HISTORICAL NOTES OF THE IRON AND ZINC MINING INDUSTRY

In Sussex County, New Jersey

BY

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PREFACE

The contents of this review is a brief outline of interesting data that have come to the attention of the writer during many years' service with the mining companies operating at Mine Hill and Sterling Hill.

The information has been compiled from various sources—conversation and interviews with old inhabitants and employees; searches of title records; reports of legal decisions, have contributed a share.

The writer, while making no claim to literary talent, has endeavored to record the information acquired in such form that the reader may obtain a general knowledge of the more important and interesting facts that are interwoven in the the history of this famous mining district of Sussex County, New Jersey.

The writer trusts that this monograph may to some extent be of interest to many, and will serve as a record when the activities of this great mining district shall have been terminated.

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HISTORICAL NOTES OF THE ZINC AND IRON MINING INDUSTRY IN THE STERLING HILL AND MINE HILL DISTRICT IN SUSSEX COUNTY, NEW JERSEY

CHAPTER I.

Settlement, Land Titles and Early Iron Mining, 1664-1800

When thinking of mines or the location of mineral deposits memory recalls that mines are usually located in remote districts, far removed from populated areas of our country. It is noteworthy that in one instance Nature has placed one of the most interesting and unique mineral districts in the world within fifty miles of the metropolis of the Western Hemisphere.

This particular field is in Sussex County, New Jersey. The localities of chief importance have been named Mine Hill and Sterling Hill. The word Sterling, as now used, has been adopted from the word Stirling. The Earl of Stirling, at an early time, had interests in the Sterling mine.

Sussex County is the most northerly county of the state. It is located within the great Appalachian Highlands, which extend from the Catskill Mountains, southwesterly to Alabama. The greater part of the county occupies a part of the Kittatinny Mountains and the Kittatinny Valley.

The county is drained by several watersheds. The southwesterly area is drained by the tributaries of the Delaware River. The streams of the northeasterly section flow northeasterly and are tributaries of the Hudson River. The Height of Land dividing the two watersheds is near the village of Lafayette.

The particular geographical area which relates to the mineral field now under consideration is located in the easterly section of the county, near the headwaters of the Wallkill River.

Iron and zinc being important resources of New Jersey, a brief review of the origin and history of titles to the land and minerals of our commonwealth will be of interest.

The area between the Hudson and Delaware Rivers was the westerly portion of lands granted by King Charles, the second, of England, to his brother James, Duke of York, in 1664. This territory included the present State of New Jersey. It was named Nova Caesarea. The Duke of York conveyed this land to Sir George Carteret and John Berkeley, who divided their territory. This division was made in 1676, Carteret taking the "East Province of New Jersey" and Berkeley the "West Province of New Jersey." The line agreed upon was "from the east side of Little Egg Harbor straight north through the country to the utmost branch of the Delaware River."

Sir George Carteret died in 1680. All of his property in the East Province of New Jersey was offered at public sale to the highest bidder. William Penn and eleven associates purchased East Jersey for thirty-four hundred pounds (Sterling). Soon after, each associate sold a one-half interest of his respective rights and title, thus creating an association of twenty-four proprietors, who then owned and controlled the Province of East New Jersey.

Grants of land from the Proprietors are the basic titles to all the lands and minerals of East Jersey. All subdivisions of land in Sussex County are parcels of grants of larger areas that the Board of Proprietors "returned"—surveyed and granted by order of the proprietors—to a prospective purchaser. Many large tracts were acquired by members of the Board of Proprietors, who afterward held title to same as individuals. This land was sometimes purchased or might be acquired as a "dividend." Proprietors accepted titles to land as annual profits of the Association, which were regarded as dividends.

The present populated area of the Borough of Franklin is within a tract of 590 and 18/100ths acres that was returned to "the heirs and assigns of Edward Byllinge" on September 4, 1787. Edward Byllinge was one of the Board of Proprietors. This grant, or return, excluded six parcels of land previously granted, one being the 93 and 16/100ths acre Mine Hill farm that was returned to "the heirs and assigns of Anthony Sharp, in the County of Morris, in the Province of East Jersey, on June 6th, 1750." Evidently ore was discovered on Mine Hill prior to that date. The mines at Sterling Hill are within a tract of 320 acres returned to the heirs of Anthony Rutgers May 4, 1730. The beginning corner of this tract is located with reference to what is known at present as Mud Pond, described as follows:

"All that parcel of land in the Province of East Jersey, beginning at two ash trees marked on the four sides with three notches, standing on the west side of Wallkill creek, which ash tree bears south seven degrees east, forty-seven chains from a certain pond at the northeast end of a certain meadow; from thence, first, North 62 degrees West, 40 chains," etc.

In the records at Perth Amboy this tract is referred to as the "Copper tract." One of the old deeds also recites that the "Stirling" tract was given the name "Mocksaw" by the Indians.

Another tract of 1500 acres comprising the Wallkill Valley in the Borough of Ogdensburg and the valley and mountain lands to the southeast, was returned to the heirs of Peter Sonmans in 1730. Peter Sonmans was one of the twenty-four Proprietors of the Province of East Jersey. The high lands on either side of the valley were called "East Mountain" and "West Mountain" in the early deed descriptions.

While no authentic date can be fixed, the mineral outcrops of Mine Hill and Sterling Hill were known to exist at a very early period. The history of events as they relate to the mining industry of the Wallkill Valley may be divided into four periods of time.

The first period, from the early settlement of the country to the end of the eighteenth century, included a term of years in which some attention was given to the exploitation of the zinc veins at Mine Hill and Sterling Hill and the discovery and early development of iron deposits.

The second period extended from 1801 through the first half of the nineteenth century, when the mining, smelting and forging of iron became an important industry, not only in this district but in other sections of Sussex County. The "Iron Works" at Andover, New Jersey, were established at a very early date and were in full operation during the Revolution. During this epoch, from 1800 to 1850, the unique ores and minerals of Mine Hill and Sterling Hill were brought to the attention of the mining and scientific world. It was the era of exploration, investigation, and the development of experimental processes for the smelting and utilization of the zinc ore deposits. This work, to a great extent, was due to the personal efforts of Dr. Samuel Fowler and his associates.

The third period, from 1850 to 1897, saw the organization of many corporations, each having various ownerships of various titles. At the end of this period the value of the ores had been fairly well

determined and the zinc mining industry well established. The output of the mines gradually increased to meet the demands of commerce. During this period the legal complications among the conflicting interests of the various mining companies were contested in the courts. The complex nature of the ore and the phraseology of the deeds conveying the different ores and minerals, led to a series of law suits that intermitently covered a period of forty years.

The fourth period takes us from 1897 to 1927. Prior to 1897, the operating mines at Sterling Hill and Mine Hill were owned and operated by four different corporations each having a subdivision of the ore bodies. In 1897 all interests of Sterling Hill and Mine Hill were united under the name of The New Jersey Zinc Company. The ample financial resources; the advantage of consolidated mining operations; the successful mechanical separation of the ores and their treatment in smelting, placed The New Jersey Zinc Company in a commanding position, whereby the mines of this district could be developed in a scientific and economical manner.

The political division of Sussex County was authorized by an act of the legislature, June 18, 1753, which recited, "that the upper parts of Morris County, in New Jersey, should be made into a separate county to be called the County of Sussex." Sussex County as thus formed, included what is now a part of Warren County.

The whole of the highlands of northwestern New Jersey produced iron ore from very early times. One of the chief industries of Sussex County during the middle period of the eighteenth century was charcoal burning, mining and smelting of iron ore. The importance of the iron industry was spoken of in the state papers of Governor Jonathan Belcher (1747-57). During the last decades of the eighteenth century, charcoal furnaces and iron forges were distributed along the headwaters of the Wallkill, which is, at the present time, the seat of the great zinc mining industry of Mine Hill and Sterling Hill, in the Borough of Franklin and the Borough of Ogdensburg..

One of the first settlers of Franklin of which we have a record was one, Michael Rorick, who, in 1765, purchased a large tract of land, then a wilderness, located on the west bank of the Wallkill. He built a home upon a clearing that had been made by the Indians, which was near an old Indian trail. This tract is located on the westerly side of the road leading from the site of the old iron furnace at Franklin to the Sterling Mine. This property was the home of the late Samuel R. Losey.

One of the early forges at this period was located where the present highway, leading from the railroad station at Ogdensburg to the Bigelow quarry, crosses the Wallkill river. This plant was owned and operated by Major Elias Ogden and continued in service until his death in 1805.

The ore supplying this forge was mined from the Ogden mine, located upon the mountain about two miles southeast of the Ogden forge and the present Borough of Ogdensburg. The Ogden mine took its name from Abram Ogden, who first opened the mine in 1772. This mine, together with a group of mines on the same ore belt, has an interesting history.

The Ogden mines group not only furnished ore for the forges of the Wallkill Valley in early times, but also supplied ore for the "iron works at Charllott's borough,"—now Charlottsburg. Charlott's Borough at that period was a thriving community. The veins of the Ogden mine as now developed are from eight to thirty feet in width, and in some mines have been proven to a depth of more than three hundred feet. The Ogden mines resumed operations from 1854 to 1868 after a long period of inactivity. Mining was again resumed in 1880, of which we shall speak in a following chapter.

The Ogden forge was perhaps one of the first to operate in the Wallkill Valley. However, at this period many other iron industries were active. Another forge was located along the Wallkill about one and one-half miles below the Ogden forge. This was located where at present the Wallkill River empties into the Franklin Lake. A portion of the old dam across the Wallkill at this locality remains in place. Farther down the stream we find the site of another forge. It is in a field north of the "Martin Mabie" farm. This field is known as the "Forge lot." The forge was on the easterly bank of the Wallkill at the southerly side of the public road crossing the Wallkill at this place.

The most important early iron industry in the Wallkill Valley was located at "Sharpe's borough." The exact location of these "iron works" is not known by the writer, but from the most reliable data to be obtained, this plant was located at or near the present mill of the Union Waxed and Parchment Paper Company at Hamburg. The following two advertisements printed in 1774, relating to this property are given verbatim:

From the *New York Gazette and Weekly Mercury*, No. 1203, October 31, 1774—

"To Be Leased for a Term of Years and entered on this fall, on a very reasonable rent, The Iron Works known by the name of Sharps borough Iron Works, situated in the County of Sussex, and Province of East New Jersey, on a stream called the Wallkill. The works consist of a furnace, with casting and bridge house, coal houses, and other houses necessary, one forge near said furnace, and a sawmill. The forge has three fires and two hammers; one other forge about a mile from the furnace, consisting of two fires and one hammer, with a good stone coal house, a dwelling house, and other houses necessary: Also the half part of a valuable grist mill, with one pair of stones, overshot, on a never failing stream of water, and lately repaired. Also between four and five thousand acres of land on which (are) five good improved farms, with one hundred acres of good meadow, in good fence, which produces hay sufficient to keep all teams necessary for the use of the works and farms. There is on said tract within two miles of the furnace three hundred acres of good ash swamp. There is on the premises a sufficient quantity of timber within three miles to supply the works in coal for a number of years longer than the above lease; Also an inexhaustable fund of excellent iron ore within a mile of the furnace. The whole is situated in a plentiful country for provisions. Any person inclining to rent the above may know the terms by applying to Joseph Sharp, living in Salem County, West Jersey, or to the subscriber living on the premises. Abia Brown.

