

The Nickel Mines of Lancaster County

by Dr. John D. Long

The Lancaster County Nickel Mines have been the subject of several articles published over the last hundred years. The earliest reference that I have been able to find is The Second Geological Survey of Pennsylvania, published in 1880¹ which gives a wealth of technical information regarding the mines. Ellis and Evans² in their "History of Lancaster County" (1883) are possibly the second earliest reference discussing the Nickel Mines, followed by R. J. Houston writing in the Lancaster County Historical Journal in 1897. Later in 1924 H. L. Willig again in the Lancaster County Historical Journal discussed the Nickel Mines in considerable detail as did Jack Locher in 1960.⁵

In the local newspapers, the Nickel Mines have been the subject of feature articles several times in 1949⁶, in 1959,⁷ 1961,⁸ and finally in 1962.⁹ However each of these references have given us only part of the interesting story so that even though there is nothing new to add (since 1893 when the mines shut down) it seems time for someone to write the whole story both from a chronological as well as a technological standpoint. Also, certain papers and photographs collected by the late Mr. Walter R. Miller of Christiana have recently been made available through the kind offices of the Moore Memorial Library of Christiana and the photographs particularly, allow us to visualize the mines during the latter half of the past century, when they were really worked intensively.

Your author has no special qualifications for this task beyond a chemical engineering background and a general interest in historical Lancaster County plus a particular and continuing interest in the Nickel Mines from childhood on. He was also a student of Professor H. H. Beck, a past president of the Historical Society, who gave him a lasting interest in mineralogy and especially in the minerals of Lancaster County.

HISTORY

Mr. R. J. Houston³ searching the official records of the Land Department at Harrisburg found that William Penn, Esquire, Proprietary and Governor of Pennsylvania in 1681 granted and conveyed to William Bacon of Ye Inner Temple (London), 5000 acres of land in Pennsylvania. Later in 1718 Bacon released this land to Humphrey Murray and John Budd. The next year Murray and Budd sold this land to James Steel, who in turn, sold all but 100 acres. The 100 acres retained by Steel is the original tract on which the Gap Nickel Mines are located.

In 1730 James Steel purchased 150 acres of adjoining land from William Markham and then endorsed the total 250 acres, in parcels of 41.67 acres (one sixth each) to Thomas Penn, Andrew Hamilton, James Logan, William Allen, Thomas Schute and James Steel. From the above, it seems reasonable to accept the fact that valuable minerals were known to exist in the Gap Mine Tract as early as 1720 or perhaps 1722, since during this period when Steel sold 1400 acres of the original 1500 he retained 100 acres marked on the record "Mine Land at Octorara." One source¹⁰ states that some Marylanders discovered the mine in 1718 and worked it until stopped by the proprietors in 1719, but this seems unlikely. It seems more probable that, while considerable prospecting was done (by digging pits, etc.) before, the first regular working of the mine came after Steel purchased the additional 150 acres of the Markham tract in November 1730 and divided the whole mine tract between the six partners. Parenthetically, it should be noted that in the early days, the mines were worked for copper, not nickel, which was discovered much later.

Previous researchers, including Mr. Houston³ have been unable to find any written history of the working of the mines during the 18th century. However, a pamphlet¹¹ by Benjamin Henfrey (1797) was discovered by Mr. Charles Doble (the mine superintendent during its later working years) which is really a prospectus for the formation of a mining company, but in addition, gives considerable information regarding the early workings of the mine.

According to this pamphlet, the Gap copper mines were discovered by a German by name of Tersey, in or before 1732, and in that year the mine was opened and vitriolic springs discovered (copper springs). In spite of the potential value of the find, nothing was apparently done until 1756, when a report was written which attests to the fact that copper salts exist in the spring water and can be precipitated and plated out by immersing bars of iron in it. Some quantitative information is given and the flow of the springs is indicated to be 700-800 hogsheads flowing in eight hours. "The water is of a pale green color, of an acid, sweet, austere, inky and nauseous taste." The author of the report, John Ruddy, M.D. of Dublin, Ireland, compares the concentration of

copper salts in the Gap Mine water with the concentration of copper in several known European vitriolic springs and concludes that the copper content of the Gap water is higher than in any known springs of Europe.

It is interesting that Dr. Logan (an intimate of Benjamin Franklin) certified that Dr. Franklin had examined some of this spring water and confirmed the presence of copper by plating it out on his penknife.

The pamphlet next discusses Mr. Henfrey's plans to rehabilitate the mines. To clear the mine of water, he proposes a 25 foot water wheel turned by water from three small streams to provide power for pumping. He chose this method over the use of a steam engine because of its much lower cost and simpler operation and maintenance.

Mr. Henfrey estimates the cost to rehabilitate the Gap Mines at \$10,000. To this figure he adds first year costs of \$20,000 for bar iron to plate out the copper, \$10,000 for labor and management and \$11,712 to be paid to the lessees (one sixth of the expected profit).

