

**LEARNING TO SEE: VISUAL TOOLS IN AMERICAN  
MINING ENGINEERING, 1860-1920**

by

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# Abstract

The period between 1860 and 1920 saw the development of mining engineering as a profession, with journals, societies, and university programs. At the same time, mining engineers, as a group, gradually assumed more control over mining operations, both by being employed by more firms and by having greater responsibilities within mining companies. Mining engineers used visual tools – mine maps, blueprints, photographs, and models – to help them do their work. The creation and control of visual tools represents an important piece of the story of the professionalization of mining engineers that has hitherto gone largely unnoticed. I argue in this dissertation that if we are to understand the ability of mining engineers to increase efficiency, we need to understand the tools that they used, including visual tools. Mining engineers gradually learned how to make and use maps, photographs, blueprints, and models to help them gain greater control over work, information, the law, and public opinion. These visual tools were an integral part of the everyday work of mining engineering by the end of this time period.

I examine each type of visual tool in turn, using specific historical examples. The Pennsylvania anthracite coal mines of Coxe Brothers & Co. allow me to trace the evolution of underground mine maps. Two Michigan copper mines, the Quincy and the Calumet & Hecla, help me explain how the advent of blueprint technology changed work and organization practices at the mines. My examination of three dimensional mine models begins with an overview and examples of their primary forms, then I use a mining law case from Tonopah, Nevada in 1914 to see how models and maps were used in the courtroom. Next, I focus on the topic of mine safety, using examples from anthracite and bituminous coal mines, to trace how managers used safety photographs to direct the work of miners. I then move outside the scope of individual mining companies and relate the project of the United States National Museum to explicitly boost the mining industry in the early 20th century by placing exhibits in the museum that painted the industry in a favorable light.

Advisor: Stuart W. Leslie

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# Contents

Abstract	ii
Acknowledgements	iv
List of Figures	ix
1 Introduction	1
2 Maps	13
3 Blueprints	70
4 Models	132
5 Photographs	223
6 Museums	276
7 Epilogue	316
Bibliography	352
Vita	384



# List of Figures

2.1	Drifton No. 2 breaker, Coxe Brothers & Company. Negative 3-23, Coxe Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Scanned from glass plate negative by Eric Nystrom, 2006. . . . .	19
2.2	“Engineer Corps, Shamokin District, Philadelphia and Reading Coal and Iron Company, January 1877.” Photo A0024, John Hoffman Photo Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. . . . .	37
2.3	“Present Workings of the Cross Creek Colliery, Drifton,” 1870. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photograph by Eric Nystrom, 2003. . . . .	47
2.4	Detail showing breaker building, breasts, and airflow. From map “Present Workings of the Cross Creek Colliery, Drifton,” 1870. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photograph by Eric Nystrom, 2003. . . . .	49
2.5	“Tracing of the C.C.C. Workings Slope No. 1 showing extension of working[sic] April 1872,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	51
2.6	Detail from “Tracing of the C.C.C. Workings Slope No. 1 ... April 1872,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	52
2.7	“Underground Workings. 2nd Lift Slope No. 1. Drifton, January 1879,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	53

2.8	Detail of “Underground Workings. 2nd Lift Slope No. 1. Drifton, January 1879,” showing “Saddle” notation, elevation measurements, and numbered surveyors stations. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	54
2.9	“Plan of Proposed Boundary Pillar between Highland and Drifton Collieries,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	56
2.10	Detail of “Plan of Proposed Boundary Pillar...” showing proposed pillar in outline and square footage calculations. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	57
2.11	Later map showing encroachment on the boundary pillar, and timber dam to prevent flooding. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	58
2.12	Detail from “Drifton No. 2, Buck Mountain Vein, West End Workings, Bottom Bench,” showing steeply pitching breasts. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	60
2.13	Detail showing breasts with feed doors and manways, from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	61
2.14	Detail showing hazards of vein caving in and cropping to the surface, from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	63
2.15	Detail showing geological faults, rolls, and pinched vein, from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	65
2.16	Detail showing robbing authorization, from from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	66

3.1	Solar blueprinting machine on rails, in situ in the Quincy Mining Company Office Building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006. . . . .	78
3.2	Drawing of Solar Blueprint Machine. Note section of window sill. From Calumet and Hecla Mining Company Papers, Michigan Technological University Archives. Photo by Eric Nystrom, 2006. . . . .	80
3.3	Blueprint Developing Sink. Note faucet. Artifact in situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006. . . . .	82
3.4	Arc Lamp Blueprint Machine, in situ in the attic of the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo courtesy of the National Park Service, 2001. . . . .	85
3.5	Table of suggested patterns for use with blueprints. Adapted by Eric Nystrom from B.H. Thwaite, "Engineering Heliography, or the Sun-Print Copying of Engineering Drawings," <i>Transactions of the Federated Institution of Mining Engineers</i> 9 (1895): 69-88. . . . .	94
3.6	Detail from "Cross Hatching For Stope Maps, Quincy Mining Co.," Box 08, Collection MS-012 "Quincy Mining Company Engineering Drawings Collection," Michigan Technological University Archives. Photo by Eric Nystrom, 2006. . . . .	96
3.7	"Map of the Workings of Tonopah Mng. Co., of Nevada," on linen. Map 610, Tonopah Historic Mining Park, Tonopah, NV. Photo by Eric Nystrom, 2005. . . . .	99
3.8	"Map of the Workings of Tonopah Mng. Co., of Nevada," colored blueprint copy. Map m126, Central Nevada Historical Society, Tonopah, NV. Photo by Eric Nystrom, 2005. . . . .	100
3.9	Key of blueprinted underground map of Isle Royale Copper Co. (C&H). C&H Geological Maps, Row 29, 2nd Set B, Drawer 14, Folder D, Michigan Technological University Archives. Photo by Eric Nystrom, 2006. . . . .	102
3.10	Eckley Coxe's desk, in Drifton, Pennsylvania, showing map compartment. Photo by Philip Metzger, courtesy of James J. Bohning. . . . .	108
3.11	Large pigeon holes in vault, above map drawers, in situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006. . . . .	109
3.12	Metal tubes and wall racks for map storage, in situ at the Calumet and Hecla Office Building, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006. . . . .	112
3.13	Coxe map with end tag. Map 14-14, Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003. . . . .	114

3.14	Window in the C&H Drafting Room, with extra window pane to prevent wind-scattered papers. In situ, Calumet and Hecla Mining Company Office Building, Calumet MI. Photo by Eric Nystrom, 2006 . . .	117
3.15	C&H Drafting Room, North Side, 1949. From <i>C&amp;H News and Views</i> 7, no. 6 (April 1949); Foster Collection, Keweenaw National Historical Park Archives, Calumet, MI. . . . .	120
3.16	C&H map drawers with tabletop, from drafting room. Keweenaw National Historical Park, Calumet MI. Photo by Eric Nystrom, 2006. . .	121
3.17	C&H hybrid map case and table, currently located in the Library Building, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006. . . . .	122
3.18	Calumet and Hecla Light Table. Note adjustable legs and trapezoidal body shape. Item 82756, Accession KEWE-00040, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006. . . . .	123
4.1	Glass plate model “Defendant’s Exhibit 11,” Bunker Hill / Pintlar Corporation Collection, Manuscript Group 413, Box 337, folder 5933, University of Idaho Special Collections and Archives. . . . .	139
4.2	Skeleton model “Plaintiff’s Exhibit 36,” from the front. Bunker Hill / Pintlar Corporation Collection, Manuscript Group 413, Box 337, folder 5933, University of Idaho Special Collections and Archives. . . . .	153
4.3	Skeleton model “Plaintiff’s Exhibit 36,” from the side. Bunker Hill / Pintlar Corporation Collection, Manuscript Group 413, Box 337, folder 5933, University of Idaho Special Collections and Archives. . . . .	156
4.4	Dowel Model at Quincy Mining Company office, Hancock, MI, circa 1925. Koepel Collection, Keweenaw National Historical Park Archives, Calumet, MI. . . . .	158
4.5	West End Skeleton Model. W.M. Keck Museum, Mackay School of Mines, University of Nevada, Reno. Photo by Eric Nystrom, 2005. . .	164
4.6	Claim map of Tonopah, Nevada, at the time of the trial. The West End is a small claim in the center-left, and the portions of the Jim Butler ground in dispute are located just to the south. Note the jagged end line of the West End claim. Map from “Apex Litigation at Tonopah,” <i>Engineering and Mining Journal</i> 99 (1915): 660-661. . . . .	167
4.7	Cross-section of geology, showing the Siebert Fault. From “Apex Litigation at Tonopah,” <i>Engineering and Mining Journal</i> 99 (1915): 660–661.	188
4.8	Cross-section of the disputed area, showing stringers, vein, and surrounding rock types. From Robert M. Searls, “Apexes and Anticlines,” <i>Mining and Scientific Press</i> 117 (1918): 43-44. . . . .	190
4.9	An overhead view of the West End model, showing the portion of the vein where one side is represented in yellow and the other in red. Photo by Eric Nystrom, 2006. . . . .	193

4.10	Judge Averill’s handmade map. From <i>Jim Butler v. West End Consolidated</i> transcript, U.S. National Archives. Photo by Eric Nystrom.	207
5.1	Iron breaker at Drifton, Pennsylvania, under construction about 1890. Negative 2-8, Coxe Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Scanned from glass plate negative by Eric Nystrom, 2006. . . . .	229
5.2	Famill large format copy camera used by the Calumet and Hecla Mining Company. Accession number KEWE-00161, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006. . . . .	232
5.3	Photograph of mine map “Hor[izontal] Plan, Kearsarge Lode, December 31st, 1940.” Note row of pins along top border and pinned date in title block. Image scanned from negative by Michigan Technological University Archives. . . . .	234
5.4	The Quincy Mining Company constructed a darkroom by walling off a portion of their office building’s attic. In situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006. . . . .	236
5.5	Window with red glass filter, and shelf stain, inside the Quincy darkroom. In situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006. . . . .	237
5.6	“Vance, a Trapper Boy, 15 years old. Has trapped for several years in a West Va. Coal mine. \$.75 a day for 10 hours work. All he does is to open and shut this door: most of the time he sits here idle, waiting for the cars to come. On account of the intense darkness in the mine, the hieroglyphics on the door were not visible until plate was developed.” (1908) Hine No. 0163, Library of Congress, Prints & Photographs Division, National Child Labor Committee Collection, LC-DIG-nclc-01076. . . . .	242
5.7	“Miner Neglecting Orders,” <i>Mine Accidents and Their Prevention</i> (New York: Coal Mining Department of the Delaware, Lackawanna and Western Railroad, 1912), 16. . . . .	253
5.8	“Thawing Frozen Dynamite (Right Way and Wrong Way),” <i>Mine Accidents</i> , 52. . . . .	255
5.9	“How To Become an American Citizen,” <i>Mine Accidents</i> , 63. . . . .	261
5.10	“Fire-Boss Sees That Orders Are Obeyed,” <i>Mine Accidents</i> , 17. . . . .	266
5.11	“Fatal Accident to Frank Hall - Mine No. 204 - 8-4-26.” Negative 2744B, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. . . . .	270

5.12	“Model Room, Mine 204, 8-18-1930.” Negative 2930, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. . . .	272
6.1	Fairmont coal mine model, installed in the United States National Museum, circa 1914. Photograph from the Smithsonian Institution. . . .	293
6.2	Fairmont model, right, on display at the 1904 Exposition. Photo from “Coal Mining at Louisiana Purchase Exposition—Description of Models Showing Works of Some of the Large Bituminous Coal Companies,” <i>Mines and Minerals</i> (September 1904): 81-84. . . . .	296
6.3	Model of the First Pool No. 2 Mine, Pittsburg Coal Company, in the United States National Museum circa 1914. . . . .	297
6.4	Pittsburg Coal Company’s model at the St. Louis Exposition of 1904. From “Coal Mining at Louisiana Purchase Exposition—Description of Models Showing Works of Some of the Large Bituminous Coal Companies,” <i>Mines and Minerals</i> (September 1904): 81 . . . . .	300
7.1	Item MHI-MN-8993C, Accession 263096, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photograph by Eric Nystrom, 2005. . . . .	320
7.2	“Bill Keating, the Singing Miner.” Note the brass check tag on his pants, and the lunch pail and bottle on his arm. Keating himself typed the caption. Photograph from the George Korson Collection, American Folklife Center, Library of Congress. . . . .	322
7.3	Music to “The Driver Boys of Wadesville Shaft,” from George Korson, <i>Minstrels of the Mine Patch</i> , 117. . . . .	324
7.4	Music to “Down, Down, Down,” from George Korson, <i>Minstrels of the Mine Patch</i> , 48. . . . .	327
7.5	George Korson, 1946. Photograph from the Korson Collection, American Folklife Center, Library of Congress. . . . .	332
7.6	William Keating being recorded in the Pottsville Public Library, with Korson in the background. Photograph from the George Korson Collection, American Folklife Center, Library of Congress. . . . .	338
7.7	Keating writing poetry, circa 1947. Photograph scanned from negative, Walter Kraus Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. . . . .	341
7.8	Keating the gardener. Photograph from Walter Kraus photograph of the <i>Orwigsburg News</i> , Sept. 27, 1956. Walter Kraus Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. . . . .	343

7.9 Miner’s bottle and miner’s lunch pail belonging to William Keating, featured in exhibit “Taking America to Lunch.” Composite image created by Eric Nystrom from photographs from “Taking America to Lunch” website, Smithsonian Institution. . . . . 350

# Chapter 1

## Introduction



The summer of 2002, as I was making preparations to move to Baltimore and begin work on this arcane subject of mine maps, the world's attention was riveted to a field in southwestern Pennsylvania. On July 24, 2002, nine bituminous coal miners were trapped underground in the Quecreek Mine by a flood of water that was released when the workers unexpectedly broke into an abandoned, flooded mine next to it. Rescue efforts began almost immediately, in hopes that the miners might still be found alive. The mine's surveyor, on the surface, used his carefully surveyed underground maps to choose the surface point that corresponded to the most likely location of the crew. They drilled a small hole to provide fresh air and to try to create enough air pressure in a high part of the mine to prevent the miners from drowning. Once the hole was drilled, the miners tapped on the bit to indicate all nine were alive. Then the operation moved into rescue mode. Huge pumps attempted to dewater the mine, and an enormous drill rig slowly created a hole large enough to lower a special rescue cage to remove the miners to safety. Seventy-seven hours and a couple of broken drill bits later, the miners were all rescued alive.<sup>1</sup>

The Quecreek rescue miners and rescuers were lauded as true heroes, and there were no obvious villains. The problem was that the adjacent abandoned mine, called the Saxman, had in actuality extended closer to the boundary line than anyone working for Quecreek realized. When the miners broke through, the Quecreek mine maps indicated that they were still 300 feet from the abandoned Saxman workings. Aban-

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<sup>1</sup> Quecreek Miners, *Our Story: 77 Hours that Tested Our Friendship and Our Faith*, ed. Jeff Goodell (New York: Hyperion, 2002).

doned mines dot the American landscape (western Pennsylvania has a tremendous number of them), and they pose a real hazard to subsequent mining operations due to risks of flooding, instability, and explosive gas. Since the 1960s, federal and state programs have collected and microfilmed maps of mines periodically, but despite regulations requiring submission of maps, many abandoned mines have old maps or no maps at all. In order to get a permit to open the Quecreek mine in 1998, its operating company had to conduct a thorough search for maps of the adjacent Saxman mine, to try to determine the exact location of its workings next to Quecreek. The company found several maps, but “most of the maps were antiquated and of no practical usefulness.” Two maps, however, could be used. One had been stored at the federal mine map repository in Greentree, Pennsylvania, and this map, dating from 1957, was also on file at two state mine map depositories. It had not been marked “Final,” however, by a certified engineer. By contacting the former owners of the Saxman mine, Quecreek officials had been able to find a map that dated to approximately 1961. This one was also not certified by an engineer, but it showed workings not on the 1957 map. This 1961 map of the Saxman was used by Quecreek to develop the map and plan of mining that comprised Quecreek’s state mining permit application. The state, for its part, double-checked to make sure that Quecreek had looked for maps in all of the conceivable places, found nothing unusual, and approved the permit in 1999. Mining began in 2001.<sup>2</sup>

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<sup>2</sup>“Investigating Grand Jury Report No. 1,” Supreme Court of Pennsylvania 208 M.D. Misc. Dkt. 2001; Court of Common Pleas, Dauphin County, Pennsylvania, No. 660 M.D. 2001, copy in possession of author. I would like to thank Peter Liebhold for obtaining this document for me.

Ironically, however, another, better map of the Saxman mine *did* exist. In June 2002, a month before the Quecreek accident, the granddaughter of the last state mine inspector of the Saxman mine donated her grandfather's personal papers to the Windber Coal Museum in Windber, Pennsylvania. Included among his effects was a 1964 map of the Saxman, marked "final," though it had not been certified by an engineer. When it was found by investigators of the Quecreek accident in August 2002, the map was "found lying in a corner of the museum's attic and was not catalogued or indexed." The map had indeed been provided to the Pennsylvania mine inspector, but had "inexplicably" not been entered into any of the federal or state map repositories.<sup>3</sup>

The Quecreek disaster and the subsequent discovery of a better mine map in the local historical museum highlight the central importance of mine maps to current mining practice. But how did they become so important? How did they change over time? The search for answers led me to mine maps as well as other materials. Indeed, I discovered that the mining industry had an active visual culture. In addition to underground maps, mining companies used blueprints, photographs, and models to represent underground spaces to different audiences. The development of this visual culture of mining was necessary, in part, precisely because underground mines are difficult to see. Unlike a nineteenth-century mechanical or civil engineer, who could see the fruits of his engineering vision as a casting or a bridge, mining engineers had

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<sup>3</sup>"Investigating Grand Jury Report No. 1."

no way to grasp the entirety of a mine except through maps, blueprints, and models. Furthermore, this visual culture of mining developed over time. At the time of the Civil War, mining engineering was in its infancy in America, and mine maps were virtually unheard-of here. By the late 1920s, which for some historians represents the zenith of the mining industry's power, technology, and scope, mining engineering was a mature profession that had integrated visual tools into its everyday work. Mining engineers made very accurate underground maps, used blueprints, maps, and photos in accomplishing day-to-day tasks, and even had a well-established tradition of three-dimensional modeling to facilitate communication with non-engineers.

The development of this visual culture of mining was intertwined with the gradual shift of the power of decisionmaking in mining from those who worked below ground to university-trained mining engineers in an office. Looking back on this shift, engineers prevailed largely because they could deliver greater amounts of finished product at lower cost. This was expressed in many ways – being able to plan for the life of a mine more effectively so capital could be acquired and spent to sustain operations, reorganizing work practices to increase efficiency and reduce cost, and using science to aid the search for new deposits and the efficient conversion of raw ore into salable metal.

So the engineers won, but how? Historians have noticed some of the elements. Engineers and mine owners throughout the country fought protracted battles against

organized labor, and usually came out ahead, often through brutal means.<sup>4</sup> Other historians have approached the topic by discussion of the application of science and scientific approaches to “systematic” mining. The foundations of the study of mining engineers by historians were laid by Clark Spence in his 1970 work, *Mining Engineers in the American West: The Lace-Boot Brigade*. Believing that mining engineers had been left out of historical accounts that focused on the romantic side of mining, Spence sought to highlight the contributions of mining engineers to the mineral industry. Spence used largely anecdotal and prosopographical approaches to craft a wide-ranging look at the broad arc of mining engineering that highlighted the uneven but steady change in the mining engineering profession from the 1860s to the 1930s. American mining engineering, according to Spence, began that time period with a largely empirical approach, augmented by a handful of European-trained engineers. This early class of mining experts was epitomized by the mining engineers of the Comstock Lode during its heyday. Gradually, a larger proportion of American mining engineers became university-trained, mostly at the American schools that opened in the last decades of the 19th century. The burgeoning opportunities created by the booming American mining industry encouraged graduates of the new American programs to have a wide knowledge base, with a mix of theoretical and practical

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<sup>4</sup>There is a tremendous amount of literature on this aspect of mining. See Richard E. Lingenfelter, *The Hardrock Miners: A History of the Mining Labor Movement in the American West, 1863-1893* (Berkeley: University of California Press, 1974); Vernon H. Jensen, *Heritage of Conflict: Labor Relations in the Nonferrous Metals Industry up to 1930* (Ithaca, NY: Cornell University Press, 1950); George Suggs, *Colorado's War on Militant Unionism* (Norman: University of Oklahoma Press, 1972); and Donald L. Miller and Richard E. Sharpless, *The Kingdom of Coal: Work, Enterprise, and Ethnic Communities in the Mine Fields* (Philadelphia: University of Pennsylvania Press, 1985).

training. The new challenges posed by mining operations in the American West, in particular, encouraged these engineers to use their scientific and practical training in equal measure to solve mining problems. These mining engineers were jacks of all trades, flexible, innovative, prepared for and capable of anything. In short, argued Spence, “in the transition from unsystematic to scientific mining under way since the mid-nineteenth century, the engineer was the focal figure.”<sup>5</sup>

Logan Hovis and Jeremy Mouat make a more nuanced version of this argument in their 1996 article that focuses primarily on the development of mass-mining techniques in the western copper industry from 1900-1930. They contend that the “crucial transition” from 1880 to 1930 was that “by 1930, the technical training of the professional engineer – rather than the talents of the ingenious mechanic and the skilled miner – had become the essential element in successful mining operations.” This shift rationalized mining and put an end to the “volatility” that marked the profession’s earlier years. Hovis and Mouat attribute much of this shift to pressures created by the depletion of the richest deposits, increased responsiveness to market forces, and “the progressive and widespread adoption” of new mining and milling techniques. They criticize earlier authors who “have tended to assume that new technology was the most significant element in altering the material conditions of the industry.” Engineers, in these narratives, stand at the forefront making decisions and rationalizing

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<sup>5</sup> Clark C. Spence, *Mining Engineers and the American West: The Lace-Boot Brigade, 1849-1933* (New Haven, CT: Yale University Press, 1970; reprint, Moscow, ID: University of Idaho Press, 1993), esp. 2, 4; Rodman Wilson Paul, “Colorado as a Pioneer of Science in the Mining West,” *The Mississippi Valley Historical Review* 47, no. 1 (June 1960): 34-50.

the work of mining in multiple ways, including by using new technologies. Hovis and Mouat see “the rise of mass-mining practices” as the key to understanding the details of changing work in western mining. “The critical element in the reorganization of the workplace was not the introduction of machinery in and of itself but rather the redesigning of the systems in which workers and machines operated,” especially the move from techniques that valued the recovery of small amounts of valuable material to techniques that sought large amounts of material, often of lower grade, to process. “Once the transition was made to nonselective or mass mining methods, however, a new generation of engineers trained in the applied sciences could redefine mining and restructure the workforce along lines consistent with practice in other mass production industries, a reorientation that transformed the nature of work in and around mines.”<sup>6</sup>

Rather than rely primarily on professional publications, as did Spence, or mid-century government analysts, as did Hovis and Mouat, Kathleen Ochs statistically analyzed the activities of the graduates of one of the most famous American mining schools, the Colorado School of Mines, as they were reported to the school’s alumni association. Her conclusion, consistent with the later findings of Mouat and Hovis, was that mining engineers in the early 20th century increasingly performed managerial work, and the focus of mining development and decision-making moved from the

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<sup>6</sup> Logan Hovis and Jeremy Mouat, “Miners, Engineers, and the Transformation of Work in the Western Mining Industry, 1880-1930,” *Technology and Culture* 37, no. 3 (July 1996): 430-435.

miners themselves to the mining engineers.<sup>7</sup> While noting that the transitions did not occur evenly, Ochs outlined a four-stage model for the periodization of mining in America.

During the rushes (e.g, 1849 in California, 1859 in Colorado), untrained miners applied relatively simple, inexpensive techniques. In the early consolidation stage, apprenticeship-trained miners, chiefly from Europe, used more capital-intensive technologies (roughly mid-1850s in California, 1870s to 1880s in Colorado). During the first wave of industrialization, (1880s/1890s to 1930s), college-educated mining engineers gradually took over control of production, automated tools were introduced, and business organization began to change. Finally, after World War II, mining engineers became established, automated mining systems became more common, and a more complex corporate system – Chandler’s managerial capitalism – emerged.<sup>8</sup>

Other historians attempted to explain mining engineering through the examination of the lives of individual engineers. These include Joshua Clayton, the Janin Brothers – Louis, Henry, and Alexis, Herbert Hoover, Thomas A. Rickard, and Philipp Deidesheimer.<sup>9</sup> Some mining engineers also wrote autobiographies, including John Hays Hammond, Herbert Hoover, and Robert Lenon.<sup>10</sup> Individual biographies, not

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<sup>7</sup> Kathleen H. Ochs, “The Rise of American Mining Engineers: A Case Study of the Colorado School of Mines,” *Technology and Culture* 33, no. 2 (April 1992): 278–301.

<sup>8</sup> Ochs, “Rise of American Mining Engineers,” 282.

<sup>9</sup> Clark C. Spence, “Joshua E. Clayton: Pioneer Western Mining Engineer,” *Arizona and the West* 22, no. 3 (1980): 211–222; Clark C. Spence, “The Janin Brothers: Mining Engineers,” *Mining History Journal* 2 (1996): 76–82; Ronald H. Limbaugh, “Pragmatic Professional: Herbert Hoover’s Formative Years as a Mining Engineer, 1895-1908,” *Mining History Journal* 11 (2004): 43–58; Otis E. Young Jr., “A Dedication to the Memory of Thomas Arthur Rickard, 1864-1953,” *Arizona and the West* 11, no. 2 (1969): 104–108; Otis E. Young Jr., “Philipp Deidesheimer, 1832-1916: Engineer of the Comstock,” *Southern California Quarterly* 57, no. 4 (1975): 361–369.

<sup>10</sup> John Hays Hammond, *The Autobiography of John Hays Hammond* 2 vols. (New York: Farrar & Rinehart, 1935); Herbert Hoover, *The Memoirs of Herbert Hoover: Years of Adventure, 1874-1920* (New York: The Macmillan Company, 1951); Robert Lenon, *It Seems Like Only Yesterday: Mining and Mapping in Arizona’s First Century Vol 1: The Yuma Years* (Lincoln, NE: iUniverse, Inc., 2004); Robert Lenon, *It Seems Like Only Yesterday: Mining and Mapping in Arizona’s First Century Vol 2: Bisbee and Patagonia* (Lincoln, NE: iUniverse, Inc., 2005).



surprisingly, tend to highlight the successful engineer's success at applying rational management to difficult situations.

Even so, the creation and control of visual tools represents an important piece of the story of the professionalization of mining engineers that has hitherto gone largely unnoticed alongside more traditional markers of professionalization such as schools, professional organizations, and journals. Some of the above historians mention surveying and mapping as some of the duties of mining engineers, but they do not delve deeply into the historical development or use of visual representations of the underground by mining engineers. I argue in this dissertation that if we are to understand the ability of mining engineers to increase efficiency, we need to understand the tools that they used, including visual tools. Mining engineers gradually learned how to make and use maps, photographs, blueprints, and models to help them gain greater control over work, information, the law, and public opinion. These visual tools were an integral part of the everyday work of mining engineering by the end of the time period I study here.

Mining engineers themselves are worth studying because of the impact that mining has had on everyday life. Mining advocates love to point out, often in the form of a bumper sticker, that "If it isn't grown, it has to be mined," which of course is true. The consequences of mining, however, are not short enough to distill into a pithy quote. The enormous natural resources of the United States contributed largely to this country's emergence as a world power in the late 19th and early 20th century. A

domestic iron and steel industry used coke made from bituminous coal and anthracite coal, together with vast deposits of iron ore, to facilitate the building of railroads, ships, bridges, and machine tools. Domestic manufacturing also led to an increase in consumer goods such as sewing machines, bicycles, and automobiles. An increased monetary supply, in the form of gold and silver, helped expand capital markets and spur economic growth, but it also contributed to inflation and speculative panics, especially those of 1873, 1893, and 1907. Copper from mines in Lake Superior and the American West formed the wires that connected the country with telegraph, telephone, and electrical lines.

The human and environmental cost of all of this mining was enormous. Coal mining had one of the highest fatality rates of any job in America in this period, and metal mining was also quite dangerous. Statistics did not take into account chronic diseases, such as silicosis or “black lung,” that shortened lives and agonized sufferers. Environmental consequences could be huge. Water that drained from mines was frequently acidic, killing fish and reducing plant life along the banks of the waterways into which it flowed. Sometimes dirty water from coal operations would be impounded behind a dam, in order to allow the particulates to settle, but this created the hazards of catastrophic flooding downstream if the dam was breached. Mining operations tended to clear hillsides of timber and stabilizing growth in order to get at the rock and to have a place to put it, but this exposed hillsides to massive erosion, removing topsoil on the hills and silting up streams and rivers in the valleys. Sometimes this was a

deliberate strategy, as with the “hydraulicking” method of mining in California, which used water from high pressure nozzles to erode entire hillsides. Due to the incredible damage caused by the flow of sediment downstream, this practice was banned in 1884, but other similarly-damaging practices continued unabated. Emissions from lead and copper smelters destroyed trees and adversely impacted human health in the Rockies and elsewhere. Processing mills, especially early mill designs such as those used on the Comstock Lode, allowed reagents including mercury to wash into rivers and gulches. And large-scale open pit mining, in common use for just over a century, has devoured communities and left enormous toxic scars on the landscape. To the extent that mining engineers have been the primary architects and builders of this mined world, it is important to understand their work in order to have a better appreciation for the world they have left for us – for better and for worse.

# Chapter 2

## Maps

## Introduction

A map is not a tool like a pick or a shovel, of course, but maps were no less important in constructing the underground mining landscapes of late 19th and early 20th century America. On a mine map, a mining engineer preserved the past, interpreted the present, and imagined the future of an underground mine. Using a map, the underground space could be rendered in whole in the engineer's "mind's eye,"<sup>1</sup> and evaluated in a systematic fashion.

Mining maps, as sources, pose a challenge to historians. They don't explain themselves, they don't look like anything else, and they describe places that no longer exist or that we can't see. Much of the information they contain is of little use in solving common historical questions. The maps are large and difficult to handle. Perhaps worst of all, they rarely survive. Once a map no longer reflected reality, a mining company had little incentive to retain it. Underground maps receive less attention from archivists than other mining company documents because they carry less obviously useful information and require so much space and curatorial attention. These factors help explain Richard Francaviglia's lament that maps "are also, sadly, among the least appreciated of the tools used by miners."<sup>2</sup>

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<sup>1</sup>See Eugene S. Ferguson, *Engineering and the Mind's Eye* (Cambridge, MA: The MIT Press, 1992).

<sup>2</sup> Richard V. Francaviglia, "Maps and Mining: Some Historical Examples from the Great Basin," *Mining History Journal* 8 (2001): 66–82; quote on p. 80. Francaviglia focuses almost exclusively on maps of the surface. Also see Richard V. Francaviglia, *Hard Places: Reading the Landscape of America's Historic Mining Districts* (Iowa City: University of Iowa Press, 1991). An earlier version of this chapter was published as Eric Nystrom, "Mapping Underground Drifton: The Evolution of Anthracite Mine Maps," *Canal History and Technology Proceedings* 25 (2006): 79–96.

Maps made it possible to accumulate, store, retrieve, and update knowledge about underground spaces with relative ease. To construct and use an underground map, nineteenth-century mining engineers had to survey, plot, draft, revise, and store them, and in so doing translated a complex space into a two-dimensional representation imbued with the power and authority of the engineer. Understanding maps and mapping is critical to understanding underground spaces, but historians have largely neglected this part of the story. This chapter will present a series of maps to sketch the evolution of this important mining technology in the context of the American anthracite industry. The anthracite coal mining industry was widely understood to be a leader in the development of American underground mapping practice.

One of the most innovative and well-respected mining engineers in the anthracite mining business was Eckley B. Coxe, whose mining maps from Drifton, Pennsylvania, illustrate larger trends in the changing underground mapping practice of the late 19th century. Coxe was born into a wealthy Philadelphia family. His grandfather was Tench Coxe, who assembled the vast tracts of coal bearing lands that his heirs, including Eckley, would later develop. Eckley Coxe studied at the University of Pennsylvania, then spent most of the period of the Civil War studying mining engineering at Freiberg and the Ecole des Mines. Upon his return to the United States in 1865, he (along with family partners) set up coal mining operations at Drifton on lands leased from his grandfather's estate. Gradually, Eckley Coxe and his partners consolidated their

control of the estate's coal lands.<sup>3</sup> Their company was one of the largest independent producers of anthracite during its best years in the 1880s and 1890s.<sup>4</sup> Coxe played an important role in the professionalization of mining engineering by encouraging the development of institutions and periodicals, supporting engineering programs, and by pushing for greater application of science and mathematics to mining activities. In short, Coxe's life is intertwined with the story of the professionalization of mining engineering, and offers a compelling case study of the development of underground mapping. To explain the story of underground maps, I will first describe anthracite collieries, like those designed by Eckley Coxe, which will set the stage for a discussion of underground mapping and mining engineering. Then we will examine a series of maps from one of Coxe's anthracite mines, and see how the maps, and their usefulness, changed over time.

## **Underground Landscapes: Places of Production**

Anthracite coal came out of the mine, was sized and processed in a factory-like building called a "breaker" located nearby, then was usually loaded into railroad cars for shipment to urban markets. The initial step of this chain of production, distribution, and use took place in a subterranean landscape spatially organized by a mining engineer for the purpose of facilitating the production of maximum quantities

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<sup>3</sup> Rossiter W. Raymond, "Biographical Notice of Eckley B. Coxe," *Transactions of the American Institute of Mining Engineers* 25 (1896): 451-454.

<sup>4</sup>"Independent" producers were those not directly controlled by a railroad company.

of anthracite coal at minimum cost. It was this space that was described by a mine map, and it was likewise the space mining engineers tried to use maps to help them control. Accordingly, it is important to understand the nature of these mines before examining maps depicting them.

Mines, as workplaces, varied in their configuration both over time and between different sectors of the mineral economy, but all such subterranean production facilities shared a handful of common characteristics. Of primary importance was the fact that miners were dependent on technology to make habitable the place that they worked. Rosalind Williams noted the power of the underground as a metaphor for an entirely artificial environment, wholly dependent on technology.<sup>5</sup> Such a picture was not far from the truth. Ventilating technologies served both to bring fresh air into the mine and to remove explosive gases. Roof support technologies such as systems of timbering and pillars of native rock were utilized to keep the roof from falling. After mines went below the level of the local water table, pumping technologies were required to drain water from the workplace. Transportation technologies were necessary both to move vertically to and from the surface, and horizontally within the mine. One characteristic distinctive of underground mines was their darkness; miners were dependent on hand-held or cap-mounted candles or oil lamps to provide what little light was available.<sup>6</sup> An additional common characteristic shared by mines, as

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<sup>5</sup>Rosalind Williams, *Notes on the Underground: An Essay on Technology, Society, and the Imagination* (Cambridge, MA: The MIT Press, 1990), 4-8.

<sup>6</sup>Carbide lamps first became available in 1900, and came into widespread use by 1910 because of the amount of light they provided. See Gregg S. Clemmer, *American Miners' Carbide Lamps: A Collector's Guide to American Carbide Mine Lighting* (Tucson, AZ: Westernlore Press, 1987).



spaces, was that the entire facility was organized for the purpose of the extraction of raw material to be processed on the surface into economically useful matter.

Eckley Coxe ran anthracite coal mines, which were found in North America only in northeast Pennsylvania. Anthracite collieries varied considerably in their details, but it is possible to give a general description of these work sites.<sup>7</sup> Their shapes and sizes were often influenced by the geology of anthracite coal. In eastern Pennsylvania, several seams or veins of anthracite exist atop one another with intervening strata of slate, shale, and sandstone. The strata that contain the coal were subject to enormous geological pressures, which both transformed the coal into anthracite, and folded and buckled the layers of strata. As a result, Pennsylvania anthracite veins can pitch quite steeply, and outcrop on the surface in many places. Prior to the 1850s, collieries were relatively unsophisticated quarrying operations or shallow underground pits, both of which dug the anthracite out of exposed seams. Beginning in the 1850s, the physical plant of these operations expanded dramatically, both above and underground, and its elements continued to be refined as long as underground operations were ongoing.

First, some means of reaching the coal underground was needed. If the coal was in a hill, above the waterline, a tunnel driven almost horizontally would reach the seam and provide an easy way in and out of the mine. If the coal was below ground, engineers could drive an inclined plane along the angle of the coal seam. This inclined

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Portable electric lights were first used in the United States in 1908, but were only gradually adopted. Mark Aldrich, *Safety First: Technology, Labor, and Business in the Building of American Work Safety, 1870-1939* (Baltimore: Johns Hopkins University Press, 1997), 219, 224-229.

<sup>7</sup>“Colliery” refers to the total mining plant, including the underground mine and surface processing facilities.



Figure 2.1: Drifton No. 2 breaker, Coxe Brothers & Company. Negative 3-23, Coxe Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Scanned from glass plate negative by Eric Nystrom, 2006.

tunnel was called a slope. Slopes were generally favored in the anthracite region for several reasons. Since they were dug through the coal, it was much easier to make sure that the vein was not lost due to a misunderstanding of geology. Additionally, the anthracite was softer and easier to tunnel through than was the surrounding rock. The extra coal gained from excavating the slope was only of minor importance. It was also possible to dig a vertical shaft to intersect the coal seam at a predetermined point. Once slope, shaft, or tunnel reached a convenient point, often the bottom of the coal seam (the syncline), horizontal tunnels called gangways branched off in both directions along the plane of the coal seam. The gangways contained the main transportation and ventilation infrastructure of the mine. From the gangways, a series of working chambers called breasts were constructed to remove the coal. Each breast was separated from the next by a pillar of coal left in place for support. When possible, these breasts were made uphill from the gangway, so as to facilitate loading coal into cars with the help of gravity. A miner and his helper were assigned to an individual breast, the working of which might take a year or more. The miner's job was to direct the working of the breast, bore holes in the face, load them with powder, and blast down the coal. The helper then loaded the coal into a mine car, which was hauled to the foot of the slope by a mule driver, then hoisted to the surface.<sup>8</sup>

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<sup>8</sup> J. Price Wetherill, "An Outline of Anthracite Coal Mining in Schuylkill County, Pa." *Transactions of the American Institute of Mining Engineers* 5 (1877): 402–422; this includes the discussion that followed the paper; H.M. Chance, *Report on the Mining Methods and Appliances Used in the Anthracite Coal Fields* (Harrisburg: Second Geological Survey of Pennsylvania, 1883) is the most comprehensive account of 1880s practice; for a thorough, but more modern description, see *The Story of Anthracite* (New York: The Hudson Coal Company, 1932), 111-181.

The surface plant of a colliery was dominated, after the 1850s, by the breaker, a large building housing coal processing machinery. Coxe's Drifton No. 2 breaker is shown in figure 2.1, on page 19, circa 1891. The breaker commonly contained the hoisting machinery as well. After coal was hoisted to the top of the breaker, it was fed by gravity through a series of spiked rollers, which broke the coal into useful sizes. The broken coal then passed through rotating or gyrating screens, which sorted the anthracite into standard market sizes. In some breakers, including the iron breaker built at Drifton by Eckley Coxe, the smaller sizes of coal passed through an automated washing machine, which separated coal from slate on the basis of specific gravity. Washed or not, the coal slid in troughs past employees who manually picked pieces of slate from the anthracite. These employees were usually children, called "breaker boys," as well as disabled miners. After being cleaned by the breaker boys, the coal slid into the appropriate "pocket" or storage bin, which was emptied at the bottom into a railroad gondola. The waste generated in the process of preparing coal for market consisted of slate and other rock, which was dumped on a slate pile, and very small coal, coal dust, and dirt, which was known as "culm" and dumped on a culm pile.<sup>9</sup>

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<sup>9</sup> Richard P. Rothwell, "The Mechanical Preparation of Anthracite," *Transactions of the American Institute of Mining Engineers* 3 (1875): 134–144; Eckley B. Coxe, "The Iron Breaker at Drifton, With a Description of Some of the Machinery Used for Handling and Preparing Coal at the Cross Creek Collieries," *Transactions of the American Institute of Mining Engineers* 19 (1891): 398–474; Coxe described his iron breaker design in exhaustive detail, with forty two plates, for a technical audience. Also see Chance, *Mining Methods and Appliances*; and *Story of Anthracite*, 182-209, for a description of a 1920s-1930s era breaker.

## Underground Mapping

Over time, maps became an essential tool for mining engineers. This shift is rooted in the visual properties of maps. Maps, as cartographic historians including Denis Wood and J.B. Harley have noted, are powerful things.<sup>10</sup> Mine maps were not like those ordinarily studied by historians of cartography, however. Because they were unpublished, were made by the application of mechanical drawing techniques, and were created by engineers for engineers, underground maps share some of the same properties as engineering drawings. Historians of technology have acknowledged the importance of visual knowledge to the work that engineers do. Eugene Ferguson, in particular, elegantly articulated the internal, visual thinking process employed by engineers.<sup>11</sup> Engineering drawings put much of this visual thought into paper form, which then serve as communication devices, both between engineers and from engineers to non-technologists. These “technological representations,” argues Steven Lubar,

have enormous power when used as part of a technological system. They vastly increase technologists’ abilities to process technological information and to communicate it to others. They define technological communities. They allow organizational feats otherwise impossible; indeed, it might be said that they make technological systems possible. And they have enormous (though little-understood) rhetorical power. When we understand

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<sup>10</sup> Denis Wood, *The Power of Maps* (New York: Guilford Press, 1992); J. Brian Harley, *The New Nature of Maps: Essays in the History of Cartography*, ed. Paul Laxton (Baltimore: Johns Hopkins University Press, 2001).

<sup>11</sup> Eugene S. Ferguson, “The Mind’s Eye: Nonverbal Thought in Technology,” *Science* 197 (August 26, 1977): 827–836; he further developed the implications of his argument in Ferguson, *Engineering and the Mind’s Eye*. Also see Walter G. Vincenti, *What Engineers Know and How They Know It: Analytical Studies from Aeronautical History* (Baltimore: Johns Hopkins University Press, 1990); and Brooke Hindle, *Emulation and Invention* (New York: New York University Press, 1981).

the power of this sort of technological representation, and the social nature of these images, we can better understand modern technology and the power of modern technological institutions.<sup>12</sup>

Lubar and Ferguson focus most closely on engineering drawings, but we should add the maps made by mining engineers to the list of technological representations. Engineers of several stripes created and used technological representations, but mining engineers worked under a particular professional handicap - they could not see the places that they were making. As a result, mining engineers had to rely heavily on visual technologies to understand and control subterranean landscapes. Lubar noted that “the engineering drawing allows the engineer to master the machine ... you can dominate a piece of paper in a way that you cannot dominate a machine.”<sup>13</sup> If we substitute “mine” for “machine,” the utility of technological representations to mining engineers becomes quite clear.

Maps of surface landscapes have been associated with mining for many centuries, and simple surveying of the underground was reported by Agricola in 1556. “There are many arts and sciences of which a miner should not be ignorant ... Fourthly, there is the science of Surveying that he may be able to estimate how deep a shaft should be sunk to reach the tunnel which is being driven to it, and to determine the limits and boundaries in these workings, especially in depth.”<sup>14</sup> However, Agricola’s surveyors platted their surveys on a “surveyor’s field” - a full-scale, open-air, tempo-

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<sup>12</sup> Steven Lubar, “Representation and Power,” *Technology and Culture* 36, no. 2, Special Issue (1995): S54–S81; quote on S62–S63.

<sup>13</sup> Lubar, “Representation and Power.”, S70.

<sup>14</sup> Georgius Agricola, *De Re Metallica*, ed. Herbert Clark Hoover and Lou Henry Hoover (London: The Mining Magazine, 1912; reprint, New York: Dover Publications, Inc., 1950), 3–4.

rary reproduction on nearby level ground. These surveys were chiefly used to ensure that tunnels and shafts being driven toward each other would meet, or that adjacent mines did not encroach on one another's property.<sup>15</sup> The earliest underground maps, according to mining engineer Herbert Hoover, were not made until after Agricola's time.<sup>16</sup> Many maps associated with mining, including those in the United States from the earliest years of the republic, are maps of the surface that show the location of mineral deposits or land ownership claims. However, all of these mining claim maps were produced with standard land survey techniques and instruments.

Another precursor of underground maps were geological maps, because they purported to show geology below the surface. The geological sciences coalesced rapidly in the first several decades of the nineteenth century, and the visual representation of geological features played an important role in geological interpretations.<sup>17</sup> William Smith is usually credited with producing the first geological map, in 1815.<sup>18</sup> Even so, J.P. Lesley, a well-known American geologist, lamented in 1856 that geological maps,

are commonly mere distortions and caricatures which illustrate the subject by confusing the observer. Neither maps nor sections are helps to the geologist—and are cruelties to the schoolboy—unless they be properly and accurately made. Then they become his efficient tools. But he must make his own tools. He will find none made to his hand. The age of maps has just set in.<sup>19</sup>

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<sup>15</sup> Agricola, *De Re Metallica*, 128-148.

<sup>16</sup> Agricola, *De Re Metallica*, 129; Hoover's comment appears at the bottom of n. 16.

<sup>17</sup> Mott T. Greene, *Geology in the Nineteenth Century: Changing Views of a Changing World* (Ithaca, NY: Cornell University Press, 1982), esp. 122-125.

<sup>18</sup> Simon Winchester, *The Map That Changed The World: William Smith and the Birth of Modern Geology* (New York: HarperCollins Publishers, 2001).

<sup>19</sup> J.P. Lesley, *Manual of Coal and its Topography* (Philadelphia: J.B. Lippincott and Co., 1856), 191.

Lesley's manual did not discuss underground mapping at all. One significant reason is that there was little mining activity in America that was deep enough to map, and very few engineers who might have done the work. Early mining in the United States, that is, before the mid-1850s, was generally a localized affair. Mines were relatively shallow, and the target minerals rarely needed much complex processing after their extraction from the earth. Accumulated local knowledge generally provided the basis for mining practice, and some foreign experts, many of whom were skilled miners from the British Isles, supplemented local methods. Occasionally a graduate of a foreign mining school might be hired as an adviser, but mining in pre-1850 America rarely posed problems of a sort that required a college-trained engineer to solve.

As American mines were pushed deeper and ore-processing problems became more complex in the 1850s and 1860s, the utility of trained engineers increased. These included foreign-trained engineers, American students who graduated from foreign mining schools (as did Eckley Coxe), and graduates of American scientific schools. Many people who performed the work of engineers were not formally educated in this period. The formation of systematic state and federal geological surveys provided a training ground for a generation of geologists and engineers, who applied geological knowledge to the solution of underground problems.

The first American schools of mining engineering were formed in this context of the increasing use of engineering techniques to solve mining problems. Initial attempts in the late 1850s resulted in a handful of graduates. Before the 1862 passage of the Mor-



mill Land Grant Act, which provided federal support for technical education through grants of federal lands which could be sold to provide permanent revenue, only eight universities in the United States (plus the two military academies) taught engineering in any form.<sup>20</sup> The Polytechnic College of Pennsylvania, a private university which closed its doors sometime after 1878, offered a track in Metallurgy from its founding in 1853 and created a School of Mines in 1857 that offered degrees in mining, making it the first American college to do so.<sup>21</sup> However, the number of graduates in mining fields were few and the school received little recognition. James McGivern cites two Bachelor of Mine Engineering recipients listed in the school's catalog of 1862-1863. Though McGivern makes a compelling case that the numbers of graduates of the school have been significantly underestimated by historians, it remains unlikely that the Polytechnic College of Pennsylvania had much impact on the American mining engineering profession.<sup>22</sup>

The first truly successful American mining school was formed at Columbia College, in New York City, in 1864. Over the next decades, mining engineering programs were started at a large number of schools, and most of the universities of states that featured major mineral industries formed mine schools, sometimes as separate campuses. The core curricula focused on geology, engineering, geometry, mathematics,

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<sup>20</sup> James G. McGivern, "Polytechnic College of Pennsylvania: A Forgotten College," *Journal of Engineering Education* 52, no. 2 (November 1961): 106.

<sup>21</sup> McGivern, "Polytechnic College of Pennsylvania," 108; Thomas Thornton Read, *The Development of Mineral Industry Education in the United States* (New York: American Institute of Mining and Metallurgical Engineers, 1941), 35-39.

<sup>22</sup> McGivern, "Polytechnic College of Pennsylvania," 106, 111.

chemistry, and physics; and almost always included practical instruction on surveying, drafting, blowpipe analysis, assaying, and the like. Most mining engineering programs required students to spend their summers in mines, gaining hands-on experience. Mine engineering, as taught in the classes and summer programs of late 19th century American colleges, included lots of sketching and drafting, a scientific approach to problem-solving, and a preference for solid numbers. The overall aim of the schools was to unite engineering theory with mine practice, and to cultivate a wide-ranging vision of the mine as a controllable (or semi-controllable), rational system.<sup>23</sup>

Concomitant with the formation of mining schools was the development of American professional journals for mining engineering and the formation of a professional society of mining engineers. Though periodicals such as *Journal of the Franklin Institute*, the *American Journal of Science*, and *Scientific American* covered some mining developments, mining journals such as the *Mining and Scientific Press* (formed in 1860 as *The Scientific Press*, in San Francisco) and the *Engineering and Mining Journal* (formed in 1866 as the *American Journal of Mining*, in New York), found a nationwide audience, and localized mining journals also flourished briefly. The American Institute of Mining Engineers (AIME) was formed in May 1871, and made its headquarters in New York. Eckley Coxe wrote a circular calling for engineers to meet for the purpose of forming the Institute, and is rightly regarded as one of its founding

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<sup>23</sup>Read, *Development of Mineral Industry Education*.

members. The AIME met three times a year, often in a place where local mining sites could be toured by the group. The society published its *Transactions* annually beginning in 1873.

Marrying technical education with practical knowledge of the underground was essential for the success of mining engineering as a profession, since theory alone was not particularly helpful in an underground space that was contingent on a host of sensitive factors and prone to complex failures. Early scientifically-trained engineers earned a bad reputation among mine owners for relying on theory that did not work under the specific conditions of a particular mine.<sup>24</sup> As a result, leaders of the mining engineering profession from the 1870s onward were careful to point out the need for graduates to gain practical experience. Eckley Coxe, in an 1878 presidential address to the members of the AIME, lauded “the true engineer,” who, according to Coxe, “mastered both the theory and the practice of his profession.” This ideal mining engineer “neither neglect[ed] the theoretical speculations of the chemist, the physicist, the geologist, and the mechanical engineer, nor the facts and opinions of the practical men whose daily contact with the actual working of the furnaces enables them to make very valuable suggestions.”<sup>25</sup>

Even though American mining operations did not regularly employ trained mining engineers before the Civil War, by the late 1850s, underground surveying had become

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<sup>24</sup> Spence, *Mining Engineers*, 70-78.

<sup>25</sup> Eckley B. Coxe, “Presidential Address, Proceedings of the Lake George and Lake Champlain Meeting, October 1878,” *Transactions of the American Institute of Mining Engineers* 7 (1879): 103-114, quote on 107.

important enough to be taught at some foreign mining schools. Only drawing, not cartography or surveying, was part of the mining curriculum of the School of Mines of the Polytechnic College of Pennsylvania.<sup>26</sup> Neither subject was included in the early curriculum of the Columbia College School of Mines either, but surveying was later added as a topic to be learned during summer excursions to working mines.<sup>27</sup> A 1909 map of one colliery in eastern Pennsylvania resurveyed old workings, since no maps existed prior to 1865.<sup>28</sup>

Mine surveying as a subset of ordinary surveying practice was not addressed separately on a regular basis until the 1880s. That same decade saw sweeping changes in the profession of mining engineering, and in the education of mining engineers in America. By the end of the 1880s, accurate mine surveying was widely understood to be an important component of any mining engineer's work, though best practices were followed consistently only at the largest mining firms. The practice of underground mapping in America was most advanced in the anthracite region in Pennsylvania, due in part to the pioneering mine safety laws passed by the state which demanded the mapping of anthracite mines. An editorial in *The Colliery Engineer* in May 1888 noted, "The profession of mining engineering has advanced more in the past decade than any other profession, and in that portion of the engineer's work, comprised un-

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<sup>26</sup> McGivern, "Polytechnic College of Pennsylvania.", 110.

<sup>27</sup> Spence, *Mining Engineers*, 30-32, 37-38, 50.

<sup>28</sup>"Map of Mamoth[sic] Vein Workings in Greenfield & Temperance Basins, Beaver Meadow Collieries, Accessibel[sic] For Surveys, Of Old Workings of 1830 to 1864 No Maps Exist," Map 2-22, Coxe Map Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution (hereafter "NMAH").

der surveying and mapping, great advances have been made.”<sup>29</sup> The editor praised the work of the larger anthracite companies in mine surveying and held them up as an example. He urged other engineers, especially bituminous coal engineers, to follow their example of careful mapping from the start to avoid problems created or exacerbated by unmapped mines. The editor made it clear that the goal was a “perfect” map, loaded with information, gathered by the observant (and hard working) mining engineer:

The engineer should use his judgement and his mental faculties continually. With a modern mining transit, he should read the vertical as well as the horizontal angle at every sight. He should note every peculiarity or fault in the vein. He can not take too many notes regarding the inclination of the vein, nor can he make his notes too complete in any sense. Paper and pencils are cheap, and the engineer’s note books should contain almost a perfect history and description of the development of a colliery: His maps should be a perfect picture of the ground plan of the inside working, outside improvements and topography of both the surface and the bed rock of the vein. Every point possible should have its elevation above a common basis marked. The date of every survey should be lettered at the places where the faces of the workings stood when each survey was made. Every synclinal and anticlinal axis, whether local or general, should be prominently shown. Each pillar robbed out should be shown as gone. The air courses should be prominently marked, and whenever practicable the course of the air through the workings should be marked by arrows; doors and brattices should be shown; and, in fact, every little detail possible should be distinctly noted and marked, for there is no telling at what moment the information concerning these points will be needed.<sup>30</sup>

The editor’s call for a perfect underground map as an essential part of all mining engineering practice would not have been practical even a decade earlier. Mine surveying was not commonly addressed as a standalone topic in mining literature until

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<sup>29</sup> “Importance of Accurate Mine Surveys,” *The Colliery Engineer* 8 (May 1888): 228.

<sup>30</sup> “Importance of Accurate Mine Surveys.”

the 1880s. Bennett H. Brough, British author of the standard work on mine surveying published in 1888, noted that the first treatise on mine surveying was Nicolaus Voigtel, *Geometria Subterranea* (1686); followed by the works of J.F Weidler (1726; Latin), H. Beyer, (1749; German), and von Oppel (1749; German). In English, Brough reported that the earliest authors to address the subject were Thomas Houghton in 1686, William Pryce in 1778, and Thomas Fenwick in 1804, but all of these works were relatively rare by the middle of the 19th century.<sup>31</sup> The first reference I have found to a book in English that included the term “mine surveying” in its title was published in 1859, but no book in English on the topic of mine surveying appeared in the catalog of the library of the Columbia College School of Mines that was compiled in 1875, and the topic was apparently new enough in 1883 for Lehigh University to grant a civil engineering degree on the basis of a thesis on the subject.<sup>32</sup> Toward the end of the 1880s, however, the situation changed. Bennett H. Brough’s popular text on mine surveying appeared in 1888, and went through many subsequent editions.<sup>33</sup>

From the 1890s, a multitude of books covered the topic of mine surveying, and gen-

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<sup>31</sup> Bennett H. Brough, *A Treatise on Mine-Surveying* (London: Charles Griffin and Company; Philadelphia: J.B. Lippincott Company, 1888), 3.

<sup>32</sup> William Rickard, *The Miner’s Manual of Arithmetic and Surveying ... With a Compendium of Mensuration and a Concise Treatise on Practical Geometry and Plane Trigonometry; also a Course of Mine Surveying ... Together With Levelling and Land Surveying* (Truro: Herd and Sons; London: Longman and Co., 1859); *Catalogue of the Books and Pamphlets in the Library of the School of Mines of Columbia College, July 1st, 1875* (New York: Printed for the Trustees, John W. Amerman, Printer, 1875); George G. Hood, “Mine Surveying” (C.E. thesis, Lehigh University, 1883), Lehigh University Library Special Collections, Thesis 1883 H777m.

<sup>33</sup> Brough, *Treatise*. I have found an edition published in 1926, thirty-eight years after the first, and eighteen years after Brough’s death in 1908.

eral purpose guides about surveying and about mining engineering generally carried at least a chapter or two about mine surveying.<sup>34</sup>

Similarly, mine surveying was not initially a part of the American education of mining engineers. Eckley Coxe played a direct role in creating the pioneering summer course for the students of the Columbia College School of Mines. Coxe responded enthusiastically to the suggestion of Henry S. Munroe, at the time an adjunct instructor in mining engineering at the Columbia School of Mines, that mining engineering students should gain practical experience by working in the mines during the summer. Coxe invited the first group to his collieries at Drifton, where the thirteen students spent July and August 1877 learning from the miners and engineers. Underground surveying was explicitly mentioned as part of the material to be learned, and the students were also required to sketch extensively and work on a detailed report. The experiment in Coxe's mines in 1877 was so successful that the trustees of the college voted to make summer trips a permanent part of the mining curriculum.<sup>35</sup> Later, the young engineers who experienced this summer program, such as Thomas H. Leggett, recalled the trip as being "of immense benefit."<sup>36</sup>

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<sup>34</sup>According to the "Preface to the First Edition" dated 1886, J.B. Johnson's treatise on surveying included a chapter on mine surveying written by a U.S. Deputy Mineral Surveyor. The chapter was completely rewritten by different authors, one a professor at the Colorado School of Mines, for the fifteenth edition, issued in 1900. J.B. Johnson, *The Theory and Practice of Surveying* 16th ed. (New York: John Wiley & Sons, 1908), xii, iv-v.

<sup>35</sup> H.S. Munroe, "A Summer School of Practical Mining," *Transactions of the American Institute of Mining Engineers* 9 (1881): 664-671.

<sup>36</sup> T.A. Rickard, *Interviews with Mining Engineers* (San Francisco: Mining and Scientific Press, 1922), 255.

In the mid-1880s, instruction on the techniques of mine mapping became more common. By 1886, underground surveying was taught theoretically and practically at most of the major mining schools. An examination of the top mining schools of 1886 found that Columbia College, Lafayette College, Lehigh University, University of California, University of Illinois, University of Pennsylvania, and Washington University gave both classroom and field instruction in underground surveying. The University of Wisconsin and the Massachusetts Institute of Technology provided only classroom instruction in underground surveying, and the University of Michigan mining engineering program did not address the topic at all.<sup>37</sup>

Thus, by the 1880s, the value of mine maps was beginning to be recognized by some mining engineers and educators, but apparently at least a significant minority had not yet made the visual representations part of the fabric of everyday mine management. Mining engineer B.W. Robinson's article advocating and explaining mine maps appeared in the Report of the Inspector of Mines of Kentucky for 1888, and was reprinted in the journal *Colliery Engineer* in 1889.<sup>38</sup> Robinson claimed that most mine managers were "slow to realize their necessity, and hence have them attended to only when works are in close proximity to the limits of their property, or to satisfy the requirement of the mine law." These unenlightened managers, Robinson claimed, used

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<sup>37</sup> R.H. Richards, "American Mining Schools," *Transactions of the American Institute of Mining Engineers* 15 (1887): 309–340; R.H. Richards, "American Mining Schools," *Transactions of the American Institute of Mining Engineers* 15 (1887): 809–819. The latter is an updated supplement to Richards' first article.

<sup>38</sup> B.W. Robinson, "Mine Maps: A Paper Showing What is Required on a Good Map, and Why Complete Maps are a Necessity," *The Colliery Engineer* 9 (April 1889): 198. Robinson was engineer for the St. Bernard Coal Company.



“careless or incompetent persons” to finish the work cheaply, which often consisted merely of measuring distance traveled and not true surveying. Inaccurate maps could give a general sense of the mine at best, and would be useless for understanding what parts of the surface were undermined. Old, unmapped workings posed hazards to miners from floods, built-up gases, and spontaneous fire in waste materials.

“A good mine map will many times repay the operator for the outlay attached to it,” stated Robinson, for it could be used to estimate materials needed, keep track of coal mined already, help engineers route new tunnels for maximum efficiency, and help solve problems of ventilation and water drainage. By using different colored inks, mining engineers could ensure that the support pillars in multiple-level mines lined up. “In fact, no mine can be altogether successful, which is not properly represented by a good, accurate map.” Robinson suggested beginning surveys at the moment the mine was opened, by establishing permanent surface base lines to orient all future surveys. Using a transit – a magnetic compass was not suitable for mine work because of the amount of iron in the form of rails and pipe typically found underground, warned Robinson – the mine should be surveyed at a maximum interval of six months; any longer, and portions of the mine, “frequently those which are most important, become inaccessible.”<sup>39</sup>

To mining engineer Robinson, “the prime object of a mine map is to show the underground workings in their relation to the boundaries of the company’s property,

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<sup>39</sup> Robinson, “Mine Maps: A Paper Showing What is Required on a Good Map, and Why Complete Maps are a Necessity.”

the amount of surface undermined and what remains, and to serve as a complete record of all the workings.” While underground surveying had been used to help respect property lines since Agricola’s time, the notion of a mine map as a “complete record” was rather new, and pointed toward the future of mine maps as information storage technologies. Since there was “no telling when such information may be needed,” Robinson counseled his readers to keep “very voluminous” survey notes. “The engineer should not forget anything that would be of use in making his map, or for future reference,” suggested Robinson. He advocated keeping sketches of the mine along with the survey notes, but Robinson’s wide-ranging view of information saturation was expressed best by his suggestions for what to include on mine maps. If a mining engineer followed his directions, his map would contain an air line, surveyor’s stations with connecting lines, tinted working stations, all the property lines, roads, streams, outcrops, “general direction of hills and valleys,” permanent objects or surface landmarks, underground elevations (though only of “prominent points”), and direction and measurement of the dip of the vein. In addition, Robinson recommended keeping a set of profiles (or sections) of the “principal entries,” with information about grade and elevation of haulage ways as well as notes on the height and “character” of the tops of tunnels.<sup>40</sup>

In sum, by the late 1880s, at least some mining engineers, such as B.W. Robinson, recognized the potential power of underground maps beyond mere legal compliance

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<sup>40</sup> Robinson, “Mine Maps: A Paper Showing What is Required on a Good Map, and Why Complete Maps are a Necessity.”

and avoidance of trespass. Instead, he understood maps to be complex artifacts where many different types of information were organized spatially; once created, this document served the engineer as a visual index of other information, and as a tool which, through its concatenation of different types of data, helped engineers visualize solutions to the problems of mining.

Underground surveying and mapping not only helped mining engineers better understand and control their mines, it also contributed to their professional identity. The power to make and wield technological representations set mining engineers, as a professional group, apart from others who could purport to do the same job, such as so-called “practical men.” In an 1888 article, bituminous coal mining engineer Reuben Street exhorted the practical, professional, and even cultural value of mine surveying for his fellow engineers:

The study of the principles of mine surveying will enable us to reach a point far above that which we now occupy, and to prove that the coal mining fraternity has in its ranks men whose minds are as susceptible to and capable of development, even in the higher arts and sciences, as are found among the men of other avocations.<sup>41</sup>

The classic symbols of the mining work hierarchy support this suggestion. Miners were represented with pick, sledge, and shovel. Foremen, or “bosses,” claimed the symbol of the safety lamp, which represented their power to inspect for explosive gas and prohibit or permit the miner to work. Engineers were represented with transit and notebook - the tools of surveying and constructing technological representations.<sup>42</sup>

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<sup>41</sup> Reuben Street, “Mine Surveying,” *The Colliery Engineer* 8 (March 1888): 177.

<sup>42</sup>Marionne Cronin noted that the airplane, which was the tool of survey geologists and mining engineers searching for new deposits in Canada, became an icon for that group as well. See Mari-

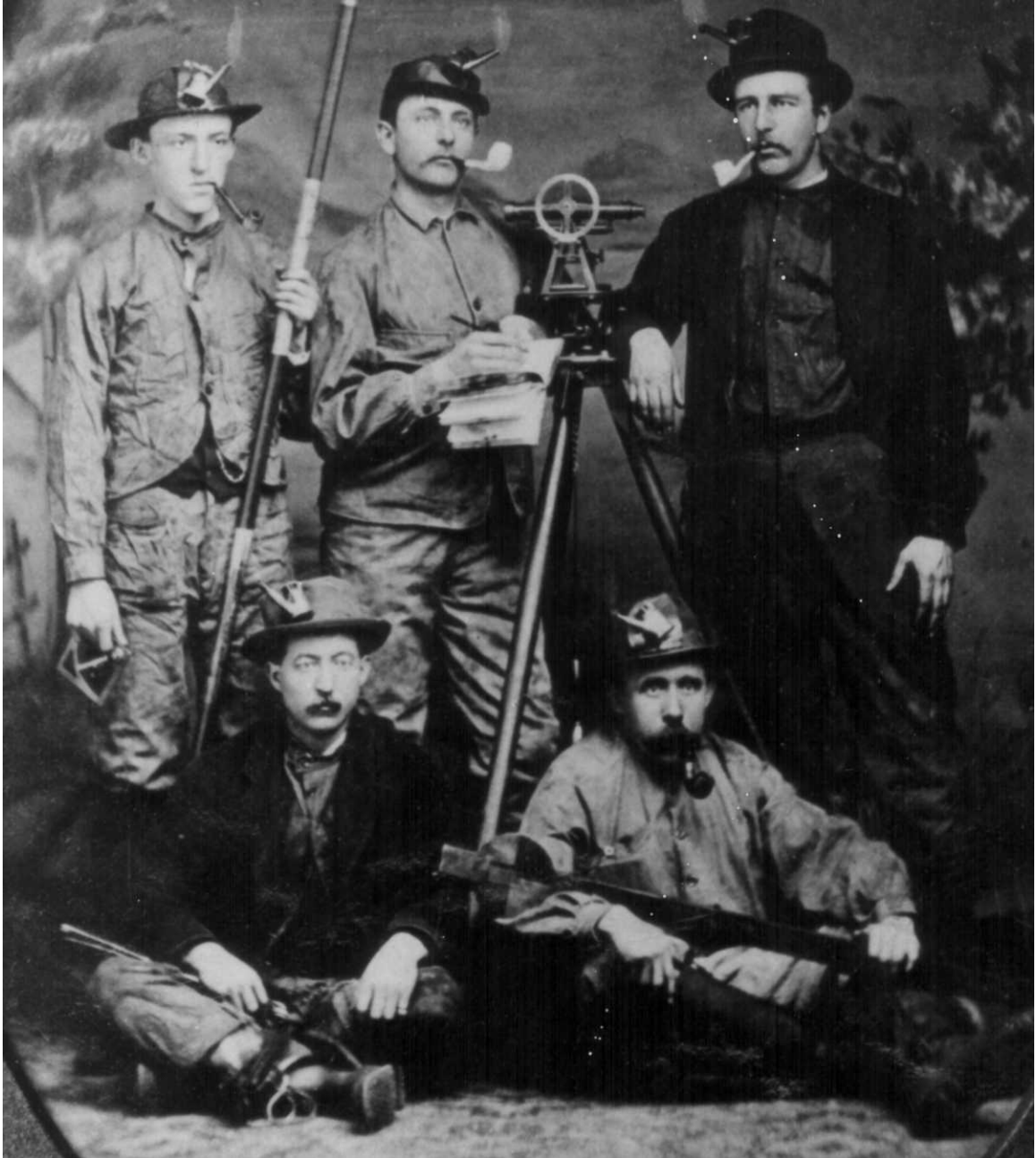


Figure 2.2: “Engineer Corps, Shamokin District, Philadelphia and Reading Coal and Iron Company, January 1877.” Photo A0024, John Hoffman Photo Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.

In figure 2.2 on page 37, the engineering and mapping team for one district of the Philadelphia and Reading Coal and Iron Company's numerous anthracite coal mining operations posed in a studio for a group portrait. As was common portraiture practice at the time, the men were pictured with objects that symbolized their identity, in this case as mining engineers. These included a transit, a surveyor's notebook, a marked rod, and other surveying tools; but their identity as specifically underground engineers was shown by their cap-mounted lamps. The photographer even went to the trouble of smudging the negative to make the lamps appear to be lit. These men shared the symbol of the underground, the cap lamp, with other mine workers, and shared the symbols of surveying with ordinary civil engineers, but the two together marked them as mining engineers.

The total vision of an all-encompassing map exposed by Robinson only gradually became accepted in American mining engineering, as engineers measured and recorded increasingly diverse data with increasing precision and accuracy. The Pennsylvania anthracite country was an early leader in accurate mine surveying, due at least in part to the influence of the 1869 and 1870 mine safety laws which required maps. Bennett Brough, addressing an audience primarily composed of British mining engineers, noted in the preface to his book on underground surveying that "[f]ew mine-surveyors in Great Britain appear to be acquainted with the methods and instruments used abroad. This is the more to be regretted, as no mine-surveys made in

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onne Cronin, "Northern Visions: Aerial Surveying and the Canadian Mining Industry, 1919-1928," *Technology and Culture* 48 (April 2007): 303-330.

this country approach in accuracy those of the collieries of Pennsylvania, or those of the metalliferous mines of the Harz.”<sup>43</sup> The Harz district was also the location of the school of mines at Clausthal. The development of mining methods in that location, like other German mining districts with mining colleges, was heavily influenced by the curriculum of the school. One early master of mine surveying, Julius Weisbach, taught at the famous Bergakademie in Freiberg. Weisbach’s contributions to the art of mine surveying included pioneering the use of the theodolite instead of a magnetic compass.<sup>44</sup> Eckley Coxe, who himself advanced the practice of mine surveying in America, studied under Weisbach and translated the German’s thick calculus text into English.<sup>45</sup> Coxe must have read Weisbach’s German book about mine surveying, which was published just a few years before Coxe’s arrival in Freiberg.<sup>46</sup> Coxe is perhaps the most interesting example, but other American mining engineers attended Freiberg as well.<sup>47</sup> Thus there was a connection between the American anthracite fields and the European silver-lead districts, the two areas of best practice of underground surveying and mapping that Brough identified in the first edition of his book in 1888.

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<sup>43</sup>Brough, *Treatise*, v.

<sup>44</sup>Hunter Rouse, “Weisbach, Julius Ludwig,” in *Dictionary of Scientific Biography*, ed. Charles Coulston Gillispie vol. 14 (New York: Charles Scribner’s Sons, 1976), 232.

