equals 2.5 tons of wood. Volumetrically, wood occupies 7.8x the space as coal. As a building material, white pine was considered best for industrial structures, while the tamarack and its "resinous" cousins were prized for their "strength and durability" in timbering the collars of shafts and adit openings. From, Foster and Whitney, *Report*, 126.

[40] William Gerald Rector, *Log transportation in the Lake States lumber industry, 1840-1918: The movement of logs and its relationship to land settlement, waterway development, railroad construction, lumber production, and prices* (Glendale, CA: A.H. Clark Co., 1953), 72-76.

[41] Clarke, "Notes from the Copper Country," 578; Lake Superior Journal, Sep. 13, 1856. At the Cliff Mine, agricultural activities not only made "money for the Company," they also "impro[ved] the appearance of the settlement."

[42] Pittsburgh and Boston Mining Company, *Report of the Committee of the Stockholders of the Pittsburgh and Boston Copper Harbor Mining Company* (Boston: S.N. Dickinson and Co., 1853), 9-10. While exploding boilers were a worry, fire was the most common disaster to befall a mine's surface infrastructure. As noted in Pittsburgh and Boston Mining Company, *Report of the Committee of the Stockholders of the Pittsburgh and Boston Copper Harbor Mining Company* (Boston: S.N. Dickinson and Co., 1853), a fire destroyed the Cliff Mine's first stamp mill, and damaged a their new stone-built mill as well. The Forest mine not only lost their stamp mill to a fire in 1856, but 4 years earlier a flooded Ontonagon River "swept away much of the company's property." From, Wright, *Annual Report*, 106.

[43] *Superior Miner* Jan. 24, 1857; *Lake Superior Miner*, Jan. 31, 1857. Captain Paull noted five portable engines in 1857, all located at small operators. George Emerson, editor of the *Miner*, calculated the cost of purchasing, transporting, and erecting a steam engine as falling between a range from $16,000-$21,000, dependent upon the horse power and design (high pressure or low pressure/condensing) desired.

[44] Lankton, *Cradle to Grave*, 42.

[45] Between 1849 and 1868, the P&BMC issued a yearly dividend payment for every year except 1860, due to expenditures for surface improvements. In total, the mine returned over $2,000,000 to its investors.

[46] *Lake Superior News and Mining Journal*, Aug. 14, 1850; *Report of the Committee of the Stockholders of the Pittsburgh and Boston Copper Harbor Mining Company,* years 1849-1870. Between 1849 and 1868, the P&BMC issued a yearly dividend payment for every year except 1860, due to expenditures for surface improvements. In total, the mine returned over $2,000,000 to its investors.

[47] *Portage Lake Mining Gazette*, Feb. 3, 1881. Technically, the Bruce Mines possessed the first stationary steam engine in the upper Great Lakes (also of Vivian design), and while copper ore was mined there, Bruce Mines is located on the Canadian side of Lake Huron, nearly 300 miles east of the Copper Country. The son of a well-known mining captain of the Wheal Towan copper mine, Vivian was raised in the mining industry of Cornwall, graduated from the Royal Polytechnic Society in 1838, and after several years in France, Wales, and Ireland, immigrated to the burgeoning industrial city of Pittsburgh in the mid-1840s to set up a small engineering firm. Joseph W.V. Rawlings' (sometimes spelled *Rawlins*) career is documented in Roy W. Drier, "Recollections of a Long Life," in *Copper Country Tales, Vol 1* (Calumet, MI: R. Drier, publisher, 1967). Vivian's and Rawlings' respective arrivals to Eagle River were noted in *Lake Superior Journal*, Jun. 5 and 19, 1850.

[48] *Lake Superior Journa*l, Nov. 13, 1850. The smaller price tag for the second engine, while of similar design, was likely due to a learning of the ropes in the piecemeal delivery of parts and associated transportation costs.

[49] Rawlings' "Recollections" in Drier, *Copper Country Tales*. Vivian's engines all possessed a similar design, marked by 17" cylinders and 5' strokes. Rawlings traveled by foot, snowshoe, and boat, never staying more than a season at any given mine until c.1860, when he returned to the Cliff to become its head engineer.

[50] Irene D. Neu, "The Building of the Sault Canada, 1852-1855," *Mississippi Valley Historical Review*, XL (June, 1953), 25-46; *Lake Superior Miner*, Jan. 24, 1857; *Lake Superior Miner*, Feb. 20, 1858. In his 1857 letter to the editor, Captain Joseph Paull tabulated the steam engines of the region, offering their orientation, pressure, and duty. The 48 engines present were calculated to cost a total of $308,700, and used on average, 3 cords of wood per 24 hours, at a cost of $2.50 per cord. This table is, simply put, the best collection of steam engine and fuel consumption data for the period.

[51] Eric C. Nystrom, *Seeing Underground: Maps: Models, and Mining Engineering in America* (Reno: University of Nevada Press, 2014), 39-40. Nystrom's work details the evolution of underground mining over the course of the late nineteenth and early twentieth centuries as mining engineering professionalized and illuminated the "pitch-dark, dangerous, three-dimensional spaces" created deep underground.

[52] B.S. Butler and W.S. Burbank, *The Copper Deposits of Michigan: USGS Professional Paper 144* (U.S. Geological Survey, 1929), 178-181. The Pewabic lode was a series of lava flows containing copper and calcite-filled cavities called amygdules. First discovered by the Pewabic Mining Company in 1853, it was the Quincy Mining Company's discovery of the lode on their property in 1856, that turned a failing mass mining enterprise into a mine known as Old Reliable for its ability to operate at a profit. The Pewabic, Franklin, Rhode Island, Albany & Boston, and Hancock mines also worked the lode on the north side of the lake.

[53] *Lake Superior Journal*, Jul. 23, 1853. The earliest road designed to connect multiple mining and commercial locations together was a road constructed in the summer of 1853 that followed the Eagle River. It allowed visitors to "comfortably reach the principal mines on Point Keweenaw in carriages from the principal landings," but it was still a regional road, and disconnected from activities to the south.

[54] Paul LaVanway, "A History of Keweenaw's Roads and Highways," *The Superior Signal* Aug. (2007). As early as 1854, local interests called for a state road to connect Copper Harbor to Portage Lake, but it took seven years for those demands to be met.

[55] *Executive Documents of the Senate for the Second Session of the Forty-Eighth Congress, 1884. No. 15.* (1884),9; A letter from S.W. Thurlow, Secretary of the Portage Lake and River Improvement Company to the Secretary of War, November 22nd, 1884; "Articles of Association and By-Laws of the Portage Lake and River Improvement Co., of Houghton, Michigan." (1863), 1-4; The initial dredging was conducted privately by the Quincy, Pewabic, and Huron Mining Companies. Two years later the Portage Lake and River Improvement Company was incorporated to collect tolls to pay for the new waterway's maintenance.

[56] Lankton, *Cradle to Grave*, 11. Geologists argued for using the term *copper ore*, but local mining interests preferred the term *copper rock* to denote the unalloyed, metallic nature of the copper in the Keweenaw. Ore, they argued, implied a compound.

[57] Wright, *Annual Report*, various. The Pittsburgh & Boston Mining Co. failed to declare a dividend in 1869 and 1870. They quickly decided to get out while they were ahead and sold the property to Marshall Simpson of New York for $100,000. The Simpson-owned Cliff sputtered for another decade, sat idle until 1906, and was then reopened as a exploratory property in the hopes of identifying paying lodes beneath the pinched out vein. This lengthy but unsuccessful phase lasted, on-and-off, until 1932. At the Minesota, a failure to invest in efficient milling (stamp work never amounting to much in its annual production) meant that when its vein gave out, it was not in a positon to survive. Several assessments in the late 1860s could not prevent closure.

[58] The best collection of archival data on the Central Mine can be found in the Central Mine Research Papers Collection (MS-749) at the Michigan Technological University Archives and Copper Country Collections, Houghton, MI. The Central Mining Company was a relative late starter for a mass mine, not reaching profitability until the 1860s. But that late start and advantageous mineral holdings meant it continued to succeed long after its forebears sat idle.

[59] Tillman, *Wood as an Energy Resource*, 11. By 1850, coal accounted for roughly 19% of industrial energy consumption nationally, while wood trailed closely behind at approximately 17%. A decade later, coal increased by 50%, while wood dropped the same amount. By 1870, coal made up 58% of national consumption, and wood dropped below 10%. In the Copper Country however, Sanborn fire insurance maps indicate that coal's rise came much later. In 1884, coal made up approximately 10% of recorded industrial consumption. By 1902, that dependence rose to nearly 80%, and a decade later, over 90%.

THE CLIFF IN THE TWENTIETH CENTURY

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This paper is published in, Donald Chaput and Sean M. Gohman, *The Cliff: America's First Great Copper Mine, Revisited* (Hancock, MI: Quincy Mine Hoist Association, 2015).

Figures courtesy of Michigan Technological University Archives and Copper Country Collections, Houghton, MI (unless otherwise noted).

An abandoned Cliff Mine and Clifton, 1906.

The Cliff is dead. So concludes the first edition of this book. While that is true if we look at the mine only in terms of production, but I'll argue that the turn of the century death of the Cliff was premature. The Cliff's death may have been certain, but it was not sudden. The mine tried to rise (only to fall again and again) over the first half of the twentieth century as management changes, copper price fluctuations, two world wars, and a Great Depression periodically refocused attention on the once great producer. Two industry giants, formed long after the Cliff had already reached its productive apogee, took control of the mine in an effort to expand and extend their own success, From 1903-1960, the Tamarack and Calumet & Hecla mining companies doubled the Cliff's extractive history by returning, leaving, and returning again to the property to conduct mineral explorations, repurpose old surface plants, reopen underground workings, and even reprocess the Cliff's waste materials. The fits and starts that came to mark the Cliff's twentieth century experience tell the story of one mine's attempts to remain relevant. They also stand as a proxy for the entirety of the native copper mining industry during that period.

As the Lake District (made up of the collective mineral districts of Keweenaw, Portage Lake/Calumet, and Ontonagon) entered its second half-century, it expanded thanks to innovations in transportation, energy, and corporate organization. It also met new opposition in the form of national competition from Butte, Montana and other western mining districts, and emboldened labor organization previously unseen in the area. In response, the Lake District's corporate powers increasingly consolidated operations in the hopes of maintaining control, finding new sources of copper, and maximizing profits. Old, dormant properties existing at the edges of the Lake District were scooped up in the hopes that they could be made to pay again. Railways were built to connect them to the industrial centers of Calumet, Torch Lake, and Houghton/Hancock. Industrial islands of limited human activity dotted open spaces once home to sprawling mining communities like Clifton. Coal and electricity made for more efficient power at these locations, and allowed for the replacing of permanent stone industrial structures with balloon-framed, temporary and/or portable surface plants. These old mining locations devolved back to an era of mineral exploration. In effect, they were returning to the pioneering 1840s; they were sparsely populated by a few men, worked intermittently, and their potential for success was tied not so much to production potential, but to decisions regarding capital outlay made far away. Once the most powerful corporate presence on the peninsula, the Cliff was now just one of many prospects in a long list of consolidated holdings. Its future was tied to the successes or failures of these other holdings as much as to its own

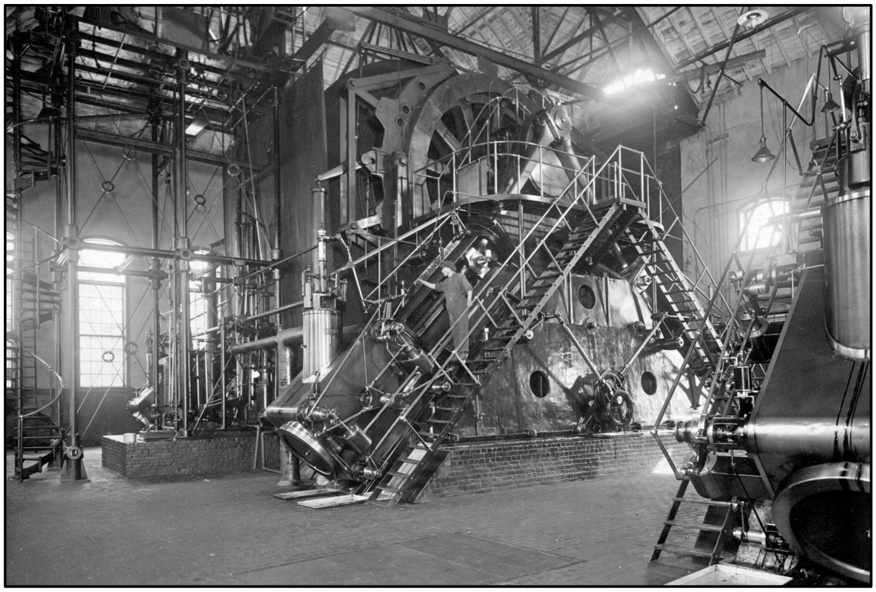
Tamarack Mine, c.1915.

potential. Increasingly over several decades, the native copper mining industry tied its future to the shrewd management of holdings like the Cliff, turning away from one work site to attend to another, then reversing the process a few years later.

Under Tamarack Management

In the fall of 1903, the Cliff Copper Company fell under the management of the Boston-based Bigelow group, owners of the Tamarack Mine, an industry heavyweight then entering decline.[1] The Tamarack had been an engineering marvel. Begun in 1882, the Tamarack Mine sat atop the great Calumet Conglomerate lode, one of the richest copper lodes in the world. However, it was only accessible one-half mile below the surface, which made reaching it an expensive prospect.

Unable to acquire lands more accessible to the lode—the mine was surrounded on all sides by the Calumet & Hecla Mining Company (C&H)—a plan was devised to drill 2,270 vertical feet through worthless ground to reach it. It took three and a half years to finally intersect the conglomerate (only ten feet deeper than projected), which gave the mine access to two decades worth of profitable copper-bearing rock. But that accessibility continued to be a challenge. By the turn of the century access required the driving of long, expensive cross cuts, which had to be outfitted with miles of underground tramlines. Time was running out for the Tamarack. Although the Cliff property was purchased primarily for its timber reserves—a survey taken in 1907 indicated 5027 acres of white and Norway pine, oak, basswood, hemlock, tamarack, cedar, spruce, ash, maple, and birch amounting to nearly 6000 cords of wood—it was believed it could supply the company with additional, and more accessible, sources of

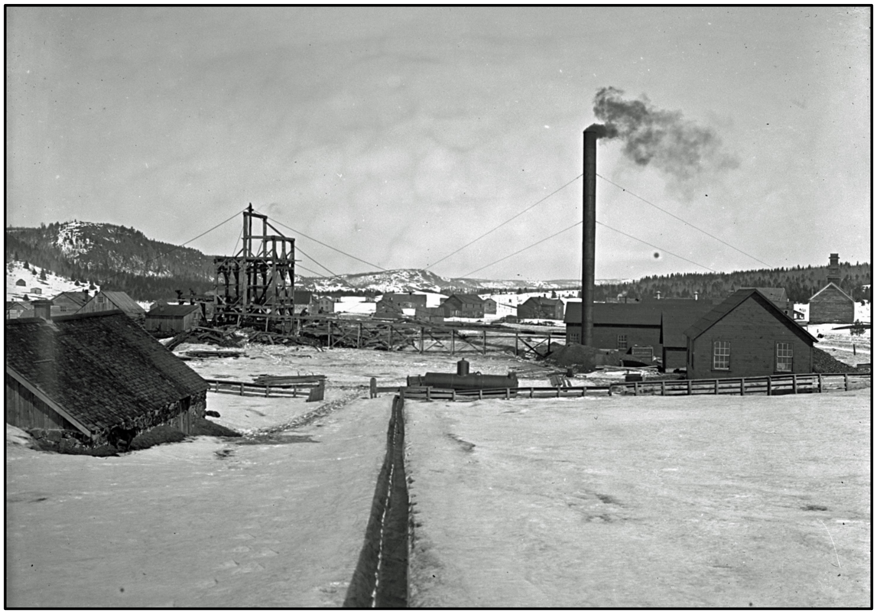


Tamarack Mining Company's No. 5 Shaft Hoist Engine, c.1915. Engines like this were far larger and more powerful than anything ever seen at the Cliff.

copper. In all, acquiring the Cliff property was believed to be of "considerable promise... and the ultimate salvation" of the Tamarack Mining Company.[2]

Tamarack's plans for the Cliff, which at that point had sat basically idle for 25 years, was to explore the property through trenching, test pitting, and diamond drilling, with a hope that a geological survey of the property would find lode deposits of copper that justified a reopening of the workings. In September, roads linking the various test sites were cut on the property, and by the next month fifteen men were hard at work searching for the Kearsarge lode, a rich deposit believed to intersect the southern end of the property. Drilling by "an outfit... secured from Isle Royale" continued through the next two years, but little was found.[3] By August of 1906, focus turned to the original Cliff vein, and work transferred to the site of the South Cliff No. 1 shaft. First opened by the North American Mining Company in the 1850s, the South Cliff No. 1 sat along the same vein as the original Cliff workings. The Pittsburgh & Boston Mining Company bought out the North American in 1860, and though the South Cliff works were never profitable, the land still held potential.

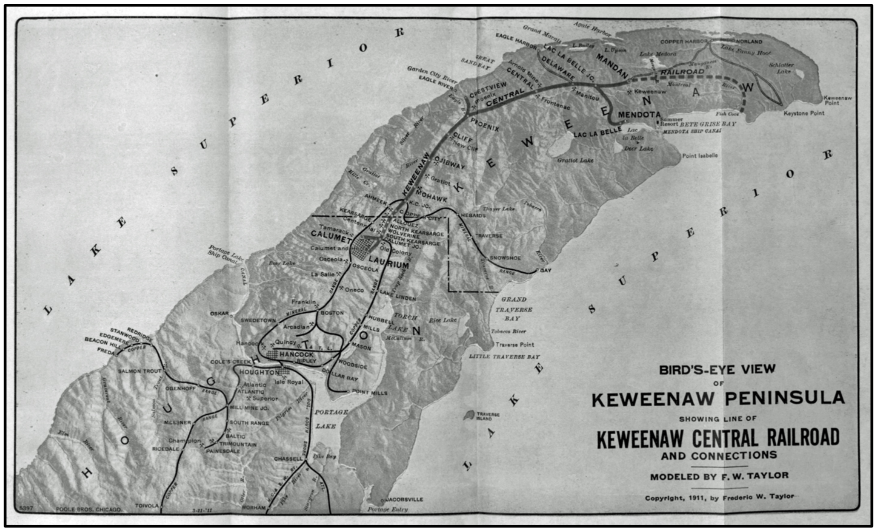
A few "cheap buildings" built to house a boiler, hoist, pump, and small compressor, were erected at the site while the shaft was dewatered. The South Cliff No. 1, originally 300 feet deep, was gradually cleaned out and found to cross several thin bands of amygdaloid ore (copper found in ancient lava flows), though only one was said to "look fair."[4] Over $28,000 had been spent on exploration and the only copper of note encountered was not due to exploration work, but rather as a result of removing and reprocessing the South Cliff's 50-year old waste rock, or burrow, pile in order to make way for a new railroad grade.[5]



Cliff Copper Company's South Cliff surface plant, c. 1908, A shaft house is under construction at left while the boiler, hoist, pump, and compressor houses are at right. The Methodist Church can be seen in the distance at far right, while in the foreground is a set-in-the-ground ice house used decades earlier to store perishable goods, and even the photographer's dog (standing on the corner of the ice house).

