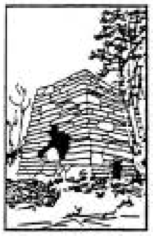
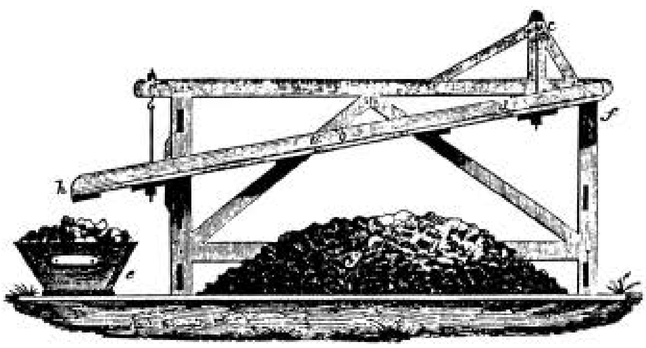


Chapter 3
Iron Mines and Ore Pits

Iron ore is found in many forms throughout the world. Long before it was being worked in primitive hearths, nodules of nearly pure iron could be found lying about on the ground. History books have numerous accounts of high-quality bar iron being made at forges from iron-rich rocks and outcroppings found up and down the mountains of western New England during colonial times. As the frontier moved slowly westward over these mountains from the early New England coastal settlements, some sharp-eyed land speculators quickly recognized the natural resources of the area. It was not only the agricultural, mineral, and lumbering resources that attracted them, but also the proximity of many of these resources to potentially excellent mill seats along the many quick-flowing mountain streams and rivers.



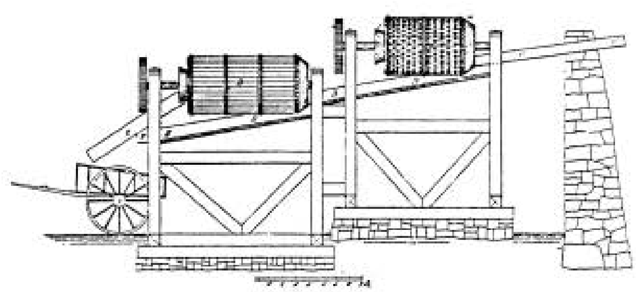
3-1. *After being hand-screened, the ore was shoveled onto a mechanical screen (the angled frame) and, by swaying this back and forth against the side uprights, ore was filtered through quarter-inch mesh into the pile below. Riddlings vibrated over the edge of the frame into the box at left to be discarded (Overman 1850:47).*

During and immediately following the Revolutionary War, thousands of acres of Vermont land were consolidated from numerous small holdings into large and expansive tracts, or grants. Choice grants were quickly acquired by the first to come, many of whom served in Vermont during the Revolution. Typical was Matthew Lyon, who in 1779 was arranging for the grant of the town of Fair Haven. Lyon had already inspected the town and became aware of the commercial value of the falls on the Castleton River and also the lumber and iron resources in the area. Likewise Ira Allen, who in 1783 was contracting for the construction of forges along the Winooski River to exploit the bog ore beds at Colchester. That same year, William Gilliland of New York State was contemplating the erection of an ironworks, which was eventually built in 1801 at Willsboro, New York, and was designed for casting anchors weighing from 300 to 1,500 pounds. They were shipped up the lake to Whitehall, overland to Fort Edward, thence by boat on the Hudson River to Troy.

Ore for these works came principally from Vermont, with small amounts from Canada. One of the early ore beds has historically been located at Basin Harbor. Owned by Platt Rogers, it was the only deposit worked during that period in the whole region (Watson 1869:438-439). But this bed was in fact across the lake in New York. Rogers settled at Basin Harbor at an early time, causing confusion between location of his residence and of his ore bed (Allen 1980:16). Soon after 1790 a number of ore beds were being worked along the western slopes of the Green Mountains. Samuel Williams wrote in 1794 that great quantities of iron ore were located at Tinmouth, Pittsford, Rutland, and Shoreham, the ore was melted and worked easily, and it made excellent nails (Williams 1794:316). The 1796 Whitelaw map also identified two "iron oar" beds at Bennington and another at Monkton, in addition to identifying ironworks sites. Major beds were opening in 1800 at Bennington, Highgate, Monkton, and Chittenden. By 1842 Zadock Thompson had recorded a total of 24 towns where iron ore was known to exist or was being actively mined. Two-thirds of these towns are in the western part of the state.

The earliest organized attempt to scientifically analyze the state's mineral resources was a series of reports published by State Geologist Charles B. Adams. In 1845 Adams published the first formal report on the geology of Vermont in which he categorized ores as brown iron ore and magnetic oxide (Adams 1845:17-27). The former included brown hematite, bog ore, and yellow ocher; magnetic oxides included red hematite, magnetic ore, and red ocher.

The brown ores were found in Bennington, Tinmouth, Dorset, Manchester, Huntington, Milton, Wallingford, Putney, Brandon, Pittsford, Monkton, Leicester, Bristol, Guilford, Salisbury, Chittenden, Highgate, Swanton, Plymouth, Rutland, Strafford, Colchester, and Sherburne. Hematite mined at Colchester in the late 1840s was boated up the lake to be smelted in an iron furnace at Westport, New York (Hodge May 19,



3-2. *A typical ore washer in which raw ore was washed and separated from waste by streams of water in two revolving cast-iron drums. The first (upper) drum was perforated with small holes and the second (lower) drum had long slits. Iron ore that reached the bottom was carted to the blast furnace* (Salisbury Iron *1878:6).*

3-3. *The entrance to one of the Somerset iron mines at West Dover.*

1849:306). A vein of iron ore at North Dorset was described as being three feet wide and within 100 feet of the ca.-1830 blast furnace there. And a mine one mile east of Sheldon was one of many in the area that provided iron to blast furnaces in the early 1800s (Morrill and Chaffee 1964:41). Brown hematite ore was mined at Forest Dale at the foot of a sandy hill to the east of the furnace, near the base of higher mountains. Some 1849 costs were: iron ore, $1.75 per ton, at the mine; iron ore, $2.50 per ton, after washing; and charcoal, $5.00 per 100 bushels.

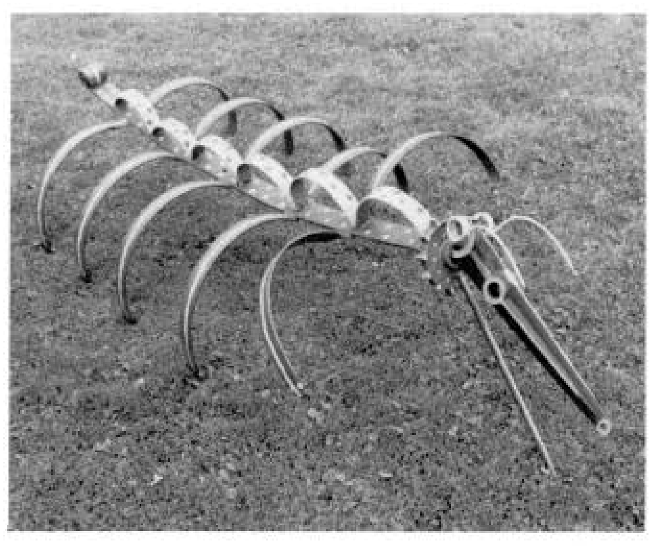
Before charging it into the furnace, the ore was washed to remove clay, stones, and dirt, allowing for a more efficient smelting process. Yield of the furnace was 5½ to 6 tons of iron a day. The annual capacity of the furnace was about 1,200 tons (Hodge May 12 and 19, 1849:290 and 305). Iron was also mined at "Selden's marble mill" in eastern Brandon, where the limestone contained several percent iron ore. This limestone was mined along with the iron and used for flux at the furnace (Hitchcock et al. 1861:640).

