1998

Smoke and ash| A study of 19th-century charcoal production in Montana and Idaho using parabolic beehive kilns

Dan Gard

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SMOKE AND ASH: A STUDY OF 19TH-CENTURY CHARCOAL PRODUCTION IN MONTANA AND IDAHO USING PARABOLIC BEEHIVE KILNS

by

Dan Craig Gard

B.A. University of Montana Missoula

Presented in partial fulfillment of the requirements

for the degree of

Master of Interdisciplinary Studies

History /Anthropology

The University of Montana

1998

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[Signatures]

Chairperson, Board of Examiners

Dean, Graduate School

8-31-98

Date
Gard, Dan Craig., M.A., 1998

Interdisciplinary Studies - History / Archaeology

"Smoke and Ash: A Study of 19th-Century Charcoal Production in Montana and Idaho Using Parabolic Beehive Kilns."

Chairman: Thomas A. Foor

For more than a century mining shaped the industrial landscape of Montana and Idaho. Boom and bust cycles of exploration and exploitation left an indelible mark upon these two states. Today, a few weathered buildings and rusted machines stand in mute testimony to a once vibrant, but often short-lived, frontier mining industry. Hidden away among a few secluded valleys are less obvious symbols of the early mining industry; large, parabolic beehive charcoal kilns, features that were unique, yet critical, to the process of turning raw ore into gold, silver, or lead.

As a method of producing charcoal, beehive kilns stand at the evolutionary apex of an age-old technology. The charcoal produced in these kilns burned in smelter furnaces, roasters, and boilers across the West and helped transform precious and base-metal ores into marketable bullion.

Charcoal production, along with the mining industry, was part of a modern world system that brought financial and technological resources to bear on the exploitation of mineral resources throughout the western United States. The charcoal operations included in this study were intricately linked to this system.

This study focuses on charcoal production and use at three specific locations; Canyon Creek and Wickes in Montana, and Birch Creek in Idaho. What is the history of charcoal use in each site? What are the structural similarities and variations of charcoal kilns found at these sites? Do these kilns follow a pattern of standardized industrial technology? What types of human behavior and land use patterns are discernable? And, finally, what factors, either local, national, or international, led to construction of these kilns and their rapid abandonment?

Using an historical and archaeological approach, a comprehensive study offers answers to these questions. From this study comes a better understanding of a unique fuel production process and its relationship to the mining, milling, and smelting of base and precious metals during the late 19th-century in Montana and Idaho.
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ACKNOWLEDGMENTS

It took a long time to complete this project and there are many who helped along the way. First, I offer my sincere appreciation to my graduate committee, Drs. Tom Foor, Dale Johnson, and Richmond Clow, for sticking with me all these years. Their frequent admonishments kept me going! I am especially indebted to Dr. Clow for helping with final review and revision.

I have been helped immeasurably by those I am fortunate enough to work with. A very special thank you to Keith Thurlkill and Milo McLeod, for moral support, reasoning, and allowing me the time I needed to bring this thesis to completion. To Mike Ryan, whose research at Canyon Creek opened many doors for me, thanks for all you’ve taught me on our PIT projects over the past few summers. Mike Beckes helped me stay focused when things began to blur. Tim Light and Mary Horstman shared thesis experiences and advice that I actually heeded.

I am deeply indebted to my longtime friend and cohort, Steve Rumley, an accomplished artist and engineer, who helped with kiln measurements and created the technical drawings used in this thesis. I promise never to ask another question about metric conversions!

My family and friends provided encouragement and support from the day I started this project and it has never wavered. I am blessed to have all of you in my life.

And finally, there aren’t enough words to thank my wife, Kimberly. Without her patience, prodding, understanding, love, and unflagging faith, I would have never arrived at this point. Thank you for not letting me give up.
Chapter 1
Charcoal - The Soul of Fire

Mankind, though feeble and short-lived, now has flaming fire and therefrom learns many crafts.
Hesiod

From 1875 to 1890, mining and smelting operations throughout Montana and Idaho relied heavily upon charcoal fuel. Nearly a decade before the railroads reached this remote part of the United States carrying coal, charcoal fires burned hot in reverberatory and blast furnaces that turned precious and base-metal ores into silver and lead bullion. Charcoal heat also turned water to steam, which powered milling machinery and equipment such as hoists, pumps, and stamp mills. At smelters throughout this region, ancient and modern methods of producing charcoal worked side by side; temporary earthen pits and permanent parabolic brick beehive kilns. The few beehive kilns left standing today are a testimony to the significant role charcoal played in the early industrial and economic development of Montana and Idaho.

For centuries, charcoal played an important role as a fuel in mankind’s technological evolution. The intense heat it generated helped to usher in the Age of Metals. Such is its character that the ancient Chinese referred to charcoal as the soul of fire. After the Chinese invented gunpowder by mixing charcoal, saltpeter and sulfur, it was used not only to light up the sky with fireworks, but changed forever the way mankind engaged in hunting and warfare. Charcoal's porosity and ability to absorb poisons lent itself as a medicine, one still used today. The black, durable marks it leaves
make charcoal useful as an artist's tool, its timeless quality attested to by prehistoric drawings found on rocks and cave walls (Uhlmann and Heinrich, 1987: 69).

The use of charcoal in metals production dates back more than two millennia, when the Haya people of Africa made carbon steel in simple mud furnaces by forcing air over a charcoal fire containing iron ore (Schmidt and Avery, 1978: 1085-1087). By the 19th century, charcoal was still being used to smelt iron, but the mud ovens had evolved into state-of-the-art blast furnaces. The intense heat it produced and its ability to cause important chemical reactions in metal-bearing ore made charcoal an invaluable resource.

An example of the chemical interaction between charcoal and metal takes place when iron is smelted. A charcoal-fueled fire produces carbon monoxide, creating an oxygen-starved environment known as a reducing atmosphere (Uhlmann and Heinrich, 50-51). As carbon molecules from the charcoal displace oxygen molecules in the iron ore, the melting point lowers (Delmonte, 1985: 241; Schallenberg, 1975: 343-344). Once liquefied, iron can be poured into castings to create cast iron. Carbon molecules absorbed from the charcoal made cast iron resistant to heat and useful for utensils such as cooking pots and firebacks. However, the high carbon content also made the iron brittle and difficult to forge. To overcome this problem hot iron was pounded with hammers, a process that drives out some of the carbon and helps create a stronger, more malleable material known as wrought iron (Uhlmann and Heinrich, 91-93).

The rise of cast and wrought iron technology brought a dramatic increase in demand for these metals. The introduction of the blast furnace in the 15th century helped lower the cost of making iron and it quickly became an affordable and popular
construction material. To keep pace with demand, British iron manufacturers needed ever increasing amounts of charcoal to fuel their furnaces. Charcoal's popularity as a furnace fuel reached its zenith in league with iron production in the late 14th century (Uhlmann and Heinrich, 96-99).

As charcoal use increased, Britain found itself facing a timber-based energy crisis. The forests of England, Wales, and Ireland suffered assaults on several fronts. Along with timber needed for charcoal, large tracts of land were cleared for agricultural purposes. By the mid-1500's, deforestation threatened Britain's national security as tall, straight trees used for masts on war ships became scarce. The intensive harvesting of wood for charcoal only added to the devastation of Britain's once vast forests and brought about laws to regulate timber cutting (Schubert, 1957: 218-222; White, 1983: 106-107).

As British iron manufacturers faced the consequences of widespread timber shortages and a corresponding increase in charcoal prices, they began searching for an alternative fuel. During the 1600's, bituminous coal was used in industries such as brick making, dying, brass-casting, and brewing. Brewers found that the heat from coal fires helped dry their hops efficiently. However, it also imparted the taste of sulfur to their beer, which proved an unacceptable consequence (Uhlmann and Heinrich, 109).

An early attempt to use coal in iron production took place in 1613, when John Robinson, an iron maker, obtained sole rights to produce iron using coal. Unfortunately, coal failed as a smelter fuel. It burned fitfully, gave off sulfurous smoke, and contained impurities that made it unsuitable for most metallurgical processes (White, 107; Ashton,
9-10; Schallenberg, 343). Because Great Britain held great reserves of coal, finding a way to utilize this natural resource became a pressing national issue.

The key to using bituminous coal lay in purging it of sulfur and other impurities. A host of patents issued over the years failed to develop a successful process. Finally, in 1709, a foundryman in Cokebrooksdale, England, discovered that by roasting coal in dirt-covered heaps drove off impurities and made it burn cleaner and hotter. With its impurities gone, coal could now be used for making iron. Abraham Darby called his new process charking (coking) and it paved the way for the widespread use of low-grade bituminous coal as a smelter fuel throughout Britain and Europe (Kelly, 1896: 12-13).

The introduction of coked coal eventually brought an end to charcoal iron production in Britain. Between 1760 and 1770, thirty-one coke-fired blast furnaces went into operation. Concurrently, charcoal iron foundries ceased to be built after 1756, and by 1790 only 25 remained in operation (Ashton, 24-31; Deane, 1965: 106; Uhlmann and Heinrich, 109-111).

While the British iron industry abandoned charcoal as a fuel for metallurgical processes by the end of the 18th century, the transition from charcoal to coal occurred more slowly in the United States. Despite new smelting technology developed overseas, the use of charcoal in iron production continued in most parts of the eastern United States until the 1890's (Schallenberg, 342). There are several explanations why American iron manufacturers were reluctant to give up their charcoal fuel. First, with the exception of smelting regions like New England, whose forests were already badly overharvested, timber continued to be a cheap and plentiful resource. Second, finding coal suitable
for coking proved difficult prior to the discovery of vast reserves in Pennsylvania. Finally, the lack of an adequate rail transportation system made locally available timber a more cost effective fuel than coal shipped in from outside sources (Bining, 1938: 72-73).

In the western United States during the nineteenth century, a different kind of metallurgical process took place, one that initially relied almost completely upon charcoal fuel. The recovery of silver and its associated by-product, lead, required heat for a variety of purposes. Silver and lead smelting, a process that entailed everything from initial crushing to the refinement of finished bullion (Fay, 627), used charcoal to fuel blast and reverberatory furnaces. Heat from charcoal fires also made steam that ran ore breakers, stamp mills, and other machinery necessary in the reduction process.

For smelting operations in Montana and Idaho, the use of charcoal fuel was a matter of availability and simple economics. While Pennsylvania held great reserves of high quality anthracite coal, the American West held vast acres of timber ready to be cut and turned into charcoal. Federal laws helped provide that resource at little or no cost.

The Mining Act of 1872 made it possible for those holding mining claims to use all of the resources contained within the parameters of their claim, above ground and below. Several years later the 45th Congress passed an act that gave bona fide residents of western Territories, including Montana and Idaho, the right "... to fell and remove, for building, agriculture, mining, and other domestic purposes, any timber or other trees growing or being on the public lands..." (U.S. Statutes at Large..., 1879: 88).

In the years prior to management of public lands by federal agencies, mining operations often exploited timber resources, cutting down vast acres of trees without
concern for its long-term effects. The Organic Administration Act of 1897 continued to allow the cutting of timber for mining purposes under 16 U.S.C. 477, but under more closely controlled conditions as spelled out in special use permits. For example, U.S. Department of Agriculture regulation L-2 (G) provides free use of national forest land for small charcoal burning operations using wood purchased from federally-managed land (U.S. Department of Agriculture, 1928: 24L) (photo 1-1). The scars left behind by the cutting of timber for 19th-century charcoal production and mining purposes, as well as open pit charring, can be seen today in the scarred or barren lands that surround many mining sites throughout Montana and Idaho.

Photo 1-1. Construction of an earthen charcoal pit, Deerlodge National Forest, circa 1920. (U.S. Forest Service photo)
Access to vast amounts of timber allowed claimants, most often the mining companies themselves, to harvest wood and make charcoal wherever convenience and economy dictated. Using temporary earthen kilns called pits, this ancient form of charcoal-making became a common feature at many frontier mining operations.

Following the introduction of permanent brick charcoal kilns in the late 1860's, both pit and kiln charring methods were often used together. Smelter operators assured themselves of a steady, uninterrupted supply by purchasing pit charcoal in addition to that produced by their own permanent kilns. It also assured them the best price whenever pit charcoal became available at a lower cost than that produced in their own brick kilns.

The arrival of the railroads in the 1880's gave many frontier smelting operations access to an even cheaper, more abundant fuel; coal. Yet, despite its lower cost and availability, coal did not displace charcoal as a blast furnace fuel until the early 20th century. Many silver and lead smelting operations throughout the West took advantage of new blast furnace technology that allowed the use of coal, charcoal, or both (White, 109; Williams, 1987: 114).

For example, after the Helena and Jefferson County Railroad laid tracks into Wickes in 1883, the smelter brought in new coal-burning furnaces and began using coal. Because it could be purchased and delivered in vast quantities, rail transportation made coal cheaper to use than locally manufactured charcoal. The Helena Reduction and Smelting Company continued to use charcoal while its smelter furnaces underwent conversion to coal, but never again did they rely solely upon charcoal as either a primary fuel or as flux. Instead, they used whichever fuel was readily available and more
affordable. Charcoal production at the Wickes kilns ceased completely after the shutdown of the smelter in 1889. The company dismantled the smelter and shipped it to East Helena, Montana, where it was rebuilt and formed the nucleus of a new lead reduction facility (Grey, 1995: 37).

Other smelter operations used coal and charcoal concurrently. Following establishment of a Utah and Northern Railroad railhead at Melrose, Montana in 1880, the Glendale smelter began stockpiling coal. For the next ten years the Hecla Consolidated Mining Company fired its furnaces with charcoal and coal together. The coal was shipped by train from Pennsylvania to Melrose (Ryan, 1988: 16-17). From there, freight wagons hauled it three miles to the Glendale smelter, where it was mixed with charcoal from the Hecla kilns at Canyon Creek just prior to being fed into the furnaces. At one point, up to 1,000 tons of coal, delivered to the site at $19.00 per ton, lay stored in a coal shed adjacent to the smelter (Sassman, 1941: 244).

