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Chapter 1

"A Savan among Us"

RUMORS OF GOLD AND SILVER IN THE ROCKY MOUNTAINS HAD drifted down through the years since Spanish times. Rivera, Purcell, Frémont, and others all claimed they had found precious metals in the high country, but their reports were conjectural. No one had ever confirmed them. The California gold rush gave rise to a new spate of rumors; yet not until the winter of 1857 descended on Auraria, Georgia, did anyone make a systematic effort to learn the truth.

It was in that season that William G. Russell took a notion to explore the foothills of the Rockies near the point where the South Platte River enters the high plains on its journey to the sea. Not much is known about Russell, but he had a forceful personality matched by a moustache and beard that made him stand out like a musketeer from a Dumas novel. Russell had been in the Rockies before. In 1850 he had driven horses to California, and he may have found a few flakes of placer gold while passing through the mountains.

Early in 1858 Russell set out from Georgia with his brothers and a few friends. At Leavenworth in Kansas Territory they joined a band of Cherokees led by John Beck, who, like Russell,

may have found gold in the high country while on his way to California in 1849. With their ranks now swelled to more than a hundred, the adventurers crossed the prairie to reach the South Platte, then traced the waterway to its rendezvous with a smaller stream known as Cherry Creek. After pitching their tattered canvas tents, Russell's men fell to work on the sands and gravels. Here on the future site of Denver they found tiny particles of placer gold, confirming the rumors that had abounded for so long.

Russell's men were exultant, but their dreams of instantaneous wealth gave way to frustration and disappointment. "Pay" from the "diggins" was meager, so meager it hardly justified the backbreaking toil of shoveling and panning, the crude techniques of placer mining. Nearly all the adventurers became discouraged and abandoned the search that fall, but by chance an itinerant trader bound for Missouri happened upon the camp. He traded for a few flakes of gold and went on his way. Once he reached the first line of settlements farther east, his exaggerated account of riches spread from town to town like a prairie fire. Merchants and newspapermen boomed the discovery to bonanza proportions, touching off the Pike's Peak gold rush that came the next year. But the Cherry Creek placers hardly justified the coming frenzy, and a fiasco loomed as winter settled over the high plains.[1]

Even before the end of 1858, the first treasure seekers arrived on Cherry Creek. It was not long before they realized that the stories of easy wealth had been vastly exaggerated. Many cursed the Pike's Peak "humbug," turned around, and went home; but others were not so easily discouraged. Miners experienced in Georgia and California perceived that the gravels at the base of the Rockies contained flakes of gold washed down from the white-tipped mountains that rimmed the western skyline. And so, as the year of discovery drew to a close, bands of prospectors set out to ascend the partly frozen streams that flowed out of the Front Range into the South Platte.[2]

In one of those companies was John H. Gregory, an old Georgia miner who arrived in the foothills late in the year. He and several companions decided to trace into the mountains a

stream known as the Vasquez Fork of the South Platte, a name soon changed to Clear Creek as the American tide overwhelmed the Spanish influence remaining in that part of the high country. Battling snow and ice and cold, the adventurers struggled up the narrow, high-walled canyon until the stream branched at the base of a steep ridge. Choosing the right-hand fork, soon known as North Clear Creek, they pushed on to where the narrows opened into a series of high hills timbered with firs. There in January 1859 John Gregory found flakes of placer gold in what became the town of Black Hawk.

Gregory and his companions, however, wanted to locate the source of the placer—and so they kept looking. They nearly perished in a late winter snowstorm, but on May 6 their persistence was rewarded when Gregory uncovered the rust-colored outcropping of the lode that bears his name. This was the first vein of gold discovered in Colorado. Like prospectors everywhere, Gregory and his friends tried to keep their good fortune secret, but this proved impossible. The news carried down to embryonic Denver City, and up Clear Creek came a rapid influx of fifty-niners. Some concentrated on placering at the Gregory diggings, but others spread out into the surrounding hills, where they located the Bobtail, Bates, Gunnell, Illinois, and other lodes. Before long the ragged tents and hastily improvised log cabins thrown up along the banks of North Clear Creek grew into the towns of Black Hawk, Central City, and Nevadaville.[3]

While Gregory and his companions were trudging upstream to the future site of Black Hawk, George A. Jackson, a veteran California miner, was tracing another path to gold. He ascended the south fork of Clear Creek until he came to a stand of barren willow trees hard by a smaller current that flowed into the main stream. Here at the confluence he panned telltale flakes of placer gold. Unlike Gregory and his friends, Jackson managed to conceal his discovery for some time, but the news leaked out a few months later, and Pike's Peakers rushed to Jackson's "diggins." By summer fortune hunters were sluicing the sands and gravels all the way from the forks of Clear Creek to the site of Jackson's discovery, soon to be the town of Idaho

Springs. Other fifty-niners pushed farther west, where they located placer and vein gold that gave rise to the mining camps of Spanish Bar, Empire, Elizabethtown, and Georgetown.

