Mining and Extraction




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In 1800 the United States had a pre-industrial economy and an overwhelmingly rural population. By 1900 it was an urban and industrial powerhouse whose economy had overtaken that of Great Britain, France, and Germany combined.

Arguably, America's emergence as an economic superpower was marked by the organization of United States Steel in 1901. This event projected America to the world as the premier manufacturing nation. But there was another aspect to America's economic development that made the manufacturing base possible: its extractive industry, including coal and metal ore mining, petroleum, and timber.

Historian David Potter has characterized the United States as a nation conditioned by abundance. The wealth of natural resources this country had at its disposal contributed to the rise of the United States as a modern nation.

Coal

Invented in 1690, the steam engine was perfected in the late eighteenth century. This coincided with American independence and the frontier's westward movement. When steam power became a driving force behind technological progress in the early nineteenth century, part of the frontier's expansion involved the search for fuel, specifically coal.

In 1866 a mining expert estimated that the United States had a reserve of four trillion tons of mineable coal. While this figure included less desirable varieties, such as lignite and sub-bituminous, it primarily represented available deposits of both anthracite (hard) coal and bituminous (soft) coal. The difference between the two is their geological age. Anthracite is older and subjected to a greater degree of pressure in formation, making it a purer form of coal than bituminous.

America's bituminous coalfields are extensive, running westward from Pennsylvania to Indiana, and southward from Maryland to Alabama. In contrast, the nation's anthracite deposits are found in only one region: eastern Pennsylvania, in and around the Susquehanna, Schuylkill, and Lehigh River basins. Although the field is small in its geographic extent, it is unusually rich in the coal it has produced, and continues to produce.

Of the two major coal varieties, bituminous was discovered first during the early colonial era. By the Revolutionary War a primitive bituminous coal industry had been established. But the anthracite field's discovery proved to be a far more important event.

Credit for its initial uncovering goes to Obadiah Gore, a Connecticut blacksmith who settled in eastern Pennsylvania during the 1760s. Gore initially used various outcroppings (where the coal protruded through the ground) to fuel his forge. By 1769 he was trying to mine the coal on a larger scale. His efforts to mine and use anthracite were stymied by a number of different problems, ranging from technological limits to lack of reliable transportation. But the biggest problem was the difficulty in igniting anthracite. Between 1795 and 1812 countless attempts were made to introduce it to Philadelphia as a domestic fuel. But it did not burn readily, and it failed to respond to stoking methods used with bituminous coal. Then in 1812 it was discovered by accident that anthracite burnt satisfactorily if simply packed in a furnace and left alone. The air passing through the heated mass in a closed firebox created a natural hot blast producing intense heat.

After this discovery anthracite became highly prized. Demand grew in the major urban markets. Schuylkill County in Pennsylvania, still a wilderness in 1828, was the anthracite field's center. By 1844 the area was sending half a million tons of coal to Philadelphia annually by a myriad of small railroads, an illustration of the close connection between the nation's coal industry and the creation of the nation's transportation system. As early as 1798, the Pennsylvania legislature chartered a company to improve navigation on the Lehigh River. Most notable were the improvements to the Schuylkill River in 1822 and the completion of the Delaware and Hudson Canal in 1829. These arteries still shipped large amounts of coal as late as 1864.

Impressive as they were, the canals were overshadowed by the railroads. In 1827 the nation's oldest rail line, the Baltimore and Ohio, was chartered by the state of Maryland. In 1842 another major line, the Philadelphia and Reading Railroad, opened its corridor between Philadelphia and Pottsville, Pennsylvania. Despite a precarious start marked by poor management, the line was shipping two million tons of coal a year by 1855.

Meanwhile, America's coal industry took shape. It lagged behind Great Britain's mature mining companies in technology and extractive technique, but those advantages were mitigated by the sheer volume of America's coal deposits and the ease with which they were accessed. A notable case in point was the large open mine located at Mauch Chunk (later Jim Thorpe), Pennsylvania. Here, an anthracite coal seam of unprecedented size was discovered very close to the surface and was quarried.