<sup>45</sup>Julius Weisbach, *Theoretical Mechanics: With an Introduction to the Calculus: Designed as a Text-Book for Technical Schools and Colleges, and for the Use of Engineers, Architects, Etc.; Translated from the Fourth Augmented and Improved German Edition*, trans. Eckley B. Coxe (New York: D. Van Nostrand, 1875).

<sup>46</sup>Julius Weisbach, *Neue Markscheidekunst und ihre Anwendung auf Bergmännische Anlagen* (Braunschweig: Verlag von Friedrich Vieweg und Sohn, 1859).

<sup>47</sup>J. C. Bartlett, “American Students of Mining in Germany,” *Transactions of the American Institute of Mining Engineers* 5 (1877): 431–447.

By the turn of the century, mapping and surveying were considered part of the common duties of mining engineers. In a 1916 advice book targeted at young engineers, F.B. Richards described mapmaking as part of the regular duties of mining engineers. “As the mine is operated, accurate maps must be kept up of all the underground working [sic], which means much underground surveying and work in the drafting room if the property be a large one.”<sup>48</sup> In short, from the formation of the first American mining schools around the time of the Civil War to about the turn of the century, maps moved from having no place in the mining curriculum to being a standard element in the education and everyday job duties of mining engineers.

In smaller mines earlier in the nineteenth century, the whole process of surveying and constructing the map might be done solely by the mining engineer, utilizing mine laborers on special duty to help with the surveying tasks underground. As operations expanded their use of drafted documents, most retained a small staff of drafting employees. These drafting personnel were often newly-graduated mining engineers, and would usually assist in performing the survey.

Underground surveying shared much in common with topographical surveying. Both types of surveying involved creating a series of points of known location by extending angular and distance measurements from other known locations, taking careful notes of the established known points (called “surveyor’s stations”) and nearby topographical features, and plotting the points and lines on a map. Mine survey-

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<sup>48</sup> F.B. Richards, “Mining,” in *Engineering as a Career: A Series of Papers by Eminent Engineers*, ed. F.H. Newell and C.E. Drayer (New York: D. Van Nostrand Company, 1916), 153.

ing introduced several complications into normal surveying practice. There are no natural reference points underground (as a mountaintop or a church steeple might be aboveground), which meant that a known point had to be carried underground from a surface survey. If underground access occurred through a horizontal tunnel, this operation was relatively simple, but taking a survey line down an inclined slope could be tricky, and getting an accurate measurement from a plumb-bob suspended in a vertical shaft swirling with air currents was a topic of frequent discussion. The underground spaces were dark, which meant that instruments and targets had to be illuminated with lamps. Mine surveyor's stations could not be established with precision on the floor of the mine because work traffic would disturb them, so the stations in a mine normally consisted of a horseshoe nail with a hole or a hook (known as a "spad" or "spud") driven into a wooden plug inserted in a small hole in the roof. The cramped spaces underground often required a dexterous transit operator, and in some cases alternatives to ordinary tripods were employed to save space. Mine surveyor's notebooks were particularly susceptible to becoming damaged and dirty, and mine surveying books cautioned surveyors to use a book with sturdy leather or aluminum covers or, better, to employ a loose-leaf notebook so that only one day's pages were underground at a time. Mine surveyors also generally needed to conduct more precise and accurate work than surface surveyors, for two distinct reasons. First, it was not always possible to connect underground surveys in a closed polygon to ensure accu-



racy, as was possible on the surface. Second, an error of even a few feet was rarely critical in most situations on the surface, but could be disastrous underground.

After the survey was conducted, the raw data needed to be transformed into a map of the underground. This procedure also had much in common with plotting ordinary surveys, including utilizing standard drafting tools. Drawing commenced in pencil. First, the survey stations were carefully plotted and connected. Using notes and measurements preserved in the surveyor's records, the nearby mine topography was filled in, usually freehand (to suggest the roughness of mine surfaces). Specific features might be added, such as air shafts, doors, elevations, or notes about the condition of the mine. Symbols were usually consistent in each company, but many variations across maps from different companies persisted long into the twentieth century. Symbols on a map were almost never explained in a legend; the only exception to this that I have seen is if parts of the map were colored to represent something specific, the meanings of the colors would be noted. Drafters ordinarily added a title panel, with the name of the map, date of revision, and perhaps a notation of scale; surveys in Pennsylvania anthracite mines almost invariably used the scale of one inch to one hundred feet. When the map was complete, it would usually be checked carefully by the mining engineer, if he did not do the drafting. Depending on factors such as its intended use, its size, and usual practice at that particular colliery, the map was either rolled, stored flat in a map drawer, or tacked to a vertical surface. Maps at the Coxe Brothers & Co. were usually rolled, with titles inscribed on the

edge lengthwise along the roll. Later Coxe maps had a tag fastened to the end of the rolled map with the map's number and title, for easy reference. Some Coxe maps also show evidence of being tacked in the corners, though it is not possible to state with certainty in any given case if the holes came from tacking up for display or tacking to hold down a map for drafting. Beginning in the last decades of the nineteenth century, maps were usually assigned a number and entered in a ledger or card catalog as part of a system of tracking critical mine documents. It was not uncommon for a firm to outgrow a numbering system; some of the older Coxe maps give evidence of two or three different numbering schemes.

The procedures for the use of mine maps are not clear, especially for the early period. It is likely that early maps were simply reflective of the status of the mine, updated relatively infrequently, and not consulted on a regular basis or involved in the chain of decision-making. As maps grew more complex, were more frequently updated, and engineers were trained in their use, they seemed to have become more useful as the basis of decision-making. It is very clear that the surviving maps of the Coxe Brothers & Co. never went underground - they were stored and used in the clean confines of the Engineering Office building. If the map was needed to convey an idea of future work to the miners working below, the mining engineer or supervisor probably brought the mine boss (or perhaps the foremen) into the Engineering Office to consult the map. The boss or foreman would likely take some personal notes,

then relay his orders verbally to miners underground when they checked in before commencing work.<sup>49</sup>

Eckley B. Coxe was an innovator in mine surveying, which likely resulted from long exposure to the topic. The coal lands he managed had belonged to his family for more than a generation, and family trips always included inspecting the coal properties. After graduating from the University of Pennsylvania, Coxe assisted Benjamin Smith Lyman in conducting a topographical survey of a portion of the family coal lands. From 1860-1864 he studied mining engineering abroad at the Ecole des Mines in Paris and at Freiberg, both institutions with surveying as part of the formal curriculum, though an examination of Coxe's student notebooks from his time at the Ecole des Mines do not give any evidence that Coxe learned surveying while at that institution.<sup>50</sup> Coxe apparently performed much of the surveying of his mines himself, and developed versions of mine surveying tools that were used well into the future. For example, in the early 1870s, Coxe designed a plummet lamp for underground work, which provided increased accuracy and speed, while requiring only one surveying assistant. The instrument was a small oil lamp built in the shape of a plumb-bob which hung from a chain. The pointed end of the plummet lamp could mark a surveying point very

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<sup>49</sup>By 1950, the procedure had changed, thanks to technology that permitted fast, accurate, and cheap reproduction of portions of a map from a drafted master copy, and an increasingly sophisticated labor force. A copy of the map was always provided to section foremen, and the latter were required to know how to read it. E.H. Bourland, *How To Read a Mine Map: Concise Instructions for Mine Foremen and Students Seeking Simple Yet Thorough Practical Knowledge of Mine Map Reading* (Beckley, WV: Diamond Supply & Service, 1951), 11. Also see the next chapter, on blueprints.

<sup>50</sup>See notebooks 1-5, Eckley Brinton Coxe Manuscripts (SC MS 059), Lehigh University Library Special Collections.

accurately, and the flame was easy to focus on in a surveyor's transit in order to take surveying measurements.<sup>51</sup> Coxe also invented a steel tape for measuring surveyed distances. Surveyor's chains were cumbersome to use to measure the steeply-pitching breasts of Coxe's anthracite mine. He initially conceived of a fine braided steel rope, with small soldered tags indicating distance, but was persuaded by his instrument maker to instead use the raw material for hoop skirt bands - tempered steel, 0.08 inch wide and 0.015 inch thick. A small brass wire was soldered across the tape every ten feet; 500 feet of the material wound on a reel weighed less than three pounds. Steel tapes of this sort quickly became common in both underground and topographical surveying. Mining engineers who sketched the history of surveying instruments in 1902 noted that "the chain . . . was quite generally used in American mines until Eckley B. Coxe and others started a reformation, some twenty-five years ago, in favor of the steel band that has now practically consigned the chain to President Cleveland's 'innocuous desuetude.'"<sup>52</sup> Thus, because of Coxe's extensive theoretical training and practical experience in underground surveying, the maps of Coxe's Drifton colliery

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<sup>51</sup> Eckley B. Coxe, "Remarks on the Use of the Plummet-Lamp in Underground Surveying," *Transactions of the American Institute of Mining Engineers* 1 (1873): 378-379. Coxe's design was a significant improvement on a lamp designed by Julius Weisbach, Coxe's professor at Freiberg. Dunbar D. Scott and Others, *The Evolution of Mine-Surveying Instruments* (New York: American Institute of Mining Engineers, 1902), 283-284, 303-304. A plummet lamp of this sort is described (without attribution) in the standard mining engineer's handbook of the twentieth century; see Robert Peele and John A. Church, eds., *Mining Engineers' Handbook* 3rd ed. vol. 2 (New York: John Wiley & Sons, Inc., 1941), 18-04. [N.B.: Peele's page references are section-page format.]

<sup>52</sup> Eckley B. Coxe, "Improved Method of Measuring in Mine Surveys," *Transactions of the American Institute of Mining Engineers* 2 (1875): 219-224; Scott and Others, *The Evolution of Mine-Surveying Instruments*, 32, 284-285. Also see Peele and Church, *Mining Engineers' Handbook*, 18-14, 18-15.

I examine below probably represent early examples of good underground mapping practice.

## Evolution of Maps of Drifton

The maps in this section are from the Drifton colliery of the Coxe Brothers & Company, an anthracite coal mining operation in eastern Pennsylvania led by Eckley Coxe.<sup>53</sup> Despite the wide diversity of mining practice during the period, I believe that the Coxe Brothers mines provide examples that highlight long-term trends in the mining industry that contributed to the changing use and usefulness of underground maps. Eckley Coxe was an early leader in the field of American mining engineering; he was educated in the mining schools of Europe, and helped to found the American Institute of Mining Engineers.<sup>54</sup> He attempted to run his colliery at Drifton according to the best practices of the day, and was recognized for his efforts. A contemporary newspaper described Coxe’s Drifton operation “the model mining plant of the world.”<sup>55</sup> Coxe was an innovative and thoughtful engineer, with the power and desire to improve his collieries and his profession, and as such his operation offers an

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<sup>53</sup>The proper name of Coxe Brothers & Company changed several times throughout the nineteenth century as the company changed its business structure, and the partnership itself was not always consistent in its naming practices. The firm also called itself the Cross Creek Colliery (C.C.C.) in its first decades. I will use “Coxe Brothers & Co.” throughout this paper for consistency. See Patrick Shea, “Against All Odds: Coxe Brothers & Company, Inc. and the Struggle to Remain Independent”, Paper delivered at the Mining History Association Conference, Scranton PA, June 17, 2005. Coxe Brothers & Co. and its predecessors were family partnerships. On proprietary firms (as distinct from “corporations”), see Philip Scranton, *Proprietary Capitalism: The Textile Manufacture at Philadelphia, 1800-1885* (New York: Cambridge University Press, 1983).

<sup>54</sup> “Wilkes-Barre Meeting, May 16th, 1871,” *Transactions of the American Institute of Mining Engineers* 1 (1873): 3–9.

<sup>55</sup>“A Pleasant Excursion,” *New York Times*, 19 October 1890, 2.

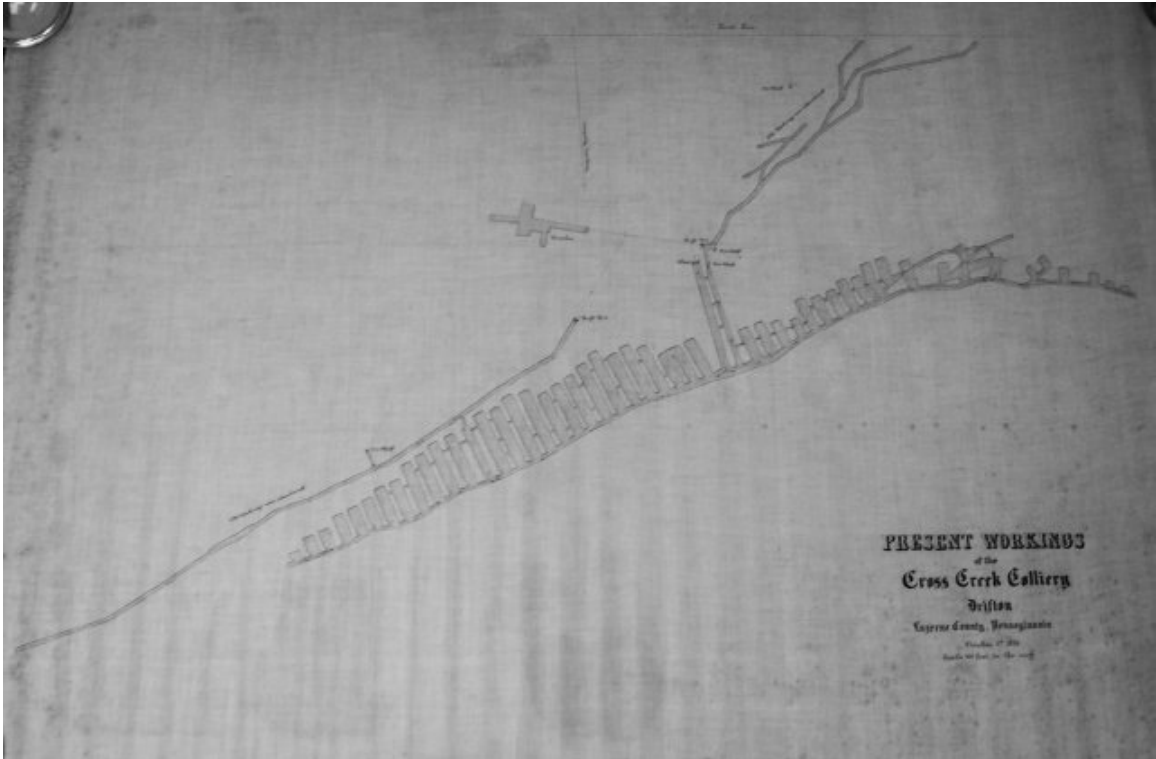


Figure 2.3: “Present Workings of the Cross Creek Colliery, Drifton,” 1870. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photograph by Eric Nystrom, 2003.

opportunity to glimpse change over time without the complicating factors of different sectors of industry or different environmental circumstances.<sup>56</sup>

The earliest underground map of the Drifton colliery that I found, shown in figure 2.3 on page 47, was drawn in 1870.<sup>57</sup> The same year was the first that coal mines in Luzerne County, including Coxe’s, were required by law to be mapped. The statewide

<sup>56</sup> Raymond, “Biographical Notice of Eckley B. Coxe.”; Philip B. McDonald, “Eckley Brinton Coxe,” *Dictionary of American Biography* Base Set, American Council of Learned Societies, 1928-1936; Reproduced in *Biography Resource Center* (Farmington Hills, MI: Thomson Gale, 2007), <http://galenet.galegroup.com/servlet/BioRC>; James J. Bohning, “Angel of the Anthracite: The Philanthropic Legacy of Sophia Georgina Coxe,” *Canal History and Technology Proceedings* 24 (2005): 150–182. Bohning is also preparing a biography of Eckley Coxe.

<sup>57</sup>“Present Workings of the Cross Creek Colliery, Drifton, Luzerne County, Pennsylvania, October 1st. 1870, Scale 100 feet to the inch.” Map 14-22, Coxe Map Collection, NMAH.

mine safety act passed that year required operators to “make, or cause to be made, an accurate map or plan of the workings” of their mines, and to provide maps or updates to state mining inspectors twice a year.<sup>58</sup> The 1870 act expanded the scope and jurisdiction of a pioneering 1869 law, which, though it applied only to Schuylkill County, was the first mine safety law in America.<sup>59</sup> The 1869 law required mines to be mapped as well, and made provisions for the mine inspectors to make maps (at the company’s expense) if none existed.<sup>60</sup>

The 1870 Drifton map was drawn in ink on tracing linen, and used colored shading effects to illustrate the “breasts,” rooms of coal usually worked by one or two miners separated by pillars of coal left standing. The map shows surveyor’s stations, unnumbered, connected with thin red lines. Blue arrows, which represent airflow, circulate through the works. Doors to regulate airflow are drawn in as well. Air shafts in several places are labeled, and the breasts are long and quite regular in appearance. Surface features, most conspicuously the breaker building, are also visible. (See figure 2.4.) One section of what appears to be a gangway is labeled “Old Works Now Abandoned.” The magnetic meridian is marked on the map, as is a “Land-Line.” This

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<sup>58</sup> “An Act Providing for the Health and Safety of Persons Employed in Coal Mines,” in *Laws of the General Assembly of the State of Pennsylvania Passed at the Session of 1870* (Harrisburg: B. Singerly, State Printer, 1870), 3–12, quote on p. 3.

<sup>59</sup>See Anthony F.C. Wallace, *St. Clair: A Nineteenth-Century Coal Town’s Experience with a Disaster-Prone Industry* (New York: Alfred A. Knopf, 1987; reprint with corrections, Ithaca, NY: Cornell University Press, 1988), 293-305; Aldrich, *Safety First*, 67-68.

<sup>60</sup> “An Act for the Better Regulation and Ventilation of Mines, and for the Protection of the Lives of the Miners in the County of Schuylkill,” in *Laws of the General Assembly of the State of Pennsylvania Passed at the Session of 1869* (Harrisburg: B. Singerly, State Printer, 1869), 852–856.

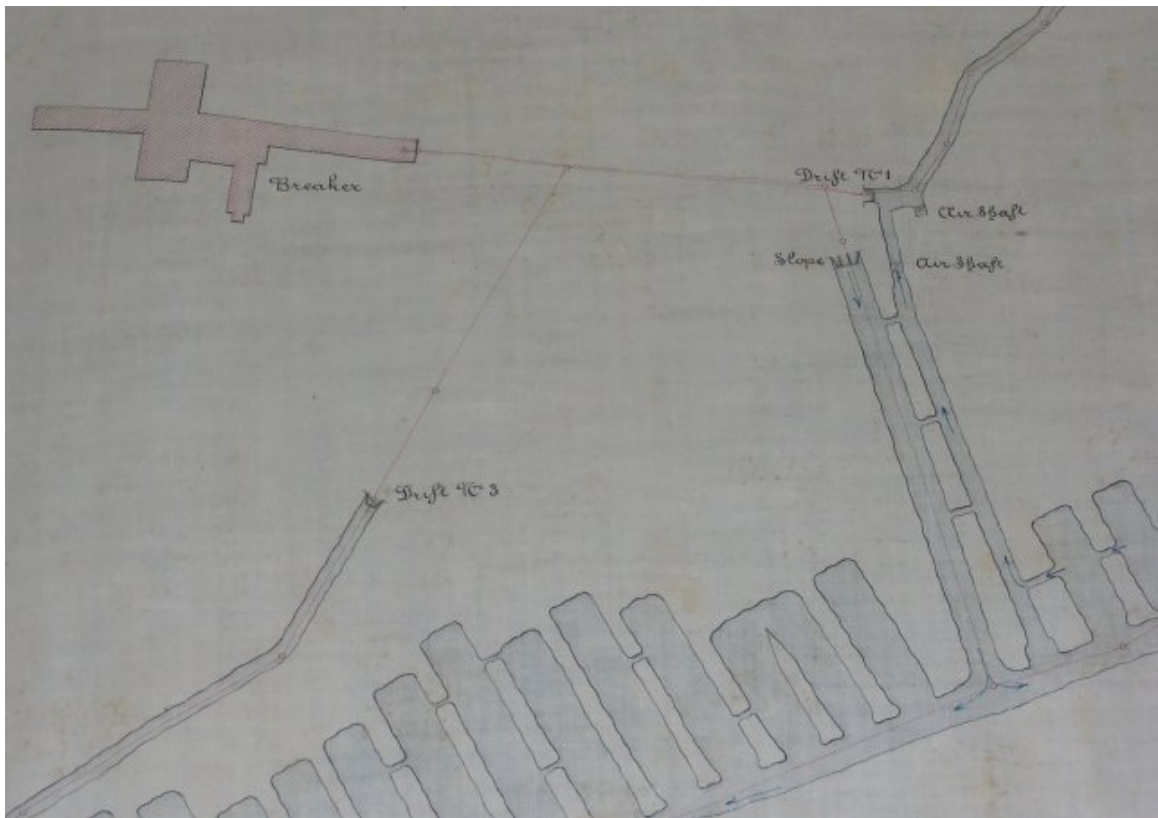


Figure 2.4: Detail showing breaker building, breasts, and airflow. From map "Present Workings of the Cross Creek Colliery, Drifton," 1870. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photograph by Eric Nystrom, 2003.



map does not appear to have been altered after it was drawn, probably because of the small size of the sheet.

A map of the same underground space produced two years later shows some different mapping techniques.<sup>61</sup> This map was also drawn in ink on tracing linen with colored shading. A view of the entire map makes it relatively easy to see where this one, from 1872, shows extensions of the workings pictured in the map of 1870. (See figure 2.5.) The working edge of the mine is indicated on both ends of the workings, where it says “Face April 24, 1872.” No surface features such as the breaker are shown on the map - it represents the underground exclusively. The airflow indicators and air doors of the 1870 map are not represented, although the air shaft is still labeled as such. Perhaps most significantly, surveyor’s stations were numbered on this map. (See figure 2.6.) Numbered stations would ease new surveys of the mine, would make translation of notes from the field into a mapped mine much easier, and would facilitate the transfer of survey information (or job duties) to other people. In other words, this 1872 map is suggestive of the start of the shift from proprietary mine knowledge (since Coxe knew his own mine, he did not need to number the survey stations) to representing the space as an idealized, engineered landscape that can be understood by other mining engineers.

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<sup>61</sup>“Tracing of the C.C.C. Workings Slope No. 1 showing extension of working[sic] April 1872,” Map 14-23, Coxe Map Collection, NMAH.

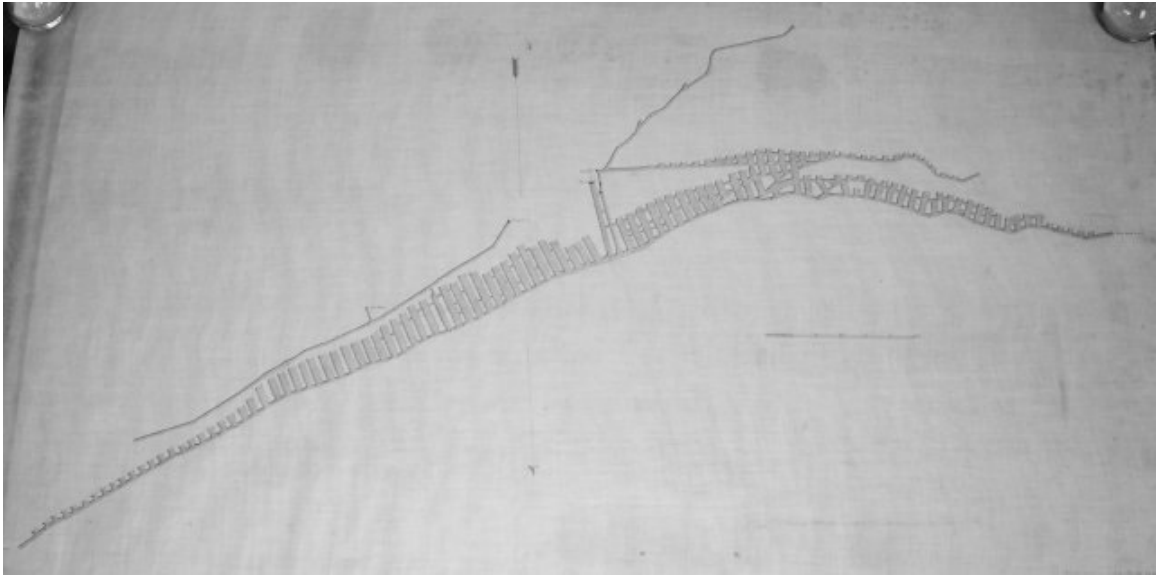


Figure 2.5: “Tracing of the C.C.C. Workings Slope No. 1 showing extension of work[ing] April 1872,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

A map made in 1879, shown in figure 2.7 on page 53, shows more information being added to the maps.<sup>62</sup> This map was also drawn with shaded relief. Surveying stations are shown, but the mixed use of letters and numbers suggests overlapping surveys. This map differs from the 1870 and 1872 maps in that it shows some elevation measurements, usually noted alongside surveying stations. The elevation measurements are four digit numbers, often with a single place past the decimal as well, and indicate elevation above average sea level.<sup>63</sup> (See figure 2.8 on page 54.) Many Pennsylvania anthracite veins pitched quite steeply, and elevation notations (or some other way of

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<sup>62</sup>“Underground Workings. 2nd Lift Slope No. 1. Drifton, January 1879,” Map 17-80, Coxe Map Collection, NMAH.

<sup>63</sup>The average elevation for the town of Drifton, Pennsylvania is 1,660 ft above sea level, according to the U.S. Geological Survey’s Geographical Names Information Service (accessed online).

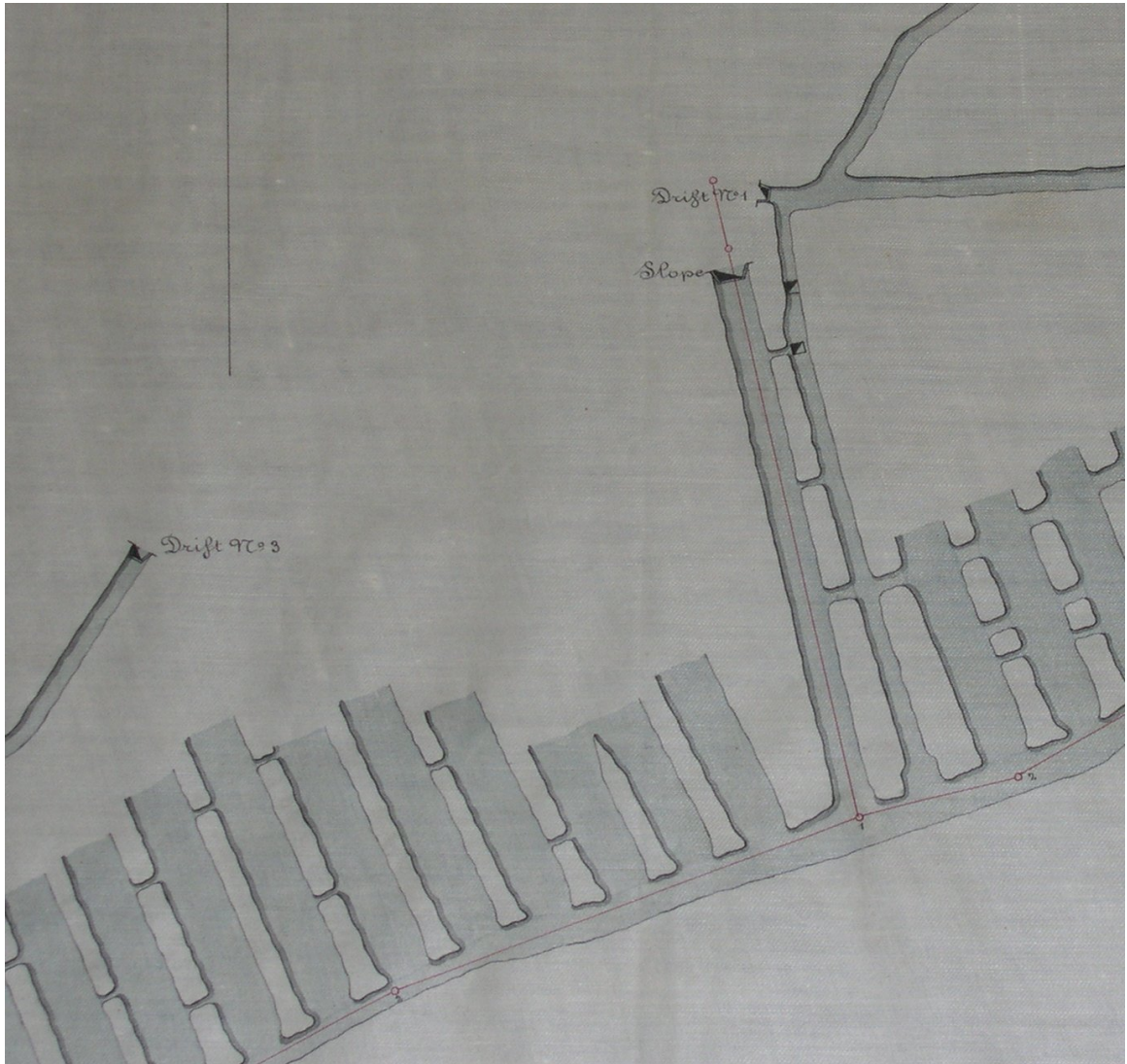


Figure 2.6: Detail from “Tracing of the C.C.C. Workings Slope No. 1 ... April 1872,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

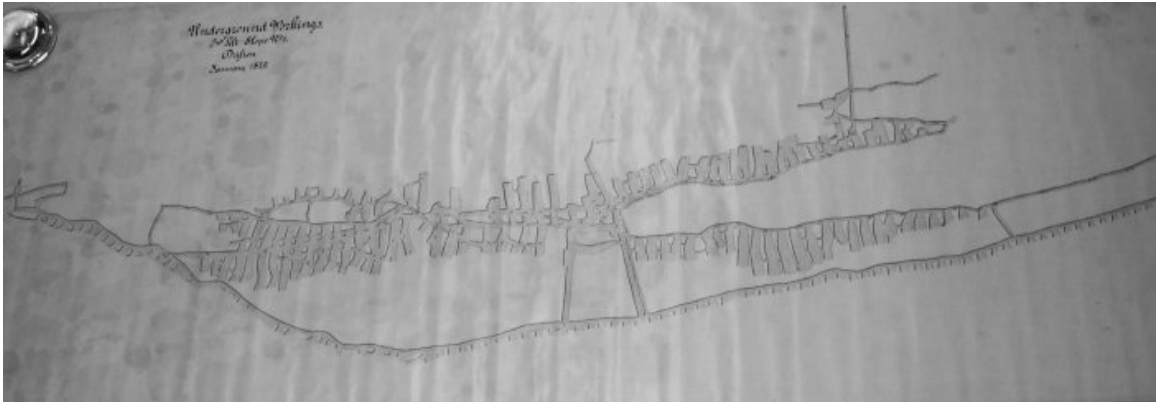


Figure 2.7: “Underground Workings. 2nd Lift Slope No. 1. Drifton, January 1879,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

indicating vertical relief) permitted a much more accurate representation of the physical geography of the underground. This map also has two places where “Saddle” with an elevation is noted, which indicates an underground geological formation. A saddle would have been a low spot along an underground ridge of coal, which could potentially cause all sorts of problems. Depending on its location, the presence of a saddle might cause the roof to be unusually low, contribute to poor drainage, or perhaps just cause confusion about the true direction and extent of the coal seam. By 1879, the information inscribed on underground maps had thus become more extensive, and began to include potentially useful geological information.<sup>64</sup>

<sup>64</sup>The *Oxford English Dictionary* defines “saddle” as: “4. a.: a depression along the axis of an anticline, concave in longitudinal section and convex in transverse section.”

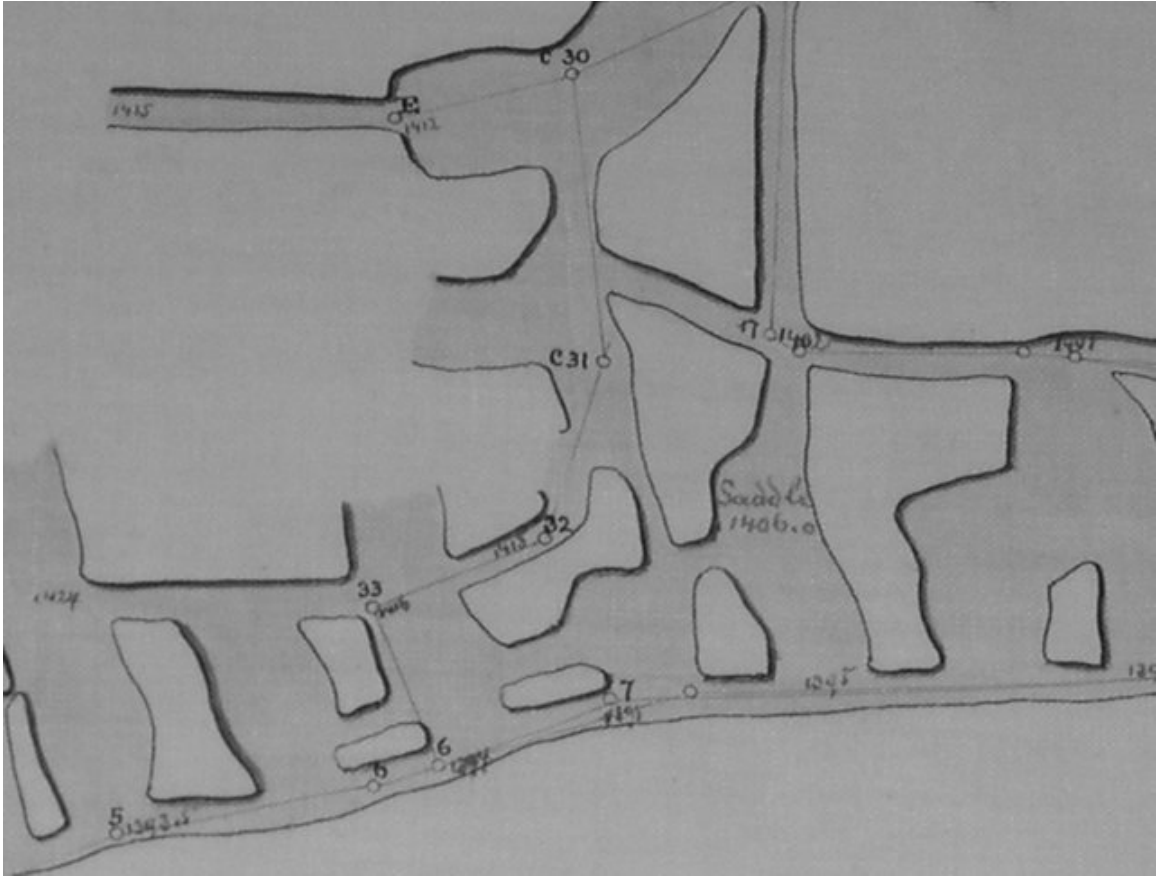


Figure 2.8: Detail of “Underground Workings. 2nd Lift Slope No. 1. Drifton, January 1879,” showing “Saddle” notation, elevation measurements, and numbered surveyors stations. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

## Maps in Boundary Disputes

Maps of underground landscapes often showed only the single property under consideration, but could also be used, like surface maps, for indicating property lines and facilitating action on boundary disputes. A series of maps made by the Coxe operation between the 1880s and 1905 were intended to articulate the company's side in an ongoing boundary dispute with the Highland Colliery, which operated on an adjacent tract of land.<sup>65</sup> The map from 1889, shown in figure 2.9 on page 56, appears similar to the 1879 map above, with shaded effects, numbered surveyors' stations, and elevation measurements. This map also featured, in a pink tint, a proposed boundary between the properties. This boundary pillar, composed of coal, was intended to provide a physical barrier to prevent water from the Highland workings from flooding the lower Coxe works. However, because of excavations that had already taken place, it was necessary to make the physical boundary deviate from the actual property line. Coxe proposed a jagged boundary pillar whose zig-zag course resulted in identical amounts of coal credited to each company, and an even split in ownership of the useless barrier coal. The map was used as a tool to calculate the area of coal transferred, retained, and lost, as can be seen in figure 2.10 on page 57.

The importance of the map for this calculation is clear. A more accurate estimate would have measured *volume*, rather than area, but the map as drawn in two dimensions did not make volume calculations easy. The amounts of the coal (in square

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<sup>65</sup>At least twelve individual maps bound together at the top form Map 14-16, Coxe Map Collection, NMAH. This analysis concentrates on the map marked "Sheet 3 of 12."

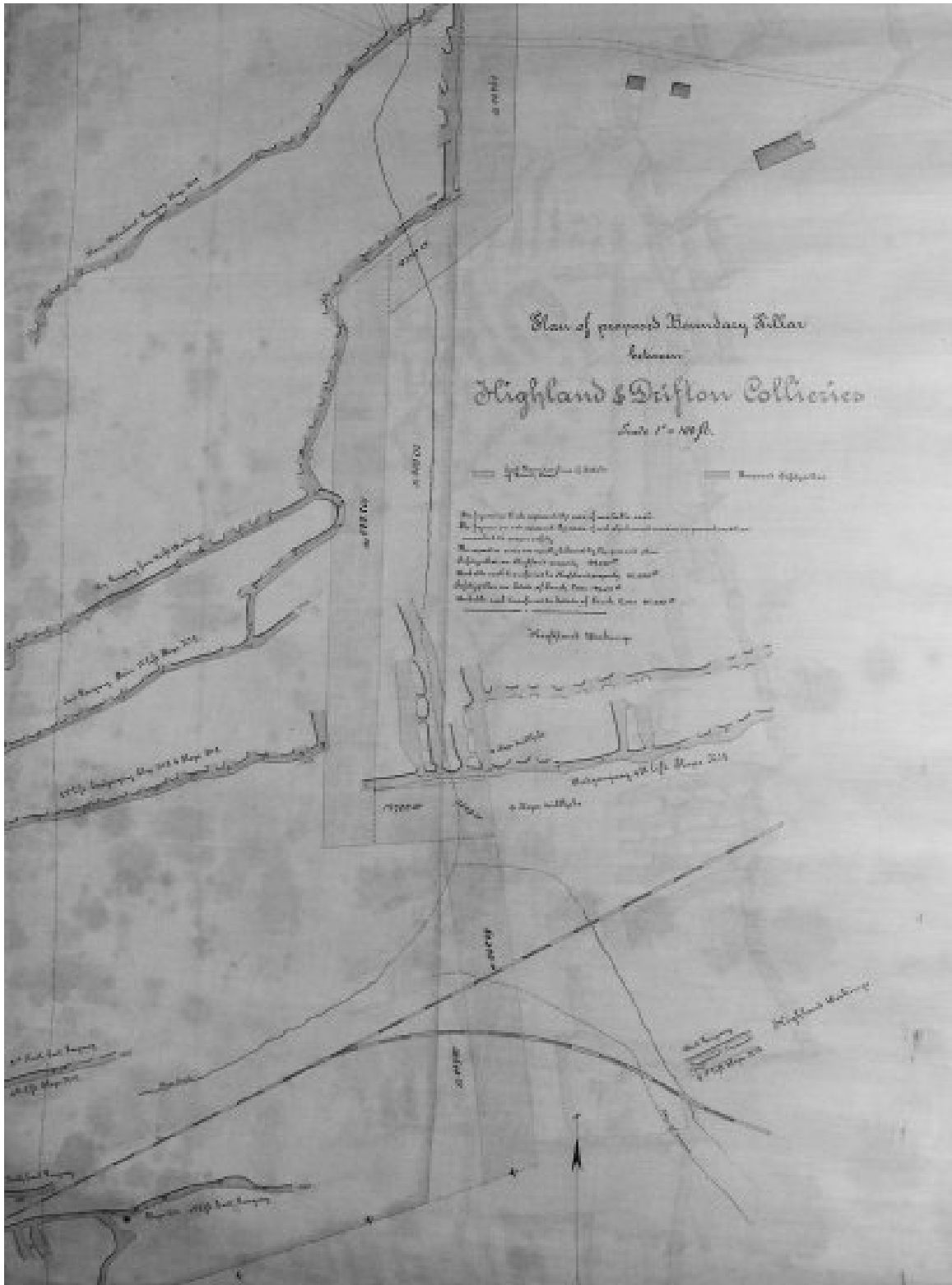


Figure 2.9: “Plan of Proposed Boundary Pillar between Highland and Drifton Collieries,” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

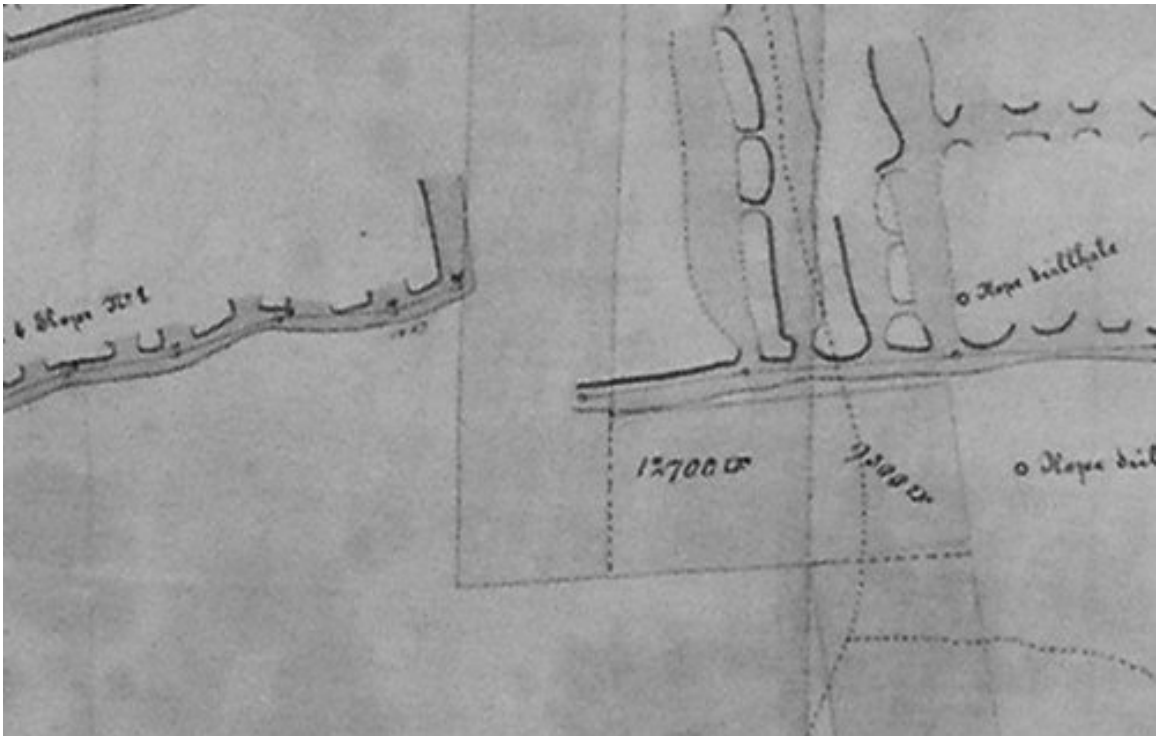


Figure 2.10: Detail of “Plan of Proposed Boundary Pillar...” showing proposed pillar in outline and square footage calculations. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.





Figure 2.11: Later map showing encroachment on the boundary pillar, and timber dam to prevent flooding. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

feet) were inscribed on the relevant portions of the map, and a narrative comparing the two sides was added near the map legend. These efforts to persuade Highland to accept the plan of the Coxes apparently paid off; later maps show the pillar as the agreed-upon line. Other maps in the series, such as one from 1894 shown in figure 2.11, were used to monitor encroachment on the pillar. The workings of the Highland Colliery are seen in outline working through the parallel lines of the boundary pillar, and the timber dam constructed to prevent flooding of Coxe's works is visible as an obstruction across the tunnel on Coxe's side of the map. Maps of this type would have been particularly useful in a legal setting.

### **Large Dynamic Maps, 1905-1928**

After the turn of the twentieth century, surviving maps of the Drifton colliery take on a more dynamic quality. The period was time of turmoil for the company, with the death of Eckley Coxe in 1895 and the sale of the Coxe Brothers & Co. operation to the Lehigh Valley Railroad in 1905. The company continued to mine and market coal, but some of the management changed, and may have brought different mapping techniques with them. Many twentieth-century maps show revisions of a decade or more on a single sheet. Two maps of Drifton No. 2 show evidence of being in use and under construction between 1914 and 1928, perhaps as early as 1905.<sup>66</sup> One

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<sup>66</sup>The maps may have been made as early as 1905, but the earliest positive date evidence they contain is 1914. "Drifton No. 2. Buck Mountain Vein, West End Workings, Bottom Bench, Scale 1" = 100 ft., Revised to 3-1-1919, Revised to 11-24-19, Revised to 5-1-1921, Revised to 1-24-1923, revised to March 1925, Revised to Dec. 1925, Revised to Dec 1927," Map 14-10, Coxe Map Collection, NMAH; "Drifton Slope No. 2, Gamma Vein, West End Workings, Revised March 30, 1918, Revised

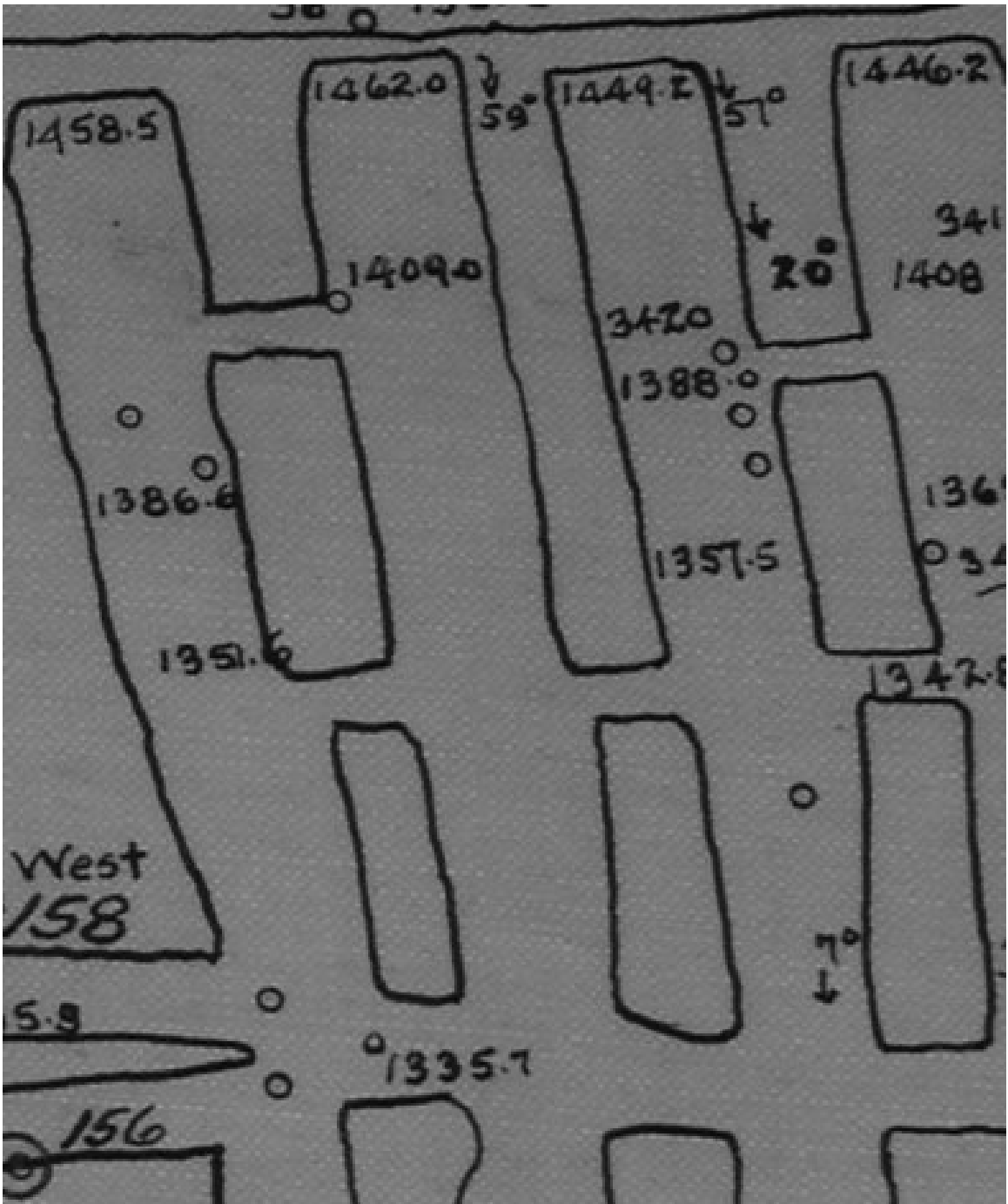


Figure 2.12: Detail from “Drifton No. 2, Buck Mountain Vein, West End Workings, Bottom Bench,” showing steeply pitching breasts. Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

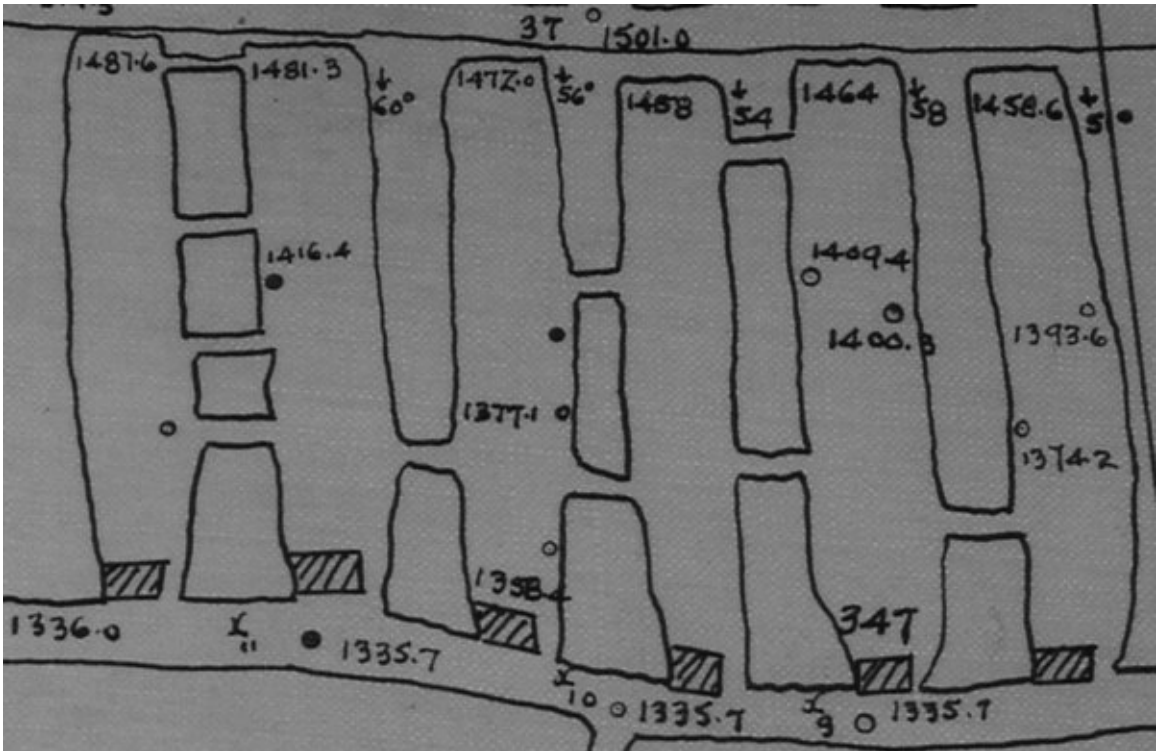


Figure 2.13: Detail showing breasts with feed doors and manways, from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

map showed the workings along the Buck Mountain vein, and the other delineated the works on the Gamma Vein. (These veins would be superimposed on one another if the strata were flat, but in the folded strata near Drifton, both veins inclined steeply and outcropped at the surface.) Both maps show clearly the evolution of such documents to store greater amounts of qualitative and quantitative information.

These maps were 6 1/2 feet and 10 feet long, respectively.

to March 1919, Revised to May 1921, Revised to March 1923, Revised to Dec 1925, Revised to November 1927,” Map 14-11, Coxe Map Collection, NMAH.

The two maps use identical notations, so I will draw my examples from the Buck Mountain Vein map. This map is a simple line drawing, lacking the shaded perspective of earlier maps, and was executed mostly in black ink, but has at least one notation in color, as well as several in pencil plus erasures. The lack of shaded features would have made such a large map faster to draw and easier to reproduce with traced copies or blueprints.

The company inscribed a considerable amount of geological information useful to their operations on this map. For example, the map contains diamond drill hole notations. Some are evidently from an earlier round of diamond drilling and occasionally feature notations on the depth to coal and the size of the coal seam, but others are marked only by a number and a bulls-eye feature. Cropping and pinching of the coal vein was noted directly on the map. Many points on the map, especially in the breasts, show measurements of degrees with an arrow. These indicate the dip of the vein, and are a suggestion of how steep the works are in that area. In some breasts two arrow/degree measurements were used, which presumably indicate both dip and strike.

This map gives some good examples of the steeply pitched breasts needed to extract coal from this mine. The example in figure 2.12 on page 60 has an elevation at the top of the third breast of 1449.2 and a pitch of 57 degrees downhill, but within approximately 50 linear feet has an elevation of 1388.0 (a change of some 61 feet in elevation), and halfway between those two points the pitch is given as 20 degrees

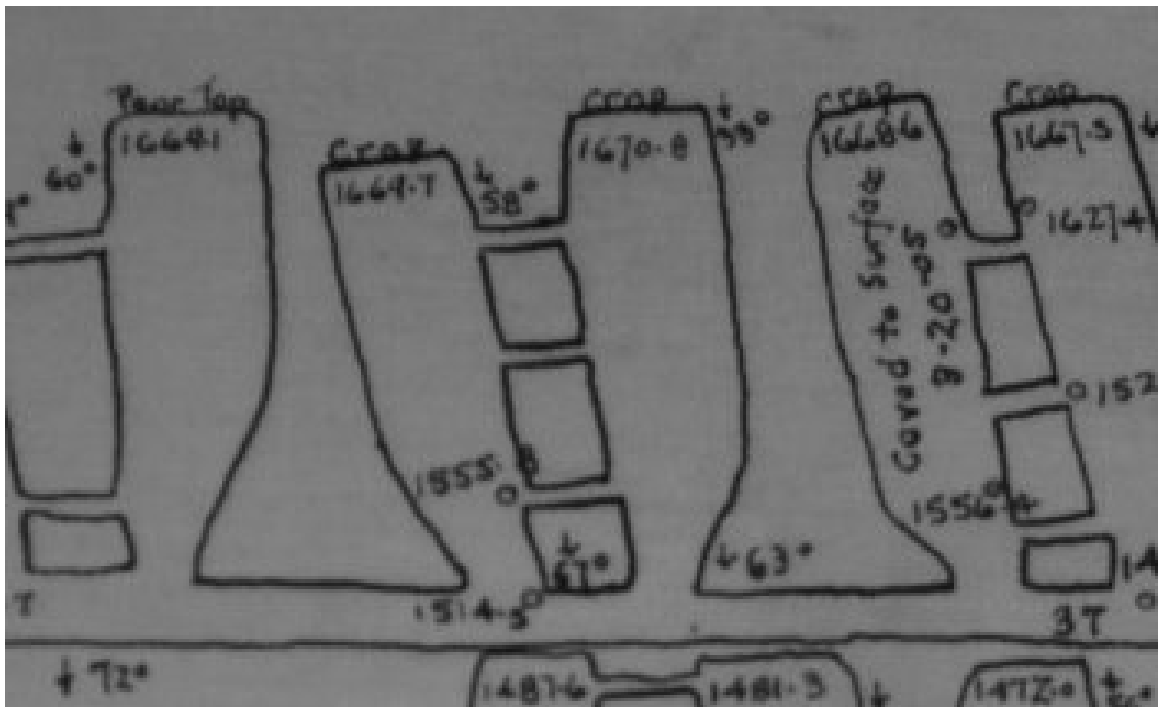


Figure 2.14: Detail showing hazards of vein caving in and cropping to the surface, from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

downhill. Another thirty or forty feet give an elevation of 1357.5 (91.7 vertical feet below the top of the breast), and a passageway 20 or so feet later records 1342.8, a change of 106.4 vertical feet. Another thirty or forty feet downhill records a pitch of only 7 degrees downhill before the gangway is reached at about 1335.7 elevation, 113.5 vertical feet from the top of the breast.

Figure 2.13 on page 61 shows breasts that appear to have an obstruction in them, marked by cross-hatching. These are probably working breasts with the feed doors at the bottom still in place. In breasts that rose at a steep enough angle, miners did not have to shovel coal into cars. Instead, they built a loading chute at the bottom of the breast, and used timbers to create a tiny hallway to one side of the breast, called a manway, for the miners to get in and out of the working space. In these types of spaces, the miner would simply blast down the coal, and it would fill the loading pocket formed by the doors at the bottom of the breast. The next day, the miner would stand on the broken coal to reach the top of the breast to blast down fresh coal. Once the breast had been fully excavated, the loose coal would be withdrawn through the feed doors in the bottom of the breast, directly into coal cars. In figure 2.13, the surveyor's stations are along one extreme edge or the other of the breast, which indicates the presence of a manway there. Also note the consistent elevation of the gangway at the bottom of the breasts, which would facilitate transportation of mined coal in cars pulled by mules or small locomotives.

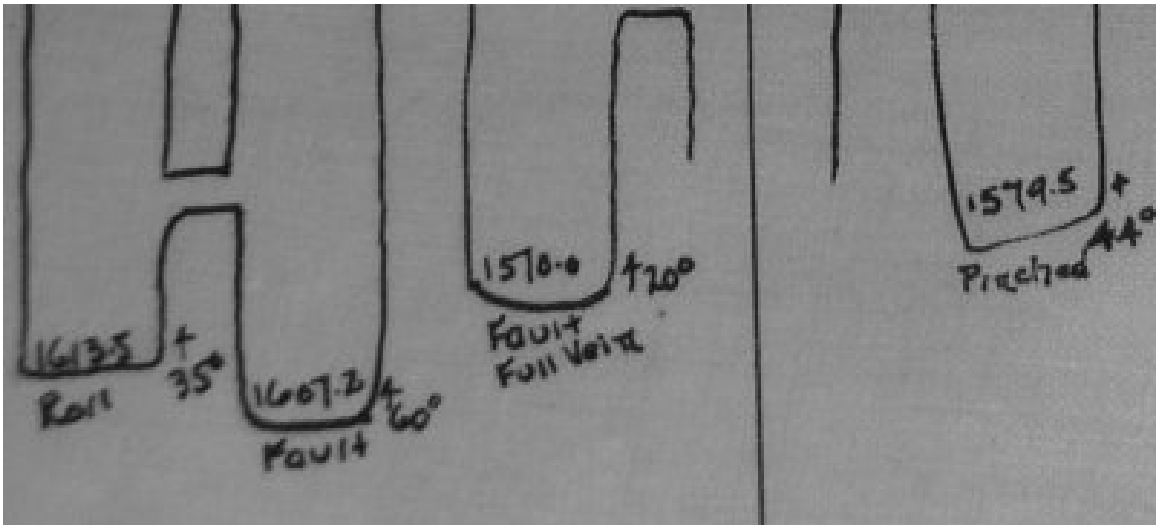


Figure 2.15: Detail showing geological faults, rolls, and pinched vein, from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

This map also gives a considerable amount of information about the work environment of the mine, particularly along the edges of the works as the coal seam approaches the surface and work becomes more hazardous. By this time, the company was actively engaged in robbing the pillars in older workings, as indicated by notes such as “To West Line of George Moore [Tract] Top and Bottom Robbed Oct. 1905.”

Many breasts on the map terminate with the term “Crop,” but one has the notation “Caved to Surface, 3-20-05”, and another says “Poor Top.” (See figure 2.14 on page 63.) The unstable nature of the mine is evident in many places on the map. A surface cave-in is indicated by a circular feature with hatchures, labeled “7-12-14, 32’ Deep,” and a different portion of the map contains some indeterminate-looking surveys and



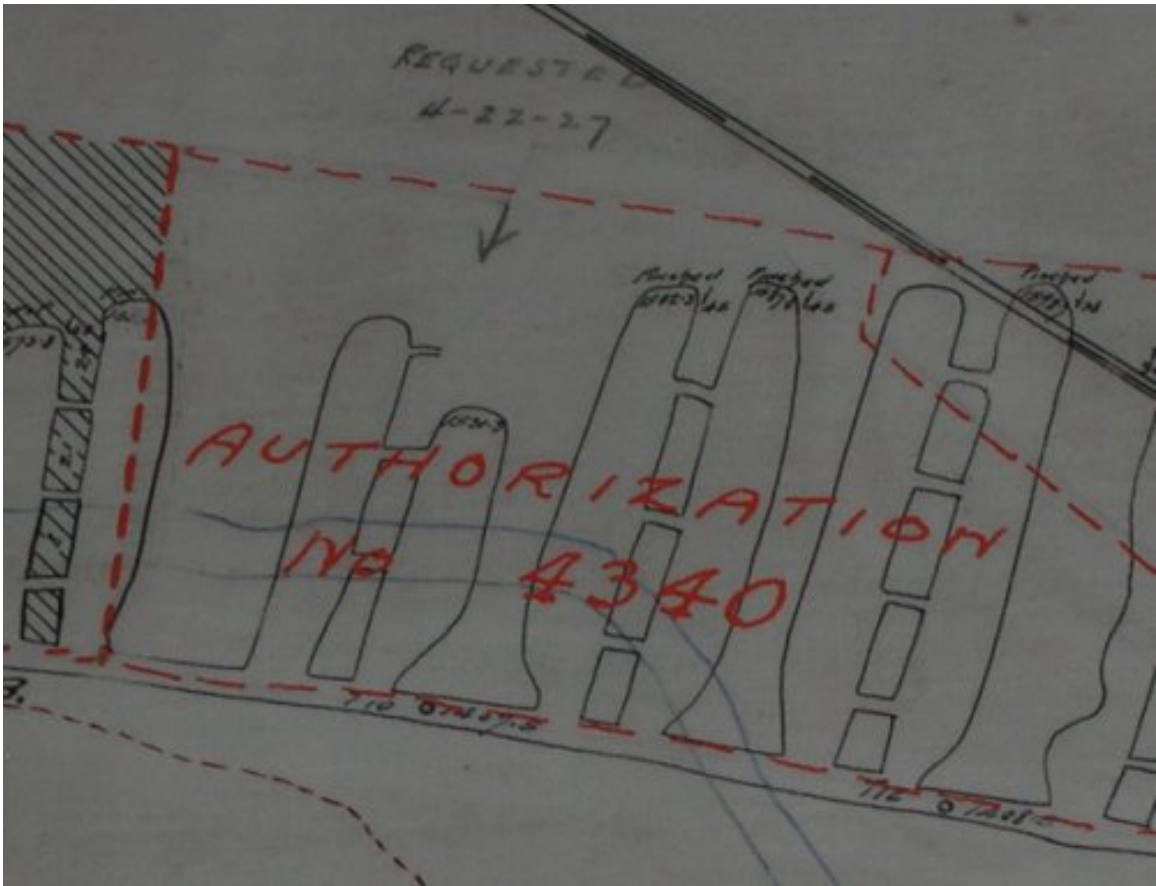


Figure 2.16: Detail showing robbing authorization, from from “Drifton No. 2, Buck Mountain Vein...” Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

the note “7-2-14 Not Safe to Go Farther.” Many notations on individual breasts in figure 2.15 – “Roll”, “Full Vein Roll”, “Pinched”, “Pinched Full Vein”, “Fault”, and “Fault Full Vein” – explain the geology of the coal seam. Taken together, these notations suggest the power of the map to collect and store important information about the always-hazardous underground environment.

Larger robbing projects were indicated, as in figure 2.16, by a dotted line in orange ink surrounding an area on the map, with “Authorization” and a number. A future authorization appeared on the map first in pencil, with the notation “Requested 4-22-27.” This authorization number referred to a series of forms and blueprinted partial maps, stored in the files of the Engineering Office, that detailed the probable damage and production yields of the proposed robbing operation. Once approved by management, the robbing was permitted to commence.<sup>67</sup>

## Conclusion

Looking at a span of maps from 1870 to 1928, of a single mine in a single place, can clarify some long term trends. Most importantly, the maps become useful as a representation of the underground. The early maps would be of little use to someone not already intimately familiar with the Drifton works, but the most recent maps provide enough information to enable someone unfamiliar with the place but familiar with the engineering language they employ to have a good appreciation of the status of the mine. As a result, the most powerful knowledge associated with the first maps - local knowledge, of the sort possessed by miners - gives way in importance to engineering and management knowledge, which harvests data about the status of the underground, encodes it in numbers, symbols and words, and inscribes it on a

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<sup>67</sup>Authorization #4340, Folder 6, “Drifton, 1923-1936,” Box 737, “Pillar Mining Authorizations, Drifton Colliery, 1923-1936,” Collection 3005, Coxe Family Mining Papers, Historical Society of Pennsylvania.

map. This shift is associated with the increasing utility of the map as a basis for decision-making by managers removed from the immediate context of underground work. It is also evidence of and a tool for the solidification of engineers' control over underground work. Mines are highly difficult places to fully control, and it would be a mistake to describe anthracite miners in particular as mere cogs in a machine;<sup>68</sup> but it is safe to say that over time management and the engineers making decisions about the construction and destruction of underground landscapes became much more powerful, made more coordinated decisions about the development of the space, and differentiated themselves more completely from the workforce. A skilled miner in 1870 was more likely to be able to make the leap into management's ranks than his counterpart in 1928; the gap in the latter case consisted in part of a professional education, and a specialized, visual, language of representation and control.<sup>69</sup>

The Coxe maps also illustrated the increasing use of maps to store a wide variety of data, particularly quantitative data. This data took two forms. The first form was hypertextual. Over time, the maps increasingly referred to other documents - first, surveyor's notebooks, but later work authorizations, borehole logs, and the like. The other trend was the increasing amount of data stored on the map itself. Later maps were not merely two-dimensional pictures of a bird's-eye view of the underground (as was the 1870 map in figure 2.3), but also described geology, elevation, work controls, and fine-grained information about the stability of the workplace.

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<sup>68</sup>See Harold W. Aurand, *Coalcracker Culture: Work and Values in Pennsylvania Anthracite* (Selinsgrove, PA: Susquehanna University Press, 2003), 70-81.

<sup>69</sup>Lubar, "Representation and Power."; Ferguson, "Mind's Eye."

In conclusion, mine maps are a rich and hitherto underutilized resource to help historians understand underground landscapes. Such maps were certainly important tools for mining engineers. Maps helped mining engineers visualize the places they were creating and managing, and served as an instrument of organizational power. Maps gave engineers a canvas on which to imagine future expansion. Maps facilitated communication with other engineers and with mine managers, and were useful to store data about the mine. Maps are also compelling sources of historical information. They give us a certain sense of the work environment of miners, at least as it was seen by those responsible for the miner's work orders. Their artifactual presence gives us clues about how nineteenth century society struggled with information - both its lack and its abundance. In sum, recognizing the historical importance of mine maps gives us fresh ways to look into spaces at the heart of industrial America.

# Chapter 3

## Blueprints

## Introduction

The term “blueprint” became a synonym for “plan” at least as early as 1926, according to the Oxford English Dictionary. This linguistic shift suggests the ease with which blueprints stood in for the original drawing, whether it be an architectural drawing, an engineering diagram, or a mine map. Since the message – the drawing – was duplicated perfectly by the blueprint process, the medium itself was overlooked. However, the introduction of the blueprint process spurred dramatic changes in how businesses, including mining companies, were organized both spatially and conceptually. Blueprints helped consolidate authority in the space of the engineering office and in the hands of upper management. This change did not happen all at once, or evenly within a firm, for engineers did not immediately adopt blueprints as soon as the technology became available. Instead, engineers only gradually figured out how to use blueprinting to their advantage and increase efficiencies in administration. In this chapter, I will survey the history of blueprints and of the technical infrastructure required to support the widespread creation and use of maps, drawings, and blueprints associated with mining operations in the late 19th and early 20th centuries. The technological characteristics of blueprints spurred engineers to change their practices and technological infrastructure in order to take advantage of the efficiencies that blueprints could offer, and in so doing changed the role and importance of visual representations in their companies. These changes extended to work itself, both in terms of the authority to do mining work and the labor of creating blueprints.

Near the end of the 19th and beginning of the 20th centuries, as engineers were more solidly in charge of operations, the importance of maps, drawings, and blueprints to companies became undeniable and individual mining companies developed and deployed systems of creating, organizing, and using them. These support networks were absolutely critical to the effective use of visual representations, and like other types of infrastructure, they demanded specialized spaces, equipment, and laborers. I will draw examples primarily from the Calumet and Hecla Mining Company (C&H) and the Quincy Mining Company. These two companies were the longest-lived and most successful companies that mined the native copper deposits of the Keweenaw Peninsula in the Upper Peninsula of Michigan. The office buildings of both companies are now part of the Keweenaw National Historical Park, and much of the physical infrastructure is still extant.<sup>1</sup>

## Blueprints

Historian JoAnne Yates recognized the importance of communication technologies to the growth of American firms in general in this time period, and specifically

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<sup>1</sup> Larry Lankton, *Cradle to Grave: Life, Work, and Death at the Lake Superior Copper Mines* (New York: Oxford University Press, 1991) is an excellent history of the Lake Superior copper district, which gives considerable space to both C&H and the Quincy. Larry D. Lankton and Charles K. Hyde, *Old Reliable: An Illustrated History of the Quincy Mining Company* (Hancock, MI: Quincy Mine Hoist Association, 1982) is a history of Quincy specifically, based on earlier work done by Lankton and Hyde for the Historic American Engineering Record (HAER). When Lankton and Hyde conducted their early work, the historical integrity of the Quincy office was extraordinary, as though the managers had simply walked away. Author conversation with Dr. Larry Lankton, July 25, 2006, Houghton, MI. The Michigan Technological University Archives and Copper Country Historical Collections hold a large amount of excellent primary source material for both C&H and Quincy; the Keweenaw NHP archives are smaller and less comprehensive, but they care for extensive collections of artifacts.

highlights the key role played by duplicating or reproduction technologies. Yates examines duplication of correspondence through copy books, letter press books, rotary presses, and carbon paper, which were all tools that enabled the creation of an additional copy at or very near the time that the original document was created.<sup>2</sup> She also briefly discusses the development of the photostat machine, which, after the turn of the century, permitted duplication of documents after they were made.<sup>3</sup> Yates leaves unmentioned the practice of blueprinting or sun-copying, a process commonly associated with the building trades but with wide applicability to any industry that utilized oversize visual representations such as underground maps. Like the much-later photostat and unlike copy books, blueprints could be made at any time after the creation of the original document.