Lumps of brown iron ore were abundant in the soil of Dr. Drury's farm, two miles south of the Pittsford blast furnace. And in Chittenden, three miles northeast of the Pittsford stack, was Mitchell's ore bed, one of the most extensive iron mines. From a main shaft 60 feet deep, galleries were dug 100 feet to the north and south. The south gallery led to a solid bed of ore, two to three yards thick in limestone rock. It provided 45 percent of the iron at the Pittsford furnace. Conant's mine at Brandon had not yet bottomed out of the ore bed at 90 feet, and he improved the yield of iron to 50 percent by working the ore with a stream of water, washing it in a rotating strainer. Other iron ore diggings were found in 1987 near Beaudry Brook on the west slope of Bloodroot Mountain in Chittenden, and also about 200 feet downhill along Steam Mill Brook. Both are associated with mound-type charcoal-making sites; the latter with stone foundation ruins of possible ore-roasting ovens.

A major hematite discovery in Sheldon in the 1830s was exploited for over 50 years. The initial outcrop, on a knoll near Black Creek, was worked (mostly by open cut) by Lawrence Brainerd and W. O. Gadcomb, both of St. Albans, who owned the property. They built a bloomery forge (location unknown) and produced blooms, working it into bar iron that was used in the vicinity, although some was shipped up Lake Champlain to Troy and Albany, New York. But lack of direct railroad connections and insufficient demand for the blooms forced abandonment of the forge. The vein was traced for nearly 20 miles, with some prospecting done on outcrops at Berkshire, Enosburg, and a few miles east of St. Albans. The vein being narrow, however, only a few carloads of ore were taken out at these places. The Keith furnace at Sheldon had also used this ore in the 1830s, mixing it with bog ore from Swanton.

A new use for the ore came with the St. Albans Iron and Steel Works, when a 10-ton Siemens open-hearth furnace was built in 1877 for the manufacture of steel track for railroads. Furnace charge consisted of pig iron, old rails, steel scrap, and magnetic ore. The ore and pig iron came at first principally from Port Henry and Crown Point, but the ore from Sheldon was successfully substituted for the magnetite and was thenceforth used exclusively. Aldis O. Brainerd, mine owner, shipped several thousand tons of ore, carried by teams three miles to the Missisquoi River and then to St. Albans, a total distance of about 13 miles.

The mine was about a mile southwest of Sheldon village, and a mile west of the St. Johnsbury & Lake Champlain Railroad, which ran along Black Creek. It consisted of two distinct parallel veins outcropping to the surface about 30 feet apart;



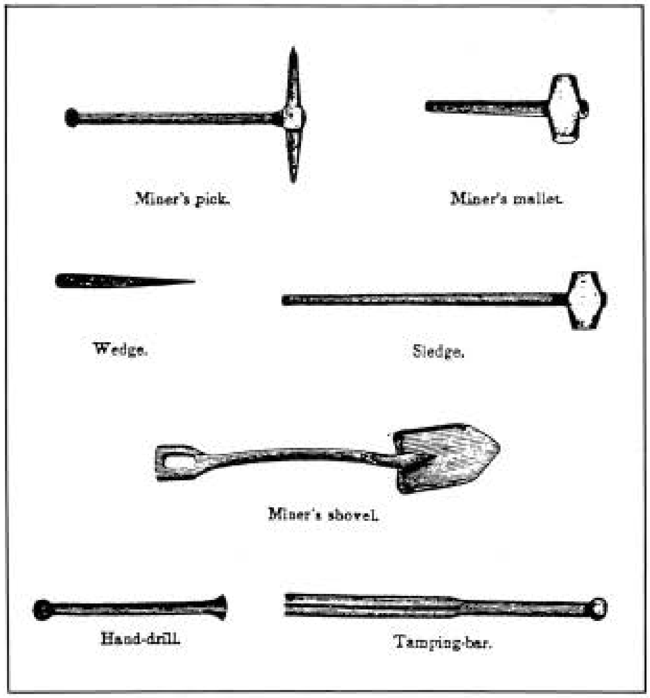
3-4. *An "iron bug" encountered at Fairfax, but not of the bog ore variety; rather, a creation of the modern-day Fairfax Forge, made of scrap hardware.*

each outcrop was about three feet wide. Work was done mostly on the westerly outcrop with several open cuts and two shafts over 60 feet deep. At the bottom of the shafts, the vein was 10 feet wide. Since the mouth of the shaft was about 100 feet above Black Creek, no water interfered with mining the depth of the shaft. Timbers were not required in sinking the shafts due to the stability of the walls (Brainerd 1884/1885:689-691).

Magnetic ore, so called because it could influence small magnets such as a compass, yielded over 70 percent iron, and was found mainly in Dover, Plymouth, Stockbridge, Bethel, Troy, Rochester, Rutland, Chester, Addison, Huntington, Bridport, Hancock, Jay, and Brandon (Adams 1845:21-27).

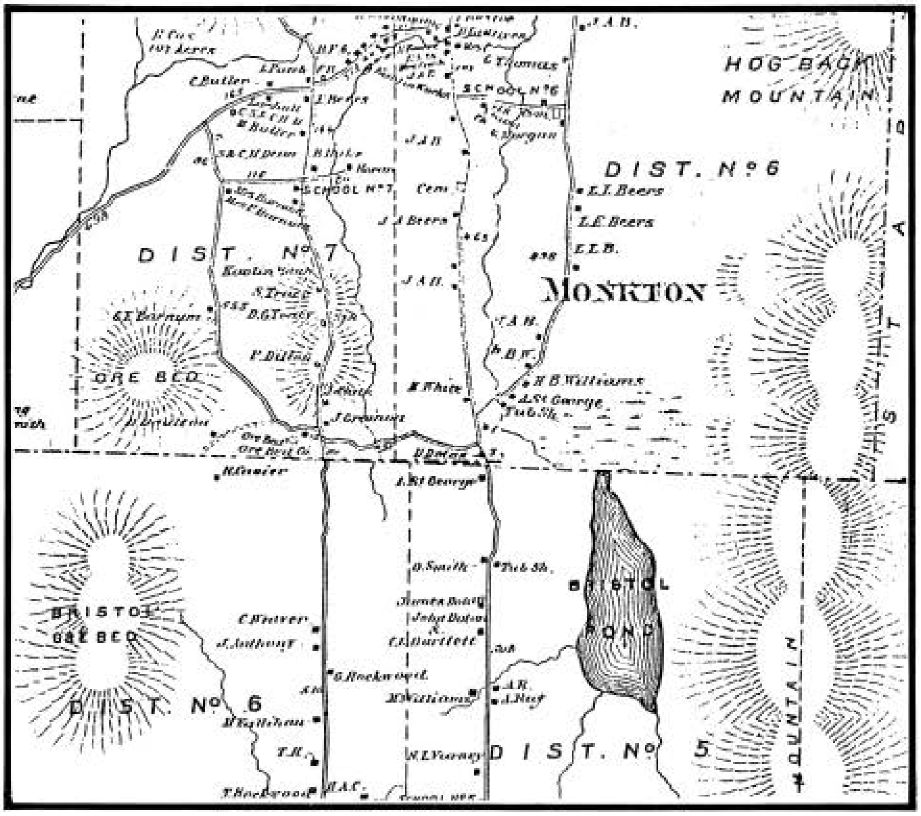
John W. Stickney (father of Vermont Governor William Stickney) was superintendent of the Tyson Iron Company at Plymouth and manager and agent for the two successive iron-works operations there, spanning a period of about 45 years and ending with the final blast in 1872. While with the iron-works, he wrote the following report on iron and other ores on the company's property in Tyson and vicinity:

> Beds of brown hæmatite near Tyson Furnace, in Plymouth, Vt., were discovered by the undersigned, in company with an older brother in 1825. The main bed was opened by I. Tyson, in 1836 and was exclusively worked by him from that time until 1855. Many thousand tons of iron were manufactured from this ore, of the very best quality. Three kinds of ore are found in this bed. . . . The largest specimen makes white iron with good success. These ore-beds are geologically situated as follows: Beginning in a valley running nearly east and west, are bounded on the north by a ridge or elevation of talcose slate, through which passes heavy veins of dolomitic and silicious limestones, and smaller veins of the carbonate of lime. On the south is quite a large mountain, being a spur of the Green Mountains. This mountain is mainly made up of gneiss rock, and heavy veins of granular quartz interstratified with it. . . . The main bed, worked by I. Tyson, is not exhausted, and can be opened without much cost.
>
> Beds of brown hæmatite, in Tinmouth, Vermont, in geological formation are not unlike the one in Plymouth, above described. They are now being worked by I. Tyson Jr., & Sons, and are situated on the west side of the Green Mountains, and within four miles of the Western Vermont Railroad.
>
> The one mainly worked the present winter, I describe thus: It is worked on its western declivity by an adit, or level, running easterly into the hill, say sixty yards, when the ore was reached. Three hands are now raising from six to ten tons per day. . . .
>
> This ore bed was opened by D. Curtis, of North Dorset, thirty-five or forty years ago,—who then run a blast-furnace at that place. Mr. Curtis informed me that this ore was repeatedly tested in his furnace at that time, and found to be of the very best quality, making iron superior to any then made in this State.
>
> I also send specimens of magnetic ores, commonly known as rock ores, from different veins in the vicinity of the furnace.



3-5. *An assortment of mid-19th-century mining tools (Overman 1850:55).*

> These are largely percented with metallic iron. . . . Two of them, the Taylor and Hall veins, have been worked by Mr. Tyson to some extent; the others have not been explored.
>
> Variegated marbles, soapstones, and sandstones abound in the vicinity, the latter suitable to use as fire-stone in lining the furnace. Strong indications of a copper vein are known to exist in the east part of the town of Plymouth, two miles from the furnace. . . .
>
> Galena (or lead ore) is also found near Plymouth, in the town of Bridgewater; being discovered when working a vein of quartz for crushing to obtain gold. This vein of quartz passes entirely through the town of Plymouth, and is the most easterly one marked on the map of said town, which is herewith sent for reference to the localities of minerals, &c., herein described.
>
> Gold had been successfully washed in the eastern part of the town . . . and exists in workable quantities on mineral rights owned in connection with the furnace property. Having no specimens of gold now on hand, I am unable to add these to this collection.
>
> Kaolin (or pipe clay as it is sometimes called) is found in an extensive bed, immediately east of the bed of hæmatite iron ore first described in this statement, and between it and the iron ore is an extensive bed of moulding sand, which has been used for moulding purposes at Tyson Furnace, and largely sold to other foundries in New England.
>
> I also send a specimen of carbonate of iron (or steel ore), a large vein of which is found one and a half miles east of the furnace, Strong indications of copper ore also exist in connection with this vein (*Geological Surveys* 1864:14-15).



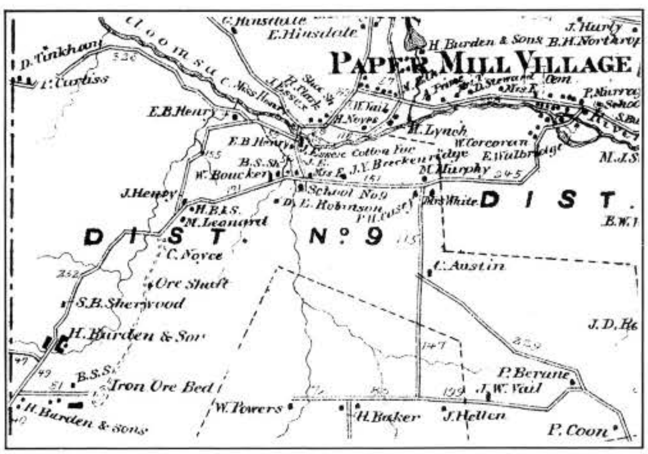
3-6. Iron ore beds in Bristol (lower) and Monkton (upper), exploited in the early 19th century for forges and furnaces at Vergennes, New Haven, and Ferrisburgh in addition to local forges at Bristol and Lincoln. Both ore beds were part of the same mineral system (Beers Addison *1871:11, 23).*

The "main bed" that Stickney's report refers to as worked by Tyson but not exhausted is probably that indicated by the 1869 Beers map of Plymouth on Weaver Hill, east of the furnace site. Reference to D. Curtis (Daniel Curtis?) reducing Tinmouth ore at his furnace provides important information as to a possible early date, about 1825, for the blast furnace operating at North Dorset. A collection of holes, mounds, and pieces of iron ore lying about on Caleb Scott's farm in the southwestern part of town might have been part of the Tinmouth ore bed. About two miles farther north above Route 140 where East Road tops a low rise are remains of a line of iron diggings, paralleling the road a few dozen feet on the east for about 200 feet.

When Stickney wrote his report, gold fever was sweeping Plymouth and surrounding towns. The prospects of mining gold were also evident in the iron company's assessment of its property value. The map Stickney said he was including with his report was probably the *Map of the Town of Plymouth,* drawn up in part by him and dated 1859. The map indicates all mineral locations then known to exist in the town, but it especially emphasizes gold locations. With the end of the Civil War in sight at the time of the report, and the impending loss of the works' prime customer, the Union Army, Stickney was already making preparations for inducing speculators to come and invest in Plymouth's new-found mineral wealth. When the gold fever eventually played out many years later, it was generally agreed that those working "the gold fields" could have made more money if they had spent the time doing honest labor on local farms.