Otherwise, there were three types of mining: drift, slope, and deep shaft. With drift and slope mining, the method was to follow a coal seam from a surface outcropping, either horizontally into a hillside or at an angle into the ground. In deep shaft, a vertical shaft was dug first, and the coal seams then worked off of it.

Two methods prevailed for extracting the coal: room and pillar and long-wall. Room and pillar was the older method, where a honeycomb of individual "rooms" was cut into the area where coal was worked. This area, known as the coal face, was interconnected by tunnels, their roofs supported by coal pillars. Once the coal was removed from an area, the pillars were taken out, allowing the roof, or "overburden," to subside.

In the long-wall method, a central tunnel was dug from the shaft to the coal seam's end. Once a working coal face was established, miners cut the coal in a single room running the width of the seam, working back toward the shaft. As the mining crew dug, the overburden was permitted to subside behind them.

Pioneered in England, long-wall mining did not gain a significant footing in the American coal industry until the twentieth century. Although it was less wasteful than room and pillar, long-wall was not attractive to American coal operators because it took much longer to establish a working coal face with long-wall than with room and pillar. Miners also preferred room and pillar because it offered greater work autonomy than long-wall did.

This was an important matter. Coal mining was a skilled occupation, requiring a practical knowledge of engineering and geology. The usual method of digging the coal was for the miner to undercut the coal face by digging a wedge-shaped trough into it at its base, running the width of the room in which he and his assistant worked. He then took an auger or hand drill and made several holes in the coal face. The holes were filled with black powder and fused. After lighting the fuses, the miner went to a safe place, yelling "fire in the hole!" The resulting explosion was known as a "shot." The pieces would then be loaded by the miner's assistant (or "buddy") into a cart and taken to the surface to be screened, cleaned, and weighed. This part of the process was a constant source of contention since most miners were paid by the ton. Small coal pieces and impurities were not counted.

Coal and mineral or "hard rock" mining was extremely dangerous. In addition to cave-ins and slate falls, gases and coal and mineral dust were constant hazards. The three most dangerous gases in mines were methane (fire damp), carbon monoxide (white damp), and carbon dioxide (black damp). Methane was the most hazardous. It is highly volatile, tasteless, colorless, odorless, lighter than air, and usually seeped from the coal face to gather in a pocket at the mine's ceiling. Testing for it involved applying flame to a suspected pocket, which was very risky.

Carbon monoxide is also colorless, odorless, and tasteless, in addition to being highly poisonous. Since there was no way to test for this gas during the nineteenth century, it was common for miners to take canaries into the mine with them as an early warning system. If the birds were overcome, it meant a carbon monoxide pocket had built up and it was time to get out.

The danger presented by coal dust was twofold. It too is highly volatile: if sufficiently concentrated, a simple spark can set it off. Also, miners subjected to long-term exposure to high concentrations of coal dust developed a degenerative respiratory condition popularly known as miner's asthma, in which the lung becomes clogged with coal dust, causing loss of elasticity and impaired breathing. First identified in England in the 1830s, the condition came under scrutiny in the United States between 1869 and 1881 by physicians John Carpenter and H. A. Learhman. Originally dubbed anthracosis, it later became known as coal workers' pneumoconiosis, or black- lung disease.

Another dust disease, primarily afflicting hard-rock miners, was silicosis. Like black lung, the condition resulted from sustained exposure to high concentrations of fine dust particles, in this case sand. The disease differed from black lung in that instead of coating the lung, the dust cut

into the lung tissue, which impaired breathing and made the miner susceptible to infectious diseases, especially tuberculosis.

While methods were developed to reduce dust levels, the first line of defense against both dust and gases was effective ventilation. Of all the engineering challenges presented by deep mining, providing sufficient breathable air was one of the most daunting. One early method involved sinking a ventilation shaft at a different height from the mine's opening. The idea was to create a partial vacuum by allowing warmer air to rise and escape out of the mine, causing a column of fresh air to rush in from the surface. Based on the same theory, another system used a furnace connected to a ventilation shaft to promote air flow. Still another produced the same effect with a cascade of cold water flowing down the central shaft. While each method worked to some degree, they were not adequate to meet the needs of deeper mines. Moreover, use of a ventilation furnace in a deep mine could be hazardous. An example was the Avondale disaster in Luzerne County, Pennsylvania, in 1869. More than one hundred men were asphyxia ed in a mine three hundred feet deep when the ventilation furnace burned the main shaft.