Mr. Henfrey expected to produce 300 tons of fine copper the first year at \$400 per ton, 300 tons of copperas at \$30 per ton and 10 tons of fine copper precipitated from ore. Altogether he calculates \$133,000 income less \$51,712 expense giving a net profit the first year of \$81,288. A net profit of \$256,000 is calculated for the second year (1799).

There is evidence that Mr. Henfrey did, in fact, organize his company and rehabilitate the mine. Captain Doble in 1897 found the remains of a twenty five foot water wheel located right on the edge of the old East Shaft and also the remains of a tail race 300 yards in length brought up from the meadow below to the water wheel. It is about equally certain that the venture was not successful and that the Gap Mines were shut down and remained down until about 50 years later.

In 1849 interest in the mines was renewed, The Gap Mining Co. was formed and the mines reopened. A 25 horsepower steam engine was installed for pumping and hoisting and considerable copper ore was found and produced. This ore was sold to smelters in Boston and Baltimore, but apparently at a loss. At that time, it was not known that the ore body contained nickel in addition to copper, and large quantities of Millerite (an important nickel sulphide ore) were mistakenly identified as "mundic", an almost worthless iron sulphide, and discarded. In 1852, a young man by name of Charles Doble (who later became mine

Map of Nickel Mines from Second Geological Survey.

Study of the old photos shows that the following shafts and facilities were grouped around the Millerite shafts: Outside Pump Shaft, Air Compressor and Hoist House, Hocking Shaft, Brown Shaft, 1880 Cave In, and Carpenter Shop. Grouped around the Old Shaft, at east end of the vein were: Main Shaft, Inside Pump Shaft, Dickerson Shaft, Laver Shaft, North Shaft, Picking House, 1885 Cave In, and Open Cut Shaft. The locations of the following shafts are not known: Blacksmith Shop Shaft, Udy Shaft, Crab Shaft and New Shaft.

superintendent) came to work as a miner for the Gap Mining Co. Being of an inquiring turn of mind and doubtful of the true nature of the discarded "mundic" he sent samples of it to chemists in Boston and Baltimore for analysis. Apparently the results were unsatisfactory because he subsequently forwarded new samples to Professor F. A. Genth of the University of Pennsylvania in Philadelphia. Professor Genth, an eminent chemist of his day, correctly analyzed the ore as nickeliferous pyrite containing two to three percent nickel. (Much later Professor H. H. Beck²² of Franklin and Marshall College confirmed the Genth analysis and identified the main ore constituent as the mineral Millerite (NiS). At this point production of nickel ore began and the name of the company was changed to the "Gap Nickel Mines." The ore was sold to a company in Philadelphia. A year or so later, another company erected smelting works about three quarters of a mile north of the mines. Smelting, however, proved unprofitable and in 1859 the Gap Nickel Mines bought the smelting works, but in 1860 they closed down all operations as unprofitable.

In November 1862 Joseph Wharton of Philadelphia bought the company. He pumped out the mines, repaired and rebuilt stacks and furnaces and in May 1863 returned the mines to operation under Captain Doble as superintendent. He also bought a factory in Camden N. J. which he fitted up as a nickel refinery and called it the "American Nickel Works." It can be inferred that the operation was profitable since sizable amounts of ore were produced, smelted and refined each year until 1877 when a business depression occurred. There is some doubt about the actual quantities of ore produced each year, but figures prepared by Captain Doble for the Second Geological Survey of 1880 show yearly productions as follows:

1858 to 1860	12,667,000 pounds
1863	4,500,000 pounds
1864 to 1875	8,378,000 pounds

For comparison, when running at full blast, production was 600 tons per month equivalent to 14,400,000 pounds per year.

It is interesting to note that in 1863 nickel was selling at \$3.50 per pound and Gap produced 15% of the world's nickel. Two years later the price dropped to \$1.58 per pound but in 1866 Gap still produced 25% of the world's supply. A year later, 800 tons of cheap nickel came down from Sudsbury, Ont. (produced by open pit mining) and by 1890 Sudsbury was producing 1700 tons of refined nickel and the price had dropped to 21c per pound. By 1893, the Gap Mines were down to 0.2% of world nickel supply and closed permanently. In 1899 a new shaft was drilled as a promotional device to sell the mine. In 1901, International Nickel Co. bought the mine from Wharton but did not record the deed since the company was not authorized to do business in Pennsylvania. All transactions were handled through Captain Doble. During World War II International Nickel Co. drilled some cores at Gap but never published the findings.

LOCATION and GEOLOGY

The Gap Nickel Mines are located in Bart Township of Lancaster County, 13 miles east of Lancaster and 5 miles south of Strasburg. They are situated on a prolongation of the same Eozoic belt which makes the Gap Hills and Welsh Mountains. The nickel lode is a vertical contact vein between the main hornblende rock formation and the walls of mica schist against which it rests. It is lenticular in shape and extends nearly east and west, varying from about 4 to 35 feet in thickness (See Map).

The ore is essentially Millerite (NiS) mixed with hornblende and mica schist. Millerite itself contains about 60% nickel but the Gap ores seem to vary from 1.5 to 5.0% nickel (and cobalt). Small amounts of copper (0.1 to 2.0%) are also present.