This new grade was for the Keweenaw Central Railroad (KC), the first rail to connect the county's struggling mining communities (Mandan, Phoenix, Central, Wyoming, and others) to the established Mineral Range and Copper Range lines that only reached the county's southern edge. The first passenger/freight line in the Lake District, the Mineral Range Railroad, connected the north shore of Portage Lake to the booming mining communities around Calumet in the early 1870s. Initially, the Mineral Range's directors intended the line to reach from Copper Harbor to a point 100 miles southwest in Ontonagon County in order to cover the entirety of the district. The involvement of other rail companies kept the goal of a single Copper Country line from succeeding. The Copper Range Railroad formed in 1899 to handle the link from Ontonagon County to Portage Lake's south shore, and the 1905 incorporation of the KC connected Mohawk, the terminus of the MR and CR lines to the northernmost points on the peninsula.[6]

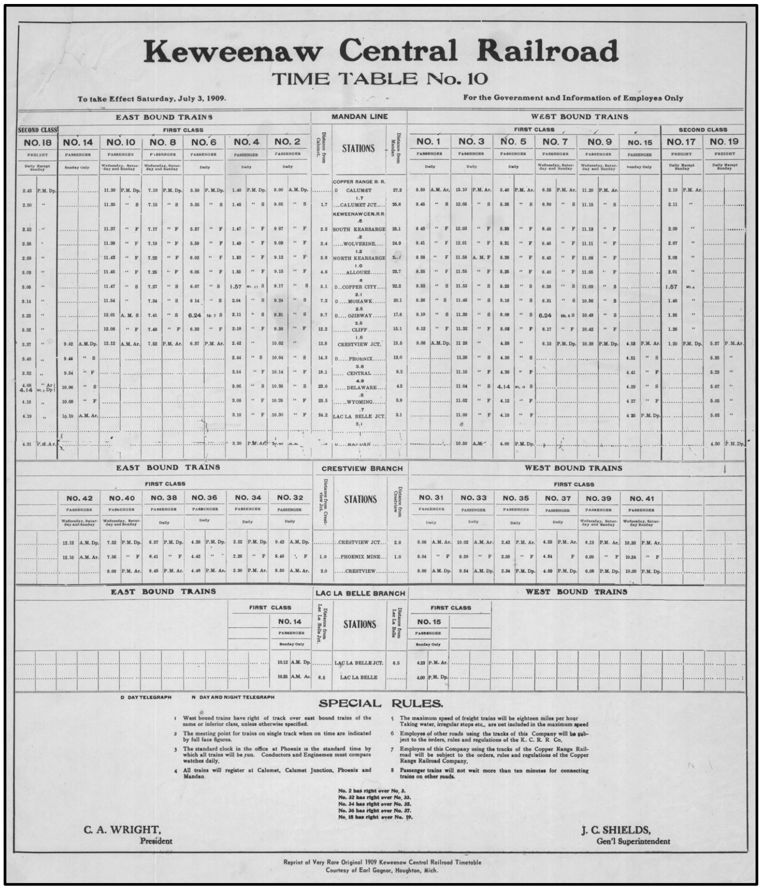
The first rail line in Keweenaw County, partially built in the mid-1860s, linked the Cliff Mine to the small village of Lac La Belle, which sat on the protected eastern side of the peninsula. The goal of the line was to "open to markets of the world the inexhaustible wealth of this mineral range," but a post-Civil War drop in copper prices and production put a halt to the project. Two decades later, the Lac La Belle & Calumet Railroad (LLB&C), a narrow gauge line constructed in 1884 linked the Conglomerate Mining



Bird's-Eye View of Keweenaw Peninsula Showing Line of
Keweenaw Central Railroad and Connections, 1911.

Company's works on the former Delaware Mine property to their stamp mill five miles away at Lac La Belle. Though it only ran for four years, the LLB&C's track laid the groundwork for the KC two decades later.[7]

While the Tamarack-controlled Cliff Copper Co. conducted its geological survey, a new mining venture promised to connect the old LLB&C to Calumet, ushering in a period of redevelopment in the county. The Keweenaw Copper Co., based in Hancock and possessing nearly 8000 acres of mineral lands—the largest holdings in Keweenaw County— incorporated in March of 1905. A month later, the company formed the Keweenaw Central Railroad with the aim of laying 35 miles of track the next year.[8] A right of way through the Cliff lands was negotiated and grading began the summer of 1906. J.J. Byers Co. of Houghton was contracted to construct the line using a "special steam shovel" to load 33 cars with earth for the filling in of recesses and ravines along the route, while lumberman David Kingston of Copper Harbor was to provide the ties. A worker shortage that summer meant that grading work moved far in advance of the laying of rails, but eventually 200 men worked to finish the job by November. Once completed, the KC had 2 locomotives, 13 passenger cars, and 82 various freight cars in service. Soon timber, cement, and feed made their way across the county by rail, with the Cliff serving as one of several destinations. Along with freight, "hundreds of people [were] leaving the Calumet district and going to the mines of Keweenaw county." The once bustling landscape of Keweenaw County, long abandoned in favor of the lode mines to the south, was reborn. One KC passenger remarked that the journey over the Cliff property "was a scene of topographical grandeur. Here the Cliffs... towered almost beyond the line of vision, their varicolored rock peering forth here and there from its covering of verdant green."[9]



Keweenaw Central Railroad

TIME TABLE No. 10

To take Effect Saturday, July 3, 1909.

For the Government and Information of Employes Only

MANDAN LINE

NO. 2 Passenger Daily		Distance from Calumet	STATIONS	Distance from Mandan
			COPPER RANGE R. R.	
9.00	A.M. Dp.		D CALUMET	27.3
9.05	" S	1.7	CALUMET JCT.	25.6
			KEWEENAW CEN. R. R.	
9.07	" F	2.2	SOUTH KEARSARGE	25.1
9.09	" F	2.4	WOLVERINE	24.9
9.12	" F	3.6	NORTH KEARSARGE	[illegible]
9.15	" F	4.6	ALLOUEZ	22.7
9.17	" S	5.1	D COPPER CITY	22.2
9.24	" S	7.2	D MOHAWK	20.1
9.31	" S	9.7	D OJIBWAY	17.6
9.38	" F	12.2	CLIFF	15.1
10.02	"	13.8	CRESTVIEW JCT.	13.5
10.04	" S	14.3	D PHOENIX	13.0
10.14	" F	18.1	CENTRAL	9.2
10.26	" S	23.0	DELAWARE	4.3
10.28	" F	23.5	WYOMING	3.8
10.30	" F	24.2	LAC LA BELLE JCT.	3.1
[illegible]	A.M.	[illegible]	D MANDAN	

CRESTVIEW BRANCH

NO. 32 Passenger Daily		Distance from Crestview Jct.	STATIONS	Distance from Crestview
9.42	A.M. Dp.		CRESTVIEW JCT.	2.0
9.46	" F	1.0	PHOENIX MINE	1.0
9.50	A.M. Ar.	2.0	CRESTVIEW	

LAC LA BELLE BRANCH

NO. 14 Passenger Sunday Only		Distance from Lac La Belle Jct.	STATIONS	Distance from Lac La Belle	NO. 15 Passenger Sunday Only	
10.12	A.M. Dp.		LAC LA BELLE JCT.	6.5	4.23	P.M. Ar.
10.35	A.M. Ar.	6.5	LAC LA BELLE		4.00	P.M. Dp.

D DAY TELEGRAPH N DAY AND NIGHT TELEGRAPH

SPECIAL RULES.

1 West bound trains have right of track over east bound trains of the same or inferior class, unless otherwise specified.

2 The meeting point for trains on single track when on time are indicated by full face figures.

3 The standard clock in the office at Phoenix is the standard time by which all trains will be run. Conductors and Enginemen must compare watches daily.

4 All trains will register at Calumet, Calumet Junction, Phoenix and Mandan.

5 The maximum speed of freight trains will be eighteen miles per hour Taking water, irregular stops etc., are not included in the maximum speed

6 Employes of other roads using the tracks of this Company will be subject to the orders, rules and regulations of the K. C. R. R. Co.

7 Employes of this Company using the tracks of the Copper Range Railroad will be subject to the orders, rules and regulations of the Copper Range Railroad Company.

8 Passenger trains will not wait more than ten minutes for connecting trains on other roads.

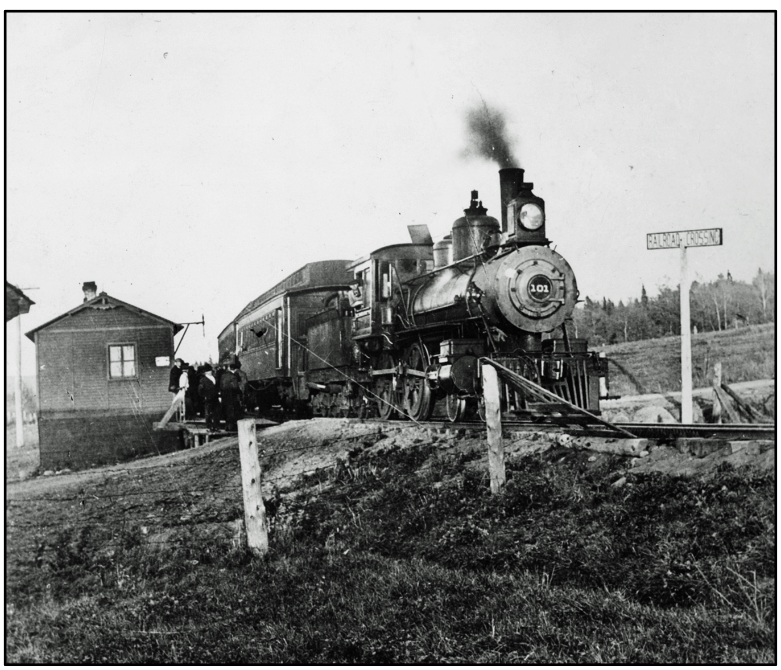
No. 2 has right over No. 3.
No. 32 has right over No. 33.
No. 34 has right over No. 35.
No. 36 has right over No. 37.
No. 18 has right over No. 19.

C. A. WRIGHT,
President

J. C. SHIELDS,
Gen'l Superintendent

Reprint of Very Rare Original 1909 Keweenaw Central Railroad Timetable
Courtesy of Earl Gagnor, Houghton, Mich.

Keweenaw Central Railroad Time Table, 1909.
"Cliff" was one of thirteen stops on the line.



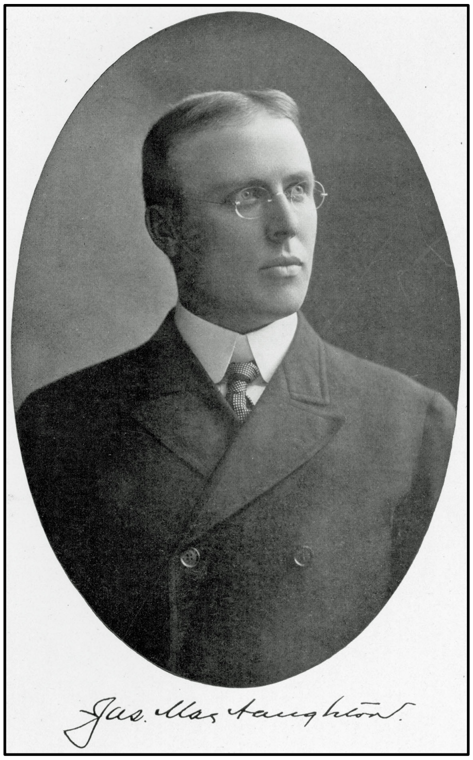
Keweenaw Central Railroad, Phoenix Station, October 13, 1911.

With a new rail in place to aid in transportation, Tamarack's Torch Lake mill soon made preparations to receive Cliff ore. Built in the 1880s and in concert with the sinking of their first shaft, by the early twentieth century the Tamarack mill consisted of Allis compound steam stamps capable of handling 3500 tons of material a day. For comparison, it took the old gravity mills a month to process that much rock.[10] Over the summer and fall of 1907 Tamarack placed skips in a new shaft rock house at the South Cliff No. 1 and worked five diamond drills underground. The company built a boarding house and two dwellings to accommodate workers, and also completed the cross sectional geological survey begun three years earlier. The Tamarack-run Cliff Copper Co. was still certain that the Kearsarge Lode could be exploited for profit at the Cliff property, though so far indications from drilling proved unfavorable.[11]

The next year saw more improvements made when the Cliff Copper Co. decided to dewater the Avery shaft and use it to access amygdaloid lodes intersecting the Cliff fissure. Workers erected a head frame over the home of the area's first man- engine, and installed a new boiler house and pumps as well. The company also discussed adding a 1,800-foot spur from the Avery to the Keweenaw Central in order to transport fuel and ore from the new opening, but opted instead to remove a narrow pillar separating the original Cliff workings from the South Cliff, thus connecting the two entry points along the fissure underground. The Avery's connection to the fissure— first sunk just off the vein in 1857—was also enlarged to allow the passing of a rock car. With improved communication between openings, poor rock could be removed via the Avery while "shipping grade" copper-bearing rock could be raised at the South Cliff No. 1. Without a rail spur connecting the two shafts at the surface, the Cliff Copper Co. creatively utilized a suspension cable anchored at one end near the South Cliff No. 1 and the KC main line with the other end along the top of the bluff, to transport coal to the Avery's boiler house via a "trolley bucket." All told, the company's footprint now consisted of: two shaft houses, two boiler plants, air compressor, smithy, boarding house, several dwellings, change house, and a combination office and warehouse building.[12] The Cliff, once dependent on manpower, ox carts, and wood fuel for its productive needs, evolved into a fully modern mining operation (albeit a small one) benefiting from compressed air drills, a rail line, and coal fuel.

Under Calumet & Hecla Management

The Cliff Copper Co. spent nearly $50,000 on explorations and much more on surface development from 1904-1909. Yet, it all came to naught. 3,500 feet of cross cuts running perpendicular to the fissure vein opened up nearly twenty amygdaloid lodes of varying grade, and shipments of 80 tons traveled every week to the Tamarack mill. Unfortunately, these "floors" were found to be "bunchy and irregular in values," and failed to justify the mine's reopening. Compounding the problem was the fact that the Tamarack Mining Co., controllers of the Cliff Copper Co., had just completed their second straight unprofitable year after nearly two decades of biannual payouts.[13] These losses caused the worried company to look elsewhere for income. Serendipitously, C&H was in the midst of a plan



James MacNaughton, 1900.

to consolidate the various mining companies north of Portage Lake in order to maintain a supply of copper- bearing rock for its own facilities. For starters, C&H began purchasing substantial shares of companies that, like the Cliff Copper Co., controlled large tracts of mineral lands. Buying 19,400 shares of the company at the close of 1909 put the Cliff concern firmly under the wing of C&H, and soon after the sale of Cliff lands to C&H, the Cliff Copper Co. completely severed property ties to the Tamarack. The Cliff Copper Co.'s 60,000 shares were transferred back to the Tamarack along with $100,000 to complete the transfer.[14] The Tamarack now had an influx of cash and shareholdings in the Cliff, but the mine was organized as a new company, one controlled entirely on C&H's terms, named the Cliff Mining Company. C&H was not finished. While it managed the workings of several mines, it still sought an outright consolidation with the Tamarack, Ahmeek, Osceola, Allouez, Seneca, Centennial, Laurium, La Salle, and Superior under one Calumet & Hecla banner. The company holding $10,000,000 in capital would have centralized management, mining, milling, smelting, and the use of energy. The consolidation was put off due to legal challenges by shareholders of one of the targeted companies, but for the Cliff Mine, this new era of C&H control meant it was even more affected by technological and social changes occurring not only in the Lake District, but in the rest of the United States.[15]

The Cliff sat unworked over the winter of 1909-1910, but flush with up to $2,500,000 in potential capital and overseen by C&H General Manager James MacNaughton, the new company did not sit idle for long. Hired by C&H's President Alexander Agassiz to manage the company in 1901, MacNaughton rode a tide of the mining industry's increasing reliance on educated, professional expertise in the management of twentieth century operations. The son of a C&H surface captain, MacNaughton was headstrong, confident, ambitious, and militantly practical. The University of Michigan-trained engineer immediately stamped his seal on the workings of a native copper mining industry he spent his whole life surrounded by. MacNaughton was the leading voice in the call for consolidation and heavy-handed paternalism. Only through total pragmatic control of the work environment—the machinery, the workers, the housing, the amenities of community life—could Calumet & Hecla, and the entire Lake District, hope to thrive in an increasingly competitive industry. This belief led to the purchasing of the Cliff and other properties, and subsequently brought half the district's workforce under his management team's watchful eye.

Cole and McDonald Company diamond drill rig working
in the Porcupine Mountains, c.1915.

Although the Cliff Copper Co. failed to turn an exploratory venture into a working mine, C&H (and Cliff Mining Co.) felt they had to keep looking and not simply leave the property as a timber holding. Attention turned away from the South Cliff and Avery, and back toward the Kearsarge Lode. That summer, MacNaughton informed Vice President Quincy Shaw that the Cliff's workers felt that diamond drilling on the vein took too much time and wasn't worth the effort until after more testing had been completed. Shaw replied that the Cliff shareholders demanded action regardless of prospects. Mineral exploration through shaft sinking and underground drilling was the way to proceed, results or no results. To hold out for better testing results could put the project off for a year or more, and as a newly created company with capital on hand, it had to act rather than wait.[16] The C&H-run Cliff Mining Co. moved exploratory work back to the edge of the Kearsarge Lode over a mile southeast of the South Cliff works, and in August it began sinking a small vertical shaft. The boiler, compressor, change house, office/warehouse, and even a smokestack from the "old Cliff mine" were moved to the new site. The following spring workers placed a small head frame over the shaft and by May 1911 they completed the operation's set up. Five men received $60 a month for mining, timbering, mucking, and pumping; another four men received $52 a month for surface work; and one boy earned $45 to assist with hoisting and boiler firing.[17]

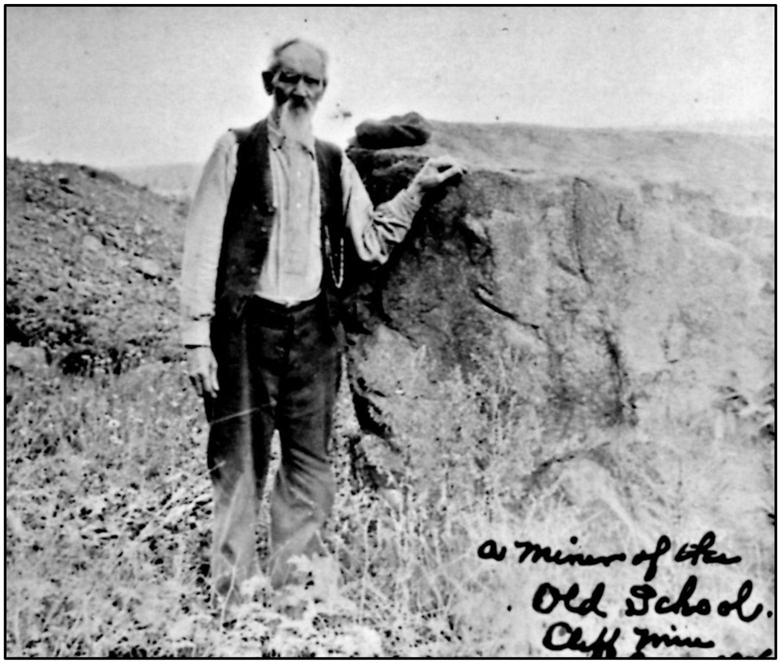
In 1911 all work centered at the new Kearsarge shaft as the men continued to drift and cross cut in search of locating a promising access to the lode. Two fruitless years later, Cliff Mining Co. put this work on hold in favor of more diamond drill testing. The company contracted with the Minnesota- based outfit Cole & McDonald to continue and expand upon the earlier Tamarack survey, and even proposed searching on the north side of the bluff where the Pittsburgh and Boston Mining Co. set up their North Cliff venture 50 years earlier.[18] The transition to diamond drill testing, which required a skeleton crew,

Mass meeting of Western Federation of Miners in Calumet, June 8, 1913,
just prior to the strike's onset.

limited fuel, temporary shelters, and little else, came just as the native copper mining industry met its biggest labor challenge yet, the strike of 1913-1914.

Since 1910, C&H and other large producers experimented with one-man drills, which threatened a traditional pattern of underground work done in teams. For three decades, miners worked in pairs operating two-man drills, and prior to that they worked in teams of three (when work was done by hand drill and chisel). With the coming of the one-man drill, men recognized that the camaraderie and safety of teamwork would be replaced with solitary, dangerous monotony. With an inevitable changeover set to take place, local labor organizers were ready to act. With the aid of the Western Federation of Miners, already established as a formidable opponent to corporate power after two decades of activity in mining states like Montana, Colorado, and Idaho, the Lake District's underground workers, be they miners or trammers, Cornish, Slav, or Finnish, shut down the mines in July of 1913. Corporate mining interests rallied around MacNaughton, and he fought back with pragmatic severity. He refused to negotiate with the striking workers. For MacNaughton, only the strikers' full submission and a return to the status quo was acceptable. For eight months, a struggle marked by acts of violence (perpetrated by both sides) wore on with poverty and distrust the only winner. Eventually through stubborn attrition, C&H and MacNaughton won, with miners returning to work in April of 1914.[19]

The strike had little verifiable impact on the workings at the Cliff. It is possible that a transition to diamond drilling was the natural outcome of exploring a property where "to date no appreciable quantities of copper have been disclosed." Cole & McDonald's men and equipment arrived twenty days before the strike began, but tensions in the district had already been simmering for some time. Perhaps work was contracted to an outside drilling outfit to bypass any possible labor shortage, and maybe more underground work

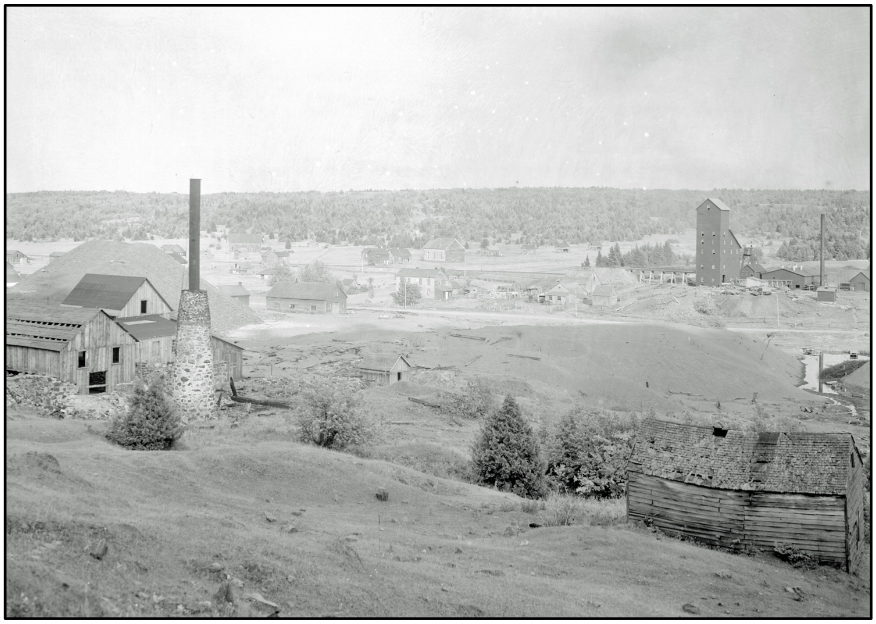


Henry Warren, “A miner of the Old School,” c.1920.
Image courtesy of Warren’s descendants.

would have been attempted if those tensions had not broken into a strike. Regardless, the Cliff was mostly abandoned again, sitting idle until MacNaughton’s desire for consolidation, not just “friendly cooperation,” could come to fruition.[20]

Henry Warren’s Mill

C&H (as the Cliff Mining Co.) undertook no work at the Cliff between 1916 and 1923. Only $500 worth of supplies sat on the property, and the only income the property generated came in the form of land rents and royalty payments resulting from the processing of the mine’s old waste rock piles.[21] Since the Pittsburgh & Boston Mining Company concentrated on finds of mass copper, it ignored much of the amygdaloid rock mined out around the Cliff vein, and left behind large quantities of marketable copper just needing careful classification and milling to capture. Locals knew of the Cliff’s burrow piles’ potential for years, though organized companies ignored that potential. As early as 1886, area resident Frank Rossberg leased the rock piles on tribute, hoping to reprocess the rock with a “Sturtevant mill and several German grinders.” The results of the project, or whether or not it even began, are unknown, but it is likely that if Rossberg was successful, more hay would have been made of it in the local press. Twenty years later, with the putting in of the Keweenaw Central, the Tamarack Mining Co. leased the waste rock piles of the Cliff to Henry Warren, a Cornishmen living in Clifton since the late 1870s who perhaps witnessed Rossberg’s attempt and felt the time was right to try again.