The introduction of the fan was a major breakthrough for the mining industry. Experiments with fans had been made as early as 1621, but these efforts failed because they attempted to force air into the mine. Air has mass and resistance, making a forced- air approach useless. Eventually, engineers discovered that fans were more effective when they drew stale air out of the mine, thereby promoting an upward flow of fresh air in. The mainstay device until well into the next century was the Guibal fan, first demonstrated in 1854.

Other innovations were comparatively minor. For most of the nineteenth century a miner's tools consisted of the pick, shovel, auger, black powder, and fuses; large-scale mechanization was a phenomenon of the twentieth century. Nevertheless, efforts were made to introduce machinery to increase productivity. One device, originally demonstrated in 1850, was a compressed-air jackhammer to replace the pick for undercutting the coal face. This device began to come into greater use around 1875. A far more important development for miners was the safety lamp. Introduced in 1815, it featured a wire mesh that prevented methane from getting to the flame in sufficient quantity to cause an explosion.

As the nineteenth century continued, America's coal output grew phenomenally. Starting from just a few hundred tons in 1800, the United States was producing a total of 22 million tons a year by 1864. During this time and immediately following the Civil War, anthracite was the leader, accounting for 52.33 percent of total coal production between 1850 and 1869. By 1870 the United States had become a major coal producer, topping all other coal-mining nations by 1890. In 1870 America's bituminous coal production began to outdistance anthracite due to the rise of the steel industry.

Iron

Like coal mining, iron making had a long history in the United States, dating back to 1619 in Virginia. Iron making was a complicated matter in which raw ore was smelted and then refined by three distinct processes: puddling, blooming, and rolling. The purpose of these was to take the very brittle smelted product (pig iron) and reduce its carbon and silica content, converting it into stronger and much more malleable wrought iron. Each of these processes required a great deal of skill. Puddling alone had nine distinct steps.

The traditional fuel source for iron making had been charcoal. But in the nineteenth century the iron industry turned its attention to anthracite and bituminous coal. Nicholas Biddle (1786-1844), who had headed the Second National Bank of the United States, offered a five-thousand-dollar reward to anyone who could produce pig iron for one hundred consecutive days using anthracite. A similar prize was offered by Philadelphia's Franklin Institute for anyone who managed to do the same with bituminous. Neither fuel, as things turned out, could replace charcoal. But an alternative was found with the development of coke.

Coke was bituminous coal heat-treated in an oven to burn off impurities. Refined in this manner, it produced heat with charcoal's intensity. Although experiments were made with it during the 1830s, it was not until 1850 that the use of coke came into vogue. By 1876 coke had displaced all other fuels in the iron industry.

It was during these same years that iron making underwent a revolution. Working independently of each other, William Kelly (1811-1888) in the United States and Henry Bessemer (1813-1898) in England developed a new way of making wrought iron between 1851 and 1855 that did away with skilled labor. Dubbed the Bessemer process, it refined pig iron by blowing excess carbon and silica off the molten mass with blasts of compressed air. The process, as perfected by Robert F. Mushet (1811-1891), paved the way to the cheap mass production of the purest and strongest of all iron products: steel.

In the years following the Civil War, demand for steel grew at a geometric rate. In 1868 total steel production in the United States stood at 26,786 tons. By 1890 that figure had grown to 4.28 million tons. As more steel was being made for buildings, bridges, and rails demand for bituminous coal also grew. From 1870 to 1890 the coal beds of south-central Appalachia were opened. By 1900 bituminous coal was the nation's, and the world's, most important fossil fuel, a position it held well into the twentieth century until displaced by petroleum.

Oil

Known in the ancient world, oil was used for heating and other purposes. It did not come into general use, however, until the second half of the nineteenth century. The major problem was how to extract it. Oil usually appeared in swamps and other bodies of water, and attempts were made to skim or channel it off the water's surface. But neither of these efforts proved very effective. A better method had to be found, especially since a new market for petroleum was emerging.

