SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS IN 1877.

CCC.



# THE GEOLOGY OF

# LANCASTER COUNTY.

BY

PERSIFOR FRAZER, JR.

WITH AN ATLAS

CONTAINING A COLORED GEOLOGICAL MAP OF THE COUNTY;
LOCAL MAP OF THE GAP NICKEL MINE;
MAP AND SECTION OF THE EAST BANK OF THE SUSQUEHANNA RIVER;
OTHER GEOLOGICAL SECTIONS ACROSS THE COUNTY;
AND TWO GEOLOGICAL COLORED MAPS
OF
YORK AND ADAMS COUNTIES.

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## Chapter IV.

### *Mining Industries, etc.*

Among the most important mining industries of Lancaster County will naturally come that which for so long a time was unique in this country, viz: a mine and furnaces by means of which nickel was produced regularly and on a large scale. The history of this enterprise will be found further on, given by the intelligent superintendent, Capt. Doble.

The mines are situated on a prolongation of the same Eozoic belt which makes the Gap Hills and Welsh Mountain and have been heretofore considered under the name of the Georgetown series. The area thus referred to is almost surrounded by limestone, the broad Lancaster limestone bounding it to the north, and the Chester Valley limestone to the south.

As will be seen in the excellent map, for permission to re-produce which in this report I am indebted to my friend Mr. Wharton, the great dyke mentioned often before cuts the S. E. corner of the hornblende mass which carries the ore.

The following is a history of the prosecution of work in this mine since 1718, made by Captain Doble for the annual report of the Secretary of Internal Affairs of the Commonwealth, in 1875:

"According to authentic history, the Gap Mines had been worked for their copper prior to the year 1744, and from traditions of the neighborhood, they were first discovered about the year 1718. For eighty or ninety years after their discovery, they were worked at intervals by four or five different companies, but none of those companies ever found

sufficient copper to pay expenses, and consequently they would work them at a loss for awhile, and then abandon them, and let them stand idle, until new parties would take hold of them, and start them up again.

"In 1849, after those mines had been standing idle for thirty or forty years, a stock company was formed under the name of Gap Mining Company, to work them again for copper. They worked them on a rather larger scale than the previous companies; put up a twenty-five-horse power steam engine, for pumping and hoisting; employed a number of miners and laborers, and found considerable copper ore, which they sold to copper smelters in Boston and Baltimore, but there was not nearly enough to pay the expenses of working the mines. Nothing was known here at that time about nickel; although in mining copper, large quantities of nickel were mined along with it, and thrown away as worthless. It was called by the miners "Mundic," (sulphuret of iron,) a very plentiful and nearly worthless mineral.

"In the beginning of 1852, the present superintendent of those works came to the Gap Mines to work as a miner. He immediately discovered, and made known that what was termed Mundic, and was being thrown away as refuse, was not Mundic, but some other mineral—what mineral he could not tell. This led to samples of it being sent to chemists in Boston and Baltimore, but their analysis proved unsatisfactory. Finally, in the latter part of 1852, or the beginning of 1853, a sample was sent to Prof. F. A. Genth, a celebrated chemist of Philadelphia, who made an analysis of it, and pronounced it nickel, and gave the percentage of pure nickel contained in the ore. Thanks to Dr. Genth.

"At this point the "Gap Copper Mines" changed to "Gap Nickel Mines." The Gap Mining Company then mined the nickel ore and sold it to a separate company who smelted it for awhile in Philadelphia. A year or two afterwards another separate company erected smelting works about three quarters of a mile north of the mines. They bought the ore from theGap Mining Company and smelted it there, but the smelting of nickel proved unprofitable, consequently the

