The recovery of gold from the matrix in which it is found has occupied the efforts of mining men ever since the discovery of the precious metal. Often, the success or failure of recovery processes has determined whether a mining town has lived or died. The prospectors who arrived in the northern Black Hills in late 1875 and early 1876 found abundant gold in a free state along and in several miles of creeks. The only tools required for recovery were the simplest and oldest of mining appliances—the shovel and gold pan. By the mid-1880s, however, free gold was no longer so abundant, and Black Hills miners began the long search for effective methods of recovering gold from hardrock ores. In the Deadwood area, pyritic smelting provided a temporary solution and kept the economy alive until more efficient milling methods could be devised.

The mining town of Deadwood had been laid out in April 1876 a little below the junction of two creeks, Deadwood and White-wood. Its first residents came with the gold rush, but merchants quickly followed the miners, and by the end of 1876, nearly all branches of business were represented in Deadwood. Within a year of the discovery of gold in the creeks, hardrock quartz claims became the miners’ main objectives. The experienced prospector knew that if he found placer gold, there had to be gold-
bearing quartz outcroppings that had yielded the gold to the streams below. Hardrock mining, however, was much more rigorous than placer mining, requiring heavy milling equipment. A stamp mill was needed to pulverize the mined rock for amalgamation, a process in which mercury was used to draw the gold from the crushed rock. This procedure had developed as a standard throughout the western mining frontier, and in 1878 nearly seven hundred stamps were dropping within a few miles of Deadwood.³

As mining processes became more sophisticated, so did Deadwood. It evolved into a mining hub, providing necessities for the miners and mining companies of the area. Beginning as a town mainly inhabited by miners, it became a business center that catered to the mining men. The census of 1880 indicated that of the nearly four thousand residents, only twenty-nine percent classified themselves as miners. The years following 1880, however, brought a gradual decline in the economy of Deadwood. The easily processed free-milling gold ores, which readily released their gold to amalgamation, were being exhausted. Except for a single group of working mines, located a few miles from Deadwood at Lead, little other activity was taking place. This group of productive mines was situated on a contiguous ore body about six thousand feet by two thousand feet on the surface that came to be known as the Homestake Belt. The few mines on this belt became so dominant in the Black Hills mineral industry that, by 1888, they were producing about ninety percent of the gold and silver recovered in the Black Hills. As general mining activity declined, Deadwood’s population slipped to less than two thousand by 1885, with neighboring Lead, the home of the Homestake mine, surpassing it. While Deadwood continued to attract much of the business from the Homestake miners, the area around the town was comprised of a multitude of nonproducing quartz claims. These unsuccessful ventures exemplified the general gloom that was overshadowing Deadwood’s economy.²

A large region a few miles southwest of the Homestake Belt contained many of the nonproducing claims. In this area, comprised of the Bald Mountain (Portland) and Ruby Basin mining districts, ores assayed at an average gold and silver content of between ten and twenty dollars per ton, with the richest running up to one hundred dollars. Despite these high assay values, little gold or silver was being produced. The problem appeared to be with the ores. From the time of first discovery in the Bald Mountain District at the Empire Mine in 1877 to the late 1880s, various mechanical amalgamating processes had been tried. The best results showed only about fifty percent of the silver and thirty percent of the gold being recovered. These ores did not appear to be totally dissimilar from those on the Homestake Belt, but while the Homestake ores carried a significant amount of free-milling gold, the ores of the Bald Mountain and Ruby Basin districts showed little evidence of such gold. After repeated failures to recover the precious metal from these ores, many miners assumed that the gold existed in particles too minute to be saved by “ordinary processes.”

Ores that showed well in an assayer’s office but were difficult to treat commercially were not unique to the Black Hills. Throughout the West, various mining camps encountered their own problem ores, and all were lumped into a class as being refractory. Wherever these refractory ores existed, the crushing and amalgamating process in common use was not capable of handling them. Many western mining camps had come across their refractory ores years before the Black Hills gold rush and had set out to find a method for retrieving their gold and silver. As early as 1867, a process that offered hope came to the forefront in Colorado. It was known as smelting, and, just as the name sounds, it was based on the melting of the ore in an effort to force the release of its gold and silver. The process was much more complex than this, however, with its first objective being to remove as much waste rock as possible from the ore. Some extra material, called “flux,” was usually added to the melted ore to help col-

lect the waste rock into a molten mass known as “slag.” The material that did not go into the slag as waste would, upon cooling, essentially be a new concentrated ore. This new ore would be called either “matte” or “bullion” and would contain copper, iron, or lead and, it was hoped, all the gold and silver in the original ore. Smelting, then, was just one step in ore treatment. It took an original mass of ore, generally discarded ninety percent as waste, and left the remainder as a more manageable, concentrated ore. The resulting matte was shipped to a refinery, where a more sophisticated process was used for final extraction of the gold and silver.\(^4\)

The specific process used in Colorado was adapted from one being used at the world-famous smelting center at Swansea,