At left, Warren's mill, c. 1908. At right, the Cliff Copper Co.'s
'South Cliff No. 1' Shaft and surface plant

Warren believed that "under modern conditions," especially in the case of milling and concentration, "the Cliff burrow may contain enough rock of [profitable] character to justify an effort to recover the copper in it."[22]

Warren built a new 8-head gravity stamp mill on the site of the old Cliff mill, originally constructed in 1851, but sitting as a ruin fifty years later.[23] Years of exposure made the Cliff's waste rock brittle, and in Warren's opinion, thus easier to stamp. Warren also acquired two Wilfley tables to concentrate the newly stamped material and sent the finished mineral via rail to the Tamarack-owned Lake Superior Smelting works at Dollar Bay for refinement. Warren's contract dictated a 15% royalty to be paid to the Tamarack Mining Co. based on the finished copper produced. Unfortunately, Warren's scheme proved unprofitable, and he closed up shop by 1908. Five years later however, Warren started up again, perhaps due to a strike-caused demand for local production, perhaps not. In that first year, Warren's mill produced 3,260 pounds of copper at 14 cents per pound, making Warren nearly $390. For the rest of the decade, Warren's annual production leveled off to around 1,000 pounds, profiting him between $220-275 per year up until he stopped in 1919, likely due to the death of his wife.[24]

The Cliff Under Consolidation

1920 was an important year for the Lake District mines. James MacNaughton, for 19 years the General Manager of Calumet & Hecla Mining Co., became its new Vice President. Able to exert more influence on day to day operations, McNaughton

immediately pushed for a district-wide geological survey of the area's copper deposits, echoing Douglass Houghton's first geologic survey of Michigan in the 1830s, though this time with modern techniques. Carried out by C&H geologists in cooperation with researchers from Harvard, the National Research Council, and the United States Geological Survey, questions regarding the mineralogy, chemistry, and petrography of the area were tackled through fieldwork, lab work, and documentary research. For four years, the survey gathered an incredible amount of data spanning over 100 miles of the western Upper Peninsula. Shafts were mapped along with drilling sites, drilling results, and the estimated boundaries of the various lodes. Drill core data and accurate cross sections confirmed the continuation of lodes previously thought to be separate. Another five years of data analysis and write-up followed. When finally completed in 1929, the USGS- published *The Copper Deposits of Michigan* was deemed the most comprehensive geological study yet done on the area. Also known as the 'Butler and Burbank report', MacNaughton believed that this document held the key to the survival of C&H and the Lake District. As for the Cliff, the report's "consistent geological story" provided a "practical basis for exploration" that again... for a time... breathed new life into the property.[25]

With this "comprehensive exploration program" underway, MacNaughton turned his attention back to the consolidation of the district's mining operations. Thirteen years earlier, MacNaughton's dream to centralize the district's production met with legal challenge. Now, as Vice President of C&H, MacNaughton encountered little opposition. Former competitors Centennial, Osceola, Ahmeek, and Allouez mining companies (and any of their subsidiary mineral holdings) soon fell under the umbrella of the Calumet & Hecla *Consolidated* Mining Co. The action saved C&H—its conglomerate lode holdings had mostly pinched out—by giving them access to several operations in the process of expansion. The Ahmeek Mine's access to a rich portion of the Kearsarge Lode, long sought after at the Cliff, was especially lucrative for the newly organized firm.[26]

So far, a profitable extension of the Kearsarge Lode on the Cliff property had eluded detection, but under the "advice and recommendation of competent geologists," who made "careful and expert examination and study of the subject," other lodes on the property were explored. Money was raised in the summer of 1924 to begin searching the Cliff property for the Calumet Conglomerate (and the Osceola Amgydaloid, another deposit exploited in and around the Calumet/Laurium area). In a repeat of the work in 1910, an earlier vertical shaft (this time the Cliff No. 5 shaft) was cleaned out, sunk deeper, and cross-cut to locate both the Cliff vein and these lodes.[27] Lying midway between the 1907 surface works at the South Cliff No. 1 and the 1910 works at the Kearsarge Shaft, the new No. 5 shaft required a whole new set of surface improvements for its operation. Again, equipment was brought on site and construction ensued on a new shaft house, powerhouse, and coal shed constructed to house them. In a clear example of the impact consolidation was having on the organization of the district's work, the Cliff Mining Co. was granted the "privilege" of renting a compressor, drills, pumps, boilers, hoist, and steam separator from C&H, rather than having to purchase them. This loaned equipment was sent from other consolidated properties: the Union coal dock in Dollar

Cliff Mine electrical sub station, 1927. Note the child at bottom center.

Bay, the Osceola and Allouez machine shops, the C&H electrolytic plant at Lake Linden, and the Ahmeek, Tamarack, and C&H mines. Along with the cost savings of rented equipment, the Cliff now had access to a power line running along the Keweenaw Central line from Ahmeek. Electricity now complemented a steady flow of coal already coming in via rail. Under the "expert departmental assistance" of C&H, work continued at the No. 5 for the next year and a half, but unfortunately neither the vein nor the Conglomerate were encountered.[28]

As No. 5 shaft explorations sputtered, C&H moved forward with their next phase in the Keweenaw's redevelopment. The Keweenaw Copper Co. sold the Keweenaw Central Railroad to C&H in order to assist in a thorough exploration of that company's 8,000 acres of mineral lands. Focusing primarily on the Phoenix Mine workings, one of the oldest operations in the Lake District, C&H hoped findings there might also be useful in assaying the Cliff's potential. At the same time, the No. 5 shaft explorations were shuttered and a plan was put in place to return to the "bottom limits" of old Cliff workings. The Avery was to again be dewatered, and the old No. 4 shaft, situated atop the bluff another 1000 feet to the north, would see attention as well. The Cliff Mining Co. was hemorrhaging funds at this point but continued assessments kept explorations, and hope, alive.[29]

The Avery had seen activity as recently as 1909, but the No. 4 shaft had sat untouched since the 1870s. The No. 4's creation, designed to access a Cliff vein that was moving away (both north of and further down from) the Pittsburgh and Boston's 1840's foot of the bluff workings, was completed by digging both down from the surface and up from an existing underground drift. Excavated over a period of 3-plus years, the completed No. 4 was a feat of engineering, as workers met almost precisely straight. When workmen returned to the site in 1927, they dropped a stone down the shaft to rate its

Cliff Mine, 1927. A new temporary surface plant is erected by the C&H-run Cliff Mining Co. atop the Tamarack-era shaft house (which itself lies atop the ruins of the Avery Shaft). The ruins of the 1850-built engine house and stack are in the foreground.

communication with the depths below. The stone fell for roughly seven seconds before a splash could be heard, which they calculated to mean an open depth of 655 feet.[30] From here on down the entirety of the underground workings were underwater, and crews set about dewatering the old Cliff for the second time. 14 men worked at the No. 4 while another 6 were stationed at the Avery. A mix of Cornish, Finnish, Slav, and German engineers, pump men, landers, and shaft repairmen made up the on site team, with a carpenter and blacksmith splitting their time between the Cliff and Phoenix set ups. Avery acted as the pump shaft while the No. 4 served as the base of exploratory operations.[31]

Changes in modern mining technology (rail cars, pneumatic drills, diamond drills) demanded an enlarging of the underground workings, and just as much time was spent in prep work and repairs as drilling and drifting. Rails were put in at the 20th level, and soon diamond drills reached depths another 2,000 feet below. Several "thin and unfavorable" lodes were crossed, but the Cliff fissure vein looked promising and "would have undoubtedly been an objective in the early days when fissure deposits were so highly regarded." But mass copper was no longer the objective. C&H geologists optimistically reported that favorable fissure findings merely indicated the existence of "important lode deposits" in the area. Fissures like the Cliff vein were believed to act merely as conduits for copper escaping larger lodes. Therefore these "satellitic fissure ore bodies" should occur near a conglomerate or amygdaloid lode. If they kept looking, they were bound to find the Cliff vein's very own source lode. They felt the No. 4 should be sunk a further 1,000 feet to begin another round of drilling.[32]

Cliff Mine, 1934. Taken from midway up the bluff looking southeast, the Avery Shaft surface plant is at left. In the distance can be seen a mostly abandoned Clifton and a rapidly encroaching tree line.

Unluckily for the Cliff, as soon as work started up again the global economy reeled under the effects of the 1929 stock market crash. While copper prices held steady for another year and a half, the customer base dried up, and led to the stockpiling of marketable copper and a strain on working capital.[33] By the early 1930s, most mining activity in the region ceased, and the Cliff was no exception. Operating as an exploratory venture, and up until then an unfavorable one at that, the Cliff was simply not a viable option for the time. Continuing work would exhaust funds, so all efforts were transferred over to the nearby Phoenix Mine location. Pumping at the Cliff continued over the course of 1931, but the Phoenix explorations turned up nothing. As a result, the Cliff Mining Co. voted to shut off the pumps on January 18, 1932, officially closing the Cliff's underground workings for good.[34] It could have been said that its 87-year extractive history had come to an end. But as it proved time and time again, the old Cliff still had some copper left (on the surface) to give.

During the years of the Great Depression the Cliff property sat idle. The few remaining buildings of Clifton were sold for $5-$10 and either removed or dismantled for their lumber. Fires over the years took care of the rest. All over the peninsula, companies were either suspending operations or liquidating assets altogether. At the start of the decade the Quincy Mine ceased nearly 75 years of profitable mining. Soon after, the Copper Range Company closed nearly all of its consolidated properties, leaving the Champion Mine as its sole producer. Even the Calumet & Hecla Mine succumbed to the inevitable. In 1933, it shut off the pumps to its original conglomerate workings, and began removing the valuable copper contained in supportive pillars on each level. This work erased any chance for future mining of the conglomerate, and by the close 1939 all of the company's conglomerate lode shafts were sealed.[35]

While the mine sat, the Cliff Mining Co.'s board of directors continued to meet annually, only to report "No work done" for the next seven years. At the close of the decade an uptick in copper prices brought with it renewed efforts at the Isle Royale, Quincy, Ahmeek, and North Kearsarge Mines. In 1939 the Cliff Mining Co. optimistically voted to extend their corporate charter for another 30 years, but the next decade again saw no work attempted.[36] Leading up to and during the Second World War, copper was highly sought after. The Federal Government instituted a favorable pricing plan for Michigan

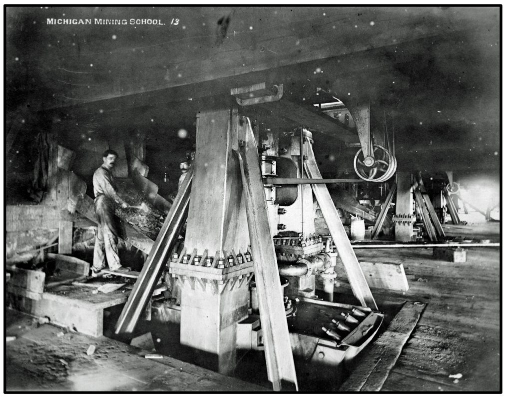
The western shore of Torch Lake, 1947. For three-quarters of a century, the mills and reclamation plants of C&H (center) and other companies deposited roughly 200 million tons of tailings into the lake, dramatically altering its shoreline and lake bottom.

producers, and companies quickly found new ways to create potential profits. Calumet & Hecla and others diversified holdings, turned to the scrap copper business, and focused efforts on the reclamation of mill tailings.

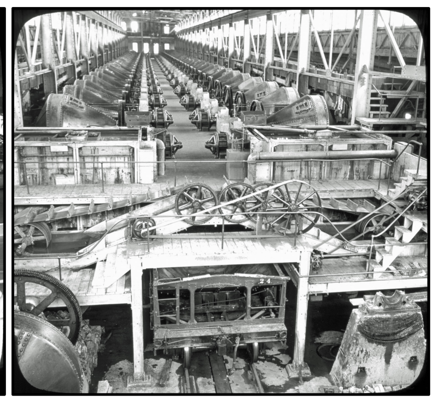
Reclamation

Reclaiming mill tailings was nothing new. Discussions of what to do with tailings still possessing high quantities of copper reached back to the earliest years of the district's development. At the industry's outset, fissure mines like the Cliff constructed simple and inefficient gravity mills located close to their shafts. Copper not freed easily through the stamping process was stockpiled in the hopes that technological improvements would come along to make their reprocessing profitable.[37] During and after the Civil War, as the industry's attention turned from fissure deposits to rich conglomerate and amygdaloid lodes, the dependence on crushing with steam-driven stamps increased, and the left over tailings deposits grew exponentially.[38] Mills were moved from mine sites to more distant inland lakes and Lake Superior itself. Their operation drastically transformed shorelines, and in some cases even impeding shipping.[39]

The efficient capturing of copper through washing these increased volumes was a slow, piecemeal evolution. In the 1840s and 50s, materials in water solution were often hand



At left, a worker feeding copper-bearing rock into a steam stamp at the Quincy mill on Torch Lake. At right, a C&H dredge reclaims tailings previously deposited in Torch Lake for regrinding at the company's Lake Linden regrinding and reclamation plant.

At left, a row of Wilfley tables at the C&H reclamation plant concentrates reground tailings. At right, hardinge ball mills like these reground tailings to a finer material for flotation and leaching.

raked and agitated in order to separate copper mineral from sand, though these processes were automated by the close of the 1860s.[40] Adaptations continued up to the close of the nineteenth century, as the introduction of the Wilfley table, flotation, and ammonia leaching marked a turning point in the successful recovery of stamped copper.[41] With the right technologies now available, Calumet & Hecla built the first reclamation plant on Torch Lake in 1915. It focused its attention to dredging the 150 acres of predominately conglomerate tailings its mills deposited along the shore of the lake.[42] A decade later, C&H added another plant on the lake (to work the Tamarack deposit in Hubbell), and the Quincy mine soon built their own plant in a struggle to keep their company afloat.[43] Surveys of exploitable inland tailings were conducted along the peninsula, with the Cliff's being mapped and measured in 1943 by the Works Projects Administration (formerly named the Works Progress Administration).

The Tamarack regrinding and reclamation plant at Torch Lake.

The Cliff's deposit measured on the small side, with an estimated 63,000 tons on hand and assayed at 17.3 pounds of copper per ton.[44] While that adds up to a lot of copper (over half a ton), and war pricing was favorable to Michigan copper producers, it was likely not enough to justify its reclaiming at that time.[45] For the next decade and a half C&H debated the costs of reprocessing the collective tailings of Keweenaw County, with the Cliff property often at the center of discussion. Assays of Keweenaw tailings were again taken in 1950. The Delaware Mine possessed the smallest deposit, at 50,000 tons, while the Conglomerate (at Lac La Belle), the Central, the Allouez, and the Copper Falls claimed 120,000, 280,000, 800,000 and 1,500,000 tons of treatable material, respectively. Though the Cliff property contained a relatively small amount of material compared to the other surveyed sites (and a fraction of what Calumet & Hecla's mill produced), the richness of its tailings made up for its low volume. The 60,000- plus tons of material was calculated to produce 545 tons of copper, while the Copper Falls deposit, nearly 25x larger than the Cliff, was only believed to contain 10x as much copper.[46]

A year later, in 1951, a plan was proposed to reclaim the Cliff tailings at the (now) C&H controlled Tamarack plant. Unfortunately the plan was scrapped, since the cost per pound for treating the tailings was calculated to be 30 cents, while the price of copper was just under 26 cents per pound.[47] More issues concerning the practicality of reclaiming the Cliff tailings were linked to its century-long exposure to the elements. Preliminary tests indicated that a *rusting* of the copper mineral (in the tailings, not contained within the copper-bearing waste rock piles) could make it difficult to process, lessening its purity and recapture rate.[48] Despite these results, the next few years saw continued discussions of the topic and two more proposals, though neither were approved.[49]

With the issue tabled for the time being, focus instead turned to the Cliff's viability as a corporate entity.[50] First incorporated in 1910 and renewed in 1939, the Cliff Mining Company was, in effect, nothing but words on paper tied to 7610 acres in Keweenaw County. By September of 1954, company directors initiated discussions on winding up the company and selling it outright to Calumet & Hecla for $76,000. Just over half of the shares of the company were already in Calumet & Hecla's name (gobbled up in a series of purchases over the years), but there were still 27,000 or so shares held by investors linked to the company's original, Tamarack-era incorporation in 1910. Although there was some worry on the part of the Cliff's directors about selling the land for anything less than $10 an acre, it was agreed in March of 1955 to dissolve the company and sell to C&H Consolidated.[51] Another nineteen months would pass before the company's liquidation was completed, but in the end each of the remaining, non-Calumet & Hecla shareholders received $2.74 per share.[52]

During and immediately after this transition, discussions about the Cliff's tailings were renewed. Challenges related to cost were no longer an impediment now that the company was wholly under C&H control, and renewed testing of the deposit improved prospects that it could be reclaimed at a profit.[53] However, labor tensions that summer put work on hold and even threatened to bring down the local industry altogether.[54] It would be another four years before the issue of the Cliff's tailings could be resolved.

Finally, in the summer of 1959, a proposal to reclaim the Cliff tailings went ahead. Sixteen trucks hauled up to 800 tons a day from the two sites, with the Tamarack reclamation plant at Torch Lake their final destination. Three quarters of the Cliff's tailings were reclaimed that summer and the "clean up of the Cliff property" finally concluded the following spring.[55] At this point, only a few working mines were still operating around the district, and none in Keweenaw County. Reclamation, either of stamp sand tailings or scrap copper, was seen as the last resort for the industry.[56] The size and profit potential of tailings lining Portage and Torch Lakes drew the attention of the media, who pointed out that the "shipping" out of sand, for fill and as a traction aid on winter roads, was depleting the Isle Royale tailings, "the largest amygdaloid sand deposit in the world." Another 37,000,000 tons of Calumet Conglomerate sands were still to be found at Lake Linden, while an additional 100,000,000 tons could be found a few miles south at Hubbell/Tamarack. Some felt that 6-10 pounds of copper could be had in the flotation process from every ton of "junk" on the landscape.[57] But in the case of the Portage Lake amygdaloid deposits, their residual copper rarely reached that level of concentration, while the majority of the Torch Lake conglomerates had already gone through one round of reclamation. The native copper mining era had finally ended.

