GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

A RECONNOISSANCE REPORT

ON THE

LEAD REGION OF HENRY COUNTY,

WITH SOME NOTES ON

OWEN AND FRANKLIN COUNTIES,

BY CHARLES J. NORWOOD.

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PRELIMINARY LETTER.

Professor N. S. SHALER, *Director Kentucky Geological Survey:*

DEAR SIR: I herewith submit to you a report of a reconnoissance made in the lead district of Henry county, during the month of May, 1875.

I trust that it may be found of service to all interested.

Respectfully yours,

CHARLES J. NORWOOD.

LEXINGTON, KY., December 1st, 1875.

A RECONNOISSANCE REPORT ON THE LEAD REGION OF HENRY COUNTY, WITH SOME NOTES ON OWEN AND FRANKLIN COUNTIES.

I.

HISTORY OF THE MINES.

The existence of lead in Henry county is not a recent discovery. It is a well-assured fact that the deposits attracted attention as far back as 1815, and perhaps even at an earlier time.

There is a legend current that silver also was found; this, however, is simply another instance of that delusion so common to all mineral districts, or even in regions having no metalliferous deposits. Those who tell the tales are, usually, thoroughly honest in their belief, however great may be their mistake. The story concerning the silver of this county grew from the fact that, some thirty-five or forty years ago, a family bearing the name of Knight, which lived on Drennon Creek, and occupied a cabin on the land then belonging to a Mr. Minor (now the property of Mr. S. Loudon), conducted themselves in such a manner as to bring them under suspicion of secretly coining money.

The story is, that persons journeying in the neighborhood at night would see bright lights in the house even at midnight, the house being so illuminated by flames, which were supposed to issue from a furnace, as, at a distance, to appear "all ablaze." The Knights, however, received warning of the traveler's approach from their dog, and the house would be darkened before it could be reached.

Finally, suspicion increasing against them, they were driven from the county. After their departure several parts of

money moulds were found where they had been secreted in the woods, and, as the relater believed, near their old cabin.*

This was accepted as conclusive proof that Knight had been engaged in making *silver* money, and that the silver was found in the immediate neighborhood.

So far as the supposition that Knight coined money is concerned, the legend is doubtless correct; that it was *silver* money, however, is not so well proven.

It seems simply to have been an instance of counterfeiting, the place being selected for the operation on account of its seclusion.

The absurdity presented by the statement that the metal was silver should be apparent to any one. Had it been that metal, it would have been a mere waste of labor and ingenuity for Knight to have done the coining, as the silver could have been exchanged at the Government Mint for its worth in dollars already coined.

This matter has been given greater prominence than would have been due to it were it not that many, both in and out of the county, have an abiding faith in the existence of a "silver lode" in the county, and entertain notions of searching for it.† All search for the metal will prove futile, and it is simply an utter waste of time and of money to prosecute it.

The oldest "digging," so far as could be ascertained, is on Mrs. Eliza Ann Green's farm, about two and a half miles eastwardly from Franklinton and eight miles from Lockport. Excepting a number of fragments of limestone which are scattered near by, all signs of the digging have disappeared, the excavation having become filled level with the surface with debris washed down from the hillside. A few years ago, however, the pit was only partially closed, sufficient yet remaining open to show that the opening was about 10 feet square. Mrs. Green states that the pit was opened about 60 years ago, before the place was cleared, the land then belonging to

* It is said that a man named Margo also coined money.

† Indeed, I noticed in one of our county papers, published in May of the present year, a letter from a gentleman professing strong belief that a silver lode is to be found in Henry county, and to a certain extent urging that it be searched for.

a Mr. Cook. It is presumed that the digging was done by the settlers in order to procure lead for domestic use. This is, doubtlessly, the correct view of the matter. Other pits were subsequently opened in the region at various times to procure the mineral.

In 1823 or 1824 a Mr. Suckett opened a pit on Jas. Roberts' place, where the "Silvér and Spar" mines are now located; it was merely a "prospect hole," and nothing of consequence was done. This pit, so far as could be learned, stands next in age to that on Mrs. Green's land.

The next record we have of any mining was in 1825 or 1826, at which period a Mr. Ficklin mined on Big Twin Creek, in Owen county, at Flannigan & Hunter's Mill. A period of 10 years then succeeded in which no new developments seem to have been made.

In 1836 Messrs. Perkins and Little (from Shelby county, it is believed) erected a furnace on the site of the present "Silver and Spar" mines, and smelted a small amount of lead. The works were on quite a modest scale, and were operated for only a short time.

Three years later, in 1839, two men, Messrs. Barbour and Waggoner, had a pit sunk to a depth of about 50 feet on the McCrell place, in Owen county, then known as Meach's bottom.

About fifteen years ago, perhaps not quite so long, quite an excitement prevailed for a while concerning the lead deposits, and considerable was done in the way of either buying or leasing lands for mining purposes. After a few excavations were made, however, the excitement died away, or rather slumbered to be renewed at intervals up to the present time, when it has, perhaps, attained its greatest degree of energy.

For an interval, however, extending from 1839 or 1840 to 1865, no openings of much consequence were made. No regularly organized plans were formed for working the deposits until about 1865 or 1866.*

*This is in accordance with what information could be gathered at the time. Much trouble was experienced in the effort to get at the history of the mining operations, as many of those who were supposed to know had, with the exception of Mr. Raser (to whom I am indebted for much of this sketch), very imperfect memories as far as regards this matter.

About the year 1865 a company from Wisconsin opened pits on farms belonging to Mr. Wallace and Mr. Roberts, near Lockport, and also leased or bought the right to mine on the farm of Mr. Aris James, which is about one mile in a westwardly direction from the village. A larger amount of work was done on the latter place than on the farm of either Mr. Wallace or Mr. Roberts. Nothing of consequence resulted from it, however, and after a number of shallow pits had been excavated, the spot was abandoned, and has so remained to this time.

At about the same period an organization known as Stewart & Company gained possession of the openings on James Roberts' place ("Roberts' Landing"), hitherto mentioned. They were succeeded by Parker & Company, a Philadelphia company, who in turn were succeeded by the present owners.

Not, however, until within the past two years has any mining been done on an extended plan. In 1873, or about that time, a company, incorporated under the name of the "Silver and Spar Mining Company," assumed charge of the mines—or more properly diggings—at Roberts' Landing, as already intimated.

Little work was done, however, until about one year ago—in the spring and summer of 1874—since which time the work has been carried forward with considerable rapidity. These mines are the only ones properly deserving the name in the county. In 1874 a shallow pit was dug in near proximity to Drennon Lick by Messrs. Hardin and Hurl; but very little more was done than sinking the shaft.

This brings the history of the mining down to the present year, during which period, at least not anterior to June 1st, when the region was examined, no new openings have been made.

Although somewhat incomplete as a detailed history, this sketch is believed to be as nearly correct and comprehensive as can now be obtained.

The several localities already mentioned are treated of in more detail on succeeding pages; and, in addition, a number of diggings that are not mentioned here are discussed.