N. B. The above works have been erected six years."

Also the following:

From *Dunlap's Pennsylvania Packet* or *General Advertiser*, No. 159, November 7, 1774.

To Be Sold

"By virtue of several writs of Fieri Facias, against the goods and chattels, lands and tenements of Joseph Sharp, to me directed, will be exposed to sale at public vendue, at Sharp's borough Iron Works, in the township of Hardyston, and County of Sussex, New Jersey, on Tuesday the third day of January next, to be continued from day to day until the whole are sold,—Slaves, horses, oxen, cows, young cattle, sheep and swine, pig and bar iron, waggons, carts, plows and

harrows, blacksmith's tools and a variety of implements necessary in carrying on the iron making business in both furnace and forge. The vendue will be opened by nine o'clock each day. On the same day between the hours of twelve and five o'clock in the afternoon at the same place, will be sold, the said Works, with the lands thereto appertaining, containing between seven hundred and eight hundred acres of very valuable land. The works consist of one forge situated on a branch of the Wallkill (a never failing stream) within fifty yards of each other. The forge contains four fires and two hammers, near the works is a good frame dwelling house, large coal house, blacksmith's shop, large barn and stables and sundry other outhouses; the land abounds in great plenty with the best of iron ore very convenient to the works.

Also at the same time and place, will be sold the undivided half part of several very valuable tracts of land, some of them contiguous to the above, others about seven or eight miles distant on Pepo-Cotton River, one of the said individual tracts about a mile from the above works and on the same stream is a large stone forge, completely finished, containing four fires and two hammers; near the forge is a neat stone dwelling house, store house, blacksmith's shop and several outhouses. The terms will be made known at the time and place of sale by THOMAS POTTS, *Sheriff*.

The above advertisements give a very clear impression of the industrial conditions of the Wallkill Valley at this period of pioneering. Abstracts of deeds and documents on file at the office of the Proprietors of East Jersey at Perth Amboy show that Joseph Sharp was a large land owner in Sussex County. Mine Hill is within the 93 and 16/100ths acre Mine Hill farm that was returned (conveyed) to the heirs of Anthony Sharp on June 6, 1750.

Joseph Sharp, undoubtedly, was a man of vision and energy. He once owned Mine Hill with all its prospective value. He was destined, however, to meet financial failure in his efforts to develop the mineral wealth he possessed.

Since there are no extensive iron mines (except the Mine Hill deposit) within "one mile of Sharpsborough," it is believed that "the inexhaustible fund of iron ore" referred to is what is now known as Mine Hill, at that time regarded as an iron ore deposit.

Little did they dream that the outcrop of the predominating

black Franklinite, as then exposed, would in later years, at greater depth, develop into one of the greatest zinc ore deposits known to the mining world.

It is not probable that the zinc and Franklinite vein at Mine Hill produced ore that was at that time used at the iron works, because we learn that Dr. Samuel Fowler forty or fifty years later failed to produce pig iron from the Franklinite at Mine Hill. The small magnetite vein which lies parallel with, and extends southwest of, the zinc vein at Mine Hill may have been mined to produce ore for the local forges and iron works. Other small deposits of magnetite located near Rudetown and McAfee may have produced workable iron ore, although this is not an established fact.

One may conclude that the scarcity of iron ore might have been the cause of the financial difficulties of Joseph Sharp.

CHAPTER II.

Ownership, Exploration and Development of Sterling Hill and Mine Hill—1800 - 1850

During all the ages of civilized man, the searching for and the possession of mineral wealth has been one of the great aims of the human family. Gold was prominent amid the splendors of King Solomon; ancient Rome took from her conquered foes tributes of gold, to accentuate her display of wealth in that luxurious age. Today we read of the marvelous golden emblems and furniture recently removed from the tomb of King Tut-ankh-Amen, having been hidden in the rocky recesses of ancient Egypt for thirty-five centuries.

Romance, tradition, speculation have ever been associated with famous mines. The zinc mines at Mine Hill and Sterling Hill are no exceptions. An imaginative and creative mind could produce a romantic story from their history. One of the interesting traditions among the older people of Franklin, is to the effect that Dr. Samuel Fowler at one time offered to a laborer as compensation for a year's work, his Mine Hill farm. This is not a fact. The records of purchases contradict it.

On October 31, 1810, Dr. Samuel Fowler and John Odell Ford purchased from Edward Sharp nine tracts of land comprising some four thousand acres. One of the tracts was the 93 and 16-100ths acre "Mine Hill" farm, upon which was the outcropping of the zinc vein and the northeasterly extension of the magnetite vein—magnetic iron ore—which lies parallel with and southwest of the zinc vein. Fowler and Ford as tenants in common, paid eleven thousand dollars for the above mentioned nine tracts of land.

During the years of 1816-1817, Dr. Fowler purchased all of John O. Ford's interests which they held in common. By a deed from Ford to Fowler on September 28, 1817, Dr. Fowler paid John O. Ford nine thousand dollars for his one-half interest in a tract of 256 and 26/100ths acres, within which was the 93 and 16/100ths acre Mine Hill farm.

The greater part of the Mine Hill ore body lies within the 93

and 16/100ths acre Mine Hill farm. The westerly outcrop of the vein extends in a northeast-southwest direction for a distance of twenty-five hundred feet. The vein varies in width at the outcrop from five to thirty feet and dips to the southeast at an angle of about fifty degrees, attaining a maximum depth of eleven hundred feet. The vein extends underground in a northeasterly direction beyond the northeasterly exposure of the outcrop.

During the early mining operations, ore was taken from the surface workings at various points along the westerly outcrop. The mine development of a later period revealed the fact that the southwesterly margin of the ore body had been thrust upward causing a bending or folding of the vein, giving it the shape of a trough. The outcrop of the easterly vein was then discovered and exposed to view. This easterly outcrop extends northeast from the extreme southwest end of the ore body for a distance of about 600 feet, from which point the east vein pitches under the capping rock. The height of this east vein from the trough of the fold gradually becomes less and disappears entirely before reaching the northeast extremity of the ore body. The extension of the vein then has a uniform dip and strike.

The east vein was first discovered in a buckwheat field, and for many years following, these workings were called the "Buckwheat Mine." Later the mine was called the Taylor Mine.

The country rock enclosing the zinc veins at Mine Hill is white limestone, crystalline in structure. Much has been written about the geology and mineralogy of Mine Hill and Sterling Hill. The interested reader will find a complete description of this district in the "Franklin Furnace Folio No. 2," published in 1908 by the United States Geological Survey.

Franklin was the scene of Dr. Samuel Fowler's activities in his efforts to utilize the unique and complex ores of Mine Hill. Dr. Fowler had the keenest appreciation of the value of this great body of ore, but he was a pioneer in a new field, because the minerals and ores were new and unknown to the mining world. He had no precedent to follow. The metallurgists of Europe had no knowledge of a zinc ore of this character, since Sterling Hill and Mine Hill were then, as now, the only mines in the world producing ore of this character.

The complex chemical combination and the mechanical admix-

ture of the different minerals constituting the ore mass, was such as to make their treatment and smelting a difficult metallurgical operation. To comprehend the difficulties encountered, one must know something of the minerals that constitute the ores of Mine Hill and Sterling Hill. The principal commercial minerals are Franklinite, willemite, and zincite.

Franklinite is a mineral, black in color, containing in chemical combination iron, manganese, and zinc, with oxygen.

Willemite has many different colors, the various shades of green and brown predominating. It is a silicate of zinc.

Zincite—Red Oxide of Zinc—is dark red in color and is an oxide of zinc.

The ore, as mined, contains the above minerals, small particles of each mineral being mechanically mixed and interlocked with each other in every conceivable combination, having the structural character of a solid rock.

This combination of zinc, iron, manganese, and other chemical elements, each having a different character and requiring a different degree of heat for its reduction into metal, when placed into a furnace and smelted, would produce a salamander of zinc, iron, and manganese that would be of no practical utility or commercial value. These were the conditions that confronted Dr. Fowler. We are led to believe that the early efforts of Dr. Fowler was to utilize the ore for the production of iron; Franklinite strongly predominated in the ore at the outcrop of the West Vein; Willemite and zincite, in the early experiments, were considered of secondary importance. It has been recorded that an effort was made to separate the Franklinite by the use of electric magnets. We have no knowledge of the method or form of this separator or of the success of its application.

At this time, charcoal was the only fuel used for the smelting of iron ore. The use of anthracite coal for developing higher temperatures was not in general use. This may have been a factor that prevented the successful treatment of the Franklinite.

As time passed, many of the early difficulties were overcome. About the year 1830, Dr. Fowler produced a "bluish-white powder" that he used as a substitute for white lead with which he painted his house. This perhaps, is the first time that oxide of zinc from the ores of an American mine was used for house painting.

Although the ores and minerals of Sterling Hill had been known, explored, and investigated at an early date, the early experimental

work and mining operations were confined to Mine Hill. Many scientific men were connected with Dr. Fowler in his efforts to convert the ores into commercial products. Mr. George Balleau devoted much time and labor to obtain metallic zinc from the Mine Hill ores by processes different from those used by the metallurgists of Europe. His efforts failed to produce metallic zinc in quantity of a commercial grade.

While Dr. Fowler was serving as a member of the House of Representatives—1833-1837—a law was passed in Congress, authorizing the preparation of a set of standard weights and measures for the use of the United States government in the different custom houses. The Secretary of the Treasury assigned this task was Mr. F. R. Hasler, LL.D., who was then superintendent of the Coast Survey. The zinc metal, spelter, that was alloyed with the copper to make the brass for these standard weights, was produced from "New Jersey Red Oxyde of Zinc." This ore came from the "Weights and Measures" opening. The location of the "Weights and Measures" opening was on the crest of the west vein, about five hundred feet northeast of the southwesterly end of the ore deposit.

During thirty-five years of his active life, with untiring zeal and with full assurance of the great wealth that lay dormant at his feet, Dr. Fowler put forth every effort to place the resources of these mines upon a commercial basis. He did not live to see the successful consummation of his efforts. Because of failing health and exhaustion of his limited funds, he disposed of his mining interests at Mine Hill and Sterling Hill a few years prior to his death.

On Sept. 1, 1836, for a consideration of $31,247.75, Dr. Samuel Fowler and Rebecca, his wife, conveyed by deed to Nathaniel Witherill and William L. Ames six tracts of land in fee simple, comprising some 3300 acres. This deed also conveyed all the mineral interests that Dr. Fowler at that time possessed in Sussex County, by the following description,—"Also, all the iron, zinc and other ores, on or within any land of said Samuel Fowler, in the said county of Sussex or on or within any land and premises heretofore sold or conveyed by said party of the first part in Sussex County, from and out of which he has reserved the mines and minerals, with full right of entering said land etc " This deed is the basic title to all the numerous and varied mineral interests of this mining district which have been continuously transferred for the past ninety years.