smelting works changed hands several times with considerable loss to the owners. In 1859 the Gap Mining Company bought those smelting works and smelted their own ore, but in 1860, finding that neither mining, nor smelting, nor both together would come near paying expenses, they closed down the whole concern, mines, smelting works, and all. This finished up the Gap Mining Company's operations; they never worked it again. It remained idle nearly two years, the mines filled with water which ran out at the top of the shafts: engines and other machinery rusting out, furnaces and stacks which were nearly worn out before, now decaying and crumbling to the ground. Such was the condition of things when the present proprietor, Joseph Wharton, Esq., a Philadelphian, took hold of it in November, 1862. He, at that time, bought of the Gap Mining Company one half of the concern, and leased the other half for a term of years, but shortly after he bought the other half also, thus owning the whole concern—mines, smelting works, machinery and all. The whole, of course, costing him a large sum of money. He immediately commenced repairing the engines, blowing cylinders, &c.; pumped the water out of the mines; re-built the furnaces and stacks; and by the following spring, May, 1863, got into operation the mining, smelting and refining of nickel. Perhaps I ought to state here, that at the time Mr. Wharton bought the mines and furnaces, he also bought a large manufacturing establishment in Camden, New Jersey, and fitted it up for a nickel refinery. For be it remembered that when the metal leaves Gap furnaces it is not nearly pure, only a part of the dross, or worthless matter, has been taken out; in that condition it is called *matte*, and is thus shipped to the refinery in Camden, where it goes through a great many processes requiring much time, labor and skill to bring out the pure nickel. In fact, the processes of making nickel are so tedious and complicated that nearly a year elapse after the ore is mined before finished nickel is produced therefrom. Surely a man must have a great amount of courage, as well as capital, who, in the face of all this, undertakes such a gigantic concern alone, after seeing that so many strong companies have tried

it before him and failed: but Mr. Wharton not only made the attempt alone, but stuck to it, and by sheer force of perseverance and expenditure overcame all obstacles, built up one of the completest nickel establishments in the world, and by vigor and economy made mining and making of nickel in America a successful industry, thus bringing many thousands of dollars every month into Lancaster county.

"The mines are situated in Bart township, and the smelting works about three quarters of a mile north of them in Paradise township. The original mine tract, bought by Mr. Wharton, of the Gap Mining Company, was 80 acres, since then he has bought 188 acres adjoining farm land. The original smelting-works tract was 9 acres. He bought in addition to this 74 acres, making total mine and smelting-works tracts 351acres. There is on those properties a large mansion-house at the mines where the superintendent of the works resides, a large country store and dwelling (White-Hall store) near the mines, 22 tenant-houses which are occupied by the workmen, 3 barns, stables, sheds, &c. A township school-house near the mines, and a commodious Episcopal church on the mine tract, erected in 1857, the Gap Mining Company donating the land for church and grave-yard. About 30 horses and mules are owned and employed about the works hauling ore, matte, fuel, &c. An hundred hands are employed at the mines, 50 at the smelting-works, and 100 in the refinery. The mines are opened out on the vein in length by shaftsand tunnels about 2,000 feet, and the deepest point attained is 235 feet. There are 6 shafts ranging from 100 feet to 235 feet deep, and a few others from 60 feet to 80 feet deep. All the shafts are vertical. The ore is rarely found in paying quantities nearer than 50 or 60 feet to the surface. There are 2 steam engines at the mines, one a low pressure Cornish pumping engine, 100 horse power, for pumping the water out of the mines, and the other a 25 horse power, high pressure, for hoisting the ore and rubbish out of the mines.

"The veinstone, or rock matter mixed with the ore, is a dark colored highly crystalline hornblende, considerable quantities of which has to be mined along and hoisted with

the ore. The ore, after it is mined, is brought through the tunnels to the hoisting shafts in small railroad cars, carrying about a ton each, it is then hoisted to the surface in large iron buckets, carrying about 1,000 pounds each, or in square wooden boxes (skips) working in guides, carrying 2,000 pounds each. After the ore is brought to the surface, it is prepared for the smelting works by breaking up the large lumps with heavy sledges, and picking out the rock or refuse matter from it, washing and hand picking the middle size, and jigging the fine, (jigging is a process of separating the rock matter from the ore in water by the difference in their specific gravity). After it is prepared it is hauled to the smelting works, where it is first put through Blake's rock-breaker, then into large roasting kilns, and set on fire to drive off a part of the sulphur it contains. When once on fire, it burns 4 or 5 weeks without other fuel. After cooling, it is next put into the smelting furnaces and melted. This smelting does not bring out the pure metal, only a part of the worthless matter is taken out by it. The product of the furnace is a kind of a concentrated ore, called matte. The matte comes out of the furnace in a liquid state, and is ran into pigs in sand moulds, similar to pig iron from an iron furnace. This pig matte is next put through the rock breaker, then through a powerful Cornish crusher, by which it is reduced to a coarseish powder, into barrels, which is filled (1,000 pounds in a barrel,), and shipped to the refinery in Camden.