Prospectors poured into the high country all year long, but not all sought their El Dorado in the sands and gravels of Clear Creek. Some traced the tawny-colored foothills to a stand of rotting cottonwoods on South Boulder Creek, about twenty-five miles northwest of Denver City. Here they located a placer they called the "deadwood diggins," which prompted more extensive mining in the mountains to the west. Still other fifty-niners crossed the Front Range of the Rockies into the great valley of South Park, traced meandering streams across to the northwest rim, and found placer and lode gold near what became the mining camps of Fairplay, Tarryall, and Buckskin Joe. And well to the south some prospectors hurrying west along the Arkansas River followed that stream into the central Rockies rather than heading to the popular tributaries of the South Platte. They realized their dreams of finding placer gold at Kelly's Bar, Cache Creek, and other sites now long forgotten.[4]

No one knows now many people came to the mountains in 1859. Some estimated the number at 100,000, but this seems a vast exaggeration—a figure inflated by enthusiasts to promote the country. A better estimate would be fewer than 25,000. Two years later the first official census showed the population to be about 23,000. In contrast, something like 80,000 newcomers poured into California in 1849. But, regardless of the number of people who arrived in the Pike's Peak Rush, there was chaos throughout the region. Denver City, Central City, and other "cities" were little more than a confusion of tents, shacks, and log cabins. And not until the middle of the secession crisis of 1861 would Congress create Colorado Territory. In the meantime, what "legal system" prevailed was hardly more than an arcane jumble of local rules and familiar customs enforced by popular opinion or lynch law. The pioneers tried to re-create the social, economic, and political institutions they had known, but their efforts only led to a mosaic that differed from camp to camp and town to town.

Despite the chaos, the first miners shaped the outline of the minerals industry for the next twenty years. The heart of all their activity would lie on the forks of Clear Creek in the country opened by the discoveries of Gregory and Jackson. The most important towns would be Black Hawk, Central City, and Nevadaville, which the first territorial legislature grouped as Gilpin County. A close second would be Empire, Georgetown, and Idaho Springs, which territorial lawmakers included in Clear Creek County. The amount of gold and silver mined in those two regions made up nearly two-thirds of Colorado's production until the epochal year of 1879.[5]

Like other western mining regions, Colorado was part of cordilleran America—the great highland formed by the Rocky Mountains on the east, the Sierra Nevada and the Cascade range on the Pacific slope, and the arid plateaus in between. When the mountains were created centuries ago, hot mineral-bearing liquids flowed upward toward the surface of the earth. Sometimes they pressed into fissures and cracks in the crust, leaving veins of metal. At other times the molten matter dissolved the existing rock and substituted other materials, creating replacement deposits. Whether the minerals formed a true vein or a replacement deposit, the result was the same—a sheet of solid rock in which the accumulation of gold, silver, or other metals varied in length, depth, and thickness. It was this crazy-quilt pattern that accounted for the high risk and heartbreaking failure that characterized the mining industry.

In Colorado the minerals lay in several forms. Some were pyrites—compounds of iron, copper, and sulfur. Others were galena-sphalerites—mixtures of lead, zinc, and sulfur. Still others were combinations of the first two—compounds of iron, copper, lead, zinc, and sulfur. And a fourth group, unimportant to the early miners, were tellurides—compounds of the metal tellurium. Encased within the minerals were gold as the free element and silver as silver chloride or silver bromide. Such deposits held valuable metals besides gold and silver, but the ores were complex, and except for placers they would be difficult to process—something no one realized in the optimistic days of 1859.[6]

In the millennia that followed deposition, the incessant activity of the atmosphere created a three-level system of ores. As air, water, and sun oxidized and disintegrated the surface minerals, rainwater and melting snow dissolved the silver compounds and washed away some gravel, leaving an outer deposit richer in gold, copper, lead, and zinc. (Running water also carried some of the gold downstream, forming the placers found by Russell, Jackson, and others.) Below the surface lay a second layer known as gossan. Here the elements oxidized and enriched the minerals down to depths of fifty or even a hundred feet, forming an ore system that could be easily mined and processed. Below this region, however, was a vast third tier of sulfides that proved far less rich and far more difficult to work than the ores above.

In 1859 fortune hunters like Gregory and Jackson sought their winnings from "dirt" with pans, cradles, and sluices—the ageless techniques of placer miners. These simple devices were all similar in principle. Each depended upon the high specific gravity of gold—its great weight relative to that of other substances—to cause it to be left behind when a current of water washed away other substances *presumed* to be worthless.

Once subterranean mining began, Colorado's miners had to employ new techniques to crush the gossan and free the gold. At first they turned to a crude device long employed by the Spaniards—the arrastra. This consisted of a circular stone trough and several heavy stones known as "mullers" that hung from an arm attached to a central pivot. The miners placed their ore in the trough, then oxen, mules, or other draft animals dragged the "mullers" over it to crush it and free the gold, which was later recovered by sluicing. The first arrastras appeared in July 1859, only two months after Gregory's discovery. By the end of the year several were in operation along the banks of North Clear Creek, each earning as much as $200 daily. Arrastras were easy to finance and simple to construct, but they were slow and inefficient—distressing faults to men bent upon instant wealth. Throughout the Rockies they were little more than transitory devices that soon gave way to stamp milling.[7]

Stamp mills were far more characteristic of an industrial society. Stamps were heavy iron blocks attached to wooden or iron rods that rose and fell in accord with a revolving horizontal beam. With monotonous, incessant crashes, they reduced hard rock to sand, which was then washed by a stream of water over large copper plates impregnated with mercury. This substance formed an amalgam—a kind of alloy—with the gold. Later, mill operators heated the amalgam in a retort. This broke down the alloy, vaporized the mercury (which was condensed and reused), and left behind the gold, which could be cast into bars. The principle was simple, but stamp milling required a knowledge of engineering, a supply of semiskilled labor, and access to capital. The appearance of mills marked a step in the passing of the fortune hunters.[8]