The smelting works are three quarters of a mile north of the mine in Paradise Township.

PHYSICAL ASSETS and FACILITIES

The mines, when fully developed in 1893 contained twelve shafts varying in depth from 60 to 235 feet over a surface distance of 2000 feet, together with connecting tunnels, galleries, pumping and hoisting equipment. Above ground there were operating facilities consisting of a compressor house, pump houses, "picking" house, smelter buildings and five shops for blacksmiths, carpenters and coopers. Non operating structures included:

- Large mansion house for the superintendent
- Large country store called the Whitehall store
- Twenty two tenant houses for workmen
- Three barns, stable and sheds
- Township schoolhouse
- Episcopal church (erected 1857)¹³

The original mine tract bought by Wharton was 80 acres. Later 188 acres of farm land adjoining was added. The smelting works tract was 9 acres and some additional land purchased later brought the total acreage to 351.

Thirty horses and mules were used in the mine operation.

LABOR and WAGES

In 1876 the following work force was employed and paid the corresponding wages:

At the Mines

First Class Miners	16	\$1.60/	Day
Miner's Helpers	30	\$1.25/	Day
Surface Laborers	40	\$0.45-0.70/	Day
Engineers and Mechanics	7	\$1.50-1.80/	Day

Total Mine Labor Force 93

At the Smelter

Furnace Hands	12	\$1.44/	Day
Engineers and Mechanics	7	\$1.50-1.80/	Day
Common Laborers*	31	\$1.05/	Day

Total Smelter Force 50

Teamsters and Farmhands 18 \$1.30/ Day

Total Workmen Employed 161 \$1.14/ Day roughly

To complete the picture, about 100 more men were employed at the Camden Refinery.

* It is difficult to understand why laborers working at the smelter were paid wages 50% or more higher than those paid laborers at the mines. Perhaps the smelter work was more hazardous and disagreeable with large volumes of sulphur dioxide continuously emitted from the hot furnaces.

OPERATION

A report prepared by Charles Doble for the Second Geological Survey dated October 2, 1875 plus backup memos provide the only detailed information on the mine operation. In addition, some notes by Mr. Miller relating to his photographs give corroborating details and some additional clarity regarding the mine equipment and operation.

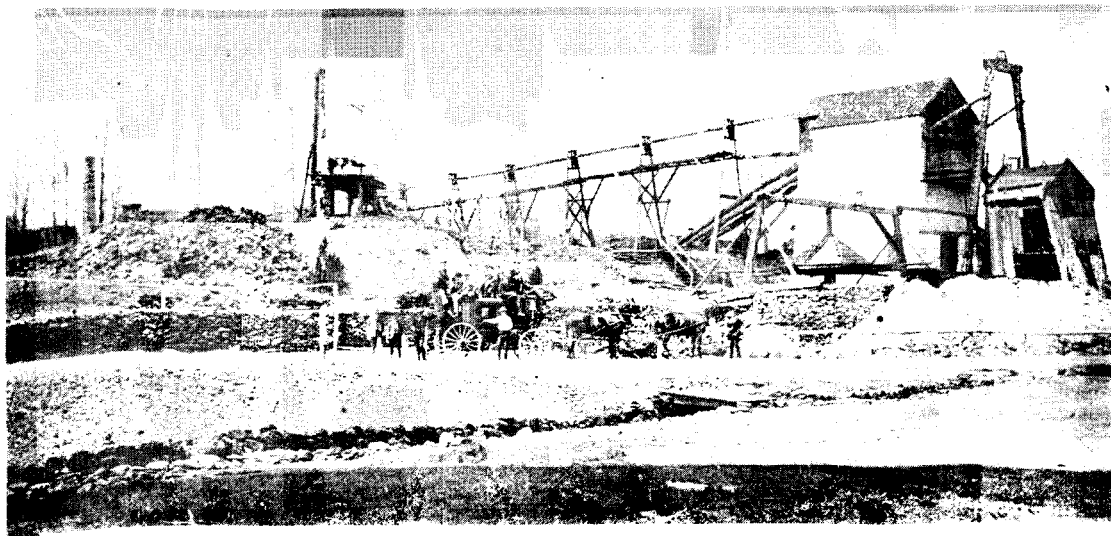
In 1875 the mine had six shafts varying from 100 to 235 feet deep plus a few other shallow shafts 60 to 80 feet deep. When the mines were shut down in 1893, as mentioned earlier, there were twelve shafts. All shafts were vertical. The shafts were spaced along the vein for a distance of 2000 feet. They were usually named either for their location such as Blacksmith Shop Shaft, North Shaft, Outside Pumphouse Shaft, Inside Pumphouse Shaft etc. or for persons such as Lavar Shaft, Hocking Shaft, Udy Shaft, Brown Shaft etc, etc.