As time advanced, the different minerals, in the various tracts of

land, were in many instances separately conveyed or leased. One or more of the mineral titles resting in one or more parcels of land was combined in a conveyance of deed or lease. This combination of interests was in turn consolidated with other ownerships of corresponding varied interest, which title would pass to some new mining corporation. In one instance a deed conveyed interests in more than sixty parcels of land.

When one contemplates the large land holdings of Dr. Fowler in 1836, and the fact that any single parcel of land may have from one to four subdivisions of title—zinc, Franklinite, iron, and surface—it is to be believed that a more complicated ownership does not exist in any mining district in the world.

From the most reliable information, it is evident that the Sterling Hill ore body was discovered prior to that of Mine Hill. Records state that about the year 1640 a colony of miners settled in the Minisink valley, near Port Jervis, and worked a mine for copper that was situated in "Pahaquarry," now Pahaquarry Township. This is, no doubt, the first actual mining operation in the United States. That these mines were of value at this early time is based on the fact that a wagon road was built from these mines to "Esopus," now Kingston, New York. This road was built for the purpose of hauling ore to water transportation. It has been stated that these miners may have discovered or had knowledge of the Sterling Hill outcrop, since it was about twenty miles distant from the copper mine.

The three hundred and twenty acre "Sterling tract" as recorded in the early part of the 18th century, was named the "Copper tract." This is also evidence of its early discovery. Sterling Hill takes its name from Lord Stirling, who at one time owned this property. In the deeds to Lord Stirling "old mine holes" are mentioned, indicating that these mine pits were opened prior to his purchase.

Major A. C. Farrington, a prominent mining engineer, who prepared a report on the mines at Sterling Hill and Mine Hill in 1852, collected much data to fix the date of discovery of the Sterling mine. He says in part, "In order to gain some light on the antiquity of these ancient pits, I caused a stump of a cedar tree, which grew in a pit, to be sawed off horizontally and planed, so that the annual rings could be counted. The rings were found to be ninety-three in number, indicating the number of years that the tree had been growing. The sapwood was partially decayed, and it was said that

this tree had been cut down twenty years. This would carry the age of the tree back one hundred thirteen years." From this data we can determine that these pits were opened as early as 1739.

Because of Lord Stirling's connection with the history of Sterling mine, a brief review of the life of this illustrious American patriot will be of interest.

Lord Stirling, or William Alexander, was the son of James Alexander. He was born in New York in 1726. In 1756, after the death of his father, he went to England and secured recognition as the heir of his father, whereby he acquired the title of Earl of Stirling. In 1761 he returned to Basking Ridge, New Jersey, and took possession of his father's estate. The same year he became a member of the Provincial Council of New Jersey.

During the Revolution he was appointed a Colonel. He had command of the American forces about New York prior to the battle of Long Island. He was with Washington on the retreat through New Jersey, and was promoted to Major General in 1777. He was in command at the battle of Saratoga in 1781. He died at Albany, New York, January 15, 1783.

In civil life he served as President of the Board of Proprietors of East Jersey. He also became Surveyor-General of the Board of Proprietors. The duties of this office was the authorization and direction of the location and survey of lands that were "returned" or granted in large tracts by and from the Board of Proprietors. These "returns" are the original titles to all the area of East Jersey as now subdivided.

The history of Sterling Hill during the last decades of the 18th century is closely interwoven into the life and activities of Lord Stirling and the Ogden family. The Sterling tract with a large area of land adjacent to it, at the beginning of the 19th century, was owned by Elias Ogden. In the records of the Surrogate of Sussex County, we find in Book A, page one, the report of a Board of Commissioners appointed by the court which divided the real estate of Elias Ogden. This report is dated March 31, 1805. It is the first recorded commissioners' report on file in Sussex County. The 320 acre Sterling tract was a part of this estate.

The Sterling tract was divided into eight lots, rectangular in shape, each containing about forty acres, and numbered consecutively. In all future transfers of the numerous mineral and surface titles, the identity of these lots has been carried through the deeds

by numbers and descriptions made by the commissioners.

The first member of the Ogden family that settled in the upper Wallkill valley was one Robert Ogden, who built a home about one mile south of the present village of Ogdensburg, in 1765. He was the son of Robert Ogden—1716-1787—of "Elizabethtown." This house has been spoken of as being "a great mansion and a home of unbounded hospitality, entertaining guests who were prominent in the affairs of the Commonwealth."

The sons of Robert Ogden, 2nd, were Robert, 3rd; 1746-1826; Matthias, 1754-(....); Aaron, 1756-1839; Elias, 1763-1805. These worthy sons were prominent in the affairs of state and active in serving their country in a conspicuous capacity during the Revolution.

Robert, 3rd, was surrogate of New Jersey; served in different capacities during the Revolution. He was appointed to the office of Quartermaster by General Washington.

Matthias saw service in two wars, having served under Washington, and in the war of 1812. He was wounded in the battle of Quebec.

Aaron was one of the most active and patriotic men of his time. He was with Lafayette in the Virginia campaign; was commended by General Washington for having stormed the last redoubt at the siege of Yorktown, and served with General Sullivan in the expedition against the Indians.

He served as Colonel of the 15th New Jersey Regiment. When peace came, he served three terms in the senate of the United States. In 1812 he was elected Governor of New Jersey. The event that is of especial interest to us is the fact that he was Aid-de-camp to Lord Stirling at the Battle of Brandywine, which would indicate that it was the personal relations of Aaron Ogden, and perhaps the close and intimate friendship of the Ogden family with Lord Stirling that explains the future ownership of Sterling Hill by Elias Ogden who was a brother of Aaron.

Dr. Samuel Fowler came into possession of Sterling Hill and adjacent lands a few years after his purchase of Mine Hill farm. He acquired these lands from the Ogden family after his marriage to Rebecca Ogden, daughter of Robert Ogden, 2nd.

It was through Dr. Fowler's interest and efforts that these new ores and minerals were brought to the attention of geologists and mineralogists of Europe and America. Among the first scientists to

examine and describe these minerals were Bruce, Gibbs, Nuttall, and others. Dr. Bruce, of New York, was perhaps the first who called public attention to these mines by publishing an account of the ores and the chemical analysis of their minerals.

In 1825 Messrs. McClure, Frost, LaSeur and VanLedenor visited the mine and obtained many mineral specimens, some of which were sent to the scientists and museums of Europe. Berthier, a distinguished chemist of the School of Mines of France, also analyzed the ores. Dr. Charles T. Jackson, of Boston, an eminent geologist and chemist, visited the mines at different times from 1825 to 1852. In 1852 he submitted to James L. Curtis, President of the New Jersey Zinc Company (of 1852) a very interesting and complete report upon the ore deposits of "Franklin Hill" (Mine Hill) and Sterling Hill.

Major A. C. Farrington in 1848 compiled a historical sketch and prospectus of these mines. At this time there were but few openings on the outcrop of the veins. The different minerals at that time exposed to view in a limited area were few in number compared with those that were discovered as the mines were developed.

The reports of the geologists of this period, who were able to make only limited observations, stated that the vein at the outcrop of Sterling Hill was not homogeneous in structure, but consisted of a stratum of ore several feet in thickness in which zincite and willemite predominated, which was called the "zinc vein." Underlying and in contact with this zinc vein was a stratum of ore with little or no zincite but having Franklinite as the principal mineral. This was known as the "Franklinite vein." This same structure was thought to exist at Mine Hill, and to be continuous throughout the whole extent of the ore body. Later and more extensive development of the mines in depth proved that these "zinc" and "Franklinite" strata were not uniformly distinct and separate veins, but the zincite, willemite and Franklinite were intermingled in every conceivable ratio and combination.

That the true structure of the Mine Hill vein was not fully known is evident from the fact that in 1848 Colonel Samuel Fowler (son of Dr. Samuel Fowler) conveyed by deed to one mining company, the zinc ore of Mine Hill, and a short time thereafter gave another company a deed for the Franklinite and other reserved ores within the same property. The future determination of the ownership of the ores of Mine Hill, based upon the nomenclature of these

deeds and the intent of the conveyance, resulted in a legal contest that is of unusual interest and importance.

This division of the title to the zincite and Franklinite was not made in the original deeds of Sterling Hill, consequently there was not at Sterling Hill disputed ownerships of this nature, although there were divisions that proved troublesome. This litigation, relating to Mine Hill, forms a most interesting chapter in the history of the development of Mine Hill. Prior to 1848, the mines at Mine Hill had been explored and developed largely by individual effort. Within a few years after the death of Dr. Fowler, Colonel Samuel Fowler, his son, had acquired by inheritance or purchase the mines of Sterling Hill and all of the known ore body at Mine Hill, which was then thought to be confined to the 93 and 16/100ths acre Mine Hill farm and the "Mackerly" or "Greer" farm to the northwest. Forty years later, 1888, diamond drill prospecting proved that the ore body extended into land northeast of the Mine Hill farm, on the farm known as the "Rutherfurd" farm. This property was operated by the Sterling Iron & Zinc Company from 1888 to 1897.

CHAPTER III.

The Zinc Industry Established and the Iron Industry Revived 1850-1897

Colonel Samuel Fowler, who succeeded his father in title to the mines of Sterling Hill and Mine Hill, became very active in his endeavors to reclaim the great wealth that this district promised to the mining world. Colonel Fowler sought financial aid by interesting capital in numerous mining companies, organized to develop the mines. He accepted shares of stock for the purchase price of some of the mineral rights or property that he conveyed to the prospective operating companies. The number of sheriff's sales to satisfy mortgages, judgments, liens, etc., indicate that many of the early mining ventures ended in financial disaster.

The record of the ownerships, activities, failures, financial and legal difficulties of but one property will give some conception of the difficulties encountered. We will take Lot No. 10 of the Ogden division of Sterling Hill as an example.

Lot No. 10 was purchased by Dr. Samuel Fowler from Elias Ogden. It passed by will to his daughter, Mary Estelle Fowler in 1844. She sold the same to her brother, John Fowler. It was purchased by Colonel Samuel Fowler from his brother John, in 1847; Colonel Fowler deeded all minerals to the Sussex Zinc and Copper Mining and Manufacturing Company in September of the same year. In 1853 Colonel Fowler repurchased the minerals of Lot No. 10,—less 12 acres reserved. Colonel Fowler now separates the mineral titles and retains the surface. He conveys the title to Franklinite to Sussex Iron Company in 1853. The same year he deeds the zinc and other ores to the National Paint Company. This zinc title passes to Ashley Ball—1863; Ball to John Farley—1864. Farley to Messrs. Jewett, Squier and Aitkin in the same year. They in turn convey the zinc to the Passaic Zinc Company in 1896. The Passaic Company passed the zinc title to The New Jersey Zinc Company—1897. During this interval the title to the Franklinite of lot No. 10 passes to Colonel Fowler and James L. Curtis—1854; from them to The

Franklinite Steel and Zinc Company; thence to The Manganese Steel and Zinc Company in 1871. From the Manganese Steel and Zinc Company to the Manganese Iron Company; from this company the Franklinite title in 1887 passes to Edward Cooper and Abram S. Hewitt by proceedings in Court of Chancery. Cooper and Hewitt deeds Franklinite to Passaic Zinc Company in 1896. Title passes from Passaic Company to The New Jersey Zinc Company—1897.