Stamp milling developed rapidly in 1859—so rapidly that the essential machinery must have been on its way to Colorado before Gregory made his famous discovery on May 6. Though they required capital, mills were relatively inexpensive to build and operate, and the first plants came into production during the summer. Returns were often large, some enterprises recovering as much as $400 in gold a day. Such spectacular yields, however, created an unjustified optimism that spurred mining companies and independent milling outfits into overconstruction. Only rich lodes, like the Gregory and the Bobtail, could produce large supplies of ore worth more than the $30 a ton, which enabled both mine and mill to work profitably. Since many ores paid no more than the cost of milling, idle stamps quickly become commonplace.[9]

Yet the boom was on. Good times brought in settlers, stimulated capital investment, and provided a measure of prosperity. The tents, shacks, and log cabins of the fifty-niners gave way to more substantial buildings, many with tall, narrow windows and false fronts. The bustle of life in the narrow streets was punctuated by the thud of underground explosions, the rattle of steam engines, the shriek of whistles, and the crash of stamps that echoed across the canyons. Trees disappeared to provide fuel for the furnaces and timber for the mines. And with all this activity the yield of gold rose steadily from just about

nothing in 1858 to perhaps $3,000,000 in 1861 and about $4,500,000 in 1863. Many back East looked to Colorado as a land where they might improve their lot in life, if not get rich quick.[10]

Yet this was an illusion. By the end of 1863 the miners had exhausted the best placers and the easily processed supplies of gossan. In the mines, all that remained at levels no more than one hundred feet below the surface was a vast tonnage of unoxidized ores known as sulfurets because they smelled so strongly of sulfur. They proved resistant to stamp milling because they held the gold in the form of a solid solution. The metal was so finely divided that crushing freed little of it. But no one understood this. When mineowners sent ores to be milled, they learned to their horror that the recovery rate dropped from as much as three-quarters of the assay value, the normal yield, to less than one-quarter of what they expected. And sometimes there was no yield at all. A few people had noticed the trouble as early as 1860, but in those days miners had dismissed the problem as an aberration peculiar to certain lodes. By the end of 1863, however, the impasse had become widespread. More than anything else, the inability of the stamp mills to recover gold from sulfurets brought on the severe economic contraction that convulsed the high country over the next few years.

Yet the failure of the stamp mills was only one problem facing the industry. As mineowners blasted farther into the earth, they had to raise more capital to buy new machinery and replace flimsy timbering. The need for money happened to coincide with the surging inflation created by the Civil War, an inflation that caused many investors to believe that shares in a gold mine were a better means of preserving wealth than the depreciating paper money. Taking advantage of this sentiment, many mineowners floated stock issues that touched off a speculative boom in Boston, New York, and other cities. Some offers were legitimate, but others were sheer fraud. When the frenzy collapsed in April 1864, an important source of capital dried up. To make matters worse, a severe drought and a hard

winter hindered wagon freighting on the high plains. Then Cheyenne and Arapaho war parties virtually severed the transportation routes for the best part of a year. Farther east, Confederate guerrillas sometimes attacked wagon trains bound for Colorado. As supplies grew scarcer, the costs of mining in isolated towns grew ever higher. Few producers could operate in such an environment. By the end of 1864 the failure of the stamp mills, the lack of new capital, and a sharp increase in costs had disrupted the mining industry.[11]

As the specter of financial ruin hovered over Colorado, mineowners launched a desperate search for a method of recovering gold from sulfurets. Yet, since scarcely anyone in Colorado possessed a thorough knowledge of mineralogy and metallurgy, the industry fell prey to a group of quasi-scientists who created what Rossiter W. Raymond, the United States commissioner of mining statistics, dubbed the "process mania." The chief objective of the extravagance was to remove sulfur from ores. As Raymond said, "Desulphurization became the abracadabra of the new alchemists." Speaking learned nonsense about "gaseous gold, silver-sheathed gold, air-filmed gold, and chemically-combined gold," these charlatans induced credulous mineowners to purchase contraptions and patent rights that, however absurd, still seemed plausible because they generally employed the familiar technique of amalgamation as the terminal step.[12]

Results were usually disastrous for luckless investors snared by their own desperation, gullibility, and greed. The Mason or Hagan process, for example, allegedly decomposed superheated steam so that elemental hydrogen could attack the sulfurets and free the gold. Dodge's desulphurizer destroyed itself upon use. And the Bartola process was so dubious that Raymond acidly noted that it was "difficult to reconcile the history of this invention with the hypothesis of honesty on the part of the inventor." Yet in spite of their untested nature, interest in the contraptions was intense. Nathaniel S. Keith, later an important figure in the development of electrometallurgy, wrote his wife that curious people came from miles around to see his

"marvelous desulphurizer." But high hopes and large investments went for naught as nearly all inventions were dismal failures. By 1867 rusting iron machinery visible throughout the gold region testified to the folly by the "process men."[13]

Early that year a reporter for *Harper's Magazine* wrote that the "El Dorado of the West" had turned into a "land of disappointment." Throughout the gold region—at Central City, along South Clear Creek, and in South Park—hard times prevailed. Entire camps lay crumbling into ruin. Mines known to be rich were boarded and locked. Mills stood "silent as a tomb." Unused machinery of every kind rusted into uselessness. Homes lay shuttered and abandoned. And miners' tenements showed "no smoke, no sound . . no living thing."[14]

Many of those remaining in Colorado despaired of recovery. The territorial governor spoke with pessimism about the possibility of a revival, and one mineowner later remembered that everyone who could get away was doing just that. Some predicted the mining towns would soon be deserted. Others thought the land might even revert to wilderness. What the mining industry needed, among many things, was a technology that could recover gold from sulfurets, and it was just about this time, as the industry collapsed, that a long series of events were about to produce a solution.[15]