Wales, Great Britain. At the Boston and Colorado Smelter in Black Hawk, Colorado, eight to ten tons of ore would be concentrated into one ton of matte, which was composed of a copper and iron-sulfide combination in which the gold and silver was dissolved. This new ore became so concentrated with the precious metals from the refractory ore that it was profitable to ship it to Swansea, Wales, for the final refining step of extracting the gold and silver. The Black Hawk smelter functioned as a custom plant where miners could either sell their ore before treatment or have their ore treated for a fee, thereby allowing the mines to operate on a small scale without the expense of a processing plant.5

The science of the matte-smelting process was eventually understood to the point where it was realized that it was the copper in the matte that insured the collection of the gold and silver. Consequently, the Black Hawk plant began to import copper ore from Montana to insure that enough copper was always present in the process to collect the gold and silver. First the plant at Black Hawk and then the other smelters that followed, many using lead instead of copper to collect the gold and silver, proved a great boon to the Colorado miners who had been nearly overpowered by their refractory ore. As the smelting processes developed, several industrial groups emerged, building plants in the Rocky Mountains for primary ore smelting. Their chief markets for the gold and silver, as well as for the other materials within the matte or bullion, were to the east of the Rocky Mountains. Consequently, several of these companies built their refineries in the Midwest and East and shipped their concentrated ore to them, with the gold and silver locked safely within.6

Primary custom smelters offered hope for the treatment of the Bald Mountain and Ruby Basin refractory ores, but because of the great distance to the plants, little ore was shipped. This situation improved in 1886 when the railroad reached Rapid City, some sixty miles from the mines, and offered transportation of the ore to a primary smelter at Omaha. The Omaha smelter could extract the gold and silver from the Black Hills' refractory ores,

but it was expensive. The ores contained about eighty percent silica, also known as sand or quartz, but by any name it was trouble for the smelter. The Omaha plant reflected this difficulty in the amount it charged for processing the ore, with the price varying from twelve to seventeen dollars per ton. Adding this cost to the expense of transportation meant that ores valued at less than about thirty dollars per ton could not be mined, shipped, and processed at a profit. Only the richest of the ores could be profitably transported, and an enormous amount of lesser ore was left behind.  

The news that a process was available that could treat the refractory ores was indeed heartening to the miners and merchants that remained in Deadwood. They realized, however, that the process would not be truly successful until it could treat a majority of the refractory ore on an economical basis and that the best way to attain this goal was to establish a local processing plant. The immediate benefit a local plant would have for the individual miner was obvious, but the Deadwood businessmen saw beyond the short-term financial gains to the revitalization of their town. Seizing the opportunity, they began discussing the need to build a local smelter the same year that the railroad reached Rapid City. In June of 1887, the Deadwood Smelting and Reduction Works Company was formed, and its board of directors consisted of the most prominent of Deadwood's citizenry. The immediate task facing the company was to guarantee funding for a potential plant. Subscriptions were sought throughout Deadwood, with most citizens expressing a willingness to invest liberally for stock in the concern. Enthusiasm was running high in the community when the local press headlined news of the company with "Hard Times No More."  

In the beginning, there seemed to be no question that a smelter using lead to collect the gold and silver like the one at Omaha would be the type of plant to build. In fact, even before the company organized, the intended rates for smelting were being published and compared with those in Omaha. Glittering reports were circulated of the vast quantities of lead ore at Galena, south

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of Deadwood, and at Iron Hill, northwest of Deadwood. Such reports reinforced the idea that the necessary lead for use as a collecting medium in a smelter was readily available in the local mines. As the question was probed further, however, the situation appeared to be different. Lead smelters had been tried previously at both Galena and Iron Hill with some success, but whether or not there were actually suitable quantities of lead ores available for smelting appeared to be questionable. The Deadwood Smelting and Reduction Works Company remained confident that a lead smelting works could be successful, but it decided to investigate other forms of ore processing before committing itself to the smelter.¹⁰

Several new ore-processing schemes were being promoted at the time. These always promised a superior recovery of gold and silver at considerably less expense than smelting and often by ingenious methods. The Deadwood company, now called the Deadwood Reduction Works Company, was attracted to one such process operated by R. D. Clark of Cortez, Nevada. In February 1888, the company hired him to erect a reduction works in Deadwood, using his special, patented process. By 1 March 1889, the stockholders had disbursed almost ninety-eight thousand dollars toward construction of the plant, and the first cleanup was planned for that day. Success, they thought, was imminent. Before the cleanup could even begin, however, a fire totally destroyed the plant. The disaster caused many rumors, but most often heard was the probability that the Clark process was a failure and that the plant had been destroyed to hide the evidence.¹¹

The destruction of the reduction works was a setback, but only a minor one, in the effort to revitalize Deadwood and the neighboring mines. Initiation of the project had generated activity, and by the time the plant burned, local enthusiasm had gained enough momentum to overcome the loss. The excitement caused by the possibility of a reduction plant in Deadwood was largely due to the efforts of two of the original members of the board of directors, James K. P. Miller and Harris Franklin. Both men had come to Deadwood during the boom times and had established successful businesses. When elected to the board, they were interested in helping Deadwood recover from hard times. They undoubtedly