"There are two 25 horse-power steam engines at the smelting works. One drives the blast cylinders which give blast to the furnaces, and the other drives the rock breaker and Cornish crusher. There are three blast furnaces, but only two in blast at a time. There are also there a cooper shop, a blacksmith shop and a wagonmaker shop. We mine and smelt 636 tons of ore per month. The ore when it leaves the mines contains from one to three per cent. of pure nickel. It also contains cobalt, copper, iron and sulphur. Pure nickel is worth from $2 to $3 per pound. The refinery is called the 'American Nickel Works,' and its products are pure nickel, nickel oxide, nickel alloys, nickel castings,

nickel salts, pure cobalt, cobalt oxide, cobalt alloys, cobalt castings, cobalt salts, copper, blue vitriol, &c.

Yours truly,

CHARLES DOBLE."

*Oct. 2, 1875.*

The following is a summary of details presented by Captain Doble for use in this report, and prepared by him for that purpose, (with Mr. Wharton's permission), September 22, 1877.

In answer to the appended printed list of questions, Captain Doble sent the replies which follow.*

1. Name of bank?
2. By whom leased, and since when?
3. How long in operation?
4. Character of ore?
5. Amount procured per day?
6. How many workmen employed, and in what manner?
7. What horse-power engine employed?
8. Cost and quantity, and kind of fuel consumed?
9. Description of important pieces of machinery?
10. Proportion of wash and lump ore?
11. Distance to shipping station, and cost per ton per mile on road?
12. Teams owned by company, or private?
13. Who uses the greater part of the ore, and for what purpose?
14. Is there too much or too little water?
15. Is it got out by cart or inclined railroad?
16. How does it lie in its bank?
17. What is its character, and dip of the foot and hanging rock?
18. Dip of all neighboring rocks, and distances from bank?

* These questions are embodied in a circular printed by me shortly after the commencement of the Survey, in 1874, for the use of my aids and to give an idea to bosses of mines, &c., of the kind of information which we required. As the mines were exclusively iron mines in the district in which I was then working, the last two questions refer to it specifically, but the circular is equally convenient for any other product.

19. What kind of iron is made, and how sold?
20. The analysis of the ore, and of the iron made from it?

Prof. PERSIFOR FRAZER, Jr.:

DEAR SIR: I herewith send you a few items in relation to Mr. Wharton's nickel works:

1st. Gap Nickel Mines and Furnaces.

2d. Owned and worked by Joseph Wharton, of Philadelphia, since 1862.

3d. . . . . .

4th. Nickel Ore (Nickel Pyrites). Contains from one to three per cent. of pure nickel; it also contains Cobalt, about one twentieth, and copper, about one third as much as the nickel.

5th. From January 1st, 1876, to January 1st, 1877, mined and smelted 7632 tons—636 tons per month.

6th. Number of workmen employed and wages paid, in 1876:

| | | |
|---|---|---|
| First class Miners, . . . . . | 16, | at $1.60 per day. |
| Miners' Helpers, . . . . . | 30, | " 1.25 " |
| Surface Laborers, selecting ore, &c., | 20, | " 1.05 " |
| Boys, washing, jigging, &c., . . . | 20, | " 45 cts. to 70 cts. |
| Engineers and Mechanics, . . . | 7, | " $1.50 to $1.80 |
| Total Force at the Mines, . . . | 93 | |
| Furnace hands at smelting works, | 12, | at $1.44 per day. |
| Engineers and Mechanics, " " | 7, | " 1.50 to 1.80 |
| Common Laborers, " " | 31, | " 1.05 |
| Total Force at smelting works, . | 50 | |
| Teamsters and Farm hands, . . | 18 | at $1.30 |
| Total workmen employed, . . | 161 | |

On April 1st, 1877, reduced the working force about one third, production about one third, and wages about fifteen per cent. In consequence of the existing stagnation in business, the force has since then been further reduced, and a complete stoppage of all operations is now contemplated.

