RED MOUTAIN IRON ORE MINING
Birmingham Industrial District
Birmingham vic
Jefferson County
Alabama

HAER No. AL-25

HAER
ALA
37-BIRM.V,
14-

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ADDENDUM TO: HAER AL-25
RED MOUNTAIN IRON ORE MINING *HAER ALA,37-BIRM.V,14-*
Birmingham Industrial District
Red Mountain
Birmingham vicinity
Jefferson County
Alabama

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD

RED MOUNTAIN IRON ORE MINING
IRON ORE MINING ON RED MOUNTAIN, 1864-1928

HAER AL-25

Location: Red Mountain, Birmingham vicinity, Jefferson County, Alabama
Birmingham Industrial District
The Red Mountain area is a large district, but the approximate center of the district is, latitude: 33.476965, longitude: -86.782147. The point was obtained using Google Earth on 30 April 2013. There is no restriction on its release to the public.

Significance: The development of the Birmingham Industrial District was based on the proximity of iron ore, coal, and limestone, all of the raw materials necessary to produce iron and steel. This geological rarity produced an industrial model that was vertically integrated; that is, individual corporations owned all the means of production, from the mining of raw materials to the marketing of finished products. On this basis, the Birmingham Industrial District became an industrial center of national stature, providing merchant pig iron, foundry products, and steel to world markets.

The genesis of this industry was in the availability of iron ore in the Red Mountain Formation. In the early stages of exploitation of this resource, the iron and coal industries developed independently. It was not until 1876, with the first successful reduction of Red Mountain ores in a blast furnace fired by locally-produced coke, that the two industries were completely joined. This event marked the beginning of large scale, systematic development of the resources of the district. Iron ore mining became a prominent feature of the industrial landscape of the area, and would remain so for nearly one hundred years. By the middle of the twentieth century, the Birmingham Industrial District had become the third largest producer of hematite iron ore in the United States; and before the industry closed, area mines had produced over 600 million long tons of ore.

Just as the geology of the district provided for the growth of industry, the composition of the mineral resources shaped and controlled the industry that evolved. High in phosphorus, the ore in the district was well-suited for iron castings, but presented metallurgical problems to economical conversion to steel. Mining methods were determined by the nature of the seams. Part of the Clinton Formation, the Red Mountain seams are stratigraphically-bound sedimentary deposits, containing numerous folds and faults. Cropping out at the surface near the crest of Red Mountain, the seams slope down to the southeast. This outcropping became the focus of Birmingham ore mining for most of the history of the industry.

Beginning in the 1840s, when a local landowner first shoveled ore into wagons from an outcropping, and ending in 1970 with the closing of the last ore mine in the district, the industry of the area spanned the evolution of modern mining technology. Consequently, the mining practices employed reflected a progression toward a larger scale, more highly mechanized operations. Each development in mining operations provided access to larger quantities of ore, with greater rates of productivity. Ultimately, however, these advances were insufficient to overcome the flaws in the ore seams, and the ore mining industry of the area succumbed to higher grade, imported ores.

Historian: Jack R. Bergstresser, Sr., PhD, 1997
Edited and reformatted to HAER standards by Anne Mason, Collections Manager, 2013.

IRON ORE MINING ON RED MOUNTAIN, 1864-1928
TABLE OF CONTENTS

IRON ORE MINING ON RED MOUNTAIN, 1864-1928

INTRODUCTION

The enormous appetite of its blast furnaces and its immense reserves of both red and brown iron ore insured that the Birmingham Industrial District would be one of the nation's leading iron mining regions for nearly eight decades, from approximately 1880 until the early 1960s. Throughout this period the underground ore mines of Red Mountain consistently ranked behind only the largest of Michigan and Minnesota's five ore mining regions. Only Michigan counted more underground mines, but they were spread over a considerably larger geographic area. The slope mines of the Birmingham Industrial District formed a relatively short string that stretched for little more than sixteen miles along the crest and in the gaps and ravines of Red Mountain. While sixteen miles itself is a compact enclosure for a group of slopes that annually produced around ten percent of the iron ore mined in this county, the majority of these openings, as many as twenty-nine mines, were crammed into a six-to-eight mile-ling area that overlooked Bessemer and the extreme southeastern tip of Birmingham.[1]

The Red Mountain mines were almost exclusively captive mines owned and operated by the major iron and steel companies. Nearly half belonged to the Tennessee Coal, Iron and Railroad Company, which in 1907 became a subsidiary of the United States Steel Company. The remaining half were distributed among the Sloss Sheffield Steel and Iron Company, Woodward Iron Company and the Pioneer Mining and Manufacturing Company, whose Thomas blast furnaces were purchased in 1899 by the Republic Iron and Steel Company.[2]

The Clinton formation of the Silurian geologic period (435-395 million years ago) provided the red hematite that these mining operations sought, it is named after the town of Clinton in Oneida County, New York where it was first identified, the formation outcrops at various points from that state all the way to the Birmingham Industrial District. Originally deposited in a near-coastal environment made up of long narrow bays and lagoons, the ore bearing seams of the Clinton formation are comprised of sand, tiny fragments of fossilized sea shells and other hard bodied marine life, ferric oxide, calcium carbonate and several other minerals in low quantities. Wave action in the ancient sea washed the sand and shell fragments back and forth coating them with