As a matter of interest and of instruction it would be well to have a trustworthy account of the amount of money that has been expended on the lead deposits of this county from 1815 to 1875, without the return of a dollar of *actual* profit; unfortunately, however, no data for this computation can be had.

II.

GEOLOGY OF THE LEAD REGION.

The sub-structure of this lead region is formed of Upper Cambrian rocks, their precise age, however, being somewhat obscure.

Fossils that in other States are considered typical of the Hudson River and of the Trenton Groups are here found together, and ranging almost throughout the series. The paleontological evidence would point to the identity of these rocks with both of the groups above named, but the mingling of the forms prevents the location of any definite line of separation. They certainly are, in part, of the same age as the Cincinnati Group, and the most pleasing solution of the question regarding their age is to consider them equivalent in part to the Hudson River Group, merging into Trenton beds below.

Dr. Newberry, in volume 1, part 1, of the "Final Geological Report on Ohio," gives as his reason for retaining the name "Cincinnati Group" (given by Meek and Worthen) for the series of limestones and shales of which the rocks in this district form a part, that the group is equivalent both to the Hudson River and Trenton Groups, of New York, and not, as some have believed, because the term "Hudson River Group" was a misnomer; later investigations prove it to have been correctly applied.

As the rocks in this district are, without doubt, near the base of the Cincinnati Group, they probably include, towards

their base, beds equivalent to the Galena limestone of Illinois. It may, therefore, be provisionally accepted, until more definite knowledge is gained concerning them, that the rocks in this district include equivalents of the *Galena limestone*, with *Hudson River* beds at the top.

Professor Whitney's description of the *Galena limestone* (which lies next below the Cincinnati Group) is as follows: "The *Galena limestone*, as usually developed, is a rather thick-bedded light grey, or light yellowish-grey dolomite, distinctly crystalline in texture, and usually rather granular, although occasionally quite compact. The coarse-grained portions frequently contain small cavities of irregular shape, which are often lined with minute crystals of brown spar. In its chemical composition this rock is quite homogeneous; it is almost a pure dolomite, since the various analyses which have been made show it to contain only from two to five per cent. of substances insoluble in acid (clay and sand), while the remainder is a mixture of carbonate of lime and magnesia, in the proportion necessary to form dolomite (carbonate of lime 54.35, and carbonate of magnesia 45.65 per cent.), with one or two per cent. of the carbonate of the protoxide of iron, which becomes gradually peroxidized on exposure to the air, and traces of the alkalies, chlorine, and sulphuric acid. * * * The upper layers of the Galena limestone are usually more regularly and thinly bedded than the middle and lower. * * At the very summit of the formation the rock is quite shaly and argillaceous, indicating a passage into the Cincinnati Group above. * * The middle portion of the Galena limestone is usually very heavy-bedded, crystalline, and marked by an abundance of flints arranged in parallel layers. * * * The maximum thickness of the Galena limestone, where none of it has been removed by denudation, is from 250 to 275 feet."

The limestone, which in this region is supposed to be the equivalent of the Galena limestone, does not answer to the foregoing description in every respect. An analysis, made in

the laboratory of the Survey, of samples taken from near the Silver and Spar mines, shows its composition to be as follows:

Carbonate of lime	95.770
Carbonate of magnesia	1.378
Alumina, iron, etc.	1.060
Silicious residue	.980
Total	99.188

It will be seen that these samples do not even approach a dolomite in composition, as the proportions of the carbonates of lime and magnesia are not such as are required to form this substance. This analysis cannot be used as a representative one, as it is not made from an averaged collection of samples. Nevertheless, it is undoubtedly true that the amount of magnesia in the rock is quite small. It is, however, of comparatively little importance, except as a matter of scientific interest, whether or not the rock is the equivalent of the Galena limestone. It at least occupies the place in this lead region that the Galena limestone holds in the lead district of Illinois, whether that limestone has thinned out in this direction or simply changed in its composition.

The group of rocks in this region is made up of a series of limestones and shales in the upper part, with a series of massive limestones at the base.

The total visible thickness of the whole section is between 325 and 375 feet.*

The shales preponderate greatly towards the summit, the limestone beds being thin and scarce. For this region the group has been locally divided into the "Shale and Limestone" division, which, without doubt, is part of the Cincinnati Group, and the "Massive Limestone" division, which may, in part, correspond to the Galena limestone.

The thickness of the first named division is at least 160 feet, and of the massive limestone about 125 feet, the base of which is not visible. The accompanying plate represents

*This is probably not the total thickness for the county; the upper series may be thicker by 50 to 75 feet, possibly more, than was seen in the region under study.

sections made at and near Lockport, which may be taken to represent typical ones of the entire region.* It may include certain rocks seen near Drennon Lick; but their place is yet unsettled; and for all practical purposes it matters little whether or not they are included.

A detailed description of the strata making up the sections is here given.

Section 1, made on the Franklin and Flat Creek road, descending toward Lockport to Six Miles Creek.

1. Drab shale and limestone. The limestone is in beds of two to six inches in thickness, sparsely scattered through the shale. The top beds abound in *Strophomena alternata*, *Zigospira modesta* (?), and corals . . . . . 50 feet.
2. Drab shale with a few limestone beds. The limestone at the top is mostly drab, earthy, and somewhat sandy, and in thin layers. *Leptaena sericea* (?) and corals are found, the latter being quite abundant. This division differs principally from No. 1 in the great preponderance of the shale over the limestone. About the middle, for 30 feet, there is scarcely any limestone. Towards the base, however, the limestone increases, some of the beds measuring six inches in thickness. . . . . 75 "
3. Drab shale and limestone. The limestone beds are coarse in texture and bluish grey usually, and are filled with *Leptaena sericea* and *Orthis emacerata* (?). The downward limit of the *Leptaena* is about five feet above the base of this division . . . . . 40 "
4. Limestone with some shale. Some of the limestone beds are 12 inches thick. Gasteropoda make their appearance in this division, and mark it as the "Gasteropod Beds;" they are *Cyclonema bilix*, *Bellerophon bilobatus*, *Pleurotomaria lenticularis* (?), *Murchisonia bicincta*, etc., associated with *Strophomena alternata*, *Zigospira modesta*, *Anodontopsis* (?), and an *Orthoceras* . . . . . 35 "
5. Nearly all limestone with some shale partings. Organic remains are mostly corals and *Zigospira modesta* . . . . . 30 "
6. Limestone abounding in *Rhynconella capax*, and containing great numbers of *Zigospira modesta* at the middle. "*Rhynconella capax* bed" . . . . . 10 "
7. Grey and bluish heavy-bedded limestone. *Strophomena alternata* is abundant in most of the layers, and especially at the bottom. The rock also contains what appears to be a small specimen of *Orthis subquadrata*, and also one of *Orthis lynx?* To Six Miles Creek . . . . . 85–90 "

Another section was made on the Pleasureville road, on the hill back of Lockport, which differs somewhat from the foregoing in its upper members. It is No. 2, and as follows:

1. Reddish-brown shale, somewhat marly, with a few beds of drab sandy limestone scattered through it . . . . . 5 feet.
2. Coarse, bluish-grey limestone and a little drab shale . . . . . 25 "

*The section representing the beds at the Silver and Spar mines should be opposite the lower part of the section No. 2. Its position on the plate is due to a mistake.