Dating extant blueprints can be difficult, because it was relatively easy to make a more recent undated print of an older, dated map. It seems that blueprinting began to appear in the American mining industry in the late 1870s, but did not become a regular part of the everyday information flow in a mining context until later, probably around the turn of the century.

The basic ferro-prussiate formula for producing sensitive paper that turned prussian blue when exposed to sunlight was discovered by John Herschel during his experimentation with photographic processes in the late 1830s and early 1840s.<sup>4</sup> The

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<sup>2</sup>JoAnne Yates, *Control Through Communication: The Rise of System in American Management* (Baltimore: Johns Hopkins University Press, 1989), 21-64.

<sup>3</sup> Yates, *Control Through Communication*, 45-56.

<sup>4</sup> John Frederick William Herschel, "On Certain Improvements on Photographic Processes Described in a Former Communication," *Abstracts of the Papers Printed in the Philosophical Transac-*



process saw some use by photographers as a way to produce a cheap print of a negative before making a proper print. The use of the process to copy drawings was apparently first introduced in Europe, but was essentially unknown in the United States until the 1870s.

P. Barnes offered one of the earliest descriptions of the blueprinting process in the American technical press. In his 1878 address to the American Institute of Mining Engineers, he credited the introduction of the blueprinting process in the U.S. to Alexander Lyman Holley, a well-read and well-traveled American engineer most famous for the perfection of the Bessemer steel making process in the United States.<sup>5</sup> Barnes also pointed out that Ogden Haight had brought up a discussion of the procedure at an earlier AIME meeting in February 1877. Haight's paper, "On Ferro-Prussiate Paper for Copying Drawings," was read to the Institute, but was not published in the *Transactions* of the society.<sup>6</sup> Barnes brought samples of tracings copied by the pro-

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*tions of the Royal Society of London* 4 (1837): 398–399; John Frederick William Herschel, "On the Action of the Rays of the Solar Spectrum on Vegetable Colours [Abstract]," *Abstracts of the Papers Printed in the Philosophical Transactions of the Royal Society of London* 4 (1837): 393–394; John Frederick William Herschel, "On the Action of the Rays of the Solar Spectrum on Vegetable Colours [Abstract]," *Abstracts of the Papers Printed in the Philosophical Transactions of the Royal Society of London* 4 (1837): 397–398; John F. W. Herschel, "On the Chemical Action of the Rays of the Solar Spectrum on Preparations of Silver and other Substances, Both Metallic and Non-Metallic; and on Some Photographic Processes [Abstract]," *Abstracts of the Papers Printed in the Philosophical Transactions of the Royal Society of London* 4 (1837): 205–210; John F. W. Herschel, "On the Chemical Action of the Rays of the Solar Spectrum on Preparations of Silver and Other Substances, Both Metallic and Non-Metallic, and on Some Photographic Processes," *Philosophical Transactions of the Royal Society of London* 130 (1840): 1–59; John F. W. Herschel, "On the Action of the Rays of the Solar Spectrum on Vegetable Colours, and on Some New Photographic Processes," *Philosophical Transactions of the Royal Society of London* 132 (1842): 181–214.

<sup>5</sup> P. Barnes, "Note Upon the 'Blue' Process of Copying Tracings Etc." *Transactions of the American Institute of Mining Engineers* 6 (1879): 197, in footnote.

<sup>6</sup> Barnes, "Note Upon the 'Blue' Process," 197, in footnote; note of Haight's paper appears in *Transactions of the American Institute of Mining Engineers* 5 (1878): 48.

cess with him, to show his audience of mining engineers. “Some of these show slight imperfections, depending upon the character of the tracing, and upon the length of the exposure to the light, but it may be clearly seen that even a faint copy would be quite available for actual use.”<sup>7</sup> Barnes advocated creating the blueprints by using a flat board, larger than the tracing, covered with a thickness or two of blankets, “to give a slightly yielding backing for the paper.” Next, the sensitized paper would be placed down, sensitive side up, followed by the tracing; after which the whole assembly would be covered with a sheet of clear plate glass and set in strong light.<sup>8</sup> Given the focus of later blueprint machine refinements on the tightness of the fit between the tracing and the paper, the imperfections in the blueprints demonstrated by Barnes might be attributable to the loose fit of his blueprint “frame.” This probably did not matter, however, as taking dimensions directly from drawings was not at all common in the shop practice of the late 1870s, and the Barnes-style prints would indeed be good enough for getting a close idea of a drawing.<sup>9</sup>

Barnes also offered his audience a formula for the sensitizing solution to be sponged onto the paper. He suggested two solutions: 1 7/8 oz. citrate of iron and ammonia together with 8 oz. clean water, and 1 1/4 oz. red prussiate of potash and 8 oz. clean water; these two solutions were then mixed together in a light-proof bottle.

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<sup>7</sup> Barnes, “Note Upon the ‘Blue’ Process,” 197.

<sup>8</sup> Barnes, “Note Upon the ‘Blue’ Process,” 197.

<sup>9</sup>On shop practice, see John K. Brown, *The Baldwin Locomotive Works, 1831-1915: A Study in American Industrial Practice* (Baltimore: Johns Hopkins University Press, 1995), 171-172, 177-179. For a mine map, the precision might matter even less than drawings, depending on the accuracy of the surveys.

This solution, according to later writers, worked well but slowly, which explains why Barnes suggested a “clear sunlight” exposure of anywhere from six to ten minutes, or an exposure of half an hour or forty-five minutes if conducted indoors near a skylight. If the sky was cloudy, an hour or hour and a half might be necessary.<sup>10</sup>

Since most engineering drawings at the time were made in pencil on heavy paper, inked in, then traced onto tracing linen if a copy was needed, Barnes recommended a slight change in procedure to save time if a blueprint was planned. “Inasmuch as such copies can be made from tracings only, it may be well to suggest, and urge, that drawings can be completed or nearly so in pencil upon paper in the usual way, and that all the inking can be done upon tracing-cloth laid upon the pencil work.” In Barnes’ scheme, the tracing-cloth copy becomes the main drawing, and the blueprint takes the place of the traced copy, except with less time and effort expended. This shift laid out by Barnes did eventually take place at mining companies, such as Quincy and C&H, when they adopted the blueprint process. Barnes finished his paper by noting the promise of the new process, though his horizons were clearly limited both by the unexplored potential of the procedure and the realities of shop practice in 1878:

It may safely be said that this method of copying can be employed if only one or two copies per week are needed of ordinarily complex drawings, with excellent results and with a very important saving of time and money.<sup>11</sup>

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<sup>10</sup> Barnes, “Note Upon the ‘Blue’ Process,” 197-198.

<sup>11</sup> Barnes, “Note Upon the ‘Blue’ Process,” 198.

Producing a blueprint required at least three distinct types of technology – sensitized paper, light application machines such as sun-frames, and washing or developing solutions. Unlike complete-system solutions, each type of technology depended relatively little on the others. For example, no matter what sort of sensitizing process was used (the popular ferro-prussiate, the unusual uranic, or the custom Pellet were examples), the solar frames or arc lamp machines were the same. Each process merely received a greater or lesser amount of time in the sun or light. Many of the processes used a simple water bath to develop the print. Some of the more exotic processes, such as the Pellet, used acidic baths that required non-metallic developing sinks, but the same lead-lined tub or beeswax-coated wooden tray could be used for several different developing processes. The result of this disconnection between the steps of the process was that it was relatively easy to innovate in small steps, for example by mixing a slightly different formula, trying some new factory-made sensitive paper instead of making one’s own, or building a different sort of frame for larger-than-usual blueprints. The other steps and technologies used did not usually need to change in order to innovate.

Until around the turn of the 20th century, the only way to create a blueprint was to expose a drawing and sensitized paper to the sun, often for fifteen minutes or more. While Barnes described using a board and a piece of plate glass to produce the blueprints in his early article, by the late years of the 19th century, specialized apparatus (probably derived originally from smaller examples used to print photographs)



Figure 3.1: Solar blueprinting machine on rails, in situ in the Quincy Mining Company Office Building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006.

were in use to produce blueprints using sunlight. The tracing and the sensitized blueprint sheet were inserted in a wooden frame that kept them squeezed together, then the whole assembly was set outside.

The Quincy Mining Company office building outside of Hancock, Michigan has one of these sun-copying machines still in place, shown in figure 3.1. When the building was constructed in 1896-7, the attic was devoted to the production of photographs

and blueprints for the engineers working in the floors below. The sun-copying device consisted of a sturdy wooden frame with a thick glass top on one side, and a system of hinged wooden shutters and spring clips on the other. The shutters would be moved aside, the tracing and sensitized paper would be inserted carefully into the frame followed by a thick felt or rubber pad to distribute the pressure evenly. Then the shutters would be replaced and the clips would hold everything tightly in place, with the drawing and paper against the glass. A tight fit was important, since variations in the pressure exerted by the springs would cause blurry lines on the blueprint copy.<sup>12</sup>

The frame was mounted on two end-pivots attached to a stand, so that it could rotate along the long axis of its rectangular form. The stand sat upon a set of tracks, set into the floor, pointed at the window which opened at floor-level. Thus, the whole frame and stand could be pushed on its tracks out the open window, and the frame could be pivoted to face the sun. (If the blueprint shop was on a ground-level floor, the frame would have casters and be pushed outside through an open door.) A disc mounted on the end provided a means to lock the frame at one of several angles by inserting a pin in one of the holes on the outer edge of the disc, so as to prevent the assembly from moving in a high wind.

It is easy to see why this blueprinting technology forced the production of blueprints of no more than a certain size. It is also not a coincidence that most of the extant

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<sup>12</sup>It was not clear from this author's investigation whether the rubber or felt pad was still in place, or used at all, in the Quincy sun-copying frame, but Brown says their use was standard in such apparatus. George E. Brown, *Ferric and Heliographic Processes: A Handbook for Photographers, Draughtsmen, and Sun Printers* (New York: Tennant & Ward, 1900), 62.

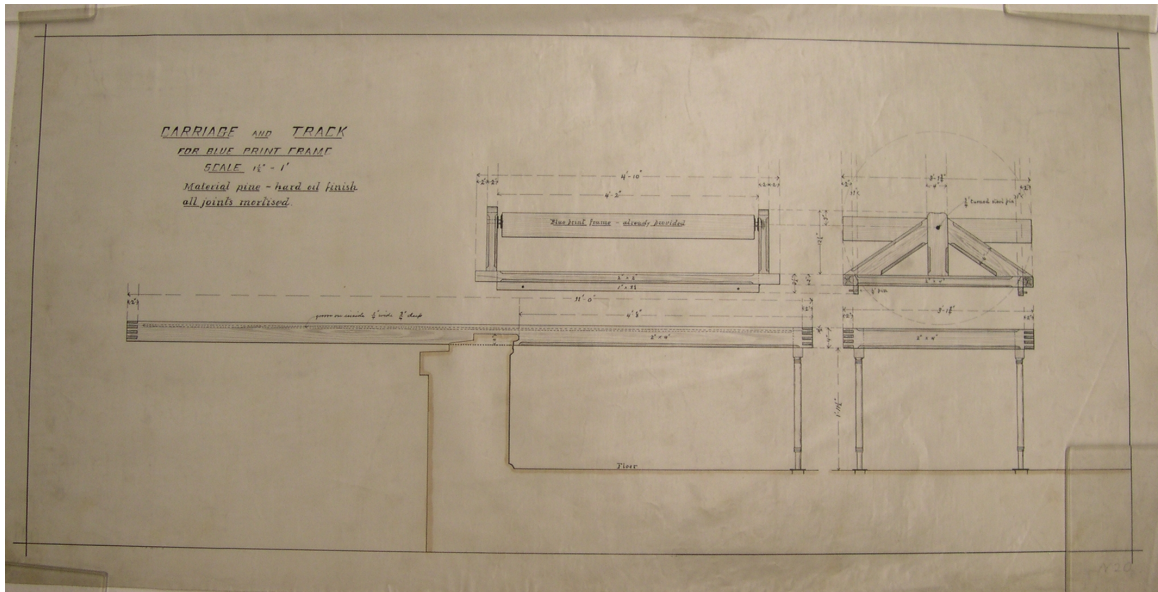


Figure 3.2: Drawing of Solar Blueprint Machine. Note section of window sill. From Calumet and Hecla Mining Company Papers, Michigan Technological University Archives. Photo by Eric Nystrom, 2006.

blueprints and tracings from the Quincy Mining Company operations are slightly smaller than the maximum dimensions of this frame. Frames themselves varied in size, but the weight and the expense of very large sheets of glass strong enough to withstand the pressure of the springs tended to preclude the construction of frames much larger than those used at Quincy.

The Quincy was not alone in using a device of this type for making blueprints. The records of the Calumet and Hecla Mining Company contain an undated drawing, probably from the late 19th century, that depicts a new stand for an existing blueprinting frame, seen in figure 3.2. The tracks of the device pass straight through what is clearly a section of a window sill.<sup>13</sup>

<sup>13</sup>The drawing cannot conclusively be credited to the Calumet and Hecla, since drawings from companies acquired by the C&H also appear in this collection. The style of writing on the drawing

Blueprints were made on paper that had been coated with a mixture of iron salts and other compounds so as to make them sensitive to the action of sunlight. One very common mixture was a solution of ferric ammonium citrate and potassium ferricyanide, both dissolved in water, but manufacturers of light-sensitive blueprint paper often had their own proprietary formulas. The light-sensitive solutions for blueprinting were relatively easy and inexpensive to prepare according to various formulas that were widely circulated. Once the solution had been mixed, it would stay fresh for several months or more in a dark bottle. To make the blueprint paper, the solution was filtered, then rubbed on the paper with a soft sponge and hung in a dark, warm place to dry. After it dried, the paper was kept stored in a dark place, such as a darkroom or a light-proof tin tube. Some of the more elaborate heliographic processes required specialized paper to achieve consistent results, but the basic and widespread ferro-prussiate process could be applied to paper of almost any grade. Some experts recommended that even relatively small blueprinting operations make their own light-sensitive paper instead of buying commercially-made pre-sensitized paper, since the paper tended to degrade over time and locally-made paper could be of assured quality and freshness.<sup>14</sup>

The widespread ferro-prussiate blueprint process, as well as several other less common processes in use before the 1920s, required the exposed blueprint paper to

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suggests that it was created in the 19th century. "Carriage and Track for Blue Print Frame," Box B4, Calumet and Hecla Unprocessed Drawings, Michigan Technological University Archives, Houghton, MI.

<sup>14</sup> Brown, *Ferric and Heliographic Processes*, 7-10, 50-53.





Figure 3.3: Blueprint Developing Sink. Note faucet. Artifact in situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006.

be washed in plain, cold water for a half-hour or more in order to fix and develop the print.<sup>15</sup> The washed prints were then hung to dry. In the attic of the Quincy Mine office building, next to the solar frame, the company installed a specialized sink for washing blueprints, seen in figure 3.3. The galvanized tub of the sink was very shallow, only a couple inches deep, but was of a wide rectangular shape that corresponded with the size of the solar frame.

The zinc-coated tub offered further proof that the common ferro-prussiate formula, or a closely-related process, was used by Quincy, since other processes required a lead-lined or other non-reactive tub for developing. For example, the Pellet process and ferro-cyanide process needed non-reactive tubs, made from papier maché, wax-coated wood, or, in the case of a permanent installation, lead-lined pine. The common ferro-prussiate process required no such special equipment, since it did not require any chemicals beyond water to develop the print.<sup>16</sup> Several boards with stains from blueprint solution, visible in figure 3.3, may have been used to hold the print flat while rinsing, or were perhaps used to hold a sheet of paper flat while it was coated with the blueprint mixture to sensitize it.

In 1898, B.J. Hall of England invented a cylindrical blue printing machine that used an arc lamp instead of the sun to expose the image. The original, on tracing paper, and the sensitized blueprint paper were applied to the outside of a vertical glass cylinder, then held in place with a roll of paper or a flexible curtain. Hall had lots

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<sup>15</sup> Brown, *Ferric and Heliographic Processes*, 9-10.

<sup>16</sup> Brown, *Ferric and Heliographic Processes*, 70-71.

of imitators. Many inventors quickly made improvements to the basic idea, resulting in a variety of machines made by a panoply of small manufacturers, all operating on the same basic principles with only minor differences distinguishing them. By 1905, a majority of blueprints were being made on the vertical machines, though the simple and inexpensive solar frames remained in use in many areas.

Sometime after 1905 the Quincy Mining Company installed a vertical blueprint machine made by the Buckeye Engine Company of Salem, Ohio, in the attic of their Office Building, alongside their earlier solar frame blueprinting machine, and close enough to their galvanized blueprint rinsing sink so as to be convenient.<sup>17</sup> (See figure 3.4.) The new machine would have made the creation of blueprints both a faster process and less subject to available sunlight. (The latter might have been a particularly important consideration due to the long Upper Peninsula winter.) At least a portion of the overall Quincy blueprint production grew at about the same time. Beginning in January 1907, the company began producing for internal use a series of small-scale, blueprinted maps that showed overall monthly progress.<sup>18</sup> These maps were made from a master tracing that was clearly designed to be blueprinted, with a black title block (which appeared white on the blueprints) so that the date could be filled in, and with cross-hatching instead of color to indicate past work. For each month, a

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<sup>17</sup>The machine included a plate with the credit, and the patent number 784,473, issued March 7, 1905. The patent was for the counterweighted ratchet mechanism for moving the arclight in the tube, and the system of pulleys that held the curtain in place, which in turn held the drawings fast to the surface of the cylinder.

<sup>18</sup>“Longitudinal Sections of Pewabic Loads,” Drawers E-J, Accession number KEWE-00033, Quincy Mine Records, Keweenaw National Historical Park Archives, Calumet MI.



Figure 3.4: Arc Lamp Blueprint Machine, in situ in the attic of the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo courtesy of the National Park Service, 2001.

copy would be made, and in orange grease pencil, the month's progress in the mine would be colored on the blueprint (along with the date on the legend). This work would be added in cross-hatching to the tracing, then the following month, another blueprint would be made and updated. The result was a folio of blueprints vividly showing the month-by-month growth of the mine spaces. The Quincy continued to produce these monthly updates until 1926, almost the end of the life of the mine.

It is not known for certain that the new vertical blueprint machine made possible the Quincy's monthly progress blueprints, but the close correspondence between the creation of the machine, which was made no earlier than 1905, and the beginning of the blueprint series in January 1907, is at least suggestive of the point. By the turn of the century, the Quincy was an old, complex, deep mine, which posed far greater challenges to its engineers than would a brand-new mine that had been entirely excavated and documented with modern technology. Historians have indicated that, due to the greater control necessary because of the age of the Quincy's underground works, the Quincy's clerical staff grew significantly larger and "began to generate a mountain of paper records," circa 1905.<sup>19</sup> Certainly, increased production of blueprints would have aided this agenda. Use of the solar frame machine on a monthly basis year-round would have been difficult to achieve consistently. The potential alternative, where information for updates piled up until several batch updates were possible, seems unlikely, since by that point the utility of a monthly record would have been diminished,

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<sup>19</sup>Lankton and Hyde, *Old Reliable: An Illustrated History of the Quincy Mining Company*, 82, 103.

and the labor involved would have been less worth the trouble, especially since the master tracing was updated with cross-hatching between each monthly blueprint. The Quincy's acquisition of an arc-light blueprinting machine made it even easier for the company's engineers to create and use more temporal visual representations, which permitted them an even more finely-grained level of control over the production of the underground mine.

The availability of electric blueprint machines certainly created precisely this increase in blueprint production in machine shops. In a 1901 presentation to the annual meeting of the American Society of Mechanical Engineers, H.G. Reist described the new custom processes and equipment he had developed in his blueprint shop at General Electric. In particular, Reist began experimenting with electric light for blueprint making because of the effects of the long winter on a large enterprise such as GE:

In large manufacturing establishments the short and frequently dark and cloudy days of winter are the occasion of great inconvenience and delay in the production of blue-prints. A printing plant suitable for making the required number of prints in summer will be entirely inadequate for the same production in winter. Unfortunately, this is a department which ordinarily cannot be worked overtime in order to make up for the loss.<sup>20</sup>

Reist's team began by installing 9 arc lamps in an array suspended from the ceiling about 18 inches apart. Custom-built reflectors directed the light from these lamps downward to the standard solar-frame blueprint machines rolled into position below. Later, Reist refined his homemade equipment, with rectangular reflectors, painted

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<sup>20</sup> H.G. Reist, "Blue-Printing by Electric Light," *Transactions of the American Society of Mechanical Engineers* 22 (1901): 888.

with white enamel on the inside, which were slightly larger than the sun-frames. A track system allowed Reist to position 5 sun-frames in a row, so that the modified lamp could be placed over each in turn, and moved easily to the next with its fresh charge. Though printing with electric light took three or four times as long as did making a blueprint in the Schenectady summer sunlight, the convenience of not having to deal with the weather and moving the frames made up for the cost of the electricity. Reist calculated that the average cost of a solar print, worked out over the year, was 2.39 cents, and that of a blueprint made with an arc-light, including the electricity but not the cost of the equipment, was 2.09 cents.<sup>21</sup> Reist thought the new technology had a promising future, not only because it eliminated the impact of the vagaries of the weather on blueprinting, but because of its compactness and decreased likelihood of making unusable prints due to the consistent exposure levels. Reist concluded that “It will often be found an advantage to use electric light printing as a supplement to the ordinary method, even if the latter method is not entirely superseded.”<sup>22</sup>

The discussion among practicing engineers (and ASME members) that followed Reist’s presentation showed that blueprints and blueprinting were in rather wide use, but that no national set of practices or equipment had yet been formulated. While the formula for ferro-prussiate blueprinting was well known and familiarity with the sun-frame equipment seemed fundamental, each of the engineers who spoke after Reist’s

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<sup>21</sup> Reist, “Blue-Printing by Electric Light,” 888-893.

<sup>22</sup> Reist, “Blue-Printing by Electric Light,” 893.

presentation was clearly confronting similar issues with blueprinting, and they sought ideas and inspiration from one another.

John Balch Blood brought the attention of the engineers to a vertical tube-style blueprint machine that had been advertised in a British engineering magazine. This machine, which was similar to the machine used at the Quincy Mine Office, retailed for about \$133, without the arc lamp and winding mechanism.<sup>23</sup> Blood also pointed out that Reist's frames were unnecessarily heavy-duty for the sort of indoor work the author had outlined, and suggested simpler, cheaper ones made only from a piece of heavy glass and a soft backing pad.

S.L.G. Knox believed that Reist had underestimated the true savings of converting to electricity. "We are arranging now to do all of our blue-printing by electric light, even though the sun is shining brightly, because we find that we can do it cheaper than we can by pushing the frames outside and tilting them to the sun and then dragging them back inside again."<sup>24</sup> Knox pointed out that one of the major limitations of the solar method was the "ability and strength of the boys to handle these frames." The time savings resulted not from the exposure time, which was certainly shorter for solar prints, but from the time saved from moving the frame in and out of the building between prints. Knox also told his audience about the managerial changes the electric blueprint method had prompted in his firm:

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<sup>23</sup> Reist, "Blue-Printing by Electric Light," 894; Blood referred to *London Engineering*, May 3, 1901, 58. The price was given in the advertisement in British pounds, and Blood estimated its American cost.

<sup>24</sup> Reist, "Blue-Printing by Electric Light," 896.



Another important thing is this. Nobody thinks of sending out a letter on a business matter without keeping a copy of it, but frequently we have had to prepare and send out rush drawings in answer to a telegram, perhaps late in the afternoon on a rainy day when we could not make prints, and the result was that we sent away sketches which we were afterwards obliged to ask the recipient to send back to us. With this process of electric-light printing, we can get an order at 29 minutes past 5, and make a blue print and have it ready at 30 minutes past 5— as quick as we can copy a letter in our letter-press copy book.<sup>25</sup>

Thomas W. Capen shared the information that the vertical tube printing machine, described by Blood, was being used by Fraser & Chalmers, a builder of heavy technology including mining machinery, “for some time, I believe, with entire success.”<sup>26</sup> The company purchased its blueprinting machine from a Pittsburgh manufacturer, and it cost \$400-\$500 installed.<sup>27</sup> C.W. Hunt chipped in, saying that he had been using the “very convenient” vertical machine for “about two years” in his office, and described its basic working procedure. Hunt, too, was impressed by the economies: “When once in operation, it was found so convenient that we abandoned sun printing.”<sup>28</sup> S.T. Wellman confirmed Hunt’s experience with the vertical machines, and recalled that the cost of his version was in the range of \$200 to \$300. This was worthwhile in the long run:

[T]he saving for the whole system paid for it in less than three months, and one boy did all the work, whereas formerly we kept two or three boys

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<sup>25</sup> Reist, “Blue-Printing by Electric Light,” 896. Knox is clearly affiliated with a machinery building shop of some kind, whose products need to match his clients. In this case, the original drawings are sent out to the client, rather than blueprints, so that the drawings can be modified for local conditions.

<sup>26</sup> Reist, “Blue-Printing by Electric Light,” 896.

<sup>27</sup> Reist, “Blue-Printing by Electric Light,” 897.

<sup>28</sup> Reist, “Blue-Printing by Electric Light,” 897.

at work, and then only made a small portion of our blue prints; we had to go outside and hire some of them made.<sup>29</sup>

Some of the engineers in the audience were unfamiliar with the new electric machines. Harry Sawyer asked those who owned the vertical printers if they experienced problems with heat from the arc lamps, as he had seen with a different type of home-made electric blueprint machine “while visiting the works of a large engineering company in Philadelphia.” The users of the vertical machines replied quickly that there was no troublesome heat buildup, and Reist described the ventilating chimney he had built into the design of his reflectors. Knox concluded the discussion by noting that the vertical cylinder-style machine and Reist’s flat frames both produced equal results with a minimum of effort - the only difference being the far lower costs of Reist’s home-made apparatus.<sup>30</sup> Cost was certainly a factor, since the arc-lamp machines were expensive. In a detailed 1918 inventory of the Massachusetts office of the landscape architect firm Olmsted Brothers, their electric blue printing machine was the most expensive single item in the building, valued at \$125. A small print frame was valued at \$15, and a printing frame that secured a tight fit of the drawings through creating a vacuum, was valued at \$30. By contrast, two surveyor’s instruments, kept in the vault, were \$75 each, several typewriters cost \$40-60 each, an adding machine was the only other item close in value, at \$100.<sup>31</sup>

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<sup>29</sup> Reist, “Blue-Printing by Electric Light,” 897.

<sup>30</sup> Reist, “Blue-Printing by Electric Light,” 898. Knox estimated that the Reist-style setup would probably cost one-tenth that of the vertical cylinder.

<sup>31</sup>“Appraisal of Personal Property Belonging to Messrs. Olmsted Brothers... May 25, 1918,” Folder 3 “Miscellany 1918-1920,” Job File 20, Olmsted Associates Records, Series B, Box B4, MS 76-171,

## Blueprints and Organization

Blueprints offered technical and organizational challenges and opportunities to mine managers. They offered managers a relatively cheap and fast method of making an exact duplicate of maps, drawings, or orders. Unlike the case with Yates' office duplications, which she sees as generally having a "centrifugal," decentralizing force in the firm,<sup>32</sup> I believe the proliferation of blueprints tended to centralize control in the hands of the engineers. With blueprints, it became significantly easier for documents to make the transition from the safe confines of the office into the hazardous spaces of the production plant, above and below ground. This in turn made it far easier to precisely convey the engineers' vision of work to be performed to those who would do the actual labor, and it allowed the engineers themselves to bring their visual representations with them to help them with decisionmaking while on-site.

The physical nature of the copies that were made with the blueprinting process also enhanced the trend toward centralization of authority. The most common output of the blueprinting process was a negative image, where dark lines and light backgrounds on an original drawing appeared as white lines on a dark blue background. Blueprints were usually printed on somewhat thick paper, which had been coated with a light-sensitive solution. As a result of these factors, it was very difficult to make a blueprint of a blueprint, because it was nearly impossible to cast enough light

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Manuscript Division, Library of Congress. Anthony Reed of the Frederick Law Olmsted National Historic Site was kind enough to pointed me in the direction of this collection.

<sup>32</sup>Yates, *Control Through Communication*, 62.

through a blueprint to expose a new sheet. The consequence was that each blueprint was a good copy, but not one that could be copied. If information was inscribed on a blueprint, the data did not become part of the information flow of the operation until it was inscribed on the original non-blueprint master tracing. Blueprints bore the stamp of authority of the engineering office, but their authority was only a derivative of the original tracing. Without the original, the blueprint had no intrinsic authority. This reified the power and importance of the original drawing (the one that could produce blueprints), which was kept safely in the confines of the engineering office vault.

Blueprints also tended to reinforce the authority of the original map because of their destructability. Since blueprints were fairly cheap and quick to make, they could be used in hazardous spaces such as machine shops or underground mines, and once any information that may have been inscribed on them was transferred to the master map, they could easily be destroyed to prevent confusion. Since significantly larger amounts of time and skill were necessary to produce a facsimile using the tracing method, managers watching the bottom line might have been more reluctant to destroy a visual representation that had been so expensive to produce and that might be reused for a different purpose to save money. Thus, the physical properties of blueprints, even their destructability, contributed to the concentration of knowledge and authority in the form of a mother-map and the engineers who controlled and updated it.

**FIG. 12.—CHARACTERISTIC HATCHINGS FOR HELIOGRAPHIC PURPOSES.**

DIMENSION LINE .....			
CENTRE LINE .....			
SECTION LINE .....			
WROUGHT IRON		WATER	
CAST IRON		GLASS	
STEEL		INDIA-RUBBER	
COPPER		RUBBLE	
BRASS		LEAD	
WOOD		PUDDLE	
BRICKWORK		MARBLE	
STONWORK		GRANITE	
CONCRETE		DEPOSITED EARTH	
CLAY		LOOSE STONES	
HARD EARTH		COAL	

Figure 3.5: Table of suggested patterns for use with blueprints. Adapted by Eric Nystrom from B.H. Thwaite, "Engineering Heliography, or the Sun-Print Copying of Engineering Drawings," *Transactions of the Federated Institution of Mining Engineers* 9 (1895): 69-88.

Compare this centralized, pyramidal structure of knowledge authority with the pre-blueprint situation. Each tracing of a map, if intended to be complete, was essentially indistinguishable from the original, leading to the possibility of parallel, competing visual representations, each with the possibility of being inscribed with new information and thus “forking” the flow of data. The Quincy Mine employed one potential solution to this problem - the primary map was inscribed on heavy stock, backed with canvas. Any map on tracing linen, therefore, was easily noticeable as a copy. This posed a problem later, however, with the introduction of blueprinting to the firm, since blueprints could not be made from the opaque master-map, and had to be made from a master-copy instead.<sup>33</sup>

The physical characteristics of blueprinting also constrained engineers and map-makers in several ways. The primary problem was that blueprints were the result of a two-tone process that could not duplicate color. Unlike even contemporary engineering drawings, where color tended to be used for aesthetic purposes, color on mine maps often carried critical information, about depth, geological characteristics, and the like. Color represented important data, and if a colored map were duplicated by the blueprint process, that data was lost. Either the blueprint had to be hand-colored, thereby losing much of the time savings of the process, or the data had to be unimportant enough to ignore in the context for which that particular copy

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<sup>33</sup>One example is the paper-backed map (6947-6971) “Section of Workings of the Quincy Mine,” Quincy #387, Box A2, Quincy Unprocessed Drawings; the same map on tracing linen (8967-8981), which is dated 1876, is “Section of Workings of the Quincy Mine,” Quincy #387, QD 0099, QD B0003, Quincy Underground Maps; both in Michigan Technological University Archives, Houghton MI.

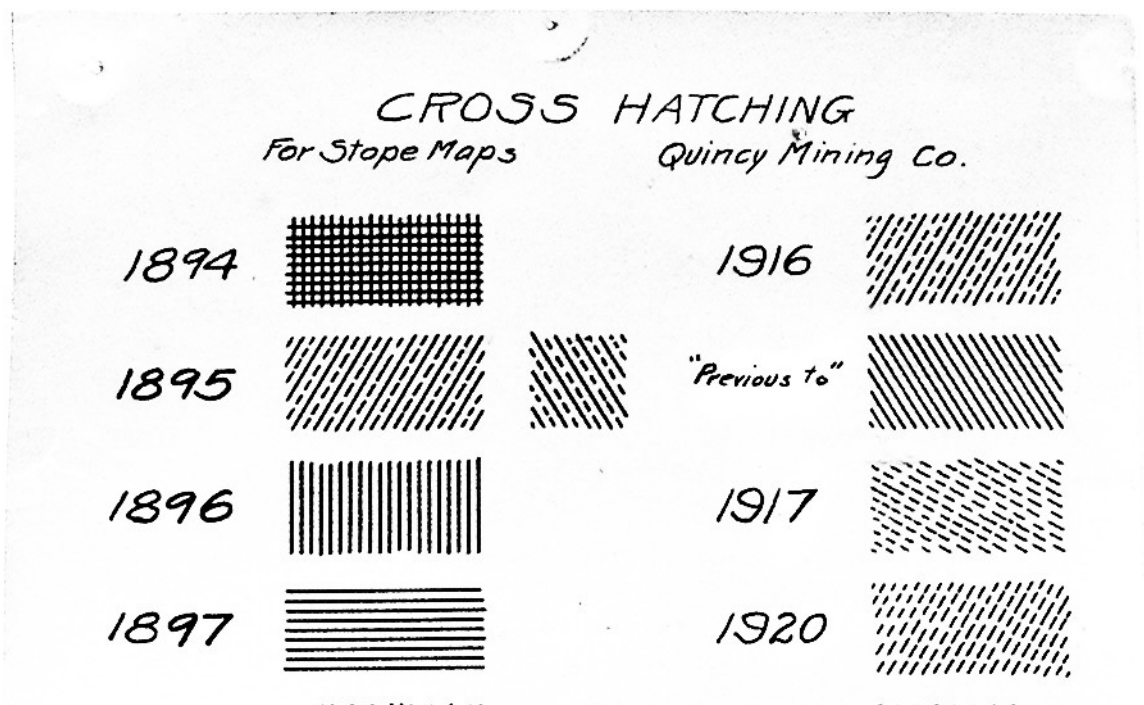


Figure 3.6: Detail from "Cross Hatching For Stope Maps, Quincy Mining Co.," Box 08, Collection MS-012 "Quincy Mining Company Engineering Drawings Collection," Michigan Technological University Archives. Photo by Eric Nystrom, 2006.

had been made. Over time, there was a gradual change in the construction of the original maps, so as to facilitate their duplication by the blueprinting process. The most important change was that where color had originally been used to represent information, different cross-hatching patterns were used instead. A blueprint of map with black and white cross-hatches could preserve all of the data that might have been represented by color in earlier years. Authors of articles about blueprinting even occasionally included a table of cross-hatchings that could be used to represent different materials in a way that could be reproduced through the blueprint process. For such a table published in a mining journal but probably intended for civil engineers, see figure 3.5.<sup>34</sup> Other blueprint-friendly map features included the elimination of shading effects, and the use of solid-black inked blocks on the master map, which when blueprinted showed up as white blocks and permitted information (such as a date) to be easily written on the blueprint. The Quincy Mining Company made up tables of patterns to use on its maps circa 1915. One set of cross-hatches, intended for ground-plan maps, used multiple colors and a few basic patterns to convey information, suggesting that the move to two-tone maps optimum for copying may not have been complete. The other set of patterns, seen in part in figure 3.6, was intended to show yearly progress on stope maps. These consisted of more complex patterns to be executed only in black and white. These patterns may have been those applied to the small-scale stope maps that were regularly blueprinted to graphically represent

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<sup>34</sup> B.H. Thwaite, "Engineering Heliography, or the Sun-Print Copying of Engineering Drawings," *Transactions of the Federated Institution of Mining Engineers* 9 (1895): 69–88, plate 18, figure 12.



the progress of stoping in the mine. Both sets of cross-hatches show prominent marks of thumbtacks on the top. The large shadows cast by the tack heads suggest that these tables of cross-hatch patterns were tacked up in the drafting room, and were an integral part of the drafting room for many years.<sup>35</sup>

Experts suggested other changes to make drawings more suitable for producing blueprinted copies. George E. Brown, author of an early text on the blueprint process, said the best blueprints were produced from tracings that used thick india-ink lines. He also recommended the addition of other pigments to the ink, such as chrome yellow or gamboge, in order to make the ink more opaque and thus produce a better blueprint copy. Brown warned his readers away from colored inks, as such lines “never come out so well as those in Indian ink, unless an exceptional thickness of ink be used, in which case the brilliancy of the color is impaired.” In any case, noted Brown, because of the several difficulties in translating color to a blueprint copy, “Wherever possible, it is best to use Indian ink lines in different styles of punctuation in place of colored inks.”<sup>36</sup> Thus, to fully exploit blueprinting technology, engineers had to change their drafting practice even to the point of reconsidering their ink. However, a less complete drafting revolution could still produce usable results at the cost of greater inefficiencies, including more drafting labor and poorer copies.

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<sup>35</sup>“Cross Hatching For Stope Maps, Quincy Mining Co.” and “Cross Hatching - Ground Plan Maps,” both in Box 08, Collection MS-012 “Quincy Mining Company Engineering Drawings Collection,” Michigan Technological University Archives.

<sup>36</sup> Brown, *Ferric and Heliographic Processes*, 59-60.

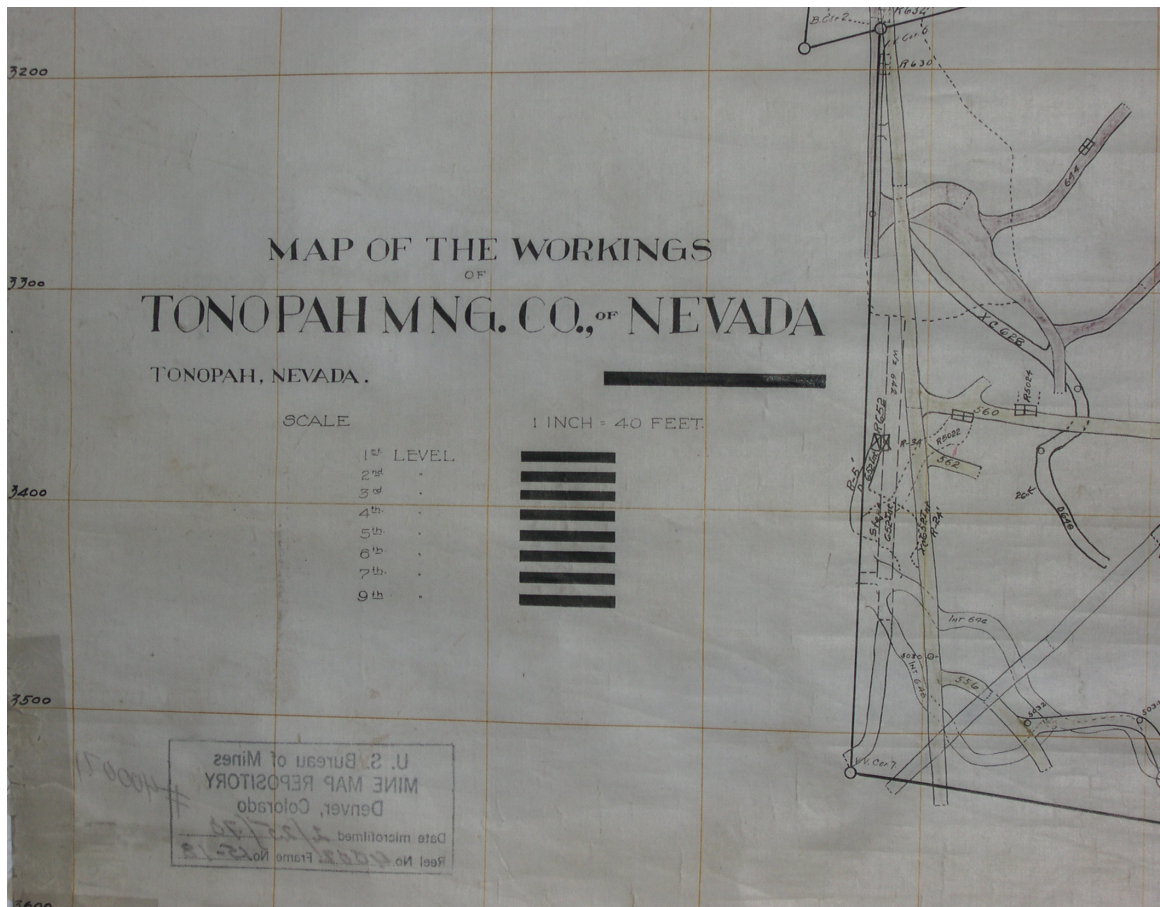


Figure 3.7: “Map of the Workings of Tonopah Mng. Co., of Nevada,” on linen. Map 610, Tonopah Historic Mining Park, Tonopah, NV. Photo by Eric Nystrom, 2005.

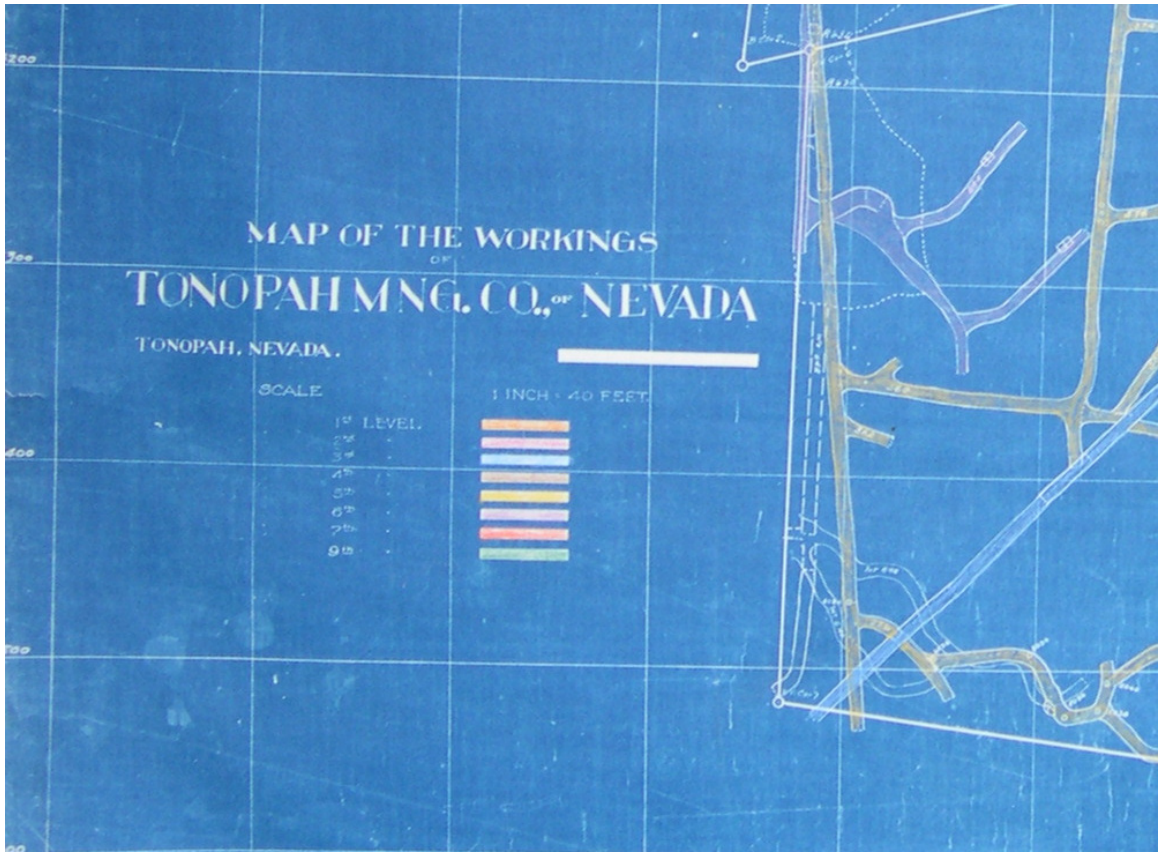


Figure 3.8: "Map of the Workings of Tonopah Mng. Co., of Nevada," colored blueprint copy. Map m126, Central Nevada Historical Society, Tonopah, NV. Photo by Eric Nystrom, 2005.

This gradual shift to a blueprint-friendly workplace did not occur all at once. Older habits or techniques of representation persisted, even when those habits prevented fully capturing the efficiencies that blueprints could provide. This gradual shift can be illustrated by a case where both traced and blueprinted maps exist, such as the map “Map of the Workings of Tonopah Mng. Co., of Nevada.” The original map, seen in figure 3.7, was drawn on tracing linen. The map is a horizontal view which uses colors to designate the various levels in the mine. However, the title block includes black bars, which are a clear sign of the map having been intended for blueprinting. A look at a blueprint copy of the same map, shown in figure 3.8, shows that it had been colored after it was duplicated, with similar, though not exact, coloring as the original. The black blocks of the title area had been included to provide a space on the blueprint for a color key. Thus, the Tonopah Mining Company maps represent a transitional time in the use of blueprints for duplicating visual representations in the mining industry, since the Tonopah mining engineers were clearly familiar with blueprinting technology, but had yet to restructure their information flows to take full advantages of the efficiencies the process was capable of delivering, since each copy had to be laboriously colored after it was printed. The Tonopah Mining Company maps suggest the potential for information loss that was inherent in the transition from colored maps to two-tone ones. These two maps also offer evidence of the linen map having served as a master copy. The linen map carries some information that was added after the blueprint was made, (in the area near the side line to the right



Figure 3.9: Key of blueprinted underground map of Isle Royale Copper Co. (C&H). C&H Geological Maps, Row 29, 2nd Set B, Drawer 14, Folder D, Michigan Technological University Archives. Photo by Eric Nystrom, 2006.

of the title block, for example) which shows its ongoing role as a central part of the Tonopah Mining Company's information infrastructure and suggests the temporality of the blueprint copy.

Because blueprints were a representation of a master drawing at a single point in its evolution, and because, as the Tonopah Mining Company maps (among many examples) illustrate, the master tracings often changed after the creation of a blueprint, it was important to situate blueprints in time. In some cases, as with the Quincy

small-scale maps, black blocks were made on the master tracing, which would print white on the blueprint copy so the month and year represented by the map at that point could be recorded on the copy with a grease pencil or an ink pen. The C&H, around the first decade of the 20th century, used an adjustable business date stamp – “PRINTED” – to indicate when the blueprint was made. This stamp is visible in figure 3.9. This map key shows that the blueprint represents the status of the underground as of March 1910, information that is recorded below the copied block in black ink. The print itself was made on April 29, 1910, according to the date stamp. Even though there may have been a delay between the moment in time that the blueprint was intended to represent and the moment when it was made, the copy in figure 3.9 was situated firmly in the business chronology of the C&H, unlike the map it copied.

The technology of blueprint production had another (probably unanticipated) effect on the organization of the mining engineering office by limiting the size of copied visual representations. Traced or hand-drawn maps could be made nearly any size, especially if additional sheets were added. There were practical limits, of course - maps that were extremely oversize were difficult to display, use, and update, but these limits were not especially restrictive. For example, the maps of the Buck Mountain Vein and Gamma Vein made and used between 1914-1928 by the Coxe Brothers and Company were over eight and ten feet long, respectively, but since they were not

wider than an average drafting table, they could be selectively unrolled and were still fairly easy to use.<sup>37</sup>

In contrast to traced maps, the technology of producing blueprints placed practical limitations on the size of the copy. While there was certainly more flexibility than offered by the modern-day Xerox machine, the limits of the machinery to handle particularly large copies had a regularizing and fragmentizing effect on the overall production and use of visual representations. The size limits of the machinery encouraged engineers to create master tracings that fit, and it also tended to produce blueprint copies of a fairly standard size. (Sizes were internally standardized, by the capabilities of each company's blueprinting apparatus, so blueprints still varied a bit in size between companies.) Over time, this meant that a great number of the visual representations in use in a company were of standard sizes, which allowed the construction of custom flat file drawers and other similar types of office infrastructure.<sup>38</sup> More maps could be stored in flat drawers, the representations could be retrieved more easily, and the flat drawers themselves were easy to build into furniture such as the large tables needed in a drawing room. Thus, the regularization of size increased the overall responsiveness and utility of the visual information system, since standard sized drawings were closer to hand, could be found more easily, and were more numerous.

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<sup>37</sup>These maps were discussed at length in the maps chapter.

<sup>38</sup>For example, see the C&H drawings for their map drawers at the Michigan Technological University Archives, Houghton, MI; the map drawers themselves are held by Keweenaw National Historical Park, though none are in-situ.

Blueprinting also contributed to the fragmentation of knowledge across multiple visual representations. Before blueprinting became a common practice in the mining industry, mine maps tended to be very information-rich resources. Since they were expensive (in terms of time) to create, update, and reproduce, the maps that were in use tended to be comprehensive, and showed many types of different information on the same sheet. To accomplish this, these early maps tended to have large sheets, use smaller scales,<sup>39</sup> and make extensive use of color to depict additional data. Scale, in particular, was a compromise between utility – a larger scale provides more information about the underground – and map size. As blueprinting (with its technical size limitations) became common after the turn of the century and mines grew larger, any map that purported to show the entirety of a mine on a single blueprint-sized sheet would have to have a scale so small as to largely preclude the map’s use in actual operations.<sup>40</sup> The alternative was to maintain a useful scale, but require multiple maps to represent a mine. Blueprinting reduced the cost of duplication and encouraged the regularization of map shape, enhancing the overall efficiency of the mining company’s visual information system, but at the same time it tended to decrease the amount of information that could be depicted on any single sheet (because of color and size restrictions). Additionally, any scale distortions that might have been fruit of the blueprinting process were less important if the scale was larger, since a

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<sup>39</sup>i.e. depicting more space on a given sheet by making objects smaller. 1 inch = 200 feet is a smaller scale than 1 inch = 100 feet.

<sup>40</sup>These sorts of maps certainly did have their uses and were produced in some cases. See, for example, the monthly progress maps made by the Quincy Mining Company from 1907 to 1926, Drawers E-J, Accession number KEWE-00033, Keweenaw National Historical Park Archives, Calumet MI.



distortion would map to a smaller amount of actual space. Taken together, these factors tended to encourage the mining companies to use more sheets, each representing a smaller area, to represent an underground space. Since each sheet represented a smaller space, more detailed information about that space could be inscribed on the map than was possible with a smaller-scale map. Consequently, having greater quantities of more detailed and more accurate information located within arm's reach in the engineering office tended to increase the power and authority of the office vis-a-vis the underground workers.

The centralization of power occasioned by the development and use of blueprinting by mining companies had its limits, however. Like the technical visual representations that they copied, blueprints required specialized knowledge to read, which was rarely possessed by skilled and unskilled laborers.<sup>41</sup> By the end of the period I discuss here, many mine foremen could read a mine map and might take a blueprinted copy underground, but very few miners could do so.<sup>42</sup> Thus, the spread of knowledge in visual form, via blueprints, also served to increase the stratification between university-trained engineers and the men whose work they directed.

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<sup>41</sup>This of course depended on the drawing being copied. Once shop employees began routinely reading dimensional drawings, the distinction between a tracing and a blueprint was minimal, in terms of its readability by the employee.

<sup>42</sup>Anecdotal evidence suggests that this is a long-term trend. In the 1950s, an instruction manual on how to read a mine map pitched its content at coal miners looking to improve their skills so as to qualify as foremen. Bourland, *How To Read a Mine Map: Concise Instructions for Mine Foremen and Students Seeking Simple Yet Thorough Practical Knowledge of Mine Map Reading*. Even today, I have found in a handful of chats with skilled miners (not engineers) of a decade's service or more, much to my surprise many still cannot read a mine map, and several expressed little interest in learning to do so.

## Storage and Retrieval

After a map, drawing, or blueprint had been made, it needed to be stored in order to protect it and facilitate its easy retrieval. Just as American businesses were addressing the need to store correspondence with a variety of filing technologies, visual representations were stored in several different ways. Furthermore, individual companies such as the Quincy or C&H sometimes used more than one means of storage, depending on the particular map or drawing's characteristics.

Pigeon holes were most useful for storing maps and drawings of varying sizes. Pigeon holes were commonly used before the turn of the century for filing letters and other business papers, and were built into many desks.<sup>43</sup> Pigeon holes for maps merely needed to be a bit larger and deeper. Eckley Coxe's desk in his office at Drifton, shown in figure 3.10, had a built-in compartment of map-sized pigeon holes, to enable him to keep a small number of drawings readily at hand yet out of the way of his other business papers.

Larger pigeon holes were used for company storage systems, especially for particularly large maps. The second story of the fireproof vault of the Quincy Mining Company office building contains a set of large, deep pigeon holes for storing maps and drawings, as shown in figure 3.11 on page 109. A slightly different way to store rolled maps, utilized by both Quincy and the C&H, involved putting rolled maps in metal or cardboard tubes and placing them horizontally on special racks attached

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<sup>43</sup> Yates, *Control Through Communication*, 28-31.



Figure 3.10: Eckley Coxe's desk, in Drifton, Pennsylvania, showing map compartment. Photo by Philip Metzger, courtesy of James J. Bohning.



Figure 3.11: Large pigeon holes in vault, above map drawers, in situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006.

to the wall. The tubes or maps were then labeled on the outside. Some of these tubes might have been the light-proof metal tubes in which commercially-prepared blueprint paper was sold. The tube storage system protected the maps as well or better than ordinary pigeonholes, and was more space efficient, since it did not require a deep space. See figure 3.12.

Flat drawers, holding flat sheets, were able to store more maps and drawings in a given space than was possible with systems such as pigeon holes or tubes, where

the maps are rolled. The big drawback to flat drawers was their inability to hold visual representations that exceed the dimensions of the drawers. As the advent of widespread blueprinting tended to restrict the maximum size of new visual representations, flat drawer filing solutions for maps and drawings became more useful. A big advantage of flat drawers was that they could be built into other drafting room furniture, as shown in figures 3.16 and 3.17, thus permitting maps and drawings to be stored close to where the engineers worked.

Most mining office buildings built for the purpose had a vault or vaults for storing payroll as well as important business documents. Especially given the remoteness of some mining operations, the office vault was thought of as the best means to defend information critical to the company from fire. Maps and drawings were, by the late 19th century, certainly included among the ranks of critical documents. Figure 3.11 on page 109 shows the large pigeon holes and map drawers built in to the second-story level of the Quincy Mine Office's vault to hold the company's most important maps and drawings. (The vault also used racks to hold rolled maps in tubes.) The Quincy vault was two stories, located at the center of the building. The business operations of the company, including the financial operations such as the paymaster window, were handled on the first floor of the building, and the first floor of the vault was set up mostly to protect books, cash, ingots, and similar materials. Engineering activities took place on the second floor of the building, and the second floor of the vault was built to hold maps and drawings. Vaults emphasized the trend of centralization of

information in the form of a master copy. If any hazardous work that a drawing needed to do could be done by a destructable blueprint copy, then the master could remain in the office vault, safe from fire and other hazards. The master needed to be removed from its stronghold only to be updated with the latest information, and to reproduce more blueprint copies to carry the information into the field.

Storage systems were largely useless without some form of organization. The simplest organization was having maps kept by the person who needed them. Eckley Coxe's desk in figure 3.10 on page 108 is a classic example. As long as there were not too many maps or drawings in use, the simplicity of such a system outweighed the cost of time it might have taken to find any particular drawing when it was needed.

As the number of visual representations in use in mining operations increased, in part because of the ease of duplication afforded by blueprinting, the organizational problem of storing and finding those representations increased dramatically. Many mining companies struggled to find a system of organization that was flexible enough to accommodate multiple copies, multiple storage locations, multiple types of documents, and multiple uses, while not creating a system of organization so complex that it could not be applied rapidly, be used universally, and be understood by its users. A vast number of surviving visual representations from mining companies bear the imprint of having been part of multiple overlapping organizational systems. For example, the underground map blueprint in figure 3.9 on page 102 has the original C&H drawing number, 816, carefully crossed out, and a new number pasted on a



Figure 3.12: Metal tubes and wall racks for map storage, in situ at the Calumet and Hecla Office Building, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006.

label above it. In this case, the new number may indicate that the blueprint was intended for a different context than was the original tracing - perhaps it was sent to a different division, and entered into their filing system in such a manner as to retain the original number for reference if necessary.<sup>44</sup>

Both the C&H and Quincy finally developed sophisticated card catalog systems to control their drawings. At least for the Quincy, the implementation of the card catalog system prompted a company-wide reorganization and renumbering of their visual representations. Quincy kept two card catalogs; one tracked the maps and drawings by the sequential number they were given upon being entered into the system, and the other filed cards by topic, possibly reflecting the spatial organization of the drawers in which they were stored. Both Quincy and C&H relied on the card catalog, rather than the number on the map, to provide the “metadata” (to use a modern term) that situated the visual representation in its work and storage context.

Not all filing systems chosen by mining companies worked in this fashion. By contrast, the last organizational system used by the Coxe Brothers & Company used a very sophisticated numbering system with three levels of hierarchy in addition to a sequential map number. Thus, if one knew the system, the map in figure 3.13 could be identified from the tag alone. The “D” signified that the map covered the Drifton Colliery; class 1 was “Land and Surface Maps;” subclass 2 embraced maps of “Townsites, Streets, Etc.”; this was the first map of in that particular class and

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<sup>44</sup>Key of blueprinted underground map of Isle Royale Copper Co. (C&H). C&H Geological Maps, Row 29, 2nd Set B, Drawer 14, Folder D, Michigan Technological University Archives. Photo by Eric Nystrom, 2006.





Figure 3.13: Coxe map with end tag. Map 14-14, Coxe Brothers and Company Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photo by Eric Nystrom, 2003.

subclass for Drifton; and the map was stored, rolled-up, in drawer or bin 203. The information was also kept in a card index, but the system was clearly designed so that the cards would not be relied upon for retrieving the correct map.<sup>45</sup>

Whatever filing system was used, the maps and drawings needed to be locatable. At C&H, a map's index card gave its drawer number. Drawers, such as those shown in figure 3.16 and figure 3.17, were numbered sequentially, but each contained a certain type of drawing, such as those showing Underground Geology. Within each drawer, every map had a four-digit number which tied it to the overall index card system. In the drawers, the drawings were arranged sequentially. Maps that were stored rolled often had filing information attached to the end. If the maps were put in tubes before being placed in pigeonholes or on racks, the end of the closed tube was labeled, as can be seen in the C&H maps in figure 3.12. In at least some cases (specifically in the Quincy office vault), the tube racks were numbered as though they were drawers. A typewritten list of the topical contents of Quincy's pigeon holes has survived, showing that the maps were filed according to coverage: "Old Miscellaneous," "Underground," "1st and 2nd Hillside Additions," and "Carpenter Shop, or Construction" were just a few of the numbered categories.<sup>46</sup> Many of the Coxe maps have tags attached to them so that they could be easily located in a pigeon hole system, such as the map in

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<sup>45</sup>"Classification and Method of Card Indexing Maps and Drawings, Coxe Bros. & Co., (1929)" folder "Coxe Collection Mining Map Drwgs," drawer "Coxe Collection (Administrative)," Mineral Technology Divisional Records, Room 5028, National Museum of American History, Smithsonian Institution.

<sup>46</sup>"Pigeon Holes," Box 08, Collection MS-012 "Quincy Mining Company Engineering Drawings Collection," Michigan Technological University Archives.

figure 3.13. In sum, as a mining organization grew, the infrastructure it used to store and retrieve visual tools such as maps, drawings, and blueprints needed to change as well.

## Spaces

The proliferation of visual representations, especially maps, facilitated a shift to more centralized operations, where an engineer (who kept the maps close at hand) directed operations potentially at a distance from the site of the mine itself. What were the spaces of this new office work like? How were they arranged to permit effective use of the power and authority of the managers and engineers who staffed them?

While the entire office building was dedicated to the exercise of managerial power, the drawing or drafting room was the most important space for the creation and use of visual representations. These rooms were usually major uses of space in specialized mining office buildings. They combined specialized furniture, especially large tables, with at least some document storage such as pigeonholes or map drawers. The rooms usually had close proximity to the private offices of the mining engineer or manager in overall charge. The rooms were usually characterized by large spans of open space, and lots of windows to provide natural light.

Since windows were also necessary for ventilation as well as for light, some compromises had to be made. For example, the windows in the drafting room of the



Figure 3.14: Window in the C&H Drafting Room, with extra window pane to prevent wind-scattered papers. In situ, Calumet and Hecla Mining Company Office Building, Calumet MI. Photo by Eric Nystrom, 2006

Calumet and Hecla Mining Company Office Building,<sup>47</sup> constructed circa 1900,<sup>48</sup> featured additional removable panes of glass, set in wooden frames held in place by wooden runners built into the window casing on the inner side. These panes were intended to block breezes that might disturb drafting papers when the windows were open. Figure 3.14 on page 117 shows one of these panes in-situ in the Calumet and Hecla office building.

These large drafting and drawing rooms were purpose-built spaces designed to accommodate most of the physical technologies and labor associated with creation and use of a system of maps, drawings, and blueprints. While the large drawing rooms were probably the most important spaces, nearby smaller spaces, such as blueprint production rooms, photography darkrooms, and storage vaults, also played a role in the system of visual representations. The offices of the managers and engineers were usually located nearby, in close proximity to the heart of the visual document system.

The drafting room contained the supplies needed to enable engineers to translate survey notes from the underground onto a two-dimensional plat. These materials included rolls of thin tracing paper, thicker vellum or tracing linen, and heavier stock for more permanent maps or drawings; pencils, ink pens, inks of various colors, colored pencils, compasses, straightedges and rulers, dividers, protractors, and similar

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<sup>47</sup>The building is now part of the Keweenaw National Historical Park, and is under renovation for adaptive reuse by the NPS. Note that I refer here to the original mine office building, not the “Library Building” across the street used as office space in the mid-20th century by the C&H.

<sup>48</sup>“The C&H Mine Office building was originally constructed in 1887, with additions ca. 1899, 1900, and 1909.” Jeremiah Mason email to author, Sept. 25, 2006. I presently don’t know when the drafting wing was built, but it seems quite likely that it was in the first round of additions.

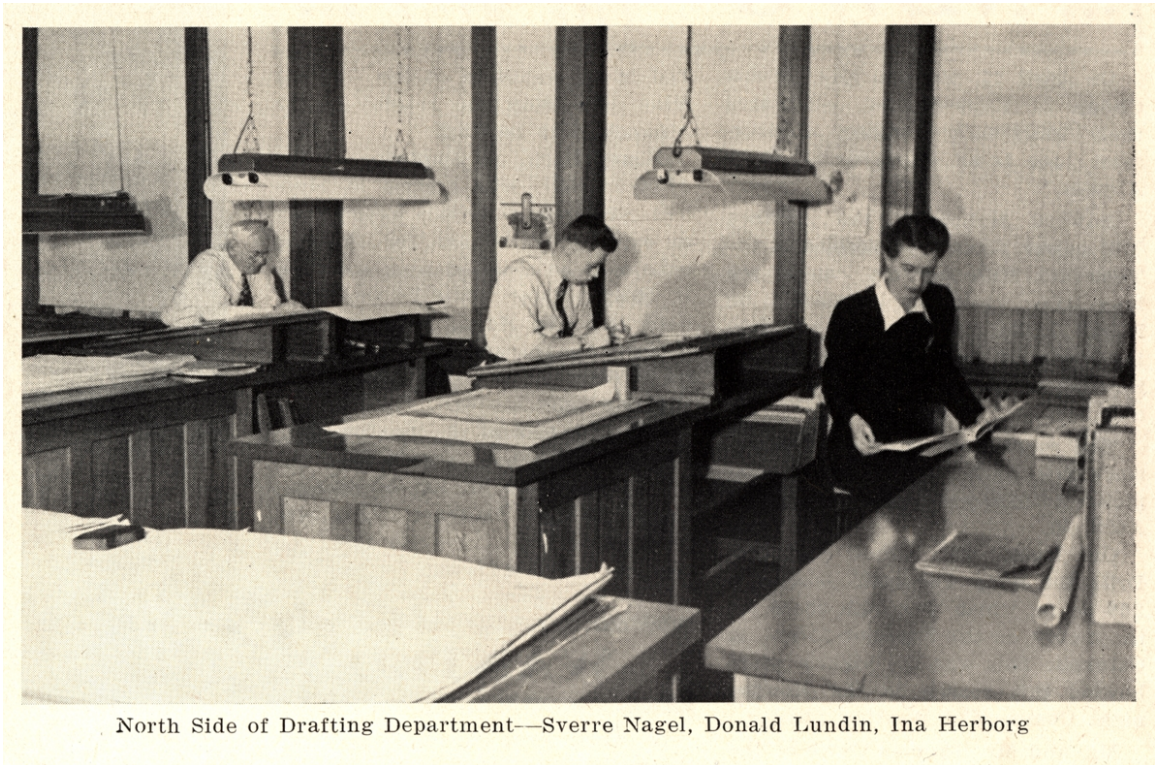
mechanical drawing apparatus. Paper would be cut to the size needed for the job at hand, and any future expansions. It was not uncommon for underground maps to outgrow their original sheets, and have additional paper glued on.<sup>49</sup> Odd scraps or mis-executed blueprints were frequently saved and used for scratch paper or smaller projects. For example, surviving maps from the Quincy Mine show how scratch paper (in this case, the back side of blueprints with printing mistakes) was used to sketch out the initial plat of a map or the outline of an item in pencil, then once the basics were established, the drawing was copied in a more finished way to a new sheet of tracing linen.<sup>50</sup>

Large, flat surfaces distinguished rooms where visual representations were made and used. Users of large maps and drawings needed to be able to unroll or otherwise deploy the large sheets in order to read, copy, or create them. Drafting tables, with slightly inclined surfaces, served as oversized desks for company draftsmen, and large flat tables accommodated larger items. For a relatively late example of these drafting tables in the office of the Calumet and Hecla, see figure 3.15. The Calumet and Hecla custom-made office furniture in their shops that combined a rack of map or drawing drawers with a solid slab top. These units allowed engineers to have a large number of drawings close at hand, stored flat, (unlike Eckley Coxe's desk, for instance) while

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<sup>49</sup>See, for example, the large Calumet and Hecla (1871) map and the later Coxe Drifton maps described in an earlier chapter. "Workings of Calumet and Hecla Mine, 1871," Box B1, Calumet and Hecla Unprocessed Drawings, Michigan Technological University Archives, Houghton, MI; "Drifton No. 2. Buck Mountain Vein..." Map 14-10, Coxe Map Collection, NMAH; "Drifton Slope No. 2, Gamma Vein..." Map 14-11, Coxe Map Collection, NMAH.

<sup>50</sup>I draw this from examples in the Quincy Mining Company Collection, MS-001, Copper Country Historical Collections and Michigan Technological University Archives, Houghton, MI.



North Side of Drafting Department—Sverre Nagel, Donald Lundin, Ina Herborg

Figure 3.15: C&H Drafting Room, North Side, 1949. From *C&H News and Views* 7, no. 6 (April 1949); Foster Collection, Keweenaw National Historical Park Archives, Calumet, MI.



Figure 3.16: C&H map drawers with tabletop, from drafting room. Keweenaw National Historical Park, Calumet MI. Photo by Eric Nystrom, 2006.

giving them large flat spaces particularly suited to working with large maps and drawings. An example is seen in figure 3.16. A hybrid table/map case, such as the C&H-built marble-topped piece seen in figure 3.17, had drawers on both sides and was clearly intended to occupy the center of a room, permitting access to all sides, but also reinforcing the point that the maps were, literally, central to engineering practice, in the office and at the mines.

A light table was used to assist in tracing a copy. The original map, usually on linen, would be placed on the table and covered with a fresh sheet of semi-transparent





Figure 3.17: C&H hybrid map case and table, currently located in the Library Building, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006.



Figure 3.18: Calumet and Hecla Light Table. Note adjustable legs and trapezoidal body shape. Item 82756, Accession KEWE-00040, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006.

paper such as tracing linen. The two sheets would be secured together, so that no slippage would take place, then the copyist would trace over the lines visible from below. A light table might also be useful to see through glass plate negatives, to evaluate an image before printing it.

Bennett Brough recommended an early version of a light table to assist with the copying of drawings. He recommended a large sheet of glass set in a sturdy frame angled at 25 degrees and pointed at a window or lamp to project the image from

below onto the tracing paper or linen.<sup>51</sup> The light tables that remain in the Calumet and Hecla office and the Quincy office use electric lamps instead, and are shaped like upside-down trapezoids in three dimensions. The shape might have facilitated a copyist seated on a stool getting close to the surface for tracing, and would have also helped ensure an even lighting of the bottom of the glass from the lightbulbs set at the bottom of the trapezoid. The tables were designed in such a way as to permit the inclination of the surface at varying angles. One of the tables owned by the C&H, seen in figure 3.18, used a complicated system of hinged legs, pegs, and holes to secure the table at any angle. Light tables would have been most useful in the era after the widespread adoption of blueprints, once drawing sizes became more regularized (so as to fit on the table) and master copies were more likely to be on semi-transparent tracing linen rather than opaque heavy paper or cloth-backed paper.

## Practice

The ability to make blueprints of drawings and maps changed how people did their jobs in mining companies. Historical day-to-day practice can be difficult to uncover, but anecdotal evidence is consistent with the changes made possible by blueprints (outlined in earlier sections of this chapter).

A series of blueprints could replace a copy of a map that had to be updated, and it seems that this was one of the early uses of blueprinting in mining. Many mine safety

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<sup>51</sup>Brough, *Treatise*, 258.

laws, beginning with Pennsylvania's pioneering law of 1869, required every mine to file a copy of a complete mine map with the state or local mine inspector, and to update that map once or twice a year. The early laws made provisions for the mine owner to comply with the update requirements by sending a small sketch of the new work only, or by submitting a verbal narrative of the work that had been done. Later safety laws specified that the inspector's map should be returned to the company for annual updates, then returned to the inspector's office. Several laws, beginning in the mid-1880s, also permitted the submission of "sun print" copies of the map instead.<sup>52</sup> Certainly the production of a blueprint was far easier for the mine owner than tracing the new work on to an old map or compiling a written account. For the mine inspector, blueprints eliminated the need to send tracings back and forth to all of the mines under jurisdiction, reduced the amount of time that any given map was unavailable, and, even better, almost certainly would have increased the compliance of mine owners with the law requiring updates.