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[1] The relative position of Alabama among the major iron ore-mining states is chronicled in yearly editions if United States Department of Interior's *Minerals Yearbook,* compiled by the Bureau of Mines, and *Mineral Resources of the United States,* compiled by the U.S. Geological Survey. It is difficult, if not impossible, to establish the exact number of ore mines that were located in the six-to-eight mile stretch of Red Mountain between Grace's Gap and Sparks Gap. During the 100 years that ore was mined, a number of maps were published, each indicating a different number. For example, Burchard, Butts, and Eckel, in their 1910 account, list twenty-five mines. In the test of their report they refer to many other old openings which they did not identify by name. See Ernest F. Burchard, Charles Buttes, and Edwin Eckel, *Iron Ores Fuels and Fluxes of the Birmingham District, Alabama,* U.S. Department of the Interior, U.S. Geological Survey, Bulletin No. 400 (Washington, D.C.: GPO, 1910), passim. The 7.5 minute series, topographic maps issued by the U.S. Geological Survey in 1959 show twenty workings in the Greenwood, Bessemer and Birmingham South Quadrangles. The number of twenty-six mines cited herein comes from Edwin Higgins, "Iron Operations of the Birmingham District," *Engineering Journal* 11 (November 1908): 1043. Another excellent map is found in Tennessee Coal, Iron and Rail Company, *Description of Plants and Mines,* (Birmingham, Ala.: Tennessee Coal, Iron and Railroad Company, 1900). See also Ethel Armes, *The Story of Coal and Iron in Alabama,* facsimile ed. (Leeds, Ala.: Beechwood Books, 1987), 471-472.
[2] Armes, *Coal and Iron in Alabama,* 356-357, 517-524.

layers of the amorphous ferric oxide. As they tumbled along the sea bottom, the elongated, rounded sand grains became encased in several concentric layers of this hematite surrounded by an outer layer of calcium carbonate. The shell fragments also received a similar coating of the iron rich material which, over time, gradually replaced most of the calcium carbonate of which they were originally comprised. Eventually the tiny fragments became cemented together by calcium carbonate into massive layers of iron ore. In localized areas where the hematite-coated sand grains, known as oolites, predominated, it was called oolitic ore. In locations where the fossilized marine life fragments were more abundant it was referred to as fossiliferous ore. The fossiliferous ore was most coveted because it often contained enough calcium carbonate to be self-fluxing, meaning that no limestone or dolomite had to be added to the furnace burden as a fluxing agent.

The minable ore seams of the Clinton formation outcrop along the northeast to southwest trending crest and slopes of Red Mountain. From their outcrop, they dip to the southwest along an angle that varies considerable, but generally averages 16 degrees for around the first 2,500 feet. At this distance from the outcrop, the seams have long since extended beyond the southeast edge of Red Mountain and have dropped to over 1,000 feet beneath the surface of the adjoining Shades Valley. The seams tend to level out at this point but become much more difficult to mine because the frequency of faults and folds increases.

The ore nearest the surface was much more friable and richer than that which lay deeper underground. Surface water percolating down into the exposed ore was responsible for this phenomenon. As it worked its way into the seam the water weakened the cement holding the ore together and carried away some of its impurities. This weathering process sometimes extended as far as 400 feet into the seams leaving a product that the miners called soft ore. In the early days, soft ore was preferred because of its richness and the relative ease with which it could be mined. Later, as iron makers became more adept at smelting the hard ore, which ranged between 32 to 45 percent metallic iron, it became the raw material of choice because in the underground works it was better suited to systematic mining methods.

Earlier accounts usually list all four seams on Red Mountain that contain iron ore; the Hickory Nut, Ida, Big and Irondale, but the latter two quickly proved to be the only seams containing iron oxide in sufficient richness to support the cost of extraction. While the Irondale seam was mined extensively in the northeast section of the mountain near the town of Irondale, the Big Seam was by far the more important commercially and was almost exclusive objective of mining activities in a large cluster of slope mines near Bessemer. The total thickness of the Big Seam at its widest point is around twenty feet, but it divided into upper and lower “benches” that are separated by a layer of shale that is sometimes as wide as twenty inches. The upper bench was lower in silica and it became the principal mining seam. By around 1925, when miners referred to the Big Seam, they meant this upper bench.

The period between 1864 and 1928 provides a convenient time frame for a discussion of the captive ore mines of Red Mountain because it is the period during which iron making was born and reached its maturity in the Birmingham Industrial District. Clearly the industry would continue to expand over subsequent decades, but by the late twenties the District’s ironmakers had come to a complete understanding of their raw material endowment. Mining on Red Mountain had passed through three stages of technological development from open strips to drifts and inclined planes, and finally to long complicated slope mines entering to ore seams from their outcrops on the mountainside. A fourth stage that at first appeared to hold great promise, accessing the ore from Shades Valley via steep slopes and vertical shafts, had been attempted with only marginal success. This disappointing discovery meant that for as long as the District mined the Clinton formation's Big Seam, it would do so through ever longer slopes on the face of Red Mountain, most of which had been opened during the 1880s and the 1890s.

Early, wildly optimistic expectations of the Birmingham Industrial District's potential, symbolized by Birmingham's nickname the Magic City, faced a sobering geological barrier much more decisive than capital availability, market range, or cultural ethos. The vast reserves of the Clinton formation could only be tapped at the rate that ore could be brought to the surface through a remarkably dense concentration of slope mines. This arrangement would never support the scale of production achievable with Great Lake ores.

HISTORICAL BACKGROUND

The history of ore mining on Red Mountain began inauspiciously a few years prior to the Civil War when Bayliss Grace, a local farmer, stripped a few wagon loads of the red hematite outcropping from his land at Grace's Gap. Grace and the ore smelted at a forge in Bibb County and distributed the blooms to Jones Valley blacksmiths. The venture amounted to little more than a heroic attempt to focus attention on the vast bed of red hematite that underlay the Birmingham Industrial District. The gesture went largely unnoticed because the state's pioneer ironmakers were still committed to the use of cold-blast, charcoal-fired furnaces that worked better on the brown ores found in other localities.[3]

Despite the allure of brown ore, Red Mountain's imposing ore seams were hard to ignore. During the late antebellum period the list of experts attesting to their potential grew. Michael Tuomey, Alabama's first State Geologist, gave a particularly impressive account. His *First Biennial Report* contained an extensive section detailing not only the merits of red hematite but also the potential of "high furnaces" to utilize such ore profitably. John T. Milner, hired as an engineer to survey the probable right-of-way for the South and North Alabama Railroad through the Birmingham Industrial District, was equally impressed. Charles Lyell, an eminent English geologist, also visited the area, predicting an impressive future for north-central Alabama as an ironmaking district. With so many influential observers singing its praises, ore mining and ironmaking were imminent in Jefferson County as the Civil War began.