The ore vein is perpendicular, (*i. e.*, *vertical*,) and is from

4 feet to 30 feet wide (and in some places is even wider than 30 feet). About two thirds of all the stuff mined goes to the furnaces, and about one third is waste. The gangue is hornblende, and the rock, for two or three hundred feet north of the vein is also hornblende, pieces of it, and also pieces of the south side rock I sent you.

The mine is opened out on the vein in length by shafts and tunnels, about two thousand feet, and the deepest point attained is 235 feet. There are eight shafts, ranging from 100 feet to 235 feet in depth, and two or three others from 60 to 80 feet deep.

All the shafts are perpendicular, (*vertical,*) and all made secure by cribbing. The ore is taken to the surface through those shafts either by skips or buckets. The skip is a square wooden box, working in guides, and takes up about a ton at a time. The buckets are made of $\frac{1}{4}$ inch boiler plate, and take up about 1200 pounds at a time. A 25 horse-power, high pressure steam engine, with a $\frac{7}{8}$ inch wire rope, does the hoisting from all the shafts.

A 100 horse-power, low pressure Cornish engine does the pumping. This Cornish engine has an unequal beam—8 feet stroke in the cylinder, and 6 feet stroke in the shaft. Cylinder, 3 feet diameter. Is calculated to run ten strokes in one minute, or one stroke in ten minutes, according to the amount of water to be lifted. It pumps from two shafts 550 feet apart, one shaft 6x11 feet, 175 feet deep—13 inch diamater plunger pump, 6 feet stroke; the other shaft, 10x 13 ft., 235 feet deep—12 inch diameter plunger pump, 6 feet stroke. At present two strokes—153 gallons—per minute keep the mines clear of water. Consumes 1000 pounds No. 1 anthracite coal in 24 hours. Delivers just the right quantity of water for washing the ore, jigging, &c.

The ore is rarely found in paying quantities nearer than 50 to 60 feet from the surface. The mining is done by shafting, tunneling, and stoping. The tunnels, or galleries, are generally about 60 feet below each other, and the vein between is taken out by stoping. The stoping is done either upwards or downwards, whichever is the most convenient. The rock and vein, to the depth of 60 or 70 feet from the

surface, is very rotten and decomposed, and it requires a great deal of heavy timbers and planks to keep the sides and top from caving in. Below that point, the rock and vein are very hard and firm, and have to be all blasted out.

The mines are situated in Bart township, 3½ miles south of Kinzer's station P. R. R., and the smelting works ¾ of a mile north of the mines in Paradise township, 2¾ miles from Kinzer's station.

At the smelting works there are 11 kilns for roasting the ore, which hold 100 tons each. It takes about 1½ cords of wood to fire a kiln. When once on fire, a kiln will burn 5 or 6 weeks without other fuel than its own gases. There are 4 smelting furnaces, 2 in blast at a time. Use limestone and quartz for fluxes. There are also two 25 horse power steam engines at the smelting works, one drives a 9x15 Blake rock-breaker, and a powerful Cornish crusher, and the other drives the blowing cylinders. Three blowing cylinders 32 inches diameter and 24 inch stroke. We have no pressure gauge, but we regulate the amount of blast according to the requirements of the furnaces.*

The works have also two blacksmith shops, a carpenter shop, a cooper shop, and a wagon-maker shop.

The original mine tract that Mr. Wharton bought with the mines in 1862 was about 100 acres. Since then he has bought 350 acres adjoining farming lands to it, which now makes one connected tract of 450 acres, of which 380 acres are farming land.

Yours, truly,

CHAS. DOBLE.

*Sept. 22, 1877.*

At the date of the visit to the Gap Nickel mines by the author, Aug. 29, 1877, the following notes were made, which will be found partly to embody the information given above by Capt. Doble, but partly also to refer to other matters.

*The matte made here was for some years mainly sold to England and Germany, but now is sent to Mr. Wharton's refinery, at Camden, N. J., (the American Nickel Works,) where metallic nickel, cobalt oxide, and blue vitriol are the principal products. All these articles are of the first quality, the two latter are consumed entirely in this country; the nickel being of latter years, in excess of the consumption of this country, has been in part exported

*The Furnaces.*

The furnaces were under the management of Mr. Rupp in Capt. Doble's absence.