Blueprints helped bring visual information in the form of maps closer to the actual working spaces of mines. A 1923 book of sample mine foreman examination questions explicitly placed blueprints at the mine: "Blueprint copies of the mine map should always be available at the mine for inspection."<sup>53</sup> In this quote, it is unclear whether

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<sup>52</sup>The earliest mention of a law with this proviso that I have found was Wyoming's 1886 law, which used the term "blue print," reproduced in Sir Frederick Augustus Abel, *Mining Accidents and Their Prevention: With Discussion by Leading Experts* (New York: The Scientific Publishing Company, 1889), 342. By 1895 and 1903, Pennsylvania and Tennessee, respectively, also had similar language in their mine safety laws, though they used the term "sun print."

<sup>53</sup>James T. Beard, *Mine Examination Questions and Answers* 1st ed. (New York: McGraw-Hill Book Company, 1923), 485.

Beard is referring to the mine as an underground space, or the mine as an operation, but blueprints could be useful in each place. In cases where a large company owned a number of mines spread out over large distances, such as in the bituminous coal fields after the turn of the century, the mine maps might be kept by the central engineering office at some distance from each mine. If a local emergency were to occur, such as a fire or a situation where a rescue was needed, the local mine foreman might not have geographic information at his disposal. However, the ease of reproduction of blueprints meant that the central engineering office could produce a blueprint of the main map for each mine, which could be kept at the local site in case it was needed. Similarly, even if the mine office was located near the shaft, as was the case at the Quincy and C&H, it would be possible for blueprinted copies of mine maps to be used by supervisors underground to direct work. If a supervisor had an underground office, a blueprint could be stored there and consulted frequently, perhaps along with individual miners. It is not clear when the practice began, but modern tours of historic mines that feature underground supervisor offices usually have a blueprint of a mine map tacked to the wall. Before blueprints, if an underground map were to inform the daily business of digging out the mine, the foreman would have had to travel to the mining office, look at the map, perhaps take some notes, and then return underground to deliver his verbal directions to the miners. With blueprints available, the foreman could consult with the engineer and receive a blueprint, which he could carry underground with him. The blueprinted map might be able to help

him answer any subsequent questions after he left the office, and perhaps the foreman would refer to it when giving orders to the miners. Whether underground or merely at the mine site, the blueprints would ensure that those performing the mining work (or supervising it) hewed more closely to the engineers' plan of what was to be done, because the visual component of that plan could be communicated to the site by using blueprints.

Geologist and mining engineer David W. Brunton, who invented a system of mapping for the Anaconda Copper Mining Company that was used to record extensive geological information on the company's maps, advocated for the use of blueprints in the underground stage of the work. Brunton's method involved first producing individual map sheets for each level of the mine, then taking copies of them underground where geological information could be added to them while on-site. This information would then be inscribed on the level maps back in the mine office. Brunton initially traced copies of portions of the level maps into notebooks using carbon paper, but he reported that in some cases, especially "where the geology is reasonably simple," a lightly-printed blueprint of the level map worked just as well. "These can be folded up into a convenient size for carrying in the pocket, and unless the geology is extraordinarily complicated, will answer every purpose."<sup>54</sup> Brunton's caveat about complicated geology probably stemmed from the inability of blueprints to reproduce color, which was ordinarily how geological information was portrayed on the level maps. In this

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<sup>54</sup>David W. Brunton, "Geological Mine-Maps and Sections," *Transactions of the American Institute of Mining Engineers* 36 (1906): 509.

case, the cheap and destructable nature of blueprints made them perfect for carrying “directly into the mine.”

The advent of blueprinting technology also changed the office practice of engineering. Mechanical engineer A.W. Robinson described in great detail the drawing office practice at the machinery building company he headed in 1893. Robinson reported that at his shop, no drawings were made on opaque paper, but were all on tracing cloth, which could be blueprinted. Tracings were used only to make blueprints, and then were immediately filed away in the fire-proof vault. Two blueprints made initially of each drawing – one for the office to use as an everyday reference, and one for the shop that was to build the equipment. Robinson also standardized his drawing office on drawings of a consistent size, which of course fit his blueprint apparatus. If a smaller drawing was needed, for a small part for example, then it was executed on a portion of a full-size sheet of tracing cloth, along with other small drawings. Once the blueprints were made, the copies would be cut up so that the shop received only the desired drawing, but the originals were never cut. This enabled Robinson to have a standard size drawer in the vault, and he did not have to worry about misplacing original drawings that were a different size. Because the blueprint could be cut apart, the original could remain on an intact sheet.<sup>55</sup>

Blueprints also forced the reorganization of labor in the drawing office, leading to further stratification even among the ranks of the engineering staff. By 1893, Eckley

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<sup>55</sup>A.W. Robinson, “The Relation of the Drawing Office to the Shop in Manufacturing,” *Transactions of the American Society of Mechanical Engineers* 15 (1894): 974-975.

Coxe, who that year served as the president of the American Society of Mechanical Engineers, noticed a shift in the employment patterns in the engineering field – “nothing less than the extension to engineering of the methods of the division of labor.” The proliferation of equipment suppliers and standardized parts meant that engineers did not have to have the wide range of experience and ability to handle all aspects of a technical operation. Furthermore, the expansion of firms resulted in fewer engineers, at the top of the managerial hierarchy, who exercised control over more work. Engineers at lower levels therefore had fewer opportunities for promotion, and older routes to advancement no longer offered the same promise to young engineers. Coxe placed part of the blame on blueprints:

The introduction of the blue-print process has done away with a large number of draughtsmen, and has changed very materially the methods of doing engineering work. A dozen blue prints are now made where two tracings would have sufficed; and as the necessity of comparing tracings after they are made is done away with (the finished drawings being usually made on tracing cloth instead of on paper as formerly), the number and character of the men employed in the draughting office have changed.<sup>56</sup>

The work force in drafting offices before the advent of blueprinting tended to be young engineers at the start of their careers. They would begin by doing relatively menial tracing work, and move up to positions of greater responsibility. Blueprints reduced the number of draftsmen needed, as Coxe indicated, because operating the blueprint machines could be done more cheaply by less skilled labor, such as boys. A blueprint, if printed correctly, was as truthful as the original drawing, but if it was

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<sup>56</sup>Eckley B. Coxe, “Technical Education,” *Transactions of the American Society of Mechanical Engineers* 15 (1894): 661.



incorrect, it was obviously wrong and could be done again. On a tracing, errors could seem like truthful data. Thus tracings needed to be executed (or double-checked) by someone capable of understanding the intellectual content of the work, where blueprints only needed to be proofed for proper exposure and readability. The shift to electric blueprint machines from solar frames reduced the labor force even further. As S.T. Wellman pointed out during his discussion of Reist's paper, the move to electric machines allowed one boy to do more blueprinting work than two or three had been able to accomplish with the solar frames.<sup>57</sup> From work practice to the constitution of the office labor force, blueprint technology served to spur organizational changes that tended to increase the decision-making power of the top managers at the expense of some of the autonomy of employees who worked for them.

## Conclusion

Maps, drawings, and blueprints were tools that helped mining engineers control increasingly complex underground environments, but the information and physical infrastructure of mining operations needed to change to permit engineers to wield their tools most effectively. As the technology of making and using visual documents changed, so too the infrastructure that supported their production and use changed. The advent of the blueprint process for copying large drawings was a major contributor to changing information practices in the late 19th and early 20th century mining

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<sup>57</sup>Reist, "Blue-Printing by Electric Light," 897.

firm. From map drafting practice to storage procedures to the increasingly centralized authority of engineers, blueprint technology proved a disruptive presence that could increase the efficiency of engineers, but only if operations and infrastructure were adapted specifically to take advantage of the opportunities and limitations the blueprints provided.

# Chapter 4

## Models

## Introduction

Three-dimensional technical models were some of the most powerful representations of the underground, but access to their visual power came at a price. These models were expensive, hard to handle, and relatively difficult to update with additional information. As a consequence, technical models were used only when more traditional visual technologies, such as maps or drawings, were considered ineffective. The special power of technical models stemmed from their ability to “speak” to non-engineers, in a way that was difficult for maps to do. Models were mostly used in courtrooms and classrooms - situations where their inflexibility was not a detriment, and their particular power was of paramount importance.

In this chapter, I will explore the uses of technical models in the American mining industry during its era of professionalization. The phrase “technical models” perhaps deserves further explanation. I use the term to describe three-dimensional representations of underground spaces that were constructed for the primary purpose of conveying measurable information about the underground, testing mechanisms, showing relationships between things, and so on. Technical models, as I conceive of them here, were not originally made to be put in a museum, even if some did end up there eventually. Technical models stand in contrast to “display models,” found primarily in museums and expositions, where the purpose of the model was to portray a broader, less technically sophisticated image of mining work, and which were directed at a general public audience. Display models, employed at expositions and museums,

will be addressed in another chapter. There was some overlap of the two types, of course, but I think the distinction is useful because it helps clarify issues of audience, authorship, and style.

The term “model” has multiple meanings in the history of science. The word can refer to a coherent theory of how phenomena relate to one another, or it can describe a thing that is perfect and worthy of emulation. Technical mine models used by mining engineers did not fall into either of these categories. Instead, the mine models I will discuss here were material artifacts that used three dimensions (instead of a map’s two) to represent underground spaces. As Ludmilla Jordanova noted, “Despite the long-standing interest in scientific and medical *thinking*, strikingly little attention has been paid to the *physicality* of models as distinct from their role as bearers of concepts.”<sup>1</sup> Mine models invite precisely this sort of historical analysis.

Mine models functioned differently than many of the material models previously described by historians of science. For example, Eric Francoeur investigated the origins and use of three-dimensional “ball and stick” models of atomic particles that were used in 20th century chemical sciences to build molecular structures. These molecular models aided scientists in their work by being manipulatable, flexible objects that themselves “embody, rather than imply, the spatial relationship of the molecule’s components.” Put another way, the “models mimic, mechanically, some of the important

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<sup>1</sup>Ludmilla Jordanova, “Material Models as Visual Culture,” in *Models: The Third Dimension of Science*, ed. Soraya de Chadarevian and Nick Hopwood (Stanford, CA: Stanford University Press, 2004), 443.

physical properties attributed to molecules.”<sup>2</sup> Scientists could test hypotheses and “experiment” by manipulating the model. By simply rearranging the balls and sticks, the model would help them understand if a thing was possibly true. As a result, molecular models could help scientists solve problems mechanically that were analytically out of reach in the pre-supercomputer era. Thus molecular models could shape scientific thinking.<sup>3</sup>

Mine models, in contrast, functioned more simply as representations of the underground. In the case of such a representation, the manipulation of the information borne by a mine model took place only in the viewer’s “mind’s eye,” as was the case with engineering drawings and mine maps.<sup>4</sup> Rearranging the sheets of glass in a glass plate model would have yielded nothing but confusion. Put another way, mine models were only suggestive; by showing what was known, they helped the viewer imagine the contents of the unknown. Molecular models, by contrast, could take the physical form (in facsimile, of course) of an unknown thing and allow the scientist to manipulate it directly.

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<sup>2</sup>Eric Francoeur, “The Forgotten Tool: The Design and Use of Molecular Models,” *Social Studies of Science* 27 (1997): 14, 16.

<sup>3</sup>Molecular models were by no means the only physical models used in a scientific context. Other common examples were models of excavations made by archaeologists, wax anatomical models and moulages, and models of the hulls of ships. See the essays in Soraya de Chadarevian and Nick Hopwood, eds., *Models: The Third Dimension of Science* (Stanford, CA: Stanford University Press, 2004); for a more recent example, see Christine Keiner, “Modeling Neptune’s Garden: The Chesapeake Bay Hydraulic Model, 1965-1984,” in *The Machine in Neptune’s Garden: Historical Studies on Technology and the Marine Environment*, ed. Helen M. Rozwadowski and David K. van Keuren (Sagamore Beach, MA: Science History Publications, 2004), 273-314.

<sup>4</sup>Ferguson, *Engineering and the Mind’s Eye*.

There is some evidence of the existence of models associated with mining that might be closer to the scientific models described by Francoeur. A wooden model of a vertical shaft compartment in the Calumet and Hecla collections at the Keweenaw National Historical Park might have been useful to help plan the internal structure of a shaft before it was constructed.<sup>5</sup> An even more pertinent example is found in a photograph of a small model of a platform made of boards and wires, made by the St. Joe Lead Co. of Missouri, circa 1950s. The platforms were intended to allow miners to drill into the roof of a mine without support from below or both sides. Full size examples of this homemade platform system can be seen in-situ in the enormous underground excavations of the Bonne Terre Mine, which was operated by the St. Joe Lead Co. in Bonne Terre, Missouri, until its closure in 1962.<sup>6</sup> Nonetheless, the majority of technical models used in a mining context were not designed to educate their users through manual manipulation or to help solve technical problems at a smaller scale, but instead were intended to encourage viewers to imagine underground mines and draw their own conclusions about geological or mining problems.

## **Models as Visual Representations**

Engineers did not generally use technical mine models as part of their everyday practice – instead, technical models were reserved for special circumstances like law-

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<sup>5</sup>Item 16, Acc. KEWE-00040 “Grid Rack (Wood),” Keweenaw National Historical Park, Calumet MI.

<sup>6</sup>The photograph is found in the John Hoffman Curatorial Files, Room 5028, National Museum of American History, Smithsonian Institution. The mine was reopened as a tourist attraction in the 1980s.

suits. One reason technical models were not used in day-to-day engineering work was that updating even the easiest-to-use models was a tedious chore. One model maker lamented in 1917 that it was difficult to convince the engineers of the worth of models.

When it comes to taking such a model apart for the purpose of making addition, the engineers and draftsmen are often inclined to lose interest and neglect it, especially as the practical part of their work is better served by the mine drawings on a working scale, which furnish them a much more intimate knowledge of underground conditions than a model. To the operating staff at the mine, a model is generally considered a clever bit of ingenuity, but of little practical value.<sup>7</sup>

Early technical models were generally made overseas. Freiberg was a center of mine model making, even in the nineteenth century. According to H.H. Stoek, professor of mining engineering at the University of Illinois, quite a few of the models found in America in 1917 came from Freiberg.<sup>8</sup> The University of Illinois Mining Engineering program owned a wooden model made in Freiberg no later than 1892.<sup>9</sup> W.R. Crane, professor of mining engineering at Pennsylvania State University, reported that he had been interested in making mining models since the late 1890s, and other professors reported some attempts at modeling.<sup>10</sup> Even so, Stoek lamented that the use of models in mining education was underdeveloped in America, “chiefly because of the cost of the models and the scarcity of model makers.”<sup>11</sup>

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<sup>7</sup>John R. Chamberlin, in discussion following H.H. Stoek, “Mine Models,” *Transactions of the American Institute of Mining Engineers* 58 (1918): 32.

<sup>8</sup>Stoek, “Mine Models,” 25.

<sup>9</sup>Stoek, “Mine Models,” 26.

<sup>10</sup>Crane, in discussion of Stoek, “Mine Models,” 32.

<sup>11</sup>Stoek, “Mine Models,” 25.



Technical models became common in America only after the turn of the twentieth century. Technical models could come in a variety of forms, and be made of almost any material. Three types of models - glass models, block models, and skeleton models - became most common, but three-dimensional models could be (and were) made in a wide variety of configurations.

### **Glass Models**

Models made from sheets of glass or some other transparent material ultimately became the most common type of three-dimensional model used in the mining industry.<sup>12</sup> Compared to wooden, metal, or plaster-of-paris models, these glass plate models were relatively cheap and easy to construct and update. Figure 4.1 shows a glass plate model constructed circa 1917 for an Idaho lawsuit.

To build a glass plate model, the maker would paint or draw the underground workings on a series of sheets of glass (such as common window panes). These sheets would then be inserted into a box-like frame, with notches cut in the sides to hold the glass in the proper position. The sheets could be arranged vertically, to show sections of the mine, or horizontally, to correspond with the levels of the mine. The spaces between the glass sheets might also be to scale, to indicate the actual space between levels in the mine, or it might be a consistent diminution of the actual vertical scale.

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<sup>12</sup>Glass was by far the most common material used for these types of models, but for similar models using celluloid sheets, see Mack C. Lake, "Mine Models Made of Celluloid Sheets," *Engineering and Mining Journal* 99 (April 24, 1915): 737–738, 957; and the advertisement for E.J. Longyear Company's geological exploration service, which includes a picture of a celluloid model, in *Engineering and Mining Journal* 99 (June 26, 1915): 19.

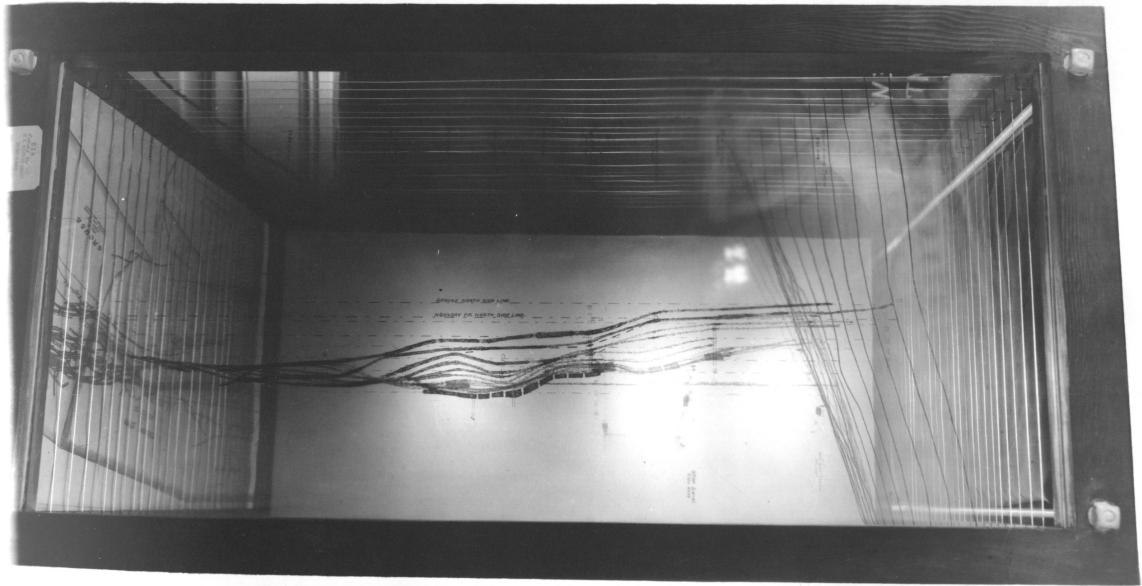


Figure 4.1: Glass plate model “Defendant’s Exhibit 11,” Bunker Hill / Pintlar Corporation Collection, Manuscript Group 413, Box 337, folder 5933, University of Idaho Special Collections and Archives.

If the model was planned for the same scale as that used by the mine’s maps, then marking the plates was simple. The modeler simply placed the glass on top of an unrolled map and traced in the workings. If a different scale was necessary, the work was slightly more complex, but in all cases, working in two dimensions enormously simplified the model making process.

The earliest example of an American glass plate model that I have found was built by Charles T. Healey in 1874. The model depicted the New Almaden quicksilver (mercury) mine in California. The New Almaden, named to capture some of the glory of the world’s most famous and productive mercury mine in Spain, was claimed

and brought into production in 1845 by Andreas Castillo, a Mexican army officer.<sup>13</sup> Mercury's major use was as a key ingredient in the refining of gold and silver ores through amalgamation. Demand for mercury from Mexico and China was already high enough to justify the rapid development of New Almaden from its discovery in 1845. The advent of the California gold rush in 1848-1849, and the development of the Comstock Lode's gold and silver ores beginning in 1859, both opened large domestic markets for California mercury that stimulated production.<sup>14</sup> At New Almaden, as in other mercury mines, the cinnabar, or mercury ore, seemed to occur only in rich pockets, mostly unconnected. Sometimes old pockets would lead to new ones, and sometimes miners seemed to get lucky, but the search for fresh deposits was even more frustrating at New Almaden than at most mines because there did not seem to be a clear system of veins for the miners to follow. New Almaden's peak production (before 1888) was in 1865, when the mine produced 47,194 flasks of mercury. (A flask, as usually measured in the United States, is approximately 76.5 pounds of mercury.) However, by the end of that decade and the beginning of the 1870s, known ore reserves had been largely exhausted and production was declining. 1874 saw the lowest recorded production for New Almaden, with only 9,084 flasks for the year, a decrease of some 2,000 from the year before.<sup>15</sup> New Almaden's decreased output

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<sup>13</sup>Control later passed to British capitalists, then through a series of lawsuits to an American company. George F. Becker, *Geology of the Quicksilver Deposits of the Pacific Slope*, U.S. Geological Survey Monograph 13 (Washington, DC: GPO, 1888), 8-10.

<sup>14</sup> David J. St. Clair, "New Almaden and California Quicksilver In the Pacific Rim Economy," *California History* 73 (1994): 281-284.

<sup>15</sup> Becker, *Quicksilver Deposits*, 10-11. New Almaden rebounded after this period and had some very good subsequent years.

drove the price of mercury up significantly in 1874-1875, which prompted the frantic search for new deposits at New Almaden and other mines in California. Adding to the price pressure on refined mercury was the increased demand of the mills on the Comstock Lode. In 1873, the Consolidated Virginia mine found the rich gold and silver deposit immortalized as the “Big Bonanza,” but mercury was a vital ingredient in the transformation of Consolidated Virginia ore into sellable metal.<sup>16</sup> Thus, in 1874, the pressure to discover new orebodies at the New Almaden was intense – production had fallen, little ore was in sight, and the demand for mercury was huge. The creation of a glass model of the New Almaden mine in 1874 should best be understood as an attempt to rearrange existing data in a format that might permit engineers to perhaps divine some new, previously overlooked relationship between the orebodies that might lead to new ones.

Charles T. Healey, the builder of the model, spent most of his life as a civil engineer employed by the government. Healey was a surveyor for New Almaden, but was let go as an economy measure sometime after building the model. He found an engineering job at a nearby mercury mine, the Guadalupe, and afterward conducted an independent engineering practice in San Francisco.<sup>17</sup> Healey sported the honorific “Captain,” which may have been a reference to Civil War service; Healey was also

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<sup>16</sup>For a detailed and reliable account of the time between the discovery of the Big Bonanza in 1873 and its termination in 1877, see Grant H. Smith and Joseph V. Tingley, *The History of the Comstock Lode* (Reno: Nevada Bureau of Mines and Geology, in association with University of Nevada Press, 1998), 145-215.

<sup>17</sup>Jimmie Schneider, *Quicksilver: The Complete History of Santa Clara County's New Almaden Mine* (San Jose, CA: Zella Schneider, 1992), 67.

sheriff of Santa Clara County, California, for several terms, which was the county in which New Almaden was located.<sup>18</sup> Healey's model was exhibited in 1874 at the "Pavilion" in San Francisco, which was an annual tradeshow, sponsored by the Mechanics' Institute of the City of San Francisco, that facilitated the city's trade in technology, especially mining technology.<sup>19</sup> "We believe this is the first attempt of this mode of mine delineation," wrote the worldly editor of the *Mining and Scientific Press*. He sounded thunderstruck:

It is not only an exquisite work of art, but it constitutes the most palpable, truthful and comprehensive work of representing the underground workings of a mine which has ever been devised. No description can do it justice; it must be seen to be appreciated. The whole mine ... [is shown] just as it would appear to a clairvoyant who might possess the power, while standing upon the lower portion of the surface of the mine, to look directly through the earth and rock, and view collectively the entire underground work.<sup>20</sup>

The model took a form that would still be recognizable in glass plate models half a century later. It consisted of twenty six glass sheets, each approximately 26 inches long and 11 inches wide, set vertically in a notched frame that held the plates exactly an inch apart. The frame was mounted on a pivot, to allow the model to be rotated before the viewer. Each glass plate represented a vertical slice of the underground geology. The surface topography, complete with buildings and trees, was painted on, then the insides of the mountain were represented – misty gray for the ordinary

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<sup>18</sup> *The Bay of San Francisco: The Metropolis of the Pacific Coast and its Suburban Cities, a History*. vol. 2 (Chicago: The Lewis Publishing Company, 1892), 389.

<sup>19</sup> Lynn R. Bailey, *Supplying the Mining World: the Mining Equipment Manufacturers of San Francisco, 1850-1900* (Tucson, AZ: Westernlore Press, 1996), 21-22. Exhibitions were held at yearly intervals beginning in 1857.

<sup>20</sup> "An Interesting Mine Model," *Mining and Scientific Press* 29 (August 29, 1874): 136.

rock, dark black for exploration tunnels that had come up empty, and vivid red, the color of cinnabar, for the chambers where ore pockets had been found and worked out. The vertical sections were based on a scale of one hundred feet to an inch, both horizontally and vertically, so when combined an inch apart in the frame the glass plates created a model of consistent scale.

The model's utility to cinnabar prospectors was immediately obvious to the *Mining and Scientific Press*. The separated ore bodies of the New Almaden mine were clear, but as a viewer slowly turned the model on its pivot, the deposits were seen to have "a most striking general conformity" with the slope of the surface. (The initial discoveries had been on the top of the aptly-named Mine Hill.) This correlation, made possible only by the three-dimensional view of Healey's model, "may afford some important hints for prospecting elsewhere among the quicksilver deposits which are now being so largely sought for in various portions of the State." The editor thought that, "no doubt," such models should be made a part of the instruction at mining schools, and forcefully suggested that a copy of Healey's model, along with "similar representatives of three or four of our principal gold and silver mines," should promptly be secured for the School of Mines at the State University.<sup>21</sup>

Assessing the impact of the 1874 glass model of the New Almaden mine is difficult. Though at least a few European models utilizing glass plates had been constructed more than a decade earlier, Healey's model seems to have been the first glass plate

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<sup>21</sup> "An Interesting Mine Model."

model mentioned in the American mining press, and its exhibition at the Pavilion would have brought many people, from both mining and other industries, in contact with it. For the mine itself, it seems likely that the comprehensive mapping program carried out in the 1870s and the higher price of mercury contributed more to the revitalization of the New Almaden's production than one small model. In fact, the better maps were probably necessary for the creation of the model at all. However, the model may have made it easier to understand the complex geology of New Almaden. In his United States Geological Survey monograph produced in 1888, Geologist George F. Becker described a system of two roughly parallel fissures which seemed to have helped form the deposits and also constrained them. The fissures were difficult to represent on a map or a vertical section, cautioned Becker, because they curved through the mountain. "Could one but represent the fissures by contours, the entire structure would be shown in three dimensions and would not be ambiguous."<sup>22</sup> By portraying the orebodies in three-dimensional space, Healey's 1874 glass plate model provided the clarified view so helpful in understanding the underground landscape of the New Almaden mine.

Even after Healey left the company, models were an important way of understanding the geology of New Almaden. Mining engineer Hennen Jennings, while at New Almaden after 1877, met Edward Benjamin, who was "at that time model-making."<sup>23</sup> Frederic P. Dewey's 1891 catalog of the Economic Geology collections at the United

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<sup>22</sup> Becker, *Quicksilver Deposits*, 321.

<sup>23</sup> Rickard, *Interviews with Mining Engineers*, 227.

States National Museum included a “fine glass model” of New Almaden among their displays. This model also was composed of 26 glass plates, but Dewey listed the plates as representing 50 feet from each other, rather than the 100 feet of the Healey model.<sup>24</sup>

After the creation of the New Almaden model in 1874, glass plate models slowly became the most common type of model of underground mines, even though the models themselves were still relatively rare before the turn of the century. In 1877, Healey helped another engineer create a similar glass model for the litigation between the Richmond mine and the Eureka mine, both in the Eureka district of Nevada. The Eureka-Richmond case attracted a large amount of attention in the mining press because of the unusual geology, high monetary stakes, and extensive participation by expert witnesses.<sup>25</sup> In 1878, mining engineer Arthur D. Foote made a small glass model of the vein in the Iron Silver Mine at Leadville, Colorado, to support his company’s side in a lawsuit. In addition to the model, Foote conducted extensive surveys and made many maps of the mine. This lawsuit, as well as the other Leadville cases, most of which involved the Iron Silver Mine, may have brought glass models to a greater audience of mining men. It was clear that the general public, at least, was unfamiliar with such models. His wife wrote in her memoirs, “His glass model of

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<sup>24</sup> Frederic P. Dewey, *A Preliminary Descriptive Catalogue of the Systematic Collections in Economic Geology and Metallurgy in the United States National Museum* (Washington, DC: GPO, 1891), 191, 193. The model was listed as item 66456.

<sup>25</sup> “Mine Model,” *Mining and Scientific Press* 34 (June 2, 1877): 337.



the vein scored a hit with the jury who admired it like a toy; for awhile it became a quite celebrated little toy.”<sup>26</sup>

Foote’s earlier work as a mining engineer, before he built the glass model at Leadville, was for the New Almaden Mine. He also mapped and surveyed that property, beginning employment in 1875 or 1876. It is likely that Foote became acquainted with Healey’s model of New Almaden during his work there, and then built the Leadville model drawing upon his previous experience. Foote got his job at New Almaden after Healey refused to return to work for the manager James B. Randol.<sup>27</sup>

Through the end of the period I study, when it was deemed necessary to display the workings in three dimensions, glass plate models were usually the technology of choice. After the major boom, in the later life of the mines of the Tonopah Mining Company in the 1930s and 1940s, when leasers did the mining, the company maintained an up-to-date glass plate model with the workings and the geology of the mine in the mine office. Before agreeing to lease a section of the mine, the leasers could come into the office and use the model to help them pick a potentially favorable spot. Leasers tended to be practical miners, without any engineering education, and likely they would not have been able to derive the same use out of traditional mine maps.<sup>28</sup>

In 1903, Nathaniel P. Hill of Colorado and John R. Chamberlin, of New York, received patents in both the United States and Great Britain for a transparent mine

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<sup>26</sup> Mary Hallock Foote, *A Victorian Gentlewoman in the Far West: the Reminiscences of Mary Hallock Foote*, ed. Rodman W. Paul (San Marino, CA: Huntington Library, 1972), 164.

<sup>27</sup> Schneider, *Quicksilver*, 67-68.

<sup>28</sup> Robert D. McCracken, *A History of Tonopah, Nevada* (Tonopah, NV: Nye County Press, 1990), 104.

model made of sheets of carved glass.<sup>29</sup> The pair noted in their patent application that “We are aware that attempts have been made to produce models or exhibits for this purpose, but we are not aware that any one [sic] has hitherto produced a model or exhibit in transparent material...” Hill and Chamberlin also filed for a patent on a machine for grinding the glass plates used in their models. The pair typically built models on a scale of 100 feet to an inch, and used inch-thick glass plates to correspond with levels 100 feet apart. Their models represented surface features as well as the underground workings. Hill and Chamberlin cut the glass in their models, rather than painting or drawing on it as later glass modelers typically did.<sup>30</sup> The primary audience for these expensive models, according to Chamberlin, was the businessmen associated with the mine; the duo made several that occupied “a prominent place in the Director’s room.”<sup>31</sup>

## **Block Models**

Some of the oldest models of mines were solid models that either omitted surface topography or showed a cutaway view of the earth. These models were not always as useful in a technical way as the later glass plate and skeleton models, in part because of their less-precise construction, but they were often more aesthetically pleasing than the alternatives, and were better suited to interpretation by non-experts.

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<sup>29</sup>The U.S. patent was number 727,140; “Mine Model or Exhibit,” *Engineering and Mining Journal* 75 (1903): 757. Note: Chamberlin’s name is misspelled by the previous article. The British patent was number 1,410 of 1903; “Mine Model,” *Engineering and Mining Journal* 75 (1903): 904.

<sup>30</sup>Patent Specification No. 727,140, 3-4.

<sup>31</sup>Chamberlin comment during discussion, in Stoek, “Mine Models,” 32.

Early examples of geological models were made by Thomas Sopwith, a British engineer. Sopwith was one of the pioneers of his craft. Though he was aware of a handful of other geological models, most produced in continental Europe, Sopwith noted in 1834 that “Topographical modelling is scarcely either known or practised; and when it is considered what extravagant sums are daily expended in mere trifles, it is surprising that a pursuit combining so much elegant amusement with practical science and utility, should be almost utterly neglected.”<sup>32</sup> His 1834 treatise on drawing included instructions for building models that depicted geology. Sopwith advocated imposing a grid of squares on a geological map, then making sections, or vertical depictions of the geology, along every line. These sections were then traced on to pasteboard or thin sheets of copper, and colored in. A series of half-notches were cut at appropriate intervals, so that the pasteboard sections fit together in a hollow grid in an egg-crate pattern. Finally, wood or plaster of paris blocks could be carved to fit in the hollow squares to represent the surface topology, but could be removed if the viewer wanted to see the geology below.<sup>33</sup> Several models built by Sopwith using this method were exhibited at the Museum of Practical Geology in London.<sup>34</sup>

Sopwith’s models attracted the attention of other mining engineers and geologists. Geologist William Buckland persuaded Sopwith to sell a set of twelve of his smaller

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<sup>32</sup>T. Sopwith, *A Treatise on Isometrical Drawing, as Applicable to Geological and Mining Plans, Picturesque Delineations of Ornamental Grounds, Perspective Views and Working Plans of Buildings and Machinery, and to General Purposes of Civil Engineering; With Details of Improved Methods of Preserving Plans and Records of Subterranean Operations in Mining Districts* (London: John Weald, Taylor’s Architectural Library, 1834), 154-155.

<sup>33</sup>Sopwith, *Treatise on Isometrical Drawing*, 154-157.

<sup>34</sup>Brough, *Treatise*, 263.

models for the purpose of teaching geology, and Sopwith and his cousin, John Sopwith, began producing them in 1841.<sup>35</sup> These small square wooden models showed vertical sections on four sides, the surface topography, and a horizontal plan of the underground geology on the bottom. The models were expensive to produce, but demand was steady, and a series of six simplified and updated models was issued in 1875. The 1875 set of six, available for three guineas, contained square models four inches to a side, but larger versions were available for lectures.<sup>36</sup> Both sets were accompanied by an explanatory book, which led the reader through a description of the geology depicted on the models much as a lecturer might have done. Sopwith stated his pedagogical hopes for the models in 1875:

This series of Models is intended to afford a familiar explanation of various phenomena, a knowledge of which is essential to the study of Geology as connected with practical mining, and more particularly as regards the nature of stratification, the denudation of valleys in mining districts, the intersection of mineral veins, &c., which cannot be so well explained by ordinary drawings or sections as by models of this description.<sup>37</sup>

The construction of even reasonably precise block models depended on reliable elevation information. Once such information had been collected (or estimated) and plotted on a two-dimensional map in the form of contour lines, the creation of a three-dimensional model required some craftsmanship but was not an intellectually

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<sup>35</sup>Thomas Sopwith, *Description of a Series of Geological Models, Illustrating the Nature of Stratification, Valleys of Denudation, Succession of Coal Seams in the Newcastle Coal Field, the Effects Produced by Faults or Dislocation of the Strata, Intersection of Mineral Veins, &c.* (Newcastle-upon-Tyne: Printed for the Author, by J. Blackwell and Co., 1841).

<sup>36</sup>T. Sopwith, *Description of a Series of Elementary Geological Models* (London: R.J. Mitchell & Sons, 1875), xii.

<sup>37</sup>Sopwith, *Elementary Geological Models*, 1.

difficult enterprise. The first maps with underground elevation contours were made by Benjamin Smith Lyman in 1866 and 1867, and the engineer showed off a photograph of one in 1867 to the American Association for the Advancement of Science. Lyman first published a map featuring underground contours in 1870 (of oil fields near Lahore, India), but the idea was still quite new when he published a description of the technique in 1873.<sup>38</sup>

Charles A. Ashburner, who played a major role in the second Pennsylvania Geological Survey, used Lyman's underground contours to produce a series of maps and an impressive block model of the Panther Creek coal basin in the anthracite country of Pennsylvania around 1882.<sup>39</sup> The Panther Creek basin was probably the most geologically complex of the anthracite areas, and Ashburner anticipated that a solid understanding of the extent of the coal at depth could provide useful information to coal entrepreneurs. Ashburner's geological survey team collected elevation measurements of the bottom of the Mammoth Vein as it was exposed in the underground workings in the Panther Creek basin. Ashburner then created underground elevation contours, 50 feet apart, which he plotted on maps at a scale of 800 feet to an inch. Though he published these maps with his report, he also wanted to represent the coal bed in a different way. Ashburner hired John Henry Harden to construct a three dimensional model using the contour data. For every other contour line on the map,

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<sup>38</sup>Benjamin Smith Lyman, "On the Importance of Surveying in Geology," *Transactions of the American Institute of Mining Engineers* 1 (1873): 187-188, 192.

<sup>39</sup>Ashburner died young after a promising initial career. See J.P. Lesley, "Biographical Notice of Charles A. Ashburner," *Transactions of the American Institute of Mining Engineers* 18 (1890): 365-370.

Harden cut thin slabs of wood to follow the curve. These pieces of wood were then stacked together to produce a three-dimensional version of the contours on the map, with 100 feet between contours. The rough steps between boards were filled in with modeling wax, and a negative cast was made, which was then used to produce at least one positive cast in plaster-of-paris. For Ashburner's report, a photograph was made of the model, then a lithograph was made from the photograph for duplication of the image.<sup>40</sup> His model, or a copy, was on display at the United States National Museum by 1891, in the collections of economic geology.<sup>41</sup> Bennett Brough, the British author of the standard treatise on mine surveying first published in 1888, summed up the importance of Ashburner's model:

Thus, the final model, made in wood and wax, not only formed a graphic representation of the structure of the strata in a highly plicated district, but also proved of great value in the definition of its geological structure, and in the deduction of many conclusions affecting the amount of coal contained in this coal basin, and the proper methods to pursue in its ultimate mining.<sup>42</sup>

Occasionally modelers combined features of different types of models. Three models of salt mines in present-day Austria, probably made in the late 1850s, were on display at the London Museum of Practical Geology by 1865. The models, at a scale of 400 feet to an inch, were made by one Bergmeister Ramsauer, who was the mining engineer in charge of the works. These models combined features of block models and

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<sup>40</sup> Charles A. Ashburner, *First Report of Progress in the Anthracite Coal Region: The Geology of the Panther Creek Basin or Eastern End of the Southern Field*, Second Geological Survey of Pennsylvania, Report AA (Harrisburg: Board of Commissioners for the Second Geological Survey, 1883), 242.

<sup>41</sup> Dewey, *Catalogue of the Collections in Economic Geology*, 224.

<sup>42</sup>Brough, *Treatise*, 262.

glass plate models. Upon first appearance the models looked like the ordinary block type, with the surface represented accurately on the top and geologic sections painted on the vertical sides of the model. However, when the top of the model was removed, the user looked down into a series of horizontal glass plates with certain features of the workings colored in. Thus the Ramsauer models combined both the block model and the glass plate modeling traditions.<sup>43</sup>

### **Skeleton Models**

Glass plate models used clear glass to make a series of two-dimensional drawings collectively give the *illusion* of a third dimension. Mining engineers developed other types of models that represented mines in three dimensions, but these lacked the ease of construction of the glass plate models. The most common type of non-plate model was usually called a “skeleton model” or a “wire model.” Skeleton models were a mirror image of the underground, since they used solid materials to depict excavated space in the mine and represented solid mine rock as simply open space on the model. The models were usually constructed out of lightweight wood, copper wire, and occasionally cloth or plaster-soaked strips.<sup>44</sup>

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<sup>43</sup>It is also notable that these three models are the earliest mention of glass plate models I have yet found. Hilary Bauerman, *A Descriptive Catalogue of the Geological, Mining, and Metallurgical Models in the Museum of Practical Geology* (London: George E. Eyre and William Spottiswoode, 1865), 102-105.

<sup>44</sup>See, for example, “Wood and Cloth Mine Model,” *Engineering and Mining Journal* 95 (February 22, 1913): 419–420.

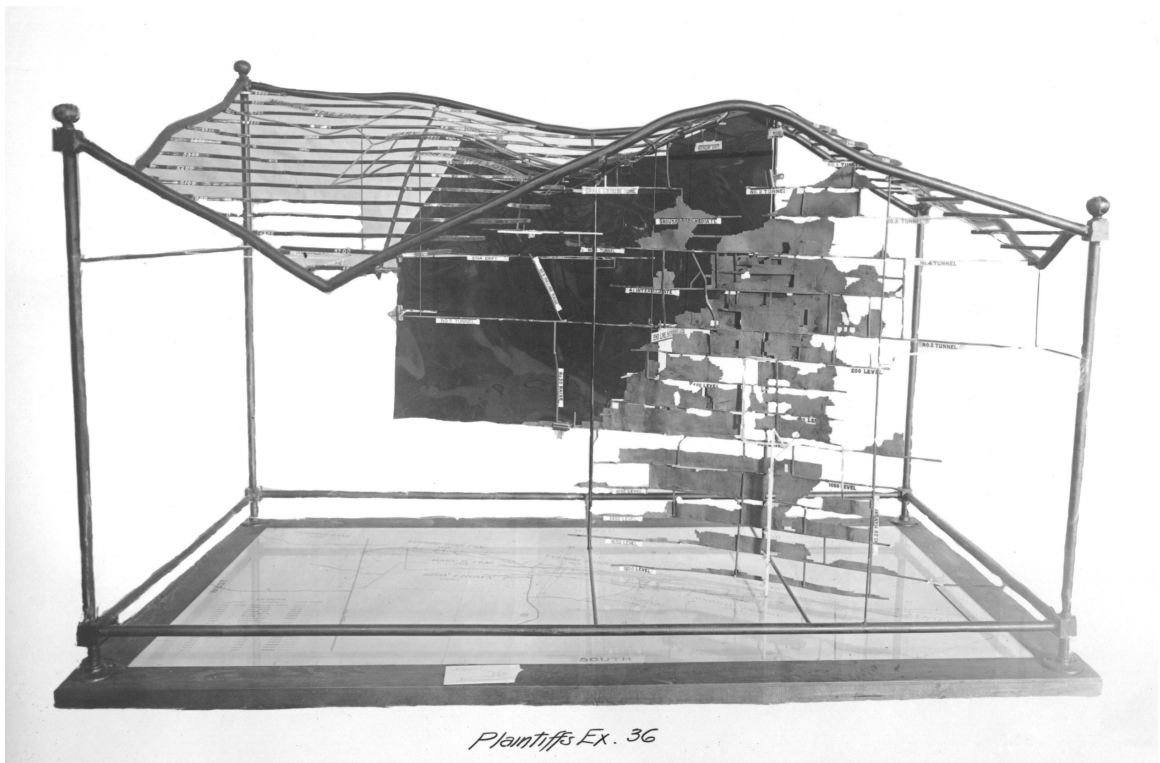


Figure 4.2: Skeleton model "Plaintiff's Exhibit 36," from the front. Bunker Hill / Pintlar Corporation Collection, Manuscript Group 413, Box 337, folder 5933, University of Idaho Special Collections and Archives.



Figures 4.2 and 4.3 show the front and side of a skeleton model constructed circa 1917 for an Idaho mining lawsuit. In this model, the top represented the surface, depicted with contour lines as on a topographic map, complete with painted elevation numbers. The bottom of the model had a two-dimensional plat map of the boundaries of the mining claims at issue in the lawsuit, along with a title block to identify it. The mining claims were also outlined on the surface topography in wire, so that the borders would be visible when the viewer looked down on the model from above.<sup>45</sup> The tunnels were mostly made from wire and the stopes, or excavated areas, appear to have been thin pieces of cardboard or wood. Each feature potentially of interest in the lawsuit was labeled with a paper tag. Though it is impossible to be certain when viewing the black and white photographs taken of the model, a legend on the bottom map suggests that the different tunnels and stopes were probably colored according to their elevation. This would follow the ordinary practice employed on composite two-dimensional mining maps of giving each level a different color as a way to tell them apart.<sup>46</sup> This model's heavy outer frame was this modelmaker's way of solving one of the primary problems with skeleton models, which was that they tended to be extremely fragile. Even with the unusually heavy frame to stabilize it, additional wires connected the "workings" to the frame for added strength. What appears to be a curtain or partial background is not part of the model. Careful examination of the full

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<sup>45</sup>Not all skeleton models represented the surface. The West End model shown later in figure 4.5 showed the underground only.

<sup>46</sup>Not all skeleton models followed this practice, however – the West End model in figure 4.5, discussed later, colored all of the workings with similar geology the same.

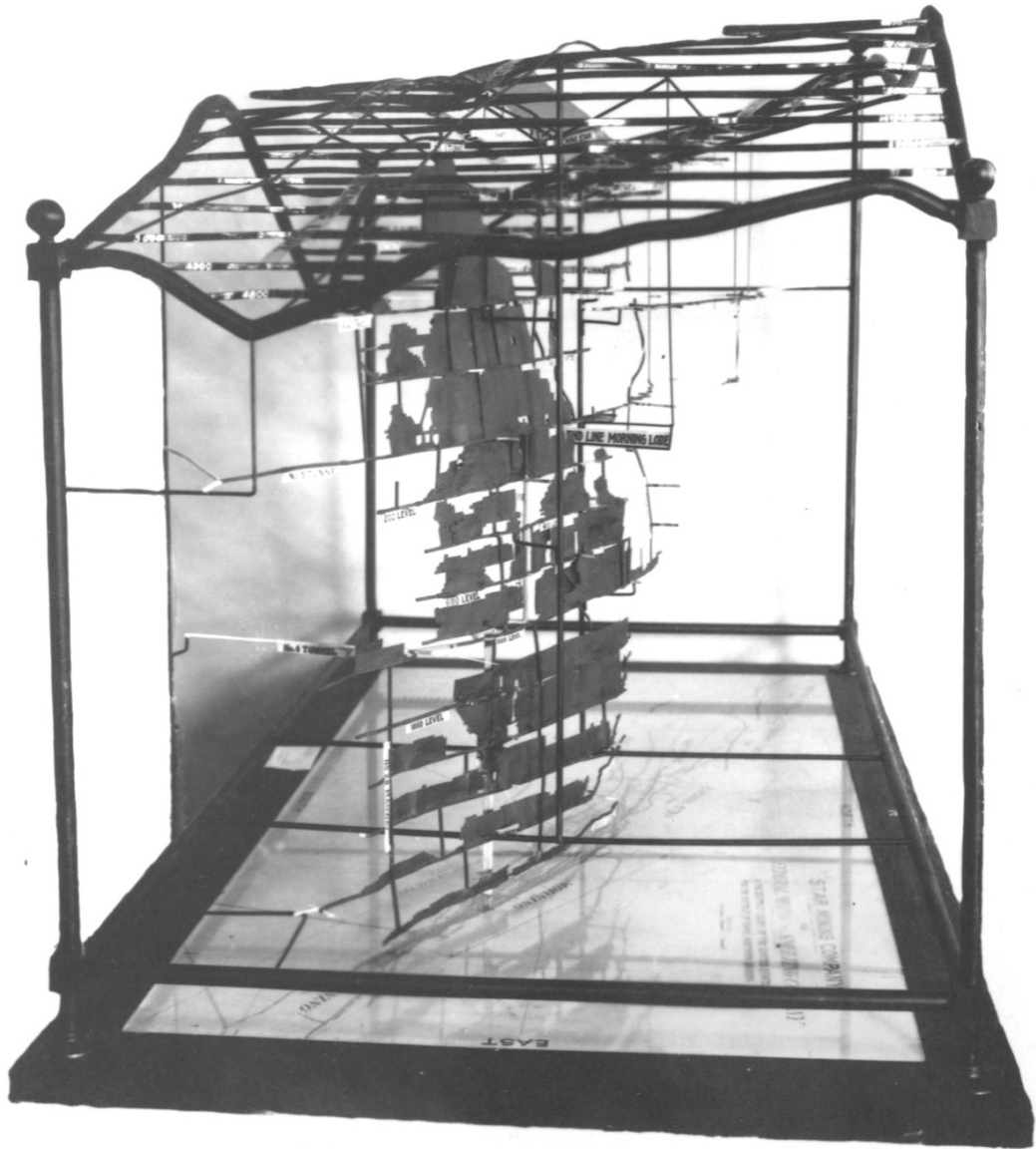
series of five photographs taken of this model shows that the photographer attempted to hold a cloth backdrop against the model to exclude the background scene. The background must not have provided adequate contrast for the photographer's taste, however, as the negative was carefully filled in with opaque ink, since dark ink on the negative yielded pure white on the print, to blot out the background. (A tell-tale touch of sloppiness with the pen on the negative can be seen on the structural members when the photo is viewed under magnification.) The complexity of the stope area on the model apparently flummoxed the photographer and he left the negative alone in that area, giving the appearance of a partial backdrop.

At least one company specialized in constructing mining models. F.A. Linforth managed the Engineering Model Works, located in Butte, Montana, after the turn of the century. His models were classic examples of the skeleton type, described as having levels and stopes cut out of maple wood, mounted to metal shafts and wire supports. As a result, "the whole model is thus open, and on it the geology can be painted in such a way as to bring out very clearly space relationships."<sup>47</sup> Linforth seemed to have worked closely with the geological department of the Anaconda Copper Mining Company, and probably helped that firm by constructing models used in the extensive apex lawsuits that plagued the company in the last years of the 1890s and first years of the 1900s.<sup>48</sup>

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<sup>47</sup>E.B. Young in discussion of Stoek, "Mine Models," 35.

<sup>48</sup>For Linforth's involvement with Anaconda's geological department, see F.A. Linforth and E.B. Milburn, "Geology Applied to Mining," *Engineering and Mining Journal* 91 (April 1, 1911): 664-667.



*Pliff. Ex. 36*

Figure 4.3: Skeleton model “Plaintiff’s Exhibit 36,” from the side. Bunker Hill / Pintlar Corporation Collection, Manuscript Group 413, Box 337, folder 5933, University of Idaho Special Collections and Archives.

## Other Model Configurations

Wood, wire, and glass were common materials for mine models, but inventive engineers could utilize any materials at their disposal to represent underground spaces. H.H. Stoek, a professor of Mining Engineering at the University of Illinois, described in a paper he delivered to the American Institute of Mining Engineers the wooden models of coal mining systems he had made for his classes. In the subsequent discussion, other engineers and educators described models that they had made of combinations of glass plates, clay, rock and concrete, wood, celluloid, paper maché, pasteboard, and wire “covered with magnesia pipe covering.”<sup>49</sup>

Mining engineers and geologists occasionally developed new ways to represent two-dimensional data in three dimensions, particularly as they generated greater amounts of information after the turn of the 20th century. The use of diamond drills to prospect for orebodies made a significant difference in the ability of engineers to plan future actions on the basis of known reserves, but the amount of data generated in the course of a drilling campaign could be difficult to visualize. One solution was to make a model of wooden dowels, to represent drill holes, set in pegboard.<sup>50</sup> A model of this type produced by the Quincy Mining Company circa 1925 is shown in figure 4.4. The height of most of the dowels probably corresponds to the relief of the terrain. The Quincy’s property, in the Upper Peninsula of Michigan, ran from the top

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<sup>49</sup> Stoek, “Mine Models,” 32-35.

<sup>50</sup>For a diamond drill hole model using painted wires, see G. C. Bateman, “Diamond Drill Hole Model,” *Engineering and Mining Journal* 95 (March 1, 1913): 471.



Figure 4.4: Dowel Model at Quincy Mining Company office, Hancock, MI, circa 1925. Koepel Collection, Keweenaw National Historical Park Archives, Calumet, MI.

of the hill, where the mine shafts were located, down toward the channel of Portage Lake below. Though it is not certain, the height of the dowels in the photograph seem to replicate this terrain. The tall white dowels that stand out from the overall trend all have small labels set in a notch at the top. These dowels probably indicated important information such as property corners. While the height of the dowels served to indicate topography, the colors on the sticks conveyed information about geology. At least three colors can be identified in the photograph of the Quincy model – white, light gray, and dark gray, though the dark color in the photograph could very well be two different colors such as red and blue. A 1910 article in the *Engineering and Mining Journal* suggested that dowels in such a model should have one color to indicate the drilling progress, and another to indicate ore found in the drill holes.<sup>51</sup> Even though the photograph of the Quincy dowel model shown in figure 4.4 is not detailed enough to permit a more nuanced analysis of the information it displayed, one glance at the photograph is sufficient to understand the power of aggregated information displayed in such a three-dimensional form.<sup>52</sup>

## Uses of Mining Models

Models were most useful in helping non-miners visualize complex underground geology. In his 1855 book, John R. Leifchild spent several pages attempting to describe

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<sup>51</sup>“Graphic Indication of Drilling,” *Engineering and Mining Journal* 89 (February 26, 1910): 453.

<sup>52</sup>Many thanks to Jeremiah Mason, of Keweenaw National Historical Park, for locating this photograph and providing scans for me.

the complex underground geology of Wheal Peever, a Cornish tin mine. Finally, perhaps sensing that his explanation and two-dimensional geometrical drawings were inadequate, Leifchild noted “Such complicated phenomena are only to be clearly apprehended by a model. I fear the reader may think I am here presenting to him the *pons asinorum* of the mineral Euclid...”<sup>53</sup>

After the turn of the century, authors of treatises on mining engineering advocated models for their utility in helping visualize the underground, especially for so-called “practical” miners (i.e., those potentially without the benefit of a university education in mining engineering). William H. Storms, in a book aimed at this “practical” audience, interrupted his 1909 discussion of the block-caving method pioneered by the Homestake Mine in South Dakota to offer his opinion as to the value of three-dimensional models of the underground. “A good model of the workings of a mine is of great value in laying out work and in studying mine methods,” he wrote. Storms believed that such models were of particular help to superintendents, foremen, and managers generally, in part because models “make it possible to present the broader problems involved within a space immediately under the eye.” The author pointed to a five foot square model of an underground stope used by the Homestake to help them develop new mining methods, and he also mentioned the plaster of paris model, sawn into sections, created by the Treadwell mine in Alaska. Storms concluded his side note by comparing models with the more familiar mine maps, while keeping his

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<sup>53</sup> John R. Leifchild, *Cornwall: its Mines and Miners; with Sketches of Scenery; Designed as a Popular Introduction to Metallic Mines* (London: Longman, Brown, Green, and Longmans, 1855), 111-113, quote on 112.

practical audience in mind: “Maps, of course, have similar advantages, but a properly constructed model is better for the purpose of studying practical mining problems than the best map.”<sup>54</sup> Storms’ advocacy of models over maps for his “practical” audience may have been in response to the increasingly fragmented and specialized nature of underground maps. These larger-scale maps showed less ground, and thus were more difficult, especially for those not formally trained as mining engineers, to reconstruct in their mind’s eye as a three-dimensional whole. In such a situation, a three-dimensional model, which necessarily was smaller-scale, could provide the overall view that maps increasingly could not.

Technical models of mines were also commonly used in the education of mining engineers. Bennett Brough reported in 1888 that students of the Stockholm School of Mines in Sweden were required to learn how to build glass plate mine models.<sup>55</sup>

W.R. Crane believed that the opportunity presented by models to see mines all at once and in three dimensions improved the work of his students “in a surprising manner.”<sup>56</sup> However, the pedagogical benefit of models was not automatic. F.W. Sperr, who taught at the Michigan School of Mines, found that simply having the student look at the models as they were being described “failed to increase the efficiency of our teaching as much as we had anticipated that it would do.” Sperr found that the models were particularly effective when he had his students sketch and describe

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<sup>54</sup> William H. Storms, *Timbering and Mining: A Treatise on Practical American Methods* 1st ed. (New York: McGraw-Hill Book Company, 1909), 243-244.

<sup>55</sup>Brough, *Treatise*, 264.

<sup>56</sup>Crane, during discussion of Stoek, “Mine Models,” 33.



them prior to visits to actual underground mines. Using their notes from the models as a reference, the students were able to grasp underground operations much more completely and quickly than before.<sup>57</sup>

Occasionally educational models were important simply to inspire students. Metallurgical engineer Edward P. Mathewson, who won worldwide fame as head of Anaconda's copper smelters for 14 years, stumbled upon his future career by accident. The son of a Canadian grocer received the first spark of interesting in mining and metallurgy in the early 1880s at McGill University:

“My first impulse toward metallurgy came when looking at some models of furnaces in the college at McGill. When I entered McGill I did not know what course I was to follow, and went through the first year without making a decision.”<sup>58</sup>

## Models in the Courtroom

“In addition to the practical value and advantage of mine models to the geologist and miner, such models will frequently be found of great advantage in suits at law, in settling mining claims and damages in dispute, when ordinary plans are unavailing,” advised Bennett Brough in his classic work on mine surveying.<sup>59</sup>

Models were better at helping viewers, especially those without technical backgrounds, understand three-dimensional underground landscapes. One of the most important sites for this sort of visual work, as Brough noted, was the courtroom, where

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<sup>57</sup>Sperr in discussion of Stoek, “Mine Models,” 35.

<sup>58</sup>Rickard, *Interviews with Mining Engineers*, 335.

<sup>59</sup>Brough, *Treatise*, 264.

non-technical judges and juries applied vague laws to specific underground conditions. In a legal context, the visual power of models outweighed their drawbacks of expense, small scale, and inflexibility. In the following section, I closely examine one particular mining trial and its models in its legal and geological context, because the primary justification for the creation and use of technical models in mining during the period I study were legal struggles.

Mining engineer and geologist David W. Brunton, who was well-respected in the courtroom as an expert witness, succinctly argued for the important of visual representations in mining trials:

The best method of placing actual mine conditions before a judge or jury is by some graphic method of visualization. Verbal descriptions of mine-workings convey little or nothing to a man who has never been underground ... their sympathies, [are] always with the side that they understand best; hence the necessity in a mining suit for introducing models, colored maps, and anything that will enable the jury to visualize conditions better than they can from verbal descriptions.<sup>60</sup>

In the rest of this chapter, I will use the opportunity presented by good documentation and a surviving model to closely investigate how models and other visual representations of underground spaces were used in a particular mining law case. Each side utilized models, but it is clear from the historical record that the competing models were used in far different ways by the litigants.

The surviving model from this case, shown in figure 4.5, is composed of fragile-looking wooden shapes and spindly wire supports, vivid with red, yellow, and green

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<sup>60</sup> Rickard, *Interviews with Mining Engineers*, 81.



Figure 4.5: West End Skeleton Model. W.M. Keck Museum, Mackay School of Mines, University of Nevada, Reno. Photo by Eric Nystrom, 2005.

pigments. Now housed in the W.M. Keck Museum at the University of Nevada–Reno, the model was built in 1914. It depicts, to scale and in three dimensions, the underground workings of a portion of the Tonopah, Nevada, mining district. It was built by the defendant in a complex lawsuit over who had the right to mine more than \$500,000 worth of silver ore. This model, and the trial in which it was used, provides an unusual window into the use of three-dimensional visual representations in the mining industry. The model played an important role in structuring the final outcome of the case. The verdict resulted in prosperity for one company and ruin for

the other, and the case also established a mining-law precedent that was affirmed by the U.S. Supreme Court.<sup>61</sup>

Since all mining law was interpreted in light of local geological conditions, I will set the stage for the discussion of the case with a brief account of the history of mining at Tonopah. Prospector Jim Butler discovered rich silver ore at the future site of Tonopah, on the flank of a mountain in central Nevada, in 1900. The following year, he returned with friends and began to develop his claims in earnest. The potential of Tonopah brought a huge crowd to the new camp, and also brought the attention of Eastern capital. Butler and his partners sold the original claims to the Tonopah Mining Company, backed by Philadelphians, and the company commenced mining in January 1902. The Tonopah Mining Company held some of the best claims, but many others had been staked by prospectors attracted by Butler's initial discoveries, and some of them turned into profitable mines as well. The boom period lasted through about 1905; after that, Tonopah mining became less speculative and more businesslike. The district's period of peak productivity was about 1908-1924. The very best years occurred almost in the middle of that period – total output from the mines exceeded 500,000 tons annually in 1913, 1914, 1915, and 1918. During these years of peak productivity, there were over half a dozen major mining companies, and many more small ones. Some of them were inter-related, sharing board members, managers, or even mining personnel, but no one company completely dominated

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<sup>61</sup> *Jim Butler Tonopah Mining Company v. West End Consolidated Mining Company*, 247 U.S. 450; 38 S. Ct. 574; 62 L. Ed. 1207.

Tonopah as was common in other districts. Figure 4.6 shows the ground controlled by the various companies as of 1915, which even extended directly under the town itself.<sup>62</sup>

One of the Tonopah mining businesses was the Jim Butler Tonopah Mining Company, named after the discoverer of the original deposits. It was formed in 1903 to work sixteen claims that were located southeast of the original discoveries.<sup>63</sup> (See figure 4.6.) Jim Butler himself was president of the namesake company until 1911, but throughout the period, the Jim Butler was operated by the Tonopah Belmont operation, which was controlled by many of the same Philadelphians as the original discoveries. From its formation in 1903 until 1910, the Butler was mined in a relatively limited fashion, with low output. In 1910, more valuable deposits were found underground, and the Butler turned a profit for the first time in 1912.<sup>64</sup>

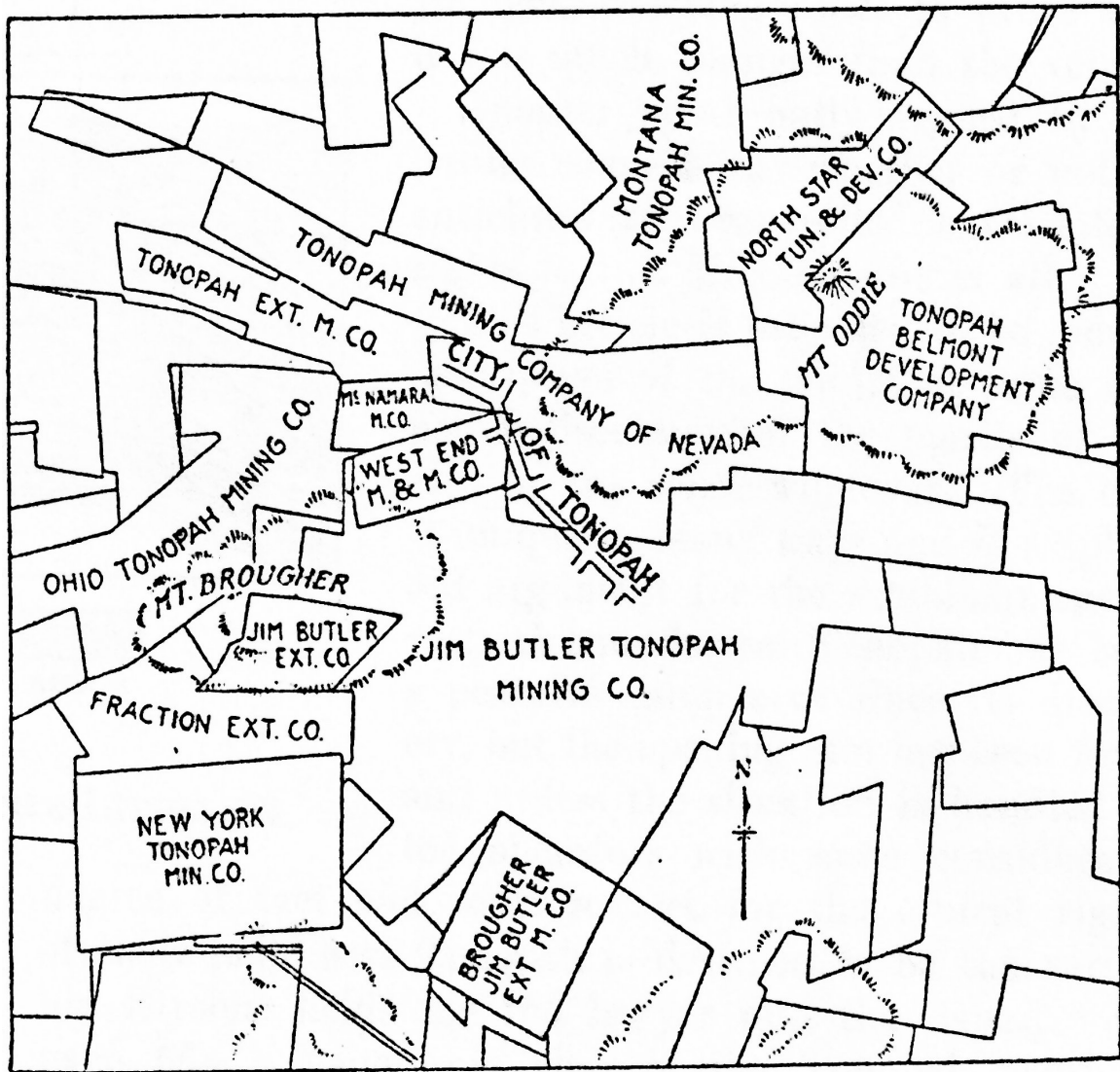
The West End Consolidated Mining Company was based on the West End claim, which was located in 1901 by several of the original leasers of Jim Butler's initial discoveries (prior to the beginnings of Philadelphia control). They formed a locally-owned company, which was relatively unusual for the area, but a lack of capital restricted production. In 1906, the miners encountered high-value ore – averaging \$62

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<sup>62</sup>On the history and importance of Tonopah, see Russell R. Elliott, *Nevada's Twentieth-Century Mining Boom: Tonopah, Goldfield, Ely* (Reno: University of Nevada Press, 1988) and McCracken, *A History of Tonopah, Nevada*. On the mining history of the town, see Jay A. Carpenter, Russell Richard Elliott, and Byrd Fanita Wall Sawyer, *The History of Fifty Years of Mining at Tonopah, 1900-1950*, University of Nevada Bulletin, Vol. 47, No. 1, Geology and Mining Series, No. 51 (Reno: Nevada Bureau of Mines and Geology, 1953), 55-58, 130-135; production statistics are on 149.

<sup>63</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 52.

<sup>64</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 52, 66, 96.



MAP OF TONOPAH SHOWING PROPERTIES IN APEX LITIGATION

Figure 4.6: Claim map of Tonopah, Nevada, at the time of the trial. The West End is a small claim in the center-left, and the portions of the Jim Butler ground in dispute are located just to the south. Note the jagged end line of the West End claim. Map from "Apex Litigation at Tonopah," *Engineering and Mining Journal* 99 (1915): 660-661.

per ton – which justified incorporation and a public stock offering to raise working capital. Francis M. “Borax” Smith bought most of the shares and became president of the company, but the original owners were still involved with active management of the mine.<sup>65</sup> The West End settled a dispute over extralateral rights with the MacNamara, the claim immediately to its north, in 1908. Figure 4.6 on page 167 shows the MacNamara north of the West End claim, which borders the Jim Butler holdings to the south, all directly under the main streets of Tonopah. By 1914, the West End had earned a solid reputation. The mine shipped ore steadily, and the management was praised for making decisions based on conservative estimates and pushing a forward-looking development strategy.<sup>66</sup>

These two neighboring businesses, the Jim Butler Tonopah Mining Company and the West End Consolidated Mining Company, were the antagonists in the high-stakes 1914 lawsuit. The fight began in February 1914, when miners employed by the Jim Butler broke through into workings made by the West End in Jim Butler ground. Over 55,000 tons of ore, it turned out, had been mined by the West End beyond its side boundary in Butler territory.<sup>67</sup> After negotiations to prevent litigation and to

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<sup>65</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 52-53. Smith was old friends with some of the original locators, who had worked with him at his first borax operation, near Candelaria, Nevada, in the 1880s. See Hugh A. Shamberger, *The Story of Candelaria and its Neighbors: Columbus, Metallic City, Belleville, Marietta, Sodaville and Coaldale, Esmeralda and Mineral Counties, Nevada* (Carson City, NV: Nevada Historical Press, 1978), 135-138.

<sup>66</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 66-67.

<sup>67</sup>“Jim Butler Company Commences Suit Against West End Con,” *Tonopah Miner*, April 11, 1914. The West End disputed the charges, even to the extent of disputing the tonnage and value of ore mined. The West End claimed, before the trial, that it had only mined 23,341 tons of ore with an “aggregate net value” of \$204,300. “West End Stands Pat on Claim of Clear Cut Apex,” *Tonopah Daily Bonanza*, July 7, 1914.

equally divide the ground failed,<sup>68</sup> the two companies prepared to battle it out in court.

The legal basis for the dispute was a branch of mining law known as “extralateral rights,” which under certain conditions permitted miners to follow a vein from their own claim underneath a neighboring one as the vein dipped into the earth.<sup>69</sup> In order to possess this extralateral right, the claim had to include the “apex” of the vein within its surface boundaries, and also meet all of the other requirements (size, fees, shape, and so on) spelled out in the law.<sup>70</sup>

A mining company needed an apex in their claim in order to have extralateral rights, but what exactly was an apex? The statute did not define the word, and it was not a traditional mining term, so no historical meaning could serve as a guide.

Congress apparently had an idealized type of fissure vein in mind when they coined

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<sup>68</sup>“West End Officers in Conference in New York,” *Tonopah Daily Bonanza*, April 3, 1914; “Counter Proposition of Butler Reported by New York Message,” *Tonopah Daily Bonanza*, April 4, 1914; “West End Stands Pat on Claim of Clear Cut Apex,” *Tonopah Daily Bonanza*, July 7, 1914.

<sup>69</sup>On American mining law, see Charles W. Miller Jr., *Stake Your Claim! The Tale of America’s Enduring Mining Laws* (Tucson, AZ: Westernlore Press, 1991), who sees the survival of the mining laws as proof of the validity of the Turner/Webb frontier thesis. Miller’s work covers the most historical ground, though his analysis of many of the decisions suggest a lack of nuance. William T. Parry, *All Veins, Lodes, and Ledges Throughout Their Entire Depth: Geology and the Apex Law in Utah Mines* (Salt Lake City: University of Utah Press, 2004) is the most recent study of the extralateral right, but he focuses primarily on Utah cases. For the Comstock Lode, where many of the early disputes about extralateral rights were worked out by the courts, see Bruce Alverson, “The Limits of Power: Comstock Litigation, 1859-1864,” *Nevada Historical Society Quarterly* 43, no. 1 (2000): 74–99. For a trans-national perspective on mining law, see Barry Barton, “The History of Mining Law in the US, Canada, New Zealand and Australia, and the Right of Free Entry,” in *International and Comparative Mineral Law and Policy*, ed. Elizabeth Bastida, Thomas Wälde, and Janeth Warden-Fernández (Kluwer Law International, 2005), 643–660.

<sup>70</sup>The 1872 mining law gave mining claimants “all veins, lodes, and ledges throughout their entire depth, the top or apex of which lies inside of such surface-lines extended downward vertically, although such veins, lodes, or ledges may so far depart from a perpendicular in their course downward as to extend outside the vertical side-lines of said surface locations...” See “An Act to Promote the Development of the Mining Resources of the United States,” *U.S. Statutes at Large* 17: 91-96, quote on 91-92.



the term, and in such a case it might have been clear enough what the apex of the vein was – but the geology of mines was rarely so simple. As a result, the courts gradually refined the term “apex” as they decided on lawsuits over extralateral rights where existing precedent was unclear.