Closure

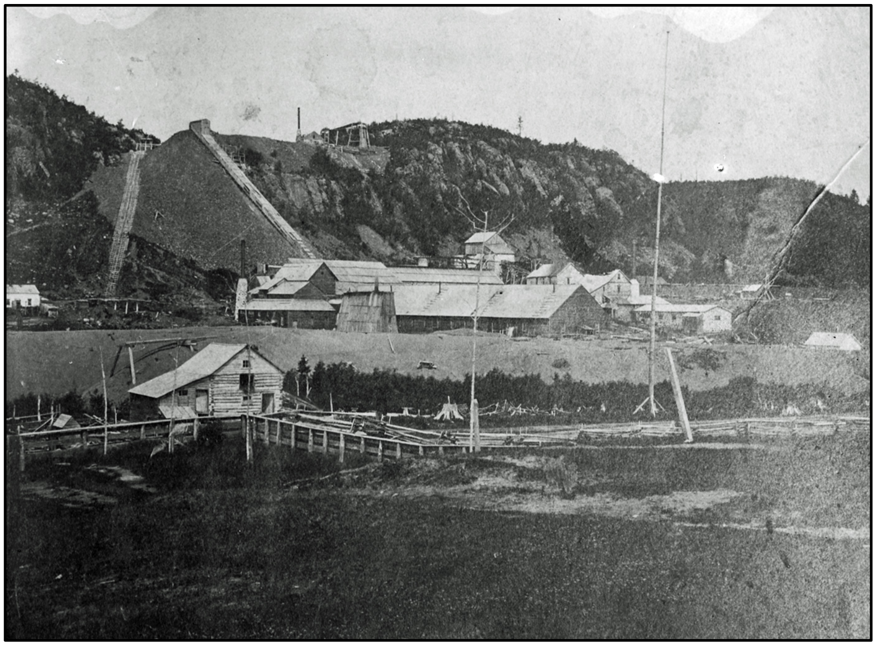
With the wrapping up of the Cliff Mining Co. in 1955, the removal of its accessible copper reserves a few years later, and the overall decline of the industry, Calumet & Hecla felt little need to pay much attention to the Cliff property. The Cliff, along with

The collapsed cap of the North Tamarack Mine's No.'s 3 & 4 Shaft, July 18, 1966. The Ruth Ann Miller tragedy spurred the securing and capping of mine openings throughout the former mining district.

dozens of other abandoned mine sites, sat ignored as the peninsula's native copper mining activity came to a close. Decades old remains crumbled and shafts sat unsecured; in many cases, still open. The safety concerns of open shafts were acknowledged, and many were plugged and then capped with concrete in areas frequented by the area's residents, but little more was done to actively protect the public. Unfortunately, it took a tragic accident to shine a spotlight on the dangers of abandoned mines.

In July of 1966, a group of children went out to pick strawberries on the former location of the (North) Tamarack Mine's No.'s 3 & 4 Shaft's surface plant. One of the children, 7-year old Ruth Ann Miller, slipped through an eroding concrete cap, and fell nine hundred feet into the flooded #4 shaft. The tragedy devastated the community, and led to a concentrated effort to locate and secure other abandoned mine shafts and openings.[58] The Houghton and Keweenaw County mine inspectors informed the Calumet & Hecla Safety Department that there were 120 abandoned mine shafts and openings in the two counties, and many of them were considered hazardous. 104 of these openings, including the North Tamarack No.'s 3 & 4 Shaft, were on C&H property, whose internal inspection found that 83 were in need of securing and closure. The company estimated a total cost of $20,000-$30,000 for the undertaking.[59]

These efforts made their way to the Cliff in August of 1968, where the Avery, the No. 4 and the South Cliff No. 1 shafts were all in varying states of hazardous condition. At the



A picture taken of the Cliff Mine at the peak of its productive life, 1862. The stamp mill and 150-foot wash house can be seen at center, with the tall Avery Shaft and engine houses standing behind it along the base of the bluff. At the top of the bluff is the No. 3 Shaft's stack and the rock chute that connected the mill to the No.'s 3 and 4 Shafts, The light material in front of the mill is the tailings deposit. A launder, a flume used to funnel tailings and water away from the mill can be seen at left.

Avery, inspectors identified a 10'x14' opening with a vertical depth of 800 feet. The shaft was, "wide open... apparently blocked at 40 feet... fenced, close to road [and having] easy access." The fence was removed and the shaft decked with timber and buried, all for just $280. The #4 was of equal size, though its depth reached 1750. While its former collar house had partially collapsed over the opening, old rails and timber jammed inside were the only things acting as a cap. Over the course of two days, and at a cost of $500 for labor and materials, the fence was removed, the collar house was pulled down into the shaft, and the remaining opening was filled. The South Cliff was also 10'x14' in size, but it was entirely open and the bottom of its flooded depths were indeterminate. In this case, the area was fenced and material bulldozed over the opening. Eventually new fences were requested at the Avery and No. 4, and altogether the work to cap and secure the Cliff's openings came to just over $1000.[60]

Other abandoned mines in the area also saw attention, including the openings of the Phoenix, Manhattan, and North American mines. By the close of the decade the shafts of the Cliff and the Keweenaw were secured. Officially, once and for all, the Cliff was surely dead.

Notes

[1] *The Mining Journal* (Marquette), September 12, 1903. Today, the former site of the South Cliff waste burrow is now the site of the Cliff's mill tailings, stockpiled there in 2014 during an environmental remediation project at the mine (further discussed in this book's *Epilogue*).

[2] 3,785 cords of hardwood at 25 cents per cord and 1,970 cords of softwood at 12 cents were on hand as of 1907. Noted in Tamarack Mining Company timber land papers, 1910. C&H Collection, MS-002, Box 208, Folder 36. (Michigan Tech Archives). The company's enthusiasm over the Cliff purchase was recorded in Horace J. Stevens, *The Copper Handbook: A Manual of the Copper Industry of the World* Vol. 5, 1905. (Houghton, MI.: H.J. Stevens, publisher, 1905), pp. 748-751.

[3] *The Mining Journal* (Marquette), September 19, October 31, and November 21, 1903. The diamond drill outfit from Isle Royale was likely Cole & McDonald, who were contracted all over the Great Lakes in the early twentieth century. *The Mining Gazette* (Houghton), May 28, 1905.

[4] Buildings erected at the site are listed in the *General Manager's Report to the Directors of the Tamarack Mining Co.*, 1906.

[5] *The Mining Gazette* (Houghton), September 29, 1907.

[6] An excellent history of the Lake District's railways can be found in John Gaertner's, *The Duluth, South Shore & Atlantic Railway: A History of the Lake Superior District's Pioneer Iron Ore Hauler* (Bloomington: Indiana University Press, 2009), pp. 109-110, 146-147.

[7] *The Mining Gazette* (Houghton), January 31, 1865. *Keweenaw Central Railway: The Copper Country Route* (November, 1968), found in the Clarence Monette Collection (Michigan Tech Archives), offers a succinct history of the Keweenaw Central.

[8] Stevens, *The Copper Handbook* (1905), p. 496.

[9] Details regarding the construction of the Keweenaw Central Railroad can be found in *The Mining Gazette* (Houghton), April 24, 1906, and April 10, 1954. A tabulation of the line's rolling stock is located in *Poor's Manual of Railroads*, 1910.

[10] Stevens, *The Copper Handbook* (1913), p. 860; C. Harry Benedict's, *Lake Superior Milling Practice: A Technological History of a Century of Copper Milling* (Houghton, MI: Michigan College of Mining and Technology Press, 1955), pp. 38, 52, is the definitive guide on the stamp mills and milling technology of the Lake District.

[11] Keweenaw Miner (Mohawk), November 1, 1907; the *General Manager's Report to the Directors of the Tamarack Mining Co.*, 1907; and Horace J. Stevens, *The Copper Handbook: A Manual of the Copper Industry of the World* Vol. 9, 1910. (Houghton, MI.: H.J. Stevens, 1910), p. 1301.

[12] *Ontonagon Herald* (Ontonagon), October 24, 1908; *The Mining Gazette* (Houghton), November 27, 1908; and Stevens, *The Copper Handbook* (1910), p. 1301.

[13] The various difficulties encountered at the Cliff from 1907-1909, along with the expenditures exhausted on those difficulties, are outlined in the *Annual Report of the Calumet & Hecla Mining Co.* for 1909, p. 48; and *The Mining Gazette* (Houghton), July 24, 1909, *Ontonagon Herald* (Ontonagon), October 24, 1908, and Stevens, *The Copper Handbook* (1910), p. 1301.

[14] The particulars of the Tamarack Mining Co.'s transfer of the Cliff Copper Co. to Calumet & Hecla can be parsed out by reading the *Annual Report of the Calumet & Hecla Mining Co.* for 1909, pp. 5, 55-56; and the Tamarack Mining Co. Accounts Journal entries for 1910, located in the C&H Collection, MS-002, Box 266, Folder 1. (Michigan Tech Archives).

[15] *Annual Report of the Tamarack Mining Co.* for 1910.

[16] Debates over why and where to drill on the Cliff property occurred over July of 1910. The diamond drill outfit tasked with working the Cliff described the drill cores as looking "hungry", i.e., not possessing copper. Correspondence from James McNaughton to Quincy Shaw, July 9th, and Shaw's reply from July 12th. C&H Collection, MS-002, Box 55, Folder 24. (Michigan Tech Archives).

[17] Cliff Mining Co.'s (name changed during the handover from Tamarack to C&H) monthly reports for the fall of 1910 are found in the C&H Collection, MS-002, Box 219, Folder 5. (Michigan Tech Archives).

[18] Testing the North Cliff showed little promise, and though drilling did occur there, nothing came of it. *Annual Report of the Cliff Mining Co.* for 1913, p. 2; see also, correspondence from C.D. Holl to James McNaughton, August 2, 1913. In, C&H Collection, MS-002, Box 56, Folder 40. (Michigan Tech Archives).

[19] There are several books published on the strike of 1913-14. A good place to start is Arthur W. Thurner, *Rebels on the Range: The Michigan Copper Miner's Strike of 1913-1914* (Lake Linden, MI: John H. Forster Press, 1984). Larry D. Lankton offers two complimentary takes on the strike in, *Cradle to Grave: Life, Work, and Deth at the Lake Superior Copper Mines* (New York: Oxford University Press, 1991), and *Hollowed Ground: Copper Mining and Community Building on Lake Superior, 1840s-1990s* (Detroit: Wayne State University Press, 2010); more recent views on the strike can be found in Alison K. Hoagland, *Mine Towns: Buildings for Workers in Michigan's Copper Country* (Minneapolis: University of Minnesota Press, 2010); and Aaron Goings and Gary Kaunonen, *Community and Conflict: A Working-Class History of the 1913-14 Michigan Copper Strike and the Italian Hall Tragedy* (Lansing: Michigan State University Press, 2013).

[20] The woeful results of diamond drilling are reported in the *Annual Report of the Cliff Mining Co.* for 1913, p. 2, while James MacNaughton's desires for consolidation can be found in his own words in "History of Calumet & Hecla since 1900," *Mining Congress Journal*, Vol 17 (Oct. 1931), pp. 474-477.

[21] Only a handful of homes were rented on the property at this time. Names on the rent books like Lahti, Waara, and Raisanen were indicative of a cultural landscape once dominated by Cornish, Irish, and German surnames now dominated by eastern European, and especially Finnish, ones. *Cash Records of the Cliff Mining Co.* 1916-1917. C&H Collection, MS-002, Box 319, Folder 7. By 1920, these land rents amounted to just $300 a year for the company.

[22] The only mention of Rossberg's reclaiming of the Cliff's rock piles is in the *Ontonagon Herald* (Ontonagon), April 17, 1886, while Warren's new mill and leasing arrangement is first mentioned in The Mining Gazette (Houghton), May 16, 1906. Born in Wisconsin c.1850, Rossberg likely moved to the Keweenaw in the 1870s, and is listed in the 1887 *Michigan Manual* as a coroner living in Phoenix. For the next few decades he lived in Montana, Utah, California, and Washington. He died in Seattle on July 26, 1923.

[23] For details about the various mills built at the Cliff site, see Chapter 9. (Not included in the dissertation version)

[24] Stevens, *The Copper Handbook* (1910), p. 1302, and the *Cash Records of the Cliff Mining Co.* Warren himself passed away in 1925, and he and his wife's graves are still cared for in Eagle River's Evergreen Cemetery.

[25] *Annual Report of the Cliff Mining Co.* for 1926, p. 3. A full geological accounting of the Lake District is found in B.S. Butler and W.S. Burbank, *The Copper Deposits of Michigan: USGS Professional Paper 144* (Washington: U.S. Government Printing Office, 1929). In an interesting connection to the Cliff's boom years, the man responsible for drafting *The Copper Deposits* map plates was Carlos V. Rawlings, grandson of Joseph W.V. Rawlings (listed as Rawlins in the original edition of this book), the on again-off again engineer of the Cliff Mine and designer of the first man-engine in the Upper Great Lakes (and discussed in Chapter 3).

[26] Lankton, *Cradle to Grave*, p. 251.

[27] C&H Collections, MS-002 (Michigan Tech Archives) possess both the July 18 and December 5, 1924 meeting minutes of the Cliff Mining Co. in Box 190, Folder 4, as well as September 5 and November 3, 1925 correspondence between Ocha Potter (Superintendent of the Cliff Mining Co.) and James McNaughton, which together outline the early developments of C&H's plans for reopening the Cliff property following consolidation.

[28] Correspondence from Chief Clerk JG Bennetts to MacNaughton, May 25, 1926. C&H Collections, MS-002, Box 321, Folder 9 (Michigan Tech Archives). *Annual Report of the Cliff Mining Co.* for 1926. P. 3.

[29] The influence of the Phoenix Mine on developments at the Cliff are discussed in the meeting minutes of the Cliff Mining Co, October 8, 1926, and the *Annual Report of the Cliff Mining Co.* for 1927, p. 4.

[30] *Report of the Committee of the Stockholders of the Pittsburgh and Boston Copper Harbor Mining Company,* (Boston: S.N. Dickinson and Co., 1854), pp. 13-14. The calculations of the distance the stone dropped were made in an un-authored note in the C&H Collections, MS-002, Box 321, Folder 1 (Michigan Tech Archives).

[31] At the No. 4 were: 3 Electrical engineers: Henry Waara, John Buhek, James Conda. 1 air hoist engine man: Homer Pelto. 2 landers (on same shift to dump poor rock): Charles Richards, Henry Dyni. 6 shaft repair men: Mike Zunich, Harold Waara, Matt Laity, Matt Mihelich, John Weiss, Joe Bahor. 2 pump men: Phipp Kajafes, William Karianen. Workers at the Avery shaft. 6 men in total. 3 engine men: John Chopp, Louis Prihek, Roy Hepting. 3 pump men: William Carlson, Ernie Dyini, Jacob Chopp. From, an un-authored note in the C&H Collections, MS-002, Box 321, Folder 1 (Michigan Tech Archives); see also, *Annual Report of the Cliff Mining Co.* for 1927, p. 2.

[32] *Annual Report of the Cliff Mining Co.* for 1927, p. 3.

[33] The crash of 1929 and its impact on the Lake Copper industry can be found in Lankton, *Cradle to Grave*, pp. 253-256.

[34] The *Annual Report[s] of the Cliff Mining Co.* for 1931, p. 2; and 1932, p. 2.

[35] Larry D. Lankton and Charles K. Hyde, Old Reliable: An Illustrated History of the Quincy Mining Company (Hancock: Quincy Mine Hoist Association, 1982), pp. 141-43; *Annual Report[s] of the Copper Range Consolidated Mining Co.* for 1929, p. 7; 1930, p.4; and 1932, p. 3; see also, Lankton, *Cradle to Grave*, pp. 254.

[36] The idleness of the Cliff Mining Co. during the 1930s are documented in the exceedingly brief *Annual Report[s] of the Cliff Mining Co.,* 1932-39.

[37] Unfortunately, in the case of nearly all the early mining ventures, operations ceased long before economical reclamation could be made practical.

[38] The first steam stamp used on the peninsula was at the Copper Falls mine in the 1850s, though they would not replace gravity stamps as the primary stamping technology until the mid-1880s. Stamping technology improved considerably with the introduction of the steam-powered stamp. Gravity stamps, consisting of wood, wrought, or cast iron frames supporting 200-300 pound iron shoes and whose force was tied directly to the height of its drop, were fully capable of breaking up veinstone in the process of freeing mass copper. However, they were less capable of handling large volumes of amygdaloids and wholly inadequate for hard conglomerates. Large cast iron and steel steam stamps possessed stamp shoes weighing upwards of 2000 pounds, and could handle much higher volumes of rock more efficiently than their gravity counterparts. The first steam stamp used on the peninsula was at the Copper Falls mine in the 1850s, though they would not replace gravity stamps as the primary stamping technology until the mid-1880s. A great discussion on the evolution of stamping and washing copper over the course of the late nineteenth century is in Benedict *Lake Superior Milling Practice.*

[39] Along the shores of Portage Lake the Quincy, Pewabic, Franklin, Hancock, Osceola, South Pewabic, Grand Portage, Shelden and Columbian, and Isle Royale all operated mills stamping rock from amygdaloid lodes. Their collective tailings encroached on the waterway, eventually necessitating the removal of stamp mills off that portion of the lake. Some of these companies moved to Torch Lake, while others opted for Lake Superior or on portions of Portage Lake sited off the shipping lane. Regardless of where the new locations lie, stamping and tailings deposition continued to expand.

[40] Several competing washing technologies were patented in the Lake District, two of which were even developed at the Cliff Mine. Eleven separate patents for ore washers were given to residents of the Keweenaw over the years 1853-1899, including two vibrating ore washers developed at the Cliff Mine itself. The first, patented to J. Paull of Clifton, came in 1857, while James Watson, Superintendent of the mine in the early 1860s, received his patent in May, 1865. *United States Patent Office, Index of Patents 1790-1873*, pp. 978-979.

[41] Benedict, *Lake Superior Milling Practice*, pp. 23, 49-51. Invented in 1898, the Wilfley table's strength was in its capacity. Much like the steam stamp, the Wilfley table could handle large volumes of material efficiently and economically. The introduction of flotation (first developed at the Australian mining town of Broken Hill) and leaching with ammonia to the process of copper capture meant not only could companies recover more copper as it was processed, it could conceivably reclaim copper in tailings previously discarded.

[42] Ibid, pp. 82-86. A 110-foot long dredge, powered electrically from shore, sucked in excess of 10,000 tons of sand lying up to 115 feet below the surface of the lake. These tailings were shot at 14 feet per second into a reservoir where it was then sucked up again and brought into the reclamation plant where they were reground, floated, and/or leached to a point where 85% of the copper contained was recovered.

[43] Ibid, pp. 89-91. The Tamarack plant was built in the 1920s, while the Quincy Mining Co. built their own reclamation plant on Torch Lake in 1943, not long after the Tamarack plant was revamped to handle a diverse collection of amygdaloid tailings from around the area.

[44] For comparison's sake, the collective mill tailings deposited in Torch Lake measured roughly 200 millions tons, dwarfing the Cliff deposit.

[45] The Works Projects Administration map of Cliff mill tailings, dated August 2nd, 1943 in located in the C&H Collections, MS-002, Box 86, Folder 12. (Michigan Tech Archives).

[46] Cost sheet included in correspondence from G.L. Craig to A.S. Kromer, dated March 28, 1955. In, C&H Collection, MS-002, Box 86, Folder 12 (Michigan Tech Archives). This cost sheet included cost analyses from both 1952 and 1955. The figures included in the text are from the 1952 analysis.

[47] Letter from Harvey S. Donald to O.A. Rockwell. Dated January 9, 1951. C&H Collection, MS-002, Box 86, Folder 12 (Michigan Tech Archives). Donald, Chief Engineer at C&H, proposed to, "load the sand into trucks... with our own or rented equipment and haul to... Allouez, where it will be loaded into railroad cars and transported to the C&H mills at Lake Linden. The sand will be dumped into an existing bin at this location. It will be loaded from the bin into trucks and hauled to the Tamarack Reclamation plant where it will be dumped into the pool at the shore plant." The proposal was rejected.

[48] *Preliminary Report on Laboratory & Mill Testing of the Cliff Sands, 1952*. Submitted January 17, 1952, by Arnold B. Landstrom, Metallurgical Engineer for Calumet & Hecla; Letter dated January 24, 1952 from R.K. Poull to O.A. Rockwell. C&H Collection, MS-002, Box 86, Folder 12 (Michigan Tech Archives). Poull remarked that preliminary tests of tailings sand in January of 1952 indicated a high rate of oxidation within a sample possessing large grains requiring alterations to the regrinding process in order to "free values to the stage where an acceptable concentrate... could be produced."

[49] Letters: from O.A. Rockwell to E.R. Lovell, dated January 29, 1952 and February. 7, 1952. C&H Collection, MS-002, Box 86, Folder 12 (Michigan Tech Archives). Later in 1951, C&H engineers claimed 2,000,000 pounds of copper could be reclaimed from the collective tailings of the Cliff, the Delaware, and the Lac La Belle deposits, but that of the three, the Cliff held the most promise. After "careful study," it was deemed unfeasible to treat the Delaware and Lac La Belle tailings, but that starting in June, the Cliff sands could be loaded up and trucked four miles to the Iroquois Mine, then loaded on rail and taken to the Calumet & Hecla reclamation plant at Lake Linden (not the Tamarack plant which was then at full capacity). Here the materials would be stockpiled while the plant underwent $375,000 in improvements including the installation of new 11-foot Hardinge ball mills, new classifiers, screens, modifications to the shore-located reservoir, and other additions. Once ready the plant would handle up to 2,000 tons daily, and take roughly two months to complete the job with a projected profit of $32,000. Again, the proposal was rejected.

