GEOLOGICAL SURVEY OF KENTUCKY.

N. S. SHALER, DIRECTOR.

REPORT OF A RECONNOISSANCE

IN THE

LEAD REGION OF LIVINGSTON, CRITTENDEN, AND CALDWELL COUNTIES,

INCLUDING A

SKETCH OF THEIR GENERAL WEALTH.

BY CHAS. J. NORWOOD.

PART VII. VOL. I. SECOND SERIES.

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INTRODUCTORY LETTER.

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

DEAR SIR: According to your instructions, I present you herewith a report of a reconnoissance of the lead region embraced in the counties of Livingston, Crittenden, and Caldwell. Accompanying it is a preliminary map, incorrect in many particulars as regards the geography, but better than none.

As there was much territory to be traversed in a short space of time, the report does not purport to be an exhaustive or elaborate one by any means.

The prime object of the reconnoissance was to obtain a knowledge of the character of the lead deposits and their probable worth. It is believed all the time requisite for such a result was devoted to the work.

I embrace this opportunity to express my gratitude to all those who rendered me kindly aid when in their region.

The Survey is under especial obligations to Mr. P. C. Barnett, Col. Callahan, the Messrs. Woods, Mr. Hodge, the Messrs. Hewlett, Hon. Chas. Webb, Mr. Lemen, Rev. Isaac McMurray, the Messrs. Glass, and Mr. Wm. Marble.

Respectfully,

CHAS. J. NORWOOD.

LEXINGTON, KY., April 15th, 1875.

REPORT OF A RECONNOISSANCE IN THE LEAD REGION OF LIVINGSTON, CRITTENDEN, AND CALDWELL COUNTIES, INCLUDING A SKETCH OF THEIR GENERAL WEALTH.

LIVINGSTON COUNTY.

This county is quite irregular in its outlines. Part of it lies between the Cumberland and Tennessee rivers, extending, in a tongue as it were, up those streams to the "*Narrows*," while the greater portion lies north of the Cumberland, the Ohio river forming the western boundary, and Crittenden county joining on the east.

Taken altogether, the county is a broken country, made up of high winding ridges, some of which rise to a height of 400 feet above the level. The highest point is, perhaps, between 500 and 600 feet above the Ohio river.*

Although the greater portion of the county is ridge land, there is yet much of it well adapted for farming, embraced in the rich valleys of the Ohio and Cumberland rivers, and the wide valleys and table lands north of the Cumberland.

The county embraces about 295 square miles of territory.

GENERAL GEOLOGY.

The geological formations found in the county are the quaternary and carboniferous.

The Quaternary.—This includes in descending order alluvium and bluff beds or loess.

I. *Alluvium.*—This division is made up of beds of sand, clay, loam and pebbles, as follows:

a. Soil and black loam, composed of decayed vegetable matter, etc., alternating with thin layers of sand.

* These heights are approximated.

b. Buff clay.

c. Red clay, with masses of earthy iron ore.

d. White and yellow sand, grains very small.

e. Pebbles. These are usually quite smooth and rounded, and are mainly of chert and hard sandstone. They vary in size from half an inch to three inches in diameter. They are often cemented by iron, and so consolidated as to form compact beds of conglomerate.

These beds are frequently exposed on the tops of the ridges, and might be mistaken as being of a date older than here ascribed to them.

II. *Bluff beds (or Loess?).*—This is a yellowish to brownish buff, somewhat sandy, porous clay. When dry it is quite pulverulent. It is developed in the bluffs of the Ohio river especially, and covers the hills at many places in the vicinity of Smithland.*

Carboniferous.—Under this head are included rocks of the coal measures and the lower or sub-carboniferous.

I. *Coal Measures.*—This formation is but sparingly developed, the only members found being the conglomerate and accompanying coal beds.

The conglomerate caps the ridges in many parts of the county; sometimes attaining a thickness of sixty feet, and again, represented by a few feet only. It does not always contain pebbles; on the contrary, it frequently passes abruptly from a hard, gritty sandstone, quite conglomerated (the pebbles varying in size from that of a small shot to that of a hen's egg), to a fine-grained compact rock, *entirely destitute of pebbles.*

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* At Carrsville a few bowlders of quartzite, syenite, granite, and hornblendic rock were observed. They vary in size from six inches to two feet in diameter. They are much worn and rounded, in this respect having the character of *glacial drift;* several of them were examined for evidences of scratches, but none discovered. Their history is somewhat obscure. It is not probable, however, that they were transported to their present location by water, as the specimens occupy a circumscribed area, and none are known to occur elsewhere in the county.

There was an Indian burial-ground at Carrsville, and perhaps a fortification, so that the bowlders may possibly been brought for some purpose by the ancient people who built there.

Another fact in regard to them is, that they are arranged in a line one after the other, partially covered with earth.

Though doubtful as to their having been brought to their present location by any means other than human, no locality in Illinois, from whence they could have been procured, can be given. It is possible for them to have been brought from Missouri.

Again, the pebbles are quite small and sparingly distributed; it presents this character often.