¹⁰ Ibid., 15, 22 June, 2 Sept. 1887.
hoped, as well, that with the proper business acumen they could personally prosper from a revitalized Deadwood.  
Each had worked to this end in his own way and would continue to do so. Harris Franklin, originally in the wholesale mercantile business, had joined with local associates in 1887 to form the Golden Reward Mining Company. This group had invested in three Ruby Basin lode claims containing refractory ore, counting on the Deadwood reduction plant to process the ore successfully. The destruction of the plant in 1889 could have been a major disaster for the Golden Reward Company, except for the ambitions of Harris Franklin. As president of both the Deadwood Reduction Works and the Golden Reward Mining Company, he needed to guarantee the survival of both after the fire. He quickly devised a stock transfer whereby the Deadwood Reduction Works was absorbed by the Golden Reward Mining Company, a transfer that made little difference to most Deadwood investors because the plant was to be rebuilt. The Golden Reward, however, would be the controlling interest, and the new plant would be using an ore-processing method of Harris Franklin’s choice—chlorination—and would mostly, if not exclusively, treat Golden Reward ores.

The other major business force on the original board of directors, James K. P. Miller, had originally operated a grocery store in Deadwood, but by 1887 he had become so confident in the future of Deadwood that he abandoned the grocery concern to become a full-time real-estate developer and business promoter. Believing that the future of Deadwood was dependent on business development, he wished to be at the forefront when the reduction works brought renewed prosperity. To do so, he needed capital, and this he found in the East, largely through Joseph Swift of Wilmington, Delaware. Swift, it was claimed, was head of a gigantic trust that already had holdings in the Black Hills. Impressed with the Deadwood situation, he invested heavily in it. With Miller doing the actual investing, Swift and the other financiers behind Miller became known collectively as the “Miller Syndicate,” or just the “Syndicate.” During six months of 1887, Miller secured all property known to be on the market in Deadwood, investing over one hundred thousand dollars. In 1888, he built the

Syndicate block in Deadwood, constructed a horse-powered rail-
way through the streets of the town, and incorporated the Dead-
wood Central Railroad Company to build a narrow-gauge line
from Deadwood to the various mines. By 1 March 1889, Swift and
Miller had also invested heavily in the Deadwood Reduction
Works, but, when deciding its fate after the fire, they advocated
locking up the ruins and abandoning it.14

1889, 17 Jan. 1890, 14 Jan., 23 Aug. 1891; Some History of Lawrence County (Dead-
wood, S.Dak.: Lawrence County Historical Society, 1981), p. 534; William W. Bald-
win, Corporate History of the Chicago, Burlington & Quincy Railroad Company
and Affiliated Companies (Chicago: Chicago, Burlington & Quincy Railroad Co.,
1921), pp. 455-57.
As contrary to their ambitions as their position seemed, the investors in the Syndicate actually wanted something beyond what the Golden Reward Company was offering. First of all, they wanted a custom plant that would reawaken all of the idle mines, not just those of the Golden Reward Company. Secondly, they wished to use a process that could recover both gold and silver because many Ruby Basin mines contained large quantities of silver. The chlorination process that Harris Franklin favored would only recover the gold. Swift and Miller believed that smelting was the method to use—not the process in common use, but a new variation being developed at the School of Mines in Rapid City. This new method would use the resources available in the Black Hills and would require neither lead nor copper to collect the gold and silver.

In 1886, when discussion of a local smelting works had first developed in Deadwood, a smelting process that could recover gold and silver without copper or lead was largely untried in the United States. The seeds of the idea had been planted, however, with the appointment, in late 1886, of Dr. Franklin R. Carpenter as the first dean of the newly created Dakota Territory School of Mines at Rapid City. Carpenter believed the new institution had been established to help the mining interests of the Black Hills. He consequently directed his first efforts toward finding an economical treatment for the local ores. As early as 1887, he had tried chlorine and bromine processes, but too much value was being lost in the tailings. To make things more difficult during these first efforts, he also found that the refractory ores were not consistent, with some being more difficult to treat than others.15

To better understand the nature of these ores, Carpenter undertook a geological survey of the Black Hills. The survey, started in 1887 and finished in 1888, covered iron, copper, and tin, as well as gold and silver, deposits. The inconsistencies in the refractory-ore bodies were explored, and two types of ore were found. The first was the surface ore, which contained iron oxide and the mineral-bearing quartz. The other ore was deeper in the mines, where the mineral-bearing quartz was mixed with a compound of iron and sulfur, called pyrite. Many early mining experts believed that it was this pyrite that made the ore refractory. The

surface ore had once contained pyrite, but it had been acted upon by natural weathering forces, which caused oxidation of its iron and sulfur, forming iron oxide. It was also found that the mines of the Bald Mountain area contained mainly gold, while those in Ruby Basin showed gold and silver in equal quantities.16