The West End clearly believed they had an apex inside their claim that gave them the right to follow their vein into the Jim Butler, but the vein didn’t look like Congress’s ideal case. It had a shape more like a handkerchief that someone pinched in the middle to pick up off a flat table. Figure 4.7, on page 188, shows one vision of the cross-section of the vein. Geologically speaking, this inverted-U shape is known as an anticline.

The problem for the West End was that earlier courts had ruled, in a series of decisions known as the “Leadville cases,” that anticlines were not enough to constitute apexes. In the Leadville cases, the courts concluded that a blanket vein that merely rolled or undulated had no true apex, and therefore no extralateral rights.<sup>71</sup> The West End attempted to dodge this precedent by arguing that, despite appearances, their vein was not an anticline, but was instead two separate veins that happened to come together at the top – two veins, two apexes (in the same place), and thus extralateral rights in both directions. During the trial the West End’s lawyers and experts were careful to always use language that reinforced this interpretation. They

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<sup>71</sup>The two most important cases were *Iron Silver Mining Co. v. Cheesman* (1886) 116 U.S. 529, 6 S. Ct. 481, 29 L. Ed. 712; and *Iron Silver Mining Co. v. Murphy et al.* (1880), 3 F. 368. See also Rossiter W. Raymond, “The Law of the Apex,” *Transactions of the American Institute of Mining Engineers* 12 (1884): 387–444.

never spoke of the whole structure as a vein; instead, they talked about the “North dipping vein” and the “South dipping vein;” likewise, the peak was always a “junction” or the apexes, never “the anticline.” The Jim Butler countered that since the vein material was continuous from one branch over the top and down the other side, the vein was clearly an anticline, and thus, by virtue of the precedent established in the Leadville cases, should not possess either an apex or extralateral rights. The Butler team spoke of “the vein” as a whole and frequently referred to the “anticline,” in a mirror of the West End’s effort to use language that supported their interpretation of the law. Both sides knew the precedent of the Leadville cases would be significant, though the Leadville cases were based on veins that were very different than those in the Tonopah district. The West End hoped that the difference was significant enough to prevent the Leadville precedent from applying to the Tonopah situation, and instead to make its two-vein theory supportable, where the Butler believed that the situation was not so different as to invalidate the general point of the Leadville cases.

The stakes were high. All told, the ore in dispute was valued at about a half million dollars, and on top of that, Nevada law allowed for triple damages in cases of mining trespass. The lawsuit seemed to promise prosperity if won, ruin if lost; the future seemed to hang in the balance – so both companies set out to assemble the best legal talent money could buy.

The two mining companies assembled a “grand galaxy” of lawyers and experts to defend their claims.<sup>72</sup> Each side’s team consisted of four different types of experts. Directing the overall strategy were hired attorneys with specific expertise in mining law and extralateral rights. These lawyers were assisted by the normal attorneys for the mining firms, who generally had little specific expertise in mining law but who were more familiar with the internal operations of the company and the local context. Both sides hired eminent expert witnesses, generally with national reputations, to testify about geology and engineering practice, and thereby connect the specific details of the case with broader scientific theory. The teams were rounded out by local engineers, whose value in court was their intimate knowledge of the specific mines under discussion. Together, these four types of experts attempted to present a coordinated vision, where legal arguments, visual representations, and geological facts worked together to make their interpretation the most compelling to the judge.

In the Jim Butler-West End trial, the expert mining attorneys were an especially distinguished group. The Jim Butler retained the biggest star of all, “Judge” Curtis H. Lindley, author of the most famous and important treatise on American mining law to that time.<sup>73</sup> In fact, the third (and ultimately final) edition of his text, widely referred to simply as *Lindley on Mines*, was published in January 1914, less than a year before the beginning of the trial.<sup>74</sup> Lindley’s father, also a lawyer, moved to California dur-

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<sup>72</sup>For more biographical details on most of the experts and lawyers, see “Grand Galaxy of Talent in The Butler-West End Suit,” *Tonopah Daily Bonanza*, December 17, 1914.

<sup>73</sup> William E. Colby, “Curtis Holbrook Lindley,” *California Law Review* 9 (1921): 87–99.

<sup>74</sup> Curtis H. Lindley, *A Treatise on the American Law Relating to Mines and Mineral Lands Within the Public Land States and Territories and Governing the Acquisition and Enjoyment of*

ing the Gold Rush in 1849. Lindley was born in Marysville, California, in 1850, which was at that time one of the major centers of mining activity on the Mother Lode. Many of his teenage years were spent on the Comstock Lode in Nevada, and he later served as a hoisting engineer before he studied law and began practicing in California. He briefly served as a magistrate in Amador County, earning him the lifetime sobriquet “Judge,” but when he wasn’t elected for a second term, he turned more specifically to the study of mining law. Relatively few books were published on mining law at the time Lindley began his work, and “the few works that had appeared were little more than digests of the statutes and the few cases the courts had then decided. They could hardly be dignified with the title of treatises.”<sup>75</sup> Lindley first published his monumental work *A Treatise on the American Law Relating to Mines and Mineral Lands Within the Public Land States and Territories and Governing the Acquisition and Enjoyment of Mining Rights in the Lands of the Public Domain*, commonly known simply as *Lindley on Mines*, in 1897.<sup>76</sup> Later heavily-revised editions also appeared in 1903<sup>77</sup> and 1914.<sup>78</sup> Lindley was apparently “such a stickler for the proprieties that we

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*Mining Rights in Lands of the Public Domain* 3rd ed. (Bancroft-Whitney Company, 1914), earlier editions appeared in 1903 and 1897. Also see Lindley’s 1913 article on secondary veins, which were a prominent part of the proceedings in the Butler-West End case; Curtis H. Lindley, “A Problem in Extralateral Rights on Secondary Veins,” *California Law Review* 1 (1913): 427–438.

<sup>75</sup> Colby, “Curtis Holbrook Lindley,” 91. Colby specifies these early works as: Yale (1869), Copp’s “U.S. Mineral Lands,” Morrison’s “Mining Rights,” Weeks on Mineral Lands in 1877 and 1880, Wade’s “American Mining Laws” (1889) and Sickel’s “Mining Laws and Decisions” (1881).

<sup>76</sup> Curtis H. Lindley, *A Treatise on the American Law Relating to Mines and Mineral Lands Within the Public Land States and Territories and Governing the Acquisition and Enjoyment of Mining Rights in Lands of the Public Domain* 1st ed. (Bancroft-Whitney Company, 1897).

<sup>77</sup> Curtis H. Lindley, *A Treatise on the American Law Relating to Mines and Mineral Lands Within the Public Land States and Territories and Governing the Acquisition and Enjoyment of Mining Rights in Lands of the Public Domain* 2nd ed. (Bancroft-Whitney Company, 1903).

<sup>78</sup> Lindley, *Lindley on Mines* (1914).

would never quote from or refer to his own book, and never allowed it to be brought into the court-room, even by his associates, when he was present.”<sup>79</sup> Even so, the text became the widely acknowledged authority on American mining law, and was even quoted extensively by U.S. Supreme Court justices in new opinions. The third edition of *Lindley on Mines* was considered the best of them all, a monumental work to cap a distinguished career. Geologist Horace V. Winchell, a famous mining geologist who testified for the West End as a geology expert opposite Lindley, termed the book “lucid,” “unambiguous,” and “indispensable” in a review published in September 1914.<sup>80</sup> Eminent mining engineer Rossiter W. Raymond, himself an expert on mining law, heaped even more praise on Lindley’s “tru[e] magnum opus.” In the most widely-read journal for mining engineers, Raymond described *Lindley on Mines* as a “magnificent treatise,” written with “candor, lucidity, and forceful suggestiveness”; a work that exuded “comprehensive and classic excellence.”<sup>81</sup> Lindley was also heavily involved in professional and civic causes. He was active in the San Francisco Bar Association, helped organize the California State Bar and served as its first president. A political progressive, Lindley was one of the leaders of a reform movement in San Francisco; played a strong role as lead counsel in the effort to dam the Hetch Hetchy Valley to create a water supply for the city; was a director of the Panama-Pacific Exposition

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<sup>79</sup> Colby, “Curtis Holbrook Lindley,” 92.

<sup>80</sup> Horace V. Winchell, “Review of ‘Lindley on Mines,’” *Economic Geology* 9, no. 6 (September 1914): 598–602.

<sup>81</sup> Rossiter W. Raymond, “Review of ‘A Treatise on the American Law Relating to Mines and Mineral Lands, Etc.’” *Engineering and Mining Journal* 97 (April 18, 1914): 817.

of 1915, and served as Park Commissioner for San Francisco as well.<sup>82</sup> Lindley was a friend of Herbert Hoover, who met the lawyer when he was engaged to help Lindley prepare for a lawsuit in the Grass Valley, California district in 1896-1897.<sup>83</sup> Later, when Hoover was appointed head of the Food Administration during World War I (Lindley had facilitated the appointment in part, by introducing him to friends in Washington), the mining engineer persuaded Lindley to come to Washington to take charge of the legal work of the department.<sup>84</sup> And Lindley was a poet, of sorts: he wrote doggerel verse during the the Jim Butler-West End trial, which was printed by the local newspaper.<sup>85</sup>

Second in command of the Butler's legal strategy was William E. Colby, Lindley's trusted assistant and a recognized authority on mining law in his own right, who had long and successful experience with apex litigation. Colby began working for Lindley in 1907, and took over the older lawyer's practice when Lindley died in 1920. Colby was most famous, later in life, as a longtime officer of the Sierra Club. Colby was the lead counsel for the anti-Hetch Hetchy Dam movement, even though he worked

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<sup>82</sup> Colby, "Curtis Holbrook Lindley," 96-97; William E. Colby, "Curtis Holbrook Lindley," *Dictionary of American Biography* Base Set, American Council of Learned Societies, 1928-1936; Reproduced in Biography Resource Center, Farmington Hills, MI: Thomson Gale, 2007, <http://galenet.galegroup.com/servlet/BioRC>. Amazingly, I have been unable to find any biography of Lindley beyond Colby's article and DAB entry.

<sup>83</sup> Hoover, *The Memoirs of Herbert Hoover: Years of Adventure, 1874-1920*, 27.

<sup>84</sup> Colby's claim that Lindley taught Hoover mining law could only be correct if Colby's recollection of the date is mistaken, since he lists it as having taken place in 1909, by which time Hoover had been away from Stanford for more than a decade and had developed an international reputation as an expert mining engineer. William E. Colby, *Reminiscences: An Interview Conducted by Corinne L. Gilb* (Berkeley: Regional Oral History Office, Bancroft Library, 1954), 108-109.

<sup>85</sup> "Butler Geologist Presents Vivid Crayon Sketch," *Tonopah Daily Bonanza*, December 16, 1914; "Jim Butler-West End Trial Concluded with Dispatch, Poetry, Banquet, and No Ill Feeling," *Tonopah Daily Bonanza*, December 22, 1914; "Muse Inspires Noted Jurist," *Tonopah Daily Bonanza*, December 23, 1914.

out of the same offices as dam advocate Lindley. (Lindley hoped to keep the fact quiet, so as to avoid any sense of impropriety of having both sides represented by the same firm.)<sup>86</sup> Colby certainly understood extralateral rights well – his 1916 four-part law review article on the apex issue, produced after the initial trial in Tonopah but before the Butler-West End case was finally settled in the U.S. Supreme Court, was, according to a modern legal scholar, “perhaps the most articulate and certainly the most comprehensive defense of the apex law.”<sup>87</sup>

The West End Consolidated’s legal team was headed by mining lawyer William H. Dickson, of Salt Lake City. A native of New Brunswick, Dickson spent eight years as a lawyer on the Comstock in Nevada.<sup>88</sup> In 1882, he moved to Salt Lake City, Utah Territory, and was appointed U.S. Attorney in 1884. As part of the Gentile minority who occupied a majority of the federal territorial offices, Dickson zealously prosecuted Mormon polygamists under the federal Edmunds Act.<sup>89</sup> He so enraged members of the Mormon community that, in 1884, he was the target of glass jars of human waste,

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<sup>86</sup>See Colby, *Reminiscences*, esp. 99-100; and Robert W. Righter, *The Battle over Hetch Hetchy: America’s Most Controversial Dam and the Birth of Modern Environmentalism* (New York: Oxford University Press, 2005).

<sup>87</sup> Don H. Sherwood, “The Extralateral Right: A Last Hurrah?,” *Rocky Mountain Mineral Law Institute* 35 (1989): 12-2, n. 1. The similarly-titled articles were: William E. Colby, “The Extralateral Right: Shall It Be Abolished?,” *California Law Review* 4, no. 5 (1916): 361-388; William E. Colby, “The Extralateral Right: Shall It Be Abolished? II: The Origin and Development of the Extralateral Right in the United States,” *California Law Review* 4, no. 6 (1916): 437-464; William E. Colby, “The Extralateral Right: Shall It Be Abolished? III: The Federal Mining Act of 1872,” *California Law Review* 5 (1916): 18-36; and William E. Colby, “The Extralateral Right: Shall It Be Abolished? IV: Conclusion,” *California Law Review* 5 (1917): 303-330.

<sup>88</sup> Stephen Cresswell, *Mormons and Cowboys, Moonshiners and Klansmen: Federal Law Enforcement in the South and West, 1870-1893* (Tuscaloosa: University of Alabama Press, 1991), 97.

<sup>89</sup> Cresswell, *Mormons and Cowboys, Moonshiners and Klansmen: Federal Law Enforcement in the South and West, 1870-1893*, 97-132. Members of the Mormon community charged that Dickson ignored Gentiles committing the same offenses. “Accused of Partiality,” *Washington Post*, Feb. 14, 1885. “Gentile” is the Mormon term for non-mormons.

lobbed through his window, which broke on the walls and carpet. In 1886, Dickson was struck in the face by the son of one of the Mormon leaders during a personal meeting.<sup>90</sup> In 1887, Dickson retired from the U.S. Attorney post, citing the low salary, and resumed a successful (and lucrative) private law career.<sup>91</sup> Over the next decades, Dickson developed an excellent reputation for mining law, especially apex suits, and tried many famous cases.<sup>92</sup> Dickson never gained the national notoriety of Lindley, probably because he never published a treatise, but his reputation as a mining lawyer seems to have been quite high. Like Lindley, Dickson had less than a decade left to live, but continued to work until the end.<sup>93</sup> Dickson was at least somewhat familiar with Tonopah, because he had business interests in the camp. He served as a member of the board of directors (along with A.C. Ellis) for the Montana-Tonopah Mining Company,<sup>94</sup> and briefly held an interest in some of the earliest claims located in the camp. Dickson later unsuccessfully defended the Tonopah company formed to work

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<sup>90</sup>On the jars, see Cresswell, *Mormons and Cowboys, Moonshiners and Klansmen: Federal Law Enforcement in the South and West, 1870-1893*, 120; on the punch in the face, see “Assaulted By Mormons,” *New York Times*, Feb. 23, 1886; and Frank J. Cannon and Harvey J. O’Higgins, *Under the Prophet in Utah: The National Menace of a Political Priestcraft* (Boston: The C. M. Clark Publishing Co., 1911) URL: <http://www.gutenberg.org/etext/7066>, chapter 2.

<sup>91</sup>In 1905, he constructed an ornate house in Salt Lake’s Capitol Hill neighborhood, which still stands. Nelson Knight, “This Old House: Dickson-Gardner-Wolfe Mansion,” *The Capitol Hill Neighborhood Council Bulletin [Salt Lake City, UT]* 49 (May 2005): 1–2.

<sup>92</sup>These included *Lawson v. U.S. Mining Company*, *Mammoth Mining Company v. Grand Central Mining Company*, *Conkling Mining Company v. Silver King Mining Company*, *Thompson et al. v. Kearns et al.*, *Niagara Mining Company v. Old Jordan Mining Company*, and *Eureka Hill Mining Company v. Bullion, Beck & Champion Mining Company*. List from “Grand Galaxy of Talent in The Butler-West End Suit,” *Tonopah Daily Bonanza*, December 17, 1914.

<sup>93</sup>Dickson left Salt Lake City in 1917 after the death of his wife, and lived in Los Angeles until his death in 1924. Knight, “Dickson-Gardner-Wolfe Mansion,” 2.

<sup>94</sup>“Montana-Tonopah Holds Meeting in Reno,” *Nevada State Journal*, July 2, 1905; for more on the Montana-Tonopah (which does not mention Dickson explicitly), see Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 50-51, 64-65, 90-95.



his claims in a series of boundary lawsuits. Ironically, at least two of those claims, the Stone Cabin and Wandering Boy, were later absorbed by the Jim Butler Tonopah Mining Company.<sup>95</sup> In short, Dickson had a long history with Nevada, Tonopah, and mining law.

The two companies both engaged leading experts in geology and mining as witnesses. The Jim Butler's top geological witness was John Wellington Finch. Finch had served as State Mineralogist of Colorado, and worked on the Amalgamated (Anaconda) geological team, probably serving together with Horace V. Winchell, that helped defend the company during apex lawsuits circa 1904. Finch made at least one glass model during the course of those trial preparations.<sup>96</sup> Finch acquired some fame in central Nevada for managing George Wingfield's Goldfield Consolidated Mining Company, and was credited with being the expert whose advice was responsible for the organization of the Goldfield Consolidated. He also had a reputation for standing as an excellent witness in mining cases, handling long cross-examinations with aplomb and bearing "the poise born of absolute knowledge of facts."<sup>97</sup> Finch's

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<sup>95</sup>"On August 1, 1901, the Cliffords conveyed by deed their right, title, and interest in the Wandering Boy, as well as in the Lucky Jim and Stone Cabin, to W.H. Dickson and A.C. Ellis, and on May 5, 1902, Dickson and Ellis conveyed the same to the complainant [the Tonopah and Salt Lake Mining Co.] herein." *Tonopah & Salt Lake Mining Co. v. Tonopah Mining Co.*, 125 F. 400. The other two lawsuits of the group had the same title and were reported as 125 F. 389 and 125 F. 408 (1903). The Stone Cabin and Wandering Boy claims were not part of the dispute between the Jim Butler and the West End, as the conflict was limited to the Eureka and Curtis claims of the Jim Butler and the West End Claim of the West End. For their ownership by the Jim Butler Company, see Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 96.

<sup>96</sup> Sewell Thomas, *Silhouettes of Charles S. Thomas: Colorado Governor and United States Senator* (Caldwell, ID: The Caxton Printers, Ltd., 1959), 75.

<sup>97</sup>"Grand Galaxy of Talent in The Butler-West End Suit," *Tonopah Daily Bonanza*, December 17, 1914.

career after the trial further enhanced his image. From 1930 to 1934, he served as the Dean of the College of Mines at the University of Idaho, then was tapped to head the U.S. Bureau of Mines, under Department of the Interior Secretary Harold Ickies, from 1934 to 1940 (despite an initial flap over the fact that Finch was a Republican).<sup>98</sup>

Another Jim Butler expert, Fred Searls, Jr. was also affiliated with Wingfield's Goldfield Consolidated, as a geologist on the payroll for three years and as a consulting geologist afterward. A 1909 graduate of the University of California, who studied under Andrew Lawson, Searls' young geological consulting career was just beginning to take off. In this case, it was Searls' study of ore deposits in tertiary volcanic rocks that made his testimony of value to the Butler company. On the stand, he mentioned his work for the "Gunn-Thompson people" as well as his other consulting engagements. Almost a decade later, in 1925, Searls would join the firm newly formed by "Gunn-Thompson people," Newmont Mining Company, and would become famous as a top executive of industry leader Newmont for several decades. That Searls would serve as a good witness in mining law cases was perhaps no surprise, given his family history. Searls' grandfather, Niles Searls, his father, Fred Searls, and two of his brothers, Carroll and Robert M. Searls, all practiced mining law in California. Fred Searls,

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<sup>98</sup> Dean Earl Bennett, *A Short History of the College of Mines and Earth Resources*, 2002, URL: [www.mines.uidaho.edu/alumni/history.pdf](http://www.mines.uidaho.edu/alumni/history.pdf), [3]; "PMG On Tour," *Time*, July 30, 1934, <http://www.time.com/time/magazine/article/0,9171,754362,00.html>, accessed March 11, 2007; "Marginalia," *Time*, Aug. 27, 1934, <http://www.time.com/time/magazine/article/0,9171,747759,00.html>, accessed March 11, 2007.

Jr.'s younger brother Robert worked in Lindley's office as a junior attorney, and was thanked in the Acknowledgements to the 1914 edition of *Lindley on Mines*.<sup>99</sup>

The Jim Butler also retained Andrew C. Lawson, who was at the time acting dean of the school of mines and professor of geology at the University of California at Berkeley, as an expert witness. Lawson earned one of the first Ph.D. degrees granted in Geology from The Johns Hopkins University in 1888, and was invited to Berkeley as a professor by Joseph LeConte. Lawson taught there until his retirement in 1928. He chaired a committee of geologists put together immediately after the 1906 San Francisco earthquake whose report was a landmark in the understanding of seismic activity.<sup>100</sup> Lawson's studies of ore deposition made him a valuable witness in apex cases. He worked on many of the cases that Lindley tried, including the earlier defense

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<sup>99</sup>His name is spelled "Searles" throughout the trial by the *Tonopah Daily Bonanza*, but the transcript of the case spells it correctly. For Searls' qualifications, see *Jim Butler Tonopah Mining Co. vs. West End Consolidated Case File*, U.S. Supreme Court Appellate Case Files, 25458, Number 249, Box 5000, Record Group 267, National Archives, Washington DC, 856-857. Searls' testimony begins on p. 856 of the trial transcript, then he is recalled on p. 1076 after Lawson testified. Also see "Geology of the Tonopah Lodes Related by Experts," *Tonopah Daily Bonanza*, December 18, 1914 for Searls' testimony, in which he used a complex geological analogy, which Ramsey said was a distinct feature of his legal testimony. For Searls' career with Newmont, see Robert H. Ramsey, *Men and Mines of Newmont: A Fifty-Year History* (New York: Octagon Books, 1973), 39-45, 179. Searls was a top executive for Newmont between 1931 and 1966. Colby later tried and won several important extralateral rights cases for Searls concerning Newmont's Empire Star mine in the Nevada City, California mining district. Searls served as a member of the U.S. Strategic Bombing Survey during World War II and was a member of Bernard Baruch's delegation to the United Nations' Atomic Energy Commission. Barton J. Bernstein, "The Quest for Security: American Foreign Policy and International Control of Atomic Energy, 1942-1946," *Journal of American History* 60, no. 4 (1974): 1032-1034. The Searls lawyers practiced almost exclusively in Nevada City, California, where Lindley was also extensively involved. The Searls' house and law library is now preserved as a research library as part of the state part system of California; see <http://www.nevadacountyhistory.org/htmls/searls.html>

<sup>100</sup> Andrew C. Lawson and Harry Fielding Reid, *The California Earthquake of April 18, 1906: Report of the State Earthquake Investigation Commission* (Washington, DC: Carnegie Institution of Washington, 1908).

of the MacNamara against the West End.<sup>101</sup> One of his works most relevant to the circumstances in Tonopah, titled “Ore Deposition In and Near Intrusive Rocks by Meteoric Waters,” was published the same year Lawson testified for the Jim Butler side.<sup>102</sup>

The mining and geology experts who testified for the West End were no less distinguished. Their primary geological witness was Horace V. Winchell, a nationally-known geologist, co-founder and president of the Geological Society of America (and son of a famous geologist as well).<sup>103</sup> Winchell co-authored the first scientific analysis

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<sup>101</sup> Fred Searls Jr., “The Consultant,” in *Andrew C. Lawson: Scientist, Teacher, Philosopher*, ed. Francis E. Vaughan (Glendale, CA: A.H. Clark, 1970), 205–211 lists cases for which Lawson testified. In addition to the *Jim Butler* case and Lawson’s work with the Bunker Hill and Sullivan in their fight against the Last Chance in 1909, which was compromised without a lawsuit, Searls notes that Lawson testified in the following cases: *Pennsylvania Co. v. Grass Valley Co.* (W.Y.O.D. case), 117 F. 509 (1902); *Utah Consolidated M. Co. v. Apex Mining Co.*, 277 F. 41; cert. denied 258 U.S. 619; *Utah Consolidated M. Co. v. Utah Apex Co.*, 285 F. 249; cert. denied 261 U.S. 615 (1921); *Clark Montana Co. v. Anaconda Co.*, 20 F.2d 1008, compromised; *Moulton Mining Co. v. Anaconda Mining Co.*, 23 F.2d 811; *Stewart Mining Co. v. Ontario M. Co.*, 132 Pac. 787; 237 U.S. 350; *Twenty-One Mining Co. v. Sixteen to One Mining Co.*, 260 F. 724; 265 F. 469; *Tom Reed v. United Eastern M. Co.* (Kingman, AZ) 209 Pac. 283; cert. denied 260 U.S. 744; *Stewart Mining Co. v. Bourne* and *Stewart Mining Co. v. Sierra Nevada Mining Co.*, (consolidated) 218 F. 327; *Empire Star Co. v. Grass Valley Bullion Mines Co.*, 99 F.2d 228; *United States v. United States Borax Co.*, 58 Land Decisions 426; *Home v. Champion Mining Co.*, settled, not reported; *Shasta Iron Co. v. United States*, citation not given. For his work for the MacNamara with Lindley against the West End, see *Jim Butler v. West End* Transcript, 273.

<sup>102</sup> Andrew C. Lawson, “Ore Deposition In and Near Intrusive Rocks by Meteoric Waters,” *Bulletin of the Department of Geology of the University of California* 8, no. 9 (1914): 219–242. For Lawson’s life and work, see Francis E. Vaughan, *Andrew C. Lawson: Scientist, Teacher, Philosopher* (Glendale, CA: A.H. Clark, 1970); Perry Byerly and George Davis Louderback, “Andrew Cowper Lawson,” *National Academy of Sciences Biographical Memoirs* 37 (1964): 185–204; and Peggy Champlin, “Lawson, Andrew Cowper,” in *American National Biography* vol. 13 (New York: Oxford University Press, 1999), 294–296. The practice tunnel in which University of California student mining engineers refined their craft, built in 1930, was named the Lawson Adit for him. Lawson’s papers are at the University of California, Berkeley.

<sup>103</sup> See above for Winchell’s glowing review of the 3rd edition of *Lindley on Mines*. Winchell was also president of the American Institute of Mining Engineers in 1919. There is an intriguing re-told Fred Searls, Jr. anecdote in Ramsey, where Searls remembers working on the “Big Jim” case with Winchell and John Gray, another well-respected mining lawyer. In this case, they opposed “old Judge Lindsay,” whom Winchell frustrated so much that the lawyer had an “internal hemorrhage that killed him.” Ramsey, *Men and Mines of Newmont: A Fifty-Year History*, 89. The parallels to

of the Mesabi Iron Range,<sup>104</sup> and was an important expert in a variety of other mining legislation. Anaconda Copper Company hired Winchell in 1898 to set up their geological department in order to prepare for apex litigation. He helped to develop a system of tracing geological sections onto semi-transparent vellum, in order to see several at once and visualize the overall relationships. Anaconda won most of the battles in its famous apex suits based largely on the testimony of Winchell and the geologists who worked for him. He started his own consulting business in 1908, and testified for clients all over the world, despite his own well-documented misgivings about the wisdom of the apex law.<sup>105</sup>

The West End also used the testimony of Walter H. Wiley, a well-respected mining engineer who had been one of the first graduates of the Colorado School of Mines in 1883. By the time the trial commenced, Wiley had a 35 year career in mine examination and litigation worldwide.<sup>106</sup> Edmund Juessen was also retained by the West End as an expert witness. The 46 year old American-born Juessen learned mining engineering at Freiberg, and received a doctorate of natural sciences at Zurich

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Lindley's death from internal bleeding during the course of an apex trial are intriguing. See Colby's account of Lindley's death, Colby, *Reminiscences*, 86-88; John Gray was named by Colby as the lead opposing attorney in the case, but the name of the case according to Colby is different than that in Ramsey's anecdote.

<sup>104</sup> N. H. Winchell and H.V. Winchell, *The Iron Ores of Minnesota: Their Geology, Discovery, Development, Qualities, and Origin, and Comparison With Those of Other Iron Districts*, Geological and Natural History Survey of Minnesota Bulletin 6 (Minneapolis: Harrison and Smith, State Printers, 1891).

<sup>105</sup> Elizabeth Noble Shor, "Winchell, Horace Vaughn," in *American National Biography Online* (New York: Oxford University Press, 2000), URL: <http://www.anb.org/articles/13/13-01835.html>; "Grand Galaxy of Talent in The Butler-West End Suit," *Tonopah Daily Bonanza*, December 17, 1914; Spence, *Mining Engineers*, 228-229. Winchell's papers are held by the University of Minnesota.

<sup>106</sup>He examined the gold mines in northern Korea, for example, which led to western investment there. Spence, *Mining Engineers*, 285.

in 1890. Like many engineers of his era, he worked at a series of mines in the West early in his career, including a two-year stint as manager of the Pittsburg Silver Peak Gold Mining Company, at Blair, Nevada, near Tonopah. After resigning in 1911, Juessen moved to the Bay Area and worked as a consulting mining engineer.<sup>107</sup>

Both companies rounded out their team of experts with locals who knew the disputed spaces intimately. During the trial individual miners were called to testify briefly, but only one man on each side testified at length to local conditions. The Butler team hired a local expert with an excellent reputation. Fred Siebert was a longtime resident mining engineer of Tonopah, for whom one of the major faults in the Tonopah district had been named. Siebert had held many technical positions in various Tonopah mines, including a stint as manager for the Tonopah and Salt Lake property in which Dickson was a major investor.<sup>108</sup>

The West End's local expert, John W. Chandler, had extensive experience with disputes over Tonopah veins. Thirty-eight years old when he took the stand in 1914, Chandler had graduated in 1901 from the Colorado School of Mines, and lived and worked in Tonopah from about 1904 to 1910.<sup>109</sup> For much of that time, Chandler was superintendent of the MacNamara Mine, which adjoined the West End to the north.

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<sup>107</sup> *Jim Butler v. West End* Transcript, 174-176; "West End Lawyers in Apex Litigation Begin to Come," *Tonopah Daily Bonanza*, December 1, 1914. Juessen's post-trial career was not as successful. He took a management job at the New Almaden mercury mine in California, and a series of poor decisions that cost the company significant amounts of money led to his firing. See Schneider, *Quicksilver*.

<sup>108</sup> "Grand Galaxy of Talent in The Butler-West End Suit," *Tonopah Daily Bonanza*, December 17, 1914.

<sup>109</sup> *Jim Butler v. West End* Transcript, 213-214.

In 1908, the two companies discovered that they each had an apex claim on a vein that dipped shallowly into the property of the other. (The "North Dipping Vein" in the West End's case against the Jim Butler was the vein that dipped northerly into the MacNamara.) Both sides did extensive work in preparation for a trial, but a late compromise averted actual litigation. The deal, which historian Carpenter judged to be more favorable to the MacNamara, forced the two companies to respect their mutual side line as a vertical boundary. The following year, in 1909, Chandler's MacNamara followed the same north dipping vein northward out of its claim into the ground of the Tonopah Extension. The MacNamara and the Tonopah Extension prepared to fight in court, but as with the earlier West End controversy, the MacNamara secured a compromise. This time, the MacNamara gave up its apex right in exchange for the Tonopah Extension yielding its right to triple damages (permitted under Nevada law for mining trespass) on the ore the MacNamara had already mined, and both sides agreed to respect the vertical boundary.<sup>110</sup> In the 1908 case against the West End, Chandler worked closely with Lindley and Lawson to prepare the MacNamara's defense, but now the manager was on the other side. Chandler had held, in his earlier work with Lindley, that there was indeed one vein and that it was an anticline, but in the context of his work for the West End, he had to expound the two-vein theory. He justified his reversal on the grounds that additional development work proved his earlier statements wrong, but the West End attorneys tried to encourage Chandler to

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<sup>110</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 66-68.

say that he had been coached to see a single vein in the earlier case. Lindley dismissed this attempt in a huff by pointing out “Certainly he knows as everybody knows that [the single vein] has always been my position and I have not changed it either.”<sup>111</sup> Chandler returned to the district and was hired as superintendent of the West End on October 1, 1914, after preparations for the Jim Butler trial were already well under way.<sup>112</sup>

## The Trial

The trial commenced on Monday, December 7, 1914, and the court began taking testimony the following day. The lawyers and experts addressed themselves only to Judge Mark R. Averill, elected Judge of the 5th District of Nevada. Both the Butler and the West End agreed to avoid the additional complexity, uncertainty, and expense of a jury trial, and have Averill pass judgement alone.<sup>113</sup> By 1914, Averill had served nearly six years on the Nevada bench. He was first elected to the position of District Judge for a two-year term following redistricting in 1909, then held the office in the Fifth Judicial District, covering Nye County, through subsequent elections until early 1923.<sup>114</sup> The judge had at least a speculative interest in Tonopah mines. In

1910 Averill, together with two Tonopah bankers, organized the Tonopah 76 Mining

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<sup>111</sup>For Chandler’s reversal, see *Jim Butler v. West End* Transcript, 235-310; Lindley’s quote is on 249.

<sup>112</sup>Chandler was apparently an excellent manager but he died young, in late 1915. Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 101, 104.

<sup>113</sup>*Jim Butler v. West End* Transcript, b, h.

<sup>114</sup>“Judge M. R. Averill Opens Third Term,” *Tonopah Daily Bonanza*, January 4, 1915; Dean Heller, ed., *Political History of Nevada, 1996* 10th ed. (Carson City, NV: State Printing Office, 1997), 228-230.



Company to coordinate the development of three claims located west beyond the ground in dispute in the case between the Jim Butler and the West End.<sup>115</sup>

It was clear from the outset that this was no ordinary trial. The court established a special procedure for recording the proceedings. The ordinary court reporter, Miss M.U. Shields, was supported by two additional court reporters, Mrs. S.A. Gillespie and Mr. Joe Lozano, who came to Tonopah from Reno for the trial. Lozano led the recording team. The court reporters worked in a relay system. Each spent fifteen minutes taking testimony in the court, then moved to an adjacent room and read their notes into a dictaphone. The local newspaper described the subsequent use of the system, which reportedly cost over \$700, to a fascinated public.<sup>116</sup>

The records are taken off as rapidly as completed and handed to the typists, who insert them in the repeating machine and begin tossing off copy on the typewriter. Each typist sits with a bonnet attached to the head to hold the ends of tubes. These, inserted in both ears, enable the operator to concentrate her attention on transcribing the notes. One foot remains on a pedal and should it be desired to slacken or speed up, the machine can easily be controlled or turned back for corrections.<sup>117</sup>

The burden of proof of the asserted apex was on the West End, despite the fact that in this particular suit it was the defendant in the case. Technically, it was the defendant in a lawsuit brought by the Jim Butler to prevent it from mining

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<sup>115</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 133.

<sup>116</sup>“Model of the West End Mine Introduced at Opening of Court,” *Tonopah Daily Bonanza*, December 8, 1914; “Jim Butler West End Apex Case Opens,” *Tonopah Daily Bonanza*, December 7, 1914; “Witnesses Tell How Tonopah Lode Had Its Origin,” *Tonopah Daily Bonanza*, December 21, 1914.

<sup>117</sup>“Model of the West End Mine Introduced at Opening of Court,” *Tonopah Daily Bonanza*, December 8, 1914.

in Butler ground.<sup>118</sup> The West End claimed that there were in fact two separate veins, both of which apexed within the limits of the West End claim, giving the company extralateral rights in both directions. The company based its claim largely on the structural geology of the area. The southerly-dipping vein, which was the one that dipped into the Jim Butler Company's claim, was slightly older than the other, northerly-dipping vein, according to the West End's geologists. Furthermore, they claimed that the south vein apexed against the footwall, or bottom, of the north vein. This northerly-dipping vein, the West End contended, continued beyond the juncture with the South Vein, and came to a different, independent apex against the overlying Midway andesite or Fraction dacite-breccia cap rock. They also claimed that the Siebert Fault constituted the hanging wall of the North Vein.

The West End based their legal case on the strategy of proving that the ore was in the form of two separate veins. The "Leadville cases," described earlier, had set the important precedent in the 1880s that an ore formation that consisted of a folded bed, with synclines (U-shaped formations) and anticlines (upside-down U formations - the opposite of synclines) undulating through the formation, did not have a true apex, and therefore did not have extralateral rights. If the geological formation under the West End were an anticline or a simple undulating vein, then it would have no apex, and therefore no extralateral rights. As a result, the West End's strategy from the beginning was to prove that the two sides were actually two veins. They formalized

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<sup>118</sup>Lindley noted in his treatise that fairness would suggest that the company asserting an extralateral right should be allowed to open and close evidence if the extralateral right was the only issue. Lindley, *Lindley on Mines* (1914), 2171.

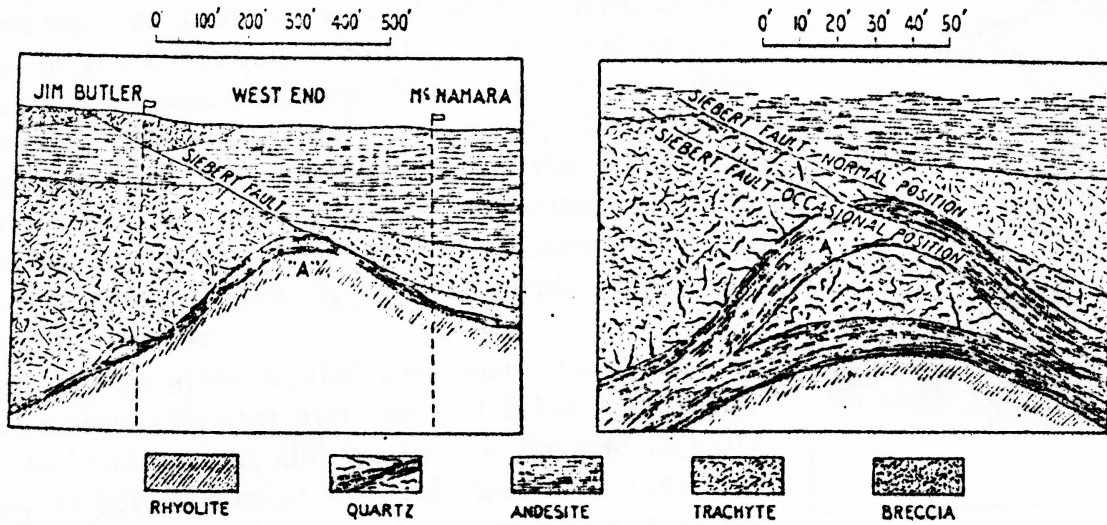


FIG. 1. FIG. 2.  
SECTIONS SHOWING GEOLOGY OF APEX AS VIEWED BY THE LITIGANTS

Figure 4.7: Cross-section of geology, showing the Siebert Fault. From "Apex Litigation at Tonopah."

their argument by providing six specific reasons why the geology should be interpreted as two veins:

1. Difference in the dip of the two veins
2. Difference in the strike of the two veins
3. Difference in the thickness of the two veins - the South Vein was thicker than the North Vein
4. Difference in the hanging walls of the two veins
5. Difference in the values of the ore, proving that it was not consistent all the way through

6. The upper part of the North Vein went above and beyond the apex of the South Vein

The Jim Butler's case for denying the West End's apex assertion was to identify the overall vein structure as a single vein with an anticlinal roll.<sup>119</sup> If it was an anticline, the Butler attorneys argued, then no apex was present, and therefore the West End violated the rights of the Jim Butler when it followed the South Vein into Butler ground. The Butler team replied to each of the West End's six justifications in turn. To the assertion that the dips were different, the Butler replied that the structure in question was a roll, which meant that dip was irrelevant. To the question of strike, the Butler pointed out that if the axis of the anticline deviated at all from horizontal, then the strikes of the limbs of the anticline must be different. The Jim Butler replied to the West End's assertion that the South Vein was thicker than the North Vein by noting that there wasn't, on average, any difference, and that both limbs varied considerably in thickness. To the West End's fourth reason, that the hanging walls were different, the Butler team argued that the hanging wall was the same, except where it was cut off by the action of the Siebert Fault. (The action of the Siebert Fault in severing the roll of the vein can be seen in figure 4.7 on page

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<sup>119</sup>This strategy may not have been apparent to all observers at first. The newspaper reporter noted that Lindley introduced four arguments: that it wasn't one vein on top of another, but just a mass of stringers; that the strike was confused for dip and vice-versa; that the West End discovery shaft, on the north dipping vein, did not convey rights to the south dipping vein, and that the broken end-line prohibited the exercise of extralateral rights. The argument that the structure was one vein instead of two makes the first point covered by the reporter necessary; but the journalist seemed to have missed the significance of the one-vein strategy. "Butler Presents Its Case," *Tonopah Daily Bonanza*, December 14, 1914.

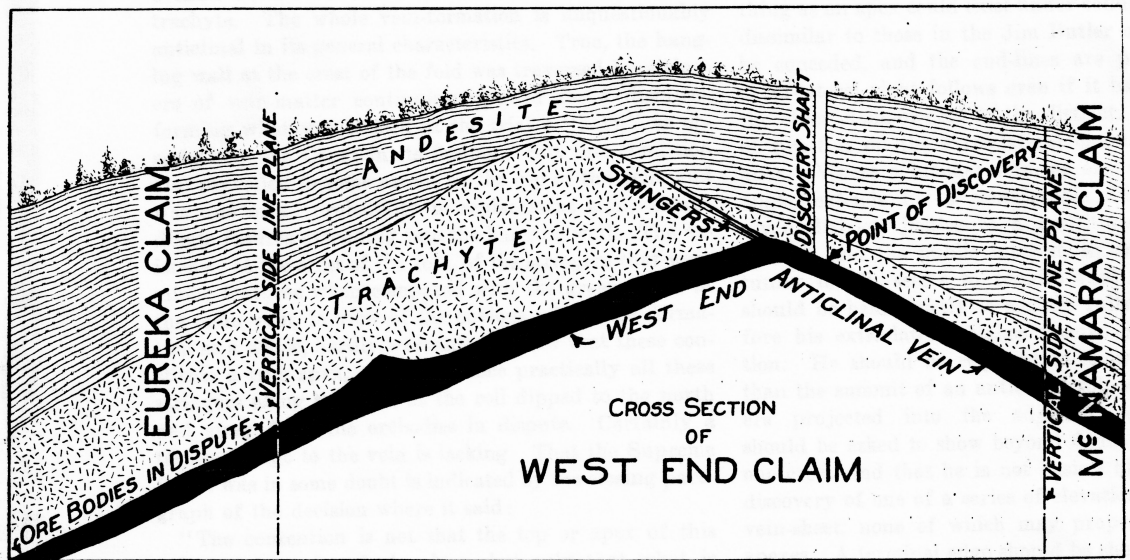


Figure 4.8: Cross-section of the disputed area, showing stringers, vein, and surrounding rock types. From Robert M. Searls, “Apexes and Anticlines,” *Mining and Scientific Press* 117 (1918): 43-44.

188.) The Butler tackled the issue of differing values of ore head-on, by contending that valuable ore continued over the top of the roll of the anticline, and further that excavations of ore (called “stopes”) went over the top of the roll under a continuous hanging wall – a clear sign of an anticline. To the West End’s final charge, that the North Vein continued upward beyond the apex of the South Vein, the Butler replied that the quartz above the anticlinal roll was a mass of stringers that took the form of a “halo” above the roll, but which did not constitute an extension of the vein. The projecting stringers are clearly labeled in figure 4.8 on page 190.

In the formal arguments outlined above, both sides were careful to use language that supported their vision of the underground. The West End always spoke of the “North Vein” or “northerly-dipping vein” and its southern counterpart, even when

the two came together underground. The Jim Butler team was similarly careful to always describe the “anticline” or the “roll,” instead of the apex, and usually termed the two sides of the anticline as “limbs” or “branches” instead of the West End’s favored “veins.” The Butler had a little more leeway here, since it believed that there was just a single vein in the form of a roll; the West End was careful to always specify the north-dipping vein or south-dipping vein whenever discussing geological conditions.<sup>120</sup>

### **Competing Models**

In order to convincingly argue their points, both the West End and the Jim Butler created and deployed a wide variety of visual representations of the underground spaces in dispute. The most expensive and elaborate of these were the models made by each side. The two models looked quite different and were intended to play different roles in the legal strategies of the two companies.

The West End legal team, led by Dickson, opened the trial by introducing their visual representations.<sup>121</sup> First to take the stand was George W. Pierce, a model maker from Los Angeles, who constructed the West End’s model at a scale of forty feet to one inch on the basis of maps and drawings provided by the West End engineers. Pierce worked constantly from July to December 1914 on the model.<sup>122</sup> The model itself purported to show the true state of the underground, minus some inaccessible

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<sup>120</sup>The trial transcript is permeated throughout with such language; for a few examples of many, see *Jim Butler v. West End* Transcript, 3-5, 18, 50.

<sup>121</sup> *Jim Butler v. West End* Transcript, 1-5.

<sup>122</sup> *Jim Butler v. West End* Transcript, 7-9.

workings, as of November 1, 1914.<sup>123</sup> Richardson, the mining engineer from the West End, periodically checked Pierce's work for accuracy, and he was the next to take the stand. Dickson used Richardson to explain the first seven defense exhibits. "Exhibit A" was the three-dimensional model, made by Pierce, which figured so significantly in the proceedings to come. (See figure 4.5 on page 164.) Next were five maps of the West End and adjacent workings, platted horizontally. Each map represented a horizontal level of the mine, like a layer in a cake, seen from an overhead perspective. The last map consisted of four representations of vertical sections through the mine. These section lines were also marked on the horizontal maps. By the time Dickson turned Richardson over to Lindley for cross-examination, the West End had given the judge ten visual representations of the West End ground - five horizontal slices, four vertical slices, and one complete three dimensional model.<sup>124</sup>

The West End's three dimensional model of the underground played a central role in their overall legal strategy. The large skeleton model served as a three-dimensional key for all of the visual representations used by the West End, and it also gave expression to rhetorical discipline comparable with the lawyers' careful efforts to always refer to separate veins.

The model, which was referred to throughout the trial as though it was simply factual evidence, actually embodied the West End's arguments about the geology of the disputed vein. The most powerful arguments were made by the choice of paint

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<sup>123</sup> *Jim Butler v. West End* Transcript, 14-15.

<sup>124</sup> *Jim Butler v. West End* Transcript, 9-27.

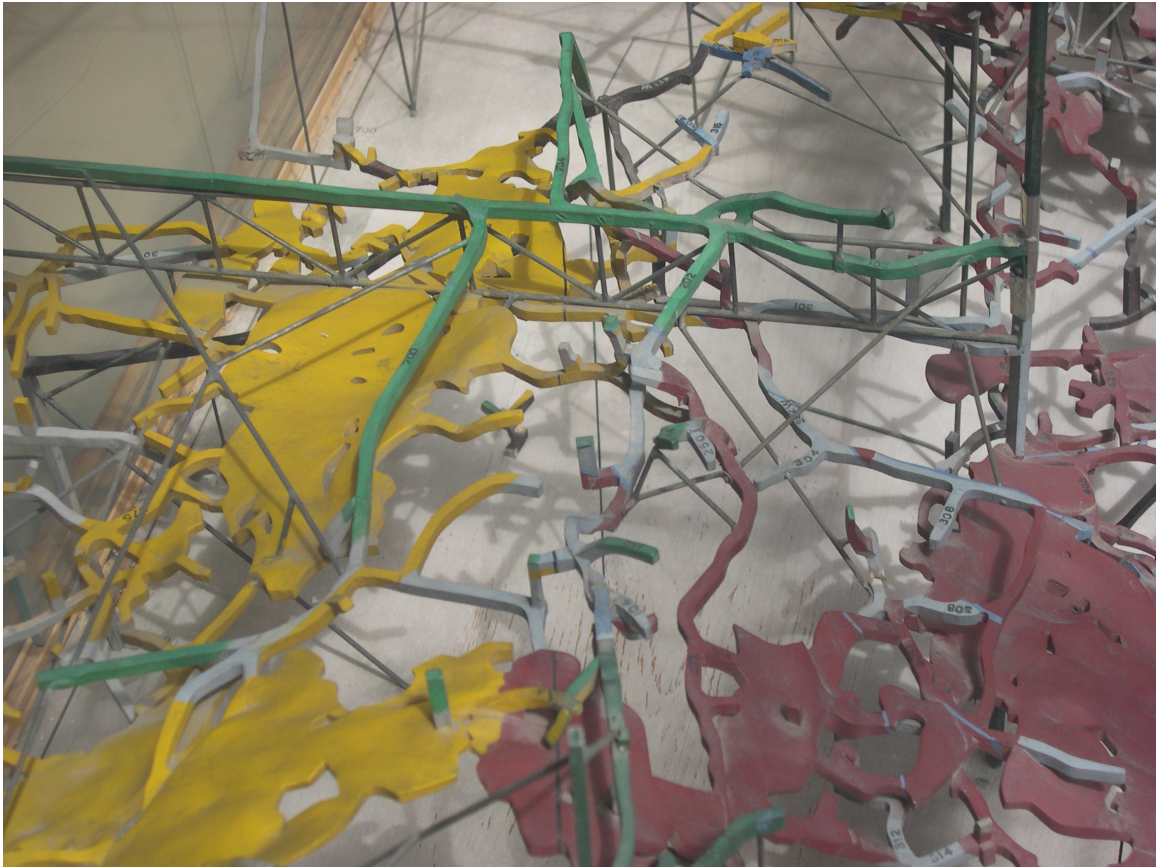


Figure 4.9: An overhead view of the West End model, showing the portion of the vein where one side is represented in yellow and the other in red. Photo by Eric Nystrom, 2006.

colors. Though the rock in the vein (or veins) was essentially identical, the West End painted the South Vein a bright red on the model, and painted the North Vein a vivid yellow. This is particularly noticeable when the two veins come together, as shown in figure 4.9. The arbitrary color choice is made more clear by the fact that they also chose to paint the Fraction Vein, a third vein or branch not of direct consequence in the suit, the same red as the South Vein. Colors were also used to emphasize arguments about geological distinctions. For example, on the model the



trachyte rock was colored purple, and the andesite, which formed part of the cap rock, was a light green.<sup>125</sup> However, the two rocks that the widely different colors represented actually looked virtually identical to the naked eye - the distinction was justified only on the basis of slight differences visible in carefully prepared slides under the microscope. Geological experts who studied the district did not all agree on even the presence of all of the rocks, much less their proper names.<sup>126</sup> Yet the West End model made a stark distinction between two very similar rocks with uncertain origins, because such a distinction supported their theory of the formation of the ore, which in turn supported their two-vein distinction for legal purposes. The rock from the veins, so clearly distinguished as red and yellow on the model, was identical-looking quartz. Even the West End's experts admitted that you couldn't tell apart samples from the two veins if they had been removed from the mine - the only difference was structural,

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<sup>125</sup>The light green color of the andesite cap was complemented by the dark green color of the other cap rock, described as Brougner dacite. Black or dark brown depicted rhyolite, blue stripes indicated faults, and gray, which was the color of the primer used on the model, did not depict any geology. Numbers and letters were painted on in black, and the whole structure was suspended above a claim map in black ink on light-colored paper. *Jim Butler v. West End* Transcript, 11-13.

<sup>126</sup>J.E. Spurr was the first geologist to report on Tonopah, and his geological nomenclature tended to be used by the Tonopah miners. See J.E. Spurr, *Geology of the Tonopah Mining District, Nevada*, U.S. Geological Survey Professional Paper 42 (Washington, DC: GPO, 1905) for the most complete statement of his early work. J.A. Burgess took issue with Spurr's interpretation, termed the rocks differently, and hypothesized geological origins different than those asserted by Spurr. See J.A. Burgess, "The Geology of the Producing Part of the Tonopah Mining District," *Economic Geology* 4 (1909): 681-712. Perhaps as a response to Burgess or as a consequence of further development in the mines, Spurr modified some of his earlier findings, including changing some of the terms for the rocks, in J.E. Spurr, "Geology and Ore Deposits at Tonopah, Nev." *Economic Geology* 10 (1915): 751-760. Augustus Locke, "The Geology of the Tonopah Mining District," *Transactions of the American Institute of Mining Engineers* 43 (1912): 157-166 summarized the dispute and tended to side with the interpretation of Burgess. Edson S. Bastin and Francis B. Laney, *The Genesis of the Ores at Tonopah, Nevada*, U.S. Geological Survey Professional Paper 104 (Washington, DC: GPO, 1918) largely attempted to avoid the issue by basing their findings more on chemical analysis. Thomas B. Nolan, "The Underground Geology of the Tonopah Mining District, Nevada," *University of Nevada Bulletin* 29, no. 5 (1935): 1-49 is largely considered the last word on the subject. Nolan later headed the USGS.

in the direction they were oriented in the ground.<sup>127</sup> The West End's two-dimensional maps and geological sections also conformed to the same scale, numbering, and color scheme, providing a unified and consistent chromatic argument for the truth of the West End's geological assertions.<sup>128</sup>

During the testimony of their expert witnesses, the West End legal team validated the model first, then had the expert describe the underground, while referring to the model or sectional maps whenever possible. Dickson guided Juessen's early testimony in this way:

Q. You are familiar of course with the coloring on that model?

A. I am.

Q. Do you from your examination endorse the coloring there which is intended to represent the south vein throughout, as correct?

A. The coloring - The red color represents the south dipping vein, or the West End vein.

Q. Does it correctly represent it according to your examination of it on the ground?

A. It does.

Q. And state whether or not on your examination you endorse the coloring of the north dipping vein as shown upon this model, and upon the other exhibit?

A. I do.

Q. And do you also endorse the coloring on this model, upon the cross section, Exhibit G, which are intended to show the enclosing rock, or foot-wall and hanging-wall boundaries of the two veins wherever they have been ascertained?

A. I do.

Q. Is there anything, any feature, any point in the color scheme as adopted in the preparation of that model which does not meet with your approval?

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<sup>127</sup>Lindley squeezed this point out of Juessen in cross-examination, in *Jim Butler v. West End* Transcript, 206; elaborated on 207-209, where Lindley went after the "abrupt change" on the model.

<sup>128</sup> *Jim Butler v. West End* Transcript, 15-16.

A. There is none.<sup>129</sup>

Dickson was also careful to integrate the model into the testimony on the underground. For example, with Juessen on the stand, after the expert testified to his satisfaction with the model, Dickson had the witness stand up and move over to the model itself. The lawyer then asked a series of questions about each raise into the geologically-disputed ground, using the model as a reference. At one point, Dickson asked a series of questions about raise 5-A – the amount of quartz (which contained the vein), faults, and so on:

Q. How far up the raise does the fault continue?

A. The quartz continues 71 feet, up into the raise and terminates against a small fault.

Q. How far is that, if at all, below where the raise as shown upon the model must have encountered trachyte and cap?

A. Trachyte and cap were encountered 271 [feet] up in the raise above the hanging wall of the south dipping vein at a point indicated here by the purple in the raise immediately below the green, indicating the cap.<sup>130</sup>

The West End model was carefully used as a visual key to the testimony of the other expert witnesses called by the company. When Dickson brought John W. Chandler to the stand for the West End, the lawyer and the witness used the model to organize Chandler's testimony. After being introduced, Chandler produced a rock, taken from the vein, and described where it was found in the mine, in reference to the model. Thus the West End model was now associated with a factual geological

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<sup>129</sup> *Jim Butler v. West End* Transcript, 177.

<sup>130</sup> *Jim Butler v. West End* Transcript, 179-180.

specimen, even though the sweeping color scheme was suggestive of a far greater uniformity than was actually found underground. Next, Dickson had Chandler testify about the conditions he found in the area where the apex should have been. In the order they were found on the model, Chandler pointed to a raise, described what he had found in the mine at the point represented on the model, then moved to the next and did the same.<sup>131</sup> After finishing with the raises, Chandler used the model to describe how the two veins, in the West End's formulation, butted up to each other. (The model's representation of a portion of this area is shown in figure 4.9.) At one point Chandler used one of the West End's two-dimensional sections, Exhibit G, to illuminate a portion of the ground that was difficult to see on the model, but the section used the same color scheme as the model and the expert returned to the three-dimensional artifact as soon as it was possible to do so.<sup>132</sup>

The Jim Butler team, in contrast to the West End's strategy of portraying the underground with a single skeleton model plus two-dimensional maps and sections, created and deployed three different models, plus maps and sections, to make their case. Unlike the West End, whose skeleton model served as the key to all the other two- and three-dimensional visual representations, the Jim Butler team's "Exhibit 1" was a large horizontal (bird's-eye) view map of the underground workings of both the Jim Butler and the West End, as well as parts of the MacNamara and Tonopah

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<sup>131</sup> *Jim Butler v. West End* Transcript, 220-227.

<sup>132</sup> *Jim Butler v. West End* Transcript, 230-232.

Mining Company.<sup>133</sup> The map was made to a scale of 20 feet to an inch from surveys conducted by E.C. Uren, who oversaw the construction of the visual representations for the Butler team, as well as two other surveyors. (Uren had drawn most of the illustrations for the third edition of *Lindley on Mines*.<sup>134</sup>) Except for the stopes, which were shown in a brownish-yellow, the workings on the map were colored to distinguish one level from another, though not with any specific key, unlike the models. The boundaries of the two mines were also outlined, the Butler in red and the West End in green. Uren numbered his surveyors stations, and used West End numbers whenever his crew followed the other surveyors, though this practice created some numerical discrepancies when the Butler engineers visited a place first, since the West End surveyors did not use the Butler numbers. He also distinguished between raises and winzes by including an appropriate up or down arrow. The mapmaker put additional “arbitrary” numbers in strategic spots on the map, such as at the ends of drifts or “at points where I thought testimony would be introduced.” The map that formed Exhibit 1 also had lines representing vertical sections through the workings, which served as other exhibits.<sup>135</sup>

The Butler’s own skeleton model served as Exhibit 2. It was made from data from the surveyor’s notes that were the basis of the large map of Exhibit 1, and was the same scale (40 feet to an inch) as the West End model. The skeleton was constructed

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<sup>133</sup>The Butler’s Exhibits were numbered, and the West End’s were lettered, so it would always be clear which litigant’s displays were under discussion.

<sup>134</sup> Lindley, *Lindley on Mines* (1914), iv.

<sup>135</sup> *Jim Butler v. West End* Transcript, 488, 492-497. Quote on 496.

by a Mr. Douglass, of the Tonopah Belmont Mining Co., with the supervision and assistance of Uren. The vein had been painted red, with the Mizpah trachyte green, the Fraction vein a brownish orange, the Fraction dacite breccia represented in yellow, Midway andesite in purple, the glassy trachyte of the Tonopah Mining Company as a light blue, the West End rhyolite in brown, and faults as blue stripes. The coloring of the various parts of the model was directed by the geologists Finch and Searls.<sup>136</sup>

Exhibit 3 for the Jim Butler team was a glass section model. Uren constructed the glass model himself, working from geological sections made by Finch and Searls, and “checked and re-checked” it for accuracy. The thirteen plates corresponded to exact north-south sectional lines, one hundred feet apart, through the most important part of the anticline. The section lines were also clearly marked on the large map, Exhibit 1. The glass sections showed the veins, as well as faults, and the lines of the drifts, levels, raises and winzes. If the projected section cut a mine excavation exactly, the level appeared outlined in black, but the section also showed nearby workings outlined in a dotted line. The geology was colored or filled in: the Fraction dacite breccia was outlined in black, and tinted light green; the Midway andesite received a black cross-hatching; the Mizpah trachyte was depicted with green dashes; and the West End rhyolite was indicated by a lines-and-dots pattern. Uren’s chromatic palette may have been hampered by the need for each glass section to be at least semi-transparent, so the ones behind it could also be seen.<sup>137</sup>

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<sup>136</sup> *Jim Butler v. West End* Transcript, 497-498, 501-503. 40 feet to an inch was probably the most common scale for maps of metal mines, but it was by no means the only scale in use at this time.

<sup>137</sup> *Jim Butler v. West End* Transcript, 498-499.

The final model used by the Butler team, introduced as Exhibit 4, was a block model, made by Uren, again under the direction of Fitch and Searls, to a scale of 100 feet to an inch. The complete model showed the present surface of the ground. This piece could be lifted off, to allow the model to show the Trachyte Surface, which was the surface of the earth immediately before the lava flows turned it into the present surface. Removing the second piece revealed a third surface, (dubbed the Original Surface in Averill's published opinion for lack of a better term) which depicted the ground as it appeared immediately after the formation of the vein and before erosion converted it into the Trachyte Surface. The Original Surface, according to the Butler team, was the oldest one, followed over a relatively long period of time by the Trachyte Surface.<sup>138</sup>

After introducing the large map and the three models, briefly describing them, and testifying to their concordance with his surveyors' notes, Uren's time on the witness stand should have been done. The strategy that both sides agreed to follow involved saving the interpretation of the visual representations for the expert witnesses, and allowing the geologists to introduce the more specific maps as necessary during their testimony. For example, Lindley only asked two short questions to George Pierce, the West End modelmaker.<sup>139</sup> However, with Uren on the stand, Dickson aggressively attempted to sow doubt about the Butler models.<sup>140</sup> The lawyer tried to have the

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<sup>138</sup> "Mine Models in Tonopah Apex Litigation," *Engineering and Mining Journal* 99 (1915): 850. Averill's description of the model is *Jim Butler v. West End* Transcript, 1138. Uren's brief description is *Jim Butler v. West End* Transcript, 499.

<sup>139</sup>Lindley clarified that Pierce wasn't a surveyor. *Jim Butler v. West End* Transcript, 9.

<sup>140</sup>The exchange between Dickson and Uren is *Jim Butler v. West End* Transcript, 500-511.

West End model moved immediately next to the Butler skeleton model, but Lindley blocked the maneuver. Dickson's cross-examination strategy was to push Uren to admit that the West End and Butler skeleton models were "practically identical," nearly the same except for color. Then Dickson asked about some minute differences – variations in a particular stope, and the absence of some workings (in the Butler ground) from the Butler model, which Uren admitted. The lawyer set up some tricky questions, asking whether the Butler model portrayed certain stopes in Tonopah Mining Company ground, for example. Uren replied that it did, and Dickson then pointed out that the West End model covered that ground too, plus more beyond where the Butler model stopped. Dickson also asked Uren, the precise modelmaker, a series of broad, sweeping questions – whether the model represented all the workings in the claims of both companies, for example – which Uren had to deny, then attempt to clarify so as not to look foolish. These questions were intended to establish that the Butler skeleton model was less comprehensive and less factually reliable than the West End model. Then, Dickson turned to sow doubt about the glass model, the Jim Butler's Exhibit 3. He began by invoking the realism of the skeleton model:

Q. So if the surface overlying the vein or veins has been removed, and the earth from that on down was transparent as glass, anyone walking over it and looking down could see the workings and the stopes on the ore, just as they are in the mine?

A. Yes.

Q. That being so, what additional light is thrown upon the condition, as you understand it, by the ... glass model?<sup>141</sup>

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<sup>141</sup> *Jim Butler v. West End* Transcript, 507-508.



Didn't the skeleton model have all of this information and more, reasoned Dickson? Uren pointed out that the faults were easier to see on the glass model, but the real value of the glass model was that it was easier to visualize the structure of the geology. But wouldn't anyone looking at the skeleton model be able to "have a perfect picture without projections?" asked Dickson. If the skeleton model was complete, wouldn't it have the information? Uren discussed the veins that had not been excavated, which were visible on the glass model, and Lindley tried to intervene, but Dickson doggedly returned to the comparison that the modelmaker was attempting to avoid.<sup>142</sup>

Q. Is there anything represented on the glass model or any of the several sheets of the glass model, that could not be observed by one if he was looking through or along that identical plane of section under the ground; that he could not see if he had this wooden model before him?

...

A. Not as to actual openings, no.

Q. Nor the ore occurrences, so far as they have been developed?

A. So far as they have been developed.

Q. That is all.<sup>143</sup>

From the very start, then, Dickson had shrewdly created doubt about the Jim Butler's visual representations by comparing them unfavorably against one another. He also added to the West End model's authority by making it clear that it covered more terrain with a greater attention to detail, and was suitable to examine where any model was needed. Dickson tried to ensure that if the two models conflicted, the West End's skeleton model would be perceived as more factual.

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<sup>142</sup> *Jim Butler v. West End* Transcript, 508-510.

<sup>143</sup> *Jim Butler v. West End* Transcript, 510-511.

The Jim Butler team's visual representations portrayed a less cohesive strategy than that employed by the West End. The West End had a single, key model, with maps and sections drawn to the same scale and employing the same color palette. The Jim Butler, by contrast, used three models, each with different scales, and a large map scaled differently than the most important models. The map and the glass model were both 20 feet to an inch; the Butler skeleton model was 40 feet to an inch (as was the West End's model), and the block model was one hundred feet to an inch. The Jim Butler's visual representations also did not correspond with each other chromatically in a consistent fashion. On the large key map, levels were colored almost at random, with the intent only of distinguishing the levels from one another, yet on the skeleton and glass models the same colors were used to represent different geological or mining facts. Additionally, the models did not use the same colors for the same things. To be sure, the models were intended to highlight different aspects of the phenomena under discussion, but the lack of chromatic unity certainly denied the Jim Butler side the subtle rhetorical authority of the West End's exhibits. The differences between the visual representations provided Dickson an opportunity to sow doubt about the reliability of all of them, while implicitly increasing the perceived reliability and correctness of his own side's models and maps.

To the Jim Butler team, concerns about the need for consistent scale or colors were relatively immaterial. During Dickson's interrogation of Uren, when the West End lawyer was trying to push Uren into admitting that the glass model was a redundant

display of information already on the skeleton model, Lindley's interruption of the exchange revealed his thoughts on the appropriate uses of visual representations in the courtroom:

...as to the comparative value of these two models as evidence, I do not think that it is proper cross examination. Of course, I do not care - they show for themselves, and we all know that these models are made to illustrate testimony as much as anything else.<sup>144</sup>

Lindley thought of the visual representations as illustrative of testimony and arguments, not so much as factual evidence. For Lindley, maps and models were intended to help the viewer understand the true nature of the underground. Showing veins and structures that had not been excavated, or that had once possibly existed but had eroded or been covered (and thus, in both cases, now had to be imagined) increased the value of the work as a representation. The limits of the plaintiff's imagination were bound by the evidentiary rules of science of geology, which permitted (or even required) at least a little cautious inference and speculation. Lindley's visual representations were not intended to be read in a more narrow way as strictly true or false evidence.

### **Averill's Decision**

The testimony was concluded on December 22, 1914. On March 8-11, 1915, the lawyers orally argued the case before the judge, and on April 30, 1915, Averill issued his verdict. The maps and models made by both sides appeared to have made a

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<sup>144</sup> *Jim Butler v. West End* Transcript, 509.

significant impact on Averill's thinking, since he referred to them many times in the decision. Averill's decision in the case, and his reasoning behind it, came as a bit of a shock to those who had been following the proceedings. He began his opinion with a recognition of the importance of getting the geological facts straight in his opinion, since higher courts would almost certainly revisit only points of law, not points of fact.<sup>145</sup> He commenced his discussion of the case by declaring that there was indeed a single vein, but, Averill cautioned, "this conclusion is not at all what might be called an absolute one, but is qualified, as will appear further in this discussion." Averill said that the vein existed in an anticlinal form, but "strictly speaking it is not true geometrically or geologically." The judge then quoted *Lindley on Mines* that, geometrically speaking, an anticline has one or two synclines, but that was not the situation in this case.<sup>146</sup> Averill offered an additional caveat about the difficulty of determining geological facts, and recognized that "whatever result may be reached in this case, it must be based upon an incomplete presentation of evidence. Should it develop in the later mining history of the Tonopah district that the conclusions of fact in this case are wrong, the error should be excused for this reason."<sup>147</sup>

Averill thus prepared himself for a conservative ruling. He declared that not enough work was done in order to show the complete anticlinal roll. Instead, its

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<sup>145</sup> *Jim Butler v. West End* Transcript, 1137. Averill's opinion is pages 1137-1158, but is also numbered 1-22, which are the numbers Averill uses when he refers to other pages in the opinion. The opinion was also printed in full, without the diagram, in "West End Wins Decision in Apex Case," *Tonopah Daily Bonanza*, April 30, 1915.

<sup>146</sup> *Jim Butler v. West End* Transcript, 1137, 1140. Averill refers to *Lindley on Mines*, §312.

<sup>147</sup> *Jim Butler v. West End* Transcript, 1140.

junction was proven to exist in only a few places. Averill described in great detail the edges of the veins, as far as they were known, and also described the “anticlinal axis” he had invented, which was an imaginary line connecting the highest points along the top of the anticline where the two veins were proved to have merged. This anticlinal axis then could stand in for a line of an apex.<sup>148</sup> The judge said the apex lines were “obvious,” which he contrasted with a newly-invented antonym “subvious” that had been used during trial arguments. Perhaps sarcastically, Averill pointed out that “‘Obvious’ is a good word.”<sup>149</sup> “Obvious” reasoning, not coincidentally, was well supported by the visual arguments made by the West End model. Throughout the rest of the opinion, Averill referred to it extensively, along with one other diagram, to explain his argument. Averill handmade the two-dimensional diagram by measuring the West End model, and it was intended to represent the highest points of the veins, with the direction in which they dipped. (See figure 4.10 on page 207.)<sup>150</sup>

There may also have been a confusion at this point about the burden of proof. The burden of proving that a clear apex exists belongs to the company attempting to assert extralateral rights, which was in this case the West End. However, because of the particular legal maneuvers that preceded the case’s trial, the Jim Butler was listed as plaintiff and the West End as defendant – even though the burden of proof of an apex was still on the West End. Averill makes note of this fact, that one

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<sup>148</sup> *Jim Butler v. West End* Transcript, 1142-1149.

<sup>149</sup> *Jim Butler v. West End* Transcript, 1146.

<sup>150</sup> For example, *Jim Butler v. West End* Transcript, 1142, 1145. Diagram is 1144. Diagram based on West End Model: 1143, lines 11-13.