[50] Lankton, *Cradle to Grave*, p. 261. C&H turned away from the Cliff and toward reopening its workings on the Osceola lode instead. At the Osceola, the work was mining, not reprocessing. By keeping a working mine open it sent a message that this was still a mining district, not one needing a cleaning up of its past.

[51] Letter dated September 21, 1954 from JH Elliot, Secretary, to AE Peterman, Vice President. C&H Collection, MS-002, Box 321, Folder 7; see also, *Bill of Sale*, March 4, 1955. Box 512, Folder 6 (Michigan Tech Archives).

[52] *Certificate of Dissolution*, March 10, 1955. C&H Collection, MS-002, Box 321, Folder 7; see also, *Banking Records*, Cliff Copper Co. November 13, 1956. Box 321, Folder 8 (Michigan Tech Archives).

[53] It also helped that in the three years after the last reclamation proposal, the price for copper had risen 53%. Testing in 1955 indicated the copper was "very bright and clean," showing "no indication of having been subjected to oxidation." Recapture rates of 60-65% were made, and a rate of 80% was soon anticipated. As a result, a new report building off of the studies from earlier in the decade recalculated the potential profits to be made from reclaiming the collective Keweenaw tailings. Two of the properties, the

Cliff and the Allouez, were now seen as profitable ventures while the Delaware, Lac La Belle, Copper Falls, and Central were deemed a lost cause. But again, nothing came of it. This report can be found in *Status of Pilot Plant Tests on Oxidized Tailings,* included in a memo dated January 19, 1955 from G.L. Craig to A.S. Kromer. C&H Collection, MS-002, Box 86, Folder 12 (Michigan Tech Archives).

[54] C. Harry Benedict *Red Metal: The Calumet & Hecla Story* (Ann Arbor: University of Michigan Press, 1952), pp. 261-62; see also, Lankton. *Hollowed* Ground, pp. 235-36.

[55] *The Daily Mining Gazette* (Houghton), May 3, 1960. The conglomerate tailings of the Allouez Mine were also included in the project.

[56] This is excluding the newly opened White Pine Mine, located in Ontonagon County at the extreme western end of the Keweenaw. The White Pine mined a sulfide copper ore, not native copper, and it can be argued that its history, while linked to the historic native copper mining period (1840s-1960s), is quite distinct due to technological process, environmental impact, and organization.

[57] *The Daily Mining Gazette* (Houghton), August 7, 1959; *Toledo Blade*, (Toledo), October 2, 1963.

[58] *The Daily Mining Gazette* (Houghton), July 16, 1966. Reports of the tragedy made its way across the country, from the *Reading Eagle* (Reading, PA) to *The Lawton Constitution and Morning Press* (Lawton, OK).

[59] Initial discussions about securing the company's various shafts, and the cost analysis of those projects, is contained with a memo from C.H. Suter to P.W. Robson, dated October 29, 1968. C&H Collection, MS-002, Box 86, Folder 9 (Michigan Tech Archives).

[60] The specific details regarding the securing of the Cliff's mine openings, as well as those related to other mines in the Lake District, are found within various Calumet & Hecla Abandoned Mines Report papers dating from the late summer and early fall of 1968. C&H Collection MS-002, Box 86, Folder 9 (Michigan Tech Archives).

IT'S NOT TIME TO BE WASTED: IDENTIFYING, EVALUATING, AND APPRECIATING MINE WASTES IN MICHIGAN'S COPPER COUNTRY

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Abstract

Over a century of mining native copper in Michigan's Copper Country has produced several million tons of workable metal and an even greater amount of waste. The remaining rock, tailings, and slag each represent a separate step in the process of hard rock mining, providing tangible links to industrial landscape narratives at both regional and site-specific scales. Recently, the Keweenaw National Historical Park's Advisory Commission funded a survey of over 350 separate sites of copper mine waste, ranging from multi-acre tailings deposits to slag heaps occupying less than 50 sq. ft. This work resulted in the development of a classification and scoring rubric designed to identify waste sites of greatest historical significance, authenticity, and integrity. These findings offer insight into understanding and appreciating the residues of extractive practice that in this case, due to the benign nature of the unalloyed copper mined there, pose a lesser threat to the environment compared with most hard rock mining activities.

Introduction

Industrial archaeology's value lies not only in studying the physical remains and archival documents associated with industrial production, but also with preserving and interpreting the toxic legacies encapsulated within industrial activities' waste residues. While industrial residues unquestionably offer vivid perspectives on environmental impact and operational scale, the urge to properly preserve their toxic legacies is fraught with barriers. While the National Historic Preservation Act of 1966 may constrain federal agencies when their proposed undertakings potentially impact cultural resources, agencies must also comply with other social values embedded in existing law. When agencies deal with historical deposits of industrial waste, they must be cognizant of the National Environmental Policy Act (NEPA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as Superfund), and other laws and regulations drafted to protect environments and human health from hazardous materials. Scholars have written about conflicts that arise between the social values of preservation and the environmental remediation of industrial waste, and they have described case studies of communities that have tried to negotiate those seemingly opposed values.[1]

But what if the environmental impact of the waste products is relatively benign? How do we take advantage of an opportunity when both industrial-period ingenuity *and* environmental disregard can be interpreted appropriately and as equals? In the Copper Country of Michigan's Keweenaw Peninsula, such an opportunity exists. To explore the possibilities presented in the Copper Country, the Keweenaw National Historical Park's Advisory Commission sponsored a study to locate and identify sites of mining waste, evaluate their historical significance and integrity, and suggest which sites possess the best potential for preservation, interpretation, and integration into the Park's programs.[2] This article summarizes the methods and results of the project and makes an argument for the importance of preserving and interpreting industrial wastes when the appropriate opportunities arise. In the case of the Keweenaw, one such opportunity is found in the relatively benign nature of the peninsula's historical industrial wastes.

"Mining landscapes may not be especially pretty to look at. Nevertheless . . . [one] can see that these mining landscapes had a story to tell that is every bit as interesting as the story of those beautiful places featured on calendars—perhaps even more interesting."[3] In the introduction to his 1991 book, *Hard Places*, Richard Francaviglia effectively captures the feelings many people have about the mostly deindustrialized historic mining landscapes of Michigan's Copper Country. The region's once prosperous copper mining industry, begun over a century and a half ago, left a legacy of company-built communities and industrial ruins from Copper Harbor, at the northern tip of the peninsula, to White Pine 100 miles to the southwest (Figure 1). Architecturally speaking, the mining heritage of the Copper Country is strong. But this is only half of the story. The process of mining native copper, found unalloyed and with little need for chemical refinement, produced not only millions of tons of marketable metal, but even greater quantities of residues in the form of poor (waste) rock, stamp sand (tailings), and slag.[4]

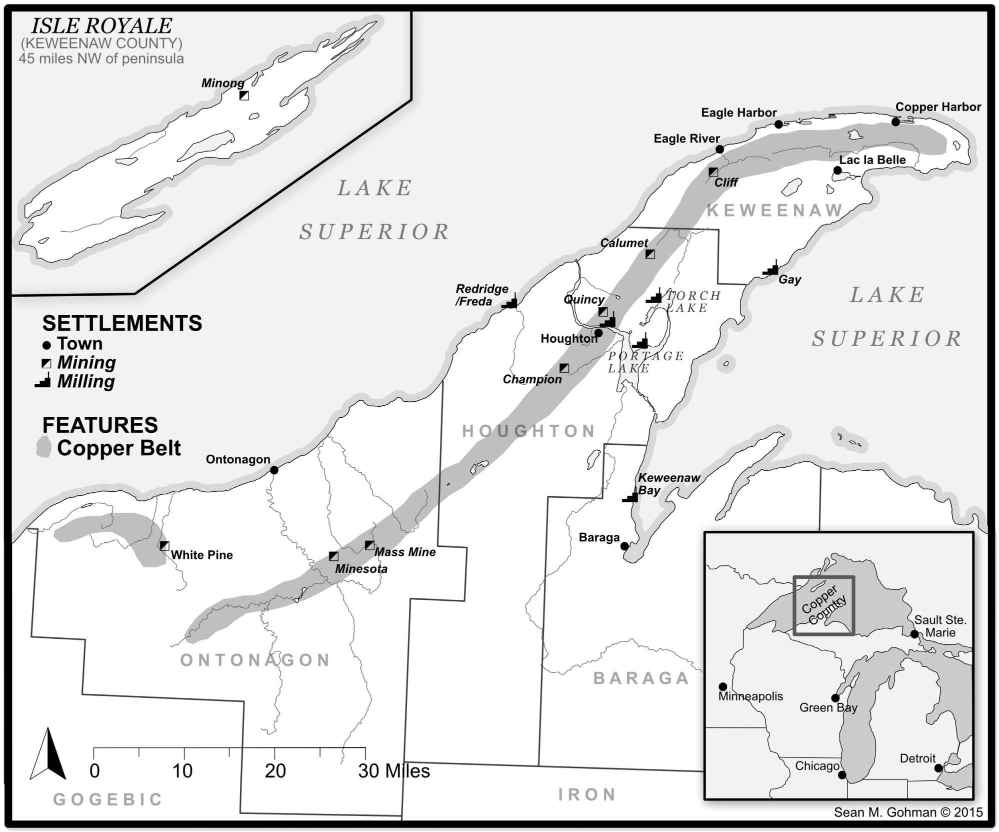

Figure 1. Map of Michigan's Copper Country showing Keweenaw, Houghton, Ontonagon, and Baraga Counties, towns and mining locations of note, and the Copper Belt, the copper-bearing geologic zone that was the primary focus of historical mining. Map by Sean M. Gohman, 2015.

While the houses and mine buildings tell us how people lived and worked, the residues tell us how companies altered the landscape to suit their productive needs, often without a concern for impact. In today's economic and environmental climate, these latter stories merit telling, and the landscapes of waste embody what is told.[5]

Most of the Copper Country's underground workings are now flooded, their access points long ago capped, and much of the present, readily visible waste has undergone drastic change. Tailings deposits that once clogged inland lakes have become real estate. Road crews, landscapers, shingle makers, and construction contractors see waste rock and slag as raw materials available without the need of quarrying. With that commercial potential in mind, it is becoming increasingly important to preserve at least some of these sites while we can and to plan how better to educate the public about its historical and cultural importance. The Copper Country's historic landscape still has many stories to tell.

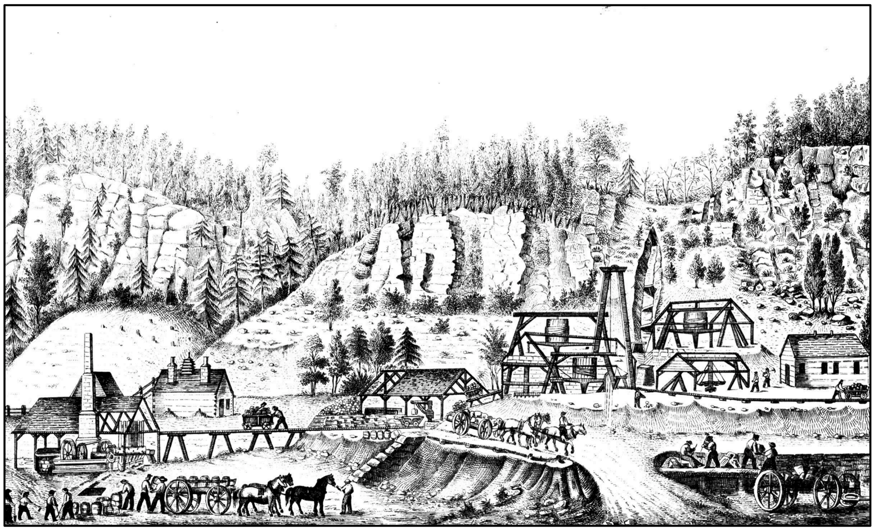

Figure 2. Cliff Mine, Lake Superior, 1849. In the earliest years of active mining, animal power was the primary form of energy transformation. Surface plants were tightly packed, with stamp mills (in this case powered by a small portable steam engine) located nearby and housed with little more than Cornish gravity stamps. Drawing courtesy of Michigan Technological University Archives and Copper Country Historical Collections.

The Copper Country

For millennia, native peoples knew of and exploited the copper deposits of Lake Superior's Keweenaw Peninsula. When seventeenth-century French explorers and missionaries made contact with the peoples of the western Great Lakes, reports sent east spoke of entire mountains and islands "all of copper."[6] Though the French, and later the British, each attempted to mine in the area, it wasn't until the 1843 Treaty of LaPointe between the United States and the local Ojibwe population that sustained prospecting and extraction took place. A year after the treaty's signing and a full four years before the discovery of gold at Sutter's Mill, the first organized mining venture began in the peninsula, and within a few years the region was teeming with activity.[7] By the close of the decade two outfits located at the extreme ends of the peninsula, the Cliff and Minesota [*sic*] mines, were extracting enough copper to produce profits (figure 2).[8] These successes encouraged the formation of additional joint stock companies mostly headquartered in Boston, New York, and Pittsburgh, and soon the "Copper Country" was home to dozens of working mines. Over the course of the latter half of the century, the continued growth of the industry, and the combined effects of mining, milling, and smelting, would eventually impact portions of four counties and a land area of over 600,000 square miles.[9]

Three types of native copper are present in the Copper Country, and over a century of historic extraction and processing of each type left large volumes of waste on the

landscape. Mass copper, the first of the deposits to be exploited, consists of large pieces of pure metallic copper adhering to a rock matrix. These masses could weigh several ounces or, in a few remarkable cases, over 500 tons.[10] Amygdaloid copper is found in small nodules of metal trapped within vesicles created through the escape of gases during the rapid cooling of ancient lava flows. Conglomerate copper, richest of the three—and the last to be economically processed—is found finely disseminated in sedimentary rock.[11] Unlike most copper ore deposits of the world, the Keweenaw's native copper deposits are relatively benign due to their purity, since they are not chemically bonded in sulfide or oxide minerals requiring further treatment to free the copper. While sulfide deposits containing traces of native copper also occur in several locations on the Keweenaw, it wasn't until the mid-twentieth century that mining and processing these sulfide compounds met with success.[12]

Today, the Copper Country consists of Keweenaw County (not including Isle Royale), the majority of Houghton and Ontonagon Counties, and the extreme northwest corner of Baraga County. The first three counties align closely with the historical Keweenaw, Portage Lake, and Ontonagon mining districts, respectively, each of which followed a unique, though linked, path toward the *winning* (successful extraction) of native copper. While mining and milling occurred in each of these districts, successful smelting only occurred in the Portage Lake district.[13] Baraga County was home to limited milling activity, but mining and smelting activities never occurred there.[14]

The Residues of Native Copper Mining Practice: A Regional Perspective

The production of marketable native copper found in Michigan was comprised of three stages: extraction, beneficiation, and refinement.[15] Each of these stages created a specific waste product that during the historical mining period was merely left in situ and was not commoditized. The process of mining native copper was more than just men venturing deep underground to blast, pry, and cut away copper from its rocky surroundings. In order to reach the profitable copper-bearing lodes, miners first had to remove millions of tons of surrounding "poor" rock. This worthless waste was hoisted to the surface and placed in tall, conical piles usually set close to the shaft. Mill tailings, colloquially termed *stamp sands*, were created as a byproduct of stamping and crushing mineralized rock to separate the rock from the copper.

In the industry's infancy, tailings were deposited either beside a stamp mill or along river and streambeds. As the industry matured, tailings created by larger lakeside milling facilities lined shorelines and extended out over the lakebed itself. In both cases, water action was an important factor in determining the tailings' present location and morphology. The copper concentrates produced by the milling process were then sent to be smelted in a furnace both to separate the rock that still adhered to the copper and to refine the copper's chemical state. The molten copper could be cast into whatever size and shape was required for commercial sale. The molten impurities separated from the copper during smelting became slag. Slag from a furnace was collected in ladles, which

Figure 3. Aerial photograph of Houghton, Michigan, on Portage Lake circa 1950. *Top left, along the horizon*: waste rock piles of the Isle Royale Mine. Photo courtesy of Michigan Technological University Archives and Copper Country Historical Collections.

were hand-trucked or trammed not far from the furnace. Molten slag was then poured onto the ground to solidify into a glass-like heap.

In the late 1840s, the earliest ventures in the Keweenaw and Ontonagon districts mined mass copper with hand drill, hammer, and chisel.[16] Horse-powered whims lifted rock and mass from shafts, though the first sign of potential profit often resulted in an investment in steam-powered hoisting machinery. For over a decade, mass mines dictated the practice of native copper mining, financially and technologically. With the coming of the Civil War, demand for copper increased, and the mass mines soon found themselves competing with new operators targeting amygdaloid and conglomerate lodes found near Portage Lake.[17] Although they generally lacked the large masses of native copper, these deposits proved incredibly rich in small bits of copper, and the Portage Lake district, predicated on separating the bits from the host rock, soon came to dominate the local industry. The Quincy Mine, the first to make this shift, eventually earned the moniker "Old Reliable" for its ability to reliably pay dividends to its investors for half a century.[18] The increased profits of lode mines initiated an expansion in the realm of steam power and its uses both above and below ground. Year by year, engines grew more powerful, drilling more economical, resulting in greater depths achieved and more waste rock created. Company towns grew up amidst these monuments to human and technological effort where, in some cases, waste rock dominated the viewshed for miles around (figure 3).

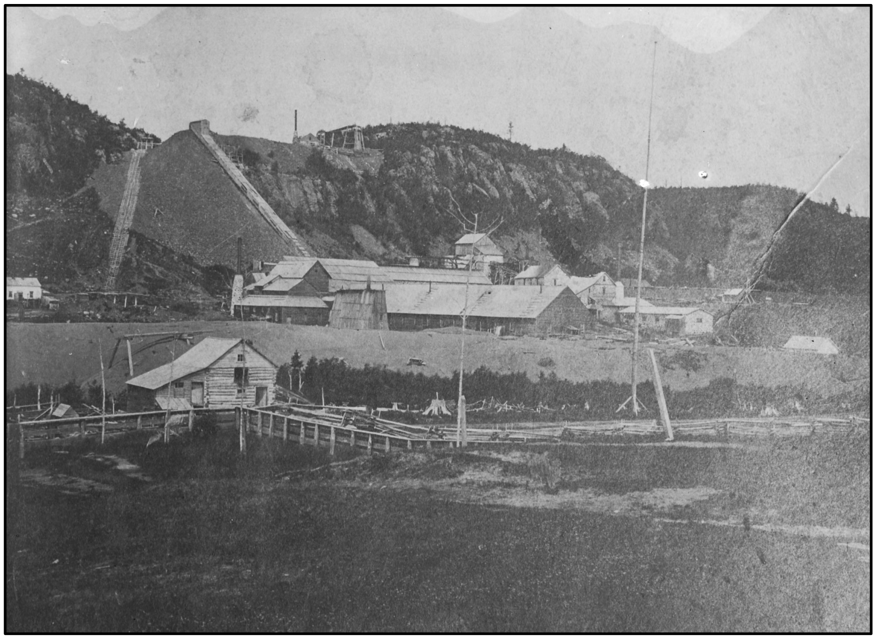

Figure 4. The Cliff Mine, 1862. *Middle band of gray:* collective mill tailings; *middle center behind tailings:* the mill is the long building with smokestack. Waste rock covers the bluff face. Photo courtesy of Michigan Technological University Archives and Copper Country Historical Collections.