Years later, Guy Hubbard of Windsor described the iron mines at Plymouth:

> This first "Hæmatite mine," (now caved in [in 1922] and inaccessible because of the decay of the timbering) was but a short distance west of the furnace. Eventually this consisted of a vertical shaft fifty feet deep and a lower gallery four feet wide by six feet high running fourteen hundred feet in a northeast and southwest direction from the foot of the shaft. This gallery sloped and its lower end opened upon a brook, into which the water drained without pumping. In one part of this gallery the ore consisted of lumps of brown hæmatite, while in another part it consisted of black oxide of manganese. A bed of high grade fire clay, suitable for use in the foundry, were also penetrated in these workings, much to the satisfaction of the management. At first, the buckets of ore were raised in the shaft by a horse power windlass, but eventually a steam hoisting engine was installed at the mouth of the mine. This hæmatite proved rather refractory, but it was discovered that this fault could be remedied by allowing water to run over it for some time before smelting.
>
> A much more picturesque mine (recently "rediscovered" by the writer [Hubbard] when he nearly fell into its abandoned vertical shaft in the midst of a clump of raspberry

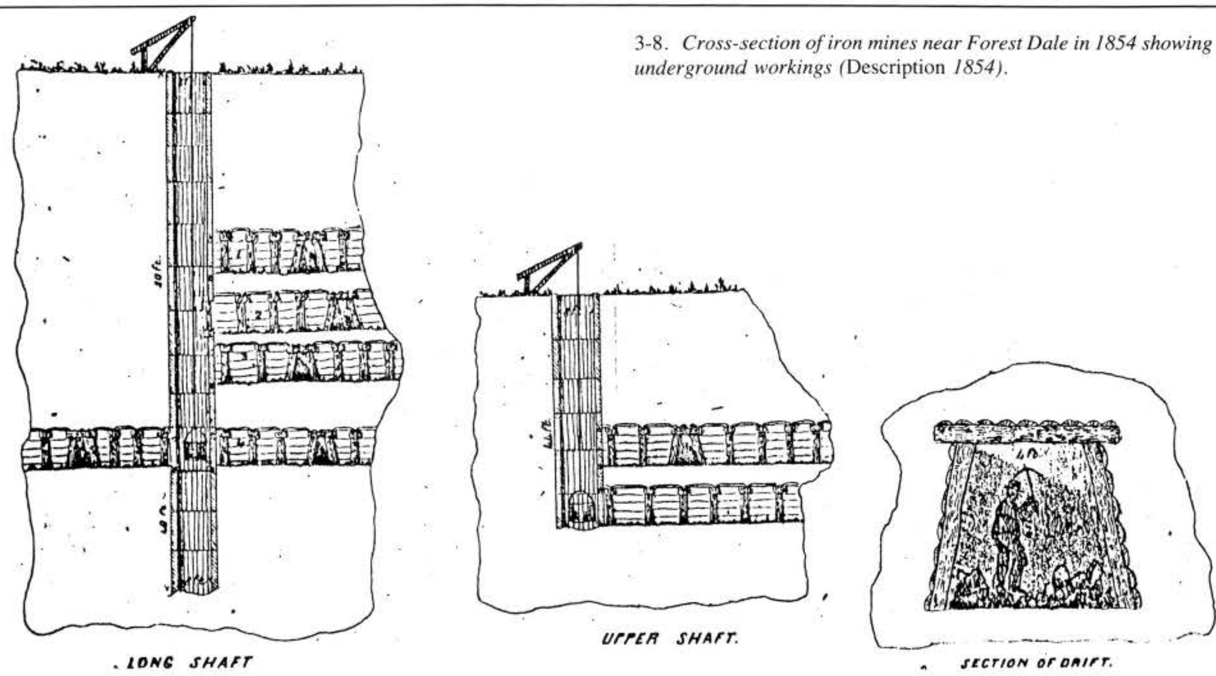


3-7. *The North Bennington Iron Works, which was the iron mining operations end of the Burden Iron Works, dug ore in western Bennington near the New York State line (lower left). Ore was carted north on Ore Bed Road to Burden's ore-washing works on Paran Creek (top center), thence two miles northeast to his blast furnace at South Shaftsbury (Beers* Bennington *1869:23).*

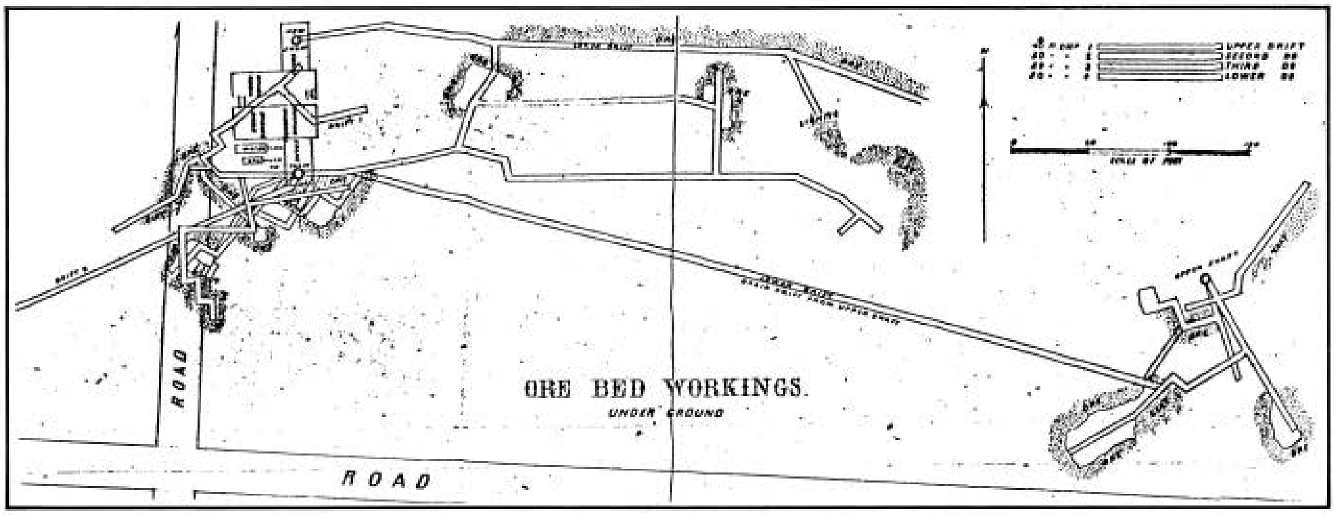
bushes) was later opened on the rugged summit of Weaver Hill, a part of Mount Tom, about three miles east of the furnace and at an elevation of fully two thousand feet. The product of this mountain mine was locally called "Spaffic" or "Steel ore," and consists of a hard lime rock of black and brown color. It is technically called "Spathic," and is crystalline carbonate of iron. This mine . . . has part of its vertical shaft and upper gallery still accessible [in 1922] on account of their being cut in the solid rock. The lower part of the shaft, and the deep galleries which penetrate hundreds of feet into the mountain, are full of cold, bluish colored water which has been accumulating during the many years since the pumps ceased to operate. This ore was dislodged by the use of black blasting powder, and the mine used to be a favorite gathering place for the farmers' boys, who made a practice of begging powder from the easy going foreman. In the course of time a new foreman came upon the scent, with the announcement that he was using "Kill-all Powder," a compound so sensitive that the sunlight would explode it, and so powerful that a grain of it would blow a man to "Kingdom Come." Mr. Tyson then suddenly ceased to supply the local munition market.

This Spathic ore contained a great deal of sulphur compound and green stone, and was roasted in kilns to drive off the sulphur and some of the other impurities before being smelted. It produced a peculiar iron which could be converted into steel by a single "blooming" operation—hence the name "steel ore" (Hubbard 1922:48-49).