In the spring of 1863, William Gilpin, the mercurial first governor of the territory, fulfilled a long-held dream by acquiring options to purchase the Sangre de Cristo grant. This was a million-acre tract of land in the San Luis Valley about 150 miles south of Denver. Gilpin, however, was insolvent as usual and could not secure the grant outright. To arrange financing, he traveled to San Francisco, where friends provided him with letters of introduction to investors in New York. He went east during the summer and with the help of Morton Fisher, a former business associate, borrowed $30,000 from the investment banking house of Duncan, Sherman & Company. To obtain additional funds, he entered into an informal partnership with Fisher and Colonel William H. Reynolds, a cotton textile manufacturer in Providence, Rhode Island. With the $41,000 needed for purchase, Gilpin and his partners sought expert

opinion on the mineral resources of their vast domain. Early in 1864 Reynolds approached Nathaniel P. Hill, professor of chemistry at Brown University, in hope that Hill would act as his personal representative in the investigation planned for that summer.[16]

Hill was thirty-two years old at the time and had a fine reputation in both academic and business circles. Born in Montgomery, New York, in 1832, he was the son of a well-to-do farmer who was prominent in state and local politics. He grew up in Montgomery, and after his father's death he managed the farm until 1854, when he entered Brown University with third-year standing. He enrolled in the "select course" in science and a year later was appointed assistant to the professor of chemistry. After his graduation Hill remained at the school teaching chemistry, geology, physiology, and other sciences. His academic advancement was steady, and his contributions to the Chemistry Department were notable. An energetic fund-raiser—an important attribute in a private school—he was largely responsible for obtaining the donations that enabled the university to erect Rogers Hall, one of the most modern science buildings of the time.[17]

In addition to teaching, Hill developed a vigorous consulting business. Mainly, he conducted scientific investigations for local industrialists, but he also analyzed autopsy materials for the city of Providence and once made a controversial study of pollution in the Providence River. Another time he took a leave of absence from the university to operate an oil refinery. Because of his wide-ranging activities, Hill developed numerous business contacts throughout the East, and he acquired a reputation for integrity, thoroughness, and sound judgment that lasted for the rest of his life.[18]

In the winter of 1863 Hill received three offers to investigate mining properties. He regarded the first two as "very advantageous," but he declined them both on the grounds that "the labor required would be incompatible with [his] obligations at the university." The third proposal came from Colonel Reynolds, and it was more lucrative than the others. He promised Hill "very liberal compensation": a salary of more than

Nathaniel P. Hill in the early 1860s, shortly before his first trip to the Rocky Mountains. Brown University Archives.

$2,500, far higher than his university pay, and an option to purchase a tenth of the tract. Hill was to work from the end of the spring semester in April through December. His first impulse was to decline, but, perhaps after Reynolds offered further inducements, he decided to accept if the university would grant him a leave of absence. The executive board granted his request, and two "disinterested" members privately told him not to make an effort to return early if it meant "sacrificing important interests."[19]

There was more to Hill's desire to visit Colorado than what he told the executive board or admitted to Reynolds. Years

before, in 1857, he had written a college friend that he considered the West "the most favored section of our country" and that one day he might "emigrate to one of those flourishing cities to seek [his] fortune." He was also intrigued by the investigation itself. He later wrote his wife Alice that he saw it as "one of the finest opportunities to make not only some money, but also fame." And he hoped to invest in mining properties as a means of safeguarding his savings from the steady erosion of depreciating greenbacks. In this he was not alone. When he left Providence, professors Albert Harkness and Alexis Caswell of Brown and Governor Elisha Dyer of Rhode Island gave him money to invest in western mines. Clearly, Hill intended to use his journey for more than the purposes outlined by Reynolds.[20]

At the end of May, Hill boarded an afternoon train at the Providence station, waved good-bye to his family, and set off for the Rocky Mountains. The first leg of his odyssey—to New York, Cleveland, and St. Louis—was by rail, and for most of the way he traveled with a Miss Rathbone, whom he accompanied as far as St. Louis. From there Hill went on alone. He took a steamboat to the port of Hannibal, Missouri, and from there continued by train to Atchison, Kansas, a town he later said was "filled with . . . every kind of abomination." The stagecoach route began at Atchison, and he booked passage for Denver despite rumors of an Indian uprising on the plains. The climate, scenery, and terrain of "the Great American Desert" engaged his attention as the coach bounced along, but he was dismayed by the crudeness of the towns along the way and predicted that "no consideration could induce [him] to live in them."

Gilpin had seen to it that the fourteenth of June would be no ordinary day in Denver City, as the dusty, windy town was still known in 1864. He passed the word of Hill's arrival to the newspapers, notable men, and a few people Hill had known in Providence. By midmorning excitement at the stage depot ran high. Reporters milled about, and one more enterprising than the rest had his editor run the headline A SAVAN AMONG US, a phrase that worried little about observing the niceties of French but befitted a faculty member from Brown University.