Wartime demands provided the first important stimulus. Encouraged by the Confederate government, two groups of investors built blast furnaces on the southeastern side of Red Mountain with the intent of producing charcoal pig iron from the mountain's red hematite. The Red Mountain Iron and Coal Company constructed the Eureka Furnaces at Oxmoor and opened the first ore mines in the southwestern section of Red Mountain along the southwestern edge of Grace's Gap. They hired Joseph Squire, an English mining engineer, to supervise their mines. Squire probably did little more than strip the surface ore on land that the company had purchased from Bayliss Grace. At about the same time, Wallace McElwain, erected the Cahaba Furnace,

[3] Armes, *Coal and Iron in Alabama,* 46; Tenney C. DeSollar, "Iron Ore Mining on Red Mountain," *Mining and Metallurgy* 18 (November 1937): 494.

and opened the first mines in the northeastern section of the county. Both iron making operations were destroyed by Union Calvary in 1865.[4]

Ore mining resumed as quickly following the war as the two pioneering furnace plants could be rebuilt. McElwain's enterprise reopened first, in early 1866, reactivating the mines that had supplied ore during the war. The effort was short lived however, and the furnace plant never again produced pig iron on a regular basis after 1872. Armes attributes the failure to a shortage of timber, but later experience would show that the highly silicious ore along that stretch of Red Mountain was not even well-suited to coke furnaces, let alone charcoal.[5] While captive ore mining would soon begin further to the northeast, when Sloss developed its Ruffner mines and Republic acquired the Alfretta property, the old McElwain mines were abandoned for good.

The successors of the wartime Red Mountain Iron and Coal Company resumed mining in the vicinity of Grace's Gap as soon as they refired the Eureka furnaces in 1872. The Eureka No. 1 mine later called East 2 and finally named Ishkooda No. 14, provided iron ore for the attempts to profitably smelt pig iron with charcoal that began in that year. According to the State Mine Inspector's *First Biennial Report*, by 1892 it would become Alabama's largest ore mine. Producing 40,213 tons in 1880, it was followed by the McElwain mine, later renamed Ishkooda No. 15. Other early mines in the immediate area that apparently were associated with the Eureka furnaces and the seminal efforts to produce coke-fired pig iron were the Eureka No. 2, and the Spaulding mine located on the opposite side of Grace's Gap. According to Burchard, who provides no source for the assertion, Spaulding was the first slope mine on the mountain although it achieved a depth of only 200 feet before closing.[6]

Following the success of the Eureka furnace experiments with coke in 1876 and the subsequent take off of the blast furnace industry, the pace of ore mining on Red Mountain began to accelerate very rapidly. Starting as the country's sixteenth largest iron ore producer in 1870, Alabama had risen to seventh place by 1880 and second by 1889. Minnesota would replace the state as the nation's second largest producer in 1894, but for decades to come Alabama would remain in third place, typically producing around 10 percent of the iron ore mined annually in the United States.[7]

In his *Report of the Valley Regions of Alabama*, written for the Geological Survey of Alabama in 1897, Henry McCalley provides the first comprehensive discussion of ore mining on Red Mountain. McCalley describes a string of mines distributed along the mountain, the majority of which are located in a sixteen mile stretch between Irondale and Bessemer. Roughly speaking,

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[4] The best general account of the Confederate government's impressive record of expanding the iron industry in Alabama is that in Armes, *Coal and Iron in Alabama*, 157-187.

[5] Armes, *Coal and Iron in Alabama, 196-199.*

[6] Henry McCalley, *Report on the Valley Regions of Alabama*, Geological Survey of Alabama, Report No. 8, Part 1, (Montgomery: Roemer Printing Co., 1897), 388; U.S. Department of the Interior, Bureau of Census, *Report on the Mineral Industries of the United States* (Washington, D.C.: GPO, 1902), 193; Taft, *Report of the Inspector of Mines, 1892-1894*, (Birmingham: Dispatch Printing, 1895), 33; Burchard, Butts, and Eckel, *Iron Ores, Fuels and Fluxes,* 65.

[7] U.S. Department of the Interior, U.S. Geological Survey, *Seventeenth Annual Report of the United States Geological Survey, 1895-1896*, Part III. Mineral Resources of the United States, (Washington D.C.: GPO, 1896), 26; U.S. Department of the Interior, Bureau of the Census, *Report on the Mineral Industries of the United States, 1892* (Washington D.C.: GPO, 1892), 14.

this line can be broken down into three sections. The first, or northeast, section consisted of Sloss' Ruffner mines and a few others owned by independent producers. The middle section, spanning the entire stretch of mountain directly overlooking Birmingham, was sparsely developed but included the independent Helen Bess and Valley View operations. The southern end of this middle section culminated at TCI's Green Springs mine.

The southwest section, which would become the core of the Red Mountain ore mining district began on the northeast edge of Grace's Gap at the Spaulding mine. Just across the gap lay previously mentioned Eureka No. 1, McElwain and Eureka No. 2 mines followed by the recently opened Smythe operations, all owned by TCI. In sequence following these sites were the additional TCI properties of Spring Gap, Redding Nos. 1 and 2, Ware, Fossil and Alice. Next came the Woodward mines and Sloss Nos. 1 and 2, followed by TCI's Muscode Nos. 3, 2, and 1. McCalley concludes his listing saying that "some 1800 feet still further to the south-west the Pioneer Mining and Manufacturing Company are said to have sunk a slope on the upper bench."[8] Doubtless this new operation would grow to become the Republic Steel Corporation's Raimund mines. In 1897, John Birkinbine listed the combined holdings of TCI as the largest of the "Prominent Iron-Ore Mines" of the United States with an annual production of 945,805 long tons.[9]

By 1928 this southwest section had been nearly fully developed into the grouping of mines that would serve the iron and steel industry of the Birmingham Industrial District until the early 1960s when Red Mountain or mining would finally cease. The principal change that would occur during the twenty-eight years after the turn of the century was the replacement of all the remaining open pit and drift mining operations with slopes. In 1900 only about half, or nine, of the extractive operations in the section were slopes with the deepest penetration of the ore seam having been achieved by the TCI No. 2 mine which had reached a depth of 1,800 feet. During this transition, Sloss and Woodward would retain the original names of their slopes but TCI would make significant organizational adjustments accompanied by several name changes. The company brought all the northeastern-most mines together under the name of Ishkooda. The next cluster which apparently included Ware, Fossil, Redding and others was consolidated into the Wenonah Division. The southernmost cluster was combined into the Muscoda Division. Further south, Republic expanded its works to include two or three Raimund slopes and TCI opened a few slopes at Potter. All totaled, this amounted to around twenty-nine slopes, most of which had reached depths of around three thousand feet.