The mine was kept clear of water by a Cornish pumping engine of 100 horsepower. It pumped from two shafts located 550 feet apart. The engine was located above the Inside Pumphouse Shaft, which was about 175 feet deep and contained a 13' diameter plunger pump with a 6' stroke, operated by the Cornish engine. The engine also supplied



Inside Pumphouse - about 1876

Structure shaped like a pyramid is the capstan. Structure behind the pumphouse is the so-called "flat rod" connecting the "bob" operated by the Cornish steam engine to the Outside Pumphouse Shaft pump (an 8" x 8" white pine timber 600' long). The opposite end of the "bob" actuates the inside pump in the shaft. The frame in front of the pumphouse is 60' high to the pulley. It was here that a man stood on his head.



Talleyho before Inside Pumphouse - 1903

Side view of Inside Pumphouse, showing "flat rod", Dickerson Shaft (left center) and

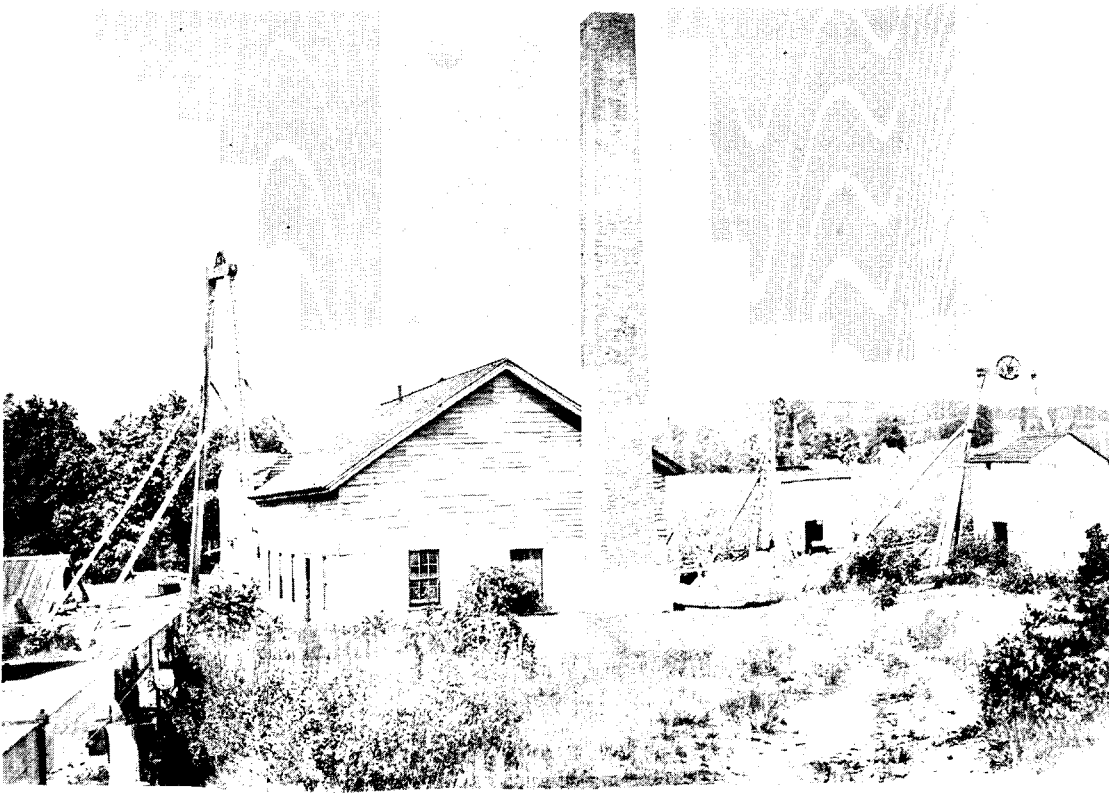
power by means of a 600' white pine rod (timber 8" square in thickness) called a "flat rod" to another shaft (called the Outside Pump-house Shaft) which was 235 feet deep and equipped with a 12" diameter plunger pump with a 6' stroke. Captain Doble says in his report¹ that in 1877 two strokes per minute equivalent to 153 gallons per minute were sufficient to keep the mines clear of water. Steam for the engine was produced from anthracite coal burned at the rate of 1000 pounds in 24 hours. A 25 horsepower high pressure steam engine supplied power for hoisting the ore from the mine.