All of these factors weighed upon Carpenter as he considered the options for ore treatment. Chlorination already showed too great a loss, which would be more appreciable with ores containing large amounts of silver. He also realized that it was the abundant unoxidized pyritic ores that were adding to the difficulties in treatment. These ores would have to be oxidized by fire roasting to eliminate most of the sulfur before chlorination could even be attempted. He began to study the other advanced metallurgical process he was familiar with — smelting. A properly run smelter could collect both gold and silver, with roasting being a variable part of the operation, depending on the ore. The copper-matte and lead-smelting practices that were being utilized so successfully in the Rocky Mountains were not feasible, however. Both lead and copper ores were too scarce in the Black Hills to consider them as collecting media, and with railroad connections just in their infancy, shipping them in would have been cost prohibitive.17 Carpenter realized that when a matte was formed to collect gold and silver, as at Black Hawk, Colorado, it contained not only copper sulfide but also iron sulfide. Even though the operators of that plant believed that copper sulfide was the essential ingredient of a successful matte, Carpenter and others suspected that the iron-sulfide portion could be just as important. If a purely iron-sulfide matte that would carry gold and silver could be developed, then the problem would be solved, for the Black Hills had plenty of iron and sulfur in the form of pyrites.

In 1889, Carpenter began to develop the concept of smelting the highly siliceous refractory ores using pyrites to form an iron-sulfide matte, and he appropriately called it pyritic smelting. The idea was not unique, and some literature was available on the subject. He found that an operation at Kongsberg, Norway, was dealing with a similar situation, and his experimentation began from that point. Adapting ideas and studying literature about other plants, he and his associates at the School of Mines repeatedly

ran experiments in which certain quantities of ore, limestone for fluxing, and pyrite were melted together until the most fusible, desirable, and profitable mixture was determined. It had to produce both a good slag, containing as much silica as possible, and, from the pyrites, an iron matte that would carry the gold and silver.\(^\text{18}\)

After completion of the experiments, various Deadwood businessmen called on Carpenter. Seth Bullock, representing the Iron Hill Mining Company, suggested that the iron ore in its mine made it especially suitable for the pyritic-smelting process, and he decided to make an experimental run using the process in August of 1889. The first run was not satisfactory, but two subsequent runs were successful, leading Bullock to announce that “to the Iron Hill company belongs the credit of inaugurating the process of pyritic smelting.”\(^\text{19}\)

Another of Carpenter’s visitors was James K. P. Miller, who studied the experiments thoroughly and became an interested observer at Iron Hill. Miller and his associates in the Syndicate became satisfied that the process was metallurgically possible and, at this point, decided to build an experimental smelter at


\(^{19}\) Black Hills Daily Times, 4 June 1890.
Deadwood in lieu of helping Harris Franklin and the Golden Reward Company rebuild the recently burned Deadwood Reduction Works. The Syndicate hired Carpenter to design and erect the trial plant, but the Syndicate was not going to duplicate the earlier folly of the Deadwood Reduction Works. Regardless of the claims coming from Iron Hill, pyritic smelting was largely untried. As a result, the Syndicate invested a mere six thousand dollars, and a small plant known as the "baby smelter" was built in the fall of 1889. It was located a little below Whitewood Creek, across from the site of the soon-to-be-rebuilt Deadwood Reduction Works.

Among the original experimental concerns, the proper charge of ore, fuel, and flux had to be finalized. The tests at the School of Mines had given the basic outline of the process, but it needed to be fine-tuned for commercial operations. The charge of ore, lime-


The first smelter of the Deadwood and Delaware company, the "baby smelter," was constructed in 1889 as an experimental plant to test the practicality of pyritic smelting in the Black Hills.
stone, and pyrites would determine the nature of the slag and matte. The slag had to carry away as much silica as possible while producing the desired iron-sulfide matte that would carry the gold and silver. Metallurgists insisted that an iron-sulfide matte would not successfully collect the gold, and Carpenter's colleagues in the lead-smelting industry predicted failure.21

While the theoretical aspects of pyritic smelting were thus being worked on, some practical problems also had to be resolved. Among them was the necessity of obtaining consistent fuel, ore, and flux supplies. The fuel originally used was coke from West Virginia, a fairly expensive commodity.22 The new coal mines near Newcastle, Wyoming, offered hope for a cheaper and more regular supply, but both sources ultimately proved inconsistent. The ore came from Ruby Basin, the iron pyrite from Galena, and the limestone flux from a mine nearly within Deadwood. All were hauled to the plant by wagon, and everything from weather to labor disputes affected the supply. All materials had to be present in the right quantities for successful operation.