STAGES OF DEVELOPMENT

It was apparent to contemporary observers that ore mining on Red Mountain passed through four successive stages of development during the time period under consideration. The first writer to describe this evolutionary sequence was Ernest Burchard writing for the U.S. Geological Survey in 1907. According to Burchard, during the first, or open put stage of development, mining

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[8] At the time of McCalley's report the Spring Gap mine was being operated by J.W. Worthington and Company, but TCI had acquired the property by 1900. McCalley, *Report on the Valley Regions of Alabama*, 368-412.

[9] U.S. Department of the Interior, U.S. Geological Survey, *Eighteenth Annual Report of the United States Geological Survey, 1896-97,* Part V. Mineral Resources of the United States, 1896 (Washington D.C.: GPO, 1896), 38-39.

consisted simply of stripping the overburden and removing the outcropping ore. As soon as the sloping ore seams dipped so deep below the surface that the layer of overburden became too thick to remove easily, miners shifted to the second, or drift mining stage. When these shallow underground works reached their productive limits, the slope mining stage began. Burchard also predicted the coming of a fourth stage based upon vertical shafts driven into the basin formed by Shades Valley lying to the east of Red Mountain.[10] While his prediction would soon come true, this latter stage would see only limited development as the Birmingham Industrial District's mining engineers opted to continue the practice of slope mining. The following discussion will describe these phases of development in some detail.

Open Pit Mining

The Eureka, McElwain and other early mines were little more than open trenches whose archaeological remains are still evident, attesting to the simple but effective means that Red Mountain's first miners used to extract and transport the soft, rich ore that outcropped on the surface. Overlooking Birmingham and Bessemer, these long, deep trenches are the only evidence that a magnificent line of red ore bluffs once jutted prominently from the mountain crest. These bluffs were the first target of the open pit miners who blasted them down then dug into the underlying ore seam. The resulting trenches parallel the ridge line and are intersected at various points by other trenches that open into Shades Valley. Miners extracted the ore from the trenches paralleling the mountain crest and transferred it in mine cars to inclined planes built into the trenches that opened into the valley. The mine cars were then lowered down the tracks of these planes to be unloaded at tipples at the base of the mountain. In the early days the ore was dumped into wagons for transport to the blast furnaces but these were soon replaced by railroad cars running on the tracks of the Birmingham Mineral Railroad. At other points along the mountain, the inclined tracks conveyed ore down the northwestern slope to tipples located along the edge of Jones Valley. These simple systems proved to be a boon to the cash-strapped pioneering industrialists because, according to the 1890 census, they provided the cheapest iron ore mine in the United States.[11]

Open pits were so simple that they were described as "primitive" or "slipshod" by some early observers, but they were remarkable effective.[12] As long as they remained the predominant extractive systems on Red Mountain, Birmingham's miners were the most productive in the nation, leading in both cost per ton of ore and tons mined per man. The ore was dug primarily by black migrant laborers from the farm regions of the state, who were willing to work very hard for

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[10] Ernest F. Burchard, *The Clinton or Red Ores of the Birmingham District, Alabama,* U.S. Department of the Interior, U.S. Geological Survey, Bulletin No. 315 (Washington D.C.: GPO, 1907) 146-147.
[11] The archaeological remains were observed by the writer and Robert Yuill during a survey of the mines and blast furnaces of the Birmingham Industrial District conducted by Sloss Furnace National Historic Landmark for the Alabama Historical Commission during the summer and winter of 1989. The methods used to extract and remove ore are described in McCalley, *Report on the Valley Regions of Alabama*, 385; *Report on the Mineral Industries of the United States, 1892,* 20.
[12] P.B. McDonald, "Iron Ore Mining in the South," *Iron Trade Review* 55 (October 1914), 759.

low wages. Their presence in growing numbers enhanced an already advantageous situation for the owners.[13]

From the beginning, however, it was apparent that open strip mining would never satisfy the growing appetite of the Birmingham Industrial District's blast furnaces. Trenches larger than about 75 to 150 feet deep and 250 feet wide ran the danger of collapsing. Moreover, the cost of removing the overburden became prohibitive as the trench became deeper. Consequently, only a finite amount of ore was available on the surface. Most of the easily-won ore had been mined by 1905.[14]

The Inclines and Drifts

While the slope of Red Mountain facing Shades Valley is a fairly even and regular surface in the vicinity of Bessemer, the terrain is quite different to the northeast, near Irondale. In this section of the ridge, known locally as Ruffner Mountain, the eastern slope is dissected by a series of deep ravines. Each ravine is separated from the next by small ridges or spurs that slant downward into the valley like a series of long fingers. Since the ore seams dip back from the crest of the mountain on about the same angle as the slope of the mountain, they have been cut into in each ravine and are exposed along the flank of each spur.[15]

The earliest mines located along this portion of the mountain were ingeniously adapted to take full advantage of these favorable terrain conditions. Robert Yuill, an industrial archaeology enthusiast, has spent many hours locating and plotting the layouts of the simple systems of gravity planes and drift openings devised to extract the ore from the steep sides of the spurs and lower it to loading facilities near the mouth of each ravine. The map that he has prepared to accompany a forthcoming monograph on the subject clearly depicts a series of harmonious and systematic operations which required no energy for lifting. The ore traveled entirely by gravity all the way form the working face of each drift to the crushers and railroad cars at the base of the mountain.[16]