3.	Shale and limestone	20 feet.
4.	Limestone and shale, mostly coarse limestone	5 "
5.	Shale, with some limestone	15 "
6.	Shale, with a little limestone at the base	45 "
7.	Shale and limestone, limestone predominating in the lower 5 feet	25 "
8.	Shale and limestone. The limestone beds are usually drab colored, and sandy in composition. Some are blue at the interior but drab outside, and a few of the beds are dark grey in color and coarse-textured. These are so abundantly filled with *Leptaena* as to fit them to be called the "*Leptaena beds*"	35 "
9.	Coarse limestone and shale, mostly limestone abounding with purple shells of *Orthis emacerata?*	5 "
10.	Limestone and shale	20 "
11.	Nearly all limestone. About five feet of the upper part is made of shale. The gasteropod beds of section No. 1 are included in this number	55 "
12.	Limestone, the *Rhynconella capax* bed	2 "
13.	Grey sparry limestone	4 "
14.	Grey limestone, containing much calcite, contains remains of *Strophomena* shells replaced by calcite; also corals, and fragments of Crinoid columns. *Strophomena alternata* is quite abundant at about the middle of the bed	15 "
15.	Hard, sparry limestone; color, bluish grey to light grey; lies in beds of from three inches to six inches or one foot in thickness, and is crossed by numerous seams of calcite. The rock is filled with *Strophomena alternata*, which was the only fossil found	3 "

The lead deposits here are in numbers 14 and 15.

On the Kentucky river, opposite "Little Mountain," near Mr. Patterson's house, the following section was obtained. The measurements were approximated:

1.	Grey crystalline limestone, with aragonite filling the shrinkage cracks	6 feet.
2.	Blue limestone, containing gasteropods, several specimens of a *Modiolopsis*, and a few trilobite plates	5 "
3.	Ashy blue earthy limestone abounding in trilobites, and with aragonite filling the cracks and joints	5 "
4.	Grey limestone, lumpy on the surface	8 "

Ambonychia radiata, *Strophomena alternata*, and trilobites, probably belonging to the genus *Asaphus*, were found in addition to those fossils mentioned above.

The rocks in this lead region are nearly horizontal, although from Frankfort down the Kentucky river to a point below the mouth of Drennon Creek there certainly is a fall of the beds in a northwardly direction. At Frankfort a limestone is exposed near the water's edge, which is below any in this district.

III.

SOME GENERAL NOTES ON MINERAL DEPOSITS.

It is deemed advisable, for the benefit of those unfamiliar with ore deposits, to give some notes on their various forms before entering into the discussion of those in this region. Among the classes of ore deposits are numbered veins, segregations, impregnations, and ore beds. The only form, however, found in this district, so far as I am aware, is to be classed among the veins.

Veins have been divided according to their texture, position, and extent into—

1. True veins;
2. Gash veins;
3. Segregated veins;
4. Bedded veins;
5. Contact veins; and,
6. Lenticular veins.

Among these many modifications are found; and all authors do not adopt precisely the same form of classification.

Lenticular veins may more properly be termed lenticular vein-masses, as they are the fillings of cavities which, lentiform in shape, terminate in all directions—thinning out as it were. They, however, often seem to be a local widening of fissures of some considerable extent. They may be either vertical or parallel with the stratification of the country rock; or, in fact, they may have any direction.

Contact veins are those inclosed between dissimilar formations, and separate the formations from each other.

Bedded veins traverse the country parallel to its stratification, and are only distinguishable from beds by their occupying a fissure, having been introduced into the rock since it was laid down, and not at the time of its deposition.

Segregated Veins or Segregated Deposits.—The latter term is the more acceptable, as all the mineral deposits placed under this heading do not have the character of *veins*.

Segregated deposits are those accumulations of minerals, or ores brought together in cavities, limited in their extent on all sides.

Sometimes these cavities have such forms that they resemble veins; but as a rule they are the result of erosion, either in the direct washing out, from the surface down, of cavities in the rock, or by undermining, or a wearing away of the bed in some other manner, and are not due to a fracturing of the rock. In size they vary from a few inches to many yards in width, and are of all forms, from the vein-like to that of the "cave" and "pot" deposits.

In some instances this class of mineral deposits are doubtlessly due to replacement; but, usually, the matter is introduced from above. It is probable that there are few such deposits which have not been introduced from the exterior. Some segregated deposits have distinct selvages, are frequently crystalline in texture, and, when vein-like in form, their character is not always to be recognized at first view.

The two following forms of veins are so well defined in Whitney's "Metallic Wealth of the United States" that I avail myself of his descriptions.

Gash veins "hold an intermediate position between segregated and true veins. Like the latter they occupy pre-existing fissures; but these are of limited extent, and not connected with any extensive movement of the rocky masses. They are usually confined to a single member of the formation in which they occur, terminating below, when a marked change in the lithological or mineralogical character of the rock takes place.

"Lateral branches will usually be found in connection with the main fissures, which may or may not be nearly vertical, according to circumstances; but whatever their position, the two sets of cracks will be nearly at right angles with each other, and will possess the same character in regard to their mineral contents, although one set will generally predominate over the other greatly in extent."

As Professor Whitney states, this class of veins occupy fissures that are never the direct result of "extensive movements of the rocky masses." But that there are instances in which the formation of the fissures have been, to a certain extent, influenced by such movements, is true beyond doubt.

Gash veins are due to a shrinkage of the rock in which they occur, and are, therefore, simply the filling matter of shrinkage cracks brought about by various agencies.

True veins are indefinitely deep fissures, which have, to some certain extent, been filled with minerals or ores; "or, in other words, an aggregation of mineral matter, accompanied by metalliferous ores, within a crevice or fissure which had its origin in some deep-seated cause, and may be presumed to extend for an indefinite distance downwards.

"True veins are almost universally admitted by geologists to have originated in 'faults' or dislocations caused by great dynamical agencies connected with extensive movements of the earth's crust, and for this reason they are believed to extend indefinitely downwards, an assumption which is supported by facts, since no well-developed and defined vein has ever been found entirely terminating in depth.

"Gash veins, on the other hand, as before remarked, occupying fissures which have resulted from shrinkage of the rock, cannot be expected to extend into strata of different character from that of the bed in which they originated.

"The linear extent of true veins is very various in different instances. Some of the longest known have been traced many miles; but, usually, even if they extend for so considerable a distance, they are not found to be impregnated with ore through the whole of their course."

IV.

CHARACTER OF THE DEPOSITS.