Finally, about eleven o'clock a dusty coach came into view, clattered up the street, and screeched to a halt. Out to shake hands with his greeters stepped Nathaniel P. Hill, the man who would do the most to revitalize the foundering mining industry, though no one, not even Hill himself, had any inkling of this.[21]

Despite the fanfare that Gilpin had engineered, the formalities at the station were brief, which was much to Hill's liking, since he was exhausted after his hard, dangerous journey across the plains. He answered a few questions to satisfy the reporters, spoke with an old friend, and exchanged pleasantries with new acquaintances. Then he walked over to his hotel with Gilpin. That night, as he relaxed in his dimly lit room, Hill wrote a letter to his wife Alice. He had arrived in safety despite the Indian uprising on the plains, but seven days and nights of uninterrupted travel in a hard-seated, springless stagecoach had taken their toll. A hot bath and his first change of clothes in two weeks had proved "almost renovating" in themselves. Despite his fatigue, he had lingered earlier to talk with Gilpin about their forthcoming expedition to southern Colorado, an expedition that would explore, survey, and map a tract of land larger than the State of Rhode Island. Hill was to file a report on the mineral resources.[22]

A few days later Hill and Gilpin set out for Central City so that Hill could examine older mining properties and confer with other members of the exploring party. They drove along in Gilpin's buggy pulled by two ponies, "the ugliest, homeliest and meanest rats" Hill had ever seen. Despite these views, which Hill kept to himself, he and Gilpin got along well, but they were very different. Gilpin, a man of medium stature, was now in his late forties (nobody really knew how old he was), his deeply etched face accentuated by a receding hairline that he counterbalanced with a large beard. The long-haired though clean-shaven Hill, a little taller than Gilpin, was nearly a generation younger. Gilpin had established as much of a reputation for bombast as for his achievements as a soldier of the Republic and a mercurial exponent of western expansion. He talked incessantly. Hill seemed introspective by comparison,

though he was hardly a quiet person. He found Gilpin amusing and discounted his braggadocio, partly because of his fascination with the environment—the changing weather, the narrow canyons, and the snow-capped mountains that he thought were "grand and sublime beyond description."[23]

In Central City, Hill met other members of the exploring party—Redwood Fisher, James Aborn, and Joe Watson. They insisted that Hill move into bachelors' quarters with them; he accepted and dined luxuriously—so he said—on canned oysters, lobster, and other delicacies. Both Fisher and Aborn were former residents of Providence, and Hill apparently knew them, particularly Aborn, a cousin of Professor John Peirce of Brown University. The day after his arrival Hill visited his first mines, on the Bobtail lode, in company with Henry B. Brastow, who was a business associate of Reynolds and another Providence emigrant Hill had known in former days. He spent the rest of the week looking into mining properties on behalf of Harkness, Caswell, and others, then returned to Denver to join Gilpin's expedition.[24]

The twenty-two-man party got off for the San Luis Valley on the Fourth of July. Gilpin was in overall command, Aborn in charge of the prospectors, Redwood Fisher the surveyor and engineer, and Hill, as he put it, the "Chemist and Mineralogist, Geologist & C." He joked that they were the four "savans" of the expedition. Gilpin had seen to it that his men were well armed and equipped. They had two wagons and an ambulance to carry medicines, tools, and scientific equipment, as well as an arsenal of pistols, rifles, and shotguns for hunting game and repelling any hostile Indians who might challenge their passage. Nonetheless, Hill belittled Gilpin's concern over hostilities raging on the plains, and perhaps Hill was right. Except for Aborn's recurrent nightmares about snakes, the journey from Denver was uneventful. They reached Fort Garland, northern outpost of the grant, a week later.[25]

Once the investigation began, Hill decided to modify his plans when he found he would be idle "nine-tenths" of the time. He had originally intended to spend four weeks on the tract and then head north to inspect mining properties near Boulder

Central City, Colorado, in 1864. Note the denuded hillsides. George D. Wakely, photographer. Colorado Historical Society, Denver.

and Central City. After that he would rejoin the expedition to examine what ore deposits Gilpin's men had located in the interim. But Hill was unwilling to do nothing while Aborn's prospectors were searching for minerals, and so he seized an opportunity to return to Denver with two hard-drinking army men traveling from Fort Garland.[26]

The next few weeks were fruitful—or at least potentially so. Hill examined new ore discoveries in the hills above Boulder, then went to Central City, where he purchased options on what he thought were valuable mines on the Bobtail, Fairfield, and other lodes. He also used a portion of his salary from Reynolds to buy a house and lot in case he should ever move to the high country. On his way to rejoin Gilpin's party in September, he wrote his wife that he was very pleased with his trip so far, although its success depended upon the "pecuniary results" of business transactions yet to come. They looked promising, but they still might fail.[27]

Hill spent only a few weeks on the Sangre de Cristo grant that fall. With the assay equipment he had carried from Providence, he tested ore samples brought in by Aborn's prospectors, recorded his findings, then returned to the "little kingdom of

Gilpin" to continue his investigation of the mining industry that by now consumed his interest.

Once in Central City, he learned that several friends had departed the previous day to inspect new ore discoveries at Red Mountain, a peak west of the Arkansas River, about ninety miles away. Hill was anxious to catch up because some of the new mines were said to be the richest in the world. The next morning he set out on horseback with the Reverend T. D. Marsh, a Methodist minister who accompanied him as far as Fairplay. From there Hill traveled alone, crossing the mountains from South Park to the Arkansas Valley in the midst of snow flurries, a sign of early winter in the high country. He caught up with his friends at Twin Lakes, a few miles west of the river, and went on with them to inspect the lodes at Red Mountain. On their return to Fairplay, they were caught on the high, bare ridges by a severe snowstorm and only with difficulty managed to reach the valley floor. When the weather cleared, Hill and a Mr. Byram rode on to Montgomery and Buckskin Joe, where they examined mining properties for two days before returning to Central City in the midst of another snowstorm.[28]