For many mining operations, the arrival of a rail transportation system spelled the end of their reliance upon charcoal fuel. The railroads gave them access to the latest in mining technology, including coal-fired milling and smelting equipment. By 1900, coal stood alone as the primary fuel used in nearly all metallurgical processes throughout the United States. Oil and electricity would later replace coal. As the 20th-century dawned, the charcoal pits and beehive kilns that provided fuel for silver and lead smelters across Montana and Idaho began to slowly disappear from the mining landscape.
Chapter 2

Smoke and Ash: Turning Wood to Charcoal

Charcoal by the bushel,
charcoal by the peck,
charcoal by the frying pan,
or any way you leck.
Old charcoal vender's cry

Permanent beehive charcoal kilns and earthen charcoal pits dotted the mining landscape of the American West during the latter part of the 19th century. Today, only a few scattered beehive kilns stand as testimony to the important role charcoal played in the mining and processing of precious metals. Charcoal fueled everything from steam-powered hoists and rock crushers, to state-of-the-art blast furnaces. For many years it was the only smelter fuel available prior to the arrival of coal, oil, and eventually, electricity. Because of this, charcoal played a crucial role in the early industrial and economic development of Montana and Idaho.

Charcoal aided in the smelting process by fueling the fires that boiled water and made steam-powered machinery run. Charcoal also burned in reverberatory furnaces, its heat helping separate precious and base metals from their ore, or gangue. A steady stream of forced air caused charcoal to burn even hotter in blast furnaces, bringing metal-bearing ores like gold, silver and lead to their melting point. Not until coal could be delivered less expensively by train was any other type of fuel available.

Charcoal kilns represent the apex of an evolutionary process in charcoal production, one that began roughly 7,000 years ago as mankind approached the dawn of the Copper Age (Uhlmann and Heinrich, 50). During that time, prehistoric people used
red hot coals to force copper, gold, silver, and other important metals, from the rocks that held them. Once released from their ores, that same intense heat helped shape those metals into jewelry, tools, and weapons. For thousands of years charcoal provided the heat and power mankind needed to master metal.

Charcoal results from burning wood within an enclosed environment under controlled conditions. The wood must undergo a slow refinement process, referred to as charring, in which heat is used to drive moisture and volatile chemicals from the wood. This process began centuries ago as a folk craft and slowly evolved to become an industry itself, as seen by the number of earthen and permanent beehive charcoal kilns once used throughout the United States (O'Rourke, 1997: 19).

One of the earliest ways of making charcoal was to fill a hole in the ground with wood, set kindling ablaze inside the pile, then cover the hole with dirt and leave the wood to smolder. Hundreds of years later that process evolved to the point of using two-story parabolic beehive charcoal kilns. The beehive kilns at Canyon Creek and Wickes in southwest Montana, and Birch Creek in eastern Idaho, represent the evolutionary apex of a unique and ancient charcoal-making process.

To understand how charcoal is made, one must first understand what charcoal is and why it makes such an efficient fuel. While seemingly a simple substance, charcoal is itself unique. It can be defined as:

... the residue of solid non-agglomerating organic matter, of vegetable or animal origin, that results from carbonization by heat in the absence of air at a temperature above 300 degrees Celsius (Emrich, 1984: 13).
Just as charcoal provides heat, it takes heat to create charcoal. While the term *charcoal burning* is often used to describe the process, the wood is never burned (Peirce, 1883: 253). Instead, it is roasted in an enclosed environment using a *dead fire*, which burns without flame (Uhlmann and Heinrich, 124). Exposure to low, sustained temperatures of approximately 300 degrees Celsius over an average period of ten days drives off gases and volatile organic properties within the wood. These properties include water, acetic acid, tar (pyroligneous acid), carbonic oxide, hydrogen, and carburated hydrogen. As the gases and chemicals are purged, the substance left behind is nearly pure carbon; porous, lightweight, and capable of burning hot, clean, and almost smoke free (Percy, 1875: 353; Overman, 1851: 102-103). Figure 2-1 illustrates the basic properties of charcoal.

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<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
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<tbody>
<tr>
<td>% Carbon</td>
<td>85.89</td>
<td>85.18</td>
<td>87.43</td>
</tr>
<tr>
<td>% Hydrogen</td>
<td>2.41</td>
<td>2.88</td>
<td>2.26</td>
</tr>
<tr>
<td>% Oxygen &amp; Nitrogen</td>
<td>1.45</td>
<td>3.44</td>
<td>0.54</td>
</tr>
<tr>
<td>% Ash</td>
<td>3.02</td>
<td>2.46</td>
<td>1.56</td>
</tr>
<tr>
<td>% Water</td>
<td>7.23</td>
<td>6.04</td>
<td>8.21</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
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I = Beech wood charcoal from piles  
II = Hard charcoal from wood-vinegar-works  
III = Light charcoal from wood-gas-works

**Figure 2-1. Properties of charcoal (from Percy, 1875: 354).**

In addition to heat, a critical step in the charring process is controlling the amount of oxygen entering the kiln. If allowed an unregulated flow of air, a controlled roasting process quickly becomes an inferno, consuming the wood within the kiln and leaving
only smoke and ash (Overman, 103). For this reason, wood was charred in an enclosed
environment, as under a thick covering of charcoal dust and earth, or within a sealed
oven, such as a retort or kiln, where oxygen flow to the fire could be carefully controlled
(Uhlmann and Heinrich, 125). In the case of brick kilns, oxygen flow was managed by
opening and closing air vents located around the base. The exothermic reaction that takes
place within the kiln is called dry distillation (Percy, 353). The result is charcoal:

    ... that is black; gives a sonorous ring when
struck; breaks with a more or less conchoidal fracture; is
easily pulverized, but does not crumble under moderate
pressure; does not sensibly blacken the fingers when it is
rubbed against a freshly fractured surface, or make a mark
which cannot be easily rubbed off; floats on water, does not
burn with flame when ignited in separate pieces
(Percy, 353).

A fire fueled by dried wood cannot reach the temperatures required for roasting
and smelting precious metal ores. With a heat value of approximately 13,000 British
Thermal Units per pound, charcoal can reach temperatures in excess of 2,000 degrees
Fahrenheit, hot enough to fuel a host of metallurgical and industrial processes (Forest
Products Laboratory, 1961: 3). Throughout Montana and Idaho, charcoal proved an
excellent fuel for blast and reverberatory furnaces, as well as steam boilers.

Charcoal’s quality as a furnace fuel for the smelting of iron, precious metals, and
base metals, can be attributed to two primary factors; porosity and purity. The porous
nature of charcoal means oxygen and fuel interact more readily, allowing it to burn with
greater intensity and generate greater calorific output. Purity means the absence of
unwanted materials, such as sulfur and other minerals.
Charcoal's primary weakness as a smelting fuel lay in its friability, or lack of firmness. Because of its porosity, charcoal lacked structural strength and often could not stand up under the heavy weight of a charge, the mixture of ore and flux that went into the blast furnace along with raw ore (White, 108-109).

The key to producing quality charcoal lay in the hands of those who built, fired, and carefully tended the pits and kilns. These were craftsmen in their own right, working in what many considered a dirty, undesirable trade. Toiling in the midst of thick smoke and charred wood turned their skin and clothing black, giving them the name colliers, a term applied to coal miners. In Italy, charcoal burning has a long history and the men who carried out this trade called themselves carbonari. They formed a guild that became a secret society known as the Carbonari, which opposed attempts by the Holy Alliance to reestablish the political system that existed in Italy prior to 1789 (Earl, 1969: 53).

Colliers lived and worked on the periphery of the mining complex, often shunned by miners, teamsters, and smelter operators because of the dirty nature of their work. In this country, charcoal-making was called the "blackest job in America" by those who found this smoky, foul smelling task objectionable. Despite their soiled reputation, a collier's ability to read the smoke from a smoldering pile of wood made them, and the product of their labor, an important adjunct of the mining and metallurgical industry (Earl, 1969: 55; Murbager, 1965: 26; Uhlmann and Heinrich, 116-124).

Although the art of making charcoal is thousands of years old, written descriptions of the process do not appear until the Renaissance. Throughout his 16th-century treatise, De Re Metallica, Georgius Agricola refers to charcoal in the making of iron and smelting
of metal-bearing ores (1950, passim). In another work of the same period, titled *The Pirotechnia of Vannoccio Biringuccio*, Italian metallurgist Biringuccio described charring wood in stacked piles and underground pits (illustration 2-2, 2-3).

To produce the best charcoal, which Biringuccio called *appagliario*, wood was carefully piled in a heap resembling a "round pyramid or haystack," (Biringuccio, 1942: 175-179) that later became known as *heaps, meilers*, or more commonly, *pits*. The pit was covered by a thick layer of dirt, creating a nearly airtight chamber. Within this enclosed environment only the oxygen required to maintain a low-temperature roasting heat of approximately 300 degree Celsius was allowed to reach the fire. This was achieved through the use of air vents located throughout the pit.

As smoke and steam rose from the chimney vents, colliers carefully monitored its color. Each change in color meant the wood had entered a different stage in the charring process. White smoke meant water was being purged in the form of steam. Later, the smoke turned clear, indicating the charcoal was near completion.

Biringuccio describes an even simpler method of charring that used a shallow, underground pit. The pit consisted of a hole in the ground filled with wood which, after ignition, the collier covered and sealed tight with earth. Both methods used vents to release steam and gases from the burning wood. Over time the simple concept behind Biringuccio's earthen kiln and underground pit evolved into the parabolic beehive charcoal kiln, a feature common to the mining landscape of Montana and Idaho three centuries later.
Illustration 2-2. Pit charring (from Biringuccio, 1940: 178).

Illustration 2-3. Earthen kiln (from Biringuccio, 1940: 177)
By the mid 19th-century, charcoal-making evolved to become a skill worthy of technical research and writing. In 1851, mining engineer Frederick Overman wrote *The Manufacture of Iron in all its Various Branches*, which offered an in-depth look at mining and milling practices, including charcoal distillation. Overman’s book includes illustrations that help to better understand the structure of earthen and permanent kilns. Two decades later a Swedish engineer, known only as G. Svedilius, devoted an entire book to the subject of charring wood when he published *Handbook for Charcoal Burners* (1875). Svedilius provides detailed information that focused almost solely on earthen kilns known as *pits* or *meilers* (illustration 2-4).
Charcoal pits were built on a large, circular area of ground approximately 16 to 17 feet in diameter. This area, known as a hearth, was first cleared of vegetation and exposed roots. A chimney was constructed by driving long poles into the ground in a small circle near the center of the hearth. The chimney allowed steam and gases to escape during charring. Precut lengths of wood, called billets, were then stacked carefully around the chimney, working outward from the center. Once the billets were stacked in a mound to a height of approximately seven feet, the entire structure was covered with a thick layer of charcoal dust and dirt (illustration 2-4). After igniting tinder placed inside the chimney, the pit was sealed and allowed to smolder (Svedelius, 45-81).

The final step involved poking holes in the dirt covering to serve as air vents. These were opened or closed as the roasting fire moved throughout the pit. After 8 to 10 days, the air vents were sealed tight in order to smother the fire. In some cases, water was poured in through the top. With the fire extinguished, workers removed the dirt cover, raked out the charcoal, and placed it in bags (Svedelius, 72-93).

**Brick Charcoal Kilns**

Since mankind began making charcoal, it was done using simple earthen pits. Little changed in that process until the mid-1800's, when permanent charcoal kilns were developed and began to gain prominence. Made of sheet iron, masonry, or most commonly, brick, permanent charcoal kilns first appeared just prior to the Civil War (Shallenberg and Ault, 1977: 453). These structures attracted the attention of mining engineers, and others associated with the mining industry, as a better way to make charcoal (illustrations 2-5 and 2-7).
Called ovens, retorts, or most often, kilns, they were an improvement over earthen pits for several reasons. First, the covering of dirt and charcoal dust used to seal an earthen pit often became mixed with the charcoal. This contamination introduced unwanted minerals into the burning fuel and flux mixture. A permanent kiln offered a clean, enclosed, weatherproof environment that allowed charring to take place during periods of rain, snow, or heavy wind that could adversely effect an earthen kiln. Second, vents located around the base of a permanent kiln could be opened and closed to allow precise regulation of airflow entering the kiln and thus control the rate of burn inside. This helped produce a stronger charcoal that was less likely to crush under the weight of
the *charge*, a mixture of charcoal and flux, in a blast furnace (Rolando, 1994: 154). Third, permanent kilns seldom collapsed. This proved a common problem in earthen kilns because of their fragile interior structure. As water and gases were driven off, the wood underneath contracted and shifted, causing the structure to become unstable.

Despite the benefits of charring wood in permanent brick kilns, they too had their drawbacks. Brick kilns were expensive to build, with costs ranging between $500 and $1,000 each (Murbarger, 1965: 27) depending on location, labor costs, and access to building materials. Unlike earthen kilns that could be built wherever convenient, permanent kilns were usually located near water, roads, or rail transportation in order for wood to be delivered and charcoal hauled away.

And finally, although not a common problem, brick kilns had the potential to explode if not carefully handled. This could occur after sealing the air vents to extinguish the roasting fire inside. Reopening the vents too soon allowed oxygen to reach the fire, igniting unburned gases inside the kiln and setting off an explosion. In 1889, another type of explosion took place at the Trapper Creek kilns, owned by Hecla Consolidated Mining Company. According to Hecla General Manager, Henry Knippenberg, green wood burning in one of the kilns produced so much steam that the sealed kiln exploded when it could no longer contain the internal pressure (James Eighorn, personal communication, April, 1998).

Mining engineer Frederick Overman offers one of the earliest accounts of permanent charcoal kilns in an 1851 report on mining practices. Though his information on charcoal production applies primarily to pit charring, Overman devotes several
pages to describing what he calls "char-ovens" (Overman, 1851: 110). He writes that the char-oven had been "brought to a state of perfection" and all that is required to build a good oven is "close joints and good brick" (ibid). Overman places considerable emphasis on the importance of proper brickwork during construction. Mortar should be made of common loam mixed with coal tar, with sea salt added as a curing agent. The bricks must be well mortared and joints broken (no overlap) to assure an airtight kiln (Overman, 110-111).

In 1879, Dr. Thomas Egelston presented an excellent narration of permanent charcoal kilns before the American Institute of Mining Engineers. Egelston's paper, titled "The Manufacture of Charcoal in Kilns," was later published in the Transactions of the American Institute of Mining Engineers. Egelston analyzed physical and technical attributes of permanent kiln structures, as well as their practicality (Egelston, 1880: 373-397). He recognized the importance of charcoal in metallurgical processes, and through his experiments, Egelston demonstrated that permanent kiln structures, particularly conical-shaped, produced the best fuel for this purpose. William Buckles attests to the popularity of this style of kiln, stating that "Conical kilns similar to those described by Egelston, occur predominately and widely in the western United States, and many may have been constructed as consequence of his research results" (1978: 785).