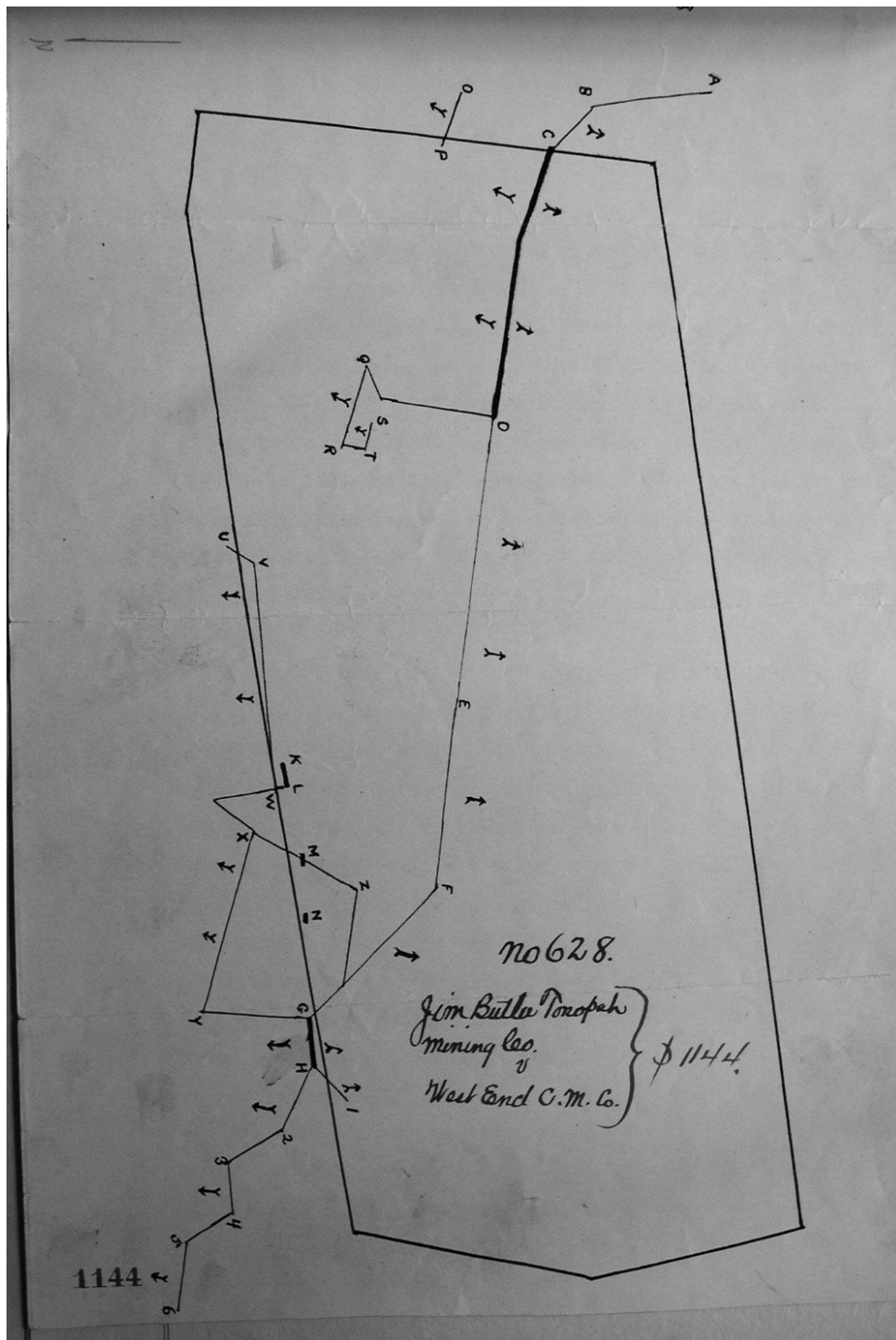


Figure 4.10: Judge Averill's handmade map. From *Jim Butler v. West End Consolidated* transcript, U.S. National Archives. Photo by Eric Nystrom.

possible reason the ground was left unexplored was because the burden of proof of an apex was on the West End, so the West End didn't want to explore and find an anticline, and the Butler was content that the West End would not have been able to prove the existence of a double-apex.<sup>151</sup> Averill noted, however, that the Butler contention was that the ground looked like the Butler's block model, which showed the roll in a continuous fashion. Therefore, Averill clearly believed, in phrasing his argument about the Butler not doing enough work to prove the anticline existed, that they had not gone to enough trouble to uncover geological facts to back up their assertions. Later in the opinion he described the Butler block model as "open to objection" (despite the well-publicized fact that neither side brought any objections at all during the trial) and noted, sarcastically, that "all this is ingenuous as well as artistic..."<sup>152</sup> He compared it implicitly to the West End skeleton model, which showed the truthful gaps in the underground, and found the block model deficient as evidence:

The vein does not exist as one unbroken sheet as depicted on the [Butler block] model, not, at any rate, as shown by present development. If, therefore, the Butler contention rests upon this model, it rests upon a foundation consisting largely of assumption, which, however, might have been turned into fact in part by proper development of the 'Terra incognita.'<sup>153</sup>

Averill then tackled the "halo" issue. He opined that the halo was more extensive, and that, as a continuation of the vein, must have reached the Trachyte Surface (which

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<sup>151</sup> *Jim Butler v. West End* Transcript, 1147-1148.

<sup>152</sup> *Jim Butler v. West End* Transcript, 1149.

<sup>153</sup> *Jim Butler v. West End* Transcript, 1150.

was the surface after the deposition of the vein but before it was all covered over by dacite from the eruption of Mt. Brougher). The fact that the halo was part of the vein and reached a prehistoric surface gave the West End a terminal edge on the vein, traditionally a key part of determining an apex.<sup>154</sup> Averill admitted that the quartz of the halo, where it would have met the surface, was not oxidized, which was a Butler argument to counter the idea that the vein had ever reached any prehistoric surface. Averill waved off the concern by noting that “half a dozen explanations can be offered against any such conclusion, one of which is that unoxidized veins are often found that undoubtedly reached a surface when forming, perhaps some in the Tonopah district.” Further, pointed out Averill, this reasoning only needed to apply to 240 feet of the juncture of the two veins, since this was the only part of the united vein that had been proven to exist.<sup>155</sup>

Averill then briefly discussed the issue of the roll of the vein. The judge argued that the geological section offered by the Butler team as proof of the vein’s roll was misleading, not because it was drawn poorly, but because the particular part of the vein shown by the section was not representative of the vein as a whole. Here Averill is again implicitly comparing a localized vision, provided by the Jim Butler’s geological section, with the broader and more obviously “factual” vision provided to the judge by the West End model.<sup>156</sup>

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<sup>154</sup>One of the primary arguments made by the Jim Butler was that the West End vein had no terminal edge, so therefore it had no apex.

<sup>155</sup> *Jim Butler v. West End* Transcript, 1151-1154.

<sup>156</sup> *Jim Butler v. West End* Transcript, 1155.



The judge concluded his discussion of the geological conditions by addressing the strike of the vein. The Butler had argued that what the West End claimed was the dip of the vein was actually its strike, and vice-versa. This was seen as important by the lawyers, because extralateral rights followed the dip and not the strike. If the Butler's argument was true, it would probably mean that the apex of the vein (if one existed) wasn't even in the West End claim at all, and that the property line with the Butler would have to be respected as a vertical plane. At minimum, if the dip was actually the strike and vice-versa, the West End would not have proven the existence of an apex, and no extralateral rights would exist. Averill noted that the "mathematical" strike of the vein depended largely on which points were used to calculate it, and that the strike could vary wildly. However, argued Averill, "as a matter of common sense rather than technical mathematics the strike of the vein as a whole is easterly and westerly, and the strike of its two slopes ... is as claimed by the West End."<sup>157</sup> The West End model would have facilitated Averill's "common sense" decision here, mostly because it left out the territory necessary to prove the Butler's contention. Indeed, a quick look at the model does make it "obvious" that the strike of the two veins or branches conforms to the West End's argument.

After discussing the geological arguments, Averill turned to the legal implications of the case. Three legal points remained to be settled. The most important question was whether a vein could have extralateral rights in two directions. Averill said that

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<sup>157</sup> *Jim Butler v. West End* Transcript, 1155.

it depended on the specific facts of the case, and in this case, it was possible to find a terminal summit at the crest of the anticline, which made “that line of highest points a true apex for the whole vein, from which apex the vein can be followed downward both northerly and southerly.”<sup>158</sup>

Averill also made short work of the second Butler argument about the law. Lindley had argued that since the extralateral rights the West End was trying to claim were on a vein other than the one that the West End had discovered originally (and which was, therefore, the basis for their right to mine the ground), they could not have extralateral rights on the other vein. Averill judged that Lindley’s argument was “fully and conclusively answered” by the West End, who argued that clear court precedents and even language in the 1872 Mining Law gave mining companies extralateral rights on any and all veins apexing in their claim, not just the so-called “discovery” vein.<sup>159</sup>

Averill then tackled the third legal point, which was a dispute over the end lines of the West End claim. In an ideal rectangular mining claim, the end lines were the short sides of the rectangle. The long sides were called side lines. Such an ideal claim would be laid out over the apex of a vein, so that the vein bisected the rectangular claim lengthwise. Accordingly, the ideal vein would cross both end lines of the ideal claim. These end lines were projected vertically downward, and limited the rights of the mining claim. Miners could follow the vein extralaterally beyond the side lines, but not beyond the end lines. The mining law of 1872 held an additional restriction

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<sup>158</sup> *Jim Butler v. West End* Transcript, 1156.

<sup>159</sup> *Jim Butler v. West End* Transcript, 1156.

on the end lines – it required them to be parallel. (This made sense, because non-parallel end lines would either converge, limiting the ability of the claimant to go extralaterally beyond the side line, or diverge, giving the claim owner more ground extralaterally than was owned by the original claim.) The principle of parallel end lines limiting the boundaries of extralateral rights was thus fairly simple, in idealized situations. Lindley argued that the western end line of the West End claim was not parallel with the other end line – in fact, the western line was jagged, a bit like a lightning bolt. Thus, according to Lindley, the claim was not laid out according to the requirements of the law, and if that was true, then the West End could have no extralateral right.

However idealized the original law may have been, geological situations were rarely ideal, since veins often meandered out a side line instead of the end line. That is what happened with the West End - the discovery vein came in through the eastern end line, turned, and crossed out through the northern side line instead of the other end line. In an earlier case with a meandering vein of this sort, the U.S. Supreme Court had ruled that the appropriate solution was to draw an imaginary vertical plane, parallel with whatever end line the vein passed through, at the point where the meandering vein crossed the side line. The claim owner then possessed extralateral rights between the end line and the imaginary plane.<sup>160</sup> On the basis of this reasoning, Averill decided that the jagged western end line of the West End had no bearing on its extralateral

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<sup>160</sup>This doctrine was most fully and finally expressed by the U.S. Supreme Court in a pair of cases, *Del Monte Mining and Milling Co. v. Last Chance Mining Co.*, 171 U.S. 55; and *Clark v. Fitzgerald*, 171 U.S. 92.

rights. Averill did note that, technically speaking, it was necessary to have a “valid” claim before any extralateral rights could exist, and one of the four criteria for a claim’s validity was that it must have parallel end lines.<sup>161</sup> However, Averill pointed out that later courts had interpreted the requirement rather loosely, and suggested that the West End’s lines were close enough to preserve the validity of the claim.<sup>162</sup>

Averill realized that his legal conclusion – that the vein was an anticline, but that an apex still existed and that extralateral rights could flow in opposite directions from the same claim – was radical and perhaps even counterintuitive. Averill attempted to forestall criticism by quoting from a noted mining judge of the previous century, Chief Justice of Nevada William H. Beatty. “If the conclusion reached herein seems revolutionary,” wrote Averill, it would be wise to remember Beatty’s argument for judicial flexibility:

We are willing to admit that cases may arise to which it will be difficult to apply the law; but this only proves that such cases escaped the foresight of Congress, or, that although they foresaw the possibility of such cases occurring, they considered the possibility so remote as not to afford a reason for departing from the simplicity of the plan they chose to adopt.<sup>163</sup>

In what may have been a subtle insult directed at the Jim Butler’s counsel, Averill lifted the Beatty quote – verbatim and without attribution – from the same section

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<sup>161</sup>The other three were that the locator must make a discovery in place; that he give notice of his claim, and that he define his boundaries. The requirement for parallel end lines stemmed from the fourth requirement, which was that the boundary lines must conform to the requirements of the law. These requirements, defined elsewhere in the statute, mandated parallel end lines, unbroken lines, maximum sizes, and so on.

<sup>162</sup> *Jim Butler v. West End* Transcript, 1156-1157. Averill cited *Lindley on Mines*, as well as Shamel.

<sup>163</sup> *Jim Butler v. West End* Transcript, 1157-1158.

of *Lindley on Mines* that Averill used earlier in his opinion to justify ruling that the vein in this case was not a “geometrical” anticline.<sup>164</sup> With his factual and legal conclusions completely explained, Averill ruled that the West End owned the apex, and was therefore entitled to follow the vein out both of the claim’s sidelines, including into Jim Butler territory.<sup>165</sup>

It is clear from Averill’s opinion that the judge did not consider the Butler models and the West End skeletal model to be equally “factual.” Dickson’s early work with Uren, the modelmaker, on the witness stand had sown doubt about the utility of the Butler skeleton model. The West End model was at least as good, more comprehensive and more thorough, and could therefore substitute for the Butler skeleton model. Averill pointed out that the Butler skeleton model showed more of a unified apex than did the West End model, but instead of taking this point as a challenge to the West End’s story, Averill interpreted it as falsely depicting underground spaces that were not known with certainty.<sup>166</sup> As a result, Averill believed the West End model could be used in place of the Butler skeleton model, with the only consequence being greater truthfulness. The unforeseen consequence, however, was that the West End model’s chromatic arguments would no longer be disputed by a countervailing representation.

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<sup>164</sup>See Lindley, *Lindley on Mines* (1914), §312, 712. Lindley attributes the quote to Beatty’s decision in *Gleeson v. Martin White M. Co.*, 13 Nev. 442, 459.

<sup>165</sup> *Jim Butler v. West End* Transcript, 1158.

<sup>166</sup> *Jim Butler v. West End* Transcript, 1142-1143, 1147.

Next, Averill compared the West End’s model to the Butler block model, and came to the conclusion that the West End’s model provided the superior view of the underground. Indeed, the block model seemed to signal that the Butler team was making rash assumptions about the underground. In the copy of the opinion included with the transcript that was sent to the U.S. Supreme Court, Averill had written a sentence calling particular attention to “a criticism of plaintiff’s block model” that he would make later, but that line was struck out and did not appear in the published opinion.<sup>167</sup> The block model made assumptions about the vein which may have been reasonable to a geologist or mining engineer, but which seemed to clearly be unproven assertions to Averill. It was easy for the judge to superimpose his own knowledge – that the underground had not been completely excavated – onto the Butler block model. That the block model could show a vein to exist where humans had never gone showed that the model was misleading or taking liberties with the truth, at least when “truth” was construed in the more rigorous sense used by the legal profession. What passed as “proof” for a science like geology did not always meet the standard in a courtroom, at least not for Mark R. Averill.

The West End model, especially when contrasted with the Butler block model’s assumptions, seemed more believable to the judge. The model gained authority from its carefully engineered origin, to scale, corresponding with other maps and sections, and inscribed with numbers. Its very skeletal “messiness” seemed to reflect the truth,

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<sup>167</sup> *Jim Butler v. West End* Transcript, 1140.

not to take liberties with it. In short, because of its design, it was easier for a person like Judge Averill accustomed to thinking about truth and falsehood in a rigorous, legal way to accept the West End model as fact, rather than argument. Once the West End skeleton model underwent this transmutation into being a source of fact, the argumentative portions of the model – its color choices, its presentation of stark boundaries where none existed, its orientation and point of view, its inclusions and exclusions – were significantly harder to distinguish from the factual content of the model. It is clear from Averill’s written opinion that he relied on the West End model as showing the truth, even when some of the truths it portrayed were fictions, the fruits of arguments carefully crafted in a visual language.

## **Aftermath**

The *Jim Butler* decision had a relatively minor legal aftermath as a precedent for other cases. The period around the First World War saw the last major developments in apex litigation, of which the *Jim Butler* case was a part. After that time, there were relatively few apex cases tried. This happened for several reasons – the increasing cost of such litigation, well borne out by the Tonopah example, was one, but a larger reason was that the mining industry was changing in such a way as to render obsolete most apex litigation. The increasingly high capital costs of mining necessitated development on a larger scale than before, which tended to mean that a company bought all the claims nearby before commencing major operations. Addi-

tionally, the postwar emphasis on larger, lower-grade deposits (such as the porphyry copper lodes of Arizona, Utah, and eastern Nevada) instead of traditional mineralized fissure veins tended to reduce fights over extralateral rights, since the huge low-grade deposits could hardly be said to have apexes at all.<sup>168</sup> Finally, few new cases were brought after World War I because most of the legal questions pertaining to extralateral rights were settled well enough to allow lower courts to manage the questions themselves.<sup>169</sup>

The *Jim Butler* case, though cited a handful of times in lower courts, was only cited once explicitly in a U.S. Supreme Court case. This was the 1921 trial of *Silver King Coalition Mines Co. v. Conkling Mining Co.*<sup>170</sup> W.H. Dickson and A.C. Ellis, Jr., and perhaps even Lindley himself, were lawyers for the defendant.<sup>171</sup> The lawyers for the defendant cited the *Butler* case to “definitively and positively” show that mining companies have as many rights on secondary veins as they do on the discovery vein.<sup>172</sup> Supreme Court Justice Holmes wrote the opinion, and cited the *Butler* decision twice. The first time he used it, along with other precedents, to support the fact that if a vein strikes across a claim’s side lines (instead of the end lines, as is supposed to be

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<sup>168</sup>The copper operators of Bisbee, Arizona, agreed amongst themselves to respect vertical sidelines, so as to avoid any type of apex litigation. Richard W. Graeme, “Bisbee, Arizona’s Dowager Queen of Mining Camps: A Look at Her First 50 Years,” in *History of Mining in Arizona*, ed. J. Michael Canty and Michael N. Greeley vol. 1 (Tucson: Mining Club of the Southwest Foundation, 1987), 51–75, 56.

<sup>169</sup> Sherwood, “The Extralateral Right: A Last Hurrah?,” 12.2-12.4.

<sup>170</sup>256 U.S. 18; 41 S. Ct. 426; 65 L. Ed. 811.

<sup>171</sup>Dickson and Ellis appear on the portion of the brief included in 256 U.S. 18, as reported on Lexis-Nexis, accessed July 10, 2006; Lindley appears along with Dickson on the brief for a case with the same name but reported differently; see *Silver King Coalition Mines Co. v. Conkling Mining Co.* (1921), 255 U.S. 151.

<sup>172</sup>256 U.S. 18



the case), then the side lines become the end lines and vice versa.<sup>173</sup> The second, more important use of the *Butler* case was to support Holmes' refusal to revisit the question of the specific geology of the vein (or veins).

We have the distinct testimony of experts that there was no such [other vein] and we agree with the view of the District Judge sustaining the petitioner's extralateral rights. Whether there are other answers to the contention we need not decide.<sup>174</sup>

Perhaps ironically, then, the most lasting judicial implication of the *Jim Butler v. West End* case was the decision that if the District Court gets the geological facts right, the Supreme Court need not consider revisiting them. Thus, three-dimensional models and other visual representations, which featured arguments about geology and law in a more fact-like form, were seen to have improved the decision-making ability of the lower courts, at least in terms of the facts of mining law disputes. The rhetorical power of the visual representations contributed to limiting the review of the information they purported to contain. To use Judge Averill's term, the information presented by the models was so "obvious" that the highest court in the land could feel free to safely ignore it as settled.

The outcome of the trial meant ruin for the Jim Butler and prosperity for the West End. The stock of both companies had increased in value during the suit, because the West End was allowed to continue to mine and mill the ore. All of the profits from the ore were placed in an escrow account, which totaled over \$400,000 by the time the

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<sup>173</sup>256 U.S. 18, 26.

<sup>174</sup>256 U.S. 18, 27.

last appeal was finished. This figure represented profit from the ore only, and does not include the triple damages that were at stake. When the Butler lost the suit, the West End gained control of the only productive parts of the Jim Butler holdings. The company was reorganized to pay down some of the debt of the Tonopah Belmont as well. Lacking proven reserves or the capital to conduct a full-scale exploration for more ore, remaining pockets of the Jim Butler were leased to small miners for more than a decade, but income from this source was miniscule, and the company never regained anything like its pre-trial prosperity. In 1938, the Tonopah Mining Company bought control of the Butler for less than \$3,000 and conducted some exploratory drilling, but nothing worthwhile was found, though leasers occasionally shipped out ore as late as 1947.<sup>175</sup>

The trial had a significantly better outcome for the West End Consolidated Mining Company, as might be expected. The company made significant profits in the years during and immediately after the trial (except for 1919, when a large strike hurt the production of all the Tonopah mines). Prosperity led to investments in mines outside of Tonopah, which proved to be a drain on the company – the profits from the West End’s Tonopah property financed the costly experiments elsewhere. Even with the baggage of failing mines, the West End continued to make profits, though on a diminishing scale, into the mid-1920s, largely on the strength of its Tonopah output. (Radical drops in the price of silver in 1923 also significantly affected the

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<sup>175</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 98, 138.

profitability of the West End and other Tonopah operations.)<sup>176</sup> The trial itself was expensive – it cost the company almost \$115,000 – though the victory put the West End firmly in the black. The company spent \$79,469 on preparations for the trial such as development work and model making, and lawyers’ fees for the trial amounted to an additional \$35,000.<sup>177</sup>

The little cabal of mining litigation experts were doubtlessly the least affected by the outcome. For Lindley and Dickson, the distinguished old lawyers, the decision came in the twilight of their careers, for neither would live much longer. Younger lawyers and experts, including Finch, Searls, and Colby, had long careers and significant accolades in their futures. Some of the locals, especially Brown, Atkinson, and Judge Averill himself, continued their careers in Nevada and tackled questions of mining law only infrequently thereafter.

After the trial was concluded at the U.S. Supreme Court, all of the exhibits were returned to the companies. Francis M. “Borax” Smith, president of the West End, donated the skeleton model to the University of Nevada’s Mackay School of Mines shortly after the conclusion of the trial, and it served as a silent teaching tool in the School’s museum along with mineral specimens. In 1939, the West End asked the University to borrow the model back, as the company hoped it “would be of real economic service to us for a time.” It is not clear if the loan was made, but the model clearly returned to the museum again, where it can be seen by visitors

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<sup>176</sup> Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 106-114.

<sup>177</sup>3 B.T.A. 128, 130; Carpenter, Elliott, and Sawyer, *Fifty Years of Mining at Tonopah*, 102.

today – a perplexing and captivating representation of a now-invisible underground landscape.<sup>178</sup>

## Conclusion

Technical models were extraordinary new ways to peer into the earth. They were complex and required relatively large amounts of time and money to construct. Because of their inflexibility and their expense, models were used most extensively in courtrooms and classrooms, where their ability to portray the invisible spaces of the underground to audiences without a technical background was of primary importance.

Models of underground spaces broadly belonged to one of three typologies: glass models, block models, or skeleton models. The characteristics of each type of model suited them for different types of representational work. Glass models were cheap and easy to make, but were not truly three-dimensional. Block models showed geology well, but did not depict underground excavations easily. Skeleton models were fragile and strange-looking, but showed mine workings in three true dimensions. The choice of a model type was the choice of a limited range of representational types.

Representational styles could directly impact the effectiveness of a model as a form of technical communication. This point is brought out clearly by taking a close look at the proceedings of a mining trial. *The Jim Butler Tonopah Mining Company v.*

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<sup>178</sup>H.D. Budelman letter to Walter S. Palmer, Aug. 30, 1939; L.W. Hartman letter to Walter S. Palmer, Sept. 20, 1939; H.D. Budelman letter to Walter S. Palmer, Sept. 22, 1939; all in the W.M. Keck Museum Administrative Files, Mackay School of Mines, University of Nevada–Reno. I am grateful to Rachel Dolbier of the Keck Museum for finding these letters and sending copies to me.

*West End Consolidated Mining Company* case offers an unusual opportunity, from the standpoint of surviving documentation, to see the ways in which models and maps of underground landscapes were used in the courtroom.<sup>179</sup> These visual representations, especially the three-dimensional models I focused on here, helped shape a particular understanding of those spaces that conformed to the demands of federal mining law. Both sides embodied arguments about underground spaces – interpretations of the surviving geological structures, to use Gaddis’ formulation – in the models and maps they made. These representations, though, transformed *arguments* into *facts* – facts which were then used to support arguments about geology and the law. The West End’s coherent and consistent system of interlocking visual representations, anchored by the three-dimensional model, performed this rhetorical sleight-of-hand most effectively. By contrast, the less consistent and occasionally contradictory messages offered by the Butler models undermined their trustworthiness in the eyes of the court.

In the trial, visual representations were at the center of a complex legal problem concerning the properties of an invisible underground space. Below the surface of the earth was rock of different types, spaces carved out by miners, and perhaps some machinery; but the models and maps transformed it into a geo-legal subterranean landscape, accessible only to experts and lawyers, ruled by abstract concepts, and divisible with a judge’s gavel.

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<sup>179</sup>The West End’s model survives in the W.M. Keck Museum, of the Mackay School of Mines at the University of Nevada Reno; many of the Jim Butler’s maps made for the trial are held by the Tonopah Historic Mining Park (see especially maps 791-815); and the very complete transcripts resulting from the special care taken to record the proceedings are located in the National Archives in Washington DC.

# Chapter 5

## Photographs

## Introduction

Photographs were by far the most common visual representation used by American businesses in the late 19th and early 20th centuries, and can serve as a rich source for historians.<sup>1</sup> Elspeth Brown argued that photography, in particular, played an important role in the development of American industrial society. She posits photography's "central" part in the "ways in which corporate managers have sought to secure the consent of workers, managers, and consumers in the unevenly successful project of rationalizing American capitalism."<sup>2</sup>

The development and spread of photography was key to the creation of a visual culture in America in the late 19th and early 20th centuries. Photographs, it seemed, were everywhere; produced by professionals, experienced amateurs, and, especially after the invention of the Kodak in the late 1880s, by consumers themselves. Businesses took advantage of photography to convey their products and messages to the public in visual form, and also used photographs to communicate internally, within the firm. Mining companies, like other businesses, utilized photographs for these purposes. However, one major context in which mining photography differs significantly from standard corporate photography and begins to look like the other visual tools I discuss in other chapters is within the context of safety education. Beginning in

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<sup>1</sup>See David E. Nye, *Image Worlds: Corporate Identities at General Electric, 1890-1930* (Cambridge, MA: The MIT Press, 1985); Alan Trachtenberg, *Reading American Photographs: Images as History, Mathew Brady to Walker Evans* (New York: Hill and Wang, 1989).

<sup>2</sup>Elspeth H. Brown, *The Corporate Eye: Photography and the Rationalization of American Commercial Culture, 1884-1929* (Baltimore: Johns Hopkins University Press, 2005), 16.

the 1910s, underground photos were used to re-enact mining accidents, with the primary goal of teaching safe practices to miners. Over time, these accident images were transformed from photographs to cartoon drawings (and are still used today to teach safety). Sometimes these photographs were used for other purposes as well - to teach English to immigrant miners, in one example - and I will explore those uses as well.

Photographs were powerful tools, but the nature of their power was different than that of maps or drawings. Maps and drawings, as we have seen in previous chapters, permitted engineers to intellectually control complex machines and spaces because the representations could be manipulated in the mind's eye or on paper in a way that was impossible to do in real life. These sorts of visual representations also served as places to aggregate and spatially analyze data, helping engineers achieve insights or do work suggested by the arrangement or availability of information on maps and drawings. Photographs, by contrast, drew most of their power from their ability to capture a complete scene at a specific moment in time. Photos were *true*, or at least they seemed to be, and this property could be used by those in charge of industrial firms to advance corporate agendas. As Elspeth Brown noted, "the photograph's privileged relationship to the real provided corporate managers with a persuasive medium of legitimization as they sought to naturalize new methods of work and consumption through various uses of photographic evidence."<sup>3</sup>

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<sup>3</sup>Brown, *Corporate Eye*, 14.



As was the case with other visual representations, mining companies only gradually learned how to take advantage of photographs as tools. In particular, the technical difficulty of underground photography limited the application of photography to surface features in the early years. Over time, however, photography came to be an accepted and common part of the business activities of mining companies. This chapter will trace the development of photography in the context of the business of mining, and will then closely examine one area, mine safety, where photography played an important role. As with maps and blueprints, the power of photographs as tools made them an important part of mining enterprises by the 1920s.

## Mining and Underground Photography

Photographs of underground mines were considered a technical trick into the 1880s, deemed of no importance to mining operations. Underground photography was not attempted successfully until the early 1860s, when French photographer Felix Nadar used electric arc-light to photograph the Paris catacombs.<sup>4</sup> Several successful attempts were made in 1865 in Great Britain, but they received little publicity. Timothy O'Sullivan, a member of Clarence King's 40th Parallel Survey, took the first underground photographs in the United States when he captured several views of the Comstock Lode in 1867 by burning bundles of magnesium wire as a light source.<sup>5</sup>

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<sup>4</sup>Chris Howes, *To Photograph Darkness: The History of Underground and Flash Photography* (Carbondale: Southern Illinois University Press, 1989), 8-9.

<sup>5</sup>William Goetzmann, *Exploration & Empire: The Explorer and the Scientist in the Winning of the American West* (New York: W.W. Norton & Company, Inc., 1966), 442; Trachtenberg, *Reading American Photographs*, 144-154; Howes, *To Photograph Darkness*, 35, 43, 73-75.

The first attempts to use underground photos as part of mining operations were made in 1876 when Frederick Brown made photographs of the working face of Bradford Colliery in Great Britain to support mining litigation, but even so, underground photographs of any sort were scarce through the mid-1870s, and mining photos nearly unheard-of.<sup>6</sup>

Technical barriers to underground photography were significant. Negatives using the wet plate process were ordinarily cumbersome to make and develop, and required a significant amount of equipment. Dirty conditions underground only exacerbated the challenges posed by wet plates. The biggest problem was creating enough light to expose the photographs. Exposures with inadequate light were sometimes so long that the wet emulsion dried before the photo was fully exposed. Early attempts at cave photography used battery-powered arc lamps, lime light, Bengal fire, and a host of other materials, but none were cheap enough, portable enough, or gave off enough light to be useful to mining companies. In 1859, the first published experiments described the intense light given off by burning magnesium wire. The paper's authors, Robert Bunsen and Henry Enfield Roscoe, even speculated on a clockwork mechanism to automatically advance the burning wire from a spool.<sup>7</sup> Patent problems and manufacturing difficulties prevented magnesium from being manufactured on a commercial basis until 1864, and even afterward use of the product proved difficult to

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<sup>6</sup> "Photography Underground," *Mining and Scientific Press* 34 (January 6, 1877): 7; Howes, *To Photograph Darkness*, 81-83, 163.

<sup>7</sup>Robert Bunsen and Henry Enfield Roscoe, "Photo-Chemical Researches, Part IV," *Philosophical Transactions of the Royal Society of London* 149 (1859): 920-923.

master.<sup>8</sup> Enterprising photographers who wanted to make underground photographs had to contend with magnesium, as did O'Sullivan, or try more unusual approaches. For example, George Bretz cooperated with the Smithsonian Institution to create underground photographs of the Kohinoor anthracite colliery in Pennsylvania in 1884. He first tried burning magnesium, but the experiment was a failure. The manager of the Philadelphia and Reading, who operated the colliery, took an interest in the work and helped Bretz borrow an electric dynamo, a compressed air engine to drive it, five arc lamps of approximately 1,600 candlepower, and 4,000 feet of wire to connect them all. The dynamo and its engine had to be installed 400 feet underground to be close enough to work. When Bretz started the dynamo and the lights, the spectacle attracted miners from throughout the colliery. "Many old miners were attracted to the spot, and were, if possible, more surprised and interested in the sight than the strangers present. Although most of them had spent the greater part of their lives in coal-mines, yet they had never before seen more than a few square feet of the coal at any one time."<sup>9</sup> Each exposure took ten to thirty minutes.

Magnesium remained expensive and difficult to use into the 1880s, but late in that decade both dry-plate negatives and flashpowder became commercially available. (Flashpowder was useful for indoor photography as well as underground photography – social reformer Jacob Riis began using it in 1888, a year after its invention, and

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<sup>8</sup>Howes, *To Photograph Darkness*, 20-23.

<sup>9</sup>Fred P. Dewey, "Photographing the Interior of a Coal Mine," *Transactions of the American Institute of Mining Engineers* 16 (1888): 307-312.



Figure 5.1: Iron breaker at Drifton, Pennsylvania, under construction about 1890. Negative 2-8, Coxe Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Scanned from glass plate negative by Eric Nystrom, 2006.

was an ardent advocate.)<sup>10</sup> Flashpowder, while still dangerous, provided enough light that relatively short exposures could be made. This meant that underground photographs, beginning in the early 1890s, could hope to feature people without significant blurring.<sup>11</sup>

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<sup>10</sup>Howes, *To Photograph Darkness*, 87, 105, 131.

<sup>11</sup>Bretz included people in some of his 1884 shots with limited blurring, but this was due to the extraordinary patience of the miners who posed for him rather than the speed of his photography.

As photographic equipment became less expensive and less cumbersome from the early 1880s invention of the dry plate to the first Kodak film cameras at the end of the decade, the use of photography by mining engineers became more widespread. In 1886 a leading mining engineer noted that “many members” of the AIME were “amateur photographers.”<sup>12</sup> Even so, most mining operations, particularly before the advent of dry-plate photography, simply hired local professional photographers for their photo production needs.<sup>13</sup> For example, Eckley Coxe used at least two local photographers for the photo series of his iron breaker under construction in 1890, though later photographic duties might have been handled by a Coxe employee.<sup>14</sup> The images of the breaker and of machinery designed and constructed by Coxe’s shops, such as figure 5.1 on page 229, were used in professional papers and may have been used in advertisements as well. For example, some of the extant photographs of the construction of the Coxe’s iron breaker were used in his extensive article for other mining engineers describing the innovative plant.<sup>15</sup> The images may also have been useful to keep other members of the family business partnership up to date. The

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<sup>12</sup>Rossiter W. Raymond, “The Ives Process of Photo-Mechanical Engraving and its Usefulness to Engineers,” *Transactions of the American Institute of Mining Engineers* 15 (1887): 271.

<sup>13</sup>Several histories of mining-town photographers exist; in addition to those cited below, see Tom Beck, “Photography Caught in the Middle: 1870-1895,” *Proceedings of the Canal History and Technology Symposium* 4 (1985): 147–173; and Duane A. Smith and Hank Wieler, *Secure the Shadow: Lachlan McLean, Colorado Mining Photographer* (Golden, CO: Colorado School of Mines Press, 1980).

<sup>14</sup>See the photographers’ markings on the prints from the iron breaker series, Coxe Collection photographs, Division of Work and Industry, National Museum of American History, Smithsonian Institution. These prints correspond to some of the glass negatives in the Coxe collection as well, which indicates that Coxe’s arrangement with the local photographer involved handing over the negatives. The possibility for a later Coxe employee handling photo duties is suggested by the glass negative time-exposure “Drifton Clad in Snow March 5th 1893, at 9:30 am Good Light,” Coxe Glass Negative 3-20, DWI.

<sup>15</sup>Coxe, “The Iron Breaker at Drifton.”

iron breaker was one of the first of its kind, as previous breakers had been made of wood. (The iron breaker replaced a wooden one that burned down, possibly due to arson, in 1887.) While Eckley Coxe, who designed and built the breaker, lived on-site in Drifton, Pennsylvania, most of his family members who were also partners in the coal mining enterprise lived outside of the anthracite country in Philadelphia. Thus, pictures such as that in figure 5.1 would have reassured the other family investors of the underlying strength of the new building, while also giving them a good look at where their money was being spent.

Commercial photographers in mining towns did not depend solely on the business of mining corporations. For example, mining companies in Goldfield, Nevada, after the turn of the century, hired P.E. Larson, the professional photographer in town, to document their works above and below ground. However, Larson also made money by selling images of mining to the general public. He would go into the mines and take posed pictures of miners at work, which then he would then retail to the public at large, including the subjects of his photo, from his studio. Miners bought these photographs, presumably in part so they could show non-miners what work underground was like, and in so doing validate, to an extent, their occupational choice.<sup>16</sup>

Some mining companies, however, decided to set up an in-house photography capability, especially as developing equipment became more reliable and less expensive.

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<sup>16</sup> Ronald T. Bailey, *Frozen in Silver: The Life and Frontier Photography of P.E. Larson* (Athens, OH: Swallow Press / Ohio University Press, 1997).



Figure 5.2: Famill large format copy camera used by the Calumet and Hecla Mining Company. Accession number KEWE-00161, Keweenaw National Historical Park, Calumet, MI. Photo by Eric Nystrom, 2006.

Both the Quincy and the Calumet and Hecla (C&H), copper mines in the Upper Peninsula of Michigan, show artifactual evidence of their in-house photography.

The mining companies of the Keweenaw probably used smaller, ordinary cameras for work in the field or underground. However, a larger camera used by the Calumet and Hecla for indoor reproduction work has also survived. The Famill camera shown in figure 5.2 on page 232 was twenty inches square, and commonly was used by the C&H to create images on glass plate negatives measuring eleven inches by seventeen inches. The wooden parts of the camera could move back and forth on the massive track base, with expandable bellows taking up the slack, in order to zoom in and focus the image. The bellows system permitted a total movement of approximately three feet horizontally. The wooden base had a two-part structure to permit vertical movement as well. A system of levers or handles permitted the inner frame of the base (to which the platform holding the camera was attached) to be raised above the level of the outer base. Overall, the camera could probably not have been moved more than about twelve or sixteen inches higher, but even this amount would have permitted the camera operator to adjust the camera vertically with respect to the object of the photograph.

The large format camera was used by C&H to take pictures of underground maps, such as the one seen in figure 5.3 on page 234. The maps themselves were fairly small-scale, intended to provide a broad look at the overall state of the underground. In contrast with a blueprint, which duplicated a map's scale faithfully enough so as



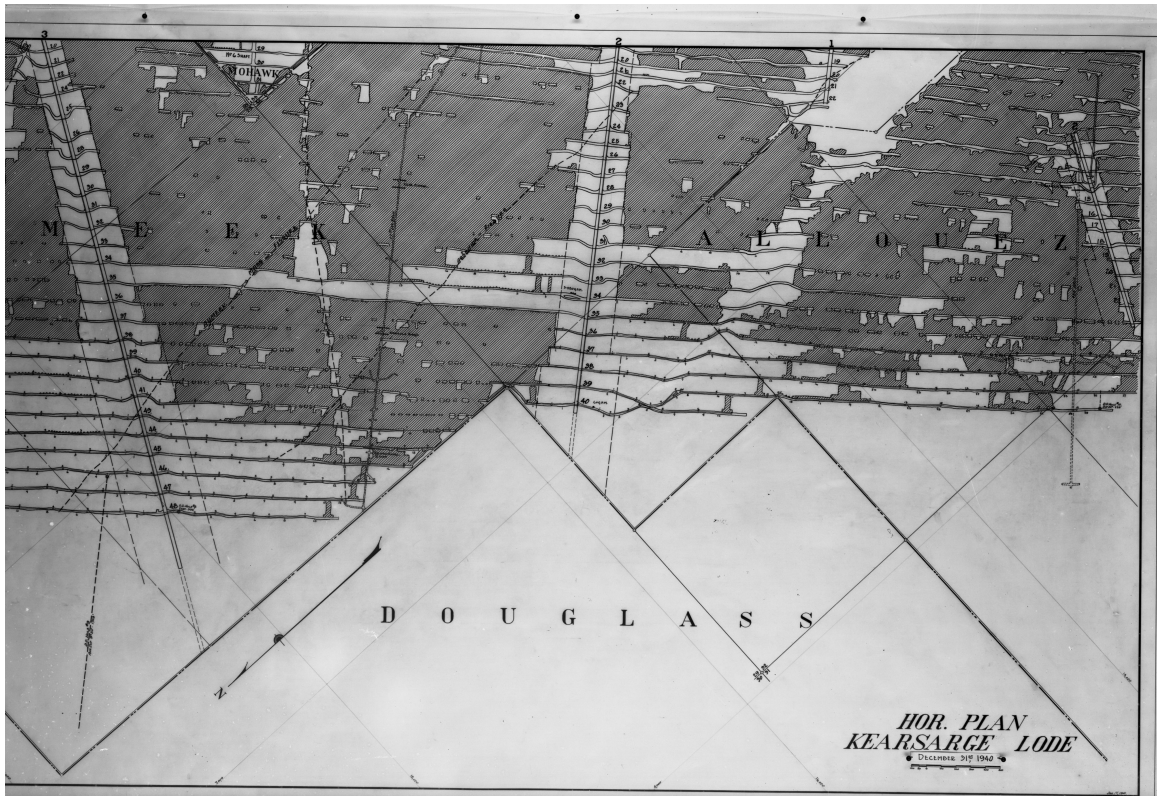


Figure 5.3: Photograph of mine map “Hor[izontal] Plan, Kearsarge Lode, December 31st, 1940.” Note row of pins along top border and pinned date in title block. Image scanned from negative by Michigan Technological University Archives.

to be usable for measurements, the large photographs would have further reduced the size of the image. Such photographs would not have been precise enough to guide on-the-spot work, but they would have provided a general sense of progress. In a fashion similar to Quincy's nearly two-decade run of monthly update blueprint folios, discussed in a previous chapter, the C&H took pictures at regular intervals as the map was updated. The map was tacked on a wall or similar surface, then a slip of paper with the current date was added, also with pins, in the area of the title block before the photograph was exposed.<sup>17</sup> The relative ease of use and low cost of photographic technology permitted mine managers and engineers at the Calumet and Hecla to make frequent facsimiles of their main maps. The resulting photographs might have been slightly more expensive than blueprints, but their smaller size made them easier to send through the mail (to corporate officers or investors, perhaps). Photographs were also, by the twentieth century, relatively easy for a commercial printer to reproduce in printed material, such as annual reports. Though this same goal of reproducing a master map periodically to track progress could be achieved by using blueprints, as was the practice at the Quincy, in both cases visual tools helped the companies make reproductions frequently enough to add a temporal dimension to the spatial representation of the underground on the maps themselves.

After a picture was taken, the negative had to be developed, and a print made if desired. This required a darkroom, and both the Quincy Mine Office and the C&H

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<sup>17</sup>No prints of these photographs are known to exist, but some have been scanned by the Michigan Tech archives. See Calumet and Hecla Large Format Glass Plate Negatives, Michigan Technological University Archives.



Figure 5.4: The Quincy Mining Company constructed a darkroom by walling off a portion of their office building's attic. In situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006.



Figure 5.5: Window with red glass filter, and shelf stain, inside the Quincy darkroom. In situ in the Quincy Mining Company office building, Keweenaw National Historical Park, Hancock, MI. Photo by Eric Nystrom, 2006.

office building had built-in darkrooms. The Quincy darkroom was located in the attic, near the blueprint production apparatus. The company used rough boards to wall off a corner of the attic. (See figure 5.4 on page 236.) The little room was fitted with a door and a window that faced the rest of the attic. This window was intended to permit light to enter the darkroom, and it was fitted with two panes of glass, in separate movable frames, which could (from inside the darkroom) be slid to cover the opening. One pane was a yellow color, to be used when natural light from the outside window was the source of illumination, and the other was the darkroom-standard heavy red, used when the attic was lit with artificial light. This window, shown in figure 5.5 on page 237, was located along the longest wall of the little room, facing one of the two attic windows. A shelf, serving as the work bench, was located along the wall immediately below it. Though the shelf itself is now gone, the horizontal line of stains from photographic chemicals immediately below the window testifies to its former presence. The room also contained, within easy reach of a worker standing at the main bench, a sturdy wall-mounted box consisting of tall, narrow pigeonholes which could have been used to store developed glass plate negatives or perhaps finished prints. The darkroom would have also been useful to store sensitized paper for blueprints, which needed to be kept in a dark or at least semi-dark place.

The extant darkroom in the Calumet and Hecla office building seems to have been updated more recently than the one in the Quincy attic, so it is not possible to deduce as much about the work flow of visual information around the turn of the century

from its layout and design. Notable, however, was the fact that the darkroom in the C&H office building was also located in the attic, which was accessible from a staircase that led directly to the large drafting room. This again reinforces the importance of specialized spaces of production of visual representations, and the need felt by turn of the century mine managers and engineers to have the infrastructure for creating and using visual representations, including photographs, close at hand.

By the turn of the century the utility of photographs for mining operations had also become a topic of discussion in the mining press. An editorial in the February 1902 issue of *Mines and Minerals* began with a recapitulation of a story in the *Daily Mining Gazette* of Michigan's Keweenaw Copper Country. “[S]ome time ago,” the Tamarack Mining Company created a full “gallery” in its mine office to facilitate the photography of its mining maps. On a monthly basis, the company updated its mine maps and took photographs of them, 20 inches by 24 inches in size. These photomaps were especially useful because of their small size, which facilitated mailing them to owners and potential investors as well as including them in reports intended for non-engineers. *Mines and Minerals* emphasized the utility of these photographs:

The great advantage of this method will be apparent at once to every engineer, as it gives maps of a size that may be easily handled or sent through the mails and which are also much more easily studied than are the large and cumbrous mine maps. A full set of such photographs also furnishes a valuable record of the exact condition of the mine at every period of its life. This is but one of the many new uses to which the camera is constantly being put about the mines and in connection with all forms of engineering work.

The editorial suggested that the Tamarack Mining Company's photographic practices proved that the company was a well-run mining enterprise. "It is common practice nowadays to keep a detailed photographic record of all construction work, and some of the more progressive mines keep a record of progress within the mines in the same way."<sup>18</sup>

Once underground photography became more reliable, photographs could be used for legal purposes, such as evidence in lawsuits. For example, in 1908, mining engineers Sewell Thomas and Jock Finney used flash photography to document the damage that leasers had done to the Mohawk Mine in Goldfield, Nevada. Thomas and Finney worked for the Goldfield Consolidated Mining Company, which had brought together many smaller mines and proposed to work them efficiently. Before their acquisition by the Goldfield Consolidated, the smaller mines had been worked by a system of leasing. Independent miners would contract with the owner of a claim to work a portion of it, in return for a cut of the proceeds. Such a system worked well where capital for initial development was scarce, but since the leasers only got paid for ore extracted, they tended to concentrate too heavily on mining ore and neglected work to stabilize and reinforce the mine. The requirement to perform this sort of work was usually spelled out in the leasing contracts, but leasers did as little of it as possible. Several leases, including the Frances-Mohawk, had been left in particularly dangerous shape. Finney and Thomas took underground photographs to

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<sup>18</sup>"The Camera in Mining," *Mines and Minerals* 22 (February 1902): 307-308.

document the dangerous conditions that the leasers left behind. One surviving photograph shows a large jumble of rocks, which had presumably fallen from the top of the excavated stope in the mine. Finney and Thomas left a miner's candlestick in the corner for scale, and centered the photograph on a mine surveyor's heavy plumb bob suspended from above, to provide a way to orient the photograph with respect to the horizontal. These photos were used by their employer, the Goldfield Consolidated, in a lawsuit against the leasers. The boom was over by the time the trial took place in 1909, but the company was awarded significant damages in part due to the testimony provided by the engineers and reinforced by their underground photographs.<sup>19</sup>

The power of photography was not always exclusively reserved for corporate use. Social reformers around the turn of the century used photography to capture scenes of exploitation, which they publicized in hopes of spurring governmental reform. Mining was one target of reformers' efforts, but underground photos made up a relatively limited number of pictures taken by the reformers, probably because of the challenges of underground photography combined with the difficulty of getting underground. (Such reformers were not customarily welcomed by industrialists.) Lewis Hine, who later in life would be recognized as one of America's greatest documentary photographers, worked for the National Child Labor Committee (NCLC) from 1908 to 1924 documenting child labor in American industries. Particularly in the period between 1908 and 1911, Hine overcame the access obstacles and took pictures of children who

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<sup>19</sup> Thomas, *Silhouettes of Charles S. Thomas*, 169-170, 171-172. The photograph I described is Plate 15.



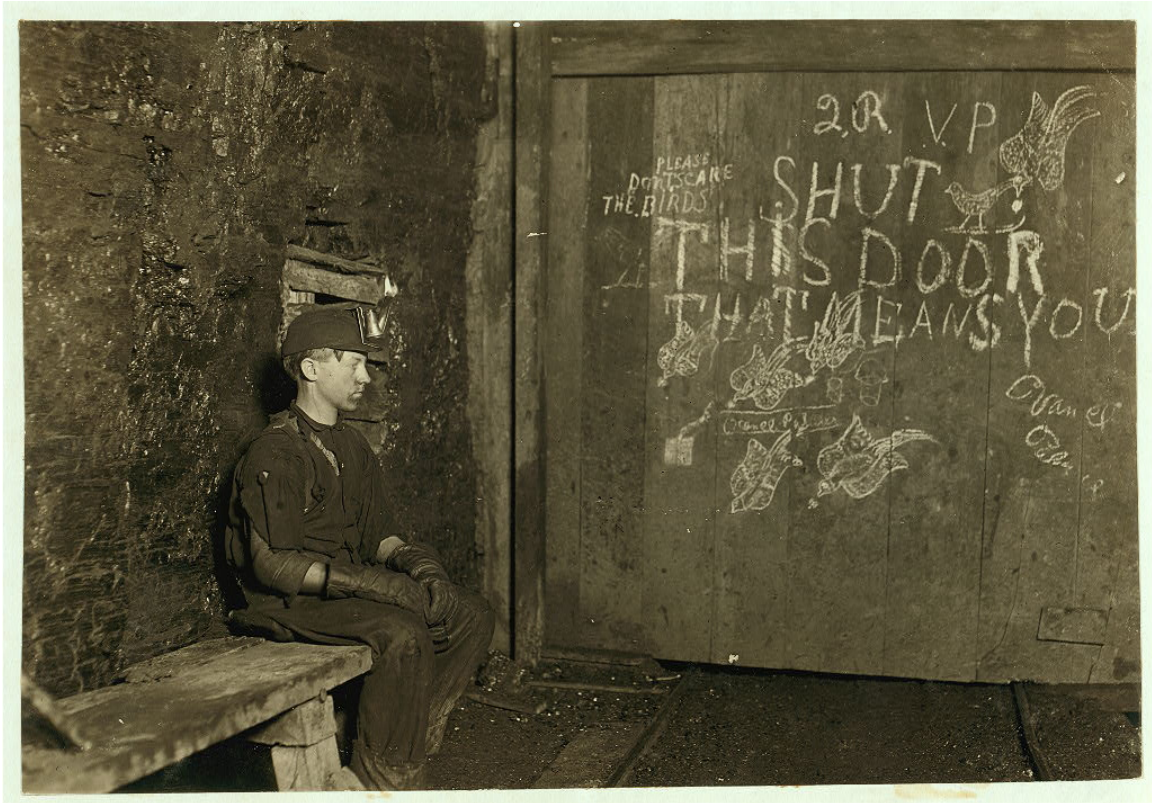


Figure 5.6: “Vance, a Trapper Boy, 15 years old. Has trapped for several years in a West Va. Coal mine. \$.75 a day for 10 hours work. All he does is to open and shut this door: most of the time he sits here idle, waiting for the cars to come. On account of the intense darkness in the mine, the hieroglyphics on the door were not visible until plate was developed.” (1908) Hine No. 0163, Library of Congress, Prints & Photographs Division, National Child Labor Committee Collection, LC-DIG-nclc-01076.

worked in the mines. Though most of his images of children in the mining industry were taken on the surface, Hine managed to take some underground as well. One of Hine's photos, shown in figure 5.6 on page 242, was taken in 1908 in a West Virginia bituminous coal mine. The photo carries Hine's typically lengthy caption describing the circumstances of his encounter with the child. Hine's photographs were used by the NCLC for exhibits, lantern slide shows, circulars, and other publicity materials aimed toward eliminating child labor.<sup>20</sup> Hine's photos were an important, albeit rare example of the power of the photographic image turned on the mining industry without the consent of those who ordinarily controlled the mines.

## Mine Safety Photographs and Americanization

Photography was used extensively in safety education for miners. Faced with the seemingly intractable issue of preventing mine accidents without invoking additional governmental regulation or incurring undue expense, anthracite mine owners of the early 1910s responded with a wide variety of education initiatives to increase safety in their mines. One of these programs produced a seventy-page book titled *Mine Accidents and Their Prevention*, published by the Delaware, Lackawanna, and Western Railroad in 1912.<sup>21</sup> This rich source allows me to examine the nature of work in the anthracite industry at a time of technological change, the close links made by mine

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<sup>20</sup>Trachtenberg, *Reading American Photographs*, 164-172, 190-209.

<sup>21</sup> *Mine Accidents*. The copy I examined is located in the coal mining collection, room 5028, National Museum of American History, Smithsonian Institution, Washington DC.

owners between safety and “Americanness” in an effort to extend their managerial reach into the mine, and how photographs were used by managers to try to achieve greater underground control. *Mine Accidents* made sense in the peculiar work culture of the Pennsylvania anthracite fields. In order to understand the context in which the book was produced and was intended to be read, it is necessary to have an understanding of the history of anthracite production, the ways in which geology, the law, and economics shaped the labor force and work traditions in the coal fields.

Anthracite’s physical properties distinguished it, and the history of its development in the United States, from other sources of coal. Anthracite is a hard coal with an extremely high carbon content, much more so than bituminous or “soft” coal. Anthracite is also much less common than soft coal. In the United States, anthracite has come almost exclusively from three coal fields in eastern Pennsylvania.<sup>22</sup> The coal was discovered in the late 1700s, but was not systematically exploited on a commercial scale until the 1830s, when problems of transportation were solved and markets had been created for the coal in nearby rural areas and major eastern cities such as Philadelphia, New York, and Baltimore. One of the first major uses of anthracite was in iron production, because iron could be smelted directly with the hot-burning fuel.<sup>23</sup>

Demonstrations of how to burn the fuel in homes succeeded in creating a market for

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<sup>22</sup>These fields are the Wyoming field, the Lehigh field, and the Schuylkill field, in order from north to south. There are some differences in patterns of ownership, markets, and geology among the three fields, but it is safe to generalize that the three eastern Pennsylvania fields have much more in common with each other than they do with other coal-producing regions.

<sup>23</sup>Robert B. Gordon, *American Iron, 1607-1900* (Baltimore: Johns Hopkins University Press, 1996), 155-170.

the coal's domestic use as well, where it was favored for its high heat output and clean flame. As the 19th century wore on, the domestic use of anthracite became increasingly important, as industrial customers began to choose cheaper fuels. Networks of canals and railroads (many of the earliest in the U.S.) were constructed to bring the coal from the mines to its markets, and over time the transportation companies, in order to ensure a steady supply of freight, extended their control over the mines themselves.<sup>24</sup>

By the first decade of the twentieth century, anthracite had been mined in Pennsylvania on a large scale for nearly one hundred years. The work performed by miners was a complex mix of traditional practices, new techniques facilitated by new technology, and the skills needed to extract coal out of specific geological spaces that varied in their characteristics.

The geology of anthracite coal helped permit the development of a spirit of independence among anthracite miners. Unlike most bituminous mines, where the coal existed as an essentially flat layer of strata that permitted the development of mining

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<sup>24</sup> *Story of Anthracite*, 1-110. This source is a company-produced history of the anthracite trade that is ultimately designed to persuade the reader of the need for labor reform in the 1930s, but the early history of the industry's development is solid and agrees with other accounts. For domestic use, see above; also see literature intended to persuade homeowners to adopt anthracite, such as George Derby, *An Inquiry Into the Influence of Anthracite Fires Upon Health; With Remarks Upon Artificial Moisture, and the Best Modes of Warming Houses* (Boston: A. Williams & Co., 1868). For anthracite's importance in the early U.S. Industrial Revolution, see Alfred D. Chandler Jr., "Anthracite Coal and the Beginnings of the Industrial Revolution," *The Business History Review* 46 (1972): 141-181; Craig Bartholomew, *The Anthracite Iron Industry of the Lehigh Valley* (Easton, PA: Center for Canal History and Technology, 1988). For transportation networks, see Jules I. Bogen, *The Anthracite Railroads: A Study in American Railroad Enterprise* (New York: The Ronald Press Company, 1927); John N. Hoffman, *Anthracite in the Lehigh Region of Pennsylvania, 1820-45*, Contributions from the Museum of History and Technology 72 (Washington, DC: Smithsonian Institution Press, 1968); F. Charles Petrillo, *Anthracite and Slackwater: The North Branch Canal, 1828-1901* (Easton, PA: Center for Canal History and Technology, 1986).

in large rooms, the anthracite strata had been folded and broken geologically, and much of it occurred in steeply pitching veins. The consequence was that most anthracite coal could not be worked in large level sections. Instead, coal was extracted from small rooms, called breasts, which were divided from one another by large pillars of coal. Each breast was only big enough to be worked by a two-person team, a miner and his laborer. The geological complexity of the anthracite fields demanded a miner who could make independent decisions about how to best extract the coal from his working space with a minimum of waste. The miner drilled holes, created and detonated explosive charges, dug out the coal by pick if necessary, and decided on the installation of roof supports. Laborers assisted miners with moving supplies, especially timbers, cleaned the coal of rock and impurities after it had been blasted down by the miner, and loaded it into cars for transport to the surface. These men worked largely free of supervision and cherished their independence. It was a tradition in the mines (reportedly from English antecedents) to stop working whenever the boss was around.<sup>25</sup>

Most anthracite miners worked in a system that rewarded them only for productivity. This tradition may have started in the early years of mining when capital was scarce, but miners usually liked it because it gave them an incentive to work longer

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<sup>25</sup> Carter L. Goodrich, *The Miner's Freedom: A Study of the Working Life in a Changing Industry* (Boston: M. Jones, 1925; reprint, New York: Arno Press, 1977), 56, quoted in Harold W. Aurand, "Mine Safety and Social Control in the Anthracite Industry," *Pennsylvania History* 52, no. 4 (1985): 234. Several of the books from early modern England available in the Early English Books Online database that deal with mining are explanations of the unique rights and customs of British miners.

(for more pay) or work less (for the same pay) if they chose, and gave them a feeling of independence. The anthracite companies liked it because the miners would not be paid unless they were producing salable coal. Miners were typically paid for every car of clean (i.e., free of rock) coal that was hoisted to the surface. The laborer was paid by the miner, not by the company. The miner had to provide his own tools. Supplies such as blasting powder and fuses were provided by the company, but the cost was deducted from the miner's pay.<sup>26</sup> The company provided the infrastructure of tunnels, transportation systems, timbers, and ventilation to make the miner's underground contract work possible. One implication of this system of production was that anything that took extra time or supplies had a direct impact on the miner's pay.

Miners also had certain job protections. While miners could be hired and fired at will by the companies, the threat of labor activism and strikes was an effective countermeasure. From the Workingmen's Benevolent Association and the Molly Maguires of the 1860s and 1870s to the United Mine Workers of America and the major strikes of 1902, 1906, 1912, 1922, 1923, and 1925-26, it was clear that the miners and their representatives were unafraid to stand up to the corporations. The anthracite operators were denied one particularly effective strikebreaking tool available to capitalists in other industries. According to Pennsylvania laws passed in 1889 that were intended

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<sup>26</sup>Not all miners were paid on the basis of production. Some miners would be contracted by the mine company to perform other kinds of work (driving gangway tunnels, for example) at a certain amount of money per foot or per yard of progress. However, miners usually made more money per hour of work if they were working on a production basis. See Aurand, *Coalcracker Culture*, 82-94.

to ensure competent miners, no person could work as a miner in an anthracite mine unless they had served as a laborer for a minimum of two years, and miners had to be certified by the state. The laws were originally intended to also serve as a means of excluding the increasing number of Slavs and Italians immigrants who came to work in the mines. Even though immigrants from eastern Europe had made significant inroads into the anthracite workforce by the start of the 20th century, the laws still served to substantially limit the number of potential replacement workers available to mine owners in case of a strike.<sup>27</sup> As a consequence, mine owners had an incentive to try to change the habits of existing employees as opposed to firing them and hiring more pliant workers.

Miners were only one category of workers in anthracite mines. Several types of employees were associated with the transportation infrastructure of the mine. When mules were used, mule drivers, farriers, and stable hands all worked underground, and with the advent of electric locomotives, motormen, brakemen, and maintenance people took their place. “Runners” helped move coal cars inside the mine, and hoisting engineers moved men and materials between the underground and the surface. A crew of people worked to extend and maintain the mine’s ventilation system, and young “doorboys” monitored huge timber doors, key parts of the air circulation system, that had to be opened to allow traffic to pass. The “fireboss” was an independent, assistant foreman-level position charged with monitoring the levels of explosive methane gas

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<sup>27</sup>Aurand, *Coalcracker Culture*, 72-73.

in the mine. As safety in the mine became more complex, the fireboss was generally responsible for ensuring the enforcement of safety rules.

Anthracite coal mining was a hazardous job.<sup>28</sup> The average fatality rate was over 3.5 per 1,000 workers per year between 1907 and 1912<sup>29</sup>; put another way, anthracite mining saw more than 400 workers per year lose their lives in the last decades of the 19th century and first decades of the 20th. Aldrich points out that “in 1916, the hard coal miners experienced a fatality rate that was 4.75 times greater than that in manufacturing. Among major occupational groups for which data are available, only railroad trainmen typically ran greater risks.”<sup>30</sup>

Anthony F.C. Wallace argues that this awful safety record was because anthracite mining was a “disaster-prone industry” where mine operators guilty of “optimum scenario thinking” blamed disasters and accidents on “careless” miners. A lack of working capital, low profit margins, high costs, and the economic structure of the industry tended to make any shutdown of the operation a costly one. As a result, operators and miners alike often chose more risky behavior in order to avoid immediate hardship rather than endure short-term economic pain to reduce risk. English Common Law precedent held that employers were not liable for damage by employees if the damage in question was caused by the carelessness or negligence of the employee. This precedent, combined with the legal notion that every employee was an independent

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<sup>28</sup>For an excellent analysis of mine safety in the context of industrial safety generally, see Aldrich, *Safety First*.

<sup>29</sup>Aurand, “Mine Safety and Social Control,” 227-228.

<sup>30</sup>Mark Aldrich, “The Perils of Mining Anthracite: Regulation, Technology and Safety, 1870-1945,” *Pennsylvania History* 64 (1997): 361.



agent, free to walk away from the job if he deemed it (or the behavior of his fellow workmen) unsafe, meant that the causes of accidents were almost always attributed to negligent employees. If conditions were truly unsafe, so the argument ran, the miner would have quit before he was injured. Instead, accidents must have been the fault of a miner who was not being careful enough. This trope of the “careless miner” is frequently invoked to explain the source of safety problems in *Mine Accidents*.<sup>31</sup>

Throughout much of the 19th century, most mine owners responded unenthusiastically to fixing safety problems. As a result, the rates of injuries and fatalities in the anthracite industry remained high. The State of Pennsylvania, spurred by the miners, passed pioneering regulations to solve some of the worst problems, but mine owners typically avoided expending any more effort than the letter of the law required.<sup>32</sup>

Near the beginning of the 20th century, mine owners began to take more proactive steps to increase safety beyond the letter of the law. The roots of this change in attitude are difficult to discern, but it is likely that fear of increasing state regulation played a role, as well as a desire to defuse rising union sentiment among the miners. Major strikes crippled the industry in 1902 and frequently afterward; paternalistic care of workers was not infrequently seen as a way to defuse labor tensions. It is also possible that mine owners were captivated by a renewed sense of social concern typically associated with the Progressive movement, were motivated by the newly-established U.S. Bureau of Mines’ work on first aid and safety, or were perhaps inspired

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<sup>31</sup> Wallace, *St. Clair*, 265-275, 446-456.

<sup>32</sup> Aurand, “Mine Safety and Social Control,” 229-230, calls the pre-20th century anthracite industry’s response “passive.” On the passage of mine safety legislation, see Wallace, *St. Clair*, 293-314.

by the social concern shown earlier by a handful of anthracite operators, such as Eckley B. Coxe.<sup>33</sup>

One popular topic among mine owners for increasing workplace safety was the education of miners. The Coal Mining Department of the Delaware, Lackawanna, and Western Railroad (DLWRR) began in 1910 a project to take some 200 staged photographs of good and bad practices underground, which were then delivered as a lantern-slide lecture to large audiences of miners, “with telling effect.”<sup>34</sup> Later, many of these photographs, some 140 in all, were combined with text into a thin, black cloth-bound book titled *Mine Accidents and Their Prevention*, which was published in 1912 by the DLWRR. This book was intended to graphically illustrate principles of safety in anthracite mines, and also to teach English to immigrant miners. (Figure 5.7, on page 253, shows a full page from the book.) The authors envisioned the book being used in a tutorial setting, with the tutor asking simple questions about the actions shown by the pictures, then using the accompanying text to deliver a more specific lesson. Each page consisted of several pictures, which themselves were intended to visually narrate a sequence of events. The events were also recounted

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<sup>33</sup>On the Bureau of Mines, see Mark Aldrich, “Preventing ‘the Needless Peril of the Coal Mine’: The Bureau of Mines and the Campaign Against Coal Mine Explosions,” *Technology and Culture* 36 (1995): 483–518; William S. Kirk, *The History of the Bureau of Mines* (Washington, DC: U.S. Department of the Interior, U.S. Bureau of Mines, 1996); and Fred Wilbur Powell, *The Bureau of Mines: Its History, Activities, and Organization* (New York: D. Appleton and Company, 1922). On Coxe’s efforts, see Bohning, “Angel of the Anthracite: The Philanthropic Legacy of Sophia Georgina Coxe.”

<sup>34</sup>Aurand, *Coalcracker Culture*, 79-80; *Mine Accidents*, 4. It is interesting that these lectures were originally a performance, in front of a large audience. What would that audience have said? What would they have understood? How were the photos presented? How did the collective discourse contribute to a learning environment? How could the presenter understand its “telling effect”?

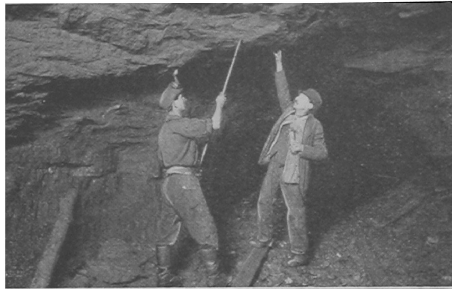
by simple sentences lower on the page, with key words in the margin for each. At the bottom of the page, the overall message of the narrative was delivered in capital letters. Each event was recounted twice, on facing pages. On the left side, incorrect procedures were followed, mistakes recounted in red text, and workers always injured or killed. On the right page, the correct way of handling the situation was explained and diagrammed. The preface states that “[e]ach series shows an accident. The first part of the series *shows how the accident happens* and the last part shows how the accident might be avoided.”<sup>35</sup> [italics mine] These were idealized, archetypal accidents, removed from association with past events. These accidents would happen again, and it was up to an educated, safe miner to avoid them.

While the attention of the U.S. Bureau of Mines and state regulatory agencies was primarily upon preventing catastrophic but relatively rare accidents such as gas and coal dust explosions, *Mine Accidents* paid closer attention to more common hazards.<sup>36</sup> Of the thirty good/bad mining scenarios contained in the book, nine were dedicated to roof and rock falls, and another nine recounted accidents with explosives. Transportation accidents accounted for eight scenarios. Two scenarios featured the hazards of electricity, and one scenario described hoisting. Only one narrative (though a three-page example, longer than the others) focused on the risks of methane gas explosion. The authors reported in the Preface that the accidents

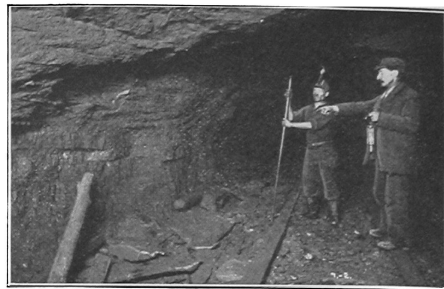
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<sup>35</sup> *Mine Accidents*, 4.

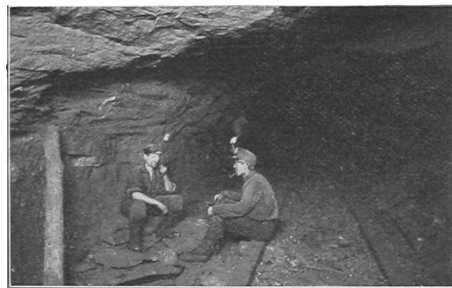
<sup>36</sup>For Bureau of Mines efforts against explosions, see Aldrich, “Preventing ‘the Needless Peril of the Coal Mine’.” In his 1997 article, Aldrich contended that “None of the [company safety] programs systematically addressed the major causes of haulage accidents, roof falls, or gas explosions.” Aldrich, “Perils of Mining Anthracite,” 376.



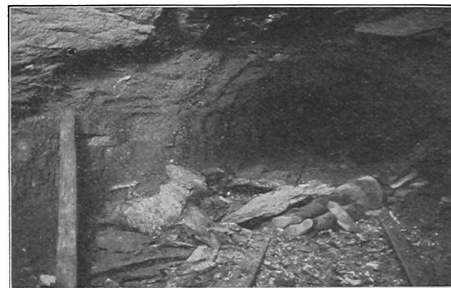
Fire-boss and Miner Testing Roof



Fire-boss Tells Miner to Stand Prop Under Roof



Miner and Laborer Smoke Before Obeying Order



Miner and Laborer Under Fall of Roof

#### MINER NEGLECTING ORDERS

- are : Here are the fire-boss and the miner.  
 hangs over: This rock hangs over the road.  
 are testing : The miner and the fire-boss are testing it.  
 is safe : The rock is not safe.  
 orders : The fire-boss orders the miner to put that prop under the rock.  
 goes away : The fire-boss goes away.  
 sit down : The miner and the laborer sit down to smoke before they stand the prop.  
 falls : The loose rock falls on them.

What does the fire-boss tell the miner to do? Does the miner obey the fire-boss at once? What are the miner and laborer doing? What happened to them while they smoked? Should the fire-boss wait till the prop is placed?

MINER, DON'T DELAY MAKING YOUR PLACE SAFE.

*Sixteen*  
16

Figure 5.7: "Miner Neglecting Orders," *Mine Accidents*, 16.

chosen for representation were “only those accidents which have been of most frequent occurrence and the most fruitful in loss of life or limb.”<sup>37</sup>

If these were ideal types of the most common anthracite accidents, it is fitting that many of them show clear evidence of the rapid pace of technological change taking place in the anthracite industry at the time. Aldrich argues that evolving technology added an additional complexity to the problem of reducing the number of accidents.<sup>38</sup> This is an easy point to understand from the view of the mine worker, who would have to unlearn old techniques or habits that were unsafe in the context of new technology, or would have to learn new skills for handling newly-developed tools.