By now it was time to depart. With an early winter setting in, Hill wound up his business affairs and made the usual round of good-byes. A local newspaper reported that he was "agreeably disappointed with the character of the country" and considered it "eminently worthy of another visit." At the end of October he left Denver by stagecoach, this time in company with William A. Abbe of Boston, a new associate whom he described as "a clever fellow with plenty of means." They arrived in New England one month later.[29]

Once back in Providence, Hill submitted his report to Colonel Reynolds. This document never became public—and no copies have come to light—but it was widely rumored that Hill had found little of value in the San Luis Valley. Circumstantial evidence tends to corroborate this view. Reynolds sold his interest a few months later, and Hill never exercised his option to acquire a one-tenth interest. Five years later, in 1869, Gilpin and his partners published a promotional brochure con-

taining a letter from Aborn claiming that the grant was as rich in minerals as Central City. If Hill had made a similar report, it would surely have appeared with Aborn's letter.[30]

Having discharged his obligations to Reynolds, Hill confronted the question of his future. Should he remain as professor of chemistry at Brown University, or should he become an industrialist? This was not an easy decision. On his travels in Colorado he had missed university life, and he had looked forward to rejoining his friends and colleagues. Yet about the time he left Central City he had grown apprehensive about his position. Somehow he had gotten wind of trouble in Providence. He wrote his wife that the "college fraternity" may have ruled him out of its ranks because "certain gentlemen of the faculty" did not appreciate his neglect of the university for the "base motive of getting money." He had hoped to smooth over any ruffled feelings and resume his academic career, but once in Providence Hill realized that he was now so committed to business that he could no longer lead the double life of professor and entrepreneur. In November he submitted his resignation to the executive board.[31]

As the drizzle, rain, and snow of a New England winter closed down on Providence, Hill disposed of the options he had taken on mines at Central City. He had little trouble in doing this, but he retained two options. With these he organized the Sterling Gold Mining Company and the Hill Gold Mining Company. Then, eager to begin operations, he left for Central City in February 1865.[32]

On the long trip west he traveled with John H. Barlow, a Bostonian he had hired as the agent, or manager, of the Hill Company. At Atchison they purchased tickets on a stagecoach "for such a ride," Hill wrote, "as but few people would be willing to undertake." They knew that Indian war parties were ranging over the route and that drifting snows had obscured the trail. They had no idea how far the driver could take them through subzero temperatures, whether they could fall in with a wagon train, or whether they would meet a military escort. En route they passed fresh graves and burned-out way stations and heard tales of narrow escapes from arrow and lance. Even

the military proved dangerous. At one stop they had to guard the stagecoach from drunken soldiers who threatened to steal their belongings. But Hill's luck still held. He and Barlow reached Denver City in safety and then went up to "Central." Here they were joined by E. C. Gould, who had suffered through an equally hazardous passage on his way west to become agent for the Sterling Gold Mining Company.[33]

Once he rented an office, Hill set to work with Gould and Barlow to begin production at the mines and build a stamp mill on the Sterling property. He had complete confidence in Barlow, but he had reservations about Gould. Hill was nonetheless elated. He wrote his wife that he was confident of "splendid results" and was "willing to live or die" with both investments. As operations rolled along in March, he thought the Sterling Company might pay a 25 or even a 35 percent dividend the first year, and a few days later he predicted that both firms would rise 100 percent above their purchase price. He also took satisfaction in the mines he had obtained for eastern investors, and he prided himself on his new reputation as a superior judge of mining property.[34]

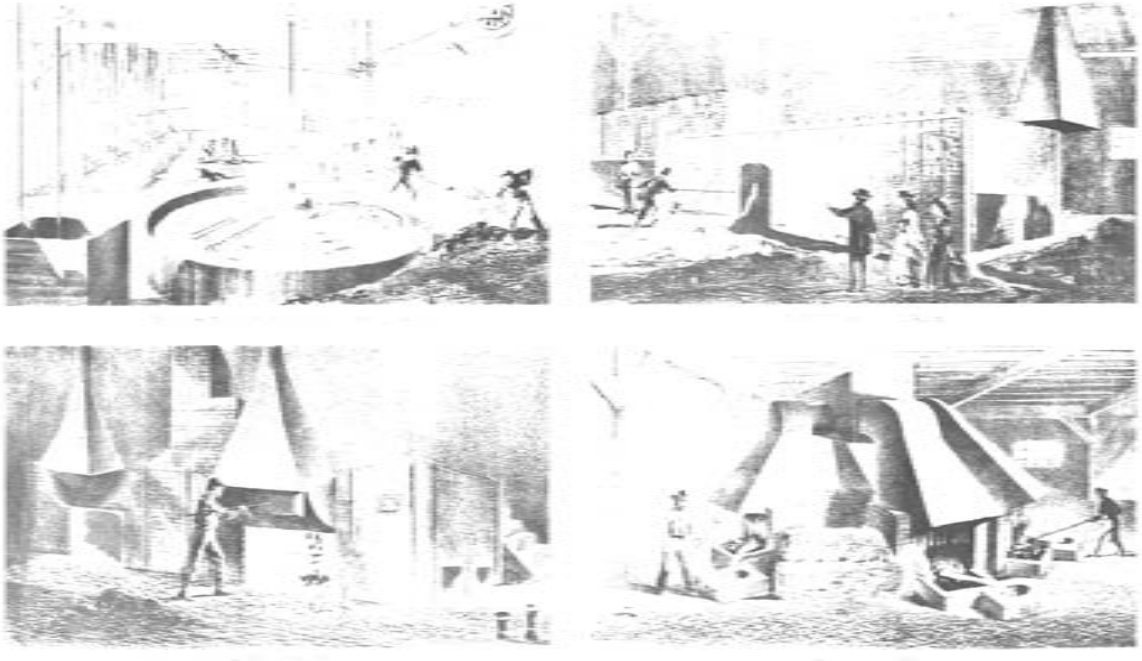
Optimism notwithstanding, Hill's enterprises soon foundered on reality. As spring gave way to summer, Gould and Barlow exhausted the layer of weathered upper ores that were easily processed by stamp milling. Below lay a great tonnage of sulfurets, the copper and iron pyrites creating havoc throughout the region. When Hill sent them to his mill, the yield of gold fell as precipitously as the stamps. Instead of enjoying a large dividend, he now faced the unpleasant prospect of personal embarrassment and financial disaster. Yet he was not deluded by the "process men" because he was himself a real chemist, one of few in the mining country. Instead, he pondered the seemingly insoluble riddle that was carrying a thriving industry into depression. It was about this time that he became involved in a project that hoped to recover gold by a method known as smelting—a complex high-heat process in which copper, lead, or other base metals in an ore served as a vehicle to collect and hold the precious metals.[35]