Of the four furnaces here but one was in blast. The blower was driven by one 25 horse-power engine, and the rock-breakers and Cornish crusher by a 25 horse power engine. The pressure at the tuyeres was about 1½ lbs. per sq. inch, (=1.0545 kilograms to the square centimeter.)

The ore at the mine is worked over with sledge hammers. The larger stuff is treated in the Blake crusher No. 9, which will take a rock 9″x15″ (22.8x37 5 centimeters), and the smaller stuff is washed and hand-picked, and the fine jigged.

From here the coarse stuff goes into the roasting kilns, and the fine stuff is cemented together into brick shaped lumps and goes into the smelting furnace.

The ore for roasting is broken coarse, 2″ to 3″, the limestone and flint (or quartz) for flux is broken finer. The matte is crushed in the Cornish crusher and is then barreled and shipped to Camden.

The rates of wages paid the hands at the above date here follow:

| | | $ cts. |
|---|---|---|
| (50) Fifty surface hands, | per day, . . . . . | 0.90 |
| (6) Six furnace " | " . . . . . | 1.25 |
| (15) Fifteen miners, | " . . . . . | 1.40 |
| (25) Twenty-five miners' laborers, | " . . . . . | 1.10 |
| 96 men, at per day, | . . . . . | 101.00 |

The fine stuff was washed at the mine, and cemented together at the smelting works by means of lime water. About 15 p. c. of all the ore mined is fine, and is thus treated.

A number of mechanics, engineers, carters, masons, carpenters, blacksmiths, &c., &c., are employed on the surface in numbers varying with the necessities of the mine.

Of these the engineers and mechanics get from $1.50 to $1.80 per day.

After the ore is thoroughly washed, it is charged in certain proportions, depending upon circumstances, into the furnaces and smelted.

There is a spring in the valley below the slag banks from which the water necessary for the boilers, brick-making, &c., was drawn, but it has so deteriorated within the last few years by the infiltration of waters, containing free sulphuric acid from the slag banks, that the necessary water is now pumped by a water-wheel in Wolf Rock Hollow, quarter of a mile away, which lifts it 102 ft. vertically.

There are eleven roasting kilns, each of 100 tons (101.6 tonnes) capacity.

On the average eight or nine kilns are kept in operation at once, and burn about five or six weeks.

The roasting is such that assuming the ore to have 25 p. c. of sulphur when put in, it comes out with about 5 p. c.

The ore, which is principally Millerite, (or Nickel Sulphide,) occurs principally as the lining to a hornblende rock, which lies like a huge "horse" in the coal regions. This rock is lenticular in shape, and strikes nearly east and west, averaging about 300 ft. (92.4 m.) in width. No ore of any consequence is found in the interior portions of the rock, but the main supply occurs as a contact vein between the surface of this hornblende gangue and the walls of the schist against which it rests.

The main shaft is nearly 240 ft. (73 meters) deep, and the hoisting is done on skips or in iron buckets, as described in the previous portion by Capt. Doble.

It is about 60 ft. (18.3 meters) from the mouth of the shaft to the top of the ore in the first drift.

The power for pumping the western mine is transported about 500 feet (152.4 meters) by a wooden shaft, commonly called by miners "flat-rods."

The consumption of coal used to be about 800 lbs. (363 kilograms) in 24 hours to pump for one mine alone. With this long connection the expenditure is only 1,000 lbs. (453.6 kilograms) per 24 hours, for pumping both mines, so that the expenditure of 200 lbs. (90.7 kilograms) frees the second mine of water. A 25 horse power engine does the hoisting.

When running at full blast, (as was the case May, 1877,) the average yield was about 600 tons (609.3 tonnes) per month, but as appears by Capt. Doble's statement above, 636 tons have been produced in this time.

At the time of this inspection about 300 or 400 tons were being got out. There are about 10 or 12 shafts altogether, old and new.

About 80 gallons of water per minute discharged from each of the two working shafts, free the entire mines from water.

Its water-making average is therefore about 160 gals. (605 liters). per minute.

E. 20° S. is about the average strike of this mass of hornblende, but this can only be said in a general way of a line which should be so placed as most nearly to divide the mass horizontally into two equal parts. The outside surface is very irregular and has only been ascertained as a result of the extensive exploitation and mining which has been done here.

At the west pump shaft the hornblende rock is about at its narrowest point.