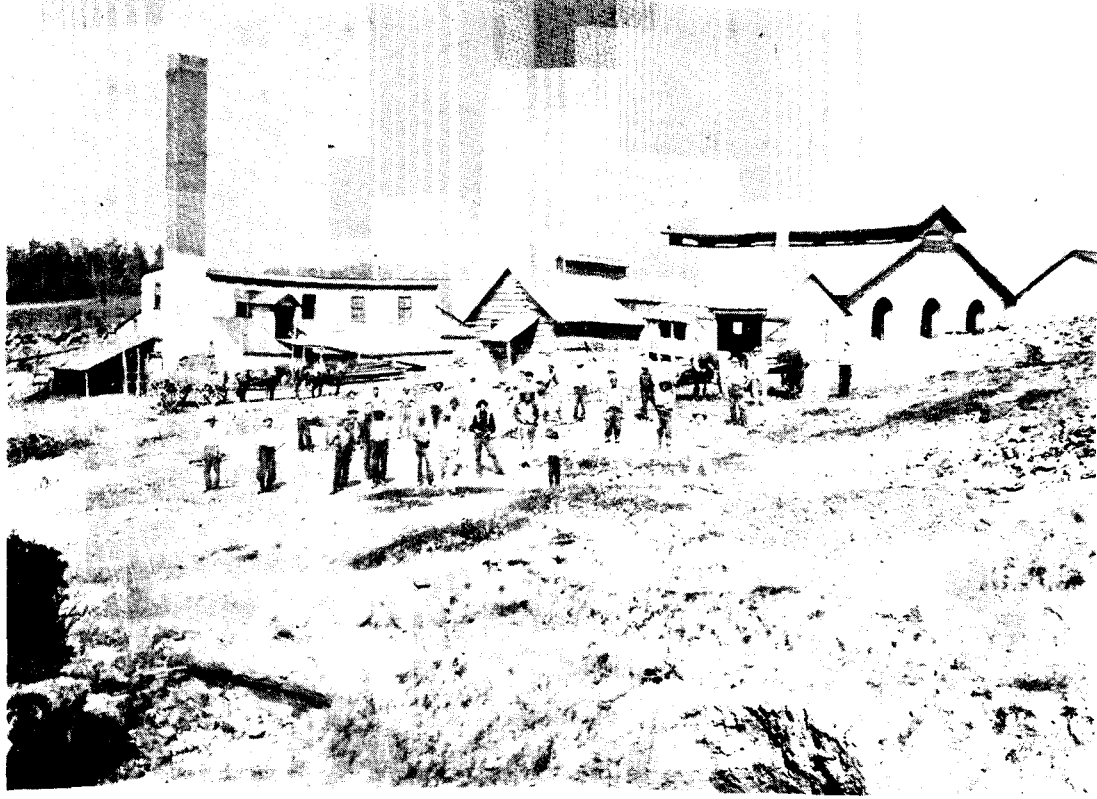
The ore, after mining, was brought to the hoisting shafts through tunnels in small railroad cars of one ton capacity and then hoisted either in large iron buckets (½ ton capacity) or in square wooden boxes of one ton capacity called "skips" working in guides, both by use of a seven eighth inch wire rope.

When the ore reached the surface, it was prepared for smelting by breaking up the large lumps with sledges, picking out and discarding the rock, washing and hand picking the middle sized chunks and

Air Compressor and Hoist Houses - 1876

Shown are (1) "flat rod" to outside pump shaft, (2) air compressor and hoist houses, Hocking and Brown shafts (to right of compressor house). Cave in occurred in 1880 over these two shafts.