Among other features, Egelston's report compared the size and capacity of conical charcoal kilns located in Platteburg, New York, Wassaic, New York, Reedsboro, Vermont, and American Forks Canon, Utah (Egelston, 391) (figure 2-6). Notable
<table>
<thead>
<tr>
<th>Diameter (ft. at base)</th>
<th>Height (ft.)</th>
<th>Kiln Capacity (cords)</th>
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<tbody>
<tr>
<td>1</td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
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<td>3</td>
<td>30</td>
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<td>4</td>
<td>28.6</td>
<td>28</td>
</tr>
<tr>
<td>Average</td>
<td>28.6</td>
<td>22.75</td>
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(1 = American Forks Canon, Utah)
(2 = Plattesburg, New York)
(3 = Wassaic, New York)
(4 = Reedsboro, Vermont)

Figure 2-6. Conical kiln dimensions and capacities (from Egelston, 1880: 390).

components of these and other conical kilns included two loading doors, as shown in figure 2-5 and 2-7. The lower door was larger and used for loading the bulk of the wood into the kiln. The smaller, upper door came into use as a way of filling the top portion of the kiln after the lower part had been loaded.

Another feature of Egelston's conical kilns was the use of three rows of air vents surrounding the base that could be opened and closed to control oxygen flow (Egelston, 390-393). Egelston also noted that kilns were often built against the side of a hill to facilitate loading through the upper door (Egelston, 390) (illustration 2-7). Interestingly, each one of these features is also found in parabolic beehive kilns studied at Canyon Creek, Birch Creek, and Wickes (Gard, field notes, 1997). Buckles also describes similar features found on beehive kilns he studied in Colorado (Buckles, 814).

A style more common to western charcoal operations was the parabolic beehive kiln. Like the conical style, the beehive kiln had three rows of air vents built into the
lower portion of the kiln. The beehive kiln also had upper and lower loading doors. After being filled with wood, these doors were closed and sealed with thick, metal plates prior to ignition (photographs 5-4, page 50, and 7-9, 7-10, pages 70 and 71). The most notable difference between beehive and conical kilns lay in the shape of the dome.

Similar to the conical kiln in its size and circular shape, the parabolic beehive kiln had more rounded dome. This arched dome had no internal support, so to counteract the effects of heat expansion and cooling contraction, wooden or cable banding was used to lend support to the rounded ceiling of the kiln (photos 7-9, page 60, and 8-7, page 82).

Beehive kilns were first introduced in Michigan in 1868 by mining engineer J.C. Cameron (Notarianni, 1982: 42). Cameron described the beehive kiln as having:

... a parabolic dome, with a base of twenty to twenty-four feet in diameter and altitude of nineteen to twenty-two feet. This size is known as a thirty cord kiln, which is found in practice to produce the greatest economy (Cameron, 1874: 38).

Cameron's experiments with beehive kilns were carried out over several years in Michigan, Wisconsin, and New York. The results proved favorable and parabolic beehive charcoal kilns gained widespread acceptance and use among mining operations throughout the United States.

Samuel Emmons wrote about parabolic beehive kilns and their use in an 1886 report published in the *Monographs of the United States Geological Society* (Emmons, 1886). Emmons described beehive kilns built by a man known simply as Mr. McAllister. He credits McAllister with introducing the kilns to the mining districts in and around Leadville, Colorado (Emmon, 642-643).
Similar in form and function to Cameron's structure, the McAllister kiln was a parabolic, beehive-shaped structure twenty-two feet in diameter and twenty-one feet high (Emmons, 643) (illustration 2-7). Beehive charcoal kilns found at Canyon Creek, Birch Creek, and Wickes closely approximate the size and shape of those described by both Cameron and Emmons (figures 7-1, 8-1, 9-1, and photos 7-9, 7-10, 8-7, and 9-7).

It is interesting to note that while there is at least some information available describing the design and function of permanent brick charcoal kilns, little is written about the men who built them. In the case of the Canyon Creek and Birch Creek kilns, it appears brick masons were brought in from outside the region. Construction of the Canyon Creek kilns was contracted to a Colorado man named G.M. McLain (Knippenburg, 1885). Also involved in their construction was a Glendale brickmason named John Streb, who used locally available clay to make bricks for the Canyon Creek kilns and reportedly built several of them as well (Beaverhead County History, 328).
At Birch Creek, construction of at least six beehive kilns was carried out by Warren King, a coal contractor from Butte, Montana (Historic American Engineering Record, No. ID-11, 1989, 5). A search of records in Butte turned up little information on Warren King, although in 1887 he is shown as being delinquent on taxes owed for "11 coal [charcoal] kilns, two horses, and merch [merchandise]" (Pettite, 1990: 58).

How these men obtained plans for building the kilns remains a mystery as well. Nothing found in historical records offered blueprints or instructions for building these seemingly complex structures. Ironically, Egelston felt that conical kilns could be built by "almost any man" (Egelston, 397). While this lack of construction information is puzzling, it can be attributed in part to the subservient nature of charcoal production in the minds of many smelter operators. While charcoal was critical to the operation of their smelters, the method used to produce it was not. Nonetheless, beehive charcoal kilns were a critical component of smelting operations throughout the West.

The first beehive kilns built in Montana appeared soon after construction of the St. Louis and Montana Company smelter at Argenta in 1866. Located along Rattlesnake Creek just north of Argenta, the kilns were made of mortared stone. Stone was a common building material found in kilns throughout the western United States, including Utah, Nevada, and Idaho (Utah Historical Quarterly, 1982: 42; Murbarger, 27).

Beehive kilns are not only associated with smelting operations in Montana and Idaho, but much of the western United States as well, including Colorado, Nevada, and California (Buckles, 1978: 781-786; Murbarger, 27-28). They were also used in eastern states such as New York, Connecticut, Pennsylvania, and Vermont, where kilns produced
charcoal for use primarily in the manufacturing of iron (Egelston, 309-393; Rolando, 167; Bining, 1938: passim).

In Montana, there are kilns located near Wolf Creek, north of Helena, as well as two badly deteriorated kilns just three miles east of Wickes at Alhambra Hot Springs. In Idaho, smelting operations at Ketchum, Muldoon, Bay Horse, and Nicholia relied on charcoal from parabolic beehive kilns, some of which still stand today near Bay Horse, Muldoon, and Birch Creek (Sparling, 77; Idaho State Historical Society, 1984: 3-5; Vlasich, 1980: 22).

Noting the existence of these and other charcoal operations, it becomes clear that both earthen and brick charcoal production facilities were significant fixtures among frontier mining and smelting operations in Montana and Idaho. Clearly an evolutionary and technological advancement in carbon fuel production, the importance of these charcoal kilns cannot be underestimated.

Without charcoal from temporary earthen and permanent brick kilns, it is doubtful that mining, milling, and smelting operations in Montana and Idaho would have begun as early as they did. Had the development of these operations been dependent upon imported coal, it would have been several years before a rail transportation system arrived to make it available. Instead, charcoal kilns and vast acres of timber provided a steady supply of carbon fuel for early milling and smelting operations. Due in part to the availability of charcoal, frontier mining operations helped build the foundation for a host of future development in Montana and Idaho.
The mining and processing of precious metals, primarily gold and silver, laid the groundwork for industrial and economic growth in Montana and Idaho during the late 1870's and throughout the 1880's. Frontier mining operations helped bring roads, railroads, water storage and distribution systems, settlement, and economic structure to remote parts of this region. The technology and infrastructure needed for remote smelting operations to turn raw ore into gold, silver, or lead bullion was later used to mine, process, and distribute copper, zinc, iron, and other important metals.

As smelting technology evolved during the late 19th century, charcoal fuel became outdated, along with what were once state-of-the-art charcoal production facilities. With the arrival of a new century, other fuels powered the smelting industry, such as coal, oil, and electricity. The smoke that once poured from dozens of charcoal kilns throughout Montana and Idaho showed the importance of this simple fuel to the rise of the mining industry. The significance of charcoal is illustrated in the colorful history of mining and smelting towns like Glendale, Montana, and the nearby Canyon Creek charcoal kilns.
Chapter 3

Mining, Milling, and Smelting in Montana and Idaho

* A Western mine is a hole in the ground owned by a liar....
  Mark Twain

Boom and bust cycles of precious metals exploration and exploitation shaped the early industrial landscapes of Montana and Idaho. The glint of gold first attracted miners to this part of the west during the 1860's, arriving by the thousands with their gold pans and sluice boxes. By the early 1880's, the focus of their attention shifted to the mining, milling, and smelting of silver and lead.

As gold miners scoured the land they generally ignored other metals encountered during their search, such as lead, copper, iron, or silver. Difficult to mine and expensive to process, silver attracted little interest until its value escalated after the government increased its use as a monetary standard. The Bland-Allison Act of 1878 called for the purchase of between $2 and $4 million dollars worth of silver per month, assuring a stable market for the metal and greatly increasing production demands (Chadwick, 1982: 19). Between 1878 and 1884, silver prices fluctuated between $1.11 and $1.15 an ounce (Graham, 1964: 45). Montana and Idaho, each harboring a tremendous wealth of silver, stood poised for mining boom that lasted into the early 1890's.

The transition from gold panning to silver mining brought industrial development to Montana and Idaho. Unlike free gold, silver and lead ore had to be mined from deep within the earth in underground deposits called *lodes*. Mining for gold, however, required little more than a round, flat-bottomed pan, a pick axe, and a strong back. *Placer*, or
surface mining, meant searching for loose, water-transported secondary deposits generally found in the gravels of a streambed (Hardesty, 20). Gold prospectors often worked alone or in small teams. Most gleaned just enough gold dust and flake to purchase food, tobacco, and the supplies needed to continue searching for the big strike they hoped would make them rich. Few ever found it.

Unlike panning for gold, silver mining was a labor and capital intensive endeavour. Wage-labor miners dug the silver ore from underground mines. It was then hoisted to the surface and hauled to a processing facility known as a smelter. Expensive to build and operate, smelters used a host of machinery and a series of processes, such as milling and amalgamation, to turn raw ore into silver bullion (Austin, 1926: 230). Today, the remnants of these facilities comprise what Donald Hardesty calls "milling feature systems" (Hardesty, 1988: 38).

Milling was the first in a series of processes necessary to make silver bullion. The treatment of silver and lead ores began by separating the metals from their gangue, or non-valuable materials. A crushing process, called comminution, began with primary, secondary, and tertiary crushing, and ended with fine grinding (Zucker and El-Shall, 1982: 1-3).

One of the earliest devices used for primary crushing was an arrastra (Hardesty, 38) (illustration 3-1). An old and simple device, the arrastra worked by using horse or water power to pull heavy stones, or a large stone wheel mounted on a central post, in a circular direction over raw ore contained within a shallow pit. Arrastras were used to
Illustration 3-1. Sectional view of an arrastra crusher (from Richard, 1908: 238).

Illustration 3-2. 10-stamp gravity mill (from Hofman, 1913: 549).
coarse grind ore on the Vipond District of southwest Montana as late as 1886 (Sassman, 1940: 224-226). In milling and smelting operations throughout Montana, Idaho and the West, primary crushing was carried out using more modern, standardized machinery, which included Blake Breakers, California stamp mills, or Krom rollers (Hofman, 1913: 535-550; Richards, 13-53) (illustration 3-2, 3-3).

After crushing and grinding, impurities still existed within the ore concentrate and had to be removed using either gravity or chemical separation. Most early milling operations relied on gravity separation, which takes advantage of the differences in the
specific gravity of valuable mineral and gangue material. Gold panning is an example of simple gravity separation. As water and gravel are swirled in a gold pan, the heavier gold particles concentrate and settle at the bottom. Large-scale concentrators, also known as jigs, sluice boxes, or shaking tables such as the Wilfrey, all served the same purpose; using water and asymmetrical motion to help separate and concentrate the heavier metals (Zucker and El-Shall, 4-6).

The flotation process used chemicals to release precious metals from the gangue. Sodium sulfide caused metals to float. Lime, sodium cyanide, and zinc sulfate worked as depressants that caused metals to sink when placed in solution. Dispersion agents, such as sulfuric acid, copper sulfate, and soda ash, helped the selective reaction of other reagents. Finally, organic chemicals, known as collectors, attached themselves to the metals and pulled them together (Zucker and El-Shall, 7-8).

Other means of recovering gold and silver were achieved through amalgamation and leaching. Amalgamation worked by passing pulverized gold or silver suspended in water, called pulp, over a plate coated with mercury. The metals bonded with the mercury, creating an alloy, or amalgam. The amalgam was then removed, heated, and the mercury driven off by distillation, leaving behind concentrates of gold or silver (Fay, 1920: 29-30; Zucker and El-Shall, 9).

Leaching, also known as cyanidation, used either potassium cyanide or alkaline cyanide to dissolve gold and silver from their ores. After pumping the ore heaps with a solution containing 0.05 percent sodium cyanide, the chemicals percolated through the pile. Gold and silver leached from the heap suspended in solution, which was then
collected in an evaporation pond. Finally, the metals were precipitated from their slime solution using either zinc shavings, zinc dust, or charcoal (Zucker and El-Shall, 9-13).

Several processes commonly used in the milling of silver ores include the *Patio process*, *Holt-Christiansen process*, and *Washoe process*. Named for the mining region in Nevada where it was developed, the Washoe process consisted of 1) coarse-crushing the ore, 2) stamping the ore fine, and 3) collecting it in settling tanks. Mercury, added to the tanks, bonded with the silver to form an amalgam (Fay, 731). The final step involved straining the mercury from the amalgam, then retorting, or heating, the silver to its melting point, and finally, pouring the liquid silver into ingot molds (Austin, 233).

Roasting is another process used in the treatment of silver and lead ores. Calicination, or kiln roasting, oxidizing, chloridizing, sulphatizing, and sinter roasting all served to heat the ore to temperatures just below its melting point. This improved the condition of the ore by removing volatile byproducts and making it ready for further processing (Austin, 93; Fay, 573). The most common method of roasting was to place the ore in a reverberatory roaster, where it was spread over a hearth and heated to a temperature of approximately 500 Celsius (Austin, 94). Once the roasting process was completed the ore was ready for the blast furnace.