One of the problems with the ore beds in Vermont, as well as elsewhere in the Northeast, was the proximity of the iron ore to veins of manganese. Under great heat, such as that of a blast furnace, manganese will release a large quantity of oxygen. A bed of manganese many feet wide in Bennington was separated from the iron ore by a layer of clay not more than a half-inch thick. An ironmaster there in the early 1800s thought the black manganese to be a purer iron ore and charged his blast furnace with a large amount of it. When the furnace was tapped, the molten stream burst into a furious fire, driving



3-8. *Cross-section of iron mines near Forest Dale in 1854 showing underground workings (*Description *1854).*



3-9. *Ore lots near Forest Dale in 1854, about a mile southeast of the blast furnace* (Description *1854*).

the workers from the building. Removal of the remaining manganese forced the expensive process of shutting down the furnace (Adams 1846:215). Another area affected by manganese was Bristol and Monkton, where extensive mining operations were carried out into the early 1800s. There were contiguous beds across the town boundaries in northeastern Bristol. The Monkton side of the beds was additionally plagued by surface water drainage problems.

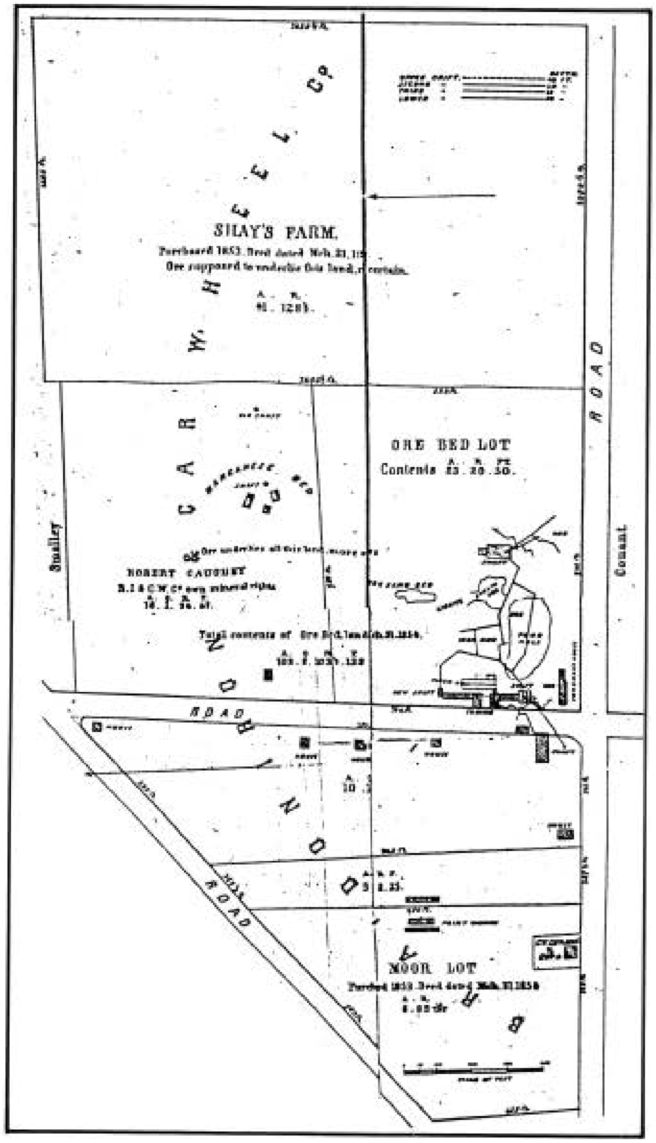
English inventor Henry Bessemer's process of making steel in 1856 was to blow air through molten cast iron in a pear-shaped thick steel container called the Bessemer Converter. The blowing raised the temperatures inside the converter, causing the impurities in the iron, including carbon, to burn away, creating a pure refined iron—wrought iron—without the use of charcoal. But if the reaction were halted before all the carbon burned away, the result would then be a low-carbon iron, or steel. Another Englishman, Robert F. Mushet, found that better results could be obtained by continuing the blowing process to the complete decarbonization of the iron, then adding small amounts of carbon and manganese back into the molten iron to create steel. What this all meant was that manganese, formerly an undesired, troublesome element in iron ore, was now needed by the steelmakers as an additive to the refined iron, and the search for rich manganese deposits was on (Lewis 1976:36-37).

The manganese associated with iron ore at Wallingford drew Andrew Carnegie's attention in the 1880s (Klock 1976:42). This black ore, as it was called, was described in an 1859 analysis as having a ratio of 84.5 iron to 15.5 manganese. The chief center of the manganese bed lay about a half-mile up Homer Stone Brook from the Otter Creek, in the midst of a boulder-strewn hollow. An adit (horizontal passage) in this area passed into a hillside first through 100 feet of gravel, then 100 feet of limestone, and finally 250 feet of red and yellow ocher and white clay before reaching the mother lode of iron ore and manganese. When smelted, it made a very hard, white iron that was also very brittle (Lesley 1859:542). Carnegie, however, worked the bed for the manganese, needed by his steel mills back in Pennsylvania. Between 1888 and 1890 more than 20,000 tons of the ore were shipped out (Jacobs 1927:211).

Another major impurity, although less dangerous than manganese, was titanium. This element did not lie next to iron ore like manganese but was part of the ore itself. Much iron ore in northern Vermont as well as the Adirondacks in New York contained titanium. Early users of cast iron ignored the titanium content, but as the state of the industry advanced and the quality of the iron became significant in more applications, the titanium became a problem. Such was the case in the town of Troy, where a three- to five-foot-wide vein of magnetic iron ore was found to be two miles long and thought to be inexhaustible. But the problem and expense of separating the titanium from the iron ore closed the blast furnace not long after it went into operation.

Most pre-1800 Vermont iron-mining activity centered around the extraction of ore from shallow, marshy areas. This ore was called bog ore and was found not only in marshes along Lake Champlain and lake-level tributaries but also in certain inland bogs a number of miles from the lake.

Bog ore consisted of various oxides of iron that had dissolved out of older, decomposed iron ore in chemical association with large amounts of sulfur or carbonate. Weathering actions slowly washed these oxides downhill from the higher, older elevations to settle and collect in marshes, and in time to accumulate in layers. The ore remained in some marshes even long after some of the more inland swamps had lost their feeder streams and dried up. There is some scientific thought that bog ore is due to actions of an "iron bacteria," whose ferric oxide and ferrous carbonate excrements resulted from the ingestion of iron from the solutions in which they lived. Whether in wet marshes or dried beds, bog ore was mined merely by shoveling up the ore-bearing soil, drying it, and feeding it into a blast furnace or forge. Depending on local stream activity, the ore



3-10. *Layout of iron mines, lignite beds, and clay beds at Forest Dale in 1854* (Description *1854*).