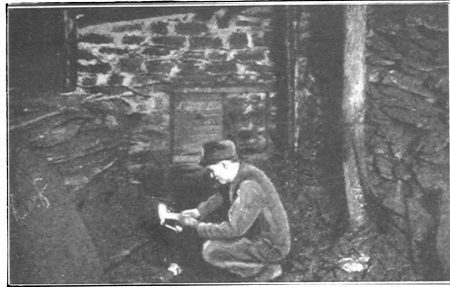
*Mine Accidents* provides vivid examples where old habits may lead to disaster in a new technological context. In both of the scenarios that discuss the hazards of electricity, for example, the miner carries something on his shoulder (a drill in one example, a metal powder can in the other) that makes contact with the bare electric wires overhead that power the mine locomotives.<sup>39</sup> Before the advent of low-hanging, exposed electric wires in mines, a miner had little to fear from carrying heavy equipment over his shoulder. With the advent of electric locomotives, however, the miner needed to adjust his habits in order to avoid becoming “careless” and the victim of an accident. Here, as elsewhere in the book, the impetus of change is thrust upon the miner – it was not the duty of the mine owners to shield the wires, but rather the miner’s responsibility to evade them.

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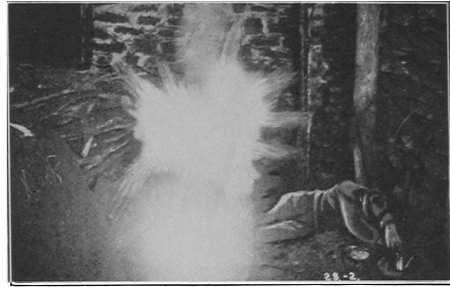
<sup>37</sup> *Mine Accidents*, 5.

<sup>38</sup> Aldrich, “Perils of Mining Anthracite,” 361-362.

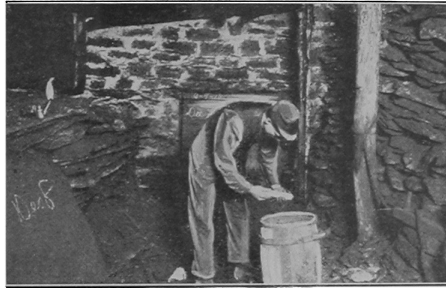
<sup>39</sup> *Mine Accidents*, 54, 55.



Thawing Dynamite with Lamp



Dynamite Exploded



Thawing Dynamite with Manure

**THAWING FROZEN DYNAMITE**  
(Wrong Way and Right Way)

- |              |   |   |
|--------------|---|---|
| is ready     | : | The miner is ready to blast some rock.                    |
| has gone     | : | He has gone for his dynamite.                             |
| is frozen    | : | The dynamite is frozen.                                   |
| cannot use   | : | The miner cannot use frozen dynamite.                     |
| must thaw    | : | He must thaw the dynamite first.                          |
| holds        | : | He holds his lamp under the stick of dynamite to thaw it. |
| makes        | : | The light makes the dynamite too hot.                     |
| explodes     | : | The dynamite explodes and kills the miner.                |
|              |   |   |
| shows        | : | The third picture shows a careful miner.                  |
| brought      | : | He brought a keg of manure from the barn.                 |
| puts         | : | He puts his dynamite in the manure.                       |
| thaws        | : | The heat from the manure thaws the dynamite.              |
| does become  | : | The dynamite does not become too hot.                     |
| is safe      | : | The miner is safe now.                                    |
| does explode | : | The dynamite does not explode.                            |

Is it right to thaw dynamite with a lamp? What happens when he thaws the dynamite with a lamp? How does the last miner thaw dynamite? Is there heat in the manure? Can the dynamite explode in the manure?

**DON'T THAW DYNAMITE WITH A LAMP.**

Figure 5.8: "Thawing Frozen Dynamite (Right Way and Wrong Way)," *Mine Accidents*, 52.

Other examples show the ongoing transition between technologies in the mine. In the realm of transportation, the first examples show mules pulling the mine cars, but the pictures themselves suggest a different reality – overhead wires, for powering electric locomotives, are visible as well.<sup>40</sup> Several later scenarios show the electric locomotives (“motors”) at work. These machines required new skills and procedures to avoid accidents, such as checking the brakes and level of sand (used for traction) at the tops of steep grades.<sup>41</sup> New trends in explosives technology are also apparent in *Mine Accidents*. Since 1858, blasting powder, a close cousin of ordinary gunpowder, had been used in mines to move rock. Alfred Nobel invented dynamite in 1868 and it first entered use in western mines in the 1870s, but its high cost tended to prevent its use by contract coal miners. After the formation of the Bureau of Mines, the agency investigated the role of explosives in the ignition of mine explosions of coal dust or methane gas, and recommended the use of substitutes for blasting powder.<sup>42</sup> *Mine Accidents* portrays a mixed use of both dynamite and blasting powder. Dynamite was certainly less familiar to the miners than traditional blasting powder, and had to be handled in different ways. One hazard of dynamite was its tendency to freeze. Thawing dynamite over an open flame or on a hot stove was considered unsafe. Although manufactured dynamite warmers existed on the market, the “careful miner” portrayed in *Mine Accidents* (shown in figure 5.8 on page 255) buried his frozen dynamite in a

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<sup>40</sup> *Mine Accidents*, 22-23, 26-27.

<sup>41</sup> *Mine Accidents*, 28-29; also see 34-35 and 36-37.

<sup>42</sup> See Eric Twitty, *Blown to Bits in the Mine: A History of Mining and Explosives in the United States* (Ouray, CO: Western Reflections Publishing Company, 2001).

keg of warm mule manure.<sup>43</sup> What if all of the mules have been replaced by electric locomotives? The book offered no suggestions. In an effort to educate mine workers about safe practices, *Mine Accidents* inadvertently threw the challenges posed by technological change into sharp relief.

*Mine Accidents and Their Prevention* was about more than mine safety. An introductory preface, printed in English, Polish, Lithuanian, Italian, and Russian, explicitly declared, “[t]he purpose of this book is to teach mine workers how to prevent accidents and at the same time to teach the English language to those who cannot speak English.”<sup>44</sup>

The book’s primary vehicle for English instruction was its textual format, known as the Roberts System. This writing system had been developed by Dr. Peter Roberts to teach English to immigrants. Roberts lived in the eastern Pennsylvania anthracite country, and studied the communities affected by the labor unrest of the 1902 strike. Interestingly, Roberts himself was quite sympathetic toward Slavic immigrants. Shriill warnings of “race suicide” and other anti-Slav rhetoric, so common among Progressive-era white elites, were absent from Roberts’ writings.<sup>45</sup> From 1907 onward, Roberts worked for the Young Men’s Christian Association’s program for the Americanization

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<sup>43</sup> *Mine Accidents*, 52.

<sup>44</sup> *Mine Accidents*, [iii]. I would like to thank Massimo Petrozzi for examining the Italian text; he agreed that it said exactly the same thing as the English translation.

<sup>45</sup> See Peter Roberts, *The Anthracite Coal Industry: a Study of the Economic Conditions and Relations of the Co-Operative Forces in the Development of the Anthracite Coal Industry of Pennsylvania* (New York: The Macmillan Company, 1901); Peter Roberts, *Anthracite Coal Communities: a Study of the Demography, the Social, Educational and Moral Life of the Anthracite Regions* (New York: The Macmillan Company, 1904). On “race suicide,” see Gail Bederman, *Manliness and Civilization: A Cultural History of Gender and Race in the United States, 1880-1917* (Chicago: University of Chicago Press, 1995), 199-206.



of recent immigrants. Roberts also sold his system to schools and set up schools of his own, enrolling a total of over 13,000 immigrants by June 1911.<sup>46</sup> Roberts' program was especially suitable for industry. Companies paid the YMCA for customized English instruction programs to educate their workers; the lessons spoke of industry-specific hazards, as well as of the need to follow orders from superiors.<sup>47</sup> A Roberts's System text had a distinct format, with the verb of the sentence isolated first for extra attention:

is walking:                      In picture three the miner is walking under the trolley wire.

is carrying:    He is carrying his drill in his hand by his side.

can touch:    The drill cannot touch the wire now.

passes under:    The miner passes under the wire safely.

does receive:    He does not receive a shock.<sup>48</sup>

As the above example shows, Roberts was evidently quite concerned with the grammatical correctness of his lessons. While technically it is true that “can touch” and “does receive” are the proper verb forms of the third sentence and last sentence, any worker who focused on the highlighted verbs to understand the intent of the lesson might be confused, at best. This suggests that the book's mission to teach

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<sup>46</sup>I rely here on an article by Paul McBride, “Peter Roberts and the YMCA Americanization Program, 1907-World War I,” *Pennsylvania History* 44 (1977): 145–162. McBride used primary sources from the YMCA archives.

<sup>47</sup> McBride, “Peter Roberts and the YMCA,” 148-152. In the Consolidation Coal Company Photograph Collection at the Smithsonian Institution, there is an image dated 25 January 1913 of miners enduring an English Language class. A poster of one of Roberts' lessons appears on the back wall. CCC negative number 732, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.

<sup>48</sup> *Mine Accidents*, 55.

safety and mining practices could have been undermined by its English lessons. So why include them at all?

When Slavic and Italian miners were first hired in large numbers by the anthracite companies in the 1870s and 1880s, the existing workforce of miners, who were predominantly from the British Isles, argued that the new immigrants would result in an unsafe workplace because of their inability to speak English. The companies hired the immigrants over the objections of the British miners, in the hope that the immigrant miners would be more dependent on the company and therefore more docile. After the strike of 1902, where the most radical miners were immigrants who were bound to each other by ethnic as well as labor solidarity, mine owners began to be more concerned about the lack of English skills among their employees.<sup>49</sup> Therefore, English instruction for immigrant mine workers should be understood as an expression of the desire of mine owners for a more stable, more controllable workforce. In fact, it seems clear that English skills were on the whole rather unnecessary for anthracite miners to do their jobs safely. One of the biggest reasons was that the underground work environment, which almost always involved just a miner and his helper, required a common language, but not necessarily English. In the aboveground works, the din of breaker machinery was so great that oral instructions could rarely be understood anyway.<sup>50</sup> Additionally, recall that *Mine Accidents* was derived from a lantern slide

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<sup>49</sup>The licensure law for miners was intended in part to exclude Eastern Europeans from the ranks of miners, but eventually had the opposite effect, discouraging experienced (non-anthracite) English and German miners from taking jobs in the anthracite country. Aurand, *Coalcracker Culture*, 75-77.

<sup>50</sup>Aurand, "Mine Safety and Social Control," 228.

presentation about safety. It was always difficult to know what even enthusiastic audiences are understanding, but it was clear that such a lecture was about mine safety and *not* about teaching English.

English language instruction was one significant component of an overall push by the YMCA and others for the Americanization of immigrants.<sup>51</sup> Ford Motor Company, for example, pushed English language instruction and Americanization efforts for immigrants in an effort to increase the stability and loyalty of its workforce.<sup>52</sup> *Mine Accidents* was developed by J.H. Dague and S.J. Phillips, Secretaries for the Education of Mine Workers of the Scranton, Pennsylvania YMCA, “under the direction” of the Superintendent and Assistant Superintendent of the Coal Mining Department of the DLWRR.<sup>53</sup> In addition to the mining content, the authors added “a number of lessons on American Citizenship especially prepared for this book by W.J. Torrey, Esq., who has been closely connected with the Young Men’s Christian Association work for Immigrants in Scranton, Pa.”<sup>54</sup> These lessons described the multiple-step process of getting first papers, getting second papers, then becoming naturalized. Two forms needed by the immigrant were included in the book. These lessons took a similar format to those on mining safety, and were illustrated with pictures such as the American flag (shown in figure 5.9 on page 261), the interior of the U.S. District

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<sup>51</sup> McBride, “Peter Roberts and the YMCA,” 154-159. These efforts did include education about mining as well; see Harold W. Aurand, “Education of the Anthracite Miner,” *Proceedings of the Canal History and Technology Symposium* 4 (1985): 93–106, who also mentions *Mine Accidents*.

<sup>52</sup> Thomas P. Hughes, *American Genesis: A History of the American Genius for Invention* (New York: Penguin Books, 1989), 218-219.

<sup>53</sup> *Mine Accidents*, [v] (title page).

<sup>54</sup> *Mine Accidents*, 5.



#### HOW TO BECOME AN AMERICAN CITIZEN

- want : Do you want to be a citizen of the United States?  
can do : There are some things which no one but a citizen can do.  
cannot vote : A man cannot vote unless he is a citizen.  
are passed : Many good laws are passed for citizens only.  
intend : Do you intend to live in this country always?  
be naturalized: If you do, you should be naturalized.  
will be : Your wife and young children will then be citizens also.  
it is : It is not hard to get citizenship papers.  
costs : It costs five dollars and you must be in the country five years.  
do not need : You do not need to have a lawyer.  
must go : You must go either to the Court House or to the United States  
District Court in the Post Office at Scranton, Pa.  
will find : There you will find a clerk to help you.

Can you vote if you are not a citizen? Do citizens have some privileges which others do not? Should you be naturalized if you remain in this country? Do you need to have a lawyer help you? Where must you go to get your citizenship papers?

Sixty-three  
63

Figure 5.9: "How To Become an American Citizen," *Mine Accidents*, 63.

Court at Scranton, and the U.S. District Court Judge.<sup>55</sup> The authors even retreated from absolute grammatical correctness by emphasizing a negative verb (“cannot”) in this section to drive home the point that non-citizens are not allowed to vote. The message was clear: being an American citizen was best.

want:	Do you want to be a citizen of the United States?
can do:	There are some things which no one but a citizen can do.
cannot vote:	A man cannot vote unless he is a citizen.
are passed:	Many good laws are passed for citizens only. <sup>56</sup>

It is likely that the DLWRR paid for the development of the book and cooperated by supplying pictures, while the YMCA personnel provided the authorial expertise. Both groups would benefit: the YMCA through financial support and further spread of its Americanizing, Evangelical Christian message, and the DLWRR through having a safer, more loyal, and more controllable workforce. It is also likely that the DLWRR managers believed that the company might be able to gain additional respect in the eyes of fellow mine operators. Company officials boasted of their safety programs in the industry journal *Coal Age*, and the copy of *Mine Accidents* that I examined had been received by another coal producing company, the Lehigh Coal & Navigation Company, from the National Safety Council, a cooperative non-profit group dedicated to increasing occupational safety.

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<sup>55</sup> *Mine Accidents*, 63-69.

<sup>56</sup> *Mine Accidents*, 63.

The DLWRR also sought to exercise a greater amount of managerial control over the notoriously independent anthracite miners by teaching them an approved “correct” way of doing their jobs in the interest of increased safety. As Aurand noted, “[a]gainst this backdrop of entrenched traditionalism, safety education provided the engineers with a platform for inculcating their notions of correct mining procedures.”<sup>57</sup> However, the engineers’ ideas of best practice frequently did not consider the economic cost to the miners. Aldrich put it a slightly different way, noting that new approaches to mining “proved a hard sell, in part – as the company soon discovered – because its approach was not always ‘the best.’ ... Convincing the men to follow company safety rules must have been difficult when it was clear that they sometimes knew more about mining efficiently than the company did.”<sup>58</sup> For example, *Mine Accidents* instructed that if a miss-fire occurred, the miner was to wait 15 minutes. If it had not yet detonated, the proper procedure was to report it, block off the entrance to the breast, and go home for the day (without wages).<sup>59</sup> In another expensive suggestion, management instructed immigrant miners to remove props with dynamite, a costly proposition for a contract miner.<sup>60</sup>

The choice of photography to assist this project of increasing managerial control over anthracite miners was undoubtedly deliberate. The reality of each scene portrayed in *Mine Accidents* lent veracity to the idea that the social relations depicted

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<sup>57</sup> Aurand, “Mine Safety and Social Control,” 234.

<sup>58</sup> Aldrich, “Perils of Mining Anthracite,” 372.

<sup>59</sup> *Mine Accidents*, 40-41.

<sup>60</sup> *Mine Accidents*, 11.

should be modeled by the immigrant miner audience. As historian Elspeth Brown argued,

Within industrialization and scientific management, in particular, the photograph's denotative meaning is often coded as scientific 'objectivity,' a mask that enables managers to cloak the photograph's contingent, connotative meanings. Managers promoted and profited from the slippage that occurred when culturally managed interpretations (connotative meanings) were misread as simple transcriptions, or analogies, of material reality (denotative meanings).<sup>61</sup>

Brown's notion of connotative and denotative meanings can help us interpret one example from *Mine Accidents* that stands out glaringly as an example of management using safety to exercise greater control over miners' work. Recall that it was traditional for miners to cease working when management was present. In a scenario titled "Miner Neglecting Orders," reproduced earlier in figure 5.7 on page 253, the fireboss and the miner test some rock that is hanging over the road.<sup>62</sup> They find that the rock is loose, and the fireboss orders its removal. The miner and laborer sit and smoke before doing so, presumably waiting for the boss to go away. While they are smoking, the rock falls and crushes them. The lesson at the bottom of the page carefully shifted the issue from disobedience to safety: "Miner, Don't Delay Making Your Place Safe." The facing page, titled "Fire-Boss Sees That Orders Are Obeyed," (shown in figure 5.10 on page 266) moved the rhetoric of instruction to the fire-boss. This linguistic shift masked both the fact that the miner was the intended audience,

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<sup>61</sup>Brown, *Corporate Eye*, 15.

<sup>62</sup>Note that the rock is in what could be considered to be "common space," not in the breast where only the miner and his helper work. This scenario is found in *Mine Accidents*, 16-17.

and that one of the miner's cherished traditions, that of not working in the presence of a boss, was under attack:

tests:	The miner tests the rock and finds it is not safe.
tells:	The fire-boss tells the miner to stand a prop under the bad rock.
does:	The fire-boss does not go away.
waits:	He waits until the prop is stood.
knows:	Now the fire-boss knows the men are not in danger.
must be:	The fire-boss must be sure every place is safe.
helps:	Every careful miner and laborer helps to prevent accidents.

Fire-Boss, See That Your Orders Are Obeyed Promptly.<sup>63</sup>

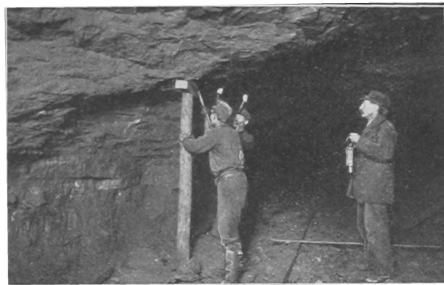
The photograph shows the fireboss standing and watching as the miner performs the work. The authors of *Mine Accidents* wanted their immigrant readers to miss (or ignore) the connotative meaning of the photograph – that they were being told to change their work habits and give up a cherished cornerstone of their traditional independence. Instead, they wanted the photograph understood for its denotative meaning alone - that (of course) it is ordinary and natural for a fireboss to directly supervise a miner, as is shown in the photograph.

In the book *Mine Accidents and Their Prevention*, the combination of safety, English instruction, and Americanization was a subtle and deliberate attempt to create a more obedient and controllable workforce in the anthracite mines and to increase

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<sup>63</sup> *Mine Accidents*, 17.





Fire-boss Waits to See Orders Carried Out

#### FIRE-BOSS SEES THAT ORDERS ARE OBEYED

- tests : The miner tests the rock and finds it is not safe.
- tells : The fire-boss tells the miner to stand a prop under the bad rock.
- does : The fire-boss does not go away.
- waits : He waits until the prop is stood.
- knows : Now the fire-boss knows the men are not in danger.
- must be: The fire-boss must be sure every place is safe.
- helps : Every careful miner and laborer helps to prevent accidents.

What are the miner and laborer doing? Why does the fire-boss not go away? Who must be sure that every place is safe? Who can help to prevent accidents?

FIRE-BOSS, SEE THAT YOUR ORDERS ARE OBEYED PROMPTLY.

*Seventeen*  
17

Figure 5.10: "Fire-Boss Sees That Orders Are Obeyed," *Mine Accidents*, 17.

the level of control by management, as well as to reduce the number of underground accidents. The book froze in time a moment of technological, social, and economic change in the anthracite coal industry. The technological transformations already underway accelerated in the next decades, creating an increasingly mechanized (and controllable) workplace underground. The mechanized mine quickly gave way, in turn, to “stripping” operations that operated from above the ground. More frequent strikes and the energy needs of World War I bolstered labor unionism, raised wages, and most importantly, created work stoppages in the immediate post-war era that permanently eroded anthracite’s market share in the U.S. domestic fuel economy. Shrinking market share, combined with high labor costs and widespread mechanization, reduced the total employment in the anthracite industry substantially even before the coalfields were essentially exhausted in the 1950s.<sup>64</sup> The Delaware, Lackawanna and Western Railroad sold its anthracite holdings relatively early, in September 1921, less than a decade after the book was published.

Perhaps the most interesting lasting effect of the safety education movement of which *Mine Accidents* was a part was the ongoing use of re-enacted accident illustrations to teach safe practices. In the Preface, the authors assert that “[t]he basic idea of these lessons, namely, the making of a series of photographs to show the successive stages in the occurrence and prevention of an accident originated with R.A. Phillips,” the Superintendent of the DLWRR’s coal operations.<sup>65</sup> It is unknown whether Phillips

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<sup>64</sup>See Thomas Dublin and Walter Licht, *The Face of Decline: the Pennsylvania Anthracite Region in the Twentieth Century* (Ithaca, NY: Cornell University Press, 2005).

<sup>65</sup> *Mine Accidents*, 4.

was the first person to create photographic re-enactments of mine accidents for learning purposes, but the photos in *Mine Accidents* (which were taken in 1910) are the first that I have found that were made for such a purpose. Later, other coal companies followed suit.

One of the DLWRR's anthracite competitors, the Delaware and Hudson Coal Company, hired independent photographer John Horgan, Jr., of Scranton, in 1915-1917 to document staged scenes of safe and unsafe practices underground. Horgan had been a professional photographer since at least the mid-1880s, and had moved permanently to Scranton in 1903. Much like the earlier photos collected in *Mine Accidents*, Horgan's scenes showed correct procedures, such as a miner and a laborer barring down loose rock overhead after firing a shot, as well as incorrect actions, such as a miner working with an open flame set on a powder box and crimping a blasting cap with his teeth.<sup>66</sup> Horgan was also engaged by the Delaware and Hudson to take pictures for other corporate purposes, including a series illustrating the history of anthracite mining that was eventually published by the corporation in 1932. The explicit intention of Hudson Coal managers was to improve the public relations of an industry in decline. Management blamed the negative publicity of the several anthracite strikes for encouraging users to turn to other fuels. If that were the case, then a public relations effort, based on putting the industry's best face forward through a positive account

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<sup>66</sup> Gwendoline E. Percival and Chester J. Kulesa, *Illustrating an Anthracite Era: The Photographic Legacy of John Horgan, Jr.* (Pennsylvania Historical and Museum Commission and Anthracite Heritage Museum, Iron Furnaces Associates, 1995), 7, 13, 17-18, 25, 28-34. A large collection of Horgan's photos, including most of his work for the D&H, are held by the Anthracite Heritage Museum in Scranton.

of the historical importance of the anthracite industry, might improve matters.<sup>67</sup> All told, Horgan worked for the Delaware and Hudson (as well as other clients) from 1905 until his death in 1926, and produced over 1,700 negatives for the company during that time.<sup>68</sup> Horgan's long relationship with the company and his substantial output on their behalf suggests the importance that photography attained by the twentieth century for a major anthracite producer such as the Delaware and Hudson.

The Consolidation Coal Company, which mined bituminous coal in western Pennsylvania, Maryland, West Virginia, and Kentucky, likewise kept a photographic archive of its activities from the 1910s through the 1930s.<sup>69</sup> The company's photos, which may have been taken by an employee of Consolidation Coal, included pictures of buildings, mines, towns, and the changes wrought by the arrival of the company to a virgin coal field. However, the photos also showed off prize-winning gardens, recorded picnics, and re-staged mining accidents.<sup>70</sup> At least some of these re-enacted accident photographs were published in the monthly newsletter sent to employees. The con-

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<sup>67</sup>*The Story of Anthracite*, (New York: The Hudson Coal Company, 1932).

<sup>68</sup>Percival and Kulesa, *Illustrating an Anthracite Era*, 3, 17.

<sup>69</sup>The photos are in the Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Geoffrey L. Buckley, *Extracting Appalachia: Images of the Consolidation Coal Company, 1910-1945* (Athens: Ohio University Press, 2004) reprints some of the photographs and sets them in the context of the business activities of Consolidation Coal. For a company-produced history prior to the 1930s, see Charles E. Beachley, *History of the Consolidation Coal Company, 1864-1934* (New York: The Consolidation Coal Company, 1934).

<sup>70</sup>For mining accidents, see, for example, negatives #2147, 2150, 2151, 2159, 2164, 2165, 2170, 2171, 2172, 2173, 2183, and 2184, Consolidation Coal Company Photograph Collection, NMAH. These date from 1922.



Figure 5.11: "Fatal Accident to Frank Hall - Mine No. 204 - 8-4-26." Negative 2744B, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.

tent of the newsletters was clearly intended to increase the loyalty of the miners to the company and teach safe mining practices.<sup>71</sup>

One such accident is shown in figure 5.11 on page 270. The miner in the picture reenacts the fatal accident that occurred to Frank Hall on August 4, 1926, in Consolidation Coal's No. 204 mine. Hall was sitting on the edge of a coal loading machine when his supporting hand slipped and he evidently became entangled in the machinery. This photograph recapitulates the trope of the careless miner by implicitly blaming the accident on Hall. The miner was clearly leaning on a surface not intended as a perch for a worker. In fact, Hall slipped while resting on a piece of metal that guarded the gears of the machine from the miners. Thus the reenacted accident photograph in figure 5.11 reiterates the culpability of the careless miner, Hall, even as it emphasizes that the company upheld its end of the bargain by providing safe machinery.

Consolidation Coal Company also produced a handful of photographs showing a positive vision of good underground practice. Figure 5.12 on page 272 depicts a "model" room in Consolidation's No. 204 mine. Newly-laid tracks would enable the coal cutting and loading machine to arrive right at the working face, and the cut-out strip shows that the cutter, at least, had already visited. The left rail has been properly fitted with a clevis block, to prevent machinery from going too far and falling off the tracks. Hand tools including a large wrench, a rotary hand drill, a hatchet,

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<sup>71</sup>Buckley, *Extracting Appalachia*, xvii-xviii.



Figure 5.12: “Model Room, Mine 204, 8-18-1930.” Negative 2930, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.

iron bars, a broom, a pick, and the ever-important coal scoop rest against the wall and boards placed on the floor. The roof is in good condition, having been carefully cleaned of any hanging rock or other obstruction. The lone prop, which must have been installed after the coal cutter carved the horizontal notch in the face, shows that the safety of the overhead roof is considered even where it might be inconvenient because of its proximity to the working portion of the room.

Such a level of cleanliness in a portion of a working coal mine would seem difficult to accomplish, or even paradoxical. At this time, almost all mining machinery operated on rails, hence the need for the tracks in the photo. We might presume that the coal cutting machine needed those tracks to make the gouge, but the lack of coal debris between the ties on the track suggest that the track is new. The hand-powered drill in the lower left is partially inserted into a hole being drilled in the face at the bottom corner. However, with the boards in place on the floor, it does not look like the drill would have sufficient clearance to turn a complete revolution. Thus, to actually work at this face, at least some of the boards on the floor at the face must be removed.

The model room portrayed in figure 5.12 represented the company's vision of an ideal work space in an explicit, denotative representation of a clean room and orderly arrangement of tools. The photograph's subtle, connotative meanings express the company's wishes as well. The mark of the coal cutting machine stands out, but no human laborers appear in the ideal room. This suggests the company's frustration



with human workers. Consolidation Coal had succeeded in destroying unions in all of the company's far-flung holdings by May, 1927.<sup>72</sup> Machines could not organize, and would always obey – if humans could not be replaced entirely, the company would at least prefer that those miners who remained behaved more like machines.

## Conclusion

Those in charge of mining corporations harnessed the visual power of photography to help them work more efficiently and to give themselves an advantage over mine labor. Whether taken by an independent professional or a member of the company staff, developed in-house or commercially, publicized, sold, or perhaps merely left ignored in company files, the act of taking and using photographs was a well-established practice in the mining industry by the 1920s. Photographs kept investors (or family members) informed about happenings at the mine, and helped managers keep records of physical progress on mine maps. Commercial photographers found a market for views of mining machinery and underground scenes, from mining companies but also from mine workers and the public at large.

Photographs made by mining companies to encourage mine safety are particularly rich sources which, when set in the appropriate context of the typical work practice of underground mining, reveal the extent of managerial efforts to exercise control over their labor force. Companies attempted to use photographs to denote underground

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<sup>72</sup>Beachley, *History of Consolidation Coal*, 70.

practices that were simply safe ways of working, but the connotation of many of these photos was that an individual's safety was dependent on the abandonment of old freedoms and the adherence to the company's way of doing things.

Mine safety photos also gave managers a new visual medium through which to deliver the old message that the individual miner was always at fault in accidents. Though the trope of the careless miner had been widespread since at least the middle of the nineteenth century as an explanation for almost all underground accidents, photographic re-enactments of mine accidents seemed to show the "objective truth" that each injured individual had been doing something wrong. The same photographs could also show proof – in the form of machine guards, for example – that the company had done its share to make the workplace a safer place. Now, it was up to the miner to be safe – and it was his fault if he was hurt or killed. By contrast, if a miner wished to turn the visual power of photographs against his employer, he had few options. Lewis Hine was able to create underground photographs that encouraged rather than stilled criticism of mining companies, but Hine's photos stood out precisely because they were so unusual. In short, when photographs were used as tools by mine management, the images – like other visual representations – tended to concentrate power in the hands of those who made and used them.

# Chapter 6

## Museums

## **Introduction**

Mining engineers were not the only people interested in using visual representations to change the mining industry and its relationship to society. In this chapter, we will see the close relationship between the federal government and the mining industry as it was expressed in the activities of the United States National Museum (USNM) in the early part of the twentieth century. The USNM, which was part of the Smithsonian Institution, pursued a deliberate policy intended to create three-dimensional displays that would aid the mining industry by promoting the industry's successes, downplaying its failures, and providing technical information to other businessmen and the public at large. Many early twentieth century museum tourists would never have seen a mine in person, and the museum could give them a visual context of a technologically sophisticated, rational industry, one where all was well, smart people were making enlightened decisions for the good of the country, and there was no need for disruptive activities such as labor activism or governmental regulation.

## **Federal Support for Mining**

The desire of the USNM to help craft a positive image of the mining industry was consistent with a long history of governmental support for mining. The development of mineral resources was a question of major national concern from before the Civil War until World War II. The mineral industries received continued and systematic scientific and technological assistance from the U.S. federal and state governments.

State-sponsored geological surveys were underway in several states by the 1820s, and the U.S. Geological Survey (USGS) was formed from several federal predecessors in 1879. These geological surveys aimed to describe and map mineral-bearing lands, with the hope that private entrepreneurs would establish mines. The USGS, in particular, conducted a tremendous amount of scientific work almost from the moment of its formation; for example, S.F. Emmons and his co-workers conducted the scientific research that enabled the exploitation of refractory ore bodies at Leadville, Colorado.<sup>1</sup> The U.S. Bureau of Mines, initially the Technologic Branch of the USGS, was spun off into an independent agency in 1910. The Bureau of Mines was to mining engineers as the USGS was to geologists of all stripes – a fount of fundamental research that was intended to be helpful both right away and in the future to private companies working to develop the mineral resources of the nation for the good of the public. In short, by 1910 the federal government offered important support to the mineral industries of the United States.

The United States National Museum, a beneficiary of federal support, assisted the other bureaus in their endeavors. George Brown Goode’s concept of the USNM as a “museum of record, museum of research, and museum of education” is helpful for

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<sup>1</sup> Samuel Franklin Emmons, *Geology and Mining Industry of Leadville, Colorado*, U.S. Geological Survey Monograph 12 (Washington, DC: GPO, 1886). Mining historian Rodman W. Paul said, “Emmons’ monograph ... genuinely deserves that over-used phrase ‘epoch-making.’ Even today it is still referred to as ‘the miners’ bible.’ More than any other event, the publication of this scientific study convinced skeptical mining operators that they could learn something of cash value from university men.” Rodman W. Paul and Elliott West, *Mining Frontiers of the Far West, 1848-1880* 2nd ed. (Albuquerque: University of New Mexico Press, 2001), 131.

understanding the museum before 1910.<sup>2</sup> One of the primary motivations for federal support for the museum from the very beginning was so that it could serve as a “museum of record” for official U.S. surveys and expeditions. In the case of geology, which was one of the original branches of the museum when it was formed, this essentially meant that the museum was an archive of rocks. For instance, when Emmons finished his analysis of rocks from Leadville, they were deposited in the geology collections of the National Museum. If he or any other scientist wished to revisit his findings, the rocks would be there. The USNM had a fully-equipped geological laboratory and in fact provided working space and offices for many USGS employees, who were then frequently on the USNM rolls as honorary curators. Museum geologists would analyze, free of charge, any mineral sample sent in by a member of the general public. The Institution sponsored research and collecting parties, as did the USGS, and products of both came back to the museum to be analyzed by geologists who in fact worked

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<sup>2</sup>Goode’s three-part conception of the mission of the USNM continued to appear as an explicit guiding principle of organization almost a decade after Goode’s death; the annual report of 1905 repeats it verbatim. *Annual Report of the Board of Regents of the Smithsonian Institution ... For the Year Ending June 30, 1905: Report of the U.S. National Museum* (Washington, DC: GPO, 1906), 1-6. Goode set down larger principles of museum organization and administration, and was particularly interested in the history of science. See “A Memorial of George Brown Goode, Together With A Selection of His Papers on Museums and on the History of Science in America” which appears as Volume II of the *Annual Report of the Board of Regents of the Smithsonian Institution ... For the Year Ending June 30, 1897: Report of the U.S. National Museum* (Washington, DC: GPO, 1901). Sally Gregory Kohlstedt has added an introductory essay to this volume and republished it as Sally Gregory Kohlstedt, ed., *The Origins of Natural Science in America: The Essays of George Brown Goode* (Washington, DC: Smithsonian Institution Press, 1991). Also see Sally Gregory Kohlstedt, “History in a Natural History Museum: George Brown Goode and the Smithsonian Institution,” *Public Historian* 10 (1988): 7–26. For a more wide-ranging discussion on the educational role of museums in the late 19th and early 20th century, see Steven Conn, *Museums and American Intellectual Life, 1876-1926* (Chicago: University of Chicago Press, 1998).

for both organizations. Generally, the results would be published in the proceedings of the agency that had funded the initial explorations.

Curators created sets of duplicate specimens and distributed them as learning aids to schools throughout the U.S., in order to extend the pedagogical reach of the museum. Most of their time and money, however, was devoted to creating exhibits in the Washington, DC museum. Curators created exhibits of the ores, minerals, and fossils they had studied, for the purpose of educating other scientists, technical experts, and the general public. The department of geology at the museum divided its collection in three distinct classes. First, ores and stones that could be useful in some way typically made up the field of economic geology or applied geology. Rocks as types, classified as “species” in a system developed by famed mineralogist James Dwight Dana, constituted the subject of mineralogy. Fossilized remains of plants and animals were the preoccupation of several subfields, collectively grouped as paleontology. All three divisions created displays in the National Museum. An 1891 description of the museum’s applied geology and metallurgy exhibit reported rows of glass cases, with specimens grouped by product. So for copper, for instance, the case displayed the initial ore, a sample of the product of each of the several steps of processing along with an explanation of the procedure, and the final product, plus photographs of the mine and mill that produced the specimens on display.<sup>3</sup>

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<sup>3</sup> Dewey, *Catalogue of the Collections in Economic Geology*, 73-111.

## New Spaces, New Priorities

The space available to the museum had a determining effect on what displays were installed, so when new spaces became available, the USNM could explore new collections and exhibits. As of 1910, the National Museum was housed in a square, one-story building opened in 1881 (today known as the Arts & Industries or A&I building), along with portions of the adjacent Smithsonian building (now commonly called the “Castle”). The building was crowded to overflowing with exhibits on anthropology, biology, and geology. The reorganization that occurred in 1881 with the opening of the museum building included displays of history, technology, musical instruments, and other artifacts relating to modern civilization (collectively called “arts & industries”), but as the space crunch intensified over the decades that followed, cultural exhibits gradually gave way to the expanding natural history exhibits. Scientists held nearly all of the curatorial and managerial positions in the museum and in the Institution, and their needs came first. Congress was persuaded in the early 20th century of the need for a new museum building to better protect and display the collections; the museum broke ground in 1904.

Before the new building was even complete, an opportunity to collect artifacts about mineral technologies presented itself to the museum in the form of the Louisiana Purchase Exposition of 1904.<sup>4</sup> Expositions were an engine of development for the Na-

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<sup>4</sup>For a complete description of the fair, see David Rowland Francis, *The Universal Exposition of 1904* (St. Louis: Louisiana Purchase Exposition Company, 1913). Governmental reports, issued at the close of the fair, generally offer comprehensive accounts of their exhibits. The classic historical study of World’s Fairs, including the St. Louis Fair, is Robert W. Rydell, *All the World’s A Fair:*



tional Museum through the early part of the 20th century. They served not only as sources of new museum material, as with the famous carloads of artifacts from the 1876 Centennial, but also provided opportunities for museum staff to marshal resources to develop new exhibits for the expositions, which were later installed in the museum. For example, George Bretz's experiments with underground mining photography in early 1884, described in the previous chapter, were undertaken at the behest of the Smithsonian for their exhibit at the upcoming New Orleans Exposition.<sup>5</sup> The 1904 Louisiana Purchase Exposition in St. Louis contained a large number of exhibits on mineral technology, which was an area that museum administrators intended to further develop once the museum had more space. Administrators formed a Department of Mineral Technology in autumn 1904, and tapped Charles D. Walcott, head of the U.S. Geological Survey and honorary curator of stratigraphic paleontology at the museum, to head it.<sup>6</sup> Walcott's job was to select material on mineral technology for the museum – 35 carloads worth – at the close of the exposition, and pack it away for long-term storage. The museum collected not only American artifacts, but also materials from the Phillipines, Siam, Japan, Great Britain, France, Mexico, Brazil, Germany, Italy, Portugal, Austria, Belgium, Canada, Cuba, and Peru.<sup>7</sup>

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*Visions of Empire At American Industrial Expositions, 1876-1916* (Chicago: University of Chicago Press, 1984). More recent works of note include Timothy J. Fox and Duane R. Sneddeker, *From the Palaces to the Pike: Visions of the 1904 World's Fair* (St. Louis: Missouri Historical Society Press, Distributed by University of New Mexico Press, 1997) and Eric Brietbart, *A World on Display: Photographs From the St. Louis World's Fair, 1904* (Albuquerque: University of New Mexico Press, 1997), who particularly emphasizes the ethnological exhibits.

<sup>5</sup>Dewey, "Photographing the Interior of a Coal Mine."

<sup>6</sup>*USNM Annual Report for 1905*, 62-63.

<sup>7</sup>*USNM Annual Report for 1905*, 15-17.

The Department of Mineral Technology, with Walcott as curator, appeared for the first time on the Museum's organizational charts in the report for fiscal year 1905. The chart lists the department at the same hierarchal rank as the long-established museum departments of anthropology, biology, and geology. This rank suggests the importance of the mineral technology project. Even though it was, for the time being, a kind of administrative storehouse rather than an active department of the museum, the collections could just as easily have been placed in the division of applied geology, in the department of geology, or perhaps in the division of technology or the division of history. An independent department suggests that administrators clearly considered it to be something different from applied geology or from any other present activities of the museum; something that required a different approach to collections and exhibits. Unlike the basic scientific research performed in the other departments, the new division was to work more closely with industry, with the hope of boosting its success. These goals would have to wait years before the museum had space or resources to devote to the department of mineral technology.<sup>8</sup>

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<sup>8</sup>The department was listed on the organizational chart of the museum in annual reports from 1905-1912, but no narrative of activity ever appeared in the reports (as did those of the other departments), because in actuality no work was being performed on the collections whatsoever. See the organizational charts in *USNM Annual Report for 1905*, 62-63; *Annual Report of the Board of Regents of the Smithsonian Institution ... For the Year Ending June 30, 1906: Report of the U.S. National Museum* (Washington, DC: GPO, 1906), 51-52; *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1907* (Washington, DC: GPO, 1907), 55-56; *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1908* (Washington, DC: GPO, 1909), 65-66; *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1909* (Washington, DC: GPO, 1909), 63-64; *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1910* (Washington, DC: GPO, 1911), 73-74; *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1911* (Washington, DC: GPO, 1912), 67-68; and *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1912* (Washington, DC: GPO, 1913), 83-84.

Walcott's role is worth noting here, as he displayed a career-long interest in science and in government efforts to increase the efficiency of the industrial use of natural resources. Walcott joined the U.S. Geological Survey in 1879 as an assistant geologist and moved up the ranks, becoming head geologist in 1893 and Director from 1894 to 1907. The USGS under Walcott played an active role in managing the natural resources of the United States for what he believed was the benefit of citizens and industry. Two USGS departments created by Walcott to investigate and publish information about the applications of technology to natural resource use were eventually spun off into the Reclamation Service and the U.S. Bureau of Mines. Walcott also had a long association with the National Museum. He served as an honorary curator of invertebrate paleontology in the department of geology in the museum from 1892 to 1907, and filled in as Acting Assistant Secretary in charge of the museum for a year after the death of George Brown Goode in 1897. In 1907, after the death of Smithsonian Secretary Samuel Pierpont Langley, Walcott was appointed Secretary of the Institution, and served in that capacity until his death in February 1927. He remained an active scientist during his tenure as secretary, venturing into the Canadian Rockies for fieldwork on Cambrian fossils every summer through the 1920s. Walcott served in many scientific organizations, including the National Academy of Sciences, and played a major part in the creation and administration of organizations such as the National Research Council, the Carnegie Institution of Washington, the Wash-

ington Academy of Sciences, and the National Advisory Committee for Aviation.<sup>9</sup> Walcott's long track record makes clear his interest in cooperation and coordination between scientists, industry, and government; an attitude which undoubtedly shaped the museum's division of mineral technology.

Walcott was nominally in charge of the new Department, but due to a lack of space nothing was done for years apart from collecting material at the 1904 exposition. Walcott was Secretary of the Smithsonian by the time the new Natural History Building of the museum was sufficiently complete in late 1909 that the movement of some collections into the new space could begin. Construction was finished in June 1911, and by mid-1912, nearly all of the natural history artifacts, exhibits, and offices had been installed in the new building.<sup>10</sup> The move made available a considerable amount of space in the old building, which administrators planned to devote to exhibits such as historical relics, period costumes, and mechanical technologies, and also to new exhibits on textiles and mineral technology. The latter displays were designed to educate the public and "serve as distinct aids to the great industries of the United

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<sup>9</sup>For a rather idiosyncratic account of Walcott's personal and professional life, see Ellis L. Yochelson, *Charles Doolittle Walcott, Paleontologist* (Kent, OH: Kent State University Press, 1998) and Ellis L. Yochelson, *Smithsonian Institution Secretary, Charles Doolittle Walcott* (Kent, OH: Kent State University Press, 2001). A laudatory account of his career can be found in *Charles Doolittle Walcott, Secretary of the Smithsonian Institution, 1907-1927... Memorial Meeting, Jan. 24, 1928*, Smithsonian Miscellaneous Collections 80 (Washington, DC: Smithsonian Institution Press, 1928); also of note is the memorial tribute to Walcott in the Smithsonian Institution Annual Report for 1927: George Otis Smith, "Charles Doolittle Walcott," in *Annual Report of the Smithsonian Institution for 1927* (Washington, DC: GPO, 1928), 555-561. For Walcott's Smithsonian papers, see the "Finding Aid to the Charles Doolittle Walcott Collection," Record Unit 7004, Smithsonian Institution Archives; some of his papers also appear in the records of the Secretary, RU 45 and RU 46, Smithsonian Institution Archives.

<sup>10</sup> *USNM Annual Report for 1905*, 6-8; *USNM Annual Report for 1910*, 13-15; *USNM Annual Report for 1911*, 12-18; *USNM Annual Report for 1912*, 12-14.

States in demonstrating their importance in the life of our people and in recording the economic changes taking place in each of them.”<sup>11</sup> Eventually a carefully planned comprehensive department of arts and industries would show off human endeavor, past and present, but in the short-term, administrators encouraged present-minded displays that would serve the interests of industry.

Helping domestic industries achieve their full potential was considered part of the museum’s mission by administrators. They connected the museum’s work with the scientific and technical investigations performed for industry by such agencies as the USGS and the Bureau of Mines, and justified their displays by elucidating the intellectual role in such a scheme that the museum’s exhibits would occupy. They argued that the plans of the National Museum did not conflict with the various bureaus established by the government for the “promotion and ... regulation” of industry. Rather, the object of the museum was “supplement” the bureaus and “cooperate in furthering their purposes” by serving as a “depository” for artifacts assembled by the bureaus, by the museum on behalf of the bureaus, and on “behalf directly of the industries themselves.” Administrators believed that providing such a service to American industry “cannot fail to do for this country what corresponding institutions have accomplished for the industries of England, France and Germany.”<sup>12</sup>

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<sup>11</sup> *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1913* (Washington, DC: GPO, 1914), 80.

<sup>12</sup>For England, they were presumably referring to both the Museum of Economic Geology and the South Kensington Museum; the German example is probably the Deutsches Museum. *USNM Annual Report for 1913*, 80-81. On industrial museums, see Russell Douglass Jones, “Engineering History: The Foundation of Industrial Museums in the United States” (PhD diss., Case Western Reserve University, 2001).

The museum charged Chester G. Gilbert with developing the division of mineral technology. Gilbert was first hired by the museum on April 1, 1911, as assistant curator of physical and chemical geology. He worked under Dr. George Merrill, the longtime head of the Department of Geology at the museum, and helped curate the collections that included ores and other products of interest to the mining industry.<sup>13</sup> Gilbert was involved in the culling out of technological artifacts from the division of applied geology and their subsequent transfer to the department of mineral technology in 1912.<sup>14</sup> Walcott's moribund department of mineral technology was reorganized as a division and Gilbert was promoted to curate it on June 6, 1913.<sup>15</sup>

Gilbert began the organization of his division by unpacking all of the material the museum had received from the 1904 exposition at St. Louis. Museum administrators had held high hopes for the exposition collections, and the presence of the collections themselves probably speeded the formation of the division intended to handle them. However, Gilbert decided that "the greater portion of the specimens proved to be wholly unsuitable for use along the accepted lines of development of the division, and were either returned to the donors or destroyed."<sup>16</sup> Gilbert clearly had little place in his plans for obsolete technology suitable only for historical displays. For example, a stamp mill from the 1850s, which was originally part of the display of the State of

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<sup>13</sup> *USNM Annual Report for 1911*, 67-68.

<sup>14</sup> *USNM Annual Report for 1912*, 59.

<sup>15</sup> *USNM Annual Report for 1913*, 114. The organization chart for the 1913 report reflects the name change to "division" rather than "department," but it retains its position at the bottom of the list, and, along with textiles, not under any other department of the museum.

<sup>16</sup> *Annual Report of the Board of Regents of the Smithsonian Institution ... For the Year Ending June 30, 1914: Report of the U.S. National Museum* (Washington, DC: GPO, 1915), 136-137.

California at the 1904 exposition, was recommended to be discarded, as it had “no value excepting from an historical view point to the State of California.”<sup>17</sup> A museum interested in the history of American mining would likely view a California stamp mill from the 1850s as a crucial artifact that illustrates the development of American mining technology. Gilbert clearly did not believe that history of mining technology was relevant to furthering his promotional aims. Gilbert did retain several models, particularly of coal mining and coking operations, as well as some large photographs of a modern coal mine suitable for display.

Gilbert created a comprehensive plan for his new division. First, he made clear the relation of his division to other established government programs. He argued that the division would not pursue research into “the latent mineral resources,” as that was the responsibility of the USGS, nor attempt to promote “increasing efficiency” of development, which was handled by the Bureau of Mines, nor advocate for standardization of mineral products, as the Bureau of Standards carried out that task. Instead, Gilbert declared that his division would first serve as a kind of information clearinghouse, connecting the results of scientific researches performed by industry to the general public, and erasing any doubts as to their efficacy along the way. The curator believed that information directly from companies risked rejection as mere advertising by the public. Gilbert noted that new information about the properties and uses of minerals was being created on a regular basis, however:

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<sup>17</sup>California State Geologist to Gilbert, in folder “Mineral Technology – Companies and Correspondence, 1916,” drawer “Mineral Technology, A-C, 1 of 4 drawers,” Min. Tech. Div. Records, NMAH.

For the dissemination of this mass of most important information the public is almost wholly dependent on the industrial advertising manager, and however accurate may be the contributions from such sources, they are bound to fail in their broader educational value through the fact that the information does not emanate from a disinterested source. In its most purely technical aspect, therefore, the real opportunity of the division to be of service lies, not in the direction of abstract research, but in the exactly opposite one of rendering assistance toward keeping the public in touch with important current developments in mineral technology.<sup>18</sup>

Gilbert's second goal for the museum was to educate the public audience about the origins and uses of the products used by Americans. "Everyone is interested in knowing the source and preparation of the materials in daily use, and by placing such information within the range of popular comprehension the Museum would be rendering a valuable service," Gilbert argued.<sup>19</sup>

To accomplish these goals, Gilbert proposed to create, for each industry, a display of models, specimens, and photographs, and to use the exhibit as the basis for a bulletin to be circulated to people outside the museum. His models would be comprehensive, showing each mineral industry from natural conditions to finished products, with careful attention to manufacturing processes and technologies. Gilbert noted that "development along such lines will attract the interest and attention essential to the success of the educational effort; will appeal in affording a direct, comprehensive summary of interesting and significant facts in logical sequence; and its possibilities will be country wide[sic] instead of limited to Museum visitors." Such a comprehensive plan would be expensive. Gilbert needed the "cordial cooperation" and resources that

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<sup>18</sup> *USNM Annual Report for 1914*, 57.

<sup>19</sup> *USNM Annual Report for 1914*, 57.



a close partnership with the mining industry could provide. “With this broad outline established, it was possible to take up the details and to enter into consideration with the producers and manufacturers as to the means for securing such models and other materials as were needed.”<sup>20</sup>

## Exhibits

Perhaps even more than other divisions in the museum, Gilbert’s Division of Mineral Technology relied upon three-dimensional models to convey the curator’s arguments to the visiting public. Some of the models, particularly those created in the late 1910s and early 1920s, were made by in-house modelers, who usually worked from plans for the authentic artifact, supplied by the companies being portrayed. Other models, especially those placed on display in the early years of the Division of Mineral Technology, were created by the companies and acquired for the USNM, often after they had been displayed at exhibitions. Below, I will discuss two models of coal mines displayed at the museum.

Gilbert had not been responsible for building or collecting the models from the 1904 exposition that had prompted the formation of his Division of Mineral Technology, but he readily embraced the pedagogical potential of such exhibits. Though he had inherited the first models as a consequence of the collecting activities of Walcott, Gilbert soon envisioned a “series of models designed to show important variations

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<sup>20</sup> *USNM Annual Report for 1914*, 58-59.

and adaptations in mining procedure” for his exhibits. He wrote to the dean of the Columbia School of Mines, the foremost such institution in the United States, for advice about his plan. Gilbert argued for the importance of models in his displays:

In studying unfamiliar drawings about 75% of the average person’s capacity for concentration goes into the effort to project his imagination into a third dimension. Models eliminate this tax on the imagination and at the same time facilitate attention.<sup>21</sup>

Here, Gilbert clearly, if implicitly understood the importance of models for non-technical audiences. An engineer generally trained his mind’s eye, over time, to readily project a two-dimensional drawings in three dimensions, but the general public did not. Thus, models were important to Gilbert because they could convey information to his targeted audience that would have been lost in two-dimensional displays in the older tradition.

As Gilbert explained his scheme in his letter, he pointed out that he recognized the expense of his plan. His initial idea was to have plaster models made that illustrated particular features of mining processes, then display the models at the museum and circulate photographs of the models in order to spread their pedagogical reach. He wanted to see if the Columbia dean, who was well connected to the mining industry, believed that the educational possibilities of such a scheme might justify the expense. Gilbert received a reply not from Dean Goetz, but from Rossiter W. Raymond, one of the greatest names in American mining engineering. Raymond, in the twilight of his

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<sup>21</sup>Gilbert to Dr. Frederick A. Goetz, March 29, 1916, folder “Mineral Techn. - Columbia University - 1916-1917,” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

career in 1916, served as an elder statesman for the mining industry and was closely connected with the Columbia School of Mines; Dean Goetz had asked Raymond personally to reply to Gilbert's letter. Raymond supported Gilbert's use of models, noting "I believe quite strongly in the utility of mine models for illustration to students, and for exhibition in museums and institutions," though he demurred on whether or not they would be sufficiently valuable to justify making a large number of them for Gilbert's Smithsonian patrons. Raymond then offered Gilbert some practical advice about model making, suggesting some sort of lightweight stucco instead of Gilbert's proposed plaster, and noting the utility of glass plate models. He closed his letter to Gilbert by remarking that he was "very much interested" in Gilbert's project and would be happy to help in any way possible.<sup>22</sup> This correspondence suggests the extent to which the use of models in certain realms of mining engineering practice, outlined in a previous chapter, had started to inform museum practice. Ultimately, however, Gilbert's model displays were influenced, especially at first, by the materials from the 1904 exposition that were already in his curatorial custody.

The first artifact received by the Division of Mineral Technology upon its organization in 1913 was a very large model of the New England mine of the Fairmont Coal Company, located in Fairmont, West Virginia, shown in figure 6.1 on page 293.<sup>23</sup> The model was constructed at a scale of one inch to one foot, so as to appear impressively lifelike. The machinery had been modeled to perfect scale, "even down to the

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<sup>22</sup>R.W. Raymond to C.G. Gilbert, April 6, 1916, folder "Mineral Techn. - Columbia University - 1916-1917," drawer "Mineral Technology (A-C 1 of 4 drawers)," Min. Tech. Div. Records, NMAH.

<sup>23</sup>The model was Mineral Technology Catalogue #1, Accession 55791.



Figure 6.1: Fairmont coal mine model, installed in the United States National Museum, circa 1914. Photograph from the Smithsonian Institution.

bolts and rivets,” and steel-wool smoke issued from the plant’s stacks. The miner’s village portrayed on the model depicted a host of tiny details including telephone poles, lawns, and flowers, “in fact, everything to make the picture a natural one.”<sup>24</sup>. The model’s popularity was helped by its substantial size (30 feet by 40 feet), as well as because its height of 18 inches off the ground permitted children a view and adults could see details from above. The real attraction, however, was the electric mine locomotive that moved in and out of mine tunnels, feeding the machinery which moved coal back and forth. Very few things in the USNM in 1914 moved at all, so such a display was quite popular. Rather than leave the model running all of the time, which would require a continuous staff presence to ensure nothing went wrong, the museum put up a sign by the display informing visitors that the model would be activated every hour. The museum guards were supposed to show up and operate the model, but on several occasions curator Gilbert showed up ten or twenty minutes after the show was scheduled to find a disappointed crowd gathered to wait because the watchman had never arrived.<sup>25</sup>

The museum claimed that the Fairmont model would allow “the visitor’s imagination” to “visualize accurately the social conditions typical of a coal-mining community.”<sup>26</sup> The model, for all of its rivet-accurate verisimilitude, would have been mis-

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<sup>24</sup>“Coal Mining at Louisiana Purchase Exposition—Description of Models Showing Works of Some of the Large Bituminous Coal Companies,” *Mines and Minerals* (September 1904): 82.

<sup>25</sup>Gilbert memorandum to J.S. Goldsmith, March 9, 1915, folder “Mineral Technology – Companies and Correspondence, Jan 27 1915 – Dec 7, 1915,” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

<sup>26</sup>*USNM Annual Report for 1914*, 135.

leading at best in the portrayal of coal mining life. The model houses were clean and their closeness to the mine would have suggested only a conveniently short commute, instead of their actual proximity to loud and dirty coal operations. The dwellings on the model looked sturdy, and each had steel-wool smoke issuing from its chimney. This fake smoke looked like a smaller version of that spewing from the stacks of the coal plant, and thus drew an implicit comparison between the seemingly orderly, rational, clean industrial operation and its apparent happy domestic counterpart, presided over by the virtuous and industrious miner's wife. The model could not, or would not speak to labor trouble or the dangerous work of mining. This is especially ironic because the worst mining accident in U.S. history, the December 1907 explosion at Monongah, West Virginia that killed 362 miners, occurred in a similar coal village owned and operated by the same company. The horror of the Monongah explosion even provided the impetus for the formation of the U.S. Bureau of Mines, because the mine operators were clearly incapable of stopping such disasters.<sup>27</sup>

The model's pro-company slant is little surprise, of course, because it had originally been constructed by the Fairmont Coal Co. for the St. Louis Exposition of 1904. There, as seen in figure 6.2 on page 296, the Fairmont model was only part of the large display of the Consolidation Coal Company and its semi-independent subsidiaries such as Fairmont. Two more models of company operations in Maryland and Pennsylvania shared the company's pavilion space. The visitor was expected to

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<sup>27</sup> Carlton Jackson, *The Dreadful Month* (Bowling Green, OH: Bowling Green University Popular Press, 1982); Aldrich, *Safety First*, 73-74.

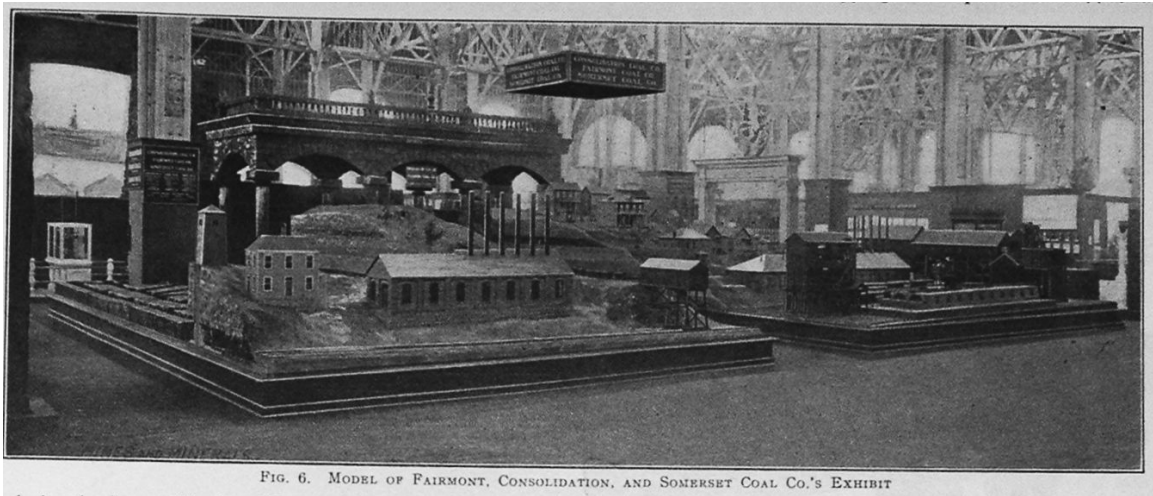


FIG. 6. MODEL OF FAIRMONT, CONSOLIDATION, AND SOMERSET COAL CO.'S EXHIBIT

Figure 6.2: Fairmont model, right, on display at the 1904 Exposition. Photo from “Coal Mining at Louisiana Purchase Exposition—Description of Models Showing Works of Some of the Large Bituminous Coal Companies,” *Mines and Minerals* (September 1904): 81-84.

be able to contrast the different mining methods used by the companies. All were up to date and state of the art, but their differences showed the exposition visitor the expertise of Consolidation in adapting their methods to suit the particular geology of each region. All three models showed similar scenes of clean, tranquil towns, suggesting the company’s benevolence, but the juxtaposition of the three models focused the visitor on the models’ technical content. Once the Fairmont model was detached from its exposition context and placed, alone, in the center of one of the halls of the United States National Museum, the new setting downplayed the model’s portrayal of up-to-date coal mining methods, and instead naturalized the clean and efficient company town as the true “object lesson” taught by the display. This model portrayed its subtle messages to museum visitors from its installation in 1914 until



Figure 6.3: Model of the First Pool No. 2 Mine, Pittsburg Coal Company, in the United States National Museum circa 1914.

it was finally dismantled and scrapped in 1943 - nearly four decades after it had first been put on public view at the exposition of 1904.

A model of the First Pool No. 2 Mine of the Pittsburg Coal Company, seen in its display case at the USNM in figure 6.3, provided another portrayal of the mining industry.<sup>28</sup> Like the Fairmont coal model, the Pittsburg coal display was originally constructed for the company's exhibit at the St. Louis Fair of 1904, and was col-

<sup>28</sup>The company's name was usually spelled without the trailing "h."



lected by Walcott for the museum at the close of the exposition.<sup>29</sup> The Pittsburg model also was long-lived, not being scrapped by the museum until 1960. Like the Fairmont model, the Pittsburg model was touted for its truthfulness, a 1:48 scale three-dimensional picture that “copies faithfully the surface conditions at the mine.”<sup>30</sup> Unlike the larger Fairmont model, however, the Pittsburg scene depicted the underground as well as the surface of the mine. The “truth” of the model thus extended to its portrayal of underground conditions as well.

The Pittsburg Coal company model showed a clean industrial operation sited just below a wholesome little village on a hill. The prominent place of the white church, alone by itself on the hill, showed that the miners were a god-fearing people, and the conspicuous white schoolhouse (largely obscured in figure 6.3, its belfry and roofline is just visible beyond the roof of the large tipple building in center-right) showed the benevolence of the company in providing for its loyal workers and their families. The village in the model seems a picture of tranquil pre-industrial village life, despite the fact that some 255 men worked for the mine at the point in time that the model was supposed to represent.

The peaceful and harmonious scene extended below ground. While a miner on his way to work can be seen just in front of the rightmost house and another supervises the mechanical loading of coal into a railroad car, most of the human figures visible in the Pittsburg coal model are underground. There they work in what seems like a

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<sup>29</sup>The model was Mineral Technology catalog #269, Accession #56153. Though it was collected in 1904, it was not accessioned until 1914, which represents the delay in forming the division.

<sup>30</sup>*USNM Annual Report for 1914*, 135-136.

relatively clean, safe, and spacious system of hallways. Many of the common hazards of mining were due to falling rock and coal from the interior roof, which was not depicted on the model. The coal seam worked in the actual mine depicted by the model was only five and a half feet thick, so any miners of above-average height would have had to stoop throughout the day, though no figures are shown on the model in the characteristic crouch of low coal mines. No coal cutting machinery is visible either, though pneumatic coal-punchers were used in most parts of the mine.<sup>31</sup> The men all have clearly ethnically-white complexions (though some do sport handlebar moustaches) and none exhibit the sort of coal grime that made coal miners instantly recognizable in the photographs of Lewis Hine. A more subtle suggestion of false harmony was evident in the underground layout. While most companies would work diligently to avoid digging for coal directly under their surface facilities and railroad tracks (literally “undermining”) for fear that the land would subside, the companies generally had no such compunction about mining under the nearby towns. In the Pittsburg model, however, the opposite is portrayed – the tunnels extend under the coal tiple and railroad, but do not reach as far as the town. Thus the viewer of the model might detect a note of corporate selflessness and concern for the homes of mine workers that would not have been the case in actuality.

As was the case with the Fairmont coal model, the removal of the Pittsburg model from its exposition context to the USNM deprived its visitors of some visual clues

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<sup>31</sup>“Coal Mining at Louisiana Purchase Exposition,” 81.

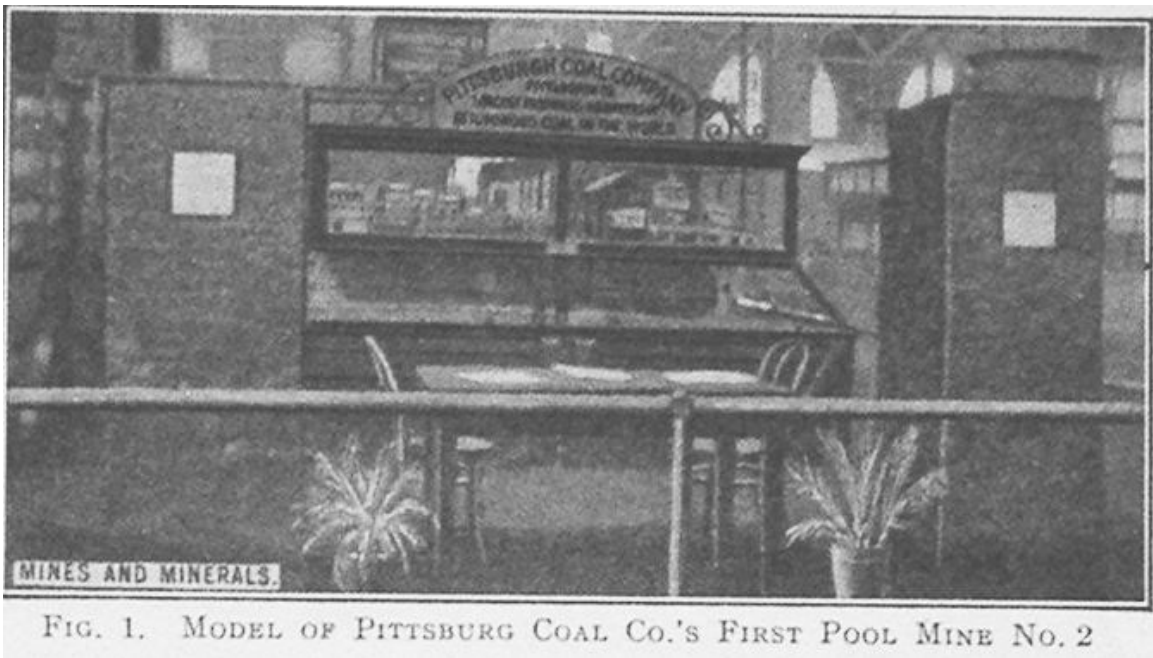


Figure 6.4: Pittsburgh Coal Company's model at the St. Louis Exposition of 1904. From "Coal Mining at Louisiana Purchase Exposition—Description of Models Showing Works of Some of the Large Bituminous Coal Companies," *Mines and Minerals* (September 1904): 81

that might have helped them contextualize the model as a product of a deliberate corporate strategy, had they encountered the display in its original setting. In figure 6.4, the Pittsburg model can be seen in its context at the St. Louis Fair of 1904. The case itself is different than the simple museum-standard glass box; the bottom portion of the exposition case juttred outward so as to better highlight the underground part of the model. A large sign on top of the case advertises the company's product as among the best coals "in the world" – a boastful claim recognizable as advertising. A small table with two chairs sits in front of the case, inviting visitors to rest and contemplate the model, or perhaps conduct some important business deal with the company's exposition representative. Two potted plants suggest a kind of informality, and are also a subtle allusion to the origin of coal in fossilized plant matter. Two large columns of the company's coal, bearing square labels, represent viscerally the height of the seams in the mine and invite the visitor to inspect the superior product up close and in person. Thus, in its original exposition context, both the presentation of the Pittsburg coal model and the objects surrounding it would have forcefully suggested the commercial context and content of the display. Once the model was removed to the museum, the context that rendered the model clearly recognizable as part of a corporate communication strategy disappeared. Instead, though the name of the company remained prominent, the commercial purpose of the model was obscured by a new pedagogical one, backed by the silent authority of the curator of the United

States National Museum, whose testimony suggested only the literal truth of the display.

## Supporting the Mining Industry

Gilbert began writing to manufacturers to find support for his plans shortly after taking the curator job. His letters make absolutely clear that he was willing to provide advertising benefits to companies in exchange for their cooperation and that, ideally, he wanted the companies to develop the exhibits on their own. The museum would merely install them in spaces reserved for individual companies. I believe that we can explain Gilbert's actions in two ways: first, he and at least some other museum curators and scientists believed they had more in common with the heads of companies and industries than with the public they proposed to educate.<sup>32</sup> Second, such development of the Museum harmonized with the Smithsonian's long involvement in federal sponsorship of scientific and technological investigations for the benefit of private industry, especially with regard to mineral resources.

Gilbert's letters also emphasized his hope for a large audience of technical experts for his displays. While models such as those of the Fairmont and Pittsburg coal mines, described above, were aimed at public education, more technical or product-oriented

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<sup>32</sup>There is an extensive historiography on the attitudes and actions of Progressive Era industrialists, scientists, and engineers, which I cannot hope to do justice to here. Daniel T. Rodgers, "In Search of Progressivism," *Reviews in American History* 10, no. 4 (1982): 113–132 provides an excellent overview. Robert Wiebe, *Search For Order, 1877-1920* (New York: Hill and Wang, 1967) is an influential classic, as are Samuel P. Hays, *Conservation and the Gospel of Efficiency* (Cambridge, MA: Harvard University Press, 1959); and James Weinstein, *The Corporate Ideal in the Liberal State 1900-1918* (Boston: Beacon Press, 1968).

exhibits would be pitched toward educated visitors. Gilbert clearly conceived of his audience as being the sort that might have been present at a World's Fair, where part of the purpose was entertainment and education for the public at large, but where technically-minded visitors could see the latest products on display and learn about their technical capabilities. Gilbert did not have the room to dedicate to full-size machinery, but he was quite interested in achieving a similar effect by exhibiting information from companies in the forms of models, photographs, and text.

In an attempt to secure the participation of the Johns-Manville Company, manufacturers of asbestos and asbestos products, Gilbert emphasized the advertising value of a display in his museum division, and reminded the company that the museum would bear the brunt of the cost of the display.

I think you cannot fail to recognize [the proposed exhibit's] decided advantages to you, viewed simply in the light of advertisement. The series would show in full, the industrial uses to which your Company has adapted asbestos, and the system of labeling would set forth your claims as to the merits in each instance, and your name would be conspicuously present. Accordingly, your name and products would be brought conspicuously to the attention of many technical men from all parts of the country daily. No expense would be attached, further than supplying the material, inasmuch as all case work, etc., is provided by the Museum. The only provision which might be regarded as profitless to you would be that of supplying photographs, etc, calculated to illustrate the technology of your mill and quarry work. Even this feature, however, can scarcely be regarded in that light, since it will serve to bring added interest and attention to your exhibit.<sup>33</sup>

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<sup>33</sup>Gilbert letter to Johns-Manville Co., September 18, 1913, folder "Mineral Technology – Companies & Correspondence, 1913," drawer "Mineral Technology (A-C 1 of 4 drawers)," Min. Tech. Div. Records, NMAH.