By May of 1890, the initial tests were proving the process successful enough that the Syndicate formed the Deadwood and Delaware Smelting Company with the intent of actively pursuing the custom-smelting business via pyritic smelting. Advertisements in the Deadwood papers offered the highest market prices for all gold and silver ore of a grade sufficient to justify smelting.23 On 23 August 1890, Carpenter confidently stated, "The 'Baby Smelter'... is almost running itself, everything working as smoothly as possible."24 It was operating in a small way, though, treating only thirty tons of ore in twenty-four hours and shipping the matte to an out-of-state refinery for final treatment.25

Whether the smelter was operating in a small way or not, Deadwood was certainly beginning to notice its effects, especially when the wind was right. The atmosphere would then become dense with sulfurous fumes, which were generally regarded as tangible evidence of a successful industry.26 Carpenter, however, went so far as to call the fumes beneficial, suggesting that they

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25. Ibid., 6 July 1890.
26. Ibid., 6 Aug. 1890.
acted as a disinfectant. "Microbes have a weary existence if exist they can in air thoroughly impregnated with the fumes from the furnace," he reportedly assured the Black Hills Daily Times. Other, more tangible effects were also apparent. The success of the pyritic smelter and of the newly rebuilt Deadwood Reduction Works was not going unnoticed by the neighboring railroad lines. For years, the Deadwood business community had promoted itself to both the Fremont, Elkhorn & Missouri Valley and the Burlington & Missouri River railroads, but both lines had skirted the Black Hills. In 1890, the railroads found themselves racing each other to Deadwood to capitalize on the boom.

In October of 1890, the backers of the Deadwood and Delaware Smelting Company began to plan for erection of a full-scale pyritic-smelting plant in Deadwood. Initial specifications called for a plant with twice the capacity of the baby smelter. The larger plant would be constructed with the hope that the railroads pushing into the Hills would solve the outside transportation problems, while the Deadwood Central, incorporated two years before, would solve the problem within the Hills. During 1889, the Deadwood Central had been built to operate between Deadwood and Lead, and in 1890, it was expanded into the Bald Mountain and Ruby Basin mining regions. The railroads offered the possibility that a constant supply of ore could keep the larger smelter operating at full capacity.

The new Deadwood and Delaware Smelter (the D & D) was built across the creek from the baby smelter, a little below the Deadwood Reduction Works. The plant was finished and placed in blast by the end of July 1891. Technically, experimentation was complete. The effectiveness of pyritic smelting for local ores had been proven, and the practical problems encountered along the way had been resolved. Continuous operation was now needed to make the plant a commercial success. Unfortunately, the plant's operation would be anything but continuous for the next two years, as new problems arose and subsequent experimentation allowed the plant to operate only sporadically.

Indeed, within a month of its opening, the plant closed, probably due to high costs of operation. The problem seemed to be with

27. Ibid., 17 Jan. 1890.
28. Ibid., 1 Jan. 1891.
29. Ibid., 28 Oct. 1890, 1 Jan. 1891; Baldwin, Corporate History, pp. 455-56.
the material being placed into the furnace. The ore came from the company's own mine, the Maggie in Ruby Basin, and this was the only material of value placed into the furnace. The other ingredients were entirely barren of any gold or silver, including the pyrite from the Bristol mine at Galena. This circumstance required that the entire cost of operation be borne by the precious metal in the Ruby Basin ore alone, a situation smelter operators wished to avoid. Even though the plant operators claimed that all gold and silver was recovered from the ore, several runs were apparently made at a loss. Since running barren materials into the furnace added to the cost of smelting and provided no return, the company suspended operations so that Carpenter could find pyrites or other fluxes that contained some gold or silver. He initially went to Utah and Montana to examine reports of valuable bodies of pyrites, but the search ended just up the hill at the Homestake mine at Lead. 31

Since 1882, the Homestake mine had been concentrating the tailings from its stamp mills, realizing that they contained gold

and silver but not knowing of any way to treat them. Early in 1892, the D & D smelter tried these tailings, which were actually concentrated pyrites containing gold and silver, as a replacement for part of the pyrites. Even though the Homestake concentrates did not replace all of the barren pyrites, they worked well in providing extra value in the furnace charge. This result, however, came only after Carpenter determined the best way to handle them. The concentrates were extremely fine and gave rise to large quantities of dust, which he wished to avoid. Before he finally decided on the best method to deal with this problem, he tried many experiments, including the creation of briquettes by mixing the concentrates with a sugar waste product resembling molasses. When dry, the briquettes gave good results in the smelter furnace, but, Carpenter conceded, “the plant smelled like a candy-factory, and apparently all the flies in South Dakota came down to investigate.”

While the search for better pyrites interrupted the plant’s operation, another problem arose that closed the smelter entirely for several months. The eastern refineries that had been processing Carpenter’s iron-sulfide matte suddenly refused to treat it. The refineries much preferred to treat the product of lead smelters since lead was a marketable product once the gold and silver had been removed. Iron and sulfur, on the other hand, were valueless, and the refineries found that they added unnecessarily to the overall cost of refining. Carpenter, however, was not going to be put out of business for want of a refinery; he decided to build his own. A new series of experiments resulted in the erection of a lead furnace and importation of lead ores. The iron matte would yield nearly all the gold it contained to the lead, but no silver. The entire process was still in the experimental phase when, in May of 1892, the refinery at Aurora, Illinois, agreed to treat the iron-sulfide matte. The experiments were discontinued, and the plant resumed normal operations.