The title to surface was many times passed to different owners during this time. The above recitation of titles is similar to that of many other mineral properties of Mine Hill and Sterling Hill.

In order to follow the history and mining operations at Sterling Hill, we will speak of the Sterling Mine tract, and lots No. 9 and No. 10 of the Ogden division, separately. The Sterling Mine tract of 62 acres included a part of Lot No. 8 of the Ogden division. The New Jersey Exploring and Mining Company purchased this tract from Colonel Samuel Fowler in 1848. Their interests were held but a short time and then transferred to the New Jersey Zinc Company in 1852. We do not find any record of any extensive mining operations on the Sterling tract prior to 1852. The New Jersey Zinc Company developed and operated the mine of the Sterling tract continuously until 1880, when the corporate name of this company was changed to The New Jersey Zinc and Iron Company, which company continued mining operations until 1896. This mine was then closed down, the plant partially dismantled and the mine allowed to fill with water. The ores from this mine were smelted at the works of the company located at Newark, New Jersey.

The first mining company to operate on lot No. 9 of the Ogden division was the Consolidated Exploring and Mining Company, organized in 1849, which acquired this tract from Colonel Fowler. The mineral titles to Lot No. 9 passed to The Passaic Mining and Manufacturing Company in 1853. The name of the Passaic Mining and Manufacturing Company was changed to the Passaic Mining Company about the year 1870. The Passaic Mining Company was the first to develop this property as an important mining operation, and was one of the first pioneer companies of the district that was financially successful. A power house and a small mill to treat the ores was constructed. The output of the mine and mill was shipped to their plant in Jersey City, New Jersey, for smelting. Much preliminary experimental work to develop the metallurgical processes for the treatment of these ores was necessary. The Passaic Company

at one time produced a considerable tonnage of calamine from the open cut workings. Many specimens of beautiful pure white crystalline calamine were found. These specimens were of rare beauty and form. Specimens of this ore are to be found today in the mineral collections of individuals and museums in both Europe and America. Lot No. 9 was called the "Passaic" mine and is sometimes spoken of as the Marshall mine, taking this name from Timothy Marshall who was for more than twenty years superintendent, his services terminating in 1897. The Passaic mine was a producing property from 1870 to 1896, when it was closed down and partially dismantled.

On Lot No. 10 of the Ogden division is located the southwesterly extension of the Sterling ore veins. The mining of this property was from an open pit, but of such character and limited extent that the quantity of the ore produced was relatively small. It is known by the name of "Noble pit" or "Mud mine." A small deposit of calamine was found in this mine. Active mining extended over a period of about ten years—1860-1870. The above three tracts constituted the Sterling Hill mines in the year 1897, at which time they were consolidated in ownership and became a part of the mining interests taken over by The New Jersey Zinc Company, a corporation then organized which united all of the active mining interests of Sterling Hill and Mine Hill.

The Sterling Hill mines were inactive from 1896 to 1910. In 1910, The New Jersey Zinc Company in order to prove the extension of the ore body in depth, prospected by diamond drilling the land lying to the northeast. The results of this drilling warranted the company in developing the property and putting the mines on a producing basis. The mines were unwatered, a new shaft was sunk, and machinery installed to forward the projected plans. A mill to separate and concentrate the ore produced at this mine was erected. The mill is modern in design, similar to the larger mill at Franklin that was previously built to treat the ores of Mine Hill.

We have endeavored to outline the history of the Sterling Hill mines. We will now follow the interesting events that relate to the development of the iron mines and zinc ore deposit of Mine Hill during the period following the activities of Dr. Fowler, up to the present time.

The records of the operation at Mine Hill prior to 1850 would indicate that the ore was treated to produce iron from the Frank-

linite. The ore as mined was not free Franklinite, but in the mass also contained willemite—a silicate of zinc—and zincite, an oxide of zinc in varying quantities. In the treatment of the ore for the production of iron, the zinc content presented many difficulties that taxed the ingenuity and skill of the metallurgists. The ore being different in composition and charcter from any known mineral deposit, original methods for treatment were necessary.

The mining operations at Mine Hill from 1850 to 1900 resulted in a gradual development of the deposit by the different companies holding title to the several subdivisions of this mining field.

As the mining progressed and the output increased, the manufactured products of the mines, particularly spelter and zinc oxide, came into more general use, and the market demand increased therewith.

There was little activity in iron mining during the first half of the nineteenth century in the Wallkill Valley, except the work of Dr. Samuel Fowler, in his efforts to treat the zinc and Franklinite deposit for the production of iron.

The magnetite deposits at Franklin and at the Ogden mines during this period received little attention until the advent of the railroads.

The ores of Sterling Hill and Mine Hill prior to 1870 were hauled by wagon from the mines to Woodport, located at the north end of Lake Hopatcong. From this point the ore was shipped via the lake and Morris and Essex canal to Jersey City and Newark. Newton was also a secondary rail shipping point. The writer was told by Mr. Clark Day, an old resident of Franklin, now deceased, that he was employed to haul ore from the Buckwheat Mine to Newton in 1865. The Buckwheat mine took its name from the fact that the deposit was first discovered in a buckwheat field. This discovery was on the cut-cropping of what is now called the east vein, near the southerly end of the Mine Hill ore body.

Prior to this discovery it was believed the ore vein as exposed along the westerly outcrop, dipped downward under the capping rock, terminating in depth. Years afterward development of the mine demonstrated that the outcrop at the Buckwheat mine was the eastern exposure of a part of the westerly vein that had extended downward, then turned upward and folded in the shape of a rounded trough, called by geologists a synclinal fold.

Railroad construction and extensions influenced mining as well

as all other industries. A brief outline of railroad building, directly connected with this mining district is worthy of notice and explains industrial conditions.

The first railroad built in Sussex County was the Sussex Mine Railroad. This line was built in 1848, extending from the Andover Iron Mines, at Andover, New Jersey, to the Morris and Essex canal at Waterloo, New Jersey. These mines were owned and operated by Messrs. Cooper & Hewitt. This railroad line was next extended as far as Newton and formally opened on December 11, 1854. A few years later this extension was built as far as Branchville. The first railroad to enter the Wallkill Valley, in Sussex County, was an extension from Newton to Franklin in 1870, known as the Sussex Railroad, now a branch of the Morris and Essex Railroad, which is a division of the Delaware, Lackawanna and Western Railroad system.

Under an old charter, the New Jersey Midland Railroad, in the spring of 1870, started the construction of a line from Deckertown—now Sussex Borough—to Franklin. The first train from Newton to Deckertown was run over these two roads on June 19, 1871. This line was extended eastward and the following year was completed as far as Newfoundland, and was later completed from Unionville, New York, to Jersey City, New Jersey, and now operates as the New York, Susquehanna and Western Railroad, being a part of the Erie Railroad system.

With transportation facilities now at hand, iron ore smelting became an industry at Franklin Furnace, near the site of the Mine Hill operations. The Franklin Iron Company, a subsidiary af the Lackawanna Steel Company, had acquired large land holdings in Sussex County, on many of which were small deposits of iron ore.

The iron ore deposit at Franklin is a magnetite vein lying west of the west vein of the zinc and Franklinite ore body at its southwesterly extremity. The magnetite vein extends southwesterly across the Wallkill River, beyond the zinc and Franklinite deposit.

The outcrop of the magnetite vein is exposed for a distance of about 1800 feet. It is from four to eight feet in thickness and has been mined to a depth of two hundred feet. A number of shafts and openings along the outcrop were in operation during the period from 1870 to 1883. This ore was utilized at a new iron furnace that was built at Franklin Furnace soon after the Sussex Railroad to Franklin was put in operation. The blast furnace was built by the

Franklin Iron Company. It was finished and first put in blast about February 1, 1874. This furnace was built for a capacity of about 2500 tons per month. It was modern in design and one of the large units of its kind when built. It was operated during the greater part of 1874 but was closed down from 1875 to 1879.

This inactivity was due in part to the depressing financial condition of the country at this time. The local ores were mixed with iron ores from other mining districts. The Franklin mines were not able to supply a quantity of ore equal to the capacity of the furnace, even had it been possible to smelt this magnetite without mixing with foreign ores. In 1879 the furnace was again put in blast and continued in operation until 1890. About nine years after, in 1899-1900, it was again operated for a short period.

The history of the furnace would indicate that it was operated only when the iron industry was at a high ebb, but when financial depressions appeared, it could not cope with the industry that had developed in larger and more economical iron ore fields. This furnace was finally dismantled in 1906.

About the year 1880 mining operations were again resumed at the Ogden iron mines. New shafts and old openings were developed on the extensive outcrop. Some of these workings had been named the "Davenport," "Old Ogden," "Roberts," and "Pardee" mines. The operations were discontinued in 1884.

In the year 1889 The New Jersey and Pennsylvania Concentrating Company purchased a large tract of land within which was the Ogden group of magnetic iron ore mines. Thomas A. Edison was the moving spirit in this corporation. In his wide vision he foresaw great possibilities in converting the great low grade magnetite iron ore deposits of this and other countries into profitable commercial enterprises.

The top soil and cover of a large area of the mines were removed. A system of tracks and equipment for mining the whole mineralized belt on a large scale was installed. Steam shovels and cableways were employed to load and transport the ore from the mine to the mill. A large mill was built to separate the ore from the rock, equipped with modern and special machinery for operations on a large scale. Magnetic separators were designed to separate the magnetite ore from the rock. Briquetting machines were invented and constructed to consolidate the crushed magnetite ore into briquets in order that the ore could be smelted in a blast furnace of standard

construction. The major part of all this equipment was of special design originated by Mr. Edison.

The average iron content of the material mined is said to have been only 8%. Owing to the low grade of the ore, commercial success depended upon a number of factors: Maximum output with minimum fixed charges; cost of plant, and market value of product. In this, as in all new or improved processes, much expensive experimental work was necessary, which in this case had its reward. The operation of the mill demonstrated that the mechanical equipment was a success. The value of the relatively small percentage of the finished product produced was a large factor that influenced the apparent financial failure. At different intervals a large tonnage of iron briquets containing about 68% metallic iron were produced. However, after several years of operation, the plant was closed and the great project abandoned. The entire plant was dismantled, and at the present time nothing remains on the site to remind one of the unsuccessful but heroic effort to convert a low grade magnetic ore body into a profitable commercial commodity.

While we may look upon this great enterprise as a commercial failure, the inventions, improvements and experience gained at the Ogden plant of The New Jersey and Pennsylvania Concentrating Company have not been lost to the industrial world. Many of the inventions and appliances developed have been utilized in cement manufacture and other industries.

The great cement manufacturing plants of New Jersey and eastern Pennsylvania were being constructed and developed in the decade following the operation of the Ogden mines and plant, and these industries utilized many of the inventions and appliances that were created by Mr. Edison during his experiments with the Ogden ore.

CHAPTER IV.

Litigation Caused by Conflicting Mineral Title: 1850-1897

One of the interesting features of the history of Mine Hill is the litigation resulting from the wrong conception of the structure of the ore body and lack of knowledge of the true character of the ore as later determined.