The intense heat created by a blast furnace served to physically separate silver and lead from their gangue. While reverberatory roasting only heated ore to a point close to melting, the blast furnace used forced air blown across a carbon-fueled fire to liquify it. At many silver and lead smelters throughout the West, charcoal provided the fuel source capable of producing such tremendous heat. Temperatures within a blast furnace rose to
such extremes that circulating water pipes, called a water jacket, were used to help dissapate and control the heat.

In a blast furnace, ores were first mixed with a carbonaceous fuel, such as charcoal, and flux. Flux generally consisted of lime, or other minerals, that served to enhance fusion within the metals (Hardesty, 66; Fay, 279). This mixture was then heated until the metals melted and drained into a cupolla, or sump, at the bottom of the furnace. There, the molten material formed layers, with the heavier metals such as gold, silver, or lead settling at the bottom. A layer of waste material, or slag, consisting of iron oxide and sand, formed on top and was skimmed off. What remained was precious metal bullion, ready to be poured into ingots and shipped to market.

In reverberatory and blast furnace systems throughout Montana, Idaho, and much of the western United States, charcoal provided the means of attaining the temperatures high enough to process precious metals. It also provided one of the chemical components needed for flux. Despite its many uses, charcoal, and the kilns needed to produce it, nearly disappeared from the mining landscape by the end of the 19th century. In its place came coal and oil. Eventually, coal and oil would be replaced by electricity.

Smelting operations at Glendale and Wickes in southwest Montana, and Nicholia in eastern Idaho, all initially relied on charcoal to fuel their furnaces and boilers. Beginning with the Hecla Consolidated Mining Company at Glendale, a careful study of these sites show how charcoal production became an integrated subsystem of the frontier mining and smelting industry.
Chapter 4

Glendale, Montana and the Canyon Creek Charcoal Kilns

The mining boom that brought miners, settlement, and industrial development to
Glendale, Montana, had its roots in activities taking place fifty miles to the south. In
1864, rich deposits of silver were found near Argenta, Montana Territory. This strike,
located approximately 15 miles northwest of present day Dillon, Montana, brought
miners pouring in from Bannack, Virginia City, and camps throughout the region. Some
of Montana’s earliest mining and industrial development took place at Argenta, including
construction of the first smelter operation in the territory. Built by S.H. Bohm &
Company, the smelter used two blast furnaces and one cupelling-hearth, and was modeled
after those used in German silver/lead works (Hahn, 1873: 128-129). The charcoal used
to fire the furnaces came from stone beehive kilns located north of Argenta along
Rattlesnake Creek (Sassman, 1940: 170).

As word of the silver deposits spread, hopeful miners headed for Argenta. With
the richest ground already claimed, many pushed north into the hills and canyons drained
by creeks feeding the Big Hole River. Between 1868 and 1870, rich silver lodes drew
prospectors onto the flanks of Trapper Hill and Lion Mountain (map, 4-1). Near the head
of Trapper Creek lay the Bryant Mining District, established in July of 1873 (Wolle,
Map 4-1. Glendale and vicinity (from Wolle, 183).
The discovery of rich silver lodes like the Forest Queen, Rocky Mountain, Trapper, Atlantis, Hecla, Cleve, and Alta prompted increased exploration of the Bryant District and resulted in establishment of several small camps. Trapper City sprang to life following William Spurr's discovery of the Forest Queen Mine in 1872, and for several years its 100 to 200 residents lived well on earnings taken from the local mines (Wolle, 188).

Within a few years the allure of Trapper City faded as silver and lead ore from the mines played out. In a pattern typical of many frontier mining settlements, the population of Trapper City simply packed up and left once the economic incentive to stay began to wane. Most moved just a few miles away to Lion City, which grew as quickly as Trapper City withered. At its peak, Lion City's population consisted of several hundred miners, as well as a "number of merchants, gamblers, saloon proprietors, women of questionable reputation, and a few families" (Sassman, 238). Just a mile above Lion City, a third mining camp, named Hecla, developed in response to mining operations on Lion Mountain. While Lion City and Hecla thrived for a short time, more permanent settlement and development was poised to take place at a nearby camp called Glendale.

Strong showings of silver ore coming from the mines on Lion Mountain, prompted local miners and entrepreneurs, Noah Armstrong and Charles Dahler, to build a 20-ton blast furnace along the banks of Trapper Creek in 1875. Located near the main stage road, the small camp surrounding the smelter prospered, grew, and became the town of Glendale. By 1876, the Butte Miner reported the Glendale smelter was turning out from "three to five tons of crude bullion every twenty-four hours" (Butte Miner, 1876).
In 1878, Armstrong organized the Hecla Consolidated Mining Company, with operation headquartered at Glendale (photo, 4-2, 4-3) (Wolle, 188). A program of capital improvements included construction of a ten-stamp mill, leaching works, a cupel furnace, two chloriding furnaces, one copper refinery building, a blacksmith shop, and one warehouse (Leeson, 1885: 482). The company installed modern machinery, such as a steam-powered hoisting works at the Cleopatra mine, that delivered workers into the tunnel and brought raw ore out (Engineering and Mining Journal, 1881).
From 1877 to 1879, the Hecla mines and smelter produced 1,000,000 ounces of silver and thousands of tons of lead (Wolle, 190). At the peak of its operation the company had 20 miles of workings "driven into the heart of Lion Mountain" (Geach, 1972: 6). Assays showing silver content of more than 100 ounces per ton and lead at 30-40% demonstrate the richness of this district (Beaverhead County History, 1990: 41).

As industrial development increased it attracted people and settlement. Workers built homes, families arrived, businesses started up, and the community of Glendale quickly rose along the banks of Trapper Creek. By 1878, more than 950 people lived...
in Glendale, and within three years the town boasted over thirty businesses, a newspaper, and a thriving economy (Wolle, 188). Even greater growth occurred after 1882, when the Utah & Northern Railroad established a railhead at Melrose, Montana, just five miles to the east. This prompted an increase in Glendale's population to more than 3,000.

Access to rail transportation meant the Hecla Consolidated Mining Company could ship finished bullion more cheaply, as well as receive raw materials, such as lime for flux. The railroad brought the latest technological advancements in mining machinery and equipment. With new machinery, which included coal-burning blast furnaces, came increased production capability. To keep pace with production the company hired more workers, many of whom arrived in Melrose by rail. More importantly, the railroad connected Glendale and its mining and smelting operations to the outside world, from which came financial and material resources, ideas, and the latest technologies.

In 1879, Henry Adkins replaced Noah Armstrong as general manager of the Hecla Consolidated Mining Company. Two years later, Adkins stepped down and Henry Knippenberg accepted the position (Sassman, 241; Wolle, 190). Knippenberg took charge of an operation nearly $78,000 in debt. One of his first executive decisions was to establish three divisions within the company and appoint a superintendent to each. James Parfet, based in the Hecla camp, took over the mining operations; George Earles supervised the reduction works at Glendale; and John Parfet ran the iron mines at Soap Gulch (Leeson, 477-478). The change in management paid off; between 1881 and 1900, the Hecla Consolidated Mining Company prospered, paying stockholders more than $2,000,000 in dividends (Sassman, 342; Winchell, 1914: 20).
Most of the ore processed by the Glendale smelter was not refractory, meaning it had a silica content higher than four percent and had to be heated in a blast furnace (Ryan, 1992: 127). With three blast furnaces in operation, the roasting capacity of the Glendale smelter totaled 150 tons of ore per day (Sassman, 243), consuming an average of 3,200 bushels of charcoal (Leeson, 478). In addition to coal, Hecla Consolidated Mining Company records indicate that from 1881 to 1900, the Glendale smelter used 7,348,849 bushels of charcoal made from 163,308 cords of wood encompassed within 11,665 acres of timber. In 1885, a peak year in charcoal consumption, 1,008,827 bushels were consumed in order to produce 5,528,635 pounds of lead bullion, 177,567 pounds of copper, and 712 ounces of silver (Hecla Consolidated Mining Company, 1901: 16). Such tremendous production numbers meant that a dependable, available, and affordable supply of charcoal was needed.

Charcoal for the Glendale smelter came from several sources. Prior to construction of permanent brick kilns, the Hecla Consolidated Mining Company purchased charcoal from independent colliers. Using temporary earthen charcoal pits, the colliers charred wood at various locations throughout the valley. Signs of pit charring exist today as black surface deposits of charcoal, some within the immediate vicinity of the brick kilns at Canyon Creek (Gard, field notes, July, 1997).

Among the colliers were Italians called carbonari, who produced a sizable amount of pit charcoal for the Hecla furnaces. In 1884 alone, the company purchased 843,259 bushels of charcoal from the carbonari, who delivered it to the smelter for eleven cents per bushel (Sassman, 243-244).
While the Hecla Company purchased some of its charcoal from outside sources, it relied primarily upon fuel from its own brick kilns. The kilns were built to assure a steady supply of fuel, avoid complete reliance upon independent colliers, and keep prices under control. Erected in various locations throughout the valley, the company built more than thirty brick beehive kilns that operated between 1876 and 1885.

The first mention of charcoal kilns comes from an 1876 newspaper article describing "two [beehive] charcoal kilns, substantially built of stone" and able to "turn out 4,000 bushels of coal every ten days. Fourteen men are employed on the works, teamsters, choppers and others to be added" (Butte Miner, 1876). Another article reported that the Wickes smelter had "three egg-shaped [beehive] charcoal kilns near by...." (Bozeman Avante-Courier, 1878). Charcoal from these kilns was "but one-third of the amount of coal [charcoal] consumed by the company and are used apparently only as a check or safeguard against possible outside monopoly" (Bozeman Avant-Courier, 1878). These kilns, each made of stone, were torn down in 1883 and the rubble used to build the Hecla Consolidated Mining Company office in Glendale (Knippenberg letter, 1883). Today, one can still see the blackened stones from these original kilns cemented into the remains of the headquarters building.

Beginning in 1884, the Hecla Company made plans for large-scale charcoal production. As reported in the Engineering and Mining Journal, Henry Knippenberg noted an agreement with G.M. McLain of Leadville, Colorado for construction of "coal-kilns on Canon Creek Park" (Engineering and Mining Journal, 1885)(photo 4-4). The article also states that the Hecla Consolidated Mining Company contracted with
McLain for the both construction of the kilns and production of charcoal for the Glendale smelter at 12 ½ cents per bushel.

Brick for the Canyon Creek kilns were purchased from a German immigrant named John Streb, who may himself have built several of the kilns. Streb and his wife, Veronica, ran a boarding house in Glendale, where John produced bricks from nearby sources of clay (Beaverhead County History, 1990: 526). Upon completion of the work at
Canyon Creek, the company operated a total of thirty-eight kilns, including those at Trapper Creek and Sucker Gulch (Ryan, 1988: 26).

Charcoal from the Canyon Creek kilns arrived at the Glendale smelter in large, tall-sided wagons driven by local teamsters (Beaverhead County History, 328). In a photo circa 1885, teamster F.A. Mosely is shown taking a wagon load of charcoal through
Cattle Gulch on the twisting road from Canyon Creek to Glendale (photo 4-5). In addition to charcoal, teamsters also delivered coke to the Glendale smelter from the Utah & Northern railhead at Melrose (Sassman, 243-244).

The smelter at Glendale consumed upwards of ten tons of coke per day at a cost of $16.65 per ton shipped by rail from Pennsylvania. Hauling it from the railhead at Melrose to the Glendale smelter increased the price to $19.00 per ton.

The strength of silver prices kept the Hecla Consolidated Mining Company profitable through much of the 1880’s. In 1889, the Glendale smelter stood among the top silver producers in the state, which included the famous Butte, Anaconda, Wickes, and Argenta smelters (Chadwick, 1982: 25). Following passage of the Bland-Allison Act in 1878, and the Sherman Silver Purchase Act in 1890, a strong, stable market for silver seemed assured.

That assurance proved short-lived after President Cleveland pushed Congress to repeal the Sherman Silver Purchase Act in 1893. Without government support the value of silver dropped, dramatically reducing the production demand for silver. Throughout Montana, small-scale silver mines shut down, never to reopen (Malone and Roeder, 146; Sassman, 347; Chadwick, 28-31).

Despite the plummeting price of silver, smelting operations at Glendale struggled on, suffering more financial loss than gain. In 1896, the company earned $36,372; the next year it lost $40,000. To stem the fiscal bleeding, Knippenberg ordered the blast furnaces torn down in 1900, a move that prevented the company from having to pay property taxes on that portion of its operations.
The decision to halt smelting operations at Glendale meant the end of charcoal production at the Canyon Creek kilns as well (Sassman, 243). The closure of the smelter came so suddenly that crews tending a set of charcoal kilns at Sucker Gulch simply walked away, leaving them charged and ready to burn. Remains of the kilns at Sucker Gulch still stand today loaded with wood, just as they were left nearly one-hundred years ago (Mike Ryan, 1997; Jim Eighorn, 1998).

The rise and fall of smelting operations at Glendale is representative of the boom and bust cycles that define the history of precious metals mining in Montana, Idaho, and throughout the West. At Glendale, the discovery of rich silver lodes prompted rapid industrial development encompassing mining and charcoal production. Industrial development was followed by settlement and community growth. But the mining boom ended less than twenty years later and brought an end to smelting and charcoal operations, as well as the near-desertion of Glendale. This process of exploration, exploitation, and abandonment was played out across Montana, including a mining community located ninety miles north of Glendale named Wickes.
Chapter 5

Wickes, Montana and the Wickes Charcoal Kiln

Nestled in a small valley twenty miles south of Helena, Montana, the remains of the Wickes smelting operation include little more than a smokestack and a single beehive charcoal kiln. Like many western mining towns, Wickes sprang to life quickly. Its smelter processed tremendous quantities of silver, then faded from existence once the ores played out and silver prices dropped. Finally, the smelter was shut down, dismantled, and moved to East Helena, Montana. For more than twenty years, however, silver and lead mining, smelting, and charcoal production made Wickes one of Montana’s most productive industrial communities.

The mining and smelting operations at Wickes developed as an indirect result of the famous gold rush of 1864. Failed prospectors from California and elsewhere came to Montana hoping to find the rich strikes that eluded them further west. Here, they turned a barren drainage known as Last Chance Gulch into a camp that grew to become Montana's future capital, Helena (map 5-1). As claims were staked and the Gulch became crowded with miners, some moved south looking for yet undiscovered lodes. A flurry of activity in an area known as the Jefferson Quadrangle lead to the discovery of the Alta, Comet, Gregory, and Minah lodes. Construction of a silver smelter took place in late 1864, but its inability to process lower-grade ores caused it to fail (Becraft, et al., 1963: 35; Gray, 1995: 34).
Map 5-1. Wickes and vicinity (from Wolle, 141).