Eastward from this west pump shaft the richest ore is found on the south side of the hornblende, and westward from the same point, on the north side. This renders it probable that this hornblende mass is cleft, or at least penetrated by the deposit under this pump shaft.

About 164 ft. (50 meters) southwest of the main shaft an opening 65 ft. (20 meters) N. E. & S. W. and 33 ft. (10 meters) wide and 40 ft. (12 meters) deep [originally 130 ft. (40 meters) deep] the ore comes nearest to day. The country rock on the S. E. side, supported by timbers, is a green mica schist. The hornblende lies to the N. W. The ore comes to within 16.4 ft. (5 meters) of the surface, and was wrought to 130 ft. (40 meters) in depth.

The country rock is generally a red ferruginous decayed mica schist.

The width of the slope varies from 6 ft. to 20 ft. (1.83 meters to 6.1 meters). It is well timbered and the timber is in good condition. Near the eastern extremity of the

drift a slope is cut, exposing the foot wall which (*in the mine*) seemed to be a kind of hydro-mica slate.

At 170 ft. (51.81 meters) from day in the East side of the main shaft the vein seems to be about 35 ft. (10.66 met.) thick. A large chamber is cut out on the N. W. side (i. e. north side of the hornblende dyke).

The north shaft enters an end of this northwest chamber which is about 20 ft. (6.1 meters) wide, the vein being vertical.

About 500 ft. (152.4 meters) west of the main shaft the vein narrows in to about 8 feet (2.4 meters) thick. The mica slate (which shows indications of the proximity of trap) dips N. 15° W.—75°, but seems to get more vertical above.

Rock in the cross cut at 110 ft. (33.8 meters) dips N. 15° W.—80°. The rock is a very arenaceous decomposing mica schist.

In the breast at the north-west heading on the 110 ft. (33.8 meter) level and about 200 feet (60.95 meters) from the west pump shaft, the men were driving in a vein about 40 ft. (12.19 meters) thick. Many so called boulders or detached masses of hornblende exist in the solid ore. Some of these are each 1 yard (or meter) in diameter. Some times but not always the contact surface of the boulder and surrounding ore is richer.

About 159 ft. (35.6 meters) north from this shaft on the sixty foot (18.29 meters) level is a very rich pocket of ore. The Millerite usually coats the upper or lower surface of fissures or cracks in the vein, the nickel being carried in solution along the cracks.

Stalactitic structure is often noticed leading from one wall of a cleft to the other, or connecting mammillary concretions.

Near the heading on the slope from the 60 ft. to the 100 ft. level (where the richest ore is at present* found, and which was just now referred to), 20 to 35 foot timber stulls were being put in, of which one end is yet in solid ore.

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*Sept. 4, 1877.

The actual thickness of the vein here exposed is about 35 ft. (7.6 meters).

The plunger of the force pump is 13 inches (30.5 centimeters) and six feet (1.83 meters) stroke.

The map of the mine and adjoining lands, made by Mr. W. M. Cooper, of Christiana, for Mr. Joseph Wharton, the proprietor, and kindly furnished the Survey by the latter gentleman for publication, will give the relative positions of the trap, ore, and schist better than any mere verbal description.

The irregular wedge shaped mass is the hornblende lying completely insulated in the mica schist.

The course of the portion of the great Point Airy—Peters Creek dyke through this map is seen in the right hand lower corner.

### *Mining Localities of Fulton Township.*

The products of Fulton township obtained by mining are essentially of three kinds.

First, the chloritic argillites which form the roofing slates on the borders of Drumore, and which are extensively mined on the York County shore of the river, and still more extensively a little over six miles (or some ten kilometers) across the S. E. corner of York County, in the State of Maryland.

Second, the Serpentine belt, from which Chromite and Magnesite are obtained, and manufactured into magnesia salts for the drug trade, and chrome colors.

Many years ago Isaac Tyson, of Baltimore, followed up the Serpentine range which crosses the Patapsco northwest of that city, for the purpose of securing all the available magnesite mines which occur principally in connection with those rocks. In this manner he located many tracts for future mining in Lancaster County, amongst which several have become famous to collectors of cabinet specimens of minerals. Although Magnesia was the product originally desired, these explorations opened up in the same localities large quantities of Chrome ores, which afterwards obtained great mercantile value.