So far as they have been explored, the lead deposits of Henry county lie in approximately vertical fissures, which occur in the "Massive Limestone" division of the Upper Cambrian rocks of this district. The lead, in the form of cubic crystals of galena, sometimes accompanied by small quantities of zinc sulphide (the black blende), is held in a gangue of dense baryta. The metal is sprinkled, apparently indiscriminately, through the baryta, and the quantity varies greatly at different parts of the lode. The vein-stone is not always

wholly of baryta. In some instances it is a mixture of baryta and calc. spar and some earthy, limy matter; and cases were noticed where calc. spar, in the form of large crystals, formed the larger portion of the vein.

No instance was observed where a vein showed a distinct selvage; the vein-stone was always found to completely fill the fissure, lying in direct contact with the limestone walls.

So far as my observations extend, there is always a set of fissures traversing the rocks in a nearly due north and south course. Extending from these are other cracks; but they are quite variable in their direction and extent. They are found coursing towards nearly every point of the compass, having, however, a more decided bearing towards the southeast.

The main fissures, however, do not extend in a decidedly straight line by any means. They, in fact, make many turns, proceeding in a series of offsets—in a zig-zag manner. This feature in the fissures alone goes far towards determining their origin and character.

They show, undoubtedly, that the fissures are simply the result of shrinkage cracks, such as exist in many limestones similar in composition to these; and that they were chiefly due to the same causes that produced other such cracks. Originally they had, perhaps, little more length or breadth than the lateral crevices now extending from the fissures.

It is reasonably to be presumed that the beds; varying in texture, shrank unequally, thus distributing the cracks somewhat irregularly and without connection with each other. This is a feature not at all uncommon in limestones having the composition of those in this region. It may, in fact, be noticed in the rock bed of any stream in this district, and the view presented there will give a very fair idea of the original form of what are now the lead-bearing fissures.

The widening of these shrinkage cracks, their connection with each other, thus producing one continuous fissure, and their northwardly course, is, in all probability, largely due to one cause.

The key to the explanation is probably found in the course of the great uplift of Upper Cambrian rocks, known as the Cincinnati axis, in which the fissures occur.

This uplift has a northwardly trend, and, according to Dr. Newberry's views, the rocks seem to have been elevated quite gradually. This elevatory process, although too slow to produce any great fractures, would certainly have a tendency to disjoint the beds, and, the beds having already been fissured to a certain extent, the pressure on them would find relief in the widening and connecting together of those previously-formed cracks, thus making the irregularly trending fissures we now see.* It is not improbable that the chemical changes which were in force when the minerals now filling the fissures were brought towards them, also bore a part in their formation; but it is probable that this was a subsequent, and, we may say, locally modifying operation, the open spaces having first existed as shrinkage cracks, towards which the minerals were carried by their solvents.

To put the explanation in simpler form, we have merely to consider that the fissures are *primarily* due to shrinkage cracks (such as are common to nearly all limestones that are at all earthy in their composition), and that the force by which they were widened, and their form was, to a large degree, caused by the uplift, the rocks being so broken by the pressure as to connect the cracks, and the fissures thus caused a decided course. The angles of the broken parts would soon have been removed by friction.

If this is accepted as a correct account of the origin of the fissures, it is not difficult to understand why we find a prominent set of fissures extending to the north and south, while those to the east and west are of minor importance.

The fact is not disregarded that in some of the lodes there seem to be evidences of friction on the vein matter, striated surfaces not being uncommon in it, as if the fissures had been filled before the uplifting of the rocks began. There are, how-

*It will be seen that I do not take this view of the formation of these veins, but attribute the fissures to contraction of the rocks due to chemical changes. See preceding report.

ever, a number of as equally important points which are to be considered that conflict with any supposition that the fissures were filled before the rocks were raised. Had such been the case, the vein matter would show faults and be fractured in many places, which is not found to be its condition. It must also be borne in mind that there is no reason to suppose that the beds were raised to their present position, and so remained without disturbance. On the contrary, just the opposite case is the most presumable; *i. e.*, that they have been gently elevated and lowered at more than one period. Indeed, the friction surfaces (if such they be) on the baryta gangue seem to indicate little, so far as the origin of the fissures are concerned.

The fissures are irregular in their downward as well as in their linear extent. A plummet dropped from one side of a fissure falls but a short distance before it encounters the other side.

This is not a matter of dip in the fissure, but of unevenness in the surface of the walls; descending to where the plummet first struck, and lowering it again, it strikes the opposite wall in a short distance, and so on.

These downward ziz-zags seem to be caused by the limestone lying in successive beds. With each distinct layer there is usually a decided change in the downward direction of the fissure, a condition which should be expected.

After all is summed up concerning them, the fissures seem to be simply large cracks in the rocks, differing materially from those commonly met with in massive limestones only in their size and extent, and from the very nature of their origin cannot have great depth.

Indeed, it is very presumable that when the base of the massive limestone is reached, the fissures will terminate.

As may be inferred from the above, the lead does not occur in true veins, but lies in what may be termed *gash* veins.

There seems to have been some law impelling the deposits to appropriate the fissures running a northwardly course.

This is especially the case with those veins of any considerable width.

Leaders, so to term them, frequently split off from the larger vein and penetrate the country for a short distance in various directions, the course, however, usually bearing towards the north.

In one instance a deposit of lead was visited, which, if what could be gathered concerning it is true, is enclosed between the horizontal layers of the limestone—in a matrix of baryta.

Although no more than a single instance, it, if true, demonstrates the possibility of there being more than one class of deposits in the region.

V.

ORIGIN OF THE LEAD.

Many theories have been constructed in the attempt to reach the history of veins, and explain the origin of metalliferous deposits.

Of the number, however, only three bear application, and these are (*a*) by injection from below; (*b*) by infiltration from above; and (*c*) by elimination from the enclosing rocks, which is termed lateral secretion.

By the first method only such veins as trap dikes (if they can with propriety be termed veins) were formed. The metals sometimes accompanying them, although apparently coexistent with the trap, have been shown to have been extracted from the strata enclosing the vein, and do not in any way militate against the first statement.

By the second method many of our metalliferous deposits that are the fillings of cavities, and not veins proper, have been formed. The seams of calcite and other common minerals frequently found traversing the rocks are due to such infiltrations.

By the third method the larger number of veins, especially in metamorphic rocks, have been formed.

The theory of injection was at one time held to be true, by some authors, for all true veins, and there may yet be some who accept it.

In view, however, of the contradictory conditions presented by the veins themselves, the theory has come to be abandoned by the better class of mineralogists, and that of lateral secretion adopted.

The filling of the fissures has been the result, according to their situation, either of heated vapors ascending from below permeating the strata, and carrying the minerals to the open spaces, and depositing them as veins, or by solutions from above, charged with solvents, extracting the matter from the beds through which they percolate. Water is of itself a powerful solvent, and under certain conditions that may be conceived of, this power may be greatly augmented. Many of our metalliferous accumulations are due to the solvent power of water, either terrestrial or subterranean, and not from heated vapors.