Continuous operation at the D & D was not yet guaranteed, however. The fuel supply was still inconsistent, and there was, amazingly, a lack of local refractory ores to treat. At times the

plant worked at less than half-capacity. The company itself owned only one mine that produced refractory ore, and the ores that needed custom treatment were not rolling in from other mines. The fault may have been with the smelter company, for it was charging $2.50 more per ton to treat the custom ore than the Omaha smelter charged. Local miners did save money on the smaller transportation charges to Deadwood, and the D & D Smelter was, overall, a cheaper outlet for local ores. Still, the ore had to be more valuable than the average to be treated successfully. The company did not explain the reason for its higher rates, which were to be temporary, but the extra charge may have been necessary for the plant to operate. Expenses were high; the initial cost of developing the pyritic process had been extraordinary; and dealing with siliceous ores and iron mattes was just more difficult than the standard procedures employed at the lead and copper smelters. Also, the intermittent operations did not allow for a continual flow of necessary capital, and all these problems were probably reflected in the high charge for smelting. In any event, local miners were hesitant about bringing their ore in for treatment. To counter this, in 1892 the company bought four additional mines in the Ruby Basin area and promptly extended its railroad to them in an attempt to insure a constant supply of ore. By the end of the year, the supply of ore looked promising enough for Carpenter to expand the plant, and continuous operation seemed assured.\footnote{35. Black Hills Daily Times, 8 Oct. 1891, 28 July, 8 Oct. 1892, 18 June 1893; Chance, “Gold-Ores of the Black Hills,” p. 284. 36. Minnesela Star, quoted in Black Hills Daily Times, 2 Sept. 1891. 37. “Pyritic Smelting at Deadwood, S. D.,” Engineering and Mining Journal 52 (24 Oct. 1891): 471.}

The rough beginnings of the new plant did not go unnoticed. The editor of a newspaper in a neighboring town averred “that no smelting process has as yet been discovered that could treat our refractory ores successfully.”\footnote{36. Minnesela Star, quoted in Black Hills Daily Times, 2 Sept. 1891.} On a more national scale, the Engineering and Mining Journal stated: “The pyritic smelter at Deadwood, S. D., is operated intermittently, with uncertain success. The slags run high and it is said there is a considerable loss by volatilization. Pyritic smelting has thus far proved more or less an ‘iridescent dream.’”\footnote{37. “Pyritic Smelting at Deadwood, S. D.,” Engineering and Mining Journal 52 (24 Oct. 1891): 471.} Iridescent dream or not, the plant had operated efficiently enough to allow some capital for expansion and, in 1893, was ready to prove, once and for all, the viability of Carpenter’s pyritic-smelting techniques. It was not to be
that easy, however, for the panic that was disrupting the national economy came to Deadwood and forced the smelter to close by the end of that year.  

The plant reopened on 16 June 1894 and once again turned out the gold-and-silver-bearing iron-sulfide matte. The mineral-recovery business had changed, however. Competition for the custom-ore trade had appeared in Deadwood. The newly developed cyanide process had come to the Black Hills, offering new possibilities for extracting most of the gold and part of the silver from the refractory ores. By 1894, the Black Hills Gold and Silver Extraction Milling and Mining Company had erected a cyanide plant in lower Deadwood that was willing to treat certain ores on a custom basis—and at a lower rate than the D & D Smelter. The Golden Reward Company was also entering the field. In 1894, it built a cyanide annex to its chlorination works and began to pursue the custom-ore business by offering to treat all oxidized gold ore in its chlorination plant at a flat rate of eight dollars per ton, well below the D & D’s charge. Both cyanide operations were small and experimental, and the Golden Reward’s larger chlorination plant still could not save the silver as the smelter could, but both companies had the potential to secure the custom-ore business that the D & D wanted.

Carpenter had to meet and defeat the competition. To do this, the smelter’s operations had to be improved so that ores of less value could be treated economically, either by reducing the cost of the operation or by getting a higher return of gold and silver from the ores treated. The cost of operation had been high, but with the expansion that had been completed before the closure in 1893, the cost would begin to decrease if the plant could stimulate increased ore production to allow it to work at capacity. Economical operation, then, depended on high volume, and the volume would increase only if a higher return was given to the miners from the ore treated. Carpenter believed that he was getting all the gold and silver from the ore that he could, and, as far as the science of pyritic smelting stood, he was. The iron-sulfide matte, however, was not having as great an affinity toward the gold as

he had hoped, and its attraction for silver was inconsistent. The slags were carrying from one to two and a half dollars worth of gold per ton, and silver was being lost at an alarming rate. The situation was indeed as the *Engineering and Mining Journal* had earlier stated. With his original monopoly on the custom-ore business, Carpenter had been able to treat the more valuable ores at a high price and still show a profit to the miner, even after some loss in the slag. Now, that practice was no longer practical. His competition was offering lower-cost treatment with, possibly, a better rate of recovery.