An expanded footprint of milling also corresponded with the industry's move from mass copper to lodes of copper-bearing rock. Initially, companies constructed small stamping mills to free mass copper fragments from rock, but little attention was paid to concentrating the very small copper particles that could not be easily separated. These earliest mills operated Cornish-style gravity stamps, lifted mechanically by steam power, and were situated inland and close to the mine, since equipment didn't necessitate large volumes of water (figure 4). A stamp mill's tailings (often still containing significant copper) accumulated just outside the building or along a nearby riverbank.[19]

The demand for copper created by the Civil War stimulated technological breakthroughs to increase mill efficiency. The lode mines began constructing larger mills located further from their shafts and closer to abundant sources of water like Portage and Torch lakes. With more water available, mill managers tinkered with their "washing" technologies in efforts to increase yield.[20] The stamp rooms saw changes as well, as wood framed mills containing dozens of gravity stamps were soon replaced by stone (and later, concrete) mills housing only a handful of steam stamps made of cast iron and capable of handling higher tonnages of rock.[21]

By the early 1880s the increase in capacity caused an increase in the volume of waste. Mill tailings in Portage Lake choked the region's main shipping route to such an extent that the U.S. Army Corps of Engineers, which had jurisdiction over the nation's

Figure 5. The western shore of Torch Lake, 1947, viewed from the north. Seventy-five years of milling, smelting, and reclamation activity drastically altered the original shoreline. *Foreground:* C&H reclamation plant; *center:* Calumet mill and the ruins of the Hecla mill; *center left near shore:* double stacks of a boiler house, remains of C&H's coal dock, C&H smelter; *left, running perpendicular to the lake:* Ahmeek mill; *further beyond,* Quincy mills and reclamation plant. Photo courtesy of Michigan Technological University Archives and Copper Country Historical Collections.

navigable waters, urged the removal of both tailings and mills from the lake.[22] Milling activity moved to nearby Torch Lake, as seven stamp mills—all but two built between 1886 and 1909—transformed a tree-lined shore into a series of tailings deltas extending into the lake (figure 5).[23] Around the turn of the century, the peninsula's eastern and western shores along Lake Superior also attracted attention. Mining companies, owned under the umbrella of the Copper Range Consolidated Company, constructed four mills on the western side of the peninsula. At the company town of Gay, on the east shore of the peninsula, the Mohawk and Wolverine mills, built side-by-side in 1902, produced enough tailings to extend 1,500 ft. into the big lake.[24] The Mass Consolidated Mining Company, a merger of many smaller outfits centered on Mass City, built a large mill at Keweenaw Bay, Baraga County, circa 1905.[25] The company shipped rock thirty-five miles from its Mass City location to Keweenaw Bay, likely the farthest of any such Copper Country mine-to-mill arrangement. Another mill, built in 1907 by the Michigan Copper Mining Company one mile north of the Mass Consolidated mill, ran for only a short period.[26]

In the 1840s, a full understanding of the region's native, unalloyed copper had yet to be made. Based on their experiences in other mining districts, most geologists believed that the real wealth to be found would be in ores containing chemical compounds of copper, sulfur, and other elements. Such copper minerals require complex smelting to produce

marketable copper.[27] This incorrect belief about the nature of the region's copper led to the installation of at least two (though possibly four) smelting furnaces in the Keweenaw District and on Isle Royale during the 1840s.[28] In the 1850s, after its chemically pure state was finally understood, all native copper was shipped to smelters in Boston, Baltimore, Pittsburgh, and Detroit, which used an efficient process referred to as "the American System."[29] This system consisted of melting either mass or mineral (the granulated copper created through milling) in a large reverberatory furnace, then refining the residual slag in a separate cupola furnace.[30] The American System thus maximized copper extraction while minimizing waste.

By 1860, the industrial development of the region was such that a local enterprise utilizing the American System could be established at Portage Lake, but it wasn't until the turn of the century that more than one smelter operated locally.[31] With smelters firing at Lake Linden, Dollar Bay, Ripley, and Houghton, the industry had developed the capacity to produce marketable copper, yet the native copper industry struggled with mines reaching greater depths, labor strife, and increasing competition from western states. Though the century's first decades were profitable as a whole, the Copper Country entered a slow decline after the 1920s. The mining and milling of native copper ceased by the 1960s, with smelting coming to a halt when the Quincy Smelter closed in the early 1970s.[32]

The Residues of Native Copper Mining Practice: The Cliff Mine

The Cliff fissure vein, discovered along the interior ridge of the peninsula two years after the copper rush began, proved to be the first profitably worked deposit in the Copper Country, and it remained the leader in the industry for nearly two decades. The Cliff, owned and operated by the Pittsburgh and Boston Mining Company, was the first to make the transitions from prospect to organized concern, from temporary timber to permanent stone construction for its buildings, and from mining camp to mining community. Underground mining at the Cliff consisted of three-man teams, working hand drills and chisels to follow the vein, remove poor rock, and cut out mass copper. The surrounding rock, some of it still containing copper, was raised out of the mine at first by horse whim, and later by wood-fueled steam engines and hoists. The waste rock was left on the surface while copper-bearing ore was processed in a 36-head gravity stamp mill that handled up to 100 tons of material per day, though inefficiently.[33] Small bits of copper were barreled and shipped by wagon to the company's lakeside dock at the mouth of the Eagle River. From there steamers hauled the copper to the company's smelting works in Pittsburgh. The remaining mill tailings were flushed out the front of the mill and deposited along the banks of the Eagle River, gradually covering an area of several acres with tailings often still containing substantial percentages of copper. During the first decade of the Cliff's run, stamp work accounted for only one-fifth of the mine's marketable output. As time went on and outside competition increased, stamped copper mineral eventually made up half of yearly production.[34]

By the close of the Civil War the Cliff's position as industry leader was eclipsed by upstart lode mines in the Portage Lake District. Even with a greater reliance on stamp work, the Cliff simply couldn't compete with the volumes of copper-bearing rock the lode mines processed, let alone the geographic advantages afforded by easy access to the lake. By 1870, the Cliff Mine was deemed unsustainable and sold the next year to an ownership group from Boston, headed by Marshall H. Simpson. For the rest of the decade, new management worked the Cliff at a reduced scale and then shut it down. The mine sat idle or saw limited work for the next twenty-five years.[35] Its stone-built industrial structures decayed and collapsed, leaving behind its collective waste to mark its pioneering activities.

The turn of the century saw a renewed interest in the Cliff, though as a site of mineral exploration, not as a working mine. The Tamarack Mining Company, a profitable venture working the rich Calumet conglomerate lode, initially purchased the Cliff lands for their vast timber stocks located along the newly constructed Keweenaw Central Railroad. Within a year, that interest shifted to the Cliff's mineral potential since improvements in rail transport meant small workforces outfitted with temporary surface plants supplied with coal, shipped from outside the district, could be moved around the property to test the sub-surface with diamond drills. The Tamarack hoped that, with a targeted geologic survey of the property, perhaps the Calumet conglomerate or other equally rich deposits could be found at the Cliff.[36] The Keweenaw Central Railroad's line, in places constructed with ballast from the Cliff's own waste rock piles, soon connected the once remote Cliff to the center of activities in the Portage Lake district. Newly mined ore was transported to the Tamarack mill on Torch Lake for processing, while newly raised waste rock soon dotted the various prospecting shafts on the property.[37]

Not interested in copper still contained within the Cliff's old waste rock piles, the Tamarack leased the deposits to a local resident, Henry Warren, for reprocessing. Warren constructed a small, eight-head gravity mill on the site of the now collapsed mid-nineteenth century mill. Worked sporadically from 1906 to 1919, Warren's mill produced 1,000-3,000 pounds of copper a year, somewhat obfuscating the original morphology and composition of the piles.[38] Abandoned in 1919, Warren's mill succumbed to fire seven years later, exposing its stamp batteries and washing tables to the elements before eventually being scrapped (figure 6).

The Tamarack venture only lasted six years, but activities at the Cliff were soon resumed by the Calumet & Hecla Mining Company (C&H), the Copper Country's biggest corporate concern. C&H believed regional consolidation and an understanding of the Copper Country's geology through a "comprehensive exploration program" was the key not only to its own survival, but also to the survival of the entire industry.[39] C&H purchased the Keweenaw Central Railroad, reopened and dewatered the Cliff's old shafts, and nearly doubled the depth of underground workings by use of pneumatic drilling in an effort to locate an "important lode deposit" that likely fed the "satellitic fissure ore bod[y]" that was the Cliff vein.[40] New waste rock was deposited over the earlier surface plants and waste piles of the mid-nineteenth century, marking (both

Figure 6. The remains of Warren's mill after the 1926 fire. The stamps, line shafting, and separating tables have yet to be scrapped. *Center left:* original mill's stone stack and engine foundations. Excavations to the right of Warren's mill revealed intact wood architecture dating from the 1860s under a layer of tailings. Photo courtesy of Michigan Technological University Archives and Copper Country Historical Collections.

Figure 7. The waste rock pile of C&H-era mineral explorations partially bury the stack of the Cliff Mine's No. 4 shaft engine house (to the right and just out of view). Photo by Sean M. Gohman, 2009.

Figure 8. The preserved wood remains of the Cliff mill's wash house, uncovered during excavations in 2011. *Upper right corner:* intact flooring and a step; *left:* subfloor plumbing; *upper edge:* vertical plank siding of Warren's mill, built five years after the original mill's collapse and destruction. Photo by Sean M. Gohman, 2011.

metaphorically and literally) the replacement of traditional mining techniques (hand trucking over low grade inclines and dumping at an ever-lengthening end point) with modern industrial practice (powered conveyors at steep inclines dumping at the apex) (figure 7). The hoped for lode deposit was never located, and the Cliff was shut down for the final time in early 1932.[41]

From the 1930s to the 1950s the whole of the native copper mining industry wound down. To stay in business, companies turned to recycling copper scrap and the reprocessing of reclaimed mill tailings. The Cliff's tailings, surveyed at 63,000 tons and assayed at 17.3 lbs. of copper per ton, were among several century-old Keweenaw district deposits targeted for reclamation.[42] Over a period of ten years, C&H conducted several studies looking into the viability and profitability of reclaiming the Cliff tailings, finally committing to a project in summer 1959. Sixteen trucks hauled up to 800 tons of tailings a day to a reclamation plant on Torch Lake. Through regrinding and flotation, recovery rates of 60-65 percent were achieved, though not all of the 63,000 tons were reprocessed.[43] Because removal was difficult, several thousand tons were left in place, creating a congested swamp of tailings and overturned topsoil.

The collective waste deposits of the Cliff were left untouched for the next fifty years. The local county road commission, viewing the rock piles as potential road fill, purchased the property in 1996. From 2010 to 2014, with the owner's permission and partially funded

by the Keweenaw National Historical Park's Advisory Commission, the Cliff was the site of an archaeological field school taught by Michigan Technological University's Department of Social Sciences. Students mapped the extent of waste deposits on the property, while excavations of the mill site identified evidence of both the mid-nineteenth century mill and Warren's twentieth-century structure (figure 8). Warren is believed to have buried the older mill in tailings in order to build atop it, and since C&H's reclamation efforts did not reclaim them, the tailings worked chemically to preserve the joists, floorboards, framing, siding, and equipment housings of both mills, a serendipitous occurrence first noted during a similar mill excavation project at the Ohio Trap Rock Mine—a Cliff contemporary in Ontonagon County—in the mid-1990s.[44]

Recently, the Cliff tailings became a target for environmental remediation. Though concentrations of copper were found to be acceptable for human exposure, the Environmental Protection Agency and Michigan's Department of Environmental Quality believe the tailings' high copper content poses a threat to the microinvertibrate fauna of the Eagle River necessary to support a trout fishery. In the fall of 2014, and after several years of cooperative study and planning with local stakeholders, a joint state/federal project removed the remaining tailings, stockpiled them at a safe remove from the river and the water table, and restructured the river to encourage a healthy trout fishery. Today, what remains (physically) of the Cliff's milling history is contained within the immediate vicinity of its mill ruins, since they now act as a preservative cap on its archaeological resources.

The collective mine and mill waste of the Cliff Mine, whose creation and exploitation spanned over a century and a half, contains within it the story of the Cliff itself, from its earliest days, to its maturity, decline, rebirth, reclamation, and remediation. Unfortunately, through remediation we have now lost some of the tangible link to the narrative of Cliff's milling practice, as well as the visual impact of that practice. Projects like the 2014 environmental remediation of the Cliff's tailings illustrate the need for a better understanding of the Copper Country's waste deposits and how they collectively tell an important facet of an industry's story.

Survey Overview and Methods

In the Summer of 2011, the Keweenaw National Historical Park's Advisory Commission, a volunteer board possessing its own granting capability that works in tandem with the National Park Service's mission, accepted proposals for the identification and evaluation of waste deposits (rock, tailings, and slag) from the historic native copper mining period (1840s to 1960s) in portions of the four counties that comprise Michigan's Copper Country: Baraga, Houghton, Keweenaw, and Ontonagon. Once identified and recorded, these deposits were to be evaluated against a rubric developed using both federally recognized standards of historic significance and integrity, and the locally specific needs and desires of the Advisory Commission. The results of the survey would be used to prioritize sites of mining-related waste for potential management and/or interpretation in

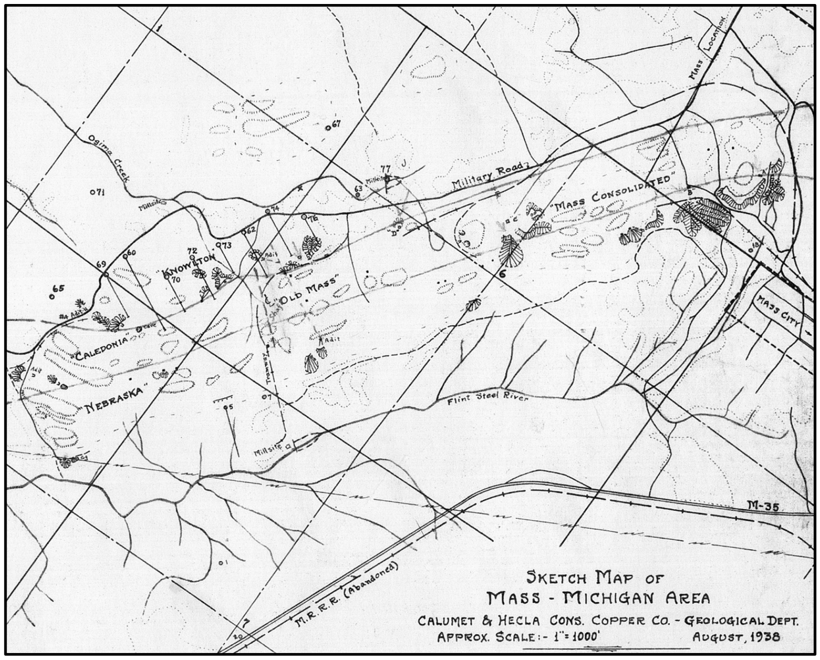

Figure 9. "Sketch Map of Mass—Michigan Area, C&H, Geological Dept., August 1938." Mapping surveys of abandoned mining lands during the 1910s–1930s were used to identify waste rock piles (drawn to look somewhat like clam shells) and stamp mill sites with their corresponding tailings. Map courtesy of Michigan Technological University Archives and Copper Country Historical Collections.

the future. Michigan Technological University's Department of Social Sciences was awarded the contract; the author conducted field investigations and wrote the report.

The mine-waste survey consisted of site identification followed by site visits, recording, and evaluation according to a project-specific rubric designed by the author. Site identification began with an archival search of historic documents and maps relating to historic mining activities. The Michigan Tech Archives and Copper Country Collections' holdings in Houghton helped to set the geographic parameters for field survey and to identify general mining locations. In many cases historical maps indicated specific shaft and mill locations, which were then charted onto modern topographic maps for use in the field.[45] Some historical maps even included waste rock deposits and, in one case, mill remains as well (figure 9). The author plotted these locations in a Geographic Information System (GIS) map that could be referenced as a check on fieldwork and points taken with handheld Global Positioning System (GPS) units.[46]

The author visited sites identified by archival maps and documents, noting features' size, integrity, current condition, and location relative to roads and trails. Each deposit was photographed to document size, shape, integrity, condition, etc. All deposits, regardless of size—from several hundred acres to fifty sq. ft.—were recorded with GPS coordinates. The author recorded 305 individual rock piles, five slag heaps, and fifty-seven tailings

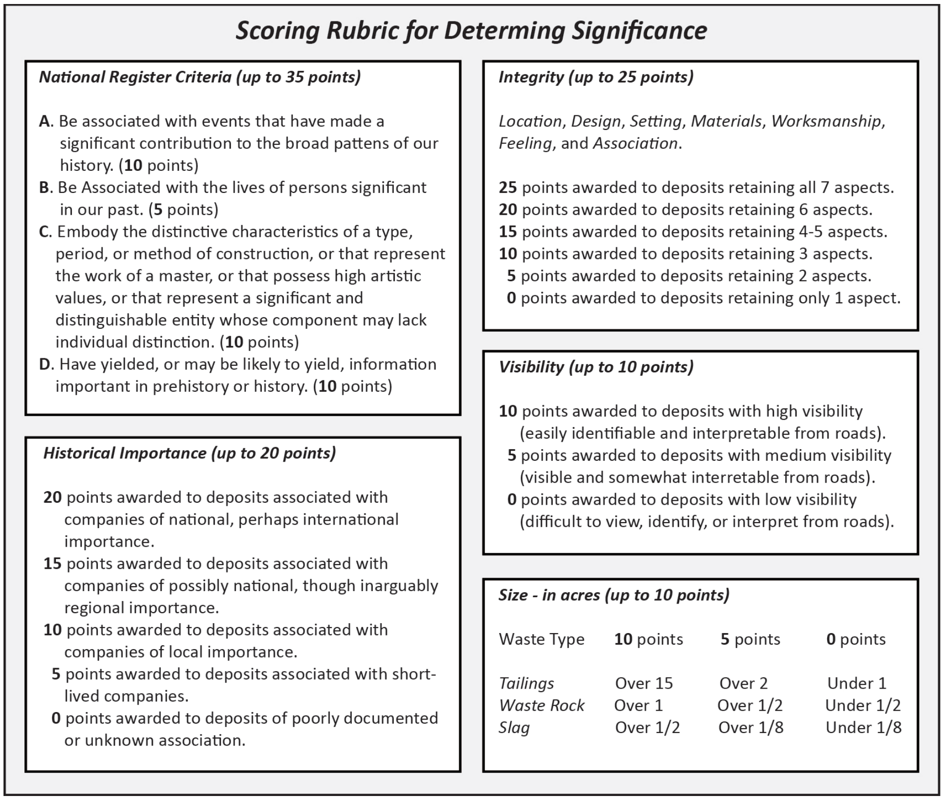

Figure 10. Scoring rubric and justifications for the project. Out of a possible 100 points, the highest awards were made to three deposits that each received ninety-five points. Chart by Sean M. Gohman, 2015.

deposits.[47] All recorded data, from field notes to GPS coordinates, were inputted to an ESRI ArcGIS software system.

Once plotted, each deposit was scored in a series of categories to evaluate its significance relative to the parameters set by the Advisory Commission (National Register Potential, Integrity, Historical Importance, Size, and Visibility). The location and accessibility of each deposit, as well as any immediate threat to it, were also considered though not included in the scoring. Category scores were then combined into the Total Overall score ranging from 0–100 (with any score 80 or above deemed Highly Significant). An outline (figure 10) shows the decision processes used for evaluating significance in each category.

Evaluating Potential

Prior to scoring, each deposit's cultural significance was evaluated, using the National Register of Historic Places Criteria for Evaluation to aid in those determinations.[48] If a deposit or site failed to potentially meet any of these four criteria, it was not considered

potentially significant and not scored. It should be noted that these evaluations were not designed to determine National Register eligibility, but rather to evaluate each site within the context of native copper mining in the Keweenaw.

National Register Criteria

Eligibility under Criterion A requires that the mining property or landscape connect with historic themes important to the broad patterns of American history at the local, state, or national level. At its height, the Keweenaw was the world's largest supplier of copper, and many of the industrial methods developed there provided a basis for large-scale mining elsewhere. The Keweenaw approached maturity prior to the arrival of railroads and economical coal. Small, early mines fueled by local timber, had shorter lives and made less money, but they had a great impact on future developments. Early mining properties like the Cliff Mine, devoted to the working of mass copper, changed understandings of the geological sciences, since native deposits such as these had never been encountered before. Early prfitable mines like the Cliff encouraged investment in the Keweenaw, leading to more mineral explorations, improvements in technology, infrastructure, and population growth. The coal-fueled operations which came to dominate the region: C&H, Copper Range, and Quincy, all dwarfed their predecessors in production and footprint, impacting the lives of at least five generations of Michigan citizens. From these companies and the towns they created, the Copper Country was truly born.

Criterion B, addressing a site's relationship with a historically significant person or persons, is the least likely criterion under which mining landscapes or waste deposits may fall. For the most part, the leading figures in Copper Country mining history didn't live near their waste deposits. The directors and presidents of nearly every mining company from the 1840s to the 1980s lived and worked far removed from Michigan. Important local engineers, mining captains, and union leaders did influence the engineering, managerial, and working practice for the area, but they also did not live near their poor rock piles or tailings deposits.

Criterion C is linked to human constructs that embody distinctive characteristics of a type, period, or method of construction. The past is further illuminated through understanding how people interacted within their built environments, and although this concept is often embodied in architecture, technical processes are also included. This is important to consider since a collection of structures, each indistinct on an individual level may become collectively distinct or representative when considered as a whole system. A rock pile may possess a shape representative of the technical process that created it, or it may lack this distinction but be associated with an assemblage of structures that together represent a distinctive method of creation, use, or process. In this way, waste may be significant individually *or* contribute as a part of a whole.

Criterion D is generally linked to archaeological potential. As previously mentioned, the copper infused tailings act as a natural preservative of delicate wooden remains found

Figure 11. Excavated wood remains of the Cliff Mine's stamp room (1851–c.1878). The mill's own copper-infused tailings were used to bury the mill during a period of renewed activity in the early twentieth century, preserving it until uncovered in 2011–2012. Photo by Mark Dice, 2011.

buried within them (figure 11). In the case of slag, the early history of copper smelting in the Keweenaw is poorly understood, and it is possible that early furnace remains are still waiting to be discovered, complete with trace evidence of early practices. Each deposit was scored based on how many Criteria under which they (may) be eligible.[49]

Integrity

Along with significance, a site must possess adequate integrity to be eligible for listing in the National Register. If a deposit met the broad requirements of National Register criteria but did not possess historical integrity, it was removed from scoring. But what determines integrity? Again, the National Register provides guidance for such determinations. The National Register recognizes seven aspects or qualities (location, design, setting, materials, workmanship, feeling, and association) that, in various combinations, de ne integrity. Each deposit was scored based on how many aspects of integrity they possessed.