The chemical operations, however, differed of course, according to the character of the minerals acted upon; and in these chemical changes it is very presumable that a certain amount of heat was generated, which would greatly facilitate the elimination of the various minerals.

Although it has attracted the attention of scientists for many years, the chemistry of metalliferous veins is not yet thoroughly understood, though considerable light has been thrown on the subject in late years, and some system obtained from the many complications that surround them.

The lodes in this district may be regarded as the result of lateral secretion, the minerals having been gathered from the enclosing rocks.*

The lead in the lodes is frequently found clinging to the walls of the fissure; but in the greatest number of cases, where present at all, it is disseminated in cubes pretty generally throughout the baryta, being more abundant, however, in that part of the gangue lying towards the wall.

* For further discussion on this point see preceding reports.

The lead is in all cases connected with the wall, usually in a continuous line of crystals, and is the oldest mineral.

The baryta is deposited over and around the lead crystals, thus giving the ore the appearance of a conglomerate. In some cases the direct connection of the cubes seems to have been broken, and the baryta completely surrounds the crystal. These cases are quite rare, however—much more so than a casual inspection of the ore would seem to show.

A careful inspection of any of the ore will show that, although apparently distributed quite irregularly through the gangue, the lead is in strings of crystals, the cubes either touching or with but little space between them. This apparent disorder in the arrangement of the crystals is due to the way the mass happens to be fractured, and in blasting it the ore is broken in such irregular fragments that it is difficult to obtain a piece showing the proper arrangement of the metal.

In some of the ore the lead crystals seem to have been removed here and there, their place being indicated by cavities of the same form as the removed crystals.

The origin of the calcite is easily explained, being due to the action of carbonic acid on the limestones; but the origin of the baryta is not so clear. That it also was derived from the limestone seems presumable, however, from the fact that in one piece a well preserved cast of a fossil (*Zigospira modesta*) was found, which also seems to give a clue to its original source.

The relative ages of the minerals are probably to be represented thus:

1. Lead.
2. Zinc. } Pyrites.
3. Calc. spar.
4. Barytes.
5. Calc. spar.

Occasionally the zinc is found in the limestone.

DOWNWARD LIMIT OF THE LODES.

Accepting the theory that the source of the galena is in organic accumulations, we would not look for the metal in

sand rock (in any appreciable quantity or unless placed under conditions that are not supposed to exist in this region), as it is of inorganic origin, there having been, in this case, no organic matter to have collected the metal in the first place.

We would, also, for the same reason, be suspicious of other rocks bearing little evidence of organic structure, excepting highly metamorphosed limestones, of which we have no examples in the region under discussion.

The metal as it now exists undoubtedly was derived from the strata enclosing the fissures. It may have come, in part, from higher strata, but it is believed to have had its most productive source in the massive limestones lying below, as the strata above the massive limestones are mostly made up of shale beds, in which organic matter was rare.

The lead is not, therefore, believed to be present in any considerable quantity either in the higher strata (the thin limestones and shale beds), or in the beds next below the massive limestone that are different lithologically or chemically from that limestone.

As a consequence, we may expect to find the downward limit of the galena wherever a distinct change in the character of the beds occurs.

At just what depth this will occur I have at present no means of determining. It is not unlikely, however, that the downward extent of the lode reaches to no more than 300 feet, if so much.

VI.

DESCRIPTIONS OF SPECIAL DEPOSITS.

There seem to be quite a number of lodes crossing this region. At least three, probably more, occur in Henry county, and others are found in Franklin and Owen counties. Without a finished map of the region it is impossible to precisely locate each lode.

One lode crops out in a ravine on Mr. Wallace's land, near Lockport. Two prospect shafts were opened there and sunk

for about eight feet. No mining was done. The vein courses north, 3° east.

Figure 2 in plate II represents the north end of one of the shafts.

A indicates the country rock; B, a baryta vein five inches wide; C, limestone six inches wide; D, a baryta vein five inches wide; E, limestone six to nine inches wide; F, a baryta vein one and a half inches wide; G, limestone—the country rock.

It will be noticed that the vein is split into three divisions.

Figure 3 in the plate represents the south end of the same shaft.

A indicates the country rock; B, a baryta vein three inches wide; C, limestone, corresponding to the limestone C in figure 2, fifteen inches wide; D, a baryta vein five and a half inches wide.

The baryta vein indicated by D in figure 3 is a continuation of the one marked B in figure 2, and is the main vein; and the baryta indicated by B in figure 3 is a continuation of the vein which is five inches wide in figure 2.

The vein measuring one and a half inches in width is merely a small crack filled with baryta for a short distance.

The baryta is dense, and, most of it, white and somewhat granular, with Galena sparingly distributed through it.

Not much more than five per cent. of the ore seen at the pits is lead, or, in other words, one ton (2,000 pounds) of the ore will, on an average, yield about 100 pounds of metal.

In one piece of the baryta a fossil shell was found in a very fair state of preservation.

By following these veins towards the south they are found to diminish in width, and little fissures or "shoots" strike off from them. The course of the veins also becomes irregular.

Shaft No. 2 is a few yards north of the above mentioned one, and is on the same vein as that indicated by B in figure 1. This shaft is sunk in a lozenge shaped "opening" in the vein about three and a half feet wide at the widest part. The average width of the vein is about five and a half inches.

This locality furnishes a very good example for study in determining the character of the lodes in this lead region.

Figure 1 in the plate represents the ground plan, for a short distance of the lode, and gives a fair idea of the manner in which the veins progress throughout the region.

About three fourths of a mile westwardly from Lockport, near the old "still," there are signs of a digging, which, it is said, was done to procure lead. According to tradition, lead was taken from the hole; there is, however, no outcrop of the lode near by, if one does exist. Baryta, however, is to be seen on some of the fragments of limestone scattered in the vicinity. The rock abounds in *Rhynconella capax* and *Zigospira modesta*, and probably lies at the same geological level as bed No. 6 in section 1.

Another admirable illustration of the character of the lead deposits is presented on the farm of Mr. Aris James, about one mile south, 50° or 60° west of Lockport, south of Six Miles Creek.

A company from Wisconsin did considerable digging at this place, there being in all some five or six pits opened. The smallness of the returns, however, caused the work to be abandoned.

One shaft was put down to the depth of 40 feet, the width of the vein being about 20 inches at the bottom.* When the shaft was commenced the vein was only 6 inches wide near the surface, thus widening towards the bottom. It is not probable that it will increase much more in width. The course of the vein is north, about 5° east.

Figure 1 in the following plate gives the relative position the shafts have with each other. As may be observed from the position of the shafts, the course of the vein varies. It is possible, however, that some of the pits were sunk on what are merely branches of the main lode. Pit No. 4 was the only one in which any satisfactory examination could be made.

* This is in accordance with a statement made by Mr. James. When it was visited the pit was not in a condition suitable for examination.