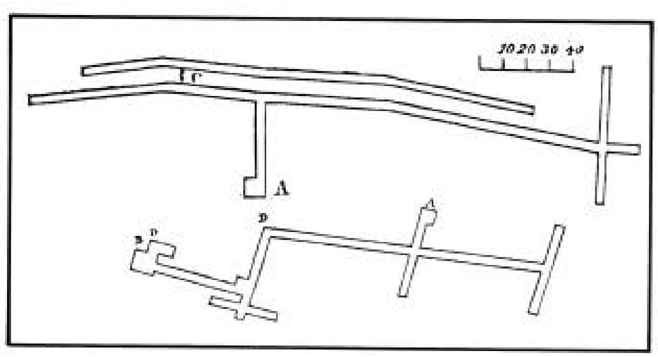
In his 1861 report on the geology of Vermont, State Geologist Albert Hager noted that much time speculating and prospecting for rich ore veins in Vermont resulted in trying to smelt tons of non-iron-bearing rock that deceived all but the educated eye. Secretly shared "Old Indian" myths hinted at locations of valuable iron mines, but the marked rocks or trees had long since been removed, so precise locations could no longer be determined. Many holes and piles of rocks up and down the state mark spots of fruitless blasting and digging in search of elusive mother lodes of rich iron ore. Hager reported that much money was expended in vain searches for a bed of ore in Ludlow and Plymouth, where horizontal exploratory tunnels called drifts were driven into terraces that showed promise. A similar prospect at Bethel proved unsuccessful in the search for iron ore and fatal to one of the miners by the premature detonation of the blasting powder.

As demand for ore increased with the construction of ironworks, activity at the mines expanded to large-scale digging operations by dozens of miners. Blasting with black powder was common, and fatal mine cave-ins such as one near Bristol were not uncommon (Hitchcock et al. 1861:816-818). As mines deepened, water seepage became a problem. This was initially relieved by waterwheel-driven pumps. With the development of steam power, machines ran the pumps, ore crushers, and washers, allowing miners to dig deeper into the Green Mountains.

As with the bog ore, initial mining techniques in Vermont consisted of nothing more than pick-and-shovel work, budging the ore out of shallow holes. The ore was separated from the excess waste rock by crushing it with sledgehammers. It was then loaded either into oversize saddlebags or horsecarts for the trip to the furnace or forge. Ore-laden boats soon were plying Lake Champlain in many directions.

In time, however, efficiency demanded that the ore delivered to the ironworks contain less waste material, leading to the invention of various ore-processing machines. One such machine was an ore crusher, or stamper, in which the iron ore was passed through in a chute while being subjected to pounding by rows of vertical hammers. At the ore washer, water played on the ore, washing away dirt and floating debris. Ores were leached back into exhausted swamps, and after twenty to fifty years bog ore could again be "mined."

Expectations that much richer beds of iron ore existed upstream in the hills surrounding the bogs or near the source of springs usually brought disappointing results (Hitchcock et al. 1861:816). Sulfurets and carbonates of iron, the usual sources of the bog ore oxides, were of no value for smelting and even injurious when used with other iron ores. Rusty iron scum (gossan), frequently seen in pools of stagnant water or as tarnish on the face of rock outcrops or road cuts, was—and still is—a mistaken indication of the existence of good iron ore in the vicinity. Bog ore deposits were worked not only in towns that bordered Lake Champlain but also on the eastern slopes of the Green Mountains.



3-11. *Plans of the two galleries that make up the Mitchell ore bed in Chittenden, which provided iron ore to the blast furnace at Pittsford, two miles to the south. Shaft A of the upper mine is 54 feet deep; shaft A of the lower mine is 62 feet deep. The long galleries run north-south (right-left), although the physical relationship between the two mines might not be exactly as illustrated* (Adams 1846:84).

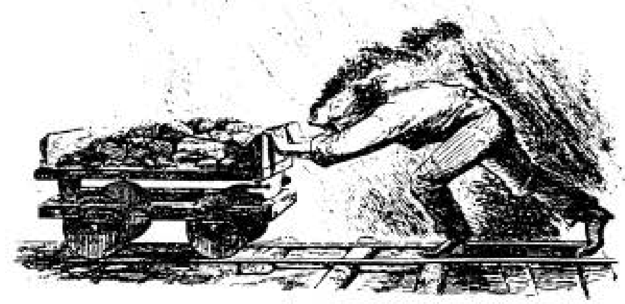
3-12. *A mid-19th-century iron miner with his pick, water jug, and barrow. Light was provided by a candle set into a holder in the brim of his hat (Orr 1860:591).*

also subjected to tumbling in a revolving wooden drum. Through small holes in the drum walls, proper-size pieces of ore fell into a waiting cart to be drawn to the furnace when filled. Pieces of ore that were too large to fit through the holes passed through the drum and out the other end, to be returned to the stamping machine. The machines were all water-driven.

The Crown Point Iron Company at Ironville, New York, separated ore from waste by use of magnets. The device that did the separation was the brainchild of Allen Penfield of Pittsford. Penfield's magnetic separator was a rotating barrel with magnetic steel points, which attracted the pieces of iron-bearing ore. Non-iron material continued through the rotating barrel and out the other end. Castings that went into the construction of the separating machine were made in Vermont by the Gibbs and Cooley foundry at Pittsford. But the problem was to keep the magnetic points strong enough to attract iron for a reasonable length of time. Professor Joseph Henry of Albany, New York, came to the rescue, connecting a galvanic cell (battery) to wire coils and wrapping the coils around the steel points in the drum, creating an electromagnet. It is generally recognized as the first practical industrial application of electricity (Allen 1967:7-9). The "henry" is today the official unit of measure for magnetic force.

It was this magnet that attracted the attention of another Vermonter, a blacksmith from Brandon named Thomas Davenport. On visiting Ironville in 1833 to buy scrap iron and seeing the separator in action, he immediately visualized the magnet's potential as a new source of motive power. Davenport and his brother-in-law, Orange Smalley, went on to experiment and eventually develop an "electromagnet engine," an early forerunner of the modern electric motor. Four years later, he and Smalley received the world's first patent on an electric motor from the U.S. Patent Office. Some disagreement exists regarding who contributed what toward the invention of "Davenport's motor." Smalley appears to have provided electrical and magnetic expertise, having dabbled with batteries; Davenport was the more mechanically minded. But the creative mind that invented the motor was not matched by practical minds that could find an application for it. Davenport's efforts kept him and his family in a continual state of destitution and he died a broken man (*Brandon* 1961:188-193).

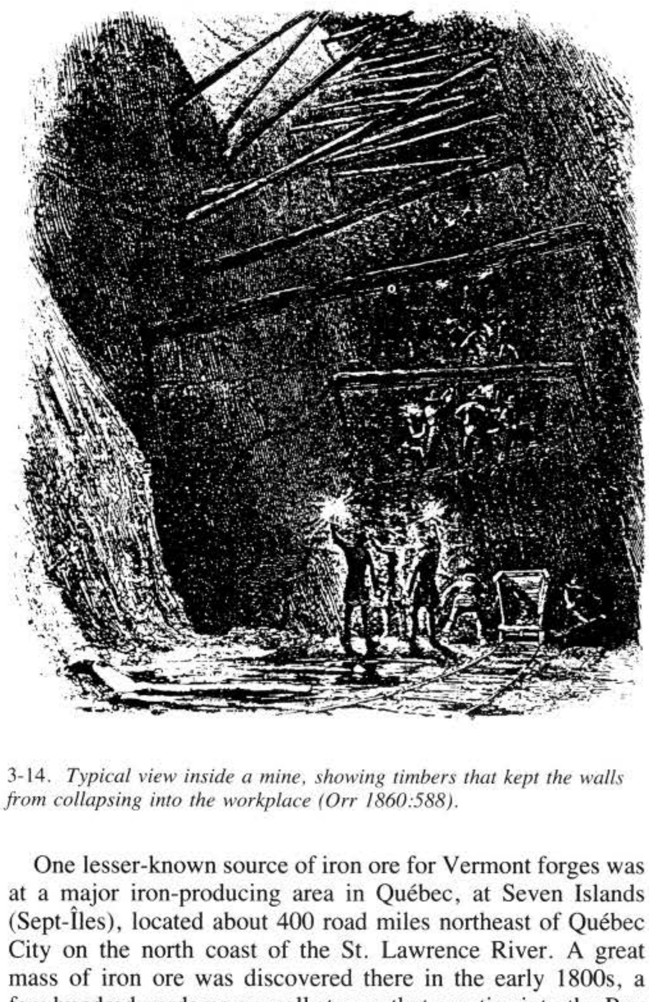
Engineering texts generally credit the English physicist and chemist Michael Faraday (a blacksmith's son) and French physicist André Ampère with experiments in the 1820s–1830s that led to the development of the modern electric motor and generator. A monument erected in 1910 by the Allied Electrical Associations in America alongside Route 73, just south of Forest Dale, marks the site of Smalley's blacksmith shop (now a house) where Davenport did most of his work on the motor (no mention is made of Smalley). The shop originally stood near the blast furnace, across from Royal Blake's house (Mary Kennedy letter to author, April 13, 1986). Davenport's shop is now part of the general store at the intersection of Routes 53 and 73 (Mary Kennedy verbal to author, May 27, 1989).