Although oil had been sold for many purposes, even as a cancer cure, demand was growing for a new lighting source. Until the 1850s, lamps were fueled by whale oil, which led to the near extinction of several whale species. With whale oil prices rising to exorbitant levels, petroleum promised to be a good and inexpensive replacement.

The stumbling block was that no technology existed to get the oil out of the ground. However, Edwin Drake (1819-1880), who assumed the honorific title of colonel, developed the basic method still in use today. Working near Titusville, in the heart of northwest Pennsylvania's oil field, Drake came upon the idea of forcing pipes into the ground and then drilling. In this way, when the pool was finally reached, the oil would flow up by force of hydrostatic pressure. After drilling sixty-seven feet, Drake's well hit oil and began flowing on 27 August 1859.

This marked the beginning not only of an oil boom in northwest Pennsylvania, but the start of the oil industry itself. Although petroleum products replaced whale oil and found other uses, demand for petroleum would receive its greatest boost with the invention of the diesel engine in the 1890s and the introduction of the internal combustion engine.

Minerals and Precious Metals

Contemporary with the coal and oil industry's development was the rise of metal or hard-rock mining. Since stone ores are incredibly dense, hard-rock mining became a generic expression for the extraction of metals from gold and silver to copper, iron, and lead.

Like coal mining, hard-rock mining presented problems related to working underground, including ventilation, safety from dust exposure, and gas explosions. Metal mining too was a skilled occupation, but the two industries diverged in the degree of difficulty, complexity, and danger involved. Whereas a colliery that reached three hundred feet was considered a deep mine, metal mines regularly went to a depth of one thousand feet to reach the principal deposit, or lode. In Nevada alone, by 1880, no fewer than thirty-seven metal mines had exceeded a depth of one thousand feet, and five had reached three thousand.

Another area of divergence was the hard-rock industry's ethnic composition. Certainly, both coal and metal mining employed a wide diversity of workers, including Native Americans, Irish, Slavs, and African Americans. In the hard-rock industry, however, one group predominated and was actively recruited: Cornish miners. Their native Cornwall was England's principal metal-ore producing region. Referred to as Cousin Jacks, these men had the experience and practical know-how needed for cutting through bedrock and reaching the mineral deposits.

As in the coal industry, metal mining relied on blasting and open extraction of surface outcroppings. Blasting in this industry was extensive, since mining through bedrock and granite was such a challenge. In addition, hard-rock miners regularly applied fire to the bedrock to crack it in order to break through.

Hard-rock mining was a midwestern and western enterprise that included the iron and copper ore deposits of Michigan and Wisconsin, the lead deposits of Montana, and especially the gold and silver deposits that ran from Colorado to California. When these territories were first explored by Lewis and Clark in 1805 and 1806, coal was already being mined in the East. Metal mining was primarily a late-nineteenth-century industry; it was not until 1850 that iron manufacturers began using Michigan iron ore.

Although the government sought to promote the development of these resources, the major impetus behind the opening of the ore fields was the coming together of supply and demand, as in the case of the Michigan copper rush of the 1840s. This not only attracted prospectors and miners, but also needed investment capital from the East and abroad, primarily Great Britain. The most famous such instance was the discovery of gold in California in 1848, which attracted people and investment in large quantities. British investors poured 250 million dollars into western

mining interests between 1860 and 1901 and held 400 million dollars in U.S. railroad stock. By 1852 California was producing 45 percent of the world's gold supply, with the major gold and silver strikes of Colorado and Nevada yet to happen.

Timber

Another resource that seemed almost endless in its abundance was timber. From Maine to California, to the Pacific Northwest and Appalachia, the lumberman was a constant presence. Like coal mining, the lumber industry fed demand created by the growth of America's eastern cities. The Erie Canal, completed in 1825, provided access to the pine forests in and around the Great Lakes. Later, railroads expanded that access.