The fact that a greater percentage of the precious metals had to be recovered prompted Carpenter to rethink his smelting theory. The plant at Black Hawk, Colorado, that had originally demonstrated the practicality of matte smelting had now been replaced by the large Argo custom smelter at Denver, Colorado. This company was still using a matte that contained both copper and iron sulfides as a collecting medium. By now, the value of copper as a collecting medium was thoroughly recognized. A matte containing copper could collect as high as ninety-six percent of the silver and ninety-nine percent of the gold present in the original ore. The solution, therefore, was an obvious one. In late 1894, Carpenter began importing copper ore from Montana to replace the last of the barren pyrites in the charge. Rail connections now made the copper ore accessible but still at considerable expense to the smelter. Nevertheless, the savings in barren pyrites and in the improved recovery in gold and silver offset the extra transportation costs. The copper in the iron-sulfide matte was now the basis for operation, and a strictly iron-sulfide matte was last produced in Deadwood in 1895.

The addition of copper ores signalled the end of the pyritic process for the Deadwood and Delaware Smelter. Carpenter had originally called his process pyritic smelting on the premise that the iron and sulfur from the pyrites would collect the minerals, but the critical element was now copper. In 1895, the D & D Smelter functioned essentially as a copper smelter, attempting to

create a copper matte within which the gold and silver would collect. Even though this process was commonly known as matte smelting or sulphide smelting, Carpenter continued to call it pyritic smelting, emphasizing the unique features employed at the D & D. Many of Carpenter’s original adaptations were unaltered and still essential for operation, such as the production of highly siliceous slags, the use of Homestake pyrites for both their added value and their iron content, and the use of limestone as a flux. 43 The original hope, however, of not having to import any outside materials for matte formation was gone.

The year 1895 may have been the end of the pyritic process in Deadwood, but by then the effect that it and its promoters had had on Deadwood was obvious. Deadwood’s population exceeded four thousand in 1895, more than doubling itself in ten years, and

was at the highest mark since the initial gold rush. This new surge of people can be credited to what could be called the refractory-ore boom. Mines reopened in the Bald Mountain and Ruby Basin districts, with the smelter being essentially the only local market for the individual miner. The railroads both fueled and supplied the boom as they came to Deadwood in the wake of the successful development of pyritic smelting. The promoters of the process confidently invested in and helped to develop Deadwood’s properties even before the process proved successful. Their confidence paid off, not only for themselves, but for Deadwood in general. Upon James K. P. Miller’s untimely death in 1891, the paper eulogized: “To J. K. P. Miller, more than to any one other man, Deadwood owes its present season of unequaled prosperity.”

The Deadwood and Delaware Smelter was destined for even greater prosperity. The larger plant, utilizing the copper matte, could now meet and beat the ore-processing competition. It offered lower rates for ore treatment, in some instances going as low as three dollars per ton, placing itself in position to become one of the most important and successful metallurgical industries in the Black Hills. During 1896, it treated nearly half of the refractory ore mined in the Bald Mountain and Ruby Basin areas. The company gradually acquired more mining ground and was occasionally accused of manipulating its processing charges to compel the passage of mining claims into its own hands. By 1898, the company held a solid block of property in Ruby Basin that was nearly two miles wide by three miles long, the largest acreage of any company in the Black Hills. The Bald Mountain and Ruby Basin districts were now producing the quantities of ore that had only been dreamed of ten years before. The Homestake Belt mines still produced a more valuable ore than the refractory districts, but their domination of the industry had gradually decreased from ninety percent to sixty percent of the total Black Hills production.

In May 1899, the Deadwood and Delaware Smelting Company sold the smelter and all its mining ground to the Golden Reward Consolidated Mining Company. The Golden Reward had become as aggressive as the D & D in buying refractory mining ground but was still using the chlorination process to treat its ore, even though it had dabbled briefly with the cyanide process. Consequently, the Golden Reward now held a vast amount of silver ore that it could not treat locally. The owners considered erecting their own smelter but decided instead to purchase the Deadwood and Delaware. The transaction exceeded in extent any mining deal made in the Black Hills up to that time, and as much as two million dollars may have changed hands in the merger.

Franklin Carpenter left the plant shortly after the sale, moving on to Colorado to continue working with his original theories in pyritic smelting. He believed that if the reaction within the furnace could be better controlled, the iron-sulfide matte and the pyritic process could be successful without copper. Theodor Knutzen, Carpenter’s assistant for many years, also left the plant at this time and went to Rapid City, where he opened the National Smelter in 1901. Using pyrites from the Bullion mine near Galena, he hoped to operate a custom smelter using the original pyritic process. His purely iron-sulfide matte was used for only a short time, as once again the precious metal loss was too great. Copper ores were brought in, and the basic concept of pyritic smelting was set aside. Under management of the Golden Reward, the Deadwood and Delaware Smelter became the Golden Reward Smelter, treating primarily the company’s own ores. The plant still accepted custom ore for treatment but charged a higher rate for the service. The Golden Reward operated the plant until February 1903, when the smelter men walked out to protest the laying off of a coworker, and the company took this opportunity to close the plant permanently.