Figures 2 and 3 of the accompanying plate exhibit views of the north and south ends of it. In figure 2, A is the limestone wall; B, 1½ to 2 inches of baryta, thinning out towards the top; C, limestone limiting the upward extension of the baryta in the limestone E; D, ¼ inch of baryta; F, the main baryta vein, which is alternately 3 inches and 4½ inches in width towards the bottom, but thinning to 3 inches at the top; G, limestone extending downwards for 15 inches and then wedging out.

In figure 3 the vein occupies the northwest corner of the pit (as indicated by *a*), and is from 3 to 5 inches wide. The limestone (2) has vertical cracks in it, as shown in the figure, but they seem to be destitute of baryta. On the extreme east (*b*) a thin thread of baryta follows the wall from the south. The vein here courses nearly due north and south. Scarcely any galena was seen in the baryta at these diggings.

This lode is distinct from the one seen at Lockport; and, as a matter of convenience, may be designated as the *James Lode.*

On Mrs. Fanny Wait's farm, about two miles above the mouth of Flat Creek, in Franklin county, some search for lead has been made. A lode certainly crosses the property; but the width could not be determined, as loose soil covered it.

Fragments of baryta holding lead were found over a considerable linear distance, the course of the line along which they were found bearing about north.

Mr. Wait states that one piece of ore, very fully charged with galena, was picked up on the property about 15 years ago and weighed about 100 pounds.

On Alexander Hardin's place, at Drennon Lick, a prospect pit has been opened and sunk down for a few feet and some ore obtained. From all that could be gathered concerning the place, it seems that the ore occurred as a sheet of baryta, 2 feet thick, extending in a plane parallel with the bedding of the limestone, and not as a vertical vein. It is possible, however (and I may say even probable), that there is some

misunderstanding about the place, as my informant did not seem to have a clear knowledge of the matter himself, and water in the pit prevented the making of a personal examination.

Very little galena was seen in the ore piled near the pit, and it does not seem probable that the locality will ever prove of much importance in a mining point of view. The limestone is coarse in texture, of a dark bluish grey color, and contains *Strophomena alternata*, *Zigospira modesta*, and a shell resembling *Rhynconella capax*.

Mr. Alexander Hardin and Mr. Samuel Herl opened the pit in the spring of 1874.

On Mrs. Eliza Ann Green's place, about 2½ miles below Franklinton, towards Drennon Lick, and 8 miles below Lockport, there are signs of a former digging for lead. It was done about 60 years ago, however, and little is known concerning the place at this day.

Fragments of coarse limestone, apparently the debris resulting from sinking the pit, were found. They were abundantly filled with *Orthis lynx*, and also contained *Zigospira modesta*, and an *Orthoceras*. No ore was seen.

THE "SILVER AND SPAR MINES."*

These mines, as stated on a preceding page, are the only ones, properly designated as such, in the county. They are apparently on the same lode as that which crops out at Lockport. They are, for the most part, open to daylight, consisting of two open ditches. One is about 50 feet deep at its deepest part, and follows the lode in a north and south direction for about four hundred yards. The other, which was intended to simply test the lode, extends into the hill for about 70 feet. Part of the ditch in which mining was in progress has been covered (for the better security of the miners), thus making it to resemble a tunnel.

* Examined May 20, 1875. I am indebted to W. H. Leatherman, Mine Superintendent, for all information that could not be obtained by personal observation.

A shaft was sunk down 50 feet below the present level of the gangway (May 20, 1875), which is about 50 feet below the surface where the initial digging was done, thus making one hundred (100) feet as the total depth to which the lode was followed.

The general character and texture of the lode, as seen in the shaft, was not to be distinguished from that in the ditch.

Mr. Leatherman states that it would "sometimes almost disappear, and then form an 'opening' or come into a pocket, and then again assume its usual width."

The lode is worked by underhand stoping. The ore was reached at about 18 inches from the surface, and continued to fill the crevice all the way down.

The richest ore, according to the statement of W. H. Leatherman, was obtained in the first 10 or 15 feet of descent of the lode.

The vein averages about 15 inches in width, which varies from 12 to 18 inches. Occasionally the vein is quite thin, but there are also places where it is 2 feet wide.

The gangue is usually massive baryta, white, and quite dense in texture; but some parts are made up of calc. spar, baryta, and a little fluor.

The galena is distributed through the vein-stone in cubes ranging from the size of a small pea or mere specks to those measuring a quarter of an inch or a little more in diameter, and generally extends through the baryta as a string of crystals.

A little zinc sulphide is mingled with the lead and spar, but the amount is small.

The baryta frequently fills narrow cracks (so-called feeders) extending from the main fissure which holds the lode. It also makes irregular seams in the limestone.

The average yield of lead is estimated to be about 10 or 11 per cent. of the ore.

The following is a statement of a section of the beds at the working place:

1. Thin-bedded limestone and shales. The limestone is usually dark grey. Many of the beds are abundantly filled with *Orthis testudinaria?* and *Zigospira modesta.* Others contain large numbers of *Bellerophons, Murchisoniæ, Pleurotomariæ,* and a few corals . . . . . 8 feet.
2. Dark-grey limestone passing into dark-bluish grey and then blue limestone. Occurs in beds divided by shale. The shale contains great numbers of corals, but of only one or two species. Occasional masses of baryta, probably connected with the vein below, are seen . . . . . 12 "
3. Heavy-bedded bluish-grey limestone. Fossils are found in the upper 10 to 15 feet, including *Rhynconella capax, Zigospira modesta* and *Orthoceras,* etc. . . . . 50 "

At the north end of the ditch, where it terminates, there is a swell in the thickness of the baryta, the vein being 2 feet wide. This is local.

Figure 1 in the accompanying plate represents the course of the vein for 75 feet at the north end of the ditch.

At the north end crystals of baryta are frequently found lying next to each wall, the body of the vein, however, being dense, massive, white baryta. The crystals, however, are usually irregularly placed and frequently are in lumpy masses attached to the massive spar; apparently showing that part of the vein has been dissolved, and then assumed the crystalline form when precipitated.

Figure 2 in the accompanying plate represents a portion of the vein, showing one of its crooks, with a short vein of baryta in the space left by the elbow, and nearly in line with the lode.

At the test ditch the width of the lode does not seem to be more than 5 or 6 inches, and the baryta splits and seems to pursue two fissures, the limestone between, however, usually being of small thickness.

The sides of the wall where the baryta rests are rough and lumpy, having about the same degree of smoothness that water would produce by flowing through the fissure for a time.

Instances were noted where the baryta extends into horizontal cracks or divisions of the limestone. It was also noticed that the lode is frequently split vertically into two, three, or more divisions, the surfaces of the sundered parts having a smooth, slightly grooved appearance, somewhat resembling slickensides. The limestone walls occasionally seem to show

the same feature, but a close inspection determines the effect to be due to a thin film of baryta coating the rock.