Photo 5-3. Helena Mining and Reduction Company smelter operation and Wickes townsite, 1886. (Haynes Foundation Collection photo courtesy of Montana Historical Society).
Despite this initial setback, others pushed ahead with plans for construction of another, more viable smelter. In 1876, Cole Saunders organized a syndicate of eastern investors and formed the Montana Company, later renamed the Alta Montana Company (Gray, 34). The growth of the Montana Company smelting operation, and an influx of workers needed to run it, prompted developers to make plans for more permanent settlement. After platting a townsit they named the new community in honor of one of the original Montana Company investors, William W. Wickes (Nigg, 1975: 13).

Construction of a new and larger smelting works took place at Wickes in 1877. The facility, Montana's first lead and silver smelter, worked ore from local mines, including the Comet, Alta, Alta South, Gregory, Mount Washington, Bertha, Blizzard, and Blue Bird (Gray, 1995: 35; Nigg, 1975: 13; Paladin and Baucus, 1983: 38). Along with the workings from mines within the Wickes/Colorado district, the smelter processed ore from as far away as Couer 'd Alene, Idaho (Malone and Roeder, 1976: 144). The output of these mines made the Wickes smelter one of the largest lead processing facilities in the world (Swallow, 1889: 102) (photos 5-2, 5-3).

Fuel for the furnaces and boilers in the Wickes smelter came from six parabolic beehive charcoal kilns (photo 5-4). The kilns, located just east of Wickes on a bench above Spring Creek, smoldered and smoked almost nonstop. At the peak of their operation in the early 1880's, the kilns produced over 25,000 bushels of charcoal per month (Gray, 70).
The kilns had a huge appetite for fuel to satisfy. The smelters processed an average of forty-five tons of ore per day, using "five tons of lime [for flux], twenty-four cord of wood, eighteen tons of fluxing iron, and 1800 bushels of charcoal...." (Rocky Mountain Husbandman, 1881). In 1882 alone, $64,000 worth of silver and $325,000 in lead came out of the Wickes smelter (Nigg, 13).

Despite impressive production numbers, the Wickes smelter struggled under mounting debt, most of it incurred through the purchase of mines, equipment, and improvements to the smelter operation designed to increase production (Gray, 35). Then, as events continued to conspire against the company, a change of ownership took place.

In 1882, fire destroyed the smelter at Wickes. Financially strapped and unable to rebuild, the Alta Montana Company sold its interests to D.C. Corbin and Helena banker Samuel T. Hauser. After assuming financial obligations totaling more than $250,000, Hauser took control of the Alta Company’s mines and facilities in 1883. This included the Wickes smelter operation, which took the name Helena Mining and Reduction Company (Swallow, 102; Leeson, 649; Gray, 35; Nigg, 13). In addition to the smelter already in operation at Wickes, the company built a concentrator just a few miles away at the tiny community of Corbin (Swallow, 104).

Through an infusion of over $190,000, the Helena Mining and Reduction Company significantly increased the size and production capacity of the Wickes operation. Calcinators, large ovens used to roast the ore, more than doubled in size from 25 to 60 ton capacity. The company upgraded its ore crushing capability from a 15-stamp mill to a 25-stamp. By rebuilding its concentrator, a machine used to shake or vibrate the
ore and separate metals from gangue, the nearby Comet mill increased its production capacity from 25 to 120 tons per day (Leeson, 661-662). A forty-ton water jacket smelter went into use in May of 1884 (Nigg, 1975: 13; Wolle, 1963: 147).

Because they were separated by a canyon, ore from the Comet mine was delivered to the Wickes smelter in buckets suspended from a wire tramway. Each bucket held 300 pounds of ore and the tramway carried an average of forty-six tons per day (Gray, 36; Swallow, 105). For a period of ten years, between 1883 and 1893, the Helena Mining and Reduction Company stood as the largest facility of its kind in Montana (Pardee and Schrader, 1933: 232).

In August 1883, the Northern Pacific Railway arrived in Helena. Awaiting its arrival were Samuel T. Hauser, Henry Villard, Thomas F. Oakes, George Gray, and Ed Stone, who two weeks earlier chartered the Helena and Jefferson County Railroad Company. By December, a spur line called the Helena and Wickes branch of the Northern Pacific linked the Wickes mining district to the rest of the world (Grey, 36). Lower transportation costs helped the Wickes smelter operation realize greater profits and brought prosperity to the town of Wickes.

Ironically, the arrival of the railroad also spelled the end of charcoal production at the Wickes kilns. New coal-burning furnaces, delivered by rail and installed during an overhaul of the smelter, cut the operation’s reliance upon charcoal fuel. The railroad delivered coal that cost less than charcoal produced in the company’s own kilns. With new furnaces and cheaper coal now available, the kilns saw use for only a few more months while the smelter made the transition from charcoal to coal (Gray, 70).
Despite the addition of state-of-the-art furnaces and equipment, many felt the Wickes smelter was too small to handle the large volume of ore coming from the mines. The end of smelting operations at the Wickes smelter came about in 1889, after the Helena Mining and Reduction Company underwent yet another reorganization and emerged as the Helena and Livingston Smelting and Reduction Company. The company soon made plans to build a new, larger smelter in East Helena, Montana. Before the end of 1889, the Wickes smelter was shut down, dismantled, and shipped by rail to East Helena. There, the structure formed the nucleus of the company's new lead smelting operation (Gray, 37; Swallow, 103). Many residents of Wickes packed up and followed when the smelter was moved to its new location.

The community of Wickes struggled on for several more years, until fire destroyed most of its buildings in 1893. The few mines still in operation reduced production sharply or closed down when silver prices dropped following the repeal the Sherman Silver Purchase Act that same year (Gray, 36-37; Chadwick, 27-29).

Today, a few old buildings, a stone chimney from the smelter, and one beehive charcoal kiln are all that stand in mute testimony to this once thriving community, mining enterprise, and charcoal production facility. From the late 1870's until 1883, the six charcoal kilns near Wickes made fuel for the blast furnaces and boilers in the Wickes smelter. Their association with the Wickes smelter made the kilns a part of one of the largest and most productive silver processing facilities in the state, one that brought industrial development, settlement, and a transportation system to this remote part of Montana.
Further south in Idaho, another silver/lead mining and smelting operation helped make a substantial contribution to that region's economic development. The mines of the Lemhi Valley, along with the Nicholia smelter, brought settlement and prosperity to a remote part of eastern Idaho. Just across the valley, the Birch Creek charcoal kilns made the fuel that drove the Nicholia operation.
Chapter 6

Nicholia, Idaho and the Birch Creek Kilns

The impetus for mining, smelting, and charcoal production at Nicholia and Birch Creek, Idaho during the 1880's began with a gold rush twenty years earlier. The Clearwater River region lays claim to Idaho’s first gold bonanza in the early 1860’s. Gold found on the Lapwai Reservation in the western panhandle of Idaho brought miners pouring in from throughout the western United States. Enough of them ended up in one place to spawn a ramshackle camp named Orofino (Watkins, 1971: 87).

Conditions in most mining camps were seldom pleasant and mining in this remote and rugged part of Idaho area tested the mettle of the toughest prospectors. In the winter months, those not driven out by the cold nearly starved to death in their snowbound camps waiting for supplies (Paul, 1963: 138-139). When spring arrived few hesitated to leave Orofino and the Clearwater River country.

Released from winter's bondage, the miners scattered like quicksilver as they continued their search for gold. Some followed the Clearwater to the Salmon River, and from there they moved westward to establish the community of Florence. As with many mining camps throughout the west, Florence prospered initially, then quickly faded once the gold played out (Watkins, 87). Neither Orofino or Florence were destined for greatness as mining camps. That honor awaited a small camp located in the southwest part of the territory that grew to become Idaho’s capital, Boise.
Map 6-1. Eastern Idaho, including the Lemhi Valley.
When Idaho's long-term mining boom began in the Boise basin in 1862, the area quickly became the most productive and populated region in the territory. Major strikes at Florence and Auburn triggered a rush that eclipsed anything yet experienced in the Pacific Northwest (Wells, 1961: 3). The surge to the new gold fields brought a horde of miners pouring in, many of them veterans of the California gold rush of 1849, as well as the mining regions of Colorado, Nevada, and Oregon (Paul, 138).

In most cases, prospecting for gold meant searching for surface, or *placer*, deposits. Placer deposits required less capital, skill, equipment, and tenacity to exploit than deposits buried underground. Because it was relatively easy to mine, placer gold disappeared quickly; within twenty years most of it had been dug, panned, sluiced, or washed from the earth by hydraulic mining. The remaining deposits lay encased in rock and earth, where another valuable metal attracted the miner's attention.

The next phase of Idaho's mining history focused on silver and its base-metal byproduct, lead. These metals required large, expensive facilities to smelt the ore and turn it into bullion (Wells, 1-9). As a result, smelting soon came to dominate the industrial landscape of mining regions throughout Idaho. In central Idaho, rich deposits of lead and silver prompted construction of the smelters at Bay Horse and Ketchum. These facilities processed precious and base-metal ore from mines throughout the area, and each relied on charcoal fuel from nearby beehive charcoal kilns to fire their furnaces (Idaho State Historical Society, 1984; Vlasich, 1980: 21-24).

East of the Bayhorse district, Lemhi County had mines in the Birch Creek Valley that were reputed to be among the richest in the territory (Oberg, 64-65) (map 6-1).
Initially, wagons hauled lead and silver ore from these mines to a railhead at Camas, Idaho, where it was shipped as far away as Omaha and Kansas City for smelting. To avoid these costly shipments, the valley's first smelter was built in 1882, near a camp called Springtown. The smelter failed, but a few years later the wealth of ore coming from the nearby Viola mine prompted formation of the Viola Mining and Smelting Company, which built a second smelter facility (Fiori, 1989: 16-18).

The Viola Mining and Smelting Company built its smelter on the east side of the Birch Creek valley, and chose John Nichols as its general superintendent (Historic American Engineering Record No. ID-11, 4). The company contracted with the Utah & Montana Machinery Company for a tramway, two tubular [water jacket] boilers, a Westinghouse 75-horsepower engine, a Blake crusher, Cornish rolls, and a No. 6 Blake blower (Engineering and Mining Journal, 1885; Historic American Engineering Record, No. ID-11, 5). By early 1885, two stacks were blown in and lead processing began in earnest (Umpleby, 1913: 35). As the operation grew, miners, smelter workers, and their families arrived and settled the tiny community of Nicholia.

The Viola Company mines produced primarily lead, with lesser amounts of silver. In 1884, an article in the Dillon Tribune estimated 40,000 tons of lead ore in the Viola mine. At peak operation, the smelter processed upwards of 80 tons of lead ore per day (Historic American Engineering Record No. ID-11, 3-4). Between 1886 and 1887, more than 11,900 tons of lead and an estimated 300,000 ounces of silver, with a production value of $1,400,000, were recovered by the Viola smelter (Umpleby, 35).
The richness of the Birch Creek mines attracted the attention of overseas investors. In 1886, the Viola Company, Limited, organized in London to "acquire shares of the Viola Mining and Smelting Company, and to continue the working of the Viola and adjoining properties" (Engineering and Mining Journal, 1886). If an estimate of $2,500,000 in total production is correct, the Viola Company did well on its investment.

In order to smelt lead and silver, the Viola Company needed a large and dependable supply of charcoal fuel. Initially, charcoal came from earthen charcoal pits. The Viola Company reportedly built three large charcoal pits near Willow Creek (Historic American Engineering Record No. ID-11, 5). Earthen charcoal pits became a common feature throughout the valley, where an estimated forty or more operated in remote canyons like Coal Kiln, Italian, Irish, Davis, and Meadow (Oberg, 1970: 74). Evidence of pit charring can be found today in the immediate vicinity of the Birch Creek kilns (Gard, field notes, October 19, 1997).

In 1883, an Idaho Falls newspaper, the Idaho Register, reported that Warren King, a "coal contractor" from Butte, had six brick charcoal kilns under construction at Birch Creek. King built the kilns at the base of the Lemhi Mountains on the west side of the valley, ten miles from the Nicholia smelter (Historic American Engineering Record No. ID-11, 5). The kilns were located strategically, with the nearby mountains providing a plentiful supply of wood (photo 6-2).

By 1888, a total of sixteen kilns kept a crew of 150 men busy cutting wood, tending the kilns, and hauling charcoal across the valley to the smelter at Nicholia. A number of these men were of foreign nationality, including Italians, Irish, and Chinese
(Oberg, 74-75). Appropriately, their charcoal camp was named Woodville, likely in homage to the 6,000 cords of wood that lay stacked neatly in rows nearby, ready to burn (Historic American Engineering Record, No. ID-11, 8). In addition to charcoal produced by the Woodville operation, the Viola Company also purchased coal for $22 a ton delivered to the smelter. In 1889, charcoal operations at Woodville ended abruptly following a dramatic drop in lead and silver prices and the shutdown of the Viola smelter at Nicholia.

The smelter at Nicholia thrived because of a world market hungry for silver and lead. Government purchase of silver through the Bland-Allison Act of 1878 helped create and maintain that demand (Chadwick, 19). Unfortunately, the push for silver output led to overproduction of these metals in states like Montana, Colorado, and Idaho.
Through the latter part of the 1880's, silver prices fell from a high of $1.30 an ounce to less than $.94 (Graham, 1964: 45). Mines that held anything less than high-grade silver deposits ceased production and closed. In addition to falling silver prices, the value of lead plummeted as well. In most cases, lead was worth processing only so long as its counterpart, silver, could also be mined in quantity and quality great enough to offset the cost of production. Although details specific to lead and silver production at Nicholdea are scarce, the demise of the nearby Bayhorse mining operations tell a similar story.

Much like the mines in the Lemhi Valley, those in the Bayhorse Mining District produced lead in addition to silver and trace elements of gold. As long as silver and lead prices remained stable, the mining operation made money. When a change in federal tariff policy allowed importation of Mexican lead it caused a glut on the market and domestic prices plummeted (Historic American Engineering Record No. ID-11, 7; Vlasich, 24).