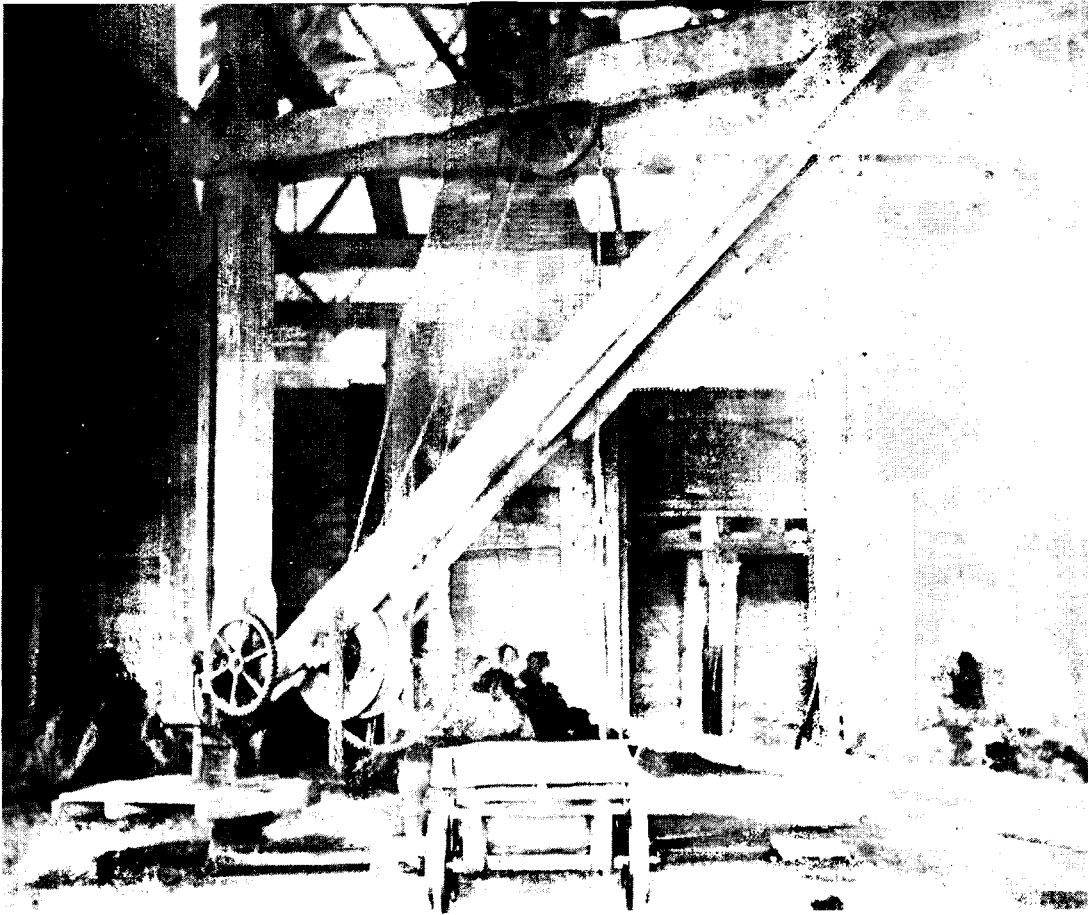
Smelting Works - about 1885

“jigging” the fine particles. “Jigging” is the separation of dross from ore by means of the difference in specific gravity when immersed in water. The ore was then transferred by horse and wagon to the smelting area. According to Mr. Miller’s notes, two horses and four mules were used to haul the ore to the smelter and to haul coal and coke from Gap to the mine.

At the smelter, the ore was first put through a Blake rock breaker and then into roasting kilns. There were eleven kilns for roasting, each of 100 tons capacity. One and one half cords of wood were needed to fire a kiln. Once fired, the kiln burned on the sulphur content of the ore for five to six weeks without additional fuel.

After cooling, the burned ore was put into a smelting furnace and melted. Four smelting furnaces were used, two in blast at a time. Limestone and quartz were used for flux in the smelting operation.

Captain Doble’s report is not explicit in the fuel needed to heat the smelters. However, the inference is that a small amount of firewood only would be needed to heat and start the combustion and smelting, after which the operation would be exothermic and furnish its own heat for melting the ore to produce “matte.” If necessary, coke was also used to provide additional heat for melting and ore reduction. Air for the combustion and melting was supplied by three blowing cylinders of 32” diameter and 24” stroke. Two of these cylinders were in blast at



Inside of Smelter Furnace House - 1885
Three furnaces shown.

one time. A 25 horsepower steam engine drove the blast cylinders, while another similarly powered engine drove the rock breaker and the Cornish crusher.

The product from the smelter furnace called "matte" was produced as a liquid and run into sand molds to form "pigs." The solid "pigmatte" was first run through a rock breaker then through a Cornish crusher to produce a coarse powder, which was put into 1000 pound barrels and shipped to the Camden refinery.

ECONOMICS

We are indebted to Jack Locher⁵ for the little information available on the financial and economic picture of nickel production at Gap.

In 1860, the Eighth Census lists the mine as producing \$30,626 worth of nickel ore. The company was capitalized at \$90,000 and it paid \$18,000 to its 40 employees. Looking first at the labor item and assum-

ing that the mine operated 300 days of the year, the average wage would have been \$1.50/Day/Man. This figure compares with about \$1.14/Day/Man in 1876 and may not be too unreasonable when considering that since large quantities of "mundic" (nickel ore) had accumulated over the years, fewer common laborers may have been needed and larger number of higher paid smelter workers.



Smelter Workers
Captain Doble sixth from right.

As mentioned earlier, at that time, refined nickel was selling at about \$3.50 per pound. It can be assumed that the ore produced and valued at \$30,626 is worth that amount to the nickel refinery plus the cost of refining. Roughly, the refinery, employing 100 people, would incur labor costs of \$1.50/Day/Man or \$150 per day. This is equivalent to about \$45,000/year. Therefore the ore to the refining company must have been worth say \$50,000 plus \$30,000 (paid to the mines) equal to \$80,000. At \$3.50/lb., this means the production was 22,900 lbs. of refined nickel. Assuming a 90% yield on smelting and refining overall and 2% nickel content in the mined ore, we arrive at an ore production figure for 1860 of 1,270,000 lbs. This figure is very much less than the

12,700,000 lbs. estimated by Captain Doble and the discrepancy is hard to explain since the census gave no tonnage figures on ore produced.

Finally, we might look at how well the company was doing from a "return on investment" standpoint. If we assume that the only major expense of the mining company is labor, the \$30,626 of ore production less \$18,000 in wages would yield \$12,626 profit. This is too high by the cost of coal for pumping and hoisting estimated at ¾ ton per day of anthracite coal- say \$5/Day or \$1500/Year. Allowing for management and miscellaneous costs we can round off the profit to \$10,000 per year. This represents a return on capital of 11% per year, hardly a good reason to shut down the operation.

Again, according to Locher, in 1870, the census showed \$24,000 of production, \$60,000 capitalization and \$6400 wages to 48 workers. Looking at labor first, the average wage would have been a very meagre \$0.44/Day/Man. Again estimating ore production, using similar means to that above and estimating the price of nickel at \$1.30/lb. gives a figure of 3,160,000 lbs./Year versus Captain Doble's figure of 8,400,000 lbs./Year.