Yuill's map shows that mine managers, including Thomas C. Culverhouse and N.S. Harris, who opened the Sloss Iron and Steel Company's Riffner mines, created incline tracks simply by cutting into the ore seams along the flanks of each spur. In this way they were actually winning ore as they created the beds for their inclines. The incline tracks extended down the spur to tipples arranged over railroad tracks at the end of the ravines. Once the inclines had been completed and easily-won surface ore had been removed, miners drove drift mines into the ore seams at right angles to the inclines. These small drifts, which were opened at regular intervals along the incline, often extended all the way through the spur and opened out into the ravine on

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[13] McDonald, "Iron Ore Mining in the South," 759; Alfred E. Brainerd, "Colored Mining Labor," *TAIME, 1886,* Vol 14 (Philadelphia: American Institute of Mining Engineers), (1886), 78-79; W.R. Crane, "Iron Mining in Birmingham District," *Engineering and Mining Journal* 79 (February 1905): 275.
[14] Burchard, Butts, and Eckel, *Iron Ores, Fuels and Fluxes,* 135; Crane, "Iron Mining in the Birmingham District," 274.
[15] "Iron Ore Mines of the Sloss Iron and Steel Company, Alabama," *Engineering and Mining Journal* 4 (October 1892), 318; Burchard, Butts, and Eckels, *Iron Ores, Fuels and Fluxes,* 58, 67.
[16] "Iron Ore Mines of the Sloss Iron and Steel Company, Alabama," 318; McCalley, *Report on the Valley Region of Alabama,* 318, 368-369; Burchard, Butts, and Eckel, *Iron Ores, Fuels and Flixes,* 58, 67.

the other side. Ore was wheeled out of the drifts in small mine cars, loaded into larger cars on the inclines, and lowered to waiting railroad cars. Variations on this basic design concept could be found at several locations along the mountain where the terrain was conducive, but the Ruffner mines were the highest expression of the form.

The Slope Mines

The long-range demands of a major blast furnace industry clearly called for more substantial and systematic mining operations that accessed the main body of ore lying beneath Shades Valley to the southeast of Red Mountain. Beyond their outcrop on the mountain, ore seams quickly plunged deep below the surface before leveling out somewhat; consequently, this meant underground mines. Considering the local geology there were three common types of systems that could be used to access and bring to the surface this deeply buried but crucial ironmaking raw material. The first option was a slope, or main haulage way, that entered the ore seam at its outcrop and followed its natural angle of descent. The second option was a slope opening that entered Red Mountain at some point above or below the ore seam which it accessed via a tunnel laid on an angle that was steep enough to intersect the seam at some point below the surface. These types of haulage ways were termed slopes because they were laid out on an angle of less than ninety degrees. Both employed either mine cars or skips that were mounted on rails and pulled to the surface by large wire rope cables. The final option was a vertical shaft or steep slope that intersected the seam in Shades Valley and brought the ore to the surface via large elevators or skip hoisting systems.

With only a few exceptions the method that proved most workable on Red Mountain was slopes driven directly into the ore seam from its outcrop. When the local terrain made such entries possible, they offered one major advantage. The mine became an ore producer from its first day of operation. Since ore rather than rock was being removed as the haulage way was being dug, the initial cost of opening the mine was offset by the value of the ore recovered. Opening a haulage way into rock meant that, until the ore seam was reached, the cost of mining was a dead loss.

The layout of the slopes changed very little in scale, throughout the entire history of underground mining. Each mine was comprised of the main slope paralleled by manways on both sides, and headings that branched off the slope at ninety degree angles. The slop was laid with track and rail and functioned as the main haulageway for hoisting ore to the surface. The manways provided ingress and egress for the miners and also served as exploratory tunnels driven ahead of the main slope in order to determine the conditions of the ore seam in advance of the workings. In later years manway were abandoned as a means of providing worker access in favor of lowering and raising the men in special trips via the main haulageway. The headings extending outward from the slope were the point where most of the ore mining was conducted. They were mined following procedures and layouts similar to the room and pillar methods employed in coal mines except that the working faces, which were cut into the ore seam parallel to the main slope and back to the surface, were called stopes instead of rooms.

As the slopes penetrated ever further into the ore seams and branched out, they grew to become some of the largest underground ore mines in the country. For years the Wenonah group, which was so interconnected below the surface that it was considered to be one mine, was listed as the nation's largest underground mine by far. Its size was exceeded only by Minnesota's Hull Rust mine, which was an open-pit operation.[17] The distance that headings could be extended, however, was limited by the fact that the adjoining property of other blast furnace companies served as boundaries constraining the lateral extension of each mine. This factor dictated mine layouts characterized by ever longer main haulageways and relatively short headings.

Surface Plants

The surface plants of the Ishkooda slopes presented such an imposing visual impression that they inspired some of Ethel Armes' most descriptive prose:

> Red Mountain, shorne of timber, stands in long, clear-cut, deep red lines, sharp against the sky…The railroad track, ascending by a series of switch backs, runs along the slope near to the summit, then curves down in and out of the gaps. It is an interesting site to watch an ore train heavily laden with its rich cargo wind its way slowly down the hillside and go on its journey to the huge furnaces.[18]

Armes might well have said the same thing about the entire compact string of slope mines overlooking the southwestern edge of Birmingham and most of Bessemer. The buildings and structures were laid out similarly at almost every mine. At most plants the main slope opening consisted of a substantial, reinforced concrete arch, called a portal, with the name of the mine and its date of construction written in relief across the top. Directly in front of the portals were tipples that presented a particularly striking silhouette because they jutted out prominently from the mountain slope. Earlier wood beam versions were eventually replaced by newer models built of structural steel set on reinforced concrete piers. The front ends of these imposing structures were topped by large wire rope sheaves that guided the cable that hoisted the mine's skip cars to the surface. The skip cars were drawn on tracks nearly to the edge of the sheave where they tipped forward to empty their contents into a large steel hopper encased below within the I-beams and channel of the tipple. The lower end of the massive hopper fed into the top of a large gyratory crusher that crushed the ore and fed it into railroad cars.[19]

Three or four sets of railroad track usually ran alongside the front of the tipple, where trains picked up loads of ore and hauled it to the blast furnaces in the valley below. The tipple tracks switched onto various company railroads or the tracks of the Birmingham Mineral Railroad. Together, the systems combined to form several tiers of tracks along the mountainside.