The following is a section of the beds at this place:

1. Limestone in thin beds with shale partings. . . . . 5 feet.
2. Bluish-grey limestone in thin beds, with partings of shale. Some of the upper beds abound in *Murchisoniæ* and *Bellerophons*. A little calc. spar and baryta occur in the irregular cracks in the beds; they do not, however, seem to be in any way connected with the vein-matter below . . . . . 8 "
3. Blue shale holding a little calc. spar and baryta, which, however, are not in direct connection with the body of the lode. This seems to be the stratum limiting the upward extension of the lode. . . . . 2 "
4. Bluish-grey massive limestone, carrying the lead lode . . . . . 12 "

At the time when these mines were visited, the following gentlemen composed the board of directors: Mr. W. H. Merriwether, President; Mr. Wm. F. Bullock, jr., Secretary and General Manager,* and Messrs. George Ainsley, James Folsen, and James Loomis, with W. H. Leatherman as the Mine Superintendent.

Not much mining was doing at the time, and neither the smelter nor crushing mill was in operation.

The furnace is built on the reverberatory plan, and is quite defective in its construction; it is undoubtedly true that an amount of lead is lost in smelting which would be saved by a properly constructed furnace.

The pigs turned out are of two sizes, weighing 80 and 120 pounds respectively. The day yield of the smelter could not be ascertained. The capacity of the crushing mill is about 20 tons daily. The amount of ore which it is possible for a single miner to raise in a day has been estimated as being half a ton, or (at 10 per cent. of lead) about 100 pounds of lead. It seems probable, however, that this is too large, or that the yield of lead is placed at too high a per centage, as the conditions observed at the mines and the history of the mining do not indicate such returns.

These mines, as an experiment, have been about as complete in their operations as it seems desirable should be tried on the lead deposits of this county, and the result has been, to say the least, not encouraging.

*Mr. Bullock died at the mines May 21st, 1875.

The conditions are as favorable here for testing the richness of the ore and value of the deposits generally as are to be found at any point in the region, and they do not seem to indicate that much profit will result from any further prosecution of the work in the county.

At Michael McAlester's, about one half of a mile east of the Silver and Spar Mines, a shaft was sunk down for 21 feet on a lode running parallel with that at the mines. Water nearly filled the pit. The vein was said to be 7 inches wide; a width of 4 inches could be distinguished at the top. But little lead was noticeable in the baryta.

At Mr. Patterson's, on the bank of the Kentucky river, near "Little Mountain," is a place reported to afford lead ore. An examination of the place, however, failed to verify the report. It seems to have arisen from the fact that the rocks contain vertical seams of aragonite (a form of carbonate of lime). It is possible, of course, that the precise spot indicated by the report was not found; but this does not seem probable. The section of the beds here has been given on a preceding page.

TWIN CREEK MINES.*

At Hunter's Mill, in Owen county, two shafts have been sunk on a lode which varies in width from 12 to 16 inches. The position that the lode holds relatively to those examined in Henry county could not well be determined, as no good map of the country was at hand, and it was not considered necessary to trace the lodes out in detail.

Each shaft was filled with water, and could not be descended for the purpose of making examinations. But a fair view of part of the vein was obtained in a shallow pit dug on the bank of Twin Creek near by. The vein-stone is baryta, having occasional masses of calcite through it, and is rather fully charged with galena. The lead is not altogether confined to the baryta, but in places clings to the country. Short fissures extending from the main one are filled with the same material as that composing the lode. Only a small part of the vein is shown

*Examined May 25th, 1875.

at this opening. The deepest shaft is said to reach to 76 feet. At 54 feet down the vein is said to have measured 22 inches.

In the new shaft, what was supposed to be another vein 2 inches wide, was observed at 3 feet from the main one; this, however, is probably merely a shoot from the larger one.

Digging was commenced at this place, if my information is correct, in 1867. In 1869 a simple log furnace was erected, and, for such means, considerable lead was run out. The returns from the smelter were estimated at 33 per cent. This, however, indicates an ore much richer than the actual conditions seem to justify.

So far as would be indicated by the small part of the vein seen, the deposit appears to be workable for a limited time. It must be borne in mind, however, that these surface indications are frequently deceptive; for, as hitherto stated, the lead is frequently bunched in the lode, lying rather compact in the baryta for a certain distance, both vertically and horizontally (the ore yielding as high as 60 per cent. of lead), while again the lode will be quite lean for a distance exceeding that of the rich portion.

A very interesting analysis of a piece of the baryta follows:*

Sulphate of baryta	80.31
" strontia	17.05
" lime	.34
Oxide of iron	.15
Silica	.29
Loss, etc.	1.86
Total	100.00

Mr. Peter remarks, concerning the analysis: "The strontia sulphate may be a little too high, at the expense of the lime sulphate." Opportunity was not given him to repeat the analysis. The per centage of strontia is quite high.

It may be remarked, in conclusion, concerning this lead region, that the inducements offered by it for mining are

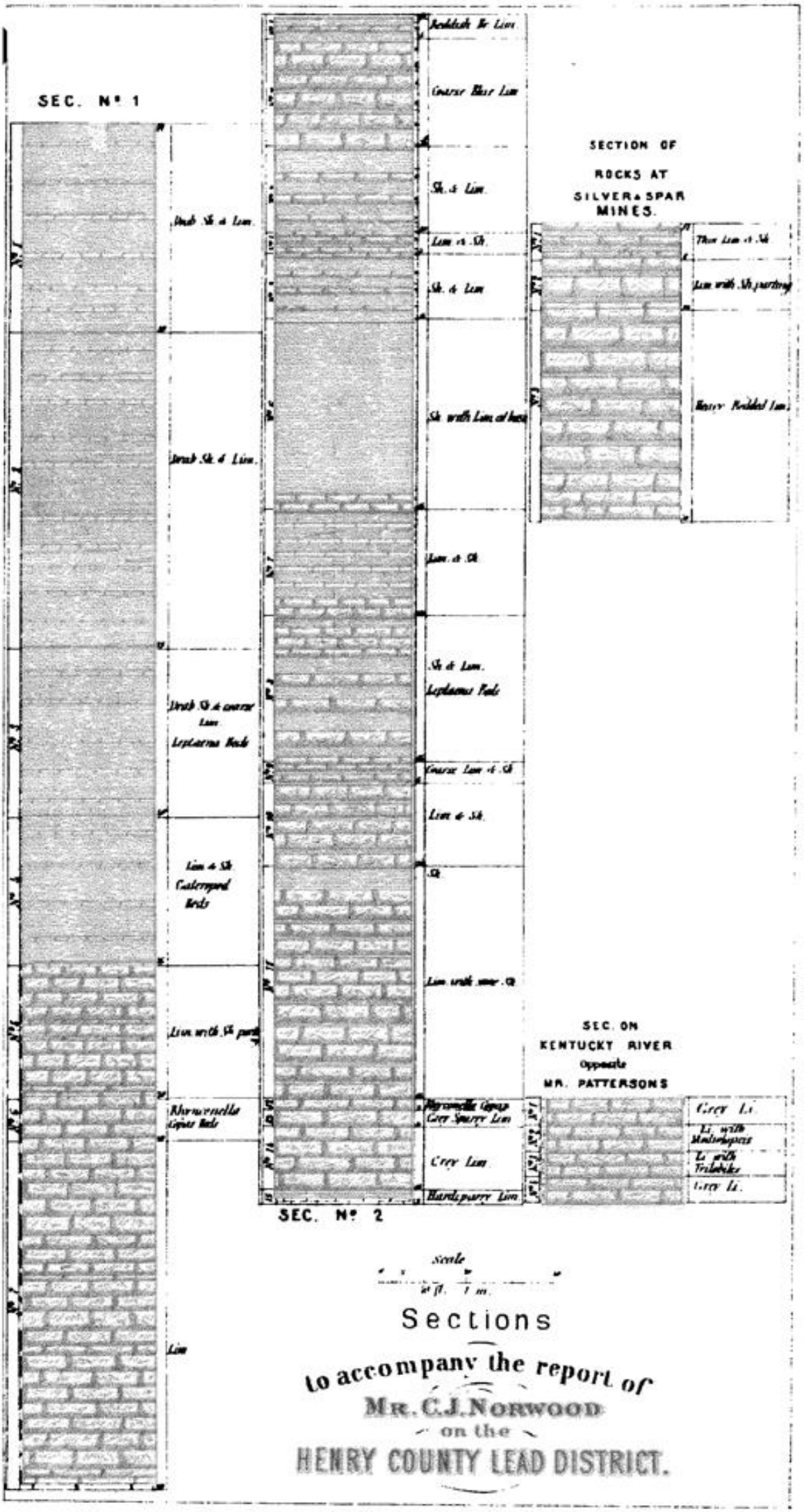
*Made by Mr. Alfred M. Peter, in the chemical laboratory of the Survey.