In addition to low market price for lead, the quality of ore coming from the Bayhorse mines decreased as well. This prompted higher production costs because larger quantities of lime and iron were needed to flux the ore (Historic American Engineering Record No. ID-11, 8). When the price of silver fell it spelled trouble for smelter operations across Idaho and the West. The effects of declining ore quality, along with lower prices for lead and silver, led to the closure of the Bayhorse smelter in 1889. Although operations resumed in 1893, they did so at greatly reduced production levels (Vlasich, 24).
The shutdown of the Bayhorse smelter in 1889 coincides with the end of smelter operations at Nicholia and charcoal production at Birch Creek that same year. The decision appears to have come quickly. Italian colliers, for whom Italian Canyon is named, left mounds of charcoal piled like haystacks, free for the taking. Colliers at the Birch Creek kilns simply walked away when word came to cease operations, leaving a number of the kilns still loaded with charcoal. For many years after, local residents, as others from as far away as Utah and Wyoming, came to Birch Creek to help themselves to free charcoal (Oberg, 76-77).

In addition to charcoal, nearly forty acres of cordwood lay stacked and ready for burning at the time of the shutdown. Much of the wood was scavenged, for today only a few small remnants of these vast woodpiles can be found (Gard, field notes, October 19, 1997; *Historic American Engineering Record* No. ID-11, 2). A photo of the kilns taken in 1898, nine years after they ceased operation, shows vast piles of cordwood cut and stacked. By then, sheep grazed among the once smoldering kilns (photo 6-2).

Similar to the smelting and charcoal operations at Glendale and Wickes, the Nicholia smelter and Birch Creek charcoal kilns followed a boom and bust pattern of existence. Rich silver lodes quickly attracted industrial development, investment, and settlement. With the start of smelting operations at Nicholia came a demand for charcoal fuel and the means of producing it cheaply and in quantity. Within a few years the reality of fluctuating silver and lead prices controlled by an ever-changing world market brought an end to smelting and charcoal production in many places throughout the West, including the Birch Creek valley.
The importance of the Birch Creek charcoal kilns and the Viola Mining Company can be measured on several fronts. Mining, silver and lead processing, and charcoal production, were the first forms of industrial development in the Birch Creek Valley. Lacking an easily accessible rail transportation system meant fuel for the smelter's blast furnaces had to come from local resources, which included the heavily timbered mountains that border this valley.

From 1883 to 1889, charcoal fuel for the Viola Company's smelting operation came from sixteen parabolic beehive kilns at Birch Creek (photo 6-2). This charcoal operation required so much manpower that a little camp called Woodville grew up around it. Charcoal production, along with lead and silver mining throughout the valley, attracted settlement to this remote part of Idaho. Once mining established a foothold, farmers and ranchers arrived. They built homesteads and raised crops and cattle that helped feed a small army of miners and smelter workers. Businesses, most geared to the needs of miners and ranchers, opened their doors and attracted further settlement. Early economic growth and agricultural activity in the Birch Creek Valley can be traced in part to the Viola Company's mining, milling, smelting, and charcoal operations.
Chapter 7

Canyon Creek Charcoal Kilns
(24BE804)

Location: Beaverhead County, Montana
Beaverhead/Deerlodge National Forest
T2S, R10W, SE 1/4, NW 1/4, Section 8
Kilns located approximately 8 miles west of Melrose, MT
on Forest Road #187 (map 7-2).

Map reference: USGS Quad, Vipond Park-1958 15'

Date of construction: circa 1885

Builder(s): G.M. McLain, John Streb

Present Owner/Manager: Beaverhead/Deerlodge National Forest
420 Barrett Street
Dillon, MT 59725

Technical Specifications:
The Canyon Creek kiln site contains 23 parabolic brick beehive charcoal kilns. Physical
conditions range from excellent (restored and stabilized) to completely destroyed.
Dimensions shown in figure 7-1, and illustrations 7-5, 7-6, 7-7 are averages based on the
measurements of seven structurally intact kilns.
(In all figures and illustrations: m = meters, cm = centimeters)

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<tr>
<td>interior- 22'4&quot; / 7 m</td>
<td>Vent row height:</td>
</tr>
<tr>
<td>exterior- 24' 6&quot; / 7.5 m</td>
<td>row 1 - base of kiln</td>
</tr>
<tr>
<td>Height:</td>
<td>row 2 - 18&quot; / 54 cm</td>
</tr>
<tr>
<td>interior- 22' 6&quot; / 6.8 m</td>
<td>row 3 - 37&quot; / 96 cm</td>
</tr>
<tr>
<td>Main door:</td>
<td>Vents per row: 26</td>
</tr>
<tr>
<td>height- 73&quot; / 1.85 m</td>
<td>Total vents: 78</td>
</tr>
<tr>
<td>width- 63 &quot; / 1.60 m</td>
<td>Vent spacing (avg): 72.5 cm</td>
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<tr>
<td>Upper door:</td>
<td>Aspect: south</td>
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<tr>
<td>height: 55&quot; / 1.40 m</td>
<td>Banding: 4 to 5 wooden bands</td>
</tr>
<tr>
<td>width: 45&quot; / 1.14 m</td>
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<tr>
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<td>dome - alternating rows</td>
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Figure 7-1. Canyon Creek charcoal kilns: average kiln dimensions.
Map 7-2. Forest Service map of southwest Montana, showing Glendale, Canyon Creek and vicinity.
Photo 7-3. Aerial view of the Canyon Creek charcoal kilns. (USDA Forest Service photo by George Wolstade, 1965).
Map 7-4. Canyon Creek kilns site map.
Illustration 7-5. Canyon Creek kilns average dimensions: front view.

Illustration 7-6. Canyon Creek kilns average dimensions: top view.
Illustration 7-7. Canyon Creek kilns average dimensions: exterior wall.

Photo 7-8. Restored and whitewashed kilns (forefront) and unrestored kilns (background). (Photo by the author, October 1997).
Photo 7-9. Canyon Creek charcoal kiln: front view showing metal door secured in place with wooden poles. This kiln has been whitewashed and restored, complete with wooden banding (Photo by the author, October 1997).
Photo 7-10. Canyon Creek charcoal kiln: rear view showing upper loading with metal door in place. (Photo by the author, October 1997).
Photo 7-11. Closeup of charcoal kiln rock foundation and vent holes. (Photo by the author, October 1997).

Photo 7-12. Remains of the Hecla Consolidated Mining Company's office and smelter, Glendale, Montana. (Photo by the author, October 1997).
Site Description

The following information comes from Cultural Site Inventory Record, Field # 1988-D2-7, State # 24BE804, and Cultural Resources Inventory Report Form, File #93-BE-2-1, as prepared by Mike Ryan, Beaverhead Forest Archaeologist, November, 1988.

The Canyon Creek kilns are located on a site eight miles west of Melrose, Montana on Forest Road #187. The kiln site occupies approximately two acres within a drainage basin at 6,400 feet above sea level, while the site boundaries for 24BE804 encompass nearly 150 acres. The Canyon Creek drainage is several thousand feet wide with canyon walls rising steeply to an elevation of 7,200 feet on the south side and nearly 8,000 feet on the north side depending on point of reference. The only water source is Canyon Creek, a permanent stream flowing west to east through the valley, passing approximately 35-40 meters feet south of the kilns.

Vegetation in the area includes sage brush, Idaho fescue, bluebunch wheatgrass, scattered Douglas fir, juniper, and willow brush in the riparian areas. The north facing canyon walls and ridge line carry Douglas fir at the lower elevations, and lodgepole pine at the upper elevations. Sage brush and fescue are the predominate vegetation within the kiln site.

Soils predominant within the kiln site consist of dark brown silty loams. Much of the soil in and around the kiln site contains a fine layer of charcoal dust. Adjacent soils are dark and light brown silty loams, as well as alluvial silts and sands.
Fauna native to this area include mule deer, elk, moose, mountain goats, black bear, and raptors. Trout populations are found in nearby lakes and in Canyon Creek.

Features associated with 24BE804 include the charcoal kilns, as well as a wooden log chute, loading platform, and a small log cabin located near the top of the south facing ridge directly above the kiln site. The log chute and platform may have been used for transporting logs from the upper mountain slopes to the kilns below. The extremely steep pitch of the log chute suggests the logs were first cut to cordwood length (4 feet) before being loaded on the chute and sent down to a staging area below.

The log cabin is located sixty-three feet east of the loading platform. While the cabin no doubt was lived in, its exact function, or the occupation of those who lived in it, is unknown. A sizable can dump exists just below the cabin, indicating fairly long-term habitation. Material from the can dump includes green, purple, and brown glass; a shoe sole, sheet tin, strap iron, tin cans of various shapes and sizes (all hole-in-top); watch fob, and tobacco cans.

**Significance**

The Canyon Creek charcoal kilns and associated features are encompassed within site number 24BE804. A 1988 report indicates that this site is eligible for inclusion in the *National Register of Historic Places* under all four criteria by which cultural properties are evaluated for significance [36CFR Section 60.4]. Although the site has been determined eligible by consensus for nomination to the *National Register*, it has not yet been nominated (Mike Ryan, personal communication, March, 1998). The significance of the Canyon Creek charcoal kilns can best be described using the criteria for nomination to

Criteria A: The kilns are associated with events that have made a significant contribution to the broad patterns of our history. The Canyon Creek kilns were critical to the successful operation of the Hecla Consolidated Mining Company's silver and lead smelting operation at Glendale. This operation produced millions of dollars worth of silver and lead, and brought settlement and economic development to this part of southwest Montana. The kilns allowed the company to produce a locally available, efficient, and relatively inexpensive smelter fuel, without which it would have been impossible to process ores from the company's mines. The kilns illustrate the broad patterns of an urban, industrial, mining frontier of the late 1800's, and are associated with a period of early mining capitalization and resource extraction in Montana.

Criteria B: History indicates that the kilns are associated with the lives of persons significant in our past. Noah Armstrong and Henry Knippenberg were important in local and regional Montana history. Armstrong not only discovered one of the most productive silver/lead mines in the territory, but helped bring settlement and economic development to a remote portion of southwest Montana. Following his retirement from the Hecla Consolidated Mining Company, Armstrong retired to his ranch in the Jefferson Valley, where he raised thoroughbred race horses. In 1889, Armstrong's horse, Spokane, won the Kentucky Derby.

Henry Knippenberg was an industrialist of great local and regional importance. He brought the Hecla Consolidated Mining Company to its zenith. He built the town of
Hecla and greatly influenced growth and development in Glendale. After leaving the company, Knippenberg served in the Montana Territorial legislature.

Criteria C: The architecture of the kilns embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master. The kilns illustrate a type of charcoal production facility used throughout the United States from at least the mid-1800's to about 1900. They are representative of a conical type of kiln considered to be among the most important kiln design. While they exhibit design features common in conical kilns across the country, they also possess variations of local influence. The overall size of the kilns found locally tend to be slightly smaller in size. In addition, local kilns show design features associated with the beehive style, as described by Cameron (1874: 38) and Emmons (1886: 644). These features include a more rounded dome and double row masonry arch over the main doorway and upper loading doors. To study the brickwork of these kilns verifies that this is the work of a master brick mason. Wooden bands, a feature seldom discussed in historical accounts or shown in descriptions and illustrations, once encircled the domed portion of the Canyon Creek kilns. Wooden banding helped maintain the structural integrity of the kilns by minimizing the stress caused by heat expansion and cooling contraction. Photos 7-8, 7-9, 7-10, 7-11 show these wooden bands in place on several refurbished kilns at Canyon Creek.

Criteria D: The kilns have the potential to yield information important in history or prehistory. Although it has not been determined if the colliers who operated the Canyon Creek kilns lived nearby, as was a common practice, further research could help make that determination. Once the location of their habitation has been ascertained,
subsurface archaeological testing may indicate ethnicity, socio-economic status, subsistence systems, and settlement types through artifact assemblages and other significant data. Unfortunately, archaeological testing conducted at two Canyon Creek cabin sites in 1997 failed to yield enough cultural material to make such determinations. Further testing of this area may be needed.

All that remains of the Glendale milling and smelting operation today are a few scattered buildings and a single smokestack (photo 7-12). These are located on private land and it is not known if restoration or interpretive efforts for the smelter site are planned. A few miles beyond Glendale, the USDA Forest Service interprets the Canyon Creek site and maintains the charcoal kilns through stabilization efforts such as Passport-In-Time (PIT) projects. Of the twenty-three kilns at the site, several have been completely restored, including whitewash, metal doors, and replacement of wooden banding (photos 7-8, 7-9, 7-10). Through the efforts of the Forest Service and local volunteers, a unique piece of Montana’s mining history has been preserved and protected.
Chapter 8

Birch Creek Charcoal Kilns
(10LH43)

Location: Lemhi County, Idaho
Targhee National Forest
T11N, R27E, SE 1/4 Section 1
UTM: Zone 12 326 300 (Easting) 490 8350 (Northing)
Kilns are located 22 miles south of Leadore, Idaho on Forest Road #188 (map 8-2).

Map reference: USGS Nicholia, Idaho-Montana

Date of Construction: 1886

Builder: Warren E. King, Butte, Montana

Present Owner/Manager: USDA Forest Service
Targhee National Forest
420 Bridge Street
St. Anthony, ID 83445

Technical specifications:
The Birch Creek kiln site once held sixteen parabolic beehive charcoal kilns. Only four kilns exist today; two are in good condition and two are partially razed. Dimensions shown in figure 8-1 and illustrations 8-4, 8-5, 8-6 are averages based on measurements from two intact kilns. (In all figures and illustrations, m = meters, cm = centimeters)

Diameter:
interior- 18' / 5.5 m
exterior- 21' / 6.4 m

Height:
interior- 23' / 7 m

Main door:
height- 74" / 1.9 m
width- 54" / 1.4 m

Upper door:
height- 60" / 1.5 m
width- 54" / 1.37 m

Masonry style: English bond

Vent rows: 3
Vent row height:
row 1 - 60 m
row 2 - 1 m
row 3 - 1.4 m

Vents per row: 27
Total vents: 81
Vent spacing (avg): 27 cm
Aspect: south
Banding: 3 cable bands
Brick pattern:
wall- 5 stretchers to 1 header
dome- alternating rows

Figure 8-1. Birch Creek kilns: average kiln dimensions.
Map 8-2. Forest Service map showing the Birch Creek Valley, including the charcoal kilns site and Nicholia.
Map 8-3. Birch Creek kilns site map.
Illustration 8-4. Birch Creek kilns average dimensions: front view.