A few years after the death of Dr. Samuel Fowler, his son, Samuel, known as "Colonel Sam," acquired all the minerals of value both at Mine Hill and Sterling Hill that had formerly belonged to his father. Soon after Colonel Samuel Fowler had obtained title to the mines, he sought the assistance of capitalists for the development and exploration of these mineral properties, largely by the organization of corporations. At this time Colonel Fowler inadvertently separated the mineral titles of the Mine Hill deposit.

On March 10, 1848, he executed a deed to the Sussex Zinc and Copper Mining and Manufacturing Company conveying "all the zinc, lead, copper, silver and gold ores, and also all other metals or ores containing metals, except the metal called Franklinite, and iron *ores* when *it* exists separate from the zinc." This deed included the area known as the 93 and 16/100ths acre Mine Hill farm, the 68-acre Scott farm and other lands.

Two years later, December 13, 1850, he conveyed to the Franklinite Mining Company the Franklinite within the 93 and 16/100ths acre Mine Hill farm, and other lands, using the following language: "All the reserved *iron* ore called Franklinite and all the reserved ores and minerals not granted to The Sussex Zinc and Copper Mining and Manufacturing Co., on March 10, 1848."

Thus we find that two distinct mineral titles to the same vein of ore were made to rest in two different corporations. The Franklinite Mining Company then divided their Franklinite interests of the Mine Hill farm into two parts by establishing an "East and West" line, the divisions thereafter being known as the north half and south half of Mine Hill.

The Franklinite Mining Company, on February 26, 1853, conveyed the Franklinite title to the south half of Mine Hill to the New Jersey Franklinite Company. The Franklinite title to the north half of Mine Hill passed into the Franklinite Steel and Zinc Company at a later date. This north half was also subdivided by leases for mining into two parts, thus complicating titles that were later contested in the courts.

Each of the above companies claimed the entire vein or ore body by virtue of their respective titles to the Franklinite or zinc in certain territorial limits as set forth in the language of their deeds. If we examine and analyze the language of the deed for the zinc from Colonel Fowler to the Sussex Company in 1848, the question confronts us as to just what was conveyed and what was excepted by the language used. All zinc and other ores are recited except Franklinite (comma) and iron *ores* (plural) when it (singular) exists separate from the zinc. This ambiguity of language was capable of different interpretations. One construction would, in effect, be contradictory to another, and of vital importance, since it would mean the possession of a mine of great value.

In the years of litigation that followed, we learn that men of the highest legal attainments disagreed upon the true legal interpretation and intent of the language as expressed in these conveyances. More confusion existed because in early times Franklinite was regarded as an ore producing iron—its zinc content being a detriment. Also zincite—red oxide of zinc—was understood to be the mineral constituting the zinc ore, while willemite—a silicate of zinc—at that period was not thought to be of great value since metallurgical methods for the treatment of this mineral had not been developed. It is an interesting fact that eventually willemite was one of the important and valuable minerals of the ore.

It may be explained also, at the time Colonel Fowler made these grants, it was generally understood that the Mine Hill ore body, based on observation at Sterling Hill, consisted of two abutting and parallel veins; in one vein or stratum of ore the Franklinite predominated and was called the Franklinite vein; in the other the zincite predominated and was regarded as the zinc vein. Later developments at greater depths demonstrated that the ore body was a mass of Franklinite, willemite and zincite, having no uniformity as to the relative quantity of the combined minerals of which the ore is composed.

With these conflicting conditions, it is inevitable that the question of title between the companies had to be determined by decisions of the courts. It would appear that a number of individuals were interlocking directors in the different companies, and that harmony did not always prevail among them as to the operations of their interests. The Sussex Zinc and Copper Company was chartered in 1848; another company named the New Jersey Exploring and Mining Company was incorporated in 1849. The latter company owned and operated the "Sterling" Mine at "Sterling" Hill, the "Sterling" Mine at that time being the northerly part of the present "Sterling" Hill Mine.

The name of the New Jersey Exploring and Mining Company was changed to the New Jersey Zinc Company in 1852. In 1851 the Sussex Zinc and Copper Exploring and Mining Company agreed to convey to the New Jersey Zinc Company all their interests and rights which, among others, was the *zinc title* to the 93 and 16/100ths acre Mine Hill farm. When this agreement was consummated, the stockholders of the Sussex Company received stock of The New Jersey Zinc Company in exchange for shares of the Sussex Company. The New Jersey Zinc Company's capitalization was $1,200,000 divided into 48,000 shares. The Zinc Company now believed they owned the Mine Hill property and started operations both at Sterling Hill and Mine Hill.

The New Jersey Franklinite Company under their deed for the Franklinite now contested the right of the New Jersey Zinc Company to operate at Mine Hill under their zinc title from the Sussex Zinc and Copper Company. Suits and counter-suits were instituted in the courts at different times while both companies were mining the same part of Mine Hill. The major contest started in June, 1857.

The New Jersey Zinc Company on July 21, 1857, filed in the Court of Chancery a bill of complaint against the New Jersey Franklinite Company, who were then in possession of the mines, setting up in the complaint that the Franklinite and magnetite were ores of iron, while willemite and zincite were ores of zinc; also that when Franklinite was combined with zinc ore, The New Jersey Zinc Company were the owners of the mine with absolute right to mine the same, excepting the Franklinite only when it was found separate and uncombined with the zinc, and prayed for an injunction to restrain the Franklinite Company from mining.

The New Jersey Franklinite Company in answer to the complaint maintained that when the Franklinite predominated in the

ore body, it shall be taken as Franklinite ore, and when zinc predominated it should be regarded as zinc ore.

A long, tedious contest followed. Many witnesses on each side appeared. Contradictory evidence was presented. All features pertaining to the character of the ore; the name of the ore as known to practical mining men; the legal interpretation of the intent of what was to be conveyed by the language of the deed for the zinc and the deed for the excepted Franklinite, were put in evidence. It was an extraordinary and very complex problem to be solved, with few precedents to guide the decision of the court. The result of this decision put the mines in possession of the New Jersey Zinc Company for a limited time. During the progress of the above suit, we find the interest of Mr. Oakes Ames appearing.

Mr. Ames in 1853 had loaned to the New Jersey Franklinite Company fifty thousand dollars, secured by a mortgage upon the property held by them under their Franklinite titles. Mr. Ames began foreclosure proceedings. On January 26, 1860, he purchased at sheriff's sale the land, mines and interests of the New Jersey Franklinite Company. The Boston Franklinite Company was incorporated on May 8, 1860. About one month later Oakes Ames conveyed by deed to the Boston Franklinite Company all the interest of the New Jersey Franklinite Company that he acquired by sheriff's deed.

The Boston Franklinite Company, now claiming title to the Franklinite, filed a supplemental bill against the New Jersey Zinc Company who were in possession of the mine under cover of an injunction that had been granted against the New Jersey Franklinite Company. This supplementary bill asked for a temporary injunction against the Zinc Company, restraining them from mining until the case then pending was settled. This injunction was granted. Litigation continued and the case finally came before Hon. Henry W. Green, who rendered an opinion that the words "zinc ore" in the deeds meant the veins in which the ore of zinc predominated, and that the term "Franklinite" did not mean the mineral particles of Franklinite that were more or less disseminated with the ore of zinc, but the vein or veins in which the mineral Franklinite predominated; therefore, the title to the ore was vested in the deed conveying the Franklinite. This decision dissolved the injunction against the New Jersey Franklinite Company and placed the title to the mine in the Boston Franklinite Company, successors in title to the New Jersey Franklinite Company. The decree also ordered

that an accounting should be taken and the New Jersey Zinc Company pay for the ores that had been mined. An appeal from this decision was immediately taken to the Court of Errors and Appeals.

The result of the decision of the Court of Errors and Appeals was a reversal of the decision of the Chancery Court, to the effect of again establishing title in the New Jersey Zinc Company to the ore deposit in the south half of Mine Hill. Some of the factors entering into this decision were the language of the conveyance from the Sussex Zinc and Copper Company to the New Jersey Zinc Company, and the conditions surrounding the transfer of title, laying particular stress upon the legal meaning of the word "premises" in this deed, as it relates to the zinc ore at the time the deed was executed.

This was not the end of the contest. More confusion and legal difficulties followed. Mr. Moses Taylor now enters upon the scene in view of his having acquired the title to the Franklinite in this disputed territory. A mortgage had been given to Oakes Ames for $45,000, partly as purchase money, by the Boston Franklinite Company soon after their organization in 1860. We may, by inference, believe that Oakes Ames was a prominent share holder in the Boston Company and had a vision of the value of the mines, although the title to the Franklinite was constantly contested in the courts.

Default of payment of this mortgage resulted in a Sheriff's sale on November 13, 1863. Edmund H. Miller purchased such property of the Boston Franklinite as was then offered for sale by the Sheriff. This purchase included the Franklinite in the south half of Mine Hill. Edmund H. Miller sold his interests to Oakes Ames on June 6, 1863, conveying all rights and interests he had acquired, this being the second time in five years that Oakes Ames had purchased this property.

Oakes Ames, on May 27, 1867, conveyed to Moses Taylor "all the metal, mineral and iron ore usually known as Franklinite in or upon the south half of Mine Hill." Moses Taylor, now sole owner of the Franklinite title, in May, 1870, filed a bill in the Circuit Court of the United States, complaining that the minerals in the southerly half of Mine Hill consisted of Franklinite, willemite, and the red oxide of zinc, each having a distinct character and appearance, and that the New Jersey Zinc Company had removed large quantities of ore owned by him, claiming it to be zinc, whereas it was, in fact, Franklinite, and asked for an injunction against the New Jersey

Zinc Company, restraining them from mining Franklinite or magnetite; also asking for an accounting for the ores that had been removed by the New Jersey Zinc Company.

The Zinc Company in replying to the bill of complaint, stated that they had removed ore, but had not removed Franklinite when it existed separate from the zinc; that the ore they mined was zinc ore and not Franklinite ore, which was confirmed by the decree of the Court of Errors and Appeals. The case was heard before Judges McKennan and Nixon. After a full review of the whole case, the decision gave to Moses Taylor title to the ore deposit in the south half of the 93 and 16/100ths acre Mine Hill farm. Before the final accounting and settlement, as ordered by the court, was finished, the New Jersey Zinc Company and Moses Taylor agreed to a consolidation of their interests. The outcome of this compromise was a reorganization in 1880 under the name of the New Jersey Zinc and Iron Company.

The combined mining interests now held by the New Jersey Zinc and Iron Company was the Sterling Mine at Sterling Hill; the mineral title to the Greer or Mackerly farm north of the Hamburg Road, abutting the Mine Hill farm, and the mineral titles to the south half of Mine Hill. They also claimed the north half of Mine Hill by virtue of the deed from Colonel Fowler to the Sussex Zinc and Copper Mining and Manufacturing Company in 1848, conveying the zinc of the 93 and 16/100ths acre Mine Hill farm, also the Franklinite in a six and one-half acre lot known as the parallelogram. Their title to the north half of Mine Hill was soon to be denied, and contested in the courts, creating another chapter of legal controversy. The New Jersey Zinc and Iron Company operated the Sterling Mine at Sterling Hill and the south half of Mine Hill from 1880 to 1897, at which time their interests were consolidated with the present New Jersey Zinc Company (of 1897).