Timber was the most visibly profligate of the extractive industries, primarily for two reasons. With wood so plentiful, it was much more cost-effective to clear-cut entire forests and then move on. Also, it had long been believed that forested areas represented untamed wilderness and that clear-cutting announced civilization's arrival. Fed by an ever-growing demand the lumber industry expanded at a prodigious rate, producing 44.5 billion board-feet per year by 1919.

Economic Concentration and Labor

The question of how these industries were structured is neither easily nor quickly addressed. Whereas iron and steel witnessed a myriad of smaller companies at first, as did hard-rock mining, it was eventually marked by the rise of corporate giants such as Carnegie Steel and the Anaconda Copper Company. The same corporate control is true of the oil industry, with John D. Rockefeller (1839-1937) and Standard Oil driving smaller companies into bankruptcy.

Coal was a different matter, however. While some large companies were formed during the nineteenth century, such as Pittsburgh Consolidated, most coal production remained in the hands of small producers. It was not until the twentieth century that the industry was concentrated and rationalized, with smaller companies being driven out of business.

Although the rate of economic growth achieved by the extractive industries during the nineteenth century was impressive, it came at a cost paid chiefly by American workers. One estimate set the coal industry's average daily wage at one dollar and fifty cents in 1868. While this masked the disparity between skilled and unskilled labor, skilled workers rarely made more than three dollars a day. Many occupations in the extractive industries were unskilled and so commanded much less.

Almost without exception local, state, and federal authorities sided with employers, even to the point where basic legal and constitutional protections were suspended. Hand in hand with such suspensions went the regular use of armed guards, such as Pennsylvania's coal and iron police, and private detective agencies, including the Pinkertons and the Baldwin-Felts organization. In addition, during times of labor strife, vigilantes were regularly deputized by county sheriffs and given a license to use whatever force was deemed necessary.

Workers' attempts to improve their situation fostered a culture of opposition. This took many forms, ranging from local benevolent associations to violence, as in the case of the Molly Maguires in the anthracite coalfield in the 1870s. Ultimately, this culture led to the creation of organized labor. While the creation of labor unions was hampered by such things as ethnic and racial diversity and economic downturns, unions were established nevertheless and won some impressive results for their members.

Most notable were the United Mine Workers of America (UMWA), founded in 1890, which represented coal miners, and the Western Federation of Miners (WFM), established in 1893, which sought to organize the hard-rock industry. In 1902 the UMWA was able to fight and win a long strike for the eight- hour day against eastern Pennsylvania's largest coal operator, the Philadelphia and Reading Railroad. This strike was one of the first instances where the federal government, under President Theodore Roosevelt, intervened in a labor dispute as an impartial arbitrator. That enabled the union to make its case to the wider public as never before and marked the start of a new and less hostile relationship between organized labor and the federal government.

Reevaluation of Resource Use and Labor Issues

Taking the long view, American economic development between 1800 and 1899 was nothing less than remarkable. The country, however, paid handsomely for it in terms of the waste of resources and human suffering. As the twentieth century began, these concerns were beginning to be addressed. In the area of conservation, the influence of Gifford Pinchot (1865-1946) and John Muir (1838-1914) would be felt. Although Muir and Pinchot disagreed on what shape conservation should take, wise use or preservation, both worked to end the profligate expending of resources.

Similarly, both the government and the courts were beginning to reevaluate their positions on such social policy issues as child labor and employer liability. Whereas the courts had originally held that the workers could not sue employers for negligence, since employees were free to seek work elsewhere, this trend was eventually reversed. By the early 1900s, the courts were awarding workers compensatory and punitive damages for injuries sustained as a result of a hazardous workplace. This ultimately led to passage of workers' compensation laws in most states between 1912 and 1920.

As for child labor, although this was not finally outlawed until the passage of the Social Security Act in 1935, the practice was coming to public attention. A great deal of the credit for this goes to the nation's first investigative journalists, the so-called muckrakers, and labor advocates such as Mary Harris "Mother" Jones (1830-1930). Thus, as the nineteenth century came to an end, its philosophy of an unlimited individualism was coming under increasing fire. Although it was not replaced by a communitarian ethic, a basic sense of social responsibility was beginning to take shape.

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