Return on capital in this case is:

$$\frac{\$24,000 - 6,400 - 2,000}{\$60,000} = 26\%/\text{Year}$$

This is, of course, an excellent return and would indicate that the company was doing very well financially although it would appear that their success was gained by squeezing the poor workers. If the company had continued to pay workers at the 1860 rate of \$1.50/Day/Man the return would have been reduced to essentially zero.

Finally, in 1880, the census showed \$149,890 production (corresponding to 299,780 lbs. of nickel ore), \$19,000 paid to 60 employees and capitalization of \$325,000.

As regards wages- \$1.06/day/man is a reasonably good check with Captain Doble's figure of \$1.14/day/man from above.

Calculating production as previously, and using \$1.06/lb. nickel price, we get:

$$\frac{\$149,890 + \$50,000}{\$1.06 \text{ (0.90) (0.02)}} = 10,482,000 \text{ lbs.}$$

a fair check with Captain Doble's figure of 8,400,000 lbs. The figure of 299,780 lbs. obviously refers to the ground "matte" shipped to Camden, containing about 63% nickel (189,000 lbs.) worth \$200,000.

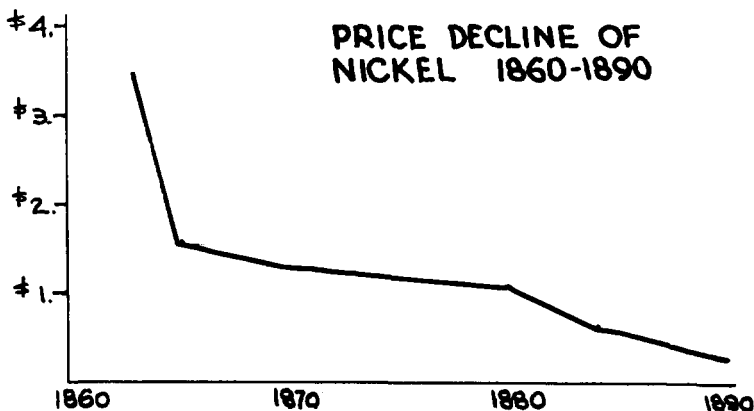
As to return on capital:

$$\frac{\$149,980 - 19,000 - 2000}{\$325,000} = 39\%/\text{year, a really hand-}$$

some return, indicating that even as late as 1880, the Gap Nickel Mines were financially healthy. The impact of the Canadian nickel had already been severe but not fatal as yet.

From the rough production calculations, it could be concluded that in 1860 production of nickel ore greatly exceeded nickel demand with the price of nickel so high. In 1870, the price had dropped to around \$1.00/lb. which stimulated demand although not enough to require the mine's capacity for ore production. In 1880, the price was still dropping and demand increased to require the full mine ore production.

We can speculate on the demise of the company as follows: In 1890, the price of nickel had dropped to \$0.21/lb. If we assume production was held constant at 8,400,000 lbs./Year, the nickel in the ore was worth only \$31,750 - less than the \$50,000 needed to refine it. Since no prospects for higher priced nickel appeared likely, the company was forced to close down operations* .



Curve showing variation of nickel prices 1860 - 1890

* It will be appreciated that a great deal of the data for the above analyses are speculative and inexact. For example, the correct price-time relationship for nickel is unknown but can be estimated reasonably well from a curve (see figure) drawn for the period 1860 through 1890. Similarly, we are uncertain as to the nickel content of the Gap ore, although some analyses¹⁴ are available from the appendix to Captain Doble's report for the Second Geological Survey. Just the same, it is interesting and informative to speculate on the economic success of the company over 30 years time.



Old Cave In - about 1885

Cave in was behind original "picking house" near the Mine Shaft. Captain Doble's house is in the background. A new shaft, called the "Open Cut Shaft" was sunk in the bottom of the cave in.

ADDED ITEMS OF INTEREST

Two cave-ins occurred in the mines- one in 1885 in back of the "picking" house and the other in 1880 near the Hocking and Brown Shafts near the compressor house.

In 1901, the mine was visited by Mr. Monel, the inventor of the important nickel alloy of the same name. He commented that the mine was a "very crude affair."

A rather prominent landmark at the mine was the capstan. It was a vertical hub with eight spokes. It was used for lowering pump rods and timbers down the shaft into the mine and usually required 10 to 15 men to operate.

In 1896, the hurricane, which destroyed the covered bridge at Columbia, Pa. blew down the stack over the boilerhouse.

Later, after operations had ceased, in 1910, a fire destroyed most of the mine buildings. They were never restored.

SUPERINTENDENT
CAPT. CHARLES DOBLE,
NICKEL MINES POST-OFFICE,
LANCASTER COUNTY, PA.

NICKEL MINES AND FURNACES.

Lancaster Co., Pa. January 27 1889
Mr. John Leech

Dear Sir

I was notified quite late last night, that Eleven hundred dollars that was promised to be paid to me next Friday - Feb 1st, will not be paid until August 1st. In consequence of this disappointment I cannot make the loan that you and I were speaking of last evening. And I now take the earliest moment to inform you of it so that the trustees may not be put to any inconvenience in the matter.