The closing of the plant could have been foretold as early as the day it had been sold in 1899, for the cyanide process came of age in that year. After 1900, new cyanide plants were built to replace

the crude plants of the mid-1890s, and these could now compete effectively for the custom-ore business, especially after the smelter increased its rates. Worse yet for the smelter, the Homestake constructed a cyanide plant to treat the pyritic product that it had formerly supplied to the smelter. Since this product was a valuable part of the furnace charge, its withdrawal forced the Golden Reward to use local barren pyrites. Except that the charge now carried copper, this situation was the same as the one that had closed the plant many years before. As a result, high-grade ore was absolutely essential for profitable operation, and its production was decreasing. The final event that presaged the closing of the plant occurred in 1902 when the Golden Reward built its own cyanide mill. The company still used the smelter until 1903 for the more refractory ores, but after the plant was closed, the company shipped the ores to smelters in Denver, Colorado, and Helena, Montana. These smelters were so efficient at handling ore and the railroad connections were so improved that the Golden Reward claimed that it could realize a greater profit.
On the feed floor of the Golden Reward Smelter (previously the Deadwood and Delaware), the workers shovel the coke, sulfides, ore, and limestone into the mouth of the blast furnace. On the matte floor (middle picture), the melted ore runs out into a vat, called the fore-hearth. The copper-sulfide matte collects the ore, which is heavy, and the matte sinks to the bottom of the vat.

The matte is next drawn from the bottom of the fore-hearth into a matte pot, which is on wheels in the left of the picture. When the matte is removed, the worker uses a long iron rod to plug the outlet with a ball of clay. These photographs, showing the inner workings of the smelter, were taken by John I. Sanford in 1902.
The slag, composed of the molten nonmetallic rock and the limestone flux, runs out from the top of the forehearth into large cast-iron kettles, called slag pots.

by shipping the more difficult ore to those smelters than it could by operating its own smelter.  

As the cyanide process ushered in a new era of ore processing and mine development, the early 1900s became the golden years of Black Hills metallurgy. From the smallest to the largest, companies turned to cyanide for ore treatment, and by 1904, sixteen cyanide mills were successfully treating low-grade ore in an efficient and cost-effective manner. Their requirements for fuel and labor were significantly less than those of the smelter, and as


The slag pots, which were also on wheels, were then pulled by electric motor to the dump, where they were tilted to empty their contents. Sanford, the photographer, commented that the dumping of the white-hot slag produced a “grand spectacle, especially at night.”
early as 1900, their average cost of operation was at least two dol-

lars per ton less than those of the smelter. As the process was re-

fined, its efficiency increased and the cost continued to drop. In-

deed, the Black Hills metallurgists of the era became so skilled

with the cyanide process that their advances left a mark through-

out the mineral world.

Deadwood was again the focal point of this new business activi-

ty—known as the cyanide boom—nearly twenty-five years after

the original gold rush and immediately after the refractory-ore

boom. What had occurred in and around Deadwood during those

first twenty-five years was essentially a microcosm of the events

that had occurred throughout the gold-rush West. First, the pros-

pectors had rushed into a promising area, diligently searched the

streams and adjacent hillsides for free gold, and established a

mining camp at the most convenient location. In their quest to lo-

cate all the mineral-bearing ore in a region, they had encountered

stubborn refractory ores that would not release their values by

the procedures then available. The miners and millers ignored

this ore until the free-milling gold was exhausted. Then, a sense

of urgency beset the businessmen and mining promoters as they

saw their property become valueless. The untapped refractory-

ore regions were looked to as the potential savior if a process

could be developed to recover the gold and silver. Smelter men

arrived next, believing that there was not a circumstance in any

mining region that precluded the erection and successful opera-

tion of a smelter. With this philosophy, copper-matte and lead

smelting came forward to help resurrect many mining regions in

the Rocky Mountains. Franklin R. Carpenter brought this philos-

ophy to the Black Hills, where he developed pyritic smelting. His

unique process had the intended effect: it allowed many mines to

open, provided a local market for the refractory ore, and brought

renewed prosperity to Deadwood. The pyritic process, while not

53. Clark, "Review of Black Hills Metallurgy," p. 607; Chance, "Gold-Ores of the

Black Hills," p. 280; Charles H. Fulton, The Cyanide Process in the Black Hills of

South Dakota, South Dakota School of Mines, Bulletin No. 5 (Rapid City, S.Dak.,

1902), p. 72.


55. Parker, Deadwood, p. 228.

56. Herbert Lang, Matte Smelting: Its Principles and Later Developments Dis-

cussed, with an Account of the Pyritic Processes, 3d ed. (New York: Engineering


a complete metallurgical success in the beginning, was easily modified to keep it at the forefront of available ore processes. It could not be modified enough, though, to overcome the technological advances of the cyanide process in the 1900s, and the plant subsequently closed.

In perfecting its pyritic smelter, the Deadwood and Delaware company reportedly spent five hundred thousand dollars. In the end, the plant produced over eleven million dollars in bullion, and it was second only to the Homestake as the most important producer of the period.\(^58\) For several years, it solved the problem of how to treat the refractory ores of the Bald Mountain and Ruby Basin mining districts. The answer it provided, however, was not the final solution, for the cyanide process ultimately proved to be the key that would unlock the refractory ores.