A hoist house, located downslope from the tipple, was equipped with large hoisting engines that turned wire rope drums up to eight feet in diameter. The turning drums pulled the hoisting cable, which extended up and over the wire rope sheave at the top of the tipple and down into the mine. Like other buildings of the surface plant, the hoist houses were usually attractive architectural

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[17] Higgins, "Iron Operations of the Birmingham District," 1043-1048; Crane, "Iron Mining in the Birmingham District," 274-277; Y.A. Dyer, "Alabama Iron Mining," *Engineering and Mining Journal* 111 (January 1921), 180.
[18] Armes, *Coal and Iron in Alabama*, 473.
[19] Dyer, "Alabama Iron Mining," 180. Several articles in trade journals and government publications refer to the regularity and standardization of mine surface plants in the Birmingham Industrial District, particularly in the vicinity of Bessemer. Three of the best brief descriptions are: Higgins, "Iron Operations of the Birmingham District," 1043-1048; McDonald, "Iron Ore Mining in the South," 759-794; and George J. Young, "Iron Mining in the Birmingham District," *Engineering and Mining Journal* 110 (August 1920), 251-252.

specimens with brick walls, arched windows, and terra cotta tile roofs. Some mines also featured power houses of the same construction, which stood near the hoist house. The tall, round brick chimney or exhaust stack, which stood adjacent to the power house, added a final imposing element to the distinctive visual image.[20]

The Evolution of Mining Methods and Equipment ca. 1900-1928

As with the three general systems of mining employed on Red Mountain, slope mining itself progressed through two distinct phases between 1900 and 1928. While underground ore mining was comprised of a remarkably complex and varied range of tasks, often dictated by localized geological factors, the overall process can be broken down into three basic activities that evolved considerably during the time period in question. The first activity consisted of breaking the ore loose from the seam and loading it into mine cars. The second consisted of hauling cars from the working face of the mine via headings to the main slope or haulageway. The final activity consisted of transferring the ore from the headings to the main haulageway and hoisting it to the surface. At the turn of the century, mines on Red Mountain employed hand loading exclusively. They used mule power to return mine cars from the main haulageway to the working faces and they hoisted the ore to the surface in groups of mine cars. By 1928 the same mines were employing mechanical scrapers for loading, many had replaced mules with mine locomotives and the ore was being hoisted to the surface in large skip cars. While in transition to these more modern techniques was not universal, it had progressed to such as extent that by 1928 the Birmingham Industrial District had entered a new era of mining practice.

In the course of discussing this transition in more detail, it is possible to establish the Birmingham Industrial District's relative technological position toward the end of the time period in question in comparison to another leading underground mining region: the Marquette District of Michigan. Such a comparison is possible because in 1925 the American Institute of Mining and Metallurgical Engineers published in its *Transactions* a series of articles on the latest mining practices. Included were articles on the Birmingham and Marquette Districts. Both articles discussed the three basic mining activities just mentioned. A comparison reveals no significant difference between the techniques used in either region. Indeed, in some categories the Birmingham Industrial District led its northern counterpart.[21]

In the case of ore loading at the working face, for example, both districts had recently begun a conversion from hand loading to the use of drag scrapers in situations where mechanical loading was feasible. The surprising thing, however, is that Birmingham may have begun to adopt this important piece of machinery earlier than the Marquette District. T.C. Abbott, a vice president of TCI, claimed in 1935 that the Birmingham District had been the first in the United States to

[20] E.M. Ball and A.W. Beck, "Iron Mining in Muscode No. 6," *Engineering and Mining Journal* 138 (September, October 1937): 29-33, 36; N.E. Thompson, "Red Ore from Raimund," *Engineering and Mining Journal* 139 (March 1939): 29-30; DeSollar, "Iron Ore Mining on Red Mountain," 493-495; McDonald, "Iron Ore Mining in the South," 760-762, 764.
[21] S.R. Elliott, J.E. Jopling, R.J. Chenneour, and E.L. Derbney, "Mining Methods of the Marquette District, Michigan," *TAIMME,1925*, Vol. 72 (New York: American Institute of Mining and Metallurgical Engineers), 122-138; W.R. Crane, "Red Iron Ore Mining and Methods in the Birmingham District," *TAIMME*, *1925*, Vol. 72, by the American Institute of Mining and Metallurgical Engineers (New York: American Institute of Mining and Metallurgical Engineers), 1925, 157-186.

employ mechanical scrapers. By 1914, TCI was clearly experimenting with such loaders at its Muscoda mine. This was at about the time that the earliest such loaders appeared in the United States.[22]

The transportation equipment that moved ore from the headings to the main slope constitutes another activity where both districts converted to modern methods at about the same time. Before the turn of the twentieth century, the Birmingham Industrial District had employed small wood mining cars. The headings were driven on a slight upward grade so that the loaded cars could roll by gravity to the main slope. In the earliest Red Mountain mines, these smaller cars were dumped into larger cars that were mounted on tracks in the main haulageway and hoisted to the surface by wire rope cables. In later mines from this same early period, the opposite headings were staggered slightly and curved, where they connected with the slope, so that the "tram cars" could be switched from the headings onto the main haulageway and hoisted directly to the surface. After they were dumped and returned to the headings, mules pulled the empty cars back up the working face to be reloaded.