A brief review of the more important facts relating to the unusual situations and complex interests that developed during the long period of legal controversy compels one to believe that the history of Mine Hill is unique and of extraordinary interest. Men of superior scientific and legal attainments; jurists of the highest courts were called into service; yet we find disagreements of opinions and reversal of decisions honestly delivered on the merits of the case as presented to them.

During the period from 1850 to 1880, many minor controversies as to titles, leases, and possession were adjudicated in the courts.

Many new mining corporations were organized, combining varied interests in leased and purchased properties at Sterling Hill, Mine Hill and vicinity.

It is reported that Colonel Samuel Fowler held interests in as many as fifteen different companies. We recall the names of The Passaic Mining Company, The Union Exploring and Mining Company, The Fowler Franklinite Company, The National Paint Company, The Consolidated Franklinite Company, The New Jersey Exploring and Mining Company, and many others, all of which passed into oblivion on account of financial failure or were absorbed into other consolidations.

These facts indicate that a wide financial interest was directed to this mining region in the early days of mining and development. In all mining ventures in a new field, a few are successful while many fail with the fond hopes of easy riches scattered to the winds. These truths have been the history of the Zinc Industry of Sussex County.

The advent of The New Jersey Zinc and Iron Company in 1880 ended the controversy of the mineral titles in the south half of Mine Hill. This company, however, continued to claim title to the ore vein in the north half of Mine Hill. The New Jersey Zinc Company (of 1852) and its predecessors in title, as early as 1848, opened some small pits on the outcrop north of the East and West line, and in a small way, at different periods mined along the outcrop of the vein, without being molested, until 1877. The Franklinite Mining Company also claimed the mine by virtue of a deed for the Franklinite, as conveyed by Colonel Fowler in 1850.

On March 6, 1877, Charles W. Trotter obtained from James L. Curtis, surviving trustee of the Franklinite Mining Company a thirty year lease to mine in the southerly part of the north half of Mine Hill, extending for a distance of about 500 feet northward from the East and West line. On April 10, 1879, Charles W. Trotter also obtained from James L. Curtis another fifteen year lease for mining the remaining part of the vein of the north half of Mine Hill, extending to the Hamburg Road.

These two leases gave Charles W. Trotter mining rights on about 1070 feet on the outcrop of the vein and its extensions in depth. Soon after Mr. Trotter had taken possession of the mine near the East and West Line, he started mining operations. The New Jersey Zinc and Iron Company obtained from the Court of Chancery a

preliminary injunction against him, restraining him from mining, claiming to own the mine because of their title to zinc ore therein. After much litigation the injunction was denied, thus placing Mr. Trotter in possession of the mine he held by the lease of 1877. The New Jersey Zinc and Iron Company, however, continued mining operations on the north end of the vein south of the Hamburg Road, which was the property of Trotter's lease of 1879, claiming this part of the vein under the title to the Franklinite within a six and one half acre tract of land, which was conveyed by a confirmatory deed from Colonel Samuel Fowler to The Sussex Zinc and Copper Mining and Manufacturing Company, March 10, 1848.

Mr. Trotter, by his lease from Mr. Curtis in 1879, had acquired the right to mine the Franklinite on this part of the vein. He now brought action of trespass against The New Jersey Zinc and Iron Company in the Circuit Court of New Jersey, and also obtained a bill in equity to quiet title, in which he asked for an accounting for the ores mined. In the trial to quiet title to this part of the vein, The New Jersey Zinc and Iron Company endeavored to show that the location of the land described in the Fowler deed of the six and one-half acres, was a tract of four courses and distances in the shape of a parallelogram, and so located as to include about 570 feet of the vein south of the Hamburg Road, although the deed called for seven courses and distances.

The jury in this case rendered a verdict that the description of this tract was so indefinite and ambiguous that they could not identify the boundaries or sustain the location of this tract, so that it could include the north part of the north half of Mine Hill. A verdict was rendered for Charles W. Trotter, assessing costs and damages.

By Writ of Error the suit was taken to the Circuit Court of the United States, where it was dismissed in May, 1883.

During this period The New Jersey Zinc and Iron Company filed another bill of complaint by which they secured a temporary stay against paying Charles W. Trotter for the ore mined and the costs of the suit, as determined in the verdict in the trespass suit, also enjoining him from mining in the disputed territory. The final result of this litigation was an agreement of May 2, 1884, whereby the southerly boundary of the tract in dispute was determined by arbitration and was permanently fixed. Mr. Trotter was paid the sum of $26,680, whereby he released all his claims and interests and

was pledged to discontinue all suits against the New Jersey Zinc and Iron Company, and not become a party against them in other litigation.

The southerly boundary of the parallelogram was marked by Messrs. James McCoy and Wm. Roome, surveyors. This line crosses the vein just south of the runway leading to the Ding Dong shaft, and is about 570 feet south of the Hamburg Road.

During the time this litigation was in the courts, other claims and complications arose. A number of suits, in law and chancery courts, were pending to determine the right titles and ownerships within the north half of Mine Hill. By the terms of the first lease from The Franklinite Mining Company to Charles W. Trotter, it was agreed that each party to the lease was to receive one-half of the net proceeds of the mining operations so long as same could be mined at a reasonable profit, and no obstructions created by legal proceedings.

Another later modifying lease recites that the Franklinite Mining Company shall pay the costs that may be incurred in defending the title to the property held under lease by Charles W. Trotter. At the time Charles W. Trotter acquired these leases The New Jersey Zinc Company and the Passaic Zinc Company were the only corporations that had developed modern processes to treat the ores produced from the Sterling and Mine Hill mines. The Lehigh Zinc and Iron Company had been operating a smelting plant at South Bethlehem, Pennsylvania, treating the zinc ores produced at the Friedensville Zinc Mines, located in the Saucon Valley, about four miles southwest of Bethlehem, Pennsylvania. In 1881, Charles W. Trotter entered into an agreement with Charles August Heckscher (later known as August Heckscher) to deliver to him 1000 tons of ore per month from the mines at Mine Hill. This ore was shipped to the Lehigh Zinc and Iron Company. When this agreement was executed, Charles W. Trotter, owing to litigation, was mining only on the property covered by his first lease of 1877, being the 500 feet of vein north of the East and West line. By a later agreement, Charles W. Trotter was to give Charles A. Heckscher an option to secure the ore in the northerly part of the north half of Mine Hill should the courts sustain the validity of the lease he held to this part of the vein.

Other interests now became active to the annoyance and detriment of Charles W. Trotter and the Lehigh Zinc and Iron Com-

pany. On August 15, 1881, Wm. H. McVicker and other stockholders of the Franklinite Steel and Zinc Company presented a bill in the Court of Chancery against Charles W. Trotter, James L. Curtis, The Franklinite Mining Company and others, alleging in their complaint that the mine now in possession of Charles W. Trotter belonged to the Franklinite Steel and Zinc Company; that James L. Curtis held a deed of trust only, and had not been authorized to lease or transfer the interests of the Franklinite Mining Company, and demanded the rents, revenues and royalties of the mine; also that the agreements held by Charles W. Trotter should be set aside.

The defendants to this complaint set forth the statement that by a resolution of the Board of Directors of the Franklinite Mining Company, James L. Curtis was empowered as trustee to lease the property in question, and that the officers of the Franklinite Steel and Zinc Company had full knowledge of this transaction.

It would appear that James L. Curtis and others were officers and stockholders in both of the Franklinite Mining Company and Franklinite Steel and Zinc Company. An injunction was issued restraining James L. Curtis, trustee, from receiving the revenues from the mine. The Court of Chancery was appointed temporary custodian of these funds. Charles W. Trotter continued mining. The ore produced was shipped to the Lehigh Zinc and Iron Company.

Owing to the undeveloped condition of the mine, and the irregularities of the vein formation, Charles W. Trotter was not able to furnish 1000 tons per month as required in his contract with Charles A. Heckscher. He had, however, from time to time received full or partial payments for ore shipped. At the same time, by the court order he was prevented from making settlements for royalties until the courts determined the legal status of the several cases then pending in the courts.

Disagreements now arose between Charles W. Trotter and Charles A. Heckscher as to breach of contract, payment of royalties, methods of mining and accounting. Attachments for debt, suits for damage, demand for accounting, followed, with countersuits and pleadings in the various courts, with varying results. On August 16, 1881, Charles A. Heckscher transferred the interests he had acquired from Charles W. Trotter to the Lehigh Zinc and Iron Company. The Lehigh Zinc and Iron Company operating under lease were soon to acquire the Franklinite, the title to which was set forth in the following conveyances.

The Fowler Franklinite Company, on January 26, 1863 gave a deed to James Langdon Curtis and Daniel H. Curtis for the Franklinite in the North Half of Mine Hill mine, to hold the same in trust for the Franklinite Mining Company.

The Franklinite Mining Company made an agreement with the Franklinite Steel and Zinc Company whereby a deed of conveyance for the Franklinite was to be delivered, on demand, to The Franklinite Steel and Zinc Company. A demand was made and a deed was given on March 5, 1883, by James L. Curtis, surviving Trustee, to The Franklinite Steel and Zinc Company.

On March 19, 1883, the same title was acquired by Charles A. Heckscher, who was the Treasurer of the Lehigh Zinc and Iron Company. By this transaction Charles A. Heckscher secured the title to the Franklinite, and by conditions of his former agreement with Charles W. Trotter he apparently was fortified in this position to operate the mine without hindrance.

On August 11, 1887, Charles W. Trotter entered into an agreement with Charles A. Heckscher and the Lehigh Zinc and Iron Company whereby he assigned to them all leases, rights, and estates then held by him from James L. Curtis and others, together with tools, machinery and mine equipment.

This agreement was to terminate when two hundred and sixty-five thousand tons of ore had been mined, the royalties for such ore to be paid to Charles W. Trotter, his heirs or assigns. He continued to operate the mines until January 31, 1888, at which date he conveyed all his titles and interest to the Lehigh Zinc and Iron Company.

While the deeds of conveyance to the Lehigh Zinc and Iron Company were based upon the early titles for the Franklinite, The New Jersey Zinc and Iron Company were successors in title to the zinc ore of the 93 and 16/100ths acre Mine Hill farm, as granted by Colonel Samuel Fowler to the Sussex Zinc and Copper Mining and Manufacturing Company in 1848.

We now find that more litigation was to follow between the Lehigh Zinc and Iron Company and The New Jersey Zinc and Iron Company to quiet title to the ore deposit within the north half of Mine Hill.

The Lehigh Zinc and Iron Company now in possession of the mine continued to operate the property. The New Jersey Zinc and Iron Company brought an action of trover to recover for the value of some twenty-three cars of ore that the Lehigh Company had

mined in 1889, claiming the title to the property under their deeds from the Sussex Zinc and Copper Mining and Manufacturing Company of March 10, 1848, and March 8, 1852. This action again brought forth the old controversy as to the interpretation and intent of the early deeds to the zinc and to the Franklinite as originally conveyed by Dr. Fowler.

The New Jersey Zinc Company claimed that the ore in question was zinc ore, and had been taken from the vein that *"was not separate from the zinc."* The Lehigh Company asked for a motion to non-suit, for the reason that they were in actual and adverse possession and that the action of trover was not the proper legal procedure. This motion was not granted.