The initiator of the scheme was James E. Lyon, a convivial

though somewhat irascible entrepreneur whose long involvement with mines and mills at Central City had thoroughly acquainted him with sulfurets. He may have considered the possibility of treating them by the smelting process as early as 1862, well before the problem became acute, but he did nothing for three years until 1865, when he shipped some ores from the Gregory lode to a smelter on Staten Island in New York City. There he watched the furnaces recover about $250 in gold from every ton—far more than stamp mills could obtain with mercury. Lyon was elated. Convinced the process would work in Colorado, he persuaded three eastern capitalists, Charles H. Moore, Elisha Mack, and Fulton Cutting, to build a smelter as an adjunct to the New York & Colorado Mining Company, an enterprise in which they had invested with Lyon and his western partner, George M. Pullman, later of palace car fame. Using some of the money, Lyon purchased equipment on Staten Island and hired Franklin Johnson and his brother Charles, two knowledgeable European metallurgists who had emigrated to the United States. Lyon also paid the passage to Colorado of several experienced smelter workers after they had agreed to remain in his employ for two years.[36]

Once he returned to Central City, Lyon engaged Hill as a consultant on the project. Why he did this, particularly with experienced metallurgists on the way, is certainly curious, because Hill had little knowledge of smelting processes. The two men knew each other at least casually, for they had met the year before, and even now Hill was running his mines from an office in one of Lyon's buildings. Perhaps Lyon needed a skillful chemist, or perhaps he valued the advice of a well-educated man. Whatever the reason, Hill acquired his first practical introduction to the smelting business that summer.

Lyon planned to install the machinery essential in smelting silver-lead ores and to integrate this later with the furnaces needed to reduce sulfurets. In August he erected a small experimental plant in Black Hawk and with the Johnson brothers set up a Scotch hearth and a cupel furnace to produce and refine silver-lead bullion. When the Johnsons turned out a silver ingot, reportedly the first ever cast in Colorado, the



Inside the smelter built by James E. Lyon. A. E. Mathews, delineator.
J. Bien, lithographer. Colorado Historical Society, Denver.

Daily Miner's Register of Black Hawk hailed the "complete success" of the experiment and proclaimed the arrival of the "millennium" for the depressed mining industry—somewhat prematurely, as events would prove.[37]

Lyon was so encouraged that he hurried the project along. He had the Johnson brothers install crushers, assaying equipment, and reverberatory furnaces, and he purchased pyrites and tailings to supplement the production of his own mines. In December the plant turned out its first bar of gold, prompting the *Rocky Mountain News* to proclaim "Victory! The Day Is Ours! The Lyon Process Successful! 500 Pounds of Bullion in the First Run!" A week later, the *News* had to modify its exaggerated estimate of the output when a correspondent discovered that the bullion weighed only one-tenth as much as first reported. When a series of technological difficulties proved the *News* had been premature in hailing Lyon's success, the editors sheepishly backtracked, claiming they had been careful not to commit themselves unguardedly.[38]

While Lyon pushed forward with his project in the fall of 1865, Hill returned home to Providence to launch his own study of ore reduction. He was by no means an expert in metallurgy, but he had some knowledge of the techniques employed, which served as his starting point. He drew up a list of several possible technologies, then whittled down the number by discarding one method after another. By November he was convinced that he should adopt a Welsh smelting technique known as the Swansea process. In this method the copper and iron sulfides in the ores could be used as a vehicle to collect and hold the gold and silver in a mixture known as a copper matte. This product could then be shipped to wherever it could be separated (or refined, in metallurgical terms) into gold, silver, and copper metal.[39]

It was only a short step from identifying a possible technology to the idea of building his own smelter, but Hill knew such an enterprise would be risky. There were no successful smelters anywhere in the intermontane West, and the Swansea process was almost wholly untried in North America. He realized that his scheme called for careful planning to attract

venture capital and provide the optimal chance for success. Rather than plunge forward as Lyon was doing, he decided to go to Europe to observe the Swansea process in operation and discuss the entire metallurgical question with experts.