During the 1920s the Birmingham Industrial District began to replace mules with electric locomotives and abandoned its old wood ore cars for larger steel cars. While the Marquette District had moved almost universally to locomotives by 1925, some mines in the Birmingham District were still using mules in the 1930s. In cases in which mules were still in use at that late date, however, they were found only in the older sections of the mines. The newer sections had all shifted to locomotive haulage.[23]

There was also very little difference in the newer systems adopted in Alabama and Michigan to hoist ore to the surface. By 1925, a few mines in the Birmingham Industrial District still employed tram-cars that hoisted "trips" of five to eight loaded ore cars to the surface at the time. Following the lead of TCI, however, which had installed the first system of its type around the turn of the century, most mines had shifted to skip-car by 1925.

The hoisting engines and drums that pulled the tram cars and skips compared favorably with those in the Marquette District. Both districts had begun to convert from older steam-driven engines to electric motors by 1925, and their horsepower ratings and hoisting drum dimensions were also similar.[24]

This brief comparison indicates that once operators in the Birmingham Industrial District had shifted to large-scale underground mining, they pursued it with the same progressive methods that were employed in other districts. This also seems to confirm that the earlier open-trench mining methods were less attributable to technological backwardness than an indication that the terrain and geology of Red Mountain had at first offered conditions under which maximum amounts of ore could be extracted by using the simplest methods. Considering the fact that these

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[22] Elliott, et al., "Mining Methods of the Marquette District," 135; Crane, "Red Iron Ore Mining Methods," 167; C.E. Abbott, "A Limestone Mine in the Birmingham District," *TAIMME, 1935*, Vol. 123 (New York: American Institute of Mining and Metallurgical Engineers, 1935), 62-75; Ball and Beck, "Iron Mining in Muscoda No. 6," 32.

[23] Elliott et al., :Mining Methods of the Marquette District," 135; Crane, "Red Iron Ore Mining Methods," 176-178; De Sollar, "Iron Ore Mining on Red Mountain," 495-496; Crane, "Iron Mining in the Birmingham District," 277; Leland H. Johnson, "Trackless Mining Improves Ore Production for TCI," *Mining Engineering* 1 (December 1950): 1226-118.

[24] Ball and Beck, "Iron Mining in Muscoda No. 6," 30-31/

supposedly slipshod workings were the most productive in the United States, it would seem that the methods they used were more of a sign of rational adaptation to existing circumstances than of technological ineptitude.

Slope mines continued to penetrate ever more deeply into the ore seams of the Birmingham Industrial District until they extended for miles beneath Shades Valley. Iron and Steel production increased over the years, but as long as local red ore was the chief source of furnace burdens, the pace of expansion would be limited to some extent by the bottleneck created by the tightly-spaced string of slope mine openings overlooking Bessemer. The massive reserves of ore cited in trade journals and government publications were meaningless unless considered in terms of how efficiently it could brought to the surface through these few mine openings.

LIMITATIONS

Despite regular upgrades and changes in mining methods and equipment, it was apparent by the middle of the first decade of the twentieth century that slope mining on Red Mountain was becoming more complicated and expansive. Faults encountered in the Sloss Number One and Woodward Number One mines by about 1908 provided the first major evidence of this. Sloss encountered a fault of undetermined displacement at 1710 feet while the Woodward mine encountered a fault with a fifteen-foot displacement at 1,500 feet. This meant, in Woodward's case, that the ore seam suddenly stopped, terminating in a solid wall of rock. The other side of the ore seam lay fifteen feet higher on the downslope side of the fault. To get around the fault, Woodward was forced to terminate its main haulage slope at this point and establish a second haulage slope. Ore mined below the fault had to be brought up via the second slope, transferred to the main haulage slope, and hoisted to the surface. This meant that not only did Woodward have to maintain a second hoisting system, in this case located underground, but also had to handle each load of ore no fewer than three times before it reached the surface: once when it was loaded at the working face of the mine, a second time when it was transferred onto the second slope, and a third time when it was transferred from the second slope to the main haulage slope.[25]

Soon, virtually every slope mine in the Birmingham Industrial District had encountered one or more faults requiring the installation of secondary haulageways. In Woodward's case, the company's Number One Mine encountered a second fault at about 3,000 feet from the surface, requiring the installation of a third haulageway. This meant that every ton of ore had to be handled four separate times on its journey of more than one-half mile to the surface. To make matters worse, when the slope mines began to reach the base of the ore seams, they encountered not only more faults but also folds and other irregularities. Before long, some mines were forced to handle ore as many as eight or nine times before it reached the surface, with a concomitant rise in mining cost with each additional handling. The advantages provided outside the mines by the short distance from the face of Red Mountain to the blast furnaces in Jones Valley began to

[25] Buchard, Butts, and Eckel, *Iron Ores, Fuels and Fluxes,* 69-71: Tenney C. DeSollar, "The Red Ore Mines of the Woodward Iron Company at Bessemer, Alabama," *TAIMME,* 1939, vol. 127, by American Institute of Mining and Metallurgical Engineers (New York: American Institute of Mining and Metallurgical Engineers, 1939), 69-77.

fade quickly as the cost of underground haulage increased. At this point, operators began to consider alternative means of accessing the Clinton formation.