The pebbles are usually not distributed indiscriminately throughout the mass, but are in horizontal layers or bands.

The conglomerate is found in the hills back of Smithland, on the Dycusburg road, about one mile and a quarter from Smithland, on the farms of the Messrs. Lemen, near Salem, and at many other points in the northern portion of the county. There are really two distinct conglomerates in the county, with a coal bed between.

Because of physical differences, the upper one has been designated the *true* or superior conglomerate, and the lower as the inferior conglomerate. The reason for so doing is, that the upper rock is nearly always *abundantly* charged with pebbles, while the lower one is seldom so.* It, in fact, rarely contains any; but as it was occasionally observed with certain parts conglomerated, it was included under the name *conglomerate*. It seems probable that the superior conglomerate occupies quite a limited area, but that the inferior member occurs frequently throughout the county.

Usually, immediately underlying the conglomerates are beds of argillaceous shales, with a few coal streaks traversing them. A jointed sandstone, some ten to twenty feet thick, parts the shales from the lower carboniferous limestones.

Frequently, however, the conglomerates rest directly on the limestones.

The following section of the rocks from Trabue's (the old Union) coal mines to the Ohio river—distance about half a mile—exhibits the position the conglomerates hold in regard to each other, very well.

1. Conglomerate		20	feet.
2. Covered space		5	"
3. Very thin-bedded, slabby sandstone, in layers from one to two inches thick. Good for ordinary whetstones		5	"
4. Drab argillaceous shale	0 to	1½	"
5. Coal		2½	"
6. Under-clay		4	"
7. Covered space		10	"

*This distinction may be merely locally applicable.

8. Sandstone. Hard, coarse-grained, cross-bedded, and in thin layers at the top. Markings of *Lepidodendron* at the top.	35	feet.
9. Covered space to the river, about	100	"

At the river the inferior and superior conglomerates are both seen, standing out in bold escarpments. The former exhibits a thickness of about forty feet; above it the coal is found, with the true conglomerate still above, and from forty to fifty feet thick.

Passing up the river to Carrsville, the true conglomerate becomes thinner, and at a point about half a mile below the town is represented by only five feet of sandstone, while the inferior conglomerate thickens rapidly, at one place attaining the thickness of one hundred feet.

This thickening and thinning of the rocks is truly remarkable.

At the point where the last of the true conglomerate is seen, there is but ten feet space between it and the lower one, which is about forty feet thick, with lower carboniferous limestone immediately under it. Passing on to Carrsville the upper conglomerate entirely disappears, and the thickness of the lower one increases, both up and down, until at a certain point it reaches one hundred feet.

From this point it thins laterally—that is, both up and down the river—and a fine-grained buff to grey sandstone, occupying a position below the superior, but above the inferior conglomerate, makes its appearance—showing a thin edge at about five feet above the lower conglomerate. In passing to Carrsville, this sandstone thickens downward to twenty-five feet, while the conglomerate thins, from above down, to forty feet, leaving a space of forty feet between it and the sandstone. Plate I[a] illustrates more clearly the various changes presented by the rocks.

The only coal examined in the county is at the old Union mines, now owned by Col. Isaac Trabue. They are located near Carrsville, and are worked by drifting. The coal measures 30 inches, but of this only one foot is of good quality; the rest is soft and brash, and almost worthless.*

* Col. Trabue states that another coal of about eighteen inches occurs just above the superior conglomerate, about half a mile from his mines.

In volume IV, page 388, and volume III, page 531, of Owen's Geological Reports on Kentucky, Lesquereux identifies this coal as No. 1 B. In his description of that coal, he states that it is the first above the conglomerate; it seems he did not see the conglomerate which *overlies* it here, showing Coal 1 B to be an *inter*-conglomerate coal, provided he was correct in the number.

The sandstone, 40 feet thick, mentioned by Dr. Long* as underlying coal three feet thick, at the Trapnel coal bank, in the vicinity of Caseyville, is doubtless the equivalent of the inferior conglomerate of Livingston county.

The coal at Trabue's dips at the angle of 10°, course north 35° west, at the entry; this angle, however, does not appear to be constant. The mines are worked very little, and, consequently, were in such condition that they could not be entered.

One mile southeast of Smithland, ——. Gordon (colored) dug for coal in the shales below the conglomerates, but without success. No coal of importance exists there.

There seems to be no reason to believe that any extensive coal beds exist in the county. There may be, however, outliers of coal (equivalent to the beds at Trabue's) in certain parts of the county not yet explored for the mineral.

II. *Lower Carboniferous.*—Two divisions of the lower carboniferous, the Chester and St. Louis Groups, may be distinguished in this county. The exact line of division between the two could not be satisfactorily ascertained, as the time requisite for such detailed examinations as would have accomplished that result could not be spared.

The Chester Group is made up of an alternating series of limestones, sandstones, and marly shales. Rocks belonging to this division are exposed at Smithland and Carrsville, and pretty generally throughout the county.

The St. Louis Group is separated from the Chester by a sandstone.

* *