Illustration 8-5. Birch Creek kilns average dimensions: top view.
Illustration 8-6. Birch Creek kilns average dimensions: exterior wall.

Photo 8-7. Birch Creek kiln, showing upper loading door and cable banding. (Photo by the author, October 1997).
Photo 8-8. Birch Creek kilns, looking east. One kiln is not visible. (Photo by the author, October 1997).

Photo 8-9. Birch Creek kilns, looking east from start of interpretive trail. (Photo by the author).
Site Description

The Birch Creek kilns are located 30 miles south of Leadore, Idaho on State Highway 28, then 5 miles west on Forest Road #188. The junction is well marked with interpretive signs. Latitude and longitude of the kiln site is given as: latitude 44 degrees, 18 minutes, 40 seconds, and longitude 113 degrees, 10 minutes, 44 seconds. A nearby geodetic survey marker shows an elevation of 7,240 feet above sea level.

The site encompasses an area approximately two acres in size. Of the sixteen kilns originally built at this site, only four remain standing today. They are located along a linear path, with a single kiln separated from a group of three by approximately 70 meters. A small stream is fed by Coal Kiln Springs and flows 20 meters south of the kilns.

Vegetation types include scattered lodgepole pine, while the upper reaches of the valley contain thick stands of Douglas fir. Sage brush and bunchgrass are the predominant ground cover vegetation types. No soil samples were taken and previous site recordation fails to indicate this information.

Significance

Kiln technology, such as that found at Birch Creek, was uniquely adapted to the needs of the nineteenth-century mining industry of the western United States. It relied upon a single resource, timber, which the mountains bordering the kilns contained. With this resource close at hand, kiln operators were able to harvest the timber and produce large quantities of low-cost charcoal for use in smelting operations at Nicholia.
The Birch Creek kilns are also associated with, and representative of, a transformation within the mining industry during the late 1870's and early 1880's. The industry was first centered on the mining and processing of precious-metals such as gold and silver. As the quantity and quality of those ores played out, the industry shifted to the extraction and efficient treatment of large volumes of the base-metal ore, lead, which is commonly associated with silver deposits.

The Birch Creek kilns are encompassed within site number 10LH43. They are representative of a transitional stage in the technology of charcoal manufacture from temporary earthen charcoal pits to permanent wood distillation plants. Prior to the mid-1800's, most charcoal was produced in temporary, earthen heaps, or pits, of a type described in Chapter 2. Local colliers relied on this age-old method of charring wood prior to construction of permanent parabolic brick beehive kilns at Birch Creek. For several years, these two systems, one ancient and the other modern, worked in conjunction with each other until the use of earthen pits eventually gave way to brick kilns (Sassman, 1940: 243-244).

The parabolic beehive kilns at Birch Creek conform to a style indicative of 19th-century charcoal production systems found throughout the West. They closely parallel charcoal kilns described in technical literature written by mining professionals such as Thomas Egelston, Samuel Franklin Emmons, and J.C. Cameron. These distinct similarities indicate the use of an evolving technological innovation and conformity to Hardesty's theory of standardization in industrial technology (Hardesty, 1986: 47-56).
The significance of the Birch Creek kilns lies in the fact that they were essential for the mining and smelting of silver/lead ores in the Lemhi Valley. The kilns utilized a relatively inexpensive local resource, standing timber, to make charcoal necessary to fuel blast furnaces, boilers, and other machinery. Without the kilns, the Viola Mining Company would have been unable to carry out smelting operations until such time as a rail transportation system arrived capable of supplying the smelter with coal, oil, or some other type of furnace fuel.

The kilns represent a style of architecture used in beehive kiln construction throughout the United States. Although this style of kiln was used nationally, the Birch Creek kilns show variations of local influence. Their smaller size, compared to the Wickes and Canyon Creek kilns, may be indicative of several factors (figures 7-1, 8-1, 9-1). Without a rail system nearby, the cost of building materials (brick) led builders to construct smaller kilns. Geographical constraints, such as limited space atop a small ridge, may have been another factor that led builders to construct kilns of a smaller size.

The Birch Creek kilns have the potential to yield information important in history and prehistory. The historical record is vague as to the ethnicity of those who worked in and around the kilns. Geographical names of local areas, such as Irish and Italian Canyons, indicate that the ethnic makeup of the work force was mixed. Location of the old community of Woodville, and subsequent archaeological testing of the area, could shed light on the cultural diversity of those who produced charcoal at Birch Creek.

Only four of the sixteen kilns at Birch Creek remain intact today, and these exist in various states of disrepair. The Birch Creek kiln site is administered by the Targhee
National Forest, who provide interpretive signing and trails, and maintain the kilns through stabilization projects. The Birch Creek kilns were listed on the *National Register of Historic Places* in 1972. Today, the few who visit this site will find that sagebrush and silence have reclaimed this once bustling charcoal camp.
Wickes Charcoal Kiln
(24JF1194)

Location: Jefferson County, Montana
T7N, R4W, NE1/4, NW1/4, SE1/4, Section 15
UTM: Zone 12, 416 525 (Easting) 5134 100 (Northing)
Kiln is located 4 miles west of Jefferson City, Montana.

Map Reference: USGS Jefferson City

Date of construction: circa 1879

Builder: unknown

Present Owner/Manager: Montana Mining Tunnels, Inc.
(a subsidiary of Pegasus Gold)

Technical Specifications:
The Wickes charcoal kiln site contains one parabolic beehive charcoal kiln of brick construction in very good condition. Circular foundations of five other kilns are located on site adjacent to extant kiln. Dome support banding is missing.
(In all figures and illustrations, \( m = \) meters, \( \text{cm} = \) centimeters).

* Diameter:*
  - interior- 20' 9" / 6.3 m
  - exterior- 22' 6" / 6.9 m

* Height:*
  - interior- 26' 4" / 8 m

* Main door:*
  - height: 59" / 1.50 m
  - width: 50" / 1.27 m

* Upper door:*
  - height: 53" / 1.35 m
  - width: 48" / 1.22 m

* Style: English bond*

* Vent rows: 3*
  - Vent row height:
    - row 1 - base of kiln
    - row 2 - 21" / 53 cm
    - row 3 - 36.5" / 93 cm

* Vents per row: 28*

* Total vents: 84*

* Vent spacing (avg): 69 cm*

* Aspect: south-southeast*

* Banding: no bands in place*

* Brick pattern:*
  - walls- 6 stretchers to 1 header
  - dome- alternating rows

Figure 9-1. Wickes kiln: dimensions.
Map 9-2. Forest Service map showing Wickes, Corbin, and vicinity.
Map 9-3. Wickes kiln site map.

Illustration 9-5. Wickes charcoal kiln dimensions: top view.
Illustration 9-6. Wickes charcoal kiln dimensions: exterior wall.

Photo 9-7. Wickes charcoal kiln, view looking north.
Photo 9-8. Wickes kiln, with kiln foundations in the foreground, looking east.
Photo 9-9. Wickes kiln exterior, showing brick pattern.
Photo 9-10. This brick chimney is all that remains of the Wickes smelter.
Site Description

The Wickes kiln stands alone as the last of six kilns originally built in late 1876 or early 1870 (GCM Services, 1995). The kiln is located 1/4 mile east of the old townsit of Wickes, Montana, within a larger area known as the Colorado Mining District. The kiln site encompasses an area of approximately 200 feet by 50 feet (10,000 sq. ft. or .23 acres) along a linear path running east to west at an elevation of 5,040 feet above sea level (1,536 m). It is located within the Spring Creek drainage, which includes Spring Creek and Wood Chuck Creek, both of which are ephemeral streams.

Vegetation within the area includes lodgepole pine, Douglas fir, big whortleberry, shinyleaf and rose spiraea, sage brush, and a variety of local grasses. Soil type is medium brown gravelly and rocky loam.

Located along this linear site are the remains of six kilns. The only evidence indicating the presence of five of the kilns are their circular foundations and a few rows of bricks rising above the base. The kiln bases measure the same diameter as the standing kiln (average 6.3 meters). Numerous loose bricks are scattered within the bases and immediately outside, while the remainder have been scavenged.

Significance

Of the six kilns originally built near Wickes in the late 1870's, only one remains intact today. The single kiln retains very good physical integrity and provides an excellent example of beehive kiln design and construction.

The Wickes kiln stands as testimony to the import role mining, smelting, and charcoal production played in the development of Montana's industrial landscape.
Between the late 1870's and 1890, the Wickes kilns produced blast furnace fuel for one of the most productive silver/lead smelting operations in the state's history. In 1886, annual output of the mines totaled $1,250,000 (Gray, 36). Without charcoal, settlement and full-scale industrial development in this area would have been forestalled by perhaps as much as a decade. Instead, mining and smelting in the Wickes/Colorado mining district brought settlement and economic prosperity.

Of the four criterion used to determine eligibility for inclusion on the National Register of Historic Places, only criterion B and C can be applied to the Wickes kiln site. Under Criterion B, the kilns are associated with the lives of persons significant in our past. Although they were built prior to his arrival, Samuel T. Hauser, a noted Helena banker and one of Montana's first and most influential silver promoters, utilized the kilns to fuel his Helena Mining and Reduction Company, which was formed at Wickes in 1882. A year later, Hauser and several partners chartered the Helena and Jefferson Railroad Company, which served the mines and smelters of the Wickes/Colorado mining district.

Hauser's name lives on in Helena and throughout Montana as an important figure in the state's political and business realm. In 1865, Hauser, along with a partner, Nathanial P. Langford, chartered the S.T. Hauser and Company Bank in Virginia City. That same year he started a mining company that built the first silver smelter in Montana Territory at Argenta. In 1866, he organized the First National Bank in Helena and the St. Louis Mining Company in Phillipsburg. His business domain included the Pioneer Cattle Company, formed in partnership with A.J. Davis and Granville Stuart. In 1885, Hauser
was named by President Grover Cleveland as Montana's first resident territorial governor (Paladin and Baucus, 1983: 64).

The remaining Wickes kiln demonstrates the work of a master as defined under Criterion C. The brickwork and overall construction are unique to a specific type of structure and utilized for one specific purpose. Despite Egelston's view that a conical kiln could be built "by almost any man" (Egelston, 1880: 397), the complexity of design and structure indicates that the Wickes kiln, as well as those at Canyon Creek and Birch Creek, were built by highly qualified masons.

Unfortunately, poor site integrity prevents the Wickes kiln or the Wickes smelter site from being evaluated for significance under National Register criteria (36 CFR 60.4). The entire Wickes district retains few of its original structures and associated mining features. The Wickes smelter was dismantled and moved to East Helena, Montana in 1889. In addition, five of the original six kilns have been torn down. For these reasons, the site has limited potential to reveal important historical information through subsurface investigations under Criterion D (GCM Services, 1995, *Montana Cultural Resources Inventory*, Site #24JF1194).

The standing brick kiln at Wickes is a local landmark and remains a good example of the early Montana brick masonry art, dome construction and kiln engineering. However, this single kiln cannot be considered a separate entity. It was only one component of the smelter fuel system that included not only the six kilns, but also platforms to the front and rear of the kilns, a tramway connecting with the smelter and a
wood harvesting network (GCM Services, Inc., *Montana Cultural Resources Inventory*, Site #24JF1194). None of these associated features exist today.

The Wickes kiln is located on private property owned by Montana Mines, Inc., a subsidiary of Pegasus Gold. While the kiln is in very good condition it is unclear if stabilization or interpretive efforts are planned. The only signs of adaptive reuse (Shiffer; 1987: 27-46) of this kiln is a layer of animal manure on the floor of the kiln, suggesting it once served as a shelter for livestock.
Chapter 10

Form and Function: A Comparative Analysis of Beehive Charcoal Kilns and at Canyon Creek, Birch Creek, and Wickes

Following a methodological examination of parabolic beehive charcoal kilns at Canyon Creek, Birch Creek, and Wickes, a comparative analysis reveals a primary characteristic. The kilns, all built within a period of six years between 1879 and 1885, exhibit distinct similarities in their overall form and function. These similarities compare with descriptions of beehive kilns used in frontier mining operations throughout the western United States, as described by Buckles (1978), Egelston (1880), Murbarger (1965), Rolando (1992), and others. Using information gained from on-site examinations, as well as historical descriptions, drawings, and technical information, it is possible to conclude that standardization of form and function took place in 19th-century charcoal operations in Montana and Idaho.

According to Donald Hardesty (1986: 48), the most typical feature in mining production systems is the use of standardized industrial technologies. Mining machinery and equipment, most manufactured by a small number of companies, were shipped from distant urban centers to remote mining and smelting outposts, where they became integrated into a highly structured operation. The artifacts (kilns) associated with charcoal production at Canyon Creek, Birch Creek, and Wickes, demonstrate the use of a highly evolved and standardized technology. The kilns comprise what Hardesty refers to as a
feature system, "a group of archaeologically visible features and objects that is the product of human activity", which can be identified using "documentary accounts of the morphology and activity of mining" (Hardesty, 1988: 9).

An examination of the historical and archaeological record of the beehive kilns at Canyon Creek, Birch Creek, and Wickes [hereafter referred to as the study group] indicates several key points. One, standardized industrial technology can be recognized in both the form and function of the study group kilns. Two, similar patterns of human behavior and land use are recognizable at each charcoal production facility. Third, mining and charcoal production at Canyon Creek, Birch Creek, and Wickes were intricately linked to a larger world system that had a bearing on many aspects of their operations. From this study an archaeological pattern emerges that demonstrates human behavior within the context of 19th-century frontier mining operations.

The research methodology used to study and record the kilns at Canyon Creek, Birch Creek, and Wickes followed several steps. First, the kilns were photographed showing a full view. Then, close-ups showing key features, such as main doorway, vent holes, upper doorway, wooden or cable banding, and masonry style were taken.