The Lehigh Company then produced its title which rested upon a deed from Dr. Samuel Fowler to James L. Curtis and Daniel H. Curtis for all "the reserved iron ore called Franklinite and all other reserved ores not granted or conveyed to the Sussex Zinc and Copper Mining and Manufacturing Company found or to be found on the Mine Hill farm . . . etc."

In this court trial much of the testimony that was offered on both sides was not allowed to be presented, many of the offers overruled by the court. Because of the vital importance of some of this testimony the case was taken to the Court of Errors and Appeals for decision. This court reversed several of the rulings of the trial court, which in effect left the Lehigh Company in possession of the mine, but did not settle the controversy. The New Jersey Zinc Company now instituted an action of ejectment against the Lehigh Company to obtain possession of the mine. At this trial a decision was rendered for the Lehigh Zinc and Iron Company.

Questions to be determined on the basis of appeal were, whether books of science are admissible as evidence to prove opinions contained in them; who is to be considered an expert; and whether his interest affects the legality and weight of his testimony, etc. The review of the above questions and the former opinions relative to this complex litigation was taken under consideration by the Court of Errors and Appeals in the June term of 1896. The decision of this court affirmed the decision of the trial court, which placed the mine in the possession of the Lehigh Zinc and Iron Company. This was the last legal contest that related to the conflicting mineral titles of Mine Hill. Soon after, in 1897, all the mining interests of Mine Hill were united in one corporation now known as The New Jersey Zinc Company.

CHAPTER V.

Progress of Zinc Mining and Mill Construction 1897-1927

Sterling Hill and Mine Hill embraced all of the zinc producing mines of this district. All of these mining interests were conveyed to The New Jersey Zinc Company February 1, 1897. A former corporation, also named The New Jersey Zinc Company operated in this field from 1852 to 1880.

It was quite logical that these joint interests, operating as a unit, would prove advantageous to all concerned, because an entire ore body, having a single ownership, could be mined more economically and the operations and business administration be directed from one source. The mineral interests consolidating in 1897 were the following properties having various rights and titles: The Passaic Zinc Company, owning the southerly part of Sterling Hill; The New Jersey Zinc and Iron Company, owning the northerly part of Sterling Hill and all the minerals in the southerly part of Mine Hill, also the minerals within the "Mackerly" or "Greer" farm north of the Hamburg Road, in Franklin; The Lehigh Zinc and Iron Company, who had acquired the minerals of the central section of the ore deposit lying between the Hamburg Road and the northerly boundary of The New Jersey Zinc and Iron Company, which boundary was an established division line known as the "East and West" line; The Sterling Iron and Zinc Company, which were operating under a lease from Honorable Richard Wayne Parker. This lease included the land known as the Rutherfurd or Scott farm, lying northeast of the Lehigh Mine. The smelting plants of the above companies were also acquired by The New Jersey Zinc Company. The smelting plant of the New Jersey Zinc and Iron Company was located at Newark, N. J. The smelting plant of the Passaic Zinc Company, at Jersey City, N. J., and the smelting plant of the Lehigh Zinc and Iron Company at South Bethlehem, Penna.

The New Jersey Zinc Company also acquired zinc mines and

property in Virginia, Missouri, Wisconsin and other states. The New Jersey Zinc Company increased its capital to ten million dollars.

The constant research and experimental work; the improved methods in mill and smelter construction; the modern mining operations; the natural resources at hand, and the wise, straightforward and conservative business management have all been instrumental in the growth and financial success of the New Jersey Zinc Company, which has developed into one of the important mining industries in the United States.

The separation of these complex ores by the application of electro-magnets, as developed by the experiments and inventions of The New Jersey Zinc Company, proved to be of vital importance. One must know the character of the ore to comprehend the importance of this invention and its use.

The ore of Sterling Hill and Mine Hill, as mined, is a mechanical admixture of the minerals, Franklinite, willemite and zincite. A varying quantity of rock and also other minerals of no commercial value are, of necessity, mined with the ore. Franklinite is iron, zinc and manganese, chemically combined with oxygen. It is slightly magnetic—small particles will be attracted to the poles of a strong electro-magnet.

Willemite, a silicate of zinc, is practically non-magnetic. Zincite, red oxide of zinc, is non-magnetic.

The Lehigh, or Trotter, mine was acquired by The Lehigh Zinc and Iron Company in 1888. The principals of this purchase were Mr. Charles August Heckscher and Mr. John Price Wetherill, who also held large interests in the abutting property of the Sterling Iron and Zinc Company. It was at this time that Mr. Wetherill conceived the idea of magnetic separation in the treatment of the ore of Mine Hill. After much study and experimental work, he designed and built a magnetic separator that was a mechanical success and well adapted for the ore produced by the Mine Hill and Sterling Hill mines.

This magnetic separator, known as the Wetherill separator, was of such merit as to warrant the Sterling Zinc and Iron Company to build a mill on the Sterling Mine property, near the Parker Shaft. This mill was equipped with the Wetherill separators as a part of the installation for the separating and concentrating of the ore. The commercial products of this mill were Franklinite, separated from all other minerals, also willemite, combined with zincite, as a distinct

product. This being achieved, it was possible to make zinc oxide and spelter from the separated mill products, whereas only zinc oxide could be made from the run-of-mine ore. Spelter made from the separated willemite is a superior product of high grade metal.

The Wetherill magnetic separator may be described briefly as follows: An endless rubber belt, about eighteen inches wide, called the conveyor or feed belt, passes around two pulleys placed about twenty feet apart. The belt travels horizontally and is supported between the end pulleys by a series of cylindrical rollers. These pulleys are about twenty four inches in diameter, having a twenty-inch face. The pulleys, magnetic poles, belts and driving mechanism of the separating unit are built within a strong framework of wood. The first pulley acts as a drive pulley which propels the eighteen-inch feed belt horizontally under the suspended magnet poles. The upper line of feed belt travels about five feet above the floor line. The magnet poles are rectangular in shape, about eighteen inches long, eighteen inches high, and eight inches thick. The lower side of the upper pole is placed above and near the travelling eighteen-inch feed belt, its long axis being set transversely to the direction of this feed belt movement. One pole, or "pole piece," is fastened to each end of a cylindrical core of iron, around this core is wound insulated copper wire through which an electric current is passed. The strength of this current and the number of times the insulated wire passes around the core determines the relative strength of the attractive force of the magnet pole or poles. Two pulleys, with four-inch face, are set in line with the long axis of each pole, in such a position that an endless belt about three inches wide may pass over these pulleys and made to travel along the lower line of the bottom of the fixed upper pole in contact with it. This three-inch belt is called the take off, or cross, belt.

The capacity of any machine unit is determined by the number of magnets installed. During the operation of the magnetic separator a film, or bed, of evenly distributed crude ore, carefully sized, flows upon the feed, or rear, end of the eighteen-inch feed belt. This mixed ore is carried forward and passes under the magnetic pole or poles above. When the ore reaches the pole and three-inch cross belt, the Franklinite particles in the ore, being magnetic, are lifted or drawn toward the upper pole of the magnet above. The Franklinite, however, cannot come into contact with the pole, but is drawn against the moving belt which travels transversely to the feed belt

along the bottom of the pole. The Franklinite particles thus clinging to or forced against, the moving cross belt are carried beyond the attractive influence of the highly magnetized pole and drop into a hopper underneath.

The remaining willemite, zincite, and other non-magnetic materials are carried forward to the end of the feed belt. This ore travelling on the feed belt may be passed under a series of poles having the same or different degrees of magnetic force tending to attract magnetic materials having different magnetic properties.

Since the installation of the first separators many changes in design and various improvements have been made. The general principle of the use of the suspended poles, cross belt, and feed belt has been maintained. Many improvements of the magnetic separators were designed by Mr. Lewis G. Rowand, who, after the active period of Mr. Wetherill's life, devoted a great deal of time to the perfecting of magnetic separating processes.

After the magnetic separation of the Franklinite, the other important operation is separating the commercial minerals, willemite and zincite, from the waste rock and non-commercial minerals. This material after leaving the feed belt of the magnetic separator, is subjected to water separation, whereby the gangue or waste rock by mechanical water agitation is separated from the commercial products. This is by a process of jigging, a common practice in milling operations, based on the application of the laws of specific gravity. When a mass of mixed-sized material of different specific gravities or weights, is agitated in water, the heavy particles will settle to the bottom of the receptacle. By the use of mechanical appliances, taking advantage of this natural law, a complete separation is possible.

The above milling processes separate these complex ores into the different minerals, that are necessary for the special treatment to which they are subjected at the smelting plant.

The treatment of Franklinite and willemite at the smelting plant may be described, as follows:

The Franklinite in a finely crushed state is mixed with fine anthracite coal and placed in a furnace of special design having a large grate area. When this charge of coal and iron is ignited and acquires a sufficiently high temperature, the zinc of the Franklinite (ZnO) is reduced to a metallic state.

Since the reduction temperature of oxide of zinc is higher than

the boiling point of the zinc, the zinc is vaporized and is re-oxidized by the excess air introduced into the system by exhaust fans. This vapor is then forced, by fan pressure, through a series of pipes and cooling chambers. When finally cooled, it is in the form of a white powder, consisting of minute particles which is the commercial oxide of zinc.

From the cooling chamber, the oxide of zinc, combined with excess air and furnace gases, by the use of blowing fans, is forced into a great number of long muslin bags suspended from the high ceiling of a building, called the bag room.

The air, gases and zinc oxide, under the fan pressure, is forced into these suspended bags. The air and gases pass through the fabric of the bags, while the oxide, partially held in suspension is filtered out and shaken to the bottom of the bags. It is then collected and packed in barrels for shipment.

The clinker or residuum remaining on the furnace grate consists of ash and iron having a large percent. of manganese. This residuum is smelted in a blast furnace designed for its treatment and produces a valuable commercial product known to the iron trade as spiegeleisen.

The treatment for reducing the willemite into zinc metal is a different process. The willemite, crushed fine and mixed with fine anthracite coal, is placed in a fire clay-carborundum receptacle called a retort. The type and size of a retort in general terms is cylindrical in shape, about seven or eight inches in diameter and three to four feet long, having one closed and one open end. A group of retorts arranged and fixed in tiers makes a furnace unit. The number of retorts constituting a furnace may be determined as the conditions warrant. The open ends of the retorts are placed in the face wall of the furnace. Another fire clay receptacle, called a condenser, is fastened at the open end of the retort, so constructed that it may be wholly or partially closed, thereby regulating the gases developed within the retort. When the furnace is heated to the required degree of heat, the zinc therein volatilizes and passes to the condenser, where it collects in the form of zinc metal. The zinc is then removed from the condensers and poured in moulds for cooling, in which form it is known as spelter. A number of commercial products, by retreatment, are manufactured from the various furnace by-products.

The progressive mill construction and operation at the Sterling and Mine Hill mines, has been planned to correlate with the demands

of the smelting plants. Nearly all the ore from these mines is smelted at the plants of The New Jersey Zinc Company of Pennsylvania at Palmerton, Pennsylvania.