During the winter he obtained letters of introduction, and in February 1866 he set sail for Great Britain on board the *Europa*. This time he traveled with Charles W. Lippitt, one of his former students and a future governor of Rhode Island. They suffered together through a stormy Atlantic crossing but reached Liverpool in safety and went on to London by train. There Hill talked with Sir Edward Sabine, president of the Royal Society, and with Dr. John Percy, a world-renowned authority on nonferrous metallurgy. These conversations convinced Hill that the Swansea process was the correct method for treating the sulfurets of Gilpin County.[40]

From London, Hill and Lippitt went on to the world-famous smelting center at Swansea, Wales. Situated between the coast and the coalfields, this community was the chief center of the British copper industry. The smelters drew ores from around the globe, and because the two held such eminence, it attracted a long line of entrepreneurs in search of technology. Nathaniel P. Hill was neither the first nor the last. Despite its significance, Swansea was a bleak place to live and work. When Hill arrived in 1866 he found "a filthy, crowded, smoky dingy town." Sulfurous fumes had choked every bit of vegetation, and smoke from the smelters hung like a pall over the whole area.

Though Swansea resembled the drab scene of a Dickens novel, Hill spent three valuable days touring plants, visiting coal mines, and talking with metallurgists. He spent much of his last day with B. J. Herrmann, a chemist at Vivian & Sons, the largest company in town. They discussed Hill's plans to erect a smelter in Colorado and arranged for a joint trip to the high country. After leaving Wales, Hill made a quick journey across the English Channel to examine ore dressing machinery at Aix-la-Chapelle (now Aachen), then returned with Lippitt to the United States.[41]

While Hill was tapping the best scientific knowledge in Europe, Lyon continued his efforts to establish a successful

smelter in Colorado. Early in 1866 he went to New York for a meeting of the stockholders of the New York & Colorado enterprise. The works at Black Hawk were not in satisfactory operation despite expenditures of nearly $225,000, more than two-thirds of it for construction. Yet Lyon still remained hopeful about the project. Largely through his efforts the firm was reorganized as the Pioneer Smelting Company, and new capital was subscribed. In the spring he discussed the mechanics of the Swansea process with Herrmann, who had arrived in the United States and was en route to Colorado with Hill.

As a result of his conversations with Herrmann, Lyon abandoned the lead-base technology in favor of the Swansea process. When he resumed operations, he obtained about a hundred tons of copper matte that he shipped to Wales for refining. But in spite of this measure of technical success, profits remained elusive and the enterprise failed. Early in 1867 the plant was sold. When workers dismantled the furnaces, they found another hundred tons of matte that had leaked undetected through the hearth into the masonry. Rossiter Raymond claimed Lyon could have made a profit if the loss had been discovered and the product shipped.[42]

Lyon failed to establish a successful smelter because he employed many different methods instead of concentrating on a single, standard process. He wasted time and money on technology that was not applicable to most of the ores mined in the vicinity of Central City. In spite of the alleged expertise of the Johnson brothers, his plant was inefficiently designed, badly built, and ill-managed. His efforts nevertheless showed that the smelting method could recover gold and silver from sulfurets, and he was the first to employ the Swansea process in Colorado. His successors, Nathaniel P. Hill in particular, profited by his failure, but this must have been little solace to Lyon.

In the meantime Hill continued his thorough investigation of the Swansea process. Instead of plunging ahead and building a smelter, as Lyon had done, he was more careful, knowing the risks involved. He wanted to ship a large quantity of ore to Wales, then go there to observe the actual treatment. This, of

course, required a large capital outlay, one that might not prove remunerative to investors. Despite the risk, Hill obtained support from J. Warren Merrill, a Massachusetts chemical manufacturer who had invested in Colorado's mines the year before. Others joined in the project, thus spreading the risk.

With the plans set, Hill met Herrmann in New York. The two men traveled to Colorado, where the Welshman examined mines and assayed samples of ore. He called stamp milling "a most wasteful expenditure" and termed smelting "the only practicable solution" to the problem of recovering gold from sulfurets. On his advice Hill spent $7,000 to purchase seventy tons of mineral from the Trust mine on the Bobtail lode. During the summer and fall he had the ore freighted across the plains to Atchison, floated down the Missouri and Mississippi rivers to New Orleans, and shipped to Vivian & Sons in Swansea. In the fall Hill made his second voyage abroad, this time to observe treatment. The process worked well, and he began formulating plans to erect works in Colorado. In spite of its success the experiment cost Hill and his associates $19,000 leaving them with a $400 loss.[43]

Early in 1867 Hill obtained financial support from easterners interested in the potential of a reduction enterprise. Together they organized the Boston and Colorado Smelting Company. On May 11 the articles of incorporation were filed in Boston by James W. Converse, J. Warren Merrill, Joseph Sawyer, and Gardner Colby, who set the capitalization at $200,000. Hill was named agent and local manager of the corporation.[44]

The founders were prominent businessmen in the Boston area. James W. Converse, president of the firm for many years to come, came from a family of shoe manufacturers and was a speculator in western enterprises. J. Warren Merrill held a seat in the general court of Massachusetts and once served as mayor of Cambridge in addition to being a chemical manufacturer. Gardner Colby was an importer of dry goods, a manufacturer of woolens, and, like Converse, a speculator in western ventures. Joseph Sawyer was another woolen producer and

mineowner. Hill apparently met Colby and Merrill through Brown University, for both were trustees of that school as well as of what are now Colby College and Andover-Newton Theological Seminary. Several of Colby's sons had also studied under Hill. Perhaps he met Converse and Sawyer through them or through his other associates in Boston. Regardless, Hill and his colleagues had one interest in common: a desire to invest in western enterprises, whether in mining, ranching, or railroad building. The Boston and Colorado Smelting Company was the type of venture that appealed to them, but even as they set their hands and seals on the legal documents, two federal mining engineers were reporting that there was "reason to believe that the proper economic conditions for smelting do not exist" in the Rocky Mountains.[45]