Second, standing kilns having sufficient structural integrity to reveal key features, as well as an intact parabolic dome, were measured. Specific measurements include the height of each vent row from the base of the kiln, distance between each vent row, the number of vents per kiln, and the horizontal space between vent holes. Next, measurements were taken showing height, width, and thickness of the main loading door and, where accessible, upper loading door.
<table>
<thead>
<tr>
<th><strong>Wickes Charcoal Kiln</strong></th>
<th><strong>Canyon Creek Kilns</strong></th>
<th><strong>Birch Creek Kilns</strong></th>
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<tr>
<td><strong>Diameter:</strong></td>
<td><strong>Diameter:</strong></td>
<td><strong>Diameter:</strong></td>
</tr>
<tr>
<td>interior- 20' 9&quot; / 6.3 m</td>
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<td>interior- 18' / 5.50 m</td>
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<td><strong>Height:</strong></td>
<td><strong>Height:</strong></td>
</tr>
<tr>
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<td><strong>Main door:</strong></td>
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<tr>
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<td>wall- 5 stretchers / 1 header</td>
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Figure 10-1. Technical dimensions and specifications of the Wickes, Canyon Creek, and Birch Creek kilns.
The philosophy of standardization in 19th-century mining operations was spelled out by Charles Mitke in his book, *Standardization of Mining Methods*, published in 1919. Because of the variety of activities associated with mining, smelting, and adjunct operations such as charcoal production, the standardization of processes and machinery was essential to an efficient and cost-effective operation. According to Mitke (1919:1),

"The satisfactory results obtained from the standardization of certain special phases of mining work have led to the belief that the working out and adoption of standard methods of operation, suitable for average mining conditions, will be of economic importance in offsetting the increased costs of production, and will prove beneficial to both the management and to the worker."

Standardization of form within charcoal production facilities is observable and measurable. Parabolic beehive kilns have size and dimension, as well as features that are unique and specific to their function. As shown in figure 10-1, the structural dimensions of kilns among the study group show striking similarities. Parallels in height, diameter, vent height and spacing, and door size, indicate that this type and size of kiln was commonly used in rural, intermontane mining and smelting operations throughout Montana, Idaho, and the west. The size of these kilns reflects Egelston’s view that smaller kilns, with a capacity ranging from 25 to 35 cord of wood, "are less expensive in construction, more easily filled, cheaper to manage, give a better yield, and can be turned more frequently than any of the other varieties of kilns" (1880: 396)

Kiln features that point to standardization of form are the position of air vents. A charring fire must be kept at, or near, 300 degrees Celsius in order to drive off volatile elements within the wood. At the same time, the oxygen flow has to be carefully
controlled in order to prevent total combustion. For those reasons, air vents were built into the kiln to help control air intake, as well as the temperature of the burning fire within the kiln. Vertical and horizontal position of the air vents, and their total number, differ insignificantly among the study group kilns. The air vents are all located along the bottom portion of the kilns and are spaced nearly the same horizontal distance apart. Birch Creek demonstrates the greatest variation with an average horizontal distance between vents of 27 centimeters. Horizontal vent spacing at Wickes and Canyon Creek averages 69 centimeters and 82.24 centimeters respectively. The variation at Birch Creek can be attributed to the smaller diameter of the kilns, which average 5.48 meters, versus an average diameter of 6.88 meters for the kilns at Canyon Creek and Wickes.

Brickwork and masonry style offer another tool for comparison of the study group kilns. At each site, brickwork and masonry style are nearly identical. Brick patterns follow Egelston's suggestion that joints between each row of bricks be broken (no overlap) and that headers (bricks laid endwise) be used frequently between rows of stretchers (bricks laid lengthwise) to tie the bricks together and give added strength (376). Among the study group, brick joints are uniformly broken and headers are laid approximately every fifth row between stretchers. The masonry style used is similar to English bond, which creates a very strong and durable structure (Plumridge and Muelencamp, 1993: 180). This can be attested to by the number of kilns still standing totally or partially intact after more than a century of exposure to harsh climate and conditions.
Standardization is observable in the construction of the walls and domes. In each of the study group kilns, wall thickness is wider at the base and becomes thinner as the height of the wall increases. For example, the Birch Creek kilns show a thickness of four-brick wythe (approximately 14 inches) at the base, receding to three-brick (approximately 10 inches) until reaching a small shelf upon which the dome is built. From the base of the dome to the top, a two-brick wythe (8 inch) thickness is used and the pattern shifts to stretchers only (A Conservation Study, 1984: n.p.).

A whitewash made of lime and water helped to seal cracks within a kiln and offer some protection from the elements. At American Forks in Utah, the kilns were whitewashed after every use (Egelston, 395). At both Canyon Creek and Birch Creek, evidence of whitewashing is still evident. The kilns shown in photo 7-8 (page 69) have been whitewashed with a lime and water coating following stabilization work in 1994.

Other similarities between the study group kilns include the use of two doorways; a larger one at the base and a slightly smaller door located in the mid-level portion of the dome. Billets of wood, precut to 4 foot lengths, were loaded through the main door until the height of the pile inside made it necessary to complete the process using the upper door. Once loaded, or charged, the kilns were closed using heavy steel doors that were then sealed to insure an airtight environment (see photos 7-9 and 7-10, page 70 and 71). Although no remnants of these steel doors were found at the study site kilns, the historical record indicate their use.

To ease loading, the kilns were often built adjacent to a ridge or hill that allowed access to the upper door using a rail car or wagon (Egelston, 392). Emmon's 1885 report
offers an example of this type of loading procedure (illustration 2-7, page 23). The use of such topographical features existed at Wickes and Birch Creek, although in both cases the earthen banks have eroded away (Gray, 70; *A Conservation Study*, 1984: n.p.).

**FUNCTION**

The functional aspects of charcoal operations at Canyon Creek, Birch Creek, and Wickes can be seen in several discernible areas. First, function was closely tied to land use patterns that are similar at all three kiln sites. Second, patterns of human behavior indicate how humans functioned within the context of 19th-century mining and charcoal operations. Third, remote mining operations studied within the context of a modern world system show how outside political, economic, and technological influences effected function. These issues will be discussed in turn.

**Land Use Patterns**

Similarities in land use patterns are noted within the study group. The intense harvesting of wood for charcoal heavily impacted the region surrounding each of the study group kilns. This can be attributed in part to federal legislation. Mining laws enacted in the late 1800's allowed the holder of a mining claim to use whatever resources exist within the boundaries of that claim, both above ground and below (Statutes at Large, 1872: 88; ). Timber resources within the boundaries of a claim were often exploited without concern for the long-term impact upon the forest. While vegetation growth has helped reclaim much of this land, the scars of 19th-century timber harvesting are still visible at each of the study group kiln sites today.
Exact figures for the amount of land affected by wood harvesting for charcoal production is difficult to ascertain. In his 1988 report on the Canyon Creek kilns, Forest Archeologist Mike Ryan used a number of estimates to conclude that 1,907 acres of timber were needed to turn 26,667 cords of wood into 1,200,00 bushels of charcoal. According to Ryan, in one year, "... the equivalent of three sections were cut to fire one or two furnaces..." (Ryan, 1988: 29). It should be noted that timber cut in the general vicinity of the kilns fulfilled a number of purposes other than charcoal production, such as wood for mine timbers and building material.

Another example of land use is demonstrated by charcoal deposits located near the Canyon Creek and Birch Creek kilns. At both sites, independent colliers produced and sold charcoal before and after company owned beehive kilns went into operation (Sassman, 243-244; Oberg, 74). Colliers often built and fired their charcoal pits near the source of their wood. For this reason, charcoal pits can be found scattered throughout the area. As an associated component of the archaeological feature system, the remains of charcoal pits indicate the important role this type of production played in the early phases of frontier metals processing.

Human settlement plays an intricate role in creating visible patterns upon the land. At Canyon Creek, the remains of two log structures indicate land use through early habitation. The cabin remains are located within several miles of the kilns and may be associated with mining or charcoal production. Historical evidence indicates that wood cutters or colliers lived and worked in this area. In 1997, the two cabin sites were excavated in hopes of determining ethnic or occupational association. While the tests
turned up too few artifacts to make a determination, further testing and research could help shed light on the origin and use of these cabins.

Adjacent to the Birch Creek kilns was a small community devoted entirely to charcoal production. Known as Woodville, this bustling charcoal camp once held a population of approximately 200 men, nearly all of whom were involved in cutting and hauling wood, making charcoal, and delivering it to the smelter at Nicholia (Historic American Engineering Record, ID-11: 10). Woodville and its residents disappeared after the kilns shut down in 1889. Only a few scattered remains of the 6,000 cords of wood they left behind are visible yet today (Gard, field notes, October 19, 1997).

Land use is further demonstrated by a linear component within the feature system comprised of a transportation network. Roads were needed for wagons to bring raw material (wood) to the kiln site and haul the finished product (charcoal) to the smelter. In some cases these roads have been improved over the years and are still used today.

In the Glendale area, roads allowed teamsters to haul ore, wood, charcoal, and coal between the mines, kilns, smelter, and the railhead at Melrose. The smelter operation at Wickes had access to both roads and rail transportation following construction of the Helena and Wickes branch of the Northern Pacific Railroad in 1883 (Gray, 36-38). Colliers at the Birch Creek kilns relied on a network of roads in order for wood to be brought to the kilns and charcoal to be shipped ten miles across the valley to the smelter at Nicholia. These roads also gave miners, colliers, and valley residents access to the nearest railhead, located sixty-five miles south at Camas, Idaho.
Patterns of Human Behavior

Distinct and similar patterns of human behavior are evident among all three study groups. Each experienced a rapid influx of miners and prospectors searching for precious metals. Soon after the miners arrived, farmers and ranchers came and established homesteads, where most raised produce and cattle to feed the miners. Businesses followed that catered primarily to the needs of the miners, such as saloons, gambling halls, brothels, and stores. If a mining camp offered the necessary amenities, families arrived and gave these rough and tumble camps some semblance of respectability.

The opposing aspect of this settlement pattern is demonstrated by the rapid abandonment of communities. Few who arrived in a mining camp had visions of platting a townsite and watching it grow. Miners came for one thing: riches buried in the earth. If any were found they were harvested and the miners moved on to search elsewhere for more. Without the miners, most business entrepreneurs moved on as well, often following the miners to their next stop. The old mining camps and “ghost towns” that lay scattered across the American West attest to this boom and bust cycle of human settlement.

Corporate involvement in the mining industry was equally as ephemeral. Despite investing hundreds of thousands of dollars to purchase claims, develop mines, build smelters, and create the necessary infrastructure, mining companies shut down operations quickly if their economic impetus faltered. For some, like the Hecla Mining Company, this shut down occurred almost overnight. When word came of the decision to cease operations at Glendale, colliers tending the charcoal kilns at Sucker Gulch simply walked
away, leaving them charged and ready to burn (Ryan, personal communication, July, 1997).

From these and other examples throughout this study, several key points are illustrated. Charcoal making evolved from a primitive craft to an industrial technology, the result of which is represented through the use of beehive charcoal kilns. Charcoal production itself became a standardized subsystem of the mining industry, one that can be recognized in the archaeological features at Canyon Creek, Birch Creek, and Wickes. Patterns of human behavior are evident through land use, minerals exploration, and settlement at each of the kiln sites studied. And, finally, mining and charcoal production were intricately tied to a larger world system through national and international corporate control and a worldwide demand for precious and base bullion. It was this demand for silver and lead that brought the kilns and their associated smelter sites quickly into existence, then led them just as quickly into extinction.

**Charcoal Production Within a “Modern World System”**

Although located in remote locations throughout the West, frontier mining operations reacted to events and forces far beyond their immediate vicinity. Emmanuel Wallerstein (1974, 1980) refers to such a relationship as a "modern world system."

Donald Hardesty describes a world system this way:

"Mining colonies were financed, manned, and supplied from the urban centers of America and Europe. Despite their geographical remoteness and small size, the colonies were linked into a vast transportation, communication, demographic, and economic network on a national and international scale" (Hardesty, 1988: 1)
Mining and charcoal production at Canyon Creek, Birch Creek and Wickes demonstrate connections to a modern world system. First, the mining industry was intimately connected to outside economic forces. National and international events caused metal prices to rise and fall, the effects of which soon reached local mining, smelting, and charcoal operations. The smelters at Nicholia, Glendale, and Wickes felt the impact of fluctuating silver and lead prices and acted accordingly. For example, a slump in silver prices throughout the late 1880's, along with the importation of Mexican lead, helped to bring about an end to smelting at Nicholia and charcoal production at Birch Creek (Vlasich, 24). The Glendale smelter weathered the same economic storm a decade longer, until depressed silver prices and declining ore quality forced it, and its charcoal operation, to shut down in 1900.

Outside ownership and control of mining, smelting, and charcoal operations demonstrates another connection to a modern world system. Corporate decisions affecting frontier mining operations came primarily from offices located in urban centers far from the mines that generated their revenues. In the case of the Viola Mining and Smelting Company, which managed the smelter at Nicholia and charcoal operations at Birch Creek, controlling stock was held by the Viola Company, Ltd., a London based firm (Engineering and Mining Journal, 1886). At Wickes, initial ownership of the Alta Montana Mining Company lay in the hands of New York capitalists, who were organized by mining promoter Cole Saunders, and Helena banker Samuel T. Hauser (Grey, 34).

Finally, a human element connected mining, milling, and charcoal production to a larger world system. The labor force needed to turn ore into ingots consisted of immigrants
from all over the world. In the Eureka mining district of Nevada for example, the presence of Italians is well documented (Earl, 1969; Zeier, 1987). The "carbonari," as they were known, developed a reputation as skilled colliers during Europe's industrial revolution and they brought that talent to bear upon charcoal operations throughout the western United States (Earl, 53).

Within the study group, Italians are known to have worked the charcoal operations at both Canyon Creek and Birch Creek (Ryan, 31; Sassman, 243-244; Oberg, 76). In his correspondence, Henry Knippenberg makes numerous references to local Italians working at the charcoal kilns at or near Canyon Creek (Hecla Mining Company Letter Book, 1878-1890). The presence of immigrants and the charcoal kilns they operated is evident today in geographical place names such as Italian, Irish, and Coal Kiln Canyons (Oberg, 76). Through examples such as this, it becomes apparent that despite their remote locations, frontier smelting and charcoal operations were never sequestered from the outside world that loomed somewhere beyond the horizon.

Much remains to be learned about beehive charcoal kilns and their association with 19th-century mining operations. Questions of ethnicity and cultural affiliation deserve greater study. What types of settlement, if any, grew out of charcoal camps? The design and construction of beehive kilns should be pursued further, as well as a history of those who built them. What is presented here may help open the door to further research. It is hoped this study has provided a better understanding of charcoal production and its role in shaping the early industrial and economic landscapes of Montana and Idaho.
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