Integrity of *location* simply means it has not been moved over time. For rock piles and slag this is generally a given, but in the case of tailings, these can move great distances via water action. Deposits of waste rock, tailings, and slag exhibit the integrity of *design* to the extent that they show the technologies humans used to put the waste materials in place as well as how their designers intended that they stay in place. Integrity of *setting* often reflects a moment in time. A waste deposit created in the nineteenth century but surrounded by modern development lacks a historical setting even though its location and

Figure 12. Mill tailings of the Mohawk (1898-1932) and Wolverine (1902–1925) mills at Gay which stretch (*right*) more than 1,500 ft. into Lake Superior. *Left:* Mohawk mill's smokestack. Photo by Sean M. Gohman, 2011.

design may be unaltered. Integrity of *materials* and *workmanship* are aspects concerned with practice: How were wastes deposited, and what materials were used in those depositions? The least tangible aspect of integrity is *feeling* because it is often dependent on a deposit's interpretation; evoking feelings through effective interpretation is the goal of any heritage entity. The final aspect of integrity to be considered is that of *association*.

Like considerations under Criterion C, an assemblage of associated period structures can enhance the integrity of a given waste deposit by enhancing its link to the historic past. If a waste deposit appeared to have the potential to be eligible under at least one of the National Register criteria and possessed integrity to a modest degree, sites were evaluated under three criteria developed for this project: historical importance, size and scale, and visibility.

Historical Importance

After determining significance and integrity, each of the deposits' historical importance (in relation to the collective history of native copper mining in the Keweenaw) was considered. Some are nationally important; others, notable only at the local level. Deposits were categorized as being: nationally/internationally important, regionally important but questionably important nationally, locally important, short-lived, or poorly documented/unknown.[50]

Size and Scale

For the most part, the size and scale of a mining waste deposit can influence its effectiveness in conveying mining's physical and environmental impact on the landscape. A half-acre tailings deposit does not evoke the same sense of awe or wonder for engineering as a 100- acre deposit. The same is true for rock and slag, though at different scales.[51] Deposits were categorized as large, medium, and small (figure 12).

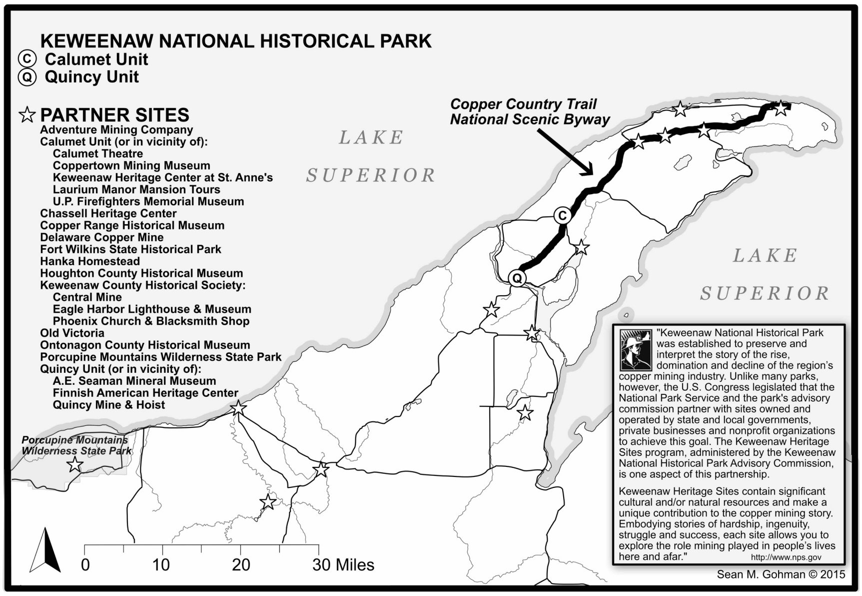

Figure 13. The Keweenaw National Historical Park, its Partner sites, and the Copper Country National Scenic Byway (from Houghton/Hancock to Copper Harbor). Calculating the proximity of deposits to these sites was important for both evaluation and interpretation of findings. Map by Sean M. Gohman, 2015.

Visibility

The final scoring category to be considered was the deposit's visibility. Most visitors will approach these deposits by road, many via the Copper Country Trail Scenic Byway. Is the deposit easily visible from a road, and/ or is it easily identifiable as a part of a larger mining landscape? A small tailings deposit off the beaten path, though still maintaining a sense of size and integrity, is not as potentially effective for interpretation as one of similar size and integrity located on the side of a major thoroughfare. Deposits were categorized as having high, medium, or low visibility.

Other Considerations

Beyond the scoring rubric, other factors must be taken into consideration when making determinations beyond significance. Although such factors were not scored in the study or included within the rubric, they were important for interpreting the results of the rubric, often reflecting the logistics of managing, preserving, and interpreting a site. In this case the two primary concerns are the *accessibility* of the deposit, and the *threat* to its integrity in the immediate future. Accessibility considers each deposit's proximity to the Keweenaw National Historical Park Headquarters in Calumet, the Park's partner sites, the Copper Country Trail Scenic Byway, other roads, and various trail systems.[52] A site may be visible, but still located far from those locations where interpretation and management will originate, while other sites may be in close physical proximity to these locations, but nearly invisible interpretively speaking, without some effort (figure 13).

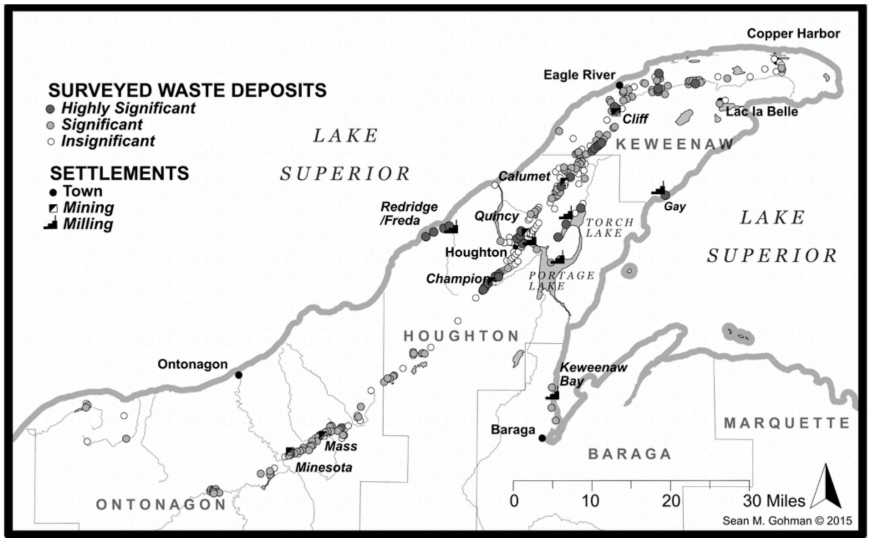

Figure 14. Map of surveyed waste, including highly significant, significant, and insignificant deposits. Note significant sites located in the historically highest producing area around Portage Lake, along Lake Superior, and at the sites of early mass mining in Keweenaw County. Map by Sean M. Gohman, 2015.

Threats to deposits include their potential removal or disturbance through remediation, commoditization, or logging activity. Each deposit was determined to possess a high, medium, or low threat to its preservation.

Results

Of the 367 deposits surveyed, and with the Advisory Commission's needs and wishes in mind, 229 were deemed Significant and scored. The mean score of the Significant deposits was ~53, with a median of 50. The highest score was 95 and the lowest 20, indicating a distribution leaning towards Significant. A threshold of 80 points was chosen to mark high significance, making 40 deposits (11 percent of surveyed sites) Highly Significant.

The first thing that struck the author was just how much mine waste there is in the Copper Country. Waste rock deposits are still present from Copper Harbor to western Ontonagon County, though as one moves from northeast to southwest the waste deposits tend gradually to have less integrity. While the mining activities of the Ontonagon district were substantial, milling and smelting activities were minimal in comparison with the other districts. Unfortunately, much of the waste rock in Ontonagon County, especially deposits associated with the district's most successful companies (Minesota, Mass Consolidated), has been removed for road fill and construction materials. Tailings are easily found along the shorelines of Lake Superior, Torch Lake, and Portage Lake, but

the amount of inland waterway tailings deposits was a welcome surprise, since their deposition was of smaller scale and (relatively speaking) poorly documented. Deep within the woods of Keweenaw and Ontonagon Counties, many small, nearly undisturbed tailings deposits exist, portraying the broad geographical distribution of mills in the Copper Country.

Of the 305 individual waste rock deposits, 177 were scored as Significant, and 23 were deemed Highly Significant (figure 14). Of all the waste types, rock piles had the widest range of scores due to the large sample size, their range in size/footprint, and their varying states of integrity. The deposits located within a few miles of Portage Lake are consistently near the top of the scored list, with those associated with the Quincy and Copper Range companies well represented. Two early leaders of the region, the Cliff and Central Mines, are found in Keweenaw County.[53]

Of tailings deposits, 57 were recorded, 41 met the scoring requirements, and 14 were deemed Highly Significant. Of these, many created by the same mill but distinctly sited (especially along rivers and streams) could be easily grouped into larger deposits but retained individual distinction for identification purposes. Because each section of a particular deposit may possess a different level of integrity and visibility, its individual parts were evaluated before considering them as a whole. Of particular note was the importance of *size* and *visibility* in those deposits deemed Highly Significant.

Although there were at least seven smelters (possibly nine) operating in the Copper Country, only three deposits of slag, all associated with the Quincy Smelter, were recorded and deemed Highly Significant. The other smelter locations, where slag would most likely be located, were either on private property, never actually fired, or were never confirmed during field survey.[54]

Conclusion

Michigan’s native copper industry was unique. It is the only place on earth where native copper, which does not require chemical processing for separation and refinement, has been mined on a large scale using both traditional and modern industrial methods. This makes the process of mining native copper more similar to the precious-metal mines of the American West than eastern districts devoted to coal and iron, or western non-ferrous metal mines. The Keweenaw was an early western mining frontier at a time when “The West” included everything beyond the Appalachian Mountains, and its place in the development of the West and hard rock mining technology is important to understanding the nation’s industrial history.

At the Cliff Mine, the narrative power of mine waste is evident. Early waste raised by animal power was soon replaced by larger quantities raised with the aid of wood-fired steam. Long after the mine ceased producing, it became the site of coal-fueled mineral exploration, and later had its mill tailings transported by truck for reprocessing and

deposition at a new location. Much of the historic built environment at the Cliff is still identifiable as ruins through which the lifespan of the mine can be retraced. The collective waste of the mine, however, adds depth, scale, and impact to that retracing. Losing sight of that depth would be a grave waste.

The author has not found other examples comparable to this project. Mines and mine waste can and have contributed to determinations of National Register eligibility, but to my knowledge, a comprehensive cataloging of an entire mining district's waste has not been done at this scale. The results of this project, while generated for a specific client with specific needs, could be adapted for other mining districts in order to increase understanding and appreciation of the potential for mine waste to historically interpret cultural resources.

Most historic hard rock mining districts may lack the relative benignity of the Keweenaw's mining waste, but through rigorous identification and evaluation, their stories of operational scale and environmental impact can find representation as well. Industrial residues, be they mine waste or otherwise, may not always be safe, but finding an appropriate way to experience and understand them should not be overlooked.

Acknowledgements

The author would like to thank the Keweenaw National Historical Park and, specifically, its Advisory Commission for the opportunity to take part in this survey. The work allowed me to traverse the entirety of Michigan's Copper Country and provided a level of interaction and understanding with its living landscape that now informs all of my subsequent research. Special thanks is also given to Mark Dice, MS student of Industrial Archaeology at Michigan Technological University, for assisting in field work, taking photographs, and offering much valued company during several weeks of long drives, hikes, and climbs over Michigan's Copper Country.

Notes/References

[1] Bode J. Morin, *The Legacy of American Copper Smelting: Industrial Heritage Versus Environmental Policy* (Knoxville: University of Tennessee Press, 2013); Fredric L. Quivik, "Integrating the Preservation of Cultural Resources with Remediation of Hazardous Materials: An Assessment of Superfund's Record," *The Public Historian* 23, no. 2 (Spring 2001): 47–61.

[2] Much of this paper is adapted from the author's project, "Identification and Evaluation of Keweenaw (Copper Country) Mine Waste Including: Tailings, Waste Rock, and Slag Deposits in Parts of Baraga, Houghton, Keweenaw, and Ontonagon Counties, Michigan" unpublished report prepared for the Keweenaw National Historical Park's Advisory Commission, Calumet, MI, 2012. As per an agreement with the Advisory Commission, certain details and specific findings must be omitted from this paper.

[3] Richard V. Francaviglia, *Hard Places: Reading the Landscape of America's Historic Mining District* (Iowa City: University of Iowa Press, 1991), xvii.

[4] William Bryan Gates, *Michigan Copper and Boston Dollars: An Economic History of the Michigan Copper Mining Industry*, *Studies in Economic History* (Cambridge: Harvard University Press, 1951), 199–200. From 1845–1946, the Copper Country produced over 315 million tons of tailings and slag. When considering the additional volume of waste rock, well over half a billion tons of mining-related wastes were left on the Copper Country's landscape.

[5] Fredric L. Quivik, "The Historical Significance of Tailings and Slag: Industrial Waste as Cultural Resource," *IA: the Journal of the Society for Industrial Archeology* 33, no. 2 (2007): 35–52; Bruce J. Noble, Jr., and Robert Spude, *Guidelines for Identifying, Evaluating, and Registering Historic Mining Properties*, National Register Bulletin no. 42 (Washington, DC: National Park Service, 1997).

[6] Pierre Radisson, *Voyages of Peter Esprit Radisson, Being an Account of His Travels and Experiences Among the North American Indians, from 1652 to 1684*, ed. G. D. Scull (Boston, MA: Prince Society, 1885), 191–192; Reuben Thwaites, *The Jesuit Relations and Allied Documents Travels and Explorations of the Jesuit Missionaries in New France, 1610– 1791*, ed. E. Kenton (New York: Albert & Charles Boni, 1925), 305–327.

[7] Charles T. Jackson, *Report to the Trustees of Lake Superior Copper Company November, 1845* (Boston, MA: Beals and Greene, 1845), 3–10.

[8] *Report of the President and Directors of the Pittsburgh and Boston Copper Harbor Mining Company* (Pittsburgh: George Parkin & Co., 1849), 3–10; James K. Jamison, *The Mining Ventures of This Ontonagon Country* (Ontonagon, MI: Ontonagon Herald Co., 1950), 69. The Minesota Mine's unique spelling (with one *n* instead of two, though still pronounced like the state) is generally attributed to a clerical error during the company's initial organization.

[9] David J. Krause, *The Making of a Mining District: Keweenaw Native Copper 1500–1870* (Detroit: Wayne State University Press, 1992), 205. Mining, milling, and smelting activities were all underway in Keweenaw County by the mid-1840s.

[10] Ibid., 222.

[11] B. S. Butler and W. S. Burbank, *The Copper Deposits of Michigan* (Washington, DC: U.S. Government Printing Office, 1929), xii.

[12] The rich sulfide ores found near White Pine and located within the Nonesuch Shale was first tackled in the 1860s by the Nonesuch Mining Co. In 1887 those efforts met with little success. C&H made another attempt in 1912, but gave up after a decline in copper prices. In 1955, the Copper Range Co. opened the White Pine mine, built a modern company town, and worked the deposit for forty years. Today the White Pine Mine's tailings cover an area of 5,600 acres, the largest copper-related waste deposit in western Upper Peninsula, Michigan.

[13] Bode J. Morin, "Reflection, Refraction, and Rejection: Copper Smelting Heritage and the Execution of Environmental Policy," PhD diss., Michigan Technological University, 2009, 130.

[14] Located to the south and east of Houghton County, Baraga County is not generally considered a part of the Copper Country. Although it never saw organized copper mining, two stamp mills were located on Keweenaw Bay, and therefore its landscape bears the residues of the mining industry.

[15] In this case, refinement is in the form of melting as opposed to smelting. Because native copper is 99 percent pure metal, it needs, if any, little refinement. For the purposes of historical continuity, however, the term smelting is used.

[16] The hammer and rock drill were used to bore holes for explosives, while chisels were used to cut large masses of copper into manageable pieces. While efforts in both districts focused on veins of mass copper, the nature of those veins were quite different. In the Keweenaw, veins ran perpendicular to the surrounding geology; in the Ontonagon District, the veins ran parallel and therefore over much longer stretches of ground, allowing for a larger number of potential rich strikes on a given property.

[17] Gates, *Michigan Copper and Boston Dollars*, 7–8 (see n. 4); Larry D. Lankton, *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines* (New York: Oxford University Press, 1991), 16.

[18] Charles K. Hyde and Larry D. Lankton, *Old Reliable: An Illustrated History of the Quincy Mining Company* (Hancock, MI: Quincy Mine Hoist Association, 1982).

[19] C. Harry Benedict, *Lake Superior Milling Practice: A Technical History of a Century of Copper Milling* (Houghton, MI: Michigan College of Mining and Technology Press, 1955), 11.

[20] Ibid., 41–53.

[21] Ibid., 58–59.

[22] "Letter from the Secretary of War, in Response to a Resolution of the House of Representatives, Transmitting a Report Relative to the Deposit of Silt and Sand in Portage Lake, Michigan," in *Index to the Executive Documents of the House of Representatives for the Second Session of the Forty-Seventh Congress 1882–83*, No. 85 (Washington, DC: Government Printing Office, 1883), 103; Benedict, *Lake Superior Milling Practice*, 36–38 (see n. 19).

[23] The C&H Mining Co. built the first stamp mill on Torch Lake in 1868 and held a monopoly of tailings production there for nearly two decades.

[24] Larry D. Lankton, *Hollowed Ground: Copper Mining and Community Building on Lake Superior, 1840s–1990s* (Detroit, MI: Wayne State University Press, 2010), 147, 249; Horace J. Stevens and Walter Harvey Weed, eds., *Mines Register,* vol. 5 (Houghton, MI: Horace J. Stevens, 1905), 831; Lankton, *Cradle to Grave*, 253 (see n. 17).

[25] Horace J. Stevens, *The Copper Handbook: A Manual of the Copper Industry of the World*, vol. 8 (Houghton, MI: Horace J. Stevens, 1908), 920. The Mass Consolidated Mining Co. consisted of the former Mass, Knowlton, Butler, North Butler, Evergreen Bluff, Ridge, and Ogima mines which all operated during the 1850–60's.

[26] Ibid., 943.

[27] Krause, *The Making of a Mining District*, 206 (see n. 9).

[28] Charles T. Jackson, *Report on the Geological and Mineralogical Survey of the Mineral Lands of the United States in the State in Michigan, Made under the Authority of an Act of Congress, Approved March 1, 1847* (Washington: Printed for the Senate, 1849), 443–444; Patrick Martin, "Technical Report on Archaeological Survey and Evaluation, Isle Royale National Park, 1986, p. 15, report prepared for Isle Royale National Park, available at Dept. of Social Sciences, Michigan Technological University, Houghton, MI; James B. Cooper, "Historical Sketch of Smelting and Refining Lake Copper," *Proceedings of the Lake Superior Mining Institute* 7 (1901): 44; Donald Chaput, *The Cliff: America's First Great Copper Mine* (Kalamazoo, MI: Sequoia Press, 1971), 18.

[29] Larry D. Lankton, *Beyond the Boundaries: Life and Landscape at the Lake Superior Copper Mines, 1840–1875* (New York; Oxford University Press, 1997), 119.

[30] Bode Morin, *The Legacy of American Copper Smelting: Industrial Heritage Versus Environmental Policy* (Knoxville: University of Tennessee Press, 2013), 15–27.

[31] Cooper, "Historical Sketch of Smelting and Refining Lake Copper," 46 (see n. 28); Gates, *Michigan Copper and Boston Dollars*, 43 (see n. 4).

[32] Lankton, *Hollowed Ground*, 225 (see n. 24).

[33] Joseph W. V. Rawlings, "Recollections of a Long Life," in Roy W. Drier, *Copper Country Tales* vol. 1 (Calumet, MI: Roy W. Drier, 1968), 105–115; Benedict, *Lake Superior Milling Practice*, 14–15 (see n. 19).

[34] Production numbers from Annual Reports of the Pittsburgh & Boston Mining Co., various years 1848–1870.

[35] Charles E. Wright, *Annual Report of the Commissioner of Mineral Statistics of the State of Michigan* (Lansing: W. S. George & Co., 1881), 19–20; *Portage Lake* (MI) *Mining Gazette*, 1 May 1879.

[36] Stevens, *The Copper Handbook*, 748–751 (see n. 25).

[37] *The Mining Gazette* (Houghton, MI), 29 September 1907; Benedict, *Lake Superior Milling Practice*, 38, 52 (see n. 19).

[38] Stevens, *The Copper Handbook*, 1302 (see n. 25); Cash Records of the Cliff Mining Co., 1910–1931, MS-002, C&H Collections, folder 5, box 319, Michigan Technological University Library Archives and Copper Country Collections, Houghton, MI (hereafter MTU Archives).