3-13. *Although mules were used in the larger galleries, the miner pushed his own heavy-laden cart in the smaller recesses of the mine (Orr 1860:591).*

A model of Davenport's motor is in the Smithsonian Institution, together with the electromagnetic separator built by Professor Henry for Allen Penfield. In 1959 descendants of Penfield and his partners placed a tablet outside the Penfield homestead at Ironville. They formed the Penfield Foundation three years later to maintain the homestead as a museum, as it continues today. In the museum rear is a reconstruction of Henry's electromagnet, built in 1933 by General Electric Company engineers from Schenectady.

By the 1860s iron mining in Vermont centered around a few good ore beds, as the demand for better iron closed down those beds whose ore quality was poor or marginal at best. Good ore beds lay in Chittenden, Manchester, Dorset, Brandon, Bennington, and Pittsford (Hitchcock et al. 1861:819-827). Iron ore was also being boated across the lake from the Crown Point area and mixed with local Vermont ore to impart improved characteristics in the cast and wrought iron made in western Green Mountain furnaces and forges. On the eastern side, ore from iron mines at Lancaster and Franconia, New Hampshire, was reduced by ironworks at St. Johnsbury. Bog ore from West Claremont, New Hampshire, was mixed with commercial bar iron at Windsor to produce a fine custom-quality iron.



3-14. *Typical view inside a mine, showing timbers that kept the walls from collapsing into the workplace (Orr 1860:588).*

One lesser-known source of iron ore for Vermont forges was at a major iron-producing area in Québec, at Seven Islands (Sept-Îles), located about 400 road miles northeast of Québec City on the north coast of the St. Lawrence River. A great mass of iron ore was discovered there in the early 1800s, a few hundred yards up a small stream that empties into the Bay of Seven Islands, imbedded in the labradorite rock of the land. Although magnetic, the ore contained a large amount of titanium, and when pulverized it yielded about 57 percent iron. This was not great by contemporary standards, but significant due to the quantity of iron ore available in the area, including a deposit of iron sand (black sand) that stretched along the coast from the Bay of Seven Islands to Moisie, a distance of 15 miles. Great ironworks were built at Moisie to work the ore.

Experiments made at the East Middlebury forge in 1867 on several tons of iron sands from Seven Islands succeeded in obtaining about 37 percent of their weight in good iron. This was done by following the practice of the forges at Moisie, which was to reduce the force of the blast, a fact apparently lost on ironworkers in northern New York, who usually rejected the fine sandy ore separated during the ore-washing process as being unsuited for the bloomery (Hunt 1870:260-262, 279-280).

A number of Vermont mining companies sprang into existence during the early to mid-19th century, speculating on a chance to strike it rich in iron or whatever mineral they chanced upon. Most were informal organizations with no officers or capital assets; just a few partners who either did their own digging or hired cheap labor to pick-and-shovel holes here and there. Others were formal organizations complete with officers, contracts, and substantial landholdings. They were chartered by the state legislature to sell stock and carry out the business of mining. A few were successful and evolved into smelting companies, such as the Pittsford Iron Company, and left significant records in history books and ruins of great furnace structures to study. Most of these mining companies, however, slipped into oblivion. Only an entry in the legislative record notes their existence; see table 3-1.

Table 3-1. Chartered Iron and/or Mining Companies

Year of Charter	Company Name
1810	Orange Mineral Company (Thetford)
1812	Vermont Iron and Coperas Factory Company (at Thetford, Norwich, and Hartford)
1825	Rutland Iron Manufacturing Company
1833	Bristol Iron Manufacturing Company
1836	Windsor and Plymouth Ascutney Iron Company
1845	Jefferson Mining Company (Newbury)
1845	Washington Iron Company (Brandon)
1845	Otter Creek Iron Company (Vergennes)
1849	American Mining Company (Windsor)
1862	Missisquoi Lime Company in Vermont
1864	Concord Mining Company
1868	North Troy Mining Company
1870	Burlington Prospecting and Mining Company
1872	Berkshire Mining Company (Richford)

The names of some companies might be deceiving, such as the Missisquoi Lime Company in Vermont, which was chartered to mine and smelt iron ore in addition to quarrying and burning lime. The firms covered themselves for any mining eventuality. The Orange Mineral Company at Thetford, for example, ensured that its charter provided "for the purpose of exploring and digging gold, silver, lead, iron, and all manner of mineral ores, which may be found on their lands. . . . And shall also have the privilege of making and manufacturing white lead, read lead, sugar of led [*sic*], lethridge of lead, white and blue vitrol, and allum and also for smelting of iron ore; and any other things that can be wrought from the ores and metals, which may be, or have been discovered on their lands . . . in the town of Thetford" (*Acts and Laws* 1810:13-14). One railroad company in southern Vermont drew its articles of incorporation on the broadest terms possible when it named itself the Bennington & Glastenbury Railroad, Mining and Manufacturing Company (Shaw 1952:20).

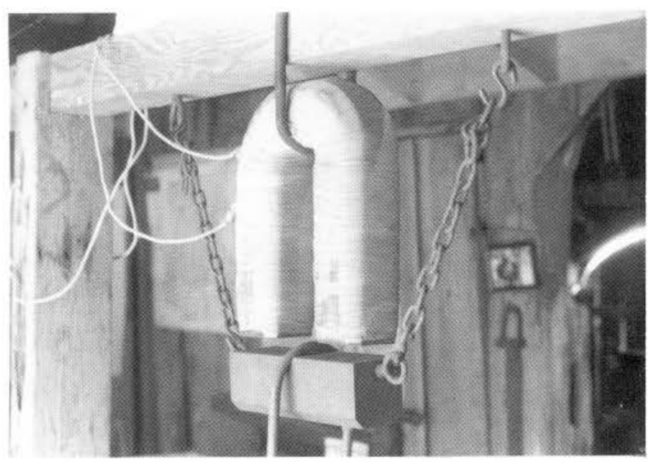
3-15. *The miners followed the vein of ore, whether it led them horizontally or vertically through the earth (Orr 1860:592).*

Mining companies speculated on a grand scale during the latter half of the century. The White River Iron Company (WN-IW01), for example, resulted from prospecting discoveries made in the 1870s by Julius J. Saltery of Boston, who claimed to have found gold in association with magnetic iron ore at many places in the White River. Saltery claimed that in some places gold and iron sand were mixed so abundantly that if both could be utilized, then "a permanent success would be gained, more so as the gold would not only pay expenses but a profit." Separation was to be by gravitation action of water, the heavy gold and iron settling out. The gold and iron were to be separated by the "California sluice process." But the company failed two years later (*Herald and News* Aug. 9, 1917:10).