Yours Truly
Chas Doble

Letter from Charles Doble to John Leech - 1889

Mr. Leech's identity is not known to the author. However, he was evidently very much interested in the mines since in 1907 he wrote a "Brief History of Copper and Nickel Mines in Bart Township, Lancaster County, Pa. 1717 - 1907," probably as a promotional device to sell the property.

At one time when the mines were operating, a man was said to have climbed to the top of the frame over the landing house and stood on his head. When Captain Doble heard of this he asked the man if it were true and when the stunt was confirmed, he reprimanded him at considerable length and then gave him 25 cents to do it again.

EPILOGUE

In order to check first hand, in so far as possible, on the accuracy of our analysis of the history and economics of the Gap Nickel Mines, the author paid a visit to Nickel Mines, Pa. and made the acquaintance of



Captain Doble's house today

Mr. Clayton Woerth, the present owner of the mine land. Mr. Woerth bought the entire mine properties from the International Nickel Co. after World War II. He had previously turned down that company's offer to install him as resident superintendent of their Gap Mining Co. properties. Since assuming ownership, Mr. Woerth has renovated many of the original mine houses (including Captain Doble's mansion house - see photo) and sold them, together with most of the land adjoin-

ing the actual mining area. At present, he still owns the mining area itself. In order to eliminate the danger of people falling into the shafts, he has filled all of them in with refuse and land fill. He has also cleared brush and debris from the area which now overlooks a pretty little artificial lake made by damming one of the small runs which was originally used to supply water for the mining operations. All mine shaft locations are still plainly visible and some mine spoil around each attests to their original purpose. It is interesting to note that the original vitriolic springs from the mine are still flowing with sufficient copper salts present to prevent any fish or other marine growth in the resulting run for several miles.

The smelter area is completely free of any of the mine buildings or



Slag Piles in Smelter Area - 1975

equipment. The tall stack, which remained for many years after fire had destroyed everything else was more recently brought down by dynamiting to prevent its becoming a hazard to people walking nearby (see photo). All that remains of the smelting operation are the great piles of slag showing the size and shape of the smelting vessels from which it came as molten material. This area still looks like the "Mountains of the Moon" as the New Era so aptly described it in a 1960 article.

The author is indebted to Mr. Woerth for his review of the present article.

NOTES AND BIBLIOGRAPHY

1. Second Geological Survey of Pennsylvania
The Geology of Lancaster County
by Persifor Frazer, Jr.
Harrisburg 1880
2. History of Lancaster County
Ellis and Evans (1883)
3. "The Gap Copper Mines"
R. J. Houston
Lancaster County Historical Society Journal
Vol. 1 (1897) pp 283-298
4. "Two Notable Mining Industries of Lancaster County"
H. Luther Willig
Lancaster County Historical Society Journal
Vol. 28 (1924) pp 73-78
5. "A History of Mining in Lancaster County"
Jack Locher
Lancaster County Historical Society Journal
Vol. 64 (1960) pp 1-16
6. New Era May 27, 1949
"Geologist says Two Idle County Mines Could Again Yield Ore"
7. New Era Feb. 21, 1959
(No title)
8. New Era (1961)
"Name Changed, Fortune Smiled on Nickel Mines"
9. Sunday News Dec. 2, 1962
"Lancaster's "Moon Mountains" Are Monument To Once Great Industry"
10. Everts and Stewarts' Historical Atlas of Lancaster County
11. "A Plan with Proposals for Forming a Company to Work Mines in the U. S. and to Smelt and Refine the Ores, Whether of Copper, Lead, Tin, Silver or Gold"
Benjamin Henfrey
Philadelphia Library, No. 91,025
Printed by Snowden and McCorkle
47 N. Fourth St., Philadelphia, Pa. 1797.
12. The Minerals of Lancaster County
H. H. Beck, Lancaster, 1912.
13. "Digging and Devotion at the Nickel Mines"
Jean M. Lichty
Journal of the Lancaster County Historical Society
Vol. 68 No.3 1964.
14. Report on "Mineralogy of Pennsylvania, 1875
Professor F. A. Genth, University of Pennsylvania.

ABOUT THE CONTRIBUTOR

John D. Long is a native Lancasterian (born here 1907) and a graduate of Franklin and Marshall (B.S. 1928), Lehigh (M.S. 1930) and Penn State (PhD 1932). Almost his entire career has been in the petroleum refining industry with the Exxon Corporation. After retirement from Exxon in 1967, he taught Business Administration at William and Mary College in Williamsburg, Va. and spent another year managing the

startup of a small oil refinery on Guam, which supplies products to the Navy and Air Force on the island. More recently, he did consulting and study work for a proposed refinery in Ireland. In 1974, he and his wife (Katherine) decided to leave the New York metropolitan area, move back to Lancaster and retire once more. His present interests are maintenance supervision for the First Presbyterian Church, Service Corps of Retired Executives, tennis, bass fishing, landscape painting, travel, two grandsons and of course the Lancaster County Historical Society.