The Steep Slope and Shaft Mines of Shades Valley

Theoretically, the best solution appeared to be to abandon the slopes once they exceeded optimum lengths and access the remaining ore beds from vertical shafts or steep slopes that tunnel down to the ore beyond the troublesome areas. In the Birmingham Industrial District, this meant opening mines on the opposite side of Red Mountain on the wide, gently-rolling surface of Shades Valley, which lay as much as 1,900 feet above the ore seams. W.R. Crane, a nationally-renowned mining expert who established a local office of the U.S. Bureau of Mines wrote extensively about ore mining on Red Mountain presenting exhaustive, detailed reasoning in favor of such a strategy.[26]

By the mid-1920s, three such mines had already been established. The first was the Shannon Mine, a very steep slope mine that extended downward for 2,482 feet at a 51.5 degree angle before it struck the ore seams. The Gulf States Steel Company had begun construction of this mine not long before 1920. After several years of tunneling through rock, it had finally begun to mine its first ore during the summer of that year.[27] Two vertical shaft mines were installed for the Woodward Iron Company. Woodward contracted the jobs to the E.J. Longyear Company of Minneapolis, Minnesota, which started work on the 1,214 foot Pyne shaft on 11 August 1918 and struck ore on 13 May 1919. The Songo shaft was opened even more quickly because it was only 384 feet deep and was designed to intersect the underground working of Woodward's Songs slope, which entered the ore seam from the face of Red Mountain.[28]

Despite the problems that plagued their slope mines and the fact that they now owned the only two such mines ever opened in the District, Woodward's owners retained a prejudice against shafts in Shades Valley. They argued that the transition to shaft mining would result in the loss of equipment in use in the old slope mines, as well as the transportation systems and worker housing that had been built on the Jones Valley side of Red Mountain. They also cited the cost of sinking and maintaining the new mines because water-bearing strata that overlay the ore seams would create complicated and expensive technical problems. Finally, company officials argued that their mines would resist working mines where the only ingress and egress was by means of cages or skip cars.

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[26] The exact depth of the workable ore beds beneath Shades Valley is variable, but a diamond drill test cited by P.B. McDonald in 1914 struck ore at 1902 feet. See McDonald, "Iron Ore Mining in the South," 790.
[27] James Bowron, "The Southern Iron and Steel Industry," *Iron Age* 94 (November 1914): 1126-28, 1184-86, 1228-30; "Alabama," *Engineering and Mining Journal* 109 (June 1920): 1286.
[28] J.S. Crawhall, "Cement Grouting Solves Serious Mine Water Problem: Francois Cementation Process Used at Shannon Mine of the Gulf Shores Steel Co.," *Engineering and Mining Journal* 127 (April 1929): 675; John V. Beall, "Opening the Pyne Mine of the Woodward Iron Co., *Mining Engineering* 187 (December 1950): 1230; J.H. Stovel, "Sinking and Concreting of Pyne and Songo Mines," *Engineering and Mining Journal* 3 (1921): 698; Dyer, "Alabama Iron Mining," 180.

Crane dismissed Woodward's arguments on several grounds. As far as the labor problem was concerned, he insisted that conditions would actually improve after miners were moved to isolated villages in Shades Valley, away from the influences of the city that lay to near on the other side of the mountain. He also asserted that the company would easily recover the heavy capital investment through substantial reductions in mining costs and the increases in productivity that would accrue from the improved mining system that could be built around the new shaft mines.[29]

Problems with the Shannon Slope

Crane's arguments lost their persuasiveness almost from the time he presented them. This was due in no small part to problems that were encountered opening the Shannon Slope. After expending substantial funds to drive half-mile long main haulageway through rock, then line it with concrete, Gulf States Steel had only been able to extract ore for about four years when an immense flow of water began to pour into several secondary slopes through a large fault. The water blasted into one section under the incredibly high pressure of 950 pounds per square inch and was accompanied by heavy flows of pyritic mud and pebbles as well as hydrogen sulphide gas.[30]

Gulf States soon realized that specialized help would be needed to correct the problem. The company signed an agreement with the Dravo Contracting Company of Pittsburgh, which had recently secured the American rights to employ the Francois Cementation process, developed by the Francois Cementation Company of London, England. The Francois process was a sophisticated procedure for injecting fine flows of grouting cement under as much pressure as 3,000 pounds per square inch into cracks and cavities in rocks. The process was so effective that it could seal anything from massive cracks to hairline fractures. After several months' time had elapsed and a variety of serious obstacles had been overcome, including flooding and injuries to the eyes of workers who came into contact with the hydrogen sulphide gases, the water flow had been stopped. There was no guarantee that further water would not be encountered, however, and the complex engineering project had been watched closely by other mine operators in the District. Trying to convince doubters, the Dravo Company argued that "never before in the history of mining has water been encountered in such volume and under such pressure, and it is certain that no organization has previously succeeded in stopping an underground flow under such conditions."[31] The message that came across louder than Dravo's admirable technological feat, however, was the fact that the Shannon Slope had become a type of operation that would be much better avoided.

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[29] W.R. Crane, *Iron Ore Mining (Hematite) Practice in the Birmingham District,* U.S. Department of Commerce, Bureau of Mines, Bulletin No. 239, (Washington, D.C.: GPO, 1926), 22-25; and *Development, Mining, and Handling Ore in Folded and Faulted Areas, Red Iron Ore Mines, Birmingham District, Alabama,* U.S. Department of Commerce, Bureau of Mines, Technical Paper No. 407, (Washington, D.C.: GPO, 1927), 20-23.
[30] Crawhall, "Cement Grouting Solves Serious Mine Water Problem," 675.
[31] Ibid., 680.

Because of the Shannon mine lesson, no other steep slope or shaft mines were ever opened in the Birmingham Industrial District. The Pyne shaft, for no apparent reason that has survived in the historical record, was not put into operations until several decades after it was completed. It lay idle until the abnormal demands of World War II brought it into production, perhaps for the first time since its construction in 1919.[32] Instead of taking the risks that shaft mines might entail, mine operators chose to continue operating their slope mines by pushing farther out from the maze of secondary haulage slopes that had been made necessary by the geological conditions that they had encountered in the ore basin below Shades Valley.

CONCLUSIONS

The glowing predictions of early boosters had not been entirely incorrect. The iron ore of Red Mountain would continue to meet the raw material demands of a major regional iron and steel center for nearly three decades beyond the time frame of this essay. But this feat would not be accomplished with anything approaching the ease that had been predicted, and Birmingham would never overtake Pittsburgh to become the nation's largest steel producer. This shortfall would be due in part to the constraints imposed by the geology of the Clinton formation which forced local ore miners to retain long, narrow, and cumbersome slope mines that stretched from their openings on the mountain side for several miles into troublesome ore seams.

[32] Beall, "Opening the Pyne Mine," 1230.

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