undoubtedly, to a large degree, fictitious. It is true that the lodes have been exploited only to a comparatively small extent, but the work has been sufficient to demonstrate the unlikelihood of any profit being gained by prosecuting it further. The character of the deposits do not justify the belief that the ore will become richer as the lode descends, and even should such be the case, its downward extent, being limited, would not justify the expense necessary to carry on the plan of mining required.

There may come a time when such deposits as these may be worked with profit, but at present that day seems in the distance.

In consideration of the baryta, which is so largely used now for the adulteration of white lead, it is possible that a white lead works might be located here with a chance for profit;* but any mining for the lead alone will be apt to prove disastrous.

*I understand that this has been done at one of the mines in Favette county.



Sections

to accompany the report of

MR. C.J. NORWOOD

on the

HENRY COUNTY LEAD DISTRICT.

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FIG. 2

FIG. 3

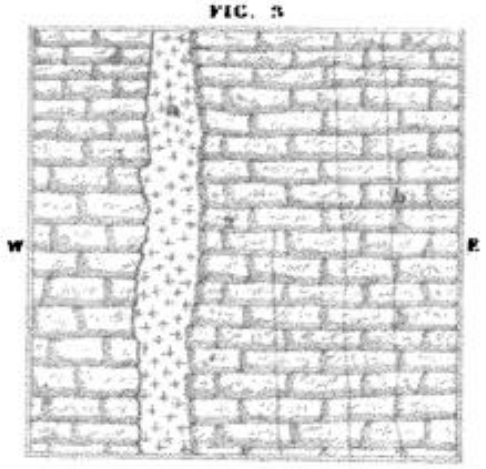

FIG. 1

FIG. 2

A *Limestone*
B *Barrels*
C *Limestone*
D *Barrels*
E *Limestone*
F *Barrels*
G *Limestone*

FIG. 3

1 *Limestone wall on the West*
2 *Limestone with vertical crake*
a *Barrels The Lode*
b *Vertical crack on the East side of Shaft*

Scale Fig. 2 & 3
10 inches

Sections

to accompany the report of

MR. C.J. NORWOOD

on the

HENRY COUNTY LEAD DISTRICT.

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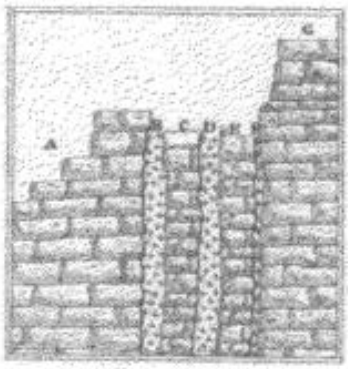
FIG. 2



Scale
1 2 3 4 5
10 inches

FIG. 3

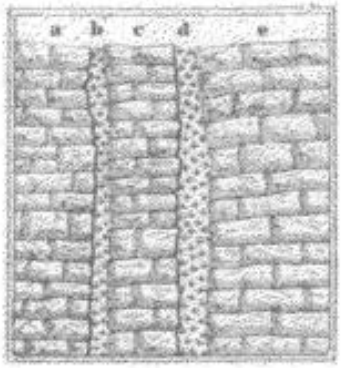
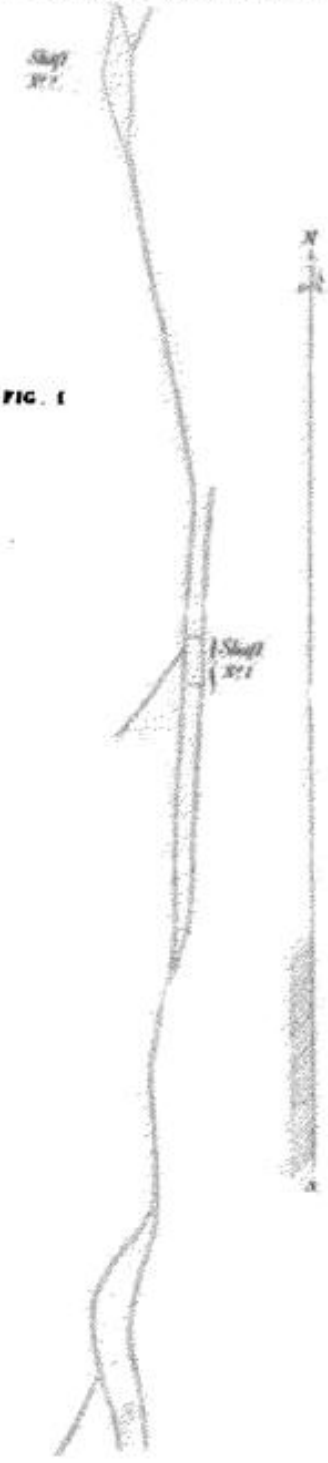


FIG. 2
A Limestone
B Barytic
C Limestone
D Barytic
E Limestone
F Barytic
G Limestone

FIG. 3
a Limestone
b Barytic
c Limestone
d Barytic
e Limestone

FIG. 1



Scale
10 ft. 1 in

Sections

to accompany the report of

MR. C.J. NORWOOD

on the

HENRY COUNTY LEAD DISTRICT.