Gilbert was not merely looking for technology that could be used as typical in the field. He was quite willing to exhibit even patented machinery made by a single company. For example, he wrote to the Braun Corporation, makers of grinding and crushing equipment, seeking “small models of such products as are covered by [the] basic patent in your name.”<sup>34</sup> Gilbert also approached the Deister Machine Company, makers of advanced milling machinery. He wished to discover “whether your Company would care to place in the hall of ore dressing an exhibit setting forth the working principle and advantages of your Tables and Slimer.” Gilbert again showed that he was quite willing to display proprietary designs in the museum as he told the company that the exhibit “would be directed simply toward displaying the advantages of your apparatus to the technical public.”<sup>35</sup>

Gilbert clearly desired to give companies an opportunity to advertise in the context of the museum’s comprehensive exhibits; he did not merely describe normal museum procedures in a manner calculated to make companies more likely to help. In an exchange between Gilbert and the Consolidation Coal Company regarding Gilbert’s efforts to exhibit samples of all of the coal types in the United States, Consolidation replied that it would be happy to donate, but recommended that the honor of representing the Iowa area in the exhibit instead “should go to some Company who

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<sup>34</sup>Gilbert letter to Braun Corporation, August 13, 1913, folder “Mineral Technology – Companies & Correspondence, 1913,” drawer “Mineral Technology” (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

<sup>35</sup>Gilbert letter to Deister Machine Co., August 19, 1913, folder “Mineral Technology – Companies & Correspondence, 1913,” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH. Incidentally, Gilbert’s pleas did not bear fruit – the Deister Machine Company politely but firmly refused to participate.

would be commercially interested.” Gilbert agreed, noting that as long as the coal is representative of the district, it did not matter what mine the coal came from, and given such, “it would probably, as you say, be better to give the opportunity to someone commercially interested, and I shall therefore act upon your suggestion.”<sup>36</sup>

Gilbert was willing to cede control of the content of mineral technology exhibits to corporations in an effort to encourage participation. In a letter to the Galigher Machinery Company, which had expressed no interest in contributing to the museum, Gilbert notes that the company would be in control of the exhibit’s form and informational content. “The Museum in arranging its exhibits in this hall is offering to make reservations of space in the names of such manufacturers as wish to be represented,” but the company did not need to worry about hewing to a strictly defined plan, as “it will be left largely with the exhibitor as to the nature of the exhibit. ... The purpose of the exhibits will be simply that of enabling such visitors to familiarize themselves with the working principles and the advantages claimed by manufacturers for their various products.”<sup>37</sup>

Gilbert attempted to secure corporate participation in his plan by emphasizing the technical sophistication of some of his visitors. When Gilbert wrote to Allis-Chalmers, makers of ore dressing machinery, to see if the company would like to participate,

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<sup>36</sup>Gilbert letter to John P. Reese, Sup’t of Consolidation Coal Company, December 30, 1914, folder “Mineral Technology – Companies & Correspondence, 1914” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

<sup>37</sup>Gilbert letter to Galigher Machinery Co., September 5, 1913, folder “Mineral Technology – Companies & Correspondence, Jul 1913 – Dec 1913,” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.



he downplayed the average museum tourist and instead highlighted the technical audience for the museum's mineral technology displays. "Every year, large numbers of mining men from all sections of the country visit Washington for one reason or another and it is largely to cater to their interests that the Division of Mineral Technology has been established," reported Gilbert, and if Allis-Chalmers wanted "a booth wherein to bring your firm-name to the attention of technical visitors," the curator would be happy to oblige.<sup>38</sup>

Not all companies thought that contributing to the museum would be worthwhile. J. E. Burleson, proprietor of a mica company of the same name in Spruce Pine, N.C., replied to Gilbert's circular, "I have no specimens of minerals that I wish to donate to any Museum for advertisements. I have donated several minerals to several Institutions and never got any results from it and consequently I am tired of that kind of business." Burleson did offer to sell Gilbert some uranium and a large amythest crystal, however.<sup>39</sup>

Gilbert's warm and occasionally sycophantic letters to mineral technology companies suggests his empathy with the industries he exhibited, but his notion of the purpose of public education highlights this property most clearly. Gilbert believed the museum's mission was to educate the public to appreciate the work of industry and

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<sup>38</sup>Gilbert letter to Allis-Chalmers Co., September 22, 1913, folder "Mineral Technology – Allis-Chalmers Mfg. Co - 1913," drawer "Mineral Technology (A-C 1 of 4 drawers)," Min. Tech. Div. Records, NMAH.

<sup>39</sup>J. E. Burleson letter to Division of Mineral Technology, October 14, 1913, folder "Mineral Technology – Companies & Correspondence, 1913," drawer "Mineral Technology (A-C 1 of 4 drawers)," Min. Tech. Div. Records, NMAH.

to create public demand for efficient use of resources. For him, this sort of education would help prevent unnecessary governmental expansion, would lead to less waste of byproducts, and was an antidote to labor unionism and creeping socialism.

In a letter to a university researcher, Gilbert asked for information on the scientist's progress on recovering nitric acid from coal byproducts. (Since nitric acid was a key component of gunpowder, a reliable domestic supply was important for a country nervous about the war raging in Europe.) "The idea is to get together a little exhibit showing the chemical procedure involved in this method of preparing nitric acid, together with the extent of the availabilities that open up and then to issue a descriptive bulletin on the subject." Gilbert described the need for such a plan, "I have been impressed with the thought that the country is running off on an unreasonable tangent in contemplating the erection of a Government controlled hydro electric plant for the fixation of atmospheric nitrogen as being the only practicable means of giving this country its own independent source of nitric acid."<sup>40</sup>

Gilbert's sense of the museum as an inoculation against growing federal control and regulation of industry appears again in a letter to American Cyanamid, offering the company an exhibit at the museum. By the time Gilbert dictated his letter to American Cyanamid, the United States had entered World War I and was embarking on a series of projects to place key industries and industrial sectors under greater federal control. Gilbert described his exhibit idea as "educational propaganda aiming

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<sup>40</sup>Gilbert letter to B.H. Hite, April 18, 1916, folder "Mineral Technology – Companies and Correspondence, Jan 6 1916 – Nov 15 1916," drawer "Mineral Technology (A-C 1 of 4 drawers)," Min. Tech. Div. Records, NMAH.

to awaken public opinion” about the need to cultivate a chemical industry that had the freedom to pursue “coordination of opportunity” – in other words, where large corporations did not need to fear anti-trust regulators. Gilbert decried the sensational “extension of public authority over industry” stimulated by the crisis of the war. The curator’s real concern, however, was not the present state of industry, but what would happen after the war, when a laboring public stimulated by its gains during wartime might demand more. “Things will not revert to the old basis at the close of the war, on the contrary it will be followed by a concentration of public attention upon socialization,” worried Gilbert. New exhibits portraying the industry in all its positive complexity were necessary, because “every effort should be made to insure [sic] enlightenment of public opinion as a basis for its demands upon the government for action.”<sup>41</sup>

Gilbert’s correspondence with the Anaconda Copper Mining Company relative to Anaconda’s support for an exhibit and bulletin on the copper industry reveals Gilbert’s pro-business thinking. “The mineral industries constitute the economic backbone of the country and the whole economic future of the country is dependent on their efficient development,” he wrote, but efficiency required large investments of capital which made such industries “particularly susceptible to the various economic diseases arising from popular ignorance.” As a result, an informed, “appreciative,” educated public was “essential to our national growth,” and working to create such

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<sup>41</sup>Gilbert letter to E. J. Pranke, September 22, 1917, folder “Mineral Technology – Companies & Correspondence,” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

public opinion was an appropriate task for the museum.<sup>42</sup> In a later letter, Gilbert clarified the need for the sort of “popular education” he had in mind to undertake on “behalf of the mineral industries.” Anaconda was at that time in the middle of a violent fight against radical labor unionism and a paralyzing strike, prompted by a disastrous underground fire in June 1917 that killed 163 miners.<sup>43</sup>

The purpose of this work is to obviate as far as possible the ill effect of such publicity as that of late accruing to the copper industry. While the direct outcome from such misinterpretations may be inconsiderable, the contribution made to the slow working cumulative influence of public opinion is serious. Whether prompted by misguided sentimentalism or deliberate dishonesty, the result is the same in tending to strengthen the position of the forces of disorganization with a consequent increment to the self confidence and to the general spirit of unrest. The significant eventualities ahead for the labor of mineral industry production are this bound to represent to an increasing degree the reactions from the shaping of public opinion, and it is therefore important to elevate public comprehension above the plane of sheer instinctive sentiment.<sup>44</sup>

Thus, the essence of the project of the division of mineral technology at the United States National Museum from 1913 to 1919 was the display of mining technologies aimed to both boost specific products to “mining men,” and also to deliver positive images of the mining industry to the general public. These displays were largely provided by the companies themselves, which were motivated to show off their products to visitors with technical education and to provide “education” about the benefits

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<sup>42</sup>Gilbert letter to Benjamin B. Thayer, Anaconda Copper Mining Co., September 14, 1916, folder “Mineral Technology – Anaconda Copper Mining Co.” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

<sup>43</sup> Arnon Gutfeld, “The Murder of Frank Little: Radical Labor Agitation in Butte, Montana, 1917,” *Labor History* 10, no. 2 (1969): 177–192; Arnon Gutfeld, “The Speculator Disaster in 1917: Labor Resurgence at Butte, Montana,” *Arizona and the West* 11, no. 1 (1969): 27–38.

<sup>44</sup>Gilbert letter to Thayer, October 23, 1917, folder “Mineral Technology – Anaconda Copper Mining Co.” drawer “Mineral Technology (A-C 1 of 4 drawers),” Min. Tech. Div. Records, NMAH.

of industry to inoculate an audience of the general public against social radicalism. The curators of the division assisted the companies in the creation of such displays as well as educational bulletins published under the aegis of the Institution, at least in part because the technically-minded curators perceived a commonality of interest with industrial concerns in education of the public, and because the Smithsonian had a long history of involvement in the federal government's project of support for the mineral industries.

## Disruption of War

Plans for the development of the industrial section of the National Museum were radically altered by the entry of the United States into World War I and the economic aftershocks of the conflict on the home front.<sup>45</sup> Gilbert and Joseph E. Pogue, the curators of the division of mineral technology, were increasingly called upon for advice and expertise in service of the war, and focused their activities with a new audience in mind – the government's wartime technical advisory bureaus. Government boards and agencies contacted the curators for answers to a wide range of questions directly relevant to wartime industrial policy, and finding answers could take “minutes to months,” depending on the complexity of the query.<sup>46</sup>

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<sup>45</sup> Robert D. Cuff, *The War Industries Board: Business-Government Relations During World War I* (Baltimore: Johns Hopkins University Press, 1973).

<sup>46</sup> *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1919* (Washington, DC: GPO, 1920), 123.

Gilbert marshaled museum resources and expertise to assist the government boards, especially those in charge of strategic minerals, to determine stockpiles and coordinate supplies in the interest of wartime efficiency. Curator Pogue was temporarily transferred to the Fuel Administration work on petroleum supply issues.<sup>47</sup> Gilbert's investigations on domestic supplies of nitrogen compounds, which formed a crucial ingredient in explosives, were reworked for government use, and Gilbert participated on wartime resource coordination committees in Washington.<sup>48</sup> Researches into the waste of natural gas resources, conducted for the Fuel Administration with the help of Samuel S. Wyer, bore fruit in a model for the museum "which brings out to advantage the tragic story of how the country's tremendous resources of natural gas have been all but squandered."<sup>49</sup>

Apart from the new natural gas exhibit and a similar one on petroleum prepared and donated by the Midwest Refining Company, traditional museum work in the division largely ceased. Instead, the efforts of the division were poured into finishing multiple bulletins and reports on the energy needs of the United States. A bulletin series was the final step of dissemination of museum information in Gilbert's orga-

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<sup>47</sup> Joseph E. Pogue and Isador Lubin, *Prices of Petroleum and its Products*, United States Fuel Administration, War Industries Board Report No. 36 (Washington, DC: GPO, 1919); also see Robert Cuff, "Harry Garfield, the Fuel Administration, and the Search for a Cooperative Order in World War I," *American Quarterly* 30, no. 1 (1978): 39–53.

<sup>48</sup> Chester G. Gilbert, "Sources of Nitrogen Compounds in the United States" Smithsonian Institution Publication 2421, issued June 30, 1916, 12pp, formed the basis of Gilbert's "Report on the Political and Commercial Control of the Nitrogen Resources of the World," circulated in mimeographed typescript among government officials, as mentioned in *USNM Annual Report for 1919*, 123. Also see Margaret Jackson Clarke, *The Federal Government and the Fixed Nitrogen Industry, 1915-1926* (Corvallis: Oregon State University Press, 1977).

<sup>49</sup> *USNM Annual Report for 1919*, 123-126.

nization plans of 1913, but had largely been ignored in favor of building the models and exhibits, from which the bulletins would be derived. The first completed bulletin, titled “Coal Products: An Object Lesson in Resource Administration” drew heavily upon the coal exhibits at the museum to argue for increased efficiency in coal utilization through use of more advanced coke and gas generating equipment.<sup>50</sup> Pogue’s bulletin about the domestic sulphur industry likewise had its roots in a display at the museum.<sup>51</sup> However, the original plan of bulletins only as culmination of exhibits was abandoned in the face of wartime exigencies.

The hardships of the war and the immediate post-war period significantly impacted the museum’s plans to boost the mineral technology industry, even as the companies themselves also suffered in the harsh economic climate. The rampant inflation and difficult economic situation that resulted immediately after the war took a substantial toll on the Smithsonian as a whole. A significant number of employees served in the military during the war. The watch force was at one point so depleted by the military that the buildings and collections could not be guarded. The Civil Service Commission was persuaded to permit the Museum to employ people who had not passed the exam as a temporary expedient. Many members of the staff of the Museum also served, though a larger portion of the scientific and curatorial staff was beyond the age of military service.<sup>52</sup> Worse, appropriations for the National Museum

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<sup>50</sup> Chester G. Gilbert, “Coal Products: An Object Lesson in Resource Administration,” *United States National Museum Bulletin* 102, no. 1 (1917): 1–16.

<sup>51</sup> Joseph E. Pogue, “Sulphur: An Example of Industrial Independence,” *United States National Museum Bulletin* 102, no. 3 (1917): 1–10.

<sup>52</sup> *USNM Annual Report for 1919*, 18, 37.

through the early 1920s were maintained at 1911 levels, despite the fact that rapid wartime inflation had seriously eroded the value of the dollar. Smithsonian employees, particularly those with economically-viable skills, left the museum in droves during and after the war. During the annual summer shutdown of the Museum's heating and electricity plant for the summer months, intended to permit repairs and allow the maintenance employees to take their annual leave, the entire force of assistant engineers and almost all of the firemen and laborers found much more lucrative jobs elsewhere. Pay raises of \$10 to \$15 per month were insufficient to coax them back, so the Museum's physical plant was staffed by new employees when the boilers were restarted in September 1918.<sup>53</sup>

The collapse of the division of mineral technology stemmed from similar economic pressures. On July 1, 1919, Carl W. Mitman, assistant curator of mineral technology, took the job he was offered as head of the division of mechanical technology. (Mitman's division was moved from the Department of Anthropology to the newly-created Department of Arts & Industries at the same time, along with the divisions of mineral technology and textiles.) On September 30, 1919, mineral technology curator Joseph E. Pogue left the museum to head Sinclair Oil's department of economic geology. A month later, on October 31, 1919, Gilbert himself resigned his position as curator in order to pursue a private career as an engineer and consultant at the Washington branch of a nationwide company. He even brought his secretary from the museum

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<sup>53</sup> *USNM Annual Report for 1919*, 16.



with him to his new office. Gilbert remained in charge of the division as an honorary curator, but was clearly unable or unwilling to give the museum much time.<sup>54</sup> Only the builder of many of the division's models, Mr. Haney, remained. Museum personnel attempted, without success, to fill the position for a year and a half. On May 1, 1921, the curatorship of the division of mineral technology was added to Carl Mitman's responsibilities as curator of mechanical technology.<sup>55</sup> Mitman had little time to devote to the mining displays. Though they had easily occupied the energies of two curators and an assistant before the war, now they shared Mitman's focus with his own division. As a consequence, it is not surprising that the mining collections languished under Mitman's charge. New accessions only trickled in, and Mitman made little effort to keep the mining models updated with the latest technologies. Mitman instead worked to create a separate Museum of Engineering and Industry.<sup>56</sup> Though the exhibits were occasionally updated even until World War II, the drive to use the resources of the United States National Museum to boost the mining industry largely fizzled.

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<sup>54</sup> *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1920* (Washington, DC: GPO, 1920), 54, 133.

<sup>55</sup> *Report on the Progress and Condition of the United States National Museum for the Year Ending June 30, 1921* (Washington, DC: GPO, 1921), 121.

<sup>56</sup> Arthur P. Molella, "The Museum That Might Have Been: The Smithsonian's National Museum of Engineering and Industry," *Technology and Culture* 32, no. 2, pt. 1 (April 1991): 237–263.

## Conclusion

While other chapters have explored some of the ways in which mining engineers used visual representations to exercise greater control over mining operations, here we see that like-minded individuals from outside the mining industry used the same tactics. The U.S. government had a long history of support of the mining industry, and the United States National Museum, a branch of the Smithsonian Institution, contributed to this support with displays and bulletins featuring a pro-mining message. The period between 1913 and about 1921 saw the zenith of the museum's active assistance for the mineral industries, largely during the tenure of curator Chester Gilbert. Gilbert played an active role in soliciting exhibits for his section of the museum that would showcase the latest in mining technology and that would give some business advantage to the firms represented in the displays. Gilbert's agenda of boosting the mineral industries, downplaying labor struggles, and fighting off government intervention was visible not only in his letters to mining companies, but implicitly in the models that formed the exhibits in the museum. The curator's use of models was deliberate - he chose them for the power of suggestion and coherence that they brought to his displays. In the end, Gilbert recognized - as had mining engineers - the utility of visual tools in a mining context, and used them to support his goal of boosting the American mining industry.

## Chapter 7

## Epilogue

## Introduction

Fundamentally, the maps, models, photographs, blueprints, and museum exhibits I describe in earlier chapters were means of rendering visible places that could otherwise not be seen. For mining engineers, many visual tools could be used directly in the day-to-day business of mining, or to help them gain the upper hand in legal struggles or in the realm of safety and the work habits of miners. At the same time, the ability to create and use maps, models, photographs, blueprints, and exhibits depicting underground spaces was almost always the prerogative of mining engineers, mine owners, and other elites such as corporate-minded museum curators. Accordingly, everyday miners have appeared in my account only rarely, mostly as those whose habits and labor engineers wished to control.

Nonetheless, miners themselves had myriad ways to depict and understand the underground spaces in which they worked. A rich repertoire of mining folklore included supernatural beings, both malevolent and those, such as the famous Cornish “tommyknockers,” that helped the miner by warning him of impending danger.<sup>1</sup> Miners used candle flames or chalk to create underground graffiti, such as that captured in a Lewis Hine photograph of a trapper and a heavy door in a West Virginia bituminous coal mine (shown in the Photographs chapter). Miners also created songs about their work. Folklore, graffiti, and music were all ways that miners sought to give meaning

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<sup>1</sup> Wayland D. Hand, “California Miners’ Folklore: Below Ground,” *California Folklore Quarterly* 1, no. 2 (1942): 127–153; Ronald M. James, “Knockers, Knackers, and Ghosts: Immigrant Folklore in the Western Mines,” *Western Folklore* 51, no. 2 (April 1992): 153–177.

to their work and their workplace, and to communicate that meaning to other miners and to outside audiences.

Music was one of the most popular ways to share an understanding of mining with an audience. Miners sang mining songs, either traditional ballads or original compositions, to their friends in the mine but also in public audiences at bars, picnics, and other gatherings in mining country. Beginning in the late 1920s, folklorists began to take an interest in these songs, and by the mid-1930s, groups of miners sang at regional and national folk festivals.

While these singers were undoubtedly miners, in front of folk festival audiences they became archetypes. Just as models represented arguments about underground spaces even as they appeared to be merely “truthful,” singing miners seemingly gave an unmediated glimpse of the true “folk” to their audiences.

My own encounter with this mining culture occurred when, as an intern in 2003, I found a folded pair of miner’s blue jeans in the vast basement collections of the Smithsonian Institution. Patched all over, and with a brass colliery check-tag attached to one belt-loop, the pants were dirty with coal dust. Other artifacts in the same drawer - including a soft miner’s cap, a mule whip, a lunchbox and a water bottle - all had the same accession number, and all belonged together. I realized that I was looking at a complete assemblage of the everyday stuff of one long-dead miner.<sup>2</sup>

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<sup>2</sup>An earlier version of this chapter was published as Eric C. Nystrom, “Miner, Minstrel, Memory: Or, Why the Smithsonian Has Bill Keating’s Pants,” *Pennsylvania Magazine of History and Biography* 131, no. 1 (2007): 81–101.

More research revealed that the man's name was William Keating, and that his collection of artifacts were unique in the museum. It was clear that Keating was the sole representative in the storehouse of national memory of a particular form of important and grueling kind of work that has all but disappeared from modern society.<sup>3</sup> (Almost two percent of all workers in the United States - some 430,000 people - were employed as coal miners in 1900.<sup>4</sup>) His was a universal story about mine work that was embedded in the dirty patched blue jeans, in the grimy cap and rusty lunch pail. Anyone, I believed, could see these pants and understand their resonance.<sup>5</sup> These artifacts brought the story of working in a coal mine to life more vividly and authentically than anything else could.

Americans trust museums more than any other purveyor of historical information, even family members, due in large part because "authentic" objects offer a more immediate, less mediated entry into history.<sup>6</sup> Museum artifacts, especially in such hallowed halls as those of the Smithsonian, are powerful in part because they are trusted to be authentic. The authentic artifact can convey a kind of spirit of association with past

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<sup>3</sup>On the Smithsonian as a keeper of object-based narratives of national memory, see Steven Lubar and Kathleen M. Kendrick, *Legacies: Collecting America's History at the Smithsonian* (Washington, DC: Smithsonian Institution Press, 2001).

<sup>4</sup>This figure includes both anthracite and bituminous coal miners. Aldrich, *Safety First*, 42.

<sup>5</sup>For "wonder" and "resonance," see Stephen Greenblatt, "Resonance and Wonder," in *Exhibiting Cultures: The Poetics and Politics of Museum Display*, ed. Ivan Karp and Steven D. Lavine (Washington, DC: Smithsonian Institution Press, 1991), 42-56, esp. 42. Greenblatt defines resonance as "the power of the displayed object to reach out beyond its formal boundaries to a larger world, to evoke in the viewer the complex, dynamic cultural forces from which it has emerged and for which it may be taken by a viewer to stand." (42) Keating's pants also have an element of wonder, described by Greenblatt as "the power of the displayed object to stop the viewer in his or her tracks, to convey an arresting sense of uniqueness, to evoke an exalted attention." (42)

<sup>6</sup>Roy Rosenzweig and David Thelen, *The Presence of the Past: Popular Uses of History in American Life* (New York: Columbia University Press, 1998), 21, 105-108.



Figure 7.1: Item MHI-MN-8993C, Accession 263096, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Photograph by Eric Nystrom, 2005.

people and events to the museum visitor, putting the viewer in close touch with the past.<sup>7</sup> These clothes were certainly those sorts of artifacts.

The importance of their authenticity was also compounded by their rarity. The Smithsonian holds seemingly endless numbers of other kinds of mining artifacts – row upon row, drawer upon drawer of mining lamps, for example – but the miner’s clothes of William Keating were the only examples in the collections. One of the challenges inherent in practicing social history in museums is the relative lack of objects with which to tell the story. Personal objects belonging to history museums overwhelmingly are from “people of comfortable means.”<sup>8</sup> Here, however, were authentic artifacts that could tell a story about industry and hard labor. That rarity made the clothes resonate even more with me.

But a chance encounter with the business files of a former curator complicated the story. A xeroxed obituary of Keating revealed that he was not just a miner, but locally famous in the anthracite country as a troubadour. The grainy newspaper photo showed him in his “singing miner” garb - including dirty, patched pants, lunch pail, water bottle, and miner’s cap. The artifacts in the Smithsonian were his costume.

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<sup>7</sup> Rachel F. Maines and James J. Glynn, “Numinous Objects,” *Public Historian* 15, no. 1 (1993): 8–25; Lubar and Kendrick, *Legacies*, 224–225.

<sup>8</sup> Spencer R. Crew and James E. Sims, “Locating Authenticity: Fragments of a Dialog,” in *Exhibiting Cultures: The Poetics and Politics of Museum Display*, ed. Ivan Karp and Steven D. Lavine (Washington, DC: Smithsonian Institution Press, 1991), esp. 164–168.





Figure 7.2: "Bill Keating, the Singing Miner." Note the brass check tag on his pants, and the lunch pail and bottle on his arm. Keating himself typed the caption. Photograph from the George Korson Collection, American Folklife Center, Library of Congress.

## William Keating, Miner

William Keating was born in 1886, in Mount Laffee Patch near Pottsville, Pennsylvania.<sup>9</sup> Keating was a third-generation miner of American-Irish ancestry.<sup>10</sup> His mother died when he was 18 months old, so he was looked after by his older sister until age six or seven.<sup>11</sup> Keating only attended one year of school before he began working, and he paid little attention in class.<sup>12</sup>

After leaving school, young Keating worked in the collieries near his home. Beginning when he was nine years old, Keating worked in the anthracite industry as a slate-picker at Glen Dower Breaker in Mt. Pleasant, Pennsylvania.<sup>13</sup> At age eleven, he went to work as a “curb-boy” or signal tender in the Philadelphia & Reading Coal & Iron Co. Wadesville Shaft, near Pottsville, where he also worked as a door boy

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<sup>9</sup>Korson reports his date of birth as March 31, 1886. George Korson, *Minstrels of the Mine Patch: Songs and Stories of the Anthracite Industry* (Philadelphia: University of Pennsylvania Press, 1938), 299. However, Keating’s obituary gives April 8, 1886, and Korson’s own early research notes give the latter date. “Wm. Keating, ‘Singing Miner,’ Wrote Ballads,” Pottsville (Pa.) *Republican*, December 9, 1964; “Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, George Korson Collection, American Folklife Center, Library of Congress (hereafter “Korson Collection”). Internal evidence suggests these notes were probably taken in 1928. The above typescript appears to be a very close transcription of Korson’s handwritten interview notes, in folder “Notebooks - anthracite songs, anecdotes, etc.,” Box 105, Korson Collection.

<sup>10</sup> Korson, *Minstrels*, 299. His parents were Michael and Kazia Reddington Keating. “Wm. Keating, ‘Singing Miner,’ Wrote Ballads,” Pottsville (Pa.) *Republican*, December 9, 1964. The 1910 manuscript census page indicates that Keating’s father, Michael Keating, had a Pennsylvania-born father and an Ireland-born mother. 1910 Manuscript Census, Sheet 1, Supervisor’s District 8, Enumeration District 64(54?), Norwegian Twp, Schuylkill County, Pennsylvania, line 35.

<sup>11</sup>Keating, quoted by Korson, in Korson, *Minstrels*, 16.

<sup>12</sup>William Keating to George Korson, August 3, 1938, in folder “Correspondence - August 1938,” Box 18, Korson Collection. This letter is also the basis for Korson’s biography of Keating in Korson, *Minstrels*, 299-300.

<sup>13</sup>“Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, Korson Collection; William Keating to George Korson, August 3, 1938, in folder “Correspondence - August 1938,” Box 18, Korson Collection.

## THE DRIVER BOYS OF WADESVILLE SHAFT

*Transcribed by Melvin LeMon*

Now boys, I'll sing you a lit - tle song, And I  
think that when I'm through, You'll say this song is  
well com - posed, And the words are ve - ry true.

The image shows a musical score for the song "The Driver Boys of Wadesville Shaft" in 3/8 time. It consists of three staves of music. The first staff begins with a treble clef and a 3/8 time signature. The melody is written on a single staff with lyrics underneath. The second staff continues the melody with lyrics. The third staff concludes the melody with lyrics. The lyrics are: "Now boys, I'll sing you a lit - tle song, And I think that when I'm through, You'll say this song is well com - posed, And the words are ve - ry true." The music is written in a simple, folk-like style with a mix of eighth and quarter notes.

Figure 7.3: Music to “The Driver Boys of Wadesville Shaft,” from George Korson, *Minstrels of the Mine Patch*, 117.

for “a couple or three years.”<sup>14</sup> While at work in 1898, Keating developed his song “The Driver Boys of Wadesville Shaft.” He was twelve years old.<sup>15</sup> Keating claimed that a group of visitors to the colliery were so impressed by his song that they offered to take him to Philadelphia for an education, but the young boy refused, a decision Keating regretted later in life.<sup>16</sup>

Keating left the anthracite country to pursue life riding the rails and working at odd jobs shortly after the turn of the century, but homesickness brought him back to Pennsylvania in 1909.<sup>17</sup> Keating soon had a family to support, so he took a job in the mines. He married Alvania Lechleitner<sup>18</sup> in February, 1910. In April of that year, the census enumerator found Keating and his wife, along with their one year old son William,<sup>19</sup> living with Keating’s father Michael and his sister Kazia. Keating was working as a “teamster” in the coal mines, and his father, a widower, labored at odd jobs. It is interesting to note that son “William” was listed as one year old, but William and Alvania (Alvina) had been married only two months. Perhaps the

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<sup>14</sup>Keating, quoted by Korson, Korson, *Minstrels*, 17.

<sup>15</sup> Korson, *Minstrels*, 104, 117-122; this is also reinforced by “Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, Korson Collection.

<sup>16</sup>Keating told Korson in an interview circa 1928 “I wish I had accepted...” “Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, Korson Collection.

<sup>17</sup>Keating, quoted in Korson, *Minstrels*, 17.

<sup>18</sup>“Alvania” is the spelling from Keating’s obituary; the manuscript census taker spelled her name “Alvina.”

<sup>19</sup>The manuscript census for 1910 and 1920 list son “William,” but Keating’s obituary records his son’s name as “Russell.” Russell B. Keating was the son that was active in Keating’s affairs in the 1960s, but it is not clear whether young “William” and “Russell” are the same person.

demands of an unexpected family had helped persuade Keating to put an end to the itinerant life.<sup>20</sup>

Keating composed “Down, Down, Down” - the song that eventually became his calling card - while working as a mule driver in the Oak Hill shaft, in 1916.<sup>21</sup>

There was no body but me and the mule during the shift. I composed this song as I traveled in and out of the gangways on the car bumper mostly to break my loneliness and to show my mule I was in a friendly mood.<sup>22</sup>

Keating would sing the song in barrooms, where he, in accordance with the traditional treatment of roving minstrels in the mining country, would be treated to drinks for his efforts. “Down, Down, Down,” in particular, had to be broken into sections due to its length.

After each section someone would call “Time out for drinks,” and everyone would have a round.<sup>23</sup> Alcohol was an integral part of working-class mining culture in the anthracite fields.<sup>24</sup> One observer noted that in 1902, Keating’s Schuylkill County supported a saloon for every fifty adult males.<sup>25</sup> Keating had a bit of a drinking problem at the time, which lends added veracity to his lyrical story of reporting to work with a hangover.

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<sup>20</sup>1910 Manuscript Census, Sheet 1, Supervisor’s District 8, Enumeration District 64(54?), Norwegian Twp, Schuylkill County, Pennsylvania, lines 35-39.

<sup>21</sup>He was working in “Buck Mountain counter gangway on the third level of Oak Hill shaft at Buckley’s Gap, Duncott,” in Schuylkill County. Keating, quoted in Korson, *Minstrels*, 38. The date appears in “Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, Korson Collection.

<sup>22</sup>The mule’s name was Jerry. “Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, Korson Collection.

<sup>23</sup>Keating, quoted in Korson, *Minstrels*, 39.

<sup>24</sup>See Wallace, *St. Clair*, 159-171. Wallace mentions Keating as a singer of anthracite ballads in this section as well.

<sup>25</sup>Roberts, *Anthracite Coal Communities: a Study of the Demography, the Social, Educational and Moral Life of the Anthracite Regions*, 223.

# DOWN, DOWN, DOWN

*Transcribed by Melvin LeMon*

With your kind at - ten - tion, a song I will  
trill, All ye who must toil with the pick and the  
drill, And sweat for your bread in that hole in Oak  
Hill, That goes down, down, down.

Figure 7.4: Music to “Down, Down, Down,” from George Korson, *Minstrels of the Mine Patch*, 48.

He said, "Billy, me bucko, how are you today?"  
"Outside of a headache," I said, "I'm O.K.  
I've been samplin' the moonshine in every cafe  
In the town, town, town."<sup>26</sup>

Singing in bars was a cheap way to drink: in one verse of "Down, Down, Down" Keating claimed "But for ballads like this, I'd have starved for a spree."<sup>27</sup> Despite his evident enjoyment of the alcoholic life, Keating quit drinking in 1934. His poetry was not affected, however. Keating expressed, in his inimitable typewritten style, the pride he had in his successful personal battle against alcohol:

'Twas Nineteen Thirty-Four (in October)  
Bill vowed: of "John Booze" he'd be rid.  
Past FOUR years—he's been, teetotally, SOBER.  
Can a "rummy" Reform ? \_\_\_\_\_ Bill DID.<sup>28</sup>

"Down, Down, Down" and the other ballads Keating sang in the barrooms of the anthracite country existed only in his head, because Keating could not write - he did not learn until he was 32, in the army for World War I. He was apparently drafted, and sent to Camp Meade, Maryland, for ten months, where army personnel taught him to write in after-hours tutorial sessions.<sup>29</sup> He served with Headquarters Company,

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<sup>26</sup>"Down, Down, Down" stanza 15, George Korson, "Coal Miners," in *Pennsylvania Songs and Legends*, ed. George Korson (Philadelphia: University of Pennsylvania Press, 1949), 364-366. Every written version of "Down, Down, Down" contains minor variations, but the largest differences are between the earlier, longer version of 39 verses that appeared in Korson, *Minstrels*, 48-53, and the 21-verse version sung by Keating in 1946 for the Library of Congress recording, which was transcribed for publication in *Pennsylvania Songs and Legends*, above.

<sup>27</sup>"Down, Down, Down," stanza 37, in Korson, *Minstrels*, 48-53. This verse did not appear on the Library of Congress recording or in *Pennsylvania Songs and Legends*.

<sup>28</sup>Typescript notes, in folder "Minstrels of the Mine Patch Research notes," Box 54, Korson Collection.

<sup>29</sup>William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, p. 2.

316th Infantry, U.S. Army. After his time at Camp Meade, he was sent to France and wounded in action.<sup>30</sup> He reportedly wrote poetry on the battlefield.<sup>31</sup>

After returning from the Army, Keating probably worked at least part of the time in the coal mines, but in the poor postwar economic climate in the anthracite country, Keating struggled to find work. In 1920, Keating was listed living with his wife and two kids in a rented house near his father, in the same township. Keating by this time could read and write, but his wife Alvania could do neither. In addition to son William, the census taker reported a daughter, eight years old, Estella. The entire family, Keating included, had “none” marked for trade or profession, and consistent with this view, Keating has no industry or sector listed.<sup>32</sup> During the early years of the Great Depression, Keating apparently worked as a bootleg coal miner, independently and illegally mining on anthracite lands owned by the large coal conglomerates.<sup>33</sup> Keating, like many of his peers in the anthracite country, struggled to get by.

## William Keating, Minstrel

In the late 1920s, Keating was relatively well-known in Schuylkill County, Pennsylvania - a colorful local drunk with a knack for rhymes. So how did his pants come

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<sup>30</sup>“Wm. Keating, ‘Singing Miner,’ Wrote Ballads,” Pottsville (Pa.) *Republican*, December 9, 1964.

<sup>31</sup>“Bill Keating is Green Thumb Gardener,” *The Orwigsburg News*, Sept. 27, 1956.

<sup>32</sup>1920 Manuscript Census, Sheet 16B, Supervisor’s District 6, Enumeration District 75, Norwegian Twp, Schuylkill County, Pennsylvania, lines 51-54. The manuscript census of 1920 seems to indicate that he was out of work (and not temporarily), but the impetus for Keating writing out “Down, Down, Down” came after he performed the song at a company picnic for Oak Hill colliery in 1927, which suggests that he may have been employed at that later time.

<sup>33</sup>“Bill Keating,” typescript notes, folder “*Minstrels of the Mine Patch* Research notes,” Box 54, Korson Collection. For bootleg mining, see Patrick Shea, “Digging in a Dog Hole: Independent Anthracite Mining in the 20th Century,” *Pennsylvania Legacies* 1, no. 1 (2001): 17–19.



to reside in the collections of the United States National Museum less than forty years later?

The turning point came when Keating met George Korson, a newspaper reporter with a budding amateur interest in industrial folklore.<sup>34</sup> Korson was the son of immigrants from Jewish Ukraine, who had come to the United States when George was seven years old. In 1912, Korson's family moved to Wilkes-Barre, Pennsylvania, in the heart of the anthracite country. Thirteen-year old George had a newspaper route, which entitled him to participate in the Boy's Industrial Association, where he befriended many boys who worked in the mines, much as Keating had done during his youth. After graduating high school in 1917, Korson worked for several years at local newspapers (apart from a year in the Jewish Legion, where he fought for the liberation of Palestine). After a short stint at Columbia College in New York City, Korson returned to Pennsylvania in 1924 to work as a reporter. His former paper in Wilkes-Barre had no jobs available, so Korson found a job with the Pottsville *Republican*.<sup>35</sup>

As a general-assignment reporter, Korson spent a considerable amount of time in the small mining communities that surrounded Pottsville. One day, he was struck by the fact that he had not heard any songs about miners' lives. Korson asked the local

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<sup>34</sup>By the conclusion of his career, Korson transcended "amateur" status and became widely recognized as an expert in industrial folklore. The American Folklore Society bestowed their highest honor on Korson when they elected him a Fellow in 1960. Angus K. Gillespie, *Folklorist of the Coal Fields: George Korson's Life and Work* (University Park, PA: Pennsylvania State University Press, 1980), 150-151. I appreciate Angus K. Gillespie pointing this out in comments on an earlier draft of this piece.

<sup>35</sup>Gillespie, *Folklorist of the Coal Fields*, 15-26.

librarian, but was informed that they had never been collected.<sup>36</sup> Korson began to gather the songs from long-time residents in the spring and summer of 1925. What Korson initially conceived of as a magazine article quickly grew into a book, and then into a life-long fascination with the folklore of mining communities.<sup>37</sup> Korson serialized his first book, entitled “Songs and Ballads of the Anthracite Miner,” in the *United Mine Workers Journal* in 1926 and 1927.<sup>38</sup> Unable to interest a traditional publisher in the book, Korson dipped into his personal savings to bring the book out with a subsidy press in 1927. To pay the bills, Korson continued to work as a reporter, in Pottsville, then New Jersey, then, beginning in 1931, in Allentown, Pennsylvania.<sup>39</sup> As often as he could, Korson collected ballads and interviewed new subjects.

Keating didn’t appear in Korson’s first book, *Songs and Ballads of the Anthracite Miner*, but “Down, Down, Down” was included in a short book of songs that was published in 1936,<sup>40</sup> and Korson included four ballads by Keating in his well-regarded

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<sup>36</sup>George Korson, *Songs and Ballads of the Anthracite Miner: A Seam of Folklore Which Once Ran Through Life in the Hard Coal Fields of Pennsylvania* (New York: Frederick H. Hitchcock, Grafton Press, 1927), xxii-xxiii.

<sup>37</sup>Korson, *Songs and Ballads of the Anthracite Miner*, xxiii-xxiv.

<sup>38</sup>The series ran from November 15, 1926 (vol. 37) to March 15, 1927 (vol. 38). Gillespie, *Folklorist of the Coal Fields*, 31-32.

<sup>39</sup>Gillespie, *Folklorist of the Coal Fields*, 28-30, 32-34, 37-41.

<sup>40</sup>George Korson and Melvin LeMon, *The Miner Sings: A Collection of Folk Songs and Ballads of the Anthracite Miner* (New York: J. Fischer and Brother, 1936).



Figure 7.5: George Korson, 1946. Photograph from the Korson Collection, American Folklife Center, Library of Congress.

1938 book, *Minstrels of the Mine Patch*. Korson probably first interviewed Keating in 1928,<sup>41</sup> and after about 1934, the two were, in Keating's words, "Good Buddies."<sup>42</sup>

Korson's interest in the folklore of the anthracite miners came at a time when interest in American folklore was on the rise nationally.<sup>43</sup> Korson was invited to bring a group of singing miners to the 1935 National Folk Festival. The director of the festival, founded the year before, had read Korson's first book and was impressed. Korson arranged some sponsorship from the miner's union, and selected a small group of miners. Inspired, Korson organized the first Pennsylvania Folk Festival, held in Allentown in May 1935. This festival was enough of a success to prompt Bucknell College, in Lewisburg, to offer the Pennsylvania Folk Festival a home and Korson a job directing it. The 1936 Pennsylvania Folk Festival was a much larger affair, and was preceded by a series of regional festivals.<sup>44</sup>

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<sup>41</sup>The notes say Keating composed "Down, Down, Down" in 1916, sang it in France, and "never wrote it down until last Spring." (emphasis in original) If the well-dated story of Keating writing down the ballad for the first time in 1927 for a mine boss named McGee after a company picnic is correct, then the notes would have been taken circa 1928. "Bill Keating," typescript notes, folder "*Minstrels of the Mine Patch* Research notes," Box 54, Korson Collection.

<sup>42</sup>William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, p. 7.

<sup>43</sup>Michael Kammen, *Mystic Chords of Memory: The Transformation of Tradition in American Culture* (New York: Vintage Books, 1991), 407-443.

<sup>44</sup>Gillespie, *Folklorist of the Coal Fields*, 41-49.

Korson took an active role in recruiting Keating to participate in the festivals.<sup>45</sup> Keating participated in the Pennsylvania festivals of 1936, 1937,<sup>46</sup> and 1938,<sup>47</sup> and at least the National festivals of 1937<sup>48</sup> and 1938.<sup>49</sup> At the festivals, the standard procedure called for a group of Pennsylvania miners, also organized by Korson, to sing several traditional mining songs, before Keating took the stage for a solo performance of “Down, Down, Down.”<sup>50</sup> Late in life, Keating reminisced about traveling with Korson and other singing miners to Chicago, Washington, Philadelphia, New York, and other places.<sup>51</sup>

The ballad “Down, Down, Down” which Keating wrote in 1916 while working as a mule driver in a coal mine, was very popular with festival crowds and readers

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<sup>45</sup>See, for example, Korson inviting Keating to sing “Down, Down, Down” at the 1937 Pennsylvania Folk Festival. George Korson to William Keating, June 12, 1937, folder “Correspondence - June 1-15, 1937,” Box 14, Korson Collection. Keating accepted. Bill Keating to George Korson, July 4, 1937, folder “Correspondence - May 1-10, 1937,” Box 14, Korson Collection.

<sup>46</sup>Keating’s performance of “Down, Down, Down” was mentioned in newspaper coverage of the 1937 Pennsylvania event. Henry Pleasants, “Pennsylvania Festival,” *New York Times*, August 22, 1937, X5.

<sup>47</sup>In Keating’s half-humorous attempt to get money out of Korson at the urging of his wife, Keating billed Korson for travel costs and lost wages for two trips to Bucknell and one to Beaver College, which is where the 1936, 1937, and 1938 Pennsylvania festivals were held (respectively). William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, 4.

<sup>48</sup>The 1937 National Folk Festival was held in Chicago. A newspaper article does not mention Keating by name, but recounts his story of how he made up a song to keep himself and his mule, Jerry, amused while working at Oak Hill colliery. “Let’s Give Them ‘Turkey in the Straw,’” *Christian Science Monitor*, June 9, 1937, 5.

<sup>49</sup>The 1938 National Folk Festival was held in Washington, DC. *Washington Post*, April 25, 1938. This issue has a special section devoted to the festival, which the *Post* co-sponsored. Keating appears on the program listing. However, Keating was not listed as part of the program for the 1939, 1940, 1941, or 1942 National Folk Festivals. See *Washington Post*, April 14, 1939, April 18, 1940, 1941 article by Korson, and April 26, 1942.

<sup>50</sup>“Let’s Give Them ‘Turkey in the Straw,’” *Christian Science Monitor*, June 9, 1937, 5; “National Folk Festival” (Special Section), *Washington Post*, April 25, 1938.

<sup>51</sup>George Korson to Russell B. Keating, June 10, 1964, folder “Correspondence - June 1964,” Box 41, Korson Collection.

of Korson's books.<sup>52</sup> The song remained in exclusively oral form until Keating was persuaded in 1927 to write it down. After performing at an Oak Hill company picnic, a mine boss named McGee offered five dollars for a copy of his ballad. Keating forgot about the offer until several weeks later, when the moonshine ran out in the midst of a post-payday spree with several friends. Determined to get more booze, the four retired to Keating's house and managed, after much effort, to write it out. They then went in search of the mine boss. After hours of fruitless searching, the men stopped at a speakeasy, as Keating later related to Korson:

we took a different "tack": I said: "Yerdy, pull over to that Pool Room, accross the rail-road, and if I can't SEL this song—I'll sing it and if there's any Grog within "getting"-distance, we'll get it, and, also, some Gas for the Flivver, for It must be (almost) as "dry" as we ARE."<sup>53</sup>

The bartender didn't know the McGee Keating was looking for, but read a portion of the song and offered Keating five dollars, plus a round of drinks, for the song if Keating would stay and teach him to sing it. "We "drank". I sang, we drank again, and I sang again; this song-without-END—aye Men!"<sup>54</sup>

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<sup>52</sup>Gillespie said that "Down, Down, Down" was "a favorite among folk festival audiences, and it is perhaps the most entertaining item in Korson's entire collection." Gillespie, *Folklorist of the Coal Fields*, 65. For popularity with readers, see for example Ann Ward Orr to George Korson, August 1, 1938, folder "Correspondence - August 1938," Box 18, Korson Collection ("I sang several [ballads] from the 'Miner Sings' ... The class seemed to be quite delighted with the songs - especially, 'Down, Down, Down', which happens to be one of my favorites."); also Elfriede[?] Mahler to George Korson, October 15, 1945, folder "Correspondence - October 1945," Box 23, Korson Collection; and Ruth D. Keener to John A. Lomax, carbon to Mrs. George (Rae) Korson, June 24, 1946, folder "Correspondence - June 1946," Box 24, Korson Collection.

<sup>53</sup>William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, p. 9. All spelling and punctuation is exactly as written by Keating.

<sup>54</sup>William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, p. 10. Keating's spelling and punctuation left intact. A summarized version of this story appears in Korson, *Minstrels*, 39-41.

The song quickly became locally popular. In 1938, Keating reported that he was able to sell, without much effort, printed copies of “Down, Down, Down” on the streets of Pottsville for fifteen cents each.<sup>55</sup> Keating let Korson know that he was quite concerned about being paid for his work, and making sure other singing minstrels could not profit from it. He attributed part of this attitude to his wife’s pressure, and also mentioned that the newspaper editor and other important people in Pottsville were quite concerned to make sure he got his due.<sup>56</sup>

In January and February 1946, Korson made a trip to Pennsylvania to record anthracite ballads for a record for the Archive of Folk Song at the Library of Congress. (Korson’s wife Rae was head of the division.)<sup>57</sup> Korson arranged to make sure that Keating and others would be present to record.<sup>58</sup> The folklorist recorded songs in the Pottsville Public Library (which he also used as his “headquarters”), in the underground Newkirk Tunnel anthracite mine, and in the homes of his singers as well.<sup>59</sup>

Korson traveled with Skip Adelman, a photographer, and Arthur Semmig, a Library

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<sup>55</sup>William Keating to George Korson, August 3, 1938, in folder “Correspondence - August 1938,” Box 18, Korson Collection, p. 10.

<sup>56</sup>William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, p. 2-8.

<sup>57</sup>Gillespie, *Folklorist of the Coal Fields*, 96-104 covers the trip and the recordings, and describes Rae Korson’s role in encouraging George Korson to make the record.

<sup>58</sup>George Korson to Edith Patterson, December 28, 1945, folder “Correspondence - December 1945,” Box 23, Korson Collection.

<sup>59</sup>Edith Patterson to George Korson, January 17, 1946, folder “Correspondence - January 1946,” Box 24, Korson Collection. Patterson reported that “Bill Keating has already appeared on the stage at the Jewish Centre. By the time you get up here, I bet he proves to have written the Psalms!” For “headquarters,” see George Korson to Edward A. Lynch, January 23, 1946, folder “Correspondence - January 1946,” Box 24, Korson Collection.

of Congress sound engineer, who was in charge of operating the portable recording equipment they brought.<sup>60</sup>

Keating recorded “Down, Down, Down” in the Pottsville public library during this trip, which became the first track on the record that resulted. Keating showed up in full minstrel garb, complete with lunch pail, water bottle, and cap surmounted by an oil lamp.

Adelman took two photos of the occasion, with Keating singing, Semmig operating the record equipment in the foreground, and Korson looking on or taking notes in the background.<sup>61</sup> (See figure 7.6.) Korson apparently played his cards rather close to his vest in terms of the possibility of a Library of Congress record resulting from the trip. When he received final approval of the record, he told his friend Edith Patterson the news, but asked her not to tell Keating or the other singing miners, so that they could have the “thrill” of receiving the news directly from the Library of Congress.<sup>62</sup>

The status of “Down, Down, Down” as an original composition of Keating’s and his skittishness about receiving his due and preventing its theft by other singers caused problems, however. Keating told Edith Patterson that he gave the Library of Congress full permission to include the song on the upcoming record. Patterson

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<sup>60</sup>George Korson to Rae Korson, January 28, 1946, folder “Correspondence - January 1946,” Box 24, Korson Collection.

<sup>61</sup>Photographs are in folder “Photographs - Library of Congress Field Trip - 1946, Pennsylvania,” Box 119, Korson Collection. The backs of the photos credit Skippy Adelman for Black Star photographs. It is clear from a letter that Adelman took the Keating photos. Edith Patterson to George Korson, April 23, 1946, folder “Correspondence - April 1946,” Box 24, Korson Collection.

<sup>62</sup>George Korson to Edith Patterson, April 25, 1946, folder “Correspondence - April 1946,” Box 24, Korson Collection. Korson also mentions that the May (1946) issue of Harper’s Bazaar Junior should have a photo-spread about the trip, but he hadn’t seen it.





Figure 7.6: William Keating being recorded in the Pottsville Public Library, with Korson in the background. Photograph from the George Korson Collection, American Folklife Center, Library of Congress.

dutifully telegraphed this information to Rae Korson, who was helping prepare the record for publication. Keating then got cold feet, and sent Rae Korson a telegram rescinding all rights. Patterson resolved the issue by visiting Keating personally. She listened to his concerns about having his song “‘lifted’ by other singers” and had him write out, “in his own hand,” permission to include “Down, Down, Down” on the record.<sup>63</sup>

“Down, Down, Down” was the first track on the Library of Congress album *Songs and Ballads of the Anthracite Miner*, released as a set of 78 rpm records in 1948. In 1958 the collection was released on a 33 rpm LP, and the album was issued on a compact disc in 1996.<sup>64</sup>

The recorded version retained the popularity Keating had cultivated for unrecorded versions of the song. “Down, Down, Down” was used as the audio track to a large, detailed working model of a breaker and mine in the Wyoming Historical and Geological Society in Wilkes-Barre. For the cost of a nickel, schoolchildren could activate the works, sending a model miner into the depths. Bulbs illuminated the parts of the mine as they were described by Keating in the soundtrack. The model was destroyed by a flood in 1972.<sup>65</sup>

Despite his fame as an anthracite troubadour, Keating apparently held a multitude of jobs. In a 1938 letter, Keating alludes to being busy with work for the W.P.A.,

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<sup>63</sup>Edith Patterson to Mrs. George [Rae] Korson, May 15, 1946, folder “Correspondence - May 1946,” Box 24, Korson Collection.

<sup>64</sup>LP: Library of Congress L 16. Compact Disc: Rounder Records Compact Disc (CDROUN1502 / 7 12136 1502 2 0).

<sup>65</sup>Gillespie, *Folklorist of the Coal Fields*, 101-102.

moving dirt and rocks with a wheelbarrow.<sup>66</sup> In 1945, he was working as a night watchman for the Cressona Ordinance Plant, and washed windows to make extra income - Keating even had a “poetic post card” as an advertisement.<sup>67</sup> Keating worked nights at the Win-Ann Manufacturing Company from 1940 until his retirement in 1955.<sup>68</sup>

Keating took pride in having his poems published. After *Minstrels of the Mine Patch* was published, Keating enthusiastically sold copies to his friends.<sup>69</sup> Keating was reportedly “delighted” that “Down, Down, Down” was included in Benjamin Botkin’s *Treasury of American Folklore*, and he quickly ordered a copy for himself.<sup>70</sup> He also continued to work on his poetry. A photograph taken by a newspaperman circa 1947 shows Keating at his desk, squinting with satisfaction at a poem emerging from his typewriter.<sup>71</sup>

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<sup>66</sup>William Keating to George Korson, August 3, 1938, in folder Correspondence - August 1938, Box 18, Korson Collection, 1, and elsewhere in same letter.

<sup>67</sup>Edith Patterson to George Korson, January 30, 1945 in folder Correspondence - January 1945, Box 23, Korson Collection.

<sup>68</sup>“Bill Keating is Green Thumb Gardener,” *The Orwigsburg News*, Sept. 27, 1956.

<sup>69</sup>Phelps Soule to William Keating, December 13, 1938, folder “Correspondence - December 1938,” Box 18, Korson Collection.

<sup>70</sup>Edith Patterson to George Korson, January 30, 1945 in folder “Correspondence - January 1945,” Box 23, Korson Collection.

<sup>71</sup>Photograph by Walter Kraus. Negative 3, Jacket “William Keating of Mount Laffee...,” Small Box “Walter Kraus Negatives - good captions,” Room 5028, National Museum of American History, Smithsonian Institution (hereafter Kraus Negative Collection).



Figure 7.7: Keating writing poetry, circa 1947. Photograph scanned from negative, Walter Kraus Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.

Many of his poems were about nature, in the spirit of “October on Mount Laffee’s Hills,”<sup>72</sup> but others, such as “I Hear the Wild Geese Calling,” intertwined natural themes with motifs from his own life, such as his wanderlust and hobo years.<sup>73</sup>

In his later years, Keating enjoyed tending his garden. He was a careful composter, and was able to grow enormous flowers, tomatoes, and pumpkins. He mentioned that he learned composting as a child from his father, who also practiced the technique. A newspaper photo shows Keating in a broad hat, outside a house wall covered in flowers.<sup>74</sup>

Keating was married twice. His first wife, Alvania Lechleitner, died in 1935. His second wife, Dorothy Kuhl Hollenbush, died in 1953. He had a son and a daughter, and four step-children (his second wife’s children), plus grandchildren.<sup>75</sup>

Keating spent almost all of 1964 in the Veterans’ Administration hospital in Wilkes-Barre. Keating did not have an operation, but was suffering “only the dregs of his old silicosis and his having lived alone without being careful enough of his diet.”<sup>76</sup> Korson had visited him in the hospital in May, 1964. Keating seemed ill, but was excited to see Korson. He wanted to go home, but the doctor would not release him. The former troubadour was in good spirits though fragile health, and he wanted Ko-

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<sup>72</sup> Korson, *Minstrels*, 21-23; “Bill Keating is Green Thumb Gardener,” *The Orwigsburg News*, Sept. 27, 1956, mentions in the last paragraph that Keating writes poems about “the wonders he sees in nature.”

<sup>73</sup>“I Hear the Wild Geese Calling,” Photograph of signed typescript, by Walter Kraus. Negative 2, Jacket “William Keating of Mount Laffee...,” Kraus Negative Collection.

<sup>74</sup>“Bill Keating is Green Thumb Gardener,” *The Orwigsburg News*, Sept. 27, 1956.

<sup>75</sup>“Wm. Keating, ‘Singing Miner,’ Wrote Ballads,” Pottsville (Pa.) *Republican*, December 9, 1964.

<sup>76</sup>Edith Patterson to George Korson, January 8, 1964, folder “Correspondence - January 1964,” Box 41, Korson Collection.

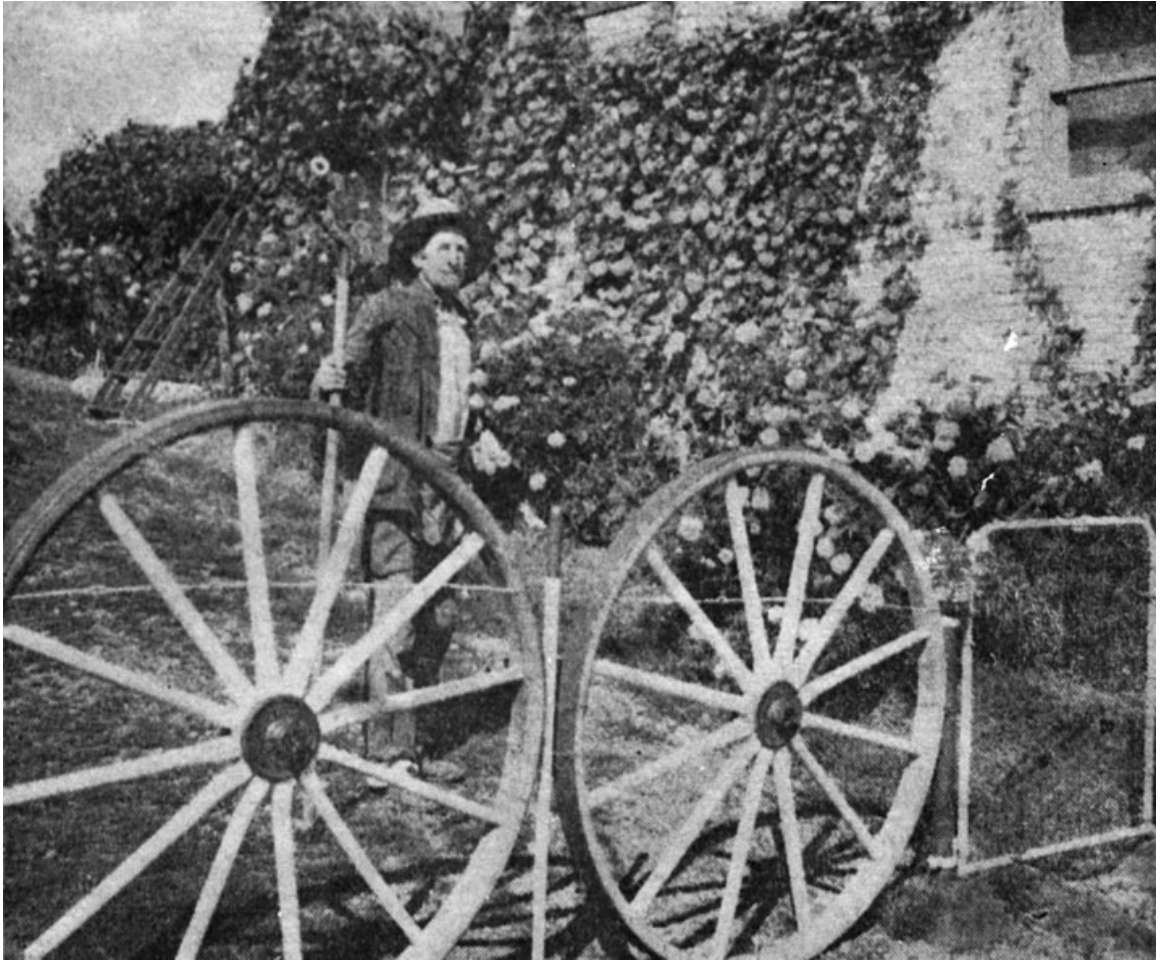


Figure 7.8: Keating the gardener. Photograph from Walter Kraus photograph of the *Orwigsburg News*, Sept. 27, 1956. Walter Kraus Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.

rson to take down more songs he had in his head.<sup>77</sup> Keating was also lonely. After the visit, Korson wrote a letter to Keating's son, saying that the old miner was in relatively good spirits, but that he also sounded homesick and "would like to have more visitors, especially of members of his family." They hadn't visited in more than three weeks when Korson saw Keating.<sup>78</sup>

Korson said he was very concerned to make sure Keating got some proper recognition when he died.

I am concerned that when he does go he should receive the right kind of an obituary. The other miner singers died almost without any recognition of their participation in the anthracite miners' folk culture. If I can help it, Bill Keating will go with the dignity and respect he deserves.<sup>79</sup>

Bill Keating died Tuesday, December 8, 1964, at the Veterans' Administration Hospital in Wilkes-Barre.<sup>80</sup> The Pottsville *Republican* published an obituary, complete with the "singing miner" photo (figure 7.2 on page 322) of Keating in his prime.

## William Keating and Historical Memory

The same year that William Keating was biding his time in a lonely hospital, John N. Hoffman was hired by the Museum of History and Technology of the Smithsonian

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<sup>77</sup>George Korson to Edith Patterson, June 10, 1964, folder "Correspondence - June 1964," Box 41, Korson Collection; George Korson to Edith Patterson, December 22, 1964, folder "Correspondence - December 1964," Box 41, Korson Collection.

<sup>78</sup>George Korson to Russell B. Keating, June 10, 1964, folder "Correspondence - June 1964," Box 41, Korson Collection; George Korson to Edith Patterson, June 10, 1964, folder "Correspondence - June 1964," Box 41, Korson Collection.

<sup>79</sup>George Korson to Edith Patterson, June 10, 1964, folder "Correspondence - June 1964," Box 41, Korson Collection.

<sup>80</sup>"Wm. Keating, 'Singing Miner,' Wrote Ballads," Pottsville (Pa.) *Republican*, December 9, 1964.

Institution to build the museum's mining collections and create a series of major exhibits about mining history.<sup>81</sup> Hoffman held a Ph.D. in Mineral Economics and had worked as a mining engineer. He had an ambitious overall plan to tell the history of mining in the United States, but he decided to concentrate his initial historical research and collection activity on the history of anthracite mining.<sup>82</sup> Hoffman made several trips to the anthracite country in late 1964 and early 1965 to make contacts and collect artifacts. His trips were a success - in addition to the artifacts Hoffman collected himself, many residents of the area sent the Smithsonian interesting items after reading about Hoffman in the local newspaper. When Keating's obituary appeared, a local contact sent Hoffman the information.<sup>83</sup> Hoffman wrote to Keating's son, Russell, explained the museum's projects, and asked to take a look at his father's items on his next trip to Pennsylvania.<sup>84</sup>

Hoffman's efforts paid off. Russell Keating sent a total of thirteen items belonging to his father William to the Smithsonian: two oil lamps, a carbide lamp, two mule whips, a lunch pail, a water bottle, a soft miner's hat, a hard miner's helmet, a leather belt, a checkered shirt, a coat, and a pair of pants.<sup>85</sup> The artifacts were tagged with

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<sup>81</sup>See John N. Hoffman Curatorial Files, Room 5028, National Museum of American History, Smithsonian Institution (hereafter Hoffman Curatorial Files). The Hoffman Curatorial Files are unprocessed. Also see "John N. Hoffman, 59," *Washington Post*, July 17, 1982, B4.

<sup>82</sup>See John N. Hoffman, *Girard Estate Coal Lands in Pennsylvania, 1801-1884*, Smithsonian Studies in History and Technology 15 (Washington, DC: Smithsonian Institution Press, 1972); Hoffman, *Anthracite in the Lehigh Region of Pennsylvania, 1820-45*.

<sup>83</sup>Photostat copy of William Keating obituary with additional type by Walter Kraus, folder "Keating," in Hoffman Curatorial Files.

<sup>84</sup>John N. Hoffman to Russell [sic] B. Keating, May 19, 1965, folder "Keating," in Hoffman Curatorial Files.

<sup>85</sup>Russell Keating's gift was acknowledged on September 8, 1965. P.W. Bishop to Russell B. Keating, September 8, 1965, Accession File #263096, National Museum of American History, Smithso-



a number and brief donor information, and were placed in storage in the basement of the museum with other mining artifacts.

Hoffman had been hired to create a Coal Hall in the newly-opened Museum of History and Technology, but major changes in Smithsonian culture and personnel stymied his plans.<sup>86</sup> Hoffman represented an interpretational and curatorial approach that painted the mining industry in a favorable light at a time when the industry was undergoing unprecedented criticism for environmental and labor abuses.<sup>87</sup> A visitor to one of Hoffman's lectures on the history of mining in 1973 was incensed by the curator's "intolerably one-sided industry pitch saluting the glories of coal." The film shown by Hoffman as an illustration had been made by an industry lobbying group and provided a "very badly distorted view of the most rapacious of American industries."

Indeed, continued the letter writer,

The film depicted bucolic scenes of strip-mine reclamation. It made no mention of the ravages of black-lung; no mention of the phenomenally high rate of injuries and deaths in the mines; no mention of ruined watersheds, despoiled mountains, depopulated communities, [and] wrecked highways.<sup>88</sup>

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nian Institution. The items also received numbers from the Division of Mining. They are as follows: miner's cap, MHI-MN-8987; miner's [hard] hat, MHI-MN-8988; lunch pail, MHI-MN-8989; water bottle, MHI-MN-8990; carbide lamp, MHI-MN-8991; oil lamp (2), MHI-MN-8992A and MHI-MN-8992B; coal mining apparel [coat] MHI-MN-8993A; coal mining apparel [shirt], MHI-MN-8993B; coal mining apparel [pants], MHI-MN-8993C; belt, MHI-MN-8994; mule driver's whips (2) MHI-MN-8995A and MHI-MN-8995B.

<sup>86</sup>For one of Hoffman's pitches, see John N. Hoffman, "Mining Hall Script (A General Proposal)," January 1971, Hoffman Curatorial Files.

<sup>87</sup>For a wider view of the negative perception of the mining industry at the time, see Duane A. Smith, *Mining America: The Industry and the Environment, 1800-1980* (Lawrence: University Press of Kansas, 1987; reprint, Niwot: University Press of Colorado, 1993).

<sup>88</sup>Ward Sinclair, letter to the editor "Coal Industry's View," *Washington Post* May 19, 1973, A15.

Public attitudes, clearly, had changed, and older views of the benefits of mining, such as Hoffman's, were out of step. The Coal Hall was never constructed, and the mining industry and its workers have continued to be almost totally ignored as topics for Smithsonian exhibits. After Hoffman's unexpected death in 1982, his position was absorbed by other curatorial staff.

Hoffman did not keep meticulous records about the things he collected. While he almost certainly knew that Keating's items were part of his costume, he did not take any steps to make sure that knowledge remained part of the collective memory of the division. The information could have been put in one of several places to be retained. It could have been written on the tags that were attached to the items themselves, or it could have been written on the cards in the catalog of items maintained by the division (which was later computerized). The information could have been inserted into the bound, handwritten master catalog, or it could have been inserted into the Accession file for the items, either the master copy maintained by the museum, or the duplicate maintained internally by the division. These are the standard places that curators look for information about the provenance of items in the collections. Since Hoffman didn't leave informational breadcrumbs for his successors in any of those places, when Hoffman died, the institutional knowledge of Keating as an anthracite troubadour died as well - only the outline of Keating, as an authentic, representative anthracite miner, remained.

Keating's artifacts were first slated for use in an exhibition entitled "Working Together." The exhibit planned to broadly outline the history of mining work in America. Curators intended to use his coat and his shirt as examples of the typical work apparel of miners, but there is no evidence that the exhibit was actually installed.<sup>89</sup>

Other items of Keating's were featured more recently in "Taking America to Lunch," a small exhibit of lunchboxes, sponsored by Thermos Corporation. The lunchboxes were installed in glass cases near the Smithsonian's Main Street Cafe in late 2004, and a companion website allowed virtual visitors to see some of the artifacts from home.<sup>90</sup>

This exhibit throws into stark relief the erasure of the troubadour Keating. His lunch pail and his water bottle were a consistent element in his costume, he showed up to make a recording of his song in costume with these items, and his most popular song, "Down, Down, Down," included a line describing how Keating was prepared to go to work, "With booze in me bottle and beer in me can."<sup>91</sup> It is difficult not to imagine Keating waving the props at the appropriate time when performing in front of a live audience.

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<sup>89</sup>The exhibit plan is in an unmarked binder in Divisional Files, Room 5028, National Museum of American History, Smithsonian Institution. The coat and shirt still bear tags that indicated that the items were separated from the collection for the exhibit.

<sup>90</sup><http://americanhistory.si.edu/lunchboxes/index.htm>, accessed May 31, 2005.

<sup>91</sup>See "Down, Down, Down," stanza 14, in Korson, "Pennsylvania Songs and Legends," 364-366; this is also stanza 14 of the recorded version.

The photograph labels on the lunchbox exhibit website describe these items only as “Miner’s dinner pail, Late 19th century” and “Miner’s bottle, Late 19th century;” and the label in the museum case does not mention them at all.

Certainly for Hoffman, because of his institutional goal to depict mining in a positive light, and by default for his successors because of their lack of information about the singer, the authenticity of Keating’s clothing trumped the value of its association with a self-fashioned representative of anthracite mining and anthracite culture. So are Keating’s items in the Smithsonian “genuine”? Is Keating’s lunch pail truly able to represent an authentic turn-of-the-century miner? If Keating’s pants are not truly miner’s pants, do they deserve a place in the primary storehouse of American national memory at all? The questions prompted by the full story of Bill Keating’s pants problematize the concept of authenticity that is usually applied to museum artifacts. He was seen by his contemporaries as an authentic anthracite troubadour, and he certainly had first-hand knowledge of anthracite mining. His costume was authentic enough to ring true with audiences who would have known the difference. More importantly, his costume is perhaps all that is left, and in a world where one of the best-preserved Pennsylvania anthracite mining villages, Eckley Miner’s Village State Historic Park, is actually a movie set built for the 1970 film *The Mollie Maguires*, the simple fact of the existence of Keating’s pants may be the thing that matters most.

The story of Bill Keating gives us a window into the ways that the miners themselves – and interested outsiders, like George Korson – tried to represent their work



Figure 7.9: Miner's bottle and miner's lunch pail belonging to William Keating, featured in exhibit "Taking America to Lunch." Composite image created by Eric Nystrom from photographs from "Taking America to Lunch" website, Smithsonian Institution.

and their culture to each other and the public. Perhaps they succeeded. It is common to think of miners as having a distinct industrial culture and folklore, while some other types of industrial workers, steelworkers for example, may not share the same recognition. Many of the themes of their songs, such as the hardship of a miner's life, the economic privation caused by corporate greed, and the danger and tragedy associated with underground work, are still commonly accepted as truisms about miners. The anthracite singers painted a visual picture of the miner as tragic hero, hardworking, but beset by danger and threatened by economic, social, and natural forces beyond his control. Perhaps it is a measure of their success that modern public media almost never discusses mining corporations in the sort of positive way that would have harmonized with curator Chester Gilbert's United States National Museum exhibits, discussed in the previous chapter, but the public depiction of tragic-hero underground miners (in coverage of a mining accident, for example) would be quite familiar to Keating, Korson, and their troubadour contemporaries.

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# Vita

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