In the year 1896 a mill was built at the Parker shaft by the Sterling Iron and Zinc Company to treat the ores of the Sterling and Lehigh mines. This original mill was built for a daily capacity of 180 tons. By the addition of an annex and improvement of processes the capacity was increased to a daily output of 250 tons. This mill operated about fifteen years when it was dismantled. A larger mill in the meantime was built along the main line of the Lehigh and Hudson River Railroad. This mill, No. 2, began operating in the year 1900. As the mine output at Mine Hill constantly increased, this mill was improved and expanded, and is now after twenty-five years' service, treating all the ore produced at Mine Hill. The daily capacity of this mill is normally about 1500 tons. Modern power plants, steam and electric; shops, dryers, elevating and conveying appliances of improved design, are included in the complete operating plant.

The electric power for the present operation of the Sterling Hill mine and mill is generated at No. 2 mill power plant, located at Franklin.

A modern mill of 450 tons capacity was built at Sterling Hill about twelve years ago to separate the ore produced at the Sterling mines, and is of the same general type as the No. 2 mill treating the Franklin ores. It is located at the Sterling Mine shaft. The ore hoisted from the mine is delivered direct to the mill.

The mining industry as well as other enterprises is not without physical and financial hazards. Man cannot foresee what obstructions nature has placed in his path when he delves into the crust of old Mother Earth, to learn her secrets. The exploration and development of that part of Mine Hill controlled by the Sterling Iron and Zinc Company in the Rutherfurd-Parker tract, was not free from interruption, caused by the heavy water flow encountered.

In the year 1887 Honorable Richard Wayne Parker, of Newark, New Jersey, acquired a mining lease from Charlotte Rutherfurd, Executrix of John Rutherfurd, on a farm of some 375 acres lying northeast and abutting the 95 and 10/100ths acre Mine Hill farm. The north half of the Mine Hill farm was being operated by the Lehigh Zinc and Iron Company. Mr. Parker had been prominent in the former litigation of the Mine Hill law suits. From knowledge

thereby acquired, he conceived of a probable extension of the ore body under the Rutherfurd farm. Mr. Parker in 1899 assigned his lease of the Rutherfurd farm to the Lehigh Zinc and Iron Company. By later assignments, the Sterling Iron and Zinc Company, in 1891, acquired by lease all the minerals of the Rutherfurd farm. This company developed and operated within this property until 1897, when its interests were assigned to the New Jersey Zinc Company. The Lehigh Iron and Zinc Company, in 1889, proceeded to explore this territory by the use of diamond drills. Within the next two years they had drilled eight holes varying in depth from nine hundred to thirteen hundred feet. The result of this drilling proved the extension of the ore body into this property.

The Sterling Iron and Zinc Company, in 1891, having been assigned the Lehigh interests, started sinking the Parker shaft. This was a vertical, three-compartment shaft, located just east of the theoretical margin of the ore body. It was sunk to a depth of 950 feet. The sinking of this shaft progressed rapidly until it reached a depth of 580 feet, at which point a large open seam was encountered. When the miners drilled into this seam a rush of water compelled them to abandon the shaft as quickly as possible to save their lives. Within thirty hours this shaft was filled with water to within forty feet from the surface of the ground, which was the water level of the subterranean water in this locality.

The situation was discouraging. A new and expensive shaft had filled with water and the operators had no knowledge of its source, volume or the possibility of reclaiming the shaft. A geological survey was made by Mr. Frank L. Nason. After carefully studying the geology of the surrounding country, Mr. Nason determined the possible quantity of water that it might be necessary to pump from the shaft in order to lower the water level to the elevation of the open seam. After fourteen months constant pumping the water was lowered to the water seam and held at this elevation. A large excavation was cut into the north side of the shaft for a pumping station. In this room was installed a triple expansion Worthington pump, which was capable of handling the water coming through the crevice at this elevation. This being done, sinking of the shaft continued to a depth of 950 feet.

A permanent steam hoisting plant was installed, and the mining operations continued. This open water seam extended to the surface. After the water intercepted at the 580 foot level was drained, the

springs and wells in the adjacent territory ceased to flow. Several years thereafter an open seam of water was encountered in the hanging wall of the mine some 400 feet south of the shaft and about 300 feet lower than where first encountered. This made necessary the installation of another large pumping station on the 950 foot level north of the shaft, from which station the water of the mine was pumped to the surface until the Parker shaft was dismantled.

This was the last serious water flow encountered. The normal mine water is at present pumped from a pumping station on the 1050 foot level, south of the inclined Palmer shaft. Three electric driven centrifugal pumps are installed in this station. The normal water flow of the mine is from the natural surface drainage.

The present modern mining methods at Mine Hill and Sterling Hill were not possible during the early period of mining. The gradual improvement in the equipment and operations of mining have advanced with the metallurgical processes. The use of dynamite; the development of the steam and air drills; the application of electric energy for drilling, pumping and hoisting, are now applied in the mining industry.

The early mining at Mine Hill was confined to the southerly end of the ore deposit on the outcropping of the west vein to the northwest. The period from 1890 to 1910 marked the development of the northerly and easterly extension of the ore body. This was facilitated by the consolidation of interests of The New Jersey Zinc Company, in 1897. The present system of mining was planned by Mr. Robert M. Catlin, who became associated with The New Jersey Zinc Company as Manager of Mines in 1906. Mr. Catlin's broad knowledge and wide experience as engineer and manager of mines, both in the United States and the great gold fields of South Africa, qualified him to meet the mining problems presented at Mine Hill.

After much study the present stope slicing and top slicing method was adopted, whereby this great ore body, eventually and in the absence of disaster, will in theory be removed without sustaining any loss by ore being left in the mine. This method in detail is very ably described by Messrs. Benjamin F. Tillson and Clarence M. Haight in the Transactions of the American Institute of Mining and Metallurgical Engineers, published in 1917, under the title, "Zinc Mining at Franklin."

The mining plans adopted for the future mining of the entire deposit involved the sinking of a new shaft, the installation of elec-

tric underground haulage systems, the construction and equipment of a new pumping station, and other associated improvements. This new shaft, called the Palmer Shaft, was started in 1906. The head frame and shaft house is located about 200 feet south of the crushing house of Mill No. 2. This location has the advantage of delivering all the ore mined at Mine Hill at the mill for separating and concentrating. Prior to the installation of the Palmer Shaft, the ore from the Parker Shaft was transferred to Mill No. 2 by a railroad switch about one and one-half miles long over very heavy gradients.

Palmer Shaft is an example of the best modern practice in shaft construction and equipment. It is a four compartment shaft, having an inclination from the horizontal of 47° 30′. It is within the footwall of the ore body and from 50 to 100 feet distant from it.

The inclined length of the shaft is 1520 feet. Four tracks of 70 pound steel rail, 3′ 6″ gauge, are laid on concrete piers. The electric haulage systems are through the foot wall rock, and in a general plan extend the length of the ore body, and parallel with it. The ore, when broken down, is transferred by small tram cars from the working faces of the mine to the loading chutes, which deliver the ore to the electric haulage trains. There are large loading bins or excavations cut into the rock between the vein and the shaft, directly under the haulage tracks. The ore from the electric trains is dumped into these bins, from which it is delivered into the six-ton ore skips, or cars, which are hoisted to the shaft house from the several loading pockets. Two double drum, direct connected hoisting engines operate the shaft skips, capable of hauling their load at the rate of 3,000 feet per minute. Each engine controls the movements of the cars, or skips, of two parallel tracks, and are operated in balance, that is, when one skip is moving down the shaft, the other is moving in the opposite direction with equal speed. An electric signal system and a supplemental telephone system are in service. This gives duplicate means of communication between the hoisting engineer and the different landing stations located along the line of the shaft.

The first ore hoisted through the Palmer Shaft was in April, 1910. The Parker Shaft was operated only a short time after the Palmer Shaft was placed in service, when it was abandoned and the power plant dismantled.

Among the great number of people of the earth, few take an interest or give much thought about the marvelous facts of nature

that surround them. They see the earth in her varied forms, but do not inquire as to their origin or history, or learn of their relation to the human family. This is particularly true of the minerals and rocks of the earth crust. The sciences of geology and mineralogy cover this wide field of investigation. For three generations the Franklin district has been a prominent and exceedingly interesting field for the geologist and mineralogist. Many scientists have contributed to the literature that has been published about the rock structure and minerals of this locality. A brief review of these papers alone would fill a volume of very interesting knowledge.

About twenty years ago, the Department of the Interior of the United States, and the Geological Survey of New Jersey, in co-operation, published a very comprehensive report on the geology and mineralogy of the Franklin Furnace quadrangle. Eminent men of scientific training were assigned to this task. The title of this report is The Geologic Atlas of New Jersey, Franklin Furnace Folio.

Franklin has been called the Mecca of mineralogists. From the time when Dr. Fowler first brought this field to the attention of scientists up to the present time, more than one hundred minerals have been discovered, investigated and named. This is a greater number than has been taken from any mining district in the world. Many of these minerals are found only in this locality. Some species are brought to light, collected by the mineralogists of that period, and do not appear again for many years. A few have been found only once in a single locality.

Many of the minerals are massive in structure, others are in the form of crystals, sometimes transparent, of symmetrical structure and of beautiful color.

The study of minerals is most fascinating, since many factors enter into their character. One would observe first perhaps, if crystalized, their form, then the color, hardness, lustre, cleavage, fracture, all of which may be considered in the determination of the group or species to which they belong. Since many varieties have many characteristics in common, the specific gravity, the chemical analysis and the refractive indices of the specimen are necessary to determine the identity of the specimen. Those minerals which are not exceedingly rare, are to be found in all the museums of this country and Europe, also in the cabinets of private collectors.

The Franklin Furnace Folio issued in 1908 contains a complete list of all Franklin minerals known at that time. This was compiled

by Professor Charles Palache of Harvard University. In order to make this report complete, Professor Palache co-operated with public museums and many private mineral collectors who had given especial attention to securing minerals from the Franklin district, which enabled him to examine all the species then known. The result of his labor was the identification of ninety-one minerals, of which he gives the name, locality, system of crystallization, and chemical composition of each mineral. A worthy work, well done.

Franklin Borough is primarily the creation and outgrowth of the mining industry as developed at Mine Hill in the last thirty years.

In 1895 "Franklin Furnace" was a village of about 500 people, the population being centered near the lake and the iron furnace. This community in 1913 was organized as a borough then taking the name of Franklin. The operations at Parker Shaft, and later the construction of No. 2 Mill and Palmer Shaft at Greenspot stimulated building in this section. In 1927 we find a community of about forty-five hundred inhabitants living under modern business and social conditions. In fact, we may believe under many advantages not available in towns or small cities of many times the population. The vocational school of fifty teachers with about 1100 pupils enrolled, is an institution that is prominent among the public schools of the State.

The social life is centered around the Community House, which is equipped with game rooms, kindergarten, bowling alleys, library, etc., for the use and enjoyment of all citizens and societies. This is maintained by The New Jersey Zinc Company.

A modern hospital, fully equipped, owned and operated by The New Jersey Zinc Company, primarily for its employees, but available to the public at large, is an appreciated blessing not often found in a small community.

A public park, a public swimming pool, an athletic field, good roads, street lights, and water supply, are all factors that make Franklin Borough a thriving, contented and happy community that is sometimes called the model mining town of America.