Not giving up easily, Saltery organized the Pittsfield Iron Ore Company, which eventually became the Pittsfield Iron and Steel Company (RU-IW14), after buying up much of the old White River Iron Company property. Mines were opened on the Tweed River West Branch and machines were put into place for crushing and concentrating the ores. But in 1882 this company also failed (Davis and Hance 1976:92).

Another company, the Lamoille and Elmore Iron Factory and Mining Company, was chartered by the state legislature in 1827 for "the manufacturing of iron, steel, etc., in its various branches, for and during the term of 25 years" (*Acts and Laws* 1827:89). The company operated two beds near Lake Elmore, one to the east of the south end of the lake about 100 feet beyond Route 12, the other about two miles southwest along an abandoned road (Willard Sanders letter to Richard S. Allen, October 31, 1955). The pit and signs of drilling were visible at the second mine as recently as the 1950s. It is immediately east of the old road, between the road and a brook that originates from Little Elmore Pond.

About a quarter-mile from Handle Road, up the eastern slope of Mount Snow in Dover, are the dramatic tunnel-like entrances in solid rock of two iron mines that were worked sporadically in the early 1800s. According to one reference, the mines were worked as early as the Battle of Bennington (Skelan 1961:147). More likely, the Trainor Mining Company first worked ore here around 1820, digging the ore out of the solid rock to support a forge about a mile to the southeast. But the high cost of transporting the reduced iron over the mountains to Bennington (and Troy, New York) soon closed both forge and mines. The mines were reopened in 1832 by two New York speculators, Wilder and Richards. More effort and more money were sunk into the holes to no further avail and the mines were soon abandoned again (Kull 1961:3-4).



3-16. *Replica of Professor Joseph Henry's electromagnet in the Penfield Homestead Museum at Crown Point, New York. It was a magnet similar to this that inspired blacksmith Thomas Davenport of Brandon to experiment and develop a rudimentary electric motor.*

The mines were found in 1984 among the trees between downhill trails of the Carinthia Ski Area. The mine entrances are deep within rock cavities amid breakdown and tailings, and tunnels (not explored by the author) extend hundreds of feet into the side of the mountain, one of them ending in a shaft that rises about sixty vertical feet to the surface. The former

3-17. *Two abandoned iron mines along the west branch of the Tweed River near the Pittsfield-Chittenden town line.*

owner of the ski area, Walter Strugger, preserved the mines as he found them, with the hopeful intent of somehow including them at some future date as part of his recreation area. Children who used to hike up the old Somerset Road in the early 1900s on the last day of school from nearby District School Number 8 for a picnic at the minehead would have appreciated that. It will be interesting to see what the new owners of the ski area will do with the mines.

A large mine opened between North Bennington and the state line in 1845. When Henry Burden and Sons of Troy, New York, operated it in the 1860s, it was known as the North Bennington Iron Works. It supplied ore to Burden's blast furnace at South Shaftsbury for about ten years (Lewis 1876-1877:228-229).

Some ore was also shipped to Burden's works at Troy until the mine was abandoned in the 1880s in favor of the superior magnetite ores from Mineville, New York (Jacobs 1944:39-41). The mine was a large open-pit operation and the huge hole is still visible today. Prospecting was done here as recently as World War II by the U.S. Bureau of Mines in anticipation of reopening some mines in New York and New England for the war effort. State Geologist Elbridge Jacobs wrote in his 1943–1944 report that Vermont iron ore appeared to have been thinly bedded deposits of bog ore and hematite, often associated with manganese. The latter usually prevented the economic smelting of the ore. He also wrote that the blast furnaces seemed to have exhausted the iron deposits near them, probably because of the thinness of the beds, but that the old Burden mine at Bennington was the most promising deposit. Since the Bureau of Mines left in 1945, only the rabbits have been interested.

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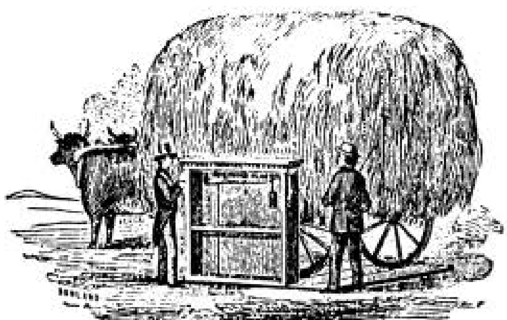

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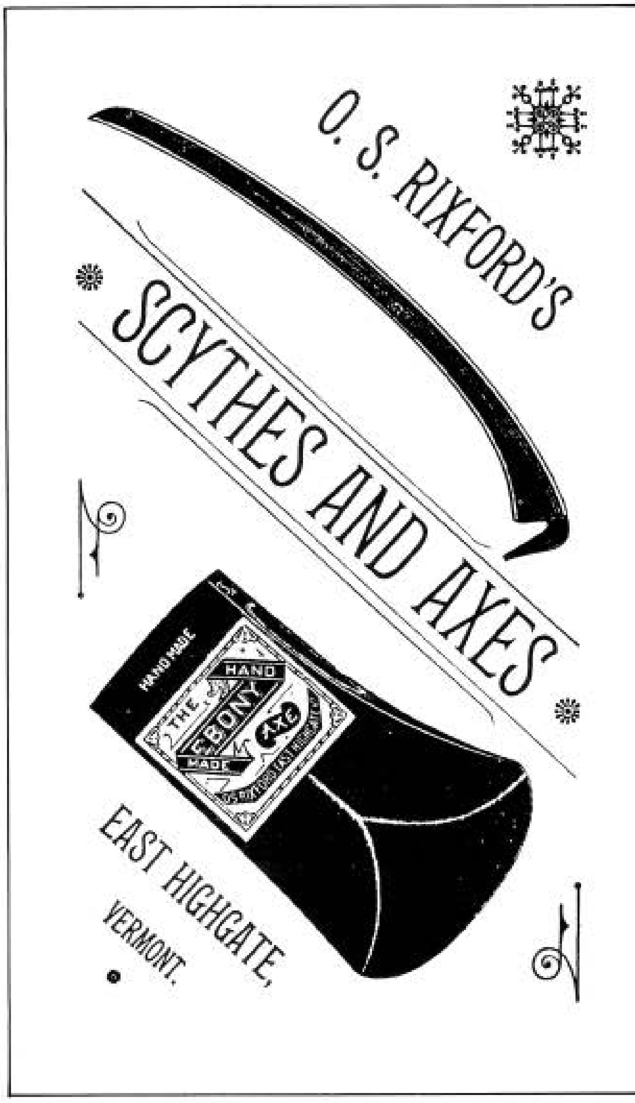

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