[39] Butler and Burbank, *The Copper Deposits of Michigan*, 3 (see n. 11); Lankton, *Cradle to Grave*, 251 (see n. 17).

[40] Annual Report of the Cliff Mining Co. (1927), 2–3.

[41] Annual Report of the Cliff Copper Co. (1932), 2.

[42] Works Progress Authority, map of Cliff mill tailings (2 August 1943), MS-002, C&H Collections, folder 12, box 86, MTU Archives.

[43] G. L. Craig to A. S. Kromer, Memorandum "Status of Pilot Plant Tests on Oxidized Tailings," 19 January 1955, MS-002, C&H Collections, folder 12, box 86, MTU Archives.

[44] David B. Landon and Timothy A. Tumberg, "Archaeological Perspectives on the Diffusion of Technology: An Example from the Ohio Trap Rock Mine Site," *IA: the Journal of the Society for Industrial Archeology* 22, no. 2 (1996): 40–57. The preservative properties of copper tailings were further supported during excavations of the Cliff Mine's stamp mill by Michigan Technological University's Department of Social Sciences, 2011–2012. Findings and photographs can be accessed via the project's blog at cliffmine.wordpress.com.

[45] An extremely useful source for site identification is Butler and Burbank, *The Copper Deposits of Michigan* (see n. 11), which details mine properties, years of operation, geologic matrices excavated, and shaft depths. This document also contains a series of plates that detail the exact location of mine shafts for multiple companies, including many long dormant before 1929.

[46] Geographic Information Systems, or GIS, is brie y defined as a computer application used to store, view, analyze, and create geo- graphical information.

[47] At times, multiple apparently discontinuous deposits related to one mill were recorded due to their dispersal along shorelines and lengths of river.

[48] To be eligible for listing in the National Register, sites must qualify under at least one of four criteria: A) be associated with events that have made a significant contribution to the broad patterns of our history; B) be associated with the lives of persons significant in local, state, or national history; C) embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose component may lack individual distinction; or, D) have yielded, or may be likely to yield, information important in prehistory or history. See *How to Apply the National Register Criteria for Evaluation*, Bulletin 15 (Washington, DC: Government Printing Office, 1990).

[49] As there was not enough time to appropriately evaluate each deposit for National Register eligibility, these decisions should not be taken as eligibility designations. The Advisory Commission desired a list of *potential* National Register eligible properties, and the decisions made for this project were made only with that goal in mind.

[50] Companies like C&H are arguably nationally and internationally important. The Adventure Mine, a fairly unsuccessful but well-known and long-running producer in Ontonagon County is an excellent example of a regionally important operation. See Dianne R. Portfleet, *Adventure Mining Company Since 1850: A History of the Adventure Mining Company from the Ancient Miners to the Present* (Grand Rapids, MI: Greenleaf-Witcop Press, 2005), 143–181. Another Ontonagon mine, the Toltec, was active in the 1850s and fits the short-lived category. See Wright, *Mineral Statistics*, 99–103 (see n. 35).

[51] For each deposit type, a different range in sizes was used to determine large, medium, and small deposits. A large slag heap (1/2 acre) would only be considered a medium-sized rock pile and a small tailings deposit.

[52] The Keweenaw National Historical Park (KNHP) possesses a unique management structure within the National Park System. Rather than owning and operating large parcels of land and resources, KNHP enters into partnership agreements with previously existing, independent owners and operators of historic sites. KNHP, in conjunction with its volunteer Advisory Commission, offers guidance and funding to these partner sites, while allowing the sites to operate under their own charters. As of publication, KNHP and its Advisory Commission have twenty-one partner sites within their roughly 800,000-acre sphere of influence.

[53] Sadly, in the last several years these Keweenaw County tailings deposits have been targets of environmental remediation. The issue spurring remediation was to restore or increase the biodiversity of the Eagle River and its tributaries, especially trout. Running parallel to the copper-bearing ridge that traverses the Keweenaw Peninsula, the Eagle River was home to several milling operations, large and small. Three projects have taken place at the Central mine site (from 2011–2013) that have either added vegetative cover to the tailings, or removed them altogether, while another removal occurred at the Cliff mine site in the fall of 2014. At the conclusion of fieldwork, however, these deposits still possessed a high level of integrity.

[54] The Michigan Smelter at Cole's Creek and Dollar Bay's Lake Superior Smelter on Portage Lake are located on private, non-accessible property. The Mendota Smelter at Lac la Belle was never put into operation. The locations of the Suffolk and Albion smelters in Keweenaw County and a short-lived, 1860's operation in Ontonagon were never confirmed (see n. 25).

Discussion

Industrial Archaeology, as practiced, is comprised of a toolkit consisting of artifact, technological, landscape, and economic analysis combined with the ability to contextualize those analyses into a coherent historical narrative for the purposes of assessment, and potentially, preservation. Documentation and analysis carried out by industrial archaeologists speaks to agency, invention, and significance. Industrial Archaeologists document the order and process of industrial production, but the mental and physical processes of the worker as well. They not only identify and interpret the significance related to sites of extraction, production, and consumption, but also to those of waste disposal and management.[1] Spatially, industrial archaeologists are adept within sites of large scale, geographically linked resource management, as well as small-scale sites of technological perseverance in the face of limited capital and geographic isolation.[2]

Going forward, the discipline will have to add to that toolkit an understanding of impacts resulting from the transition from cyclical sources of power (wind, water) to seemingly superabundant sources of power for industrial purposes (fossil fuels, nuclear). This adheres to a view of industrial processes, the environment, and human agency as interconnected technological, ecological, and social systems. These systems take place upon the landscape, and it is within these enviro-technical landscapes that myriad social, economic, and technological questions must be asked. The answers from these questions will result in complex narratives that should, in a discipline that wants to be more than merely a practical exercise, contribute to the reinforcement of identity and shared ownership of our messy extractive past.

Over the course of the mid-nineteenth century technological advancements aided by the increased thermal energy potential of fossil fuels led to scalar changes in American industrial production.[3] These changes came to the Copper Country somewhat later than other areas due to transportation limitations and an abundance of readily available and cheap wood fuel, but when they did it created curious spatial dichotomies. Coal, or rather, coke-fueled steel production and regional railroads (arriving in the Copper Country in 1883, a full forty years after the onset of copper mining in the region) expanded the reach of native copper mining interests all the way to coal producing areas back East.[4] At a smaller, more localized scale, this transition allowed and encouraged the rearrangement of surface plants, since ore processing mills no longer had to be placed in close proximity to the mine itself. Rails connected to coal docks meant that mills could be placed near the water's edge, sometimes miles from their associated mine sites and the timberlands they were once dependent upon. Coal and rail also permitted the shuffling of labor and equipment around the region in an attempt to discover new disseminated lodes with minimal on-site investment.

The higher thermal temperatures provided by burned coal also increased the power potential of steam machinery.[5] At the mine, this allowed for the consolidation of surface plants as more powerful engines, connected to an ever-expanding network of steam

conduit, could drive more machinery housed over larger footprints. At the mill, greater power meant larger volumes of rock could be processed, leading to subsequent increases in copper barreled and mill waste tailings. As the footprint of coal-dependent lode mining grew, efficiency and specialization produced a larger array of small islands of industrial activity, while simultaneously creating larger industrial assemblages and more widely dispersed spatial footprints of impact.

This kinetic restructuring of the Copper Country was made possible due to gradual changes in transportation capabilities both on water and land, as well as technological innovations. At the start of the industry, the falls of the St. Mary's River, separating Lakes Superior and Huron, acted as a pinch point against the economical transportation of heavy machinery and mass quantities of goods. The irregular quantities of mass copper produced in the first decade of the industry could be portaged overland around the falls, but when quantities increased, it necessitated a technological solution. The opening of the Soo Locks in 1855 allowed for larger steamships to traverse Lake Superior, opening the way for increased shipping.

Within another decade, the expansion of copper mining to the interior of the Keweenaw Peninsula, and centered around the protected shores Portage Lake, produced a new transportation problem. Portage Lake was connected to Lake Superior by a narrow channel on its southern end, too shallow for steamships, that required the unloading and reloading of materials entering and leaving the interior. The Portage Canal, first begun at the southern end in 1860 (and eventually the northern end by 1874), opened up what would become the new focus for copper mining in the later third of the nineteenth century.

With the newly created Keweenaw Waterway came an increase in mining and milling activity on it, along with a hitherto inaccessible supply of coal. The reciprocal relationship between coal supply and increased production in turn increased waste output in the form of mill tailings. These *stamp sands* eventually choked the waterway to the point that milling activities had to be moved off of it. Fortunately, a third canal, begun not long after the Portage Canal and connecting Torch Lake to Portage Lake, allowed for the establishment of milling activity along another protected shore out of the way of shipping traffic. Here, incoming coal, outgoing copper, and disposed stamp sands could move freely.

Finally, and much later than in other parts of an industrializing America, the Copper Country was connected to the rest of the nation via rail in the early 1880s. Narrow gauge, company-owned lines had been in operation for quite some time in the region, and initially, regional connecting lines had little impact on the mining industry beyond passenger transport. In time, and especially by the early twentieth century, rail expansion would come to restructure the industrial landscape again, as former mass mines were reestablished as islands of industrial activity connected to Portage and Torch Lake via coal-fueled rail.

In *Routes of Power* (2015), Christopher F. Jones tackles America's transition from organic to mineral energy by examining three areas of impact: infrastructure, supply, and social change. The creation of transportation systems for the delivery of energy established *landscapes of intensification* that, much like the relationship between milling and coal use mentioned above, operated reciprocally. Without the infrastructure, there would be little need for the supply. And with the supply, the infrastructure must be maintained and expanded.[6] In the Copper Country, the landscape of intensification brought about by the cutting of canals and locks altered the extractive and processing capabilities of the region's lode mines, whose production was just beginning to replace that of the older mass mines that put the region on the map. For the next several decades, the mines located around Portage Lake dominated activity, and for a time drained the northern and southern ends of the Copper Country of people and work until rails allowed for exploratory expansion to return to those abandoned areas.

The small and specialized islands of industry that resulted from this coal-fueled kinetic restructuring of the native copper mining landscape extended the notion of what an extractive lifespan is in the Copper Country. Marginal areas, once teeming with activity but now sparsely populated and rural, looked to be on the rebound. It was believed these areas would once again possess value, and spread the urban wealth found at the center of the Copper Country to the rural Keweenaw and Ontonagon regions. Though while coal-fueled technologies and rail transportation increased the rate of mined materials, these activities were manned by small numbers of laborers when compared to activities of a few decades earlier. And due to rail transportation and the consolidated structure of mining in the twentieth century, the profits of these activities were not shared in these marginal areas. The persistence of mining was evident, but the scale of local impact had changed, making that persistence less alluring.

Today, fracking and gas drilling offer similar tales of hope in the development of marginal areas. But again, the persistence of extraction does not mean sustained success. Improvements in geological understanding and technological innovations turn attention to and from areas of exploitable resources of fossil fuel. These modern islands of activity, also manned by small and mobile labor forces, have not spread wealth to rural regions, but instead to corporate offices located at a far remove from these activities. But as society enters into a new energy transition, away from fossil fuels and returning to sustainable sources of energy, understanding the persistence of extraction becomes ever more important. Just as the mass mines of the Copper Country persisted in exploiting wood fuel, today's industries persist in the use of fossil fuels. By the time the mass mines passively accepted coal as an industrial fuel source, it was too late. What lessons for today's industrial society can be found in that story?

Mining sites exploited in Antiquity and earlier are still receiving attention by global mining firms today. In the Copper Country itself, evidence of prehistoric mining stretches back several thousand years, and newly capitalized ventures are seeking leases to explore lodes of copper sulfide ores and kick-start a new phase of local mining activity. Over millennia and across the globe, needs, technologies, and methods evolved that allowed

humans to return time and time again to areas of seemingly exhausted resource supply to successfully re-open them.[7] In most cases, the gradual progression of that persistence is growth, be it in scale of operation or expense. The transition from organic to fossilized energy sources both dramatically expanded that growth, while also allowing for the exploitation of areas incompatible with organically-fueled industrial enterprise.

The copper mining industry of South Australia is one such incompatible locale. Its 1840s beginnings are contemporaneous with the start of activities in the copper country, though mining in South Australia was focused on complex copper ores requiring chemical processing (smelting, not just melting), and situated in an area lacking sufficient sources of wood fuel. While its distance from markets was greater, the advantage of year-round, open-ocean shipping combined with necessity set South Australia up for fossil fuel dependence several decades earlier than in the Copper Country. As early as 1846, coal delivered from Newcastle, England made its way to Adelaide and the copper mines of South Australia's "Little Cornwall."[8] As a result, and similar to Portage and Torch Lakes, the shorelines of South Australia connected to mining activities in the interior rapidly intensified both to accommodate coal as well as to set up coal-fueled ancillary industries, though again at a more rapid pace. The persistence of extraction created similar spatial relationships in Little Cornwall and the Copper Country, though at different paces due to the supply of affordable and accessible fuel.[9]

The kinetic restructuring of Little Cornwall and the Copper Country for the purposes of coal-fueled extraction provides lessons for other areas of industrial landscape study. From the linear development of rail depots in America's grain belt, to the spatially similar arrangement of oil and gas pipelines, transitions in fossil fuel use and supply have altered the view of a landscape's potential from one being bound by its finite and sustainable resources, to one exhaustible thanks to superabundant outside resources. A productive landscape is no longer tied to its local resources, but rather its ability to connect to transportation networks and other markets. The mass mining communities of the Copper Country, unwilling or unable to connect to the networks that were most advantageous to the landscape's success (rail, inland lake traffic), were incapable of surviving even as their own resources were still accessible. And by the time those networks expanded to reach them, market forces prevented their successful extraction.

The Copper Country's Potential (For Research)

To repeat, changes in infrastructure and coal accessibility dramatically altered the Copper Country's landscape, and that alteration is deserving of more study. A wood-fueled and remote industry became a coal-fueled and intensified one within a few decades. Archaeologically, this change over time can be seen most clearly in the lakeshores of Portage and Torch Lakes, both in its built environment, and its stamp sand waste deposits. Further research should examine those aforementioned technological breakthroughs that opened up the Copper Country to a supply of coal that, in turn, helped to speed up the intensification of the Copper Country's landscape. Evidence of this

intensification can be found both in the archives and on the ground, and an archaeological approach that builds off the documentary evidence could illuminate the significance of energy transitions in the shaping of cultural landscapes.

The spatial dimensions of this transition open another area for further inquiry. The collection of historical maps related to nineteenth century native copper mining activities and housed at the Michigan Technological University Archives and Copper Country Collections, is vast. There is incredible potential to digitize, store, reference, and ultimately analyze not only changes in the Copper Country's landscape over time, but also what locations, activities, and features were deemed worthy of documenting. The Copper Country Historical Spatial Data Infrastructure and Keweenaw Time Traveler (CCHSDI and KeTT), while still in its infancy, must expand beyond the historic Sanborn Fire Insurance maps covering 1880s-1940s upon which its Geographic Information Systems is built, to include earlier historic imagery to broaden the temporal scope of the project.[10] As it stands, CCHSDI and KeTT echo the traditional, late-nineteenth century starting point narratives of the Copper County. The mining maps of the mass mining era, while more difficult to digitize accurately, are key to understanding those early visions of potential for the Copper Country, and how those early visions were modified as energy sourcing and practices changed.

Geographic Information Systems can also offer analytical tools to studying the activities of mass mining. Knowing the ownership footprints of mining companies, combined with historic data regarding forest types, archaeologically identified transportation networks, and topographic modeling could shed light on the decisions companies made about supplying their energy needs, as well as the limits to the harvesting of economical timber fuel.

Another area of research that emerged through the writing of this dissertation is the period of geological inquiry that followed the consolidation of Calumet & Hecla's disparate mining ventures into one corporation in 1920. Looking to expand attention to the possible continuation of known disseminated lodes in formerly abandoned areas of mass mining, C&H Consolidated, along with the USGS and other, undertook a nearly decade-long survey of the region's continued copper mining potential. This work was the largest directed geologic examination of the area since the Houghton and Jackson led surveys of the 1840s, and it was hoped its impact—the opening of new sites of copper extraction and a boon to regional development—would be similar. Unfortunately, the findings were never given much time to be substantiated on/under the ground. The Great Depression of the 1930s put a stop to wide-ranging exploratory work in favor of a contracted focus on proven workings.

The resulting report, *The Copper Deposits of Michigan* (1929) is a treasure-trove of geological, historical, and spatial data, but as of yet, the story of the report's creation, and its impact at the time, have yet to be fully studied. Again, the KTT is one avenue for combining the report's spatial data with other contemporary datasets, but the real potential lies in the examination of the engineers and geologists involved in the work.

Much like *Lake Superior Milling Practice*, *The Copper Report* illuminates the technical expertise of twentieth century copper milling, a similar study of geological understanding in the 1920s could bookend the 1840s debates over native copper detailed in Krause's *Making of a Mining District* (1992).[11]

Finally, it must be mentioned that perhaps an argument can be made that the era of mass copper mining, which in this dissertation has been described as a formative stage in a much longer story of the Copper Country's extractive lifespan, is itself a mining era deserving its own, separate lifespan of formation, development, maturation, restructuring, and divestment. The practices of mass copper mining did inform later disseminated lode mining practice, but its geographic spread, resource demands, spatial arrangements, and impact on the world copper market also set it apart from the intensified activities of disseminated lode mining. At one stage in this dissertation's development, that argument was going to be made, and this author believes the case for it is strong. This author did attempt to apply that argument to the singular site of the Cliff in *The Cliff… Revisited*, with some success, but for the purposes of this dissertation, discussions of lifespan required a larger context. Perhaps making that site level argument is the next step, or, is it enough to demonstrate that this formative period of extractive practice deserves a focus equal to that given the periods that followed it, while keeping it within a larger temporal continuum?

Conclusion: A Living Landscape of Native Mass Copper Mining

This dissertation makes several arguments about mass copper mining's place in the extractive lifespan of the Copper Country: that the landscape of mass mining demands attention due to its physical isolation, the extractive practices utilized to exploit a unique mineralogical deposit, and a dependence upon organic sources of energy to complete those practices; that when those factors were mitigated during the rise of disseminated lode mining and the technological innovations that came with it, the landscapes of mass mining were given new extractive lives; and that it is in the collective wastes of this landscape that industrial archaeology can best identify, interpret, preserve, and appreciate these practices.

This dissertation concludes with an argument borrowed from *The Cliff… Revisited*, within which the second chapter of this dissertation is printed, that the Cliff's extractive landscape is not a memorial to past activities, but rather a living landscape. This dissertation illustrates what makes it a living landscape is its persistence in the public's minds, and the continued potential envisioned for it. When mining began there in the 1840s, the Keweenaw Peninsula and what would become the Copper Country was, practically speaking, merely a formative landscape of envisioned potential. The Cliff's quick success encouraged further region-wide development, and that potential was slowly realized. When activities at the Cliff first ceased around 1880, other areas of the Copper Country carried on, pushing the area into a period of industrial intensification and maturation. And furthermore, the Cliff's first closure did not mark the end of the mine's

significance in the minds of the public, as it became a favored site for visitors and those enthralled by the Keweenaw's pioneering past.

Two failed redevelopment projects in the first third of the twentieth century prolonged the Cliff's extractive lifespan. With the laying of the Keweenaw Central Railroad in 1906-07, the once abandoned Cliff site found itself as a hub on a line that connected to Calumet, Portage Lake, and ultimately, the rest of America. The Tamarack Mining Company (and later, C&H) supplied small teams of diamond drill operators and miners with coal from afar in the hopes of identifying new disseminated lodes intersecting the Cliff vein. These redevelopment projects ultimately failed, and it has been shown that they would not have been made possible without changes in both energy transformation and technological accessibility. These changes in practice and the targeting of new mineral deposits at the Cliff echoed the structural changes the Copper Country underwent in the 1880s as wood-fueled mass mines located at the extreme ends of the peninsula (such as the Cliff) were overtaken by centrally-located coal-fueled lode mines.

Yet again, the reclamation of much of the Cliff's tailings in the 1960s did not mark the end of the Cliff's significance in the minds of the public. Archaeological investigations of the site in the 1970s and 2010s also drew attention from the public, and later informed remediation efforts at the mine site. The Cliff today, a site of interest for heritage practitioners, foresters, environmental scientists, and the general public, represents the cooperative possibilities between preserving and learning from cultural and natural resources. Though the landscape of the Cliff may sit idle for periods of time, it's historical and contemporary resources seem to draw attention. As perhaps the best site to represent mass copper mining surviving today, the Cliff is an interpretive proxy for activities that took place over a hundred mile stretch of the Copper Country, as well as offers lessons about the often-protracted declines of mining landscapes. Other mass copper mining sites of lesser importance may, in the future, add further depth to our understandings of both this formative period of extractive practice and that protracted decline. But for now, the Cliff's living landscape will—as it has admirably for decades—have to do.

Notes

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[10] You can access the Keweeanaw Time Traveler at: http://www.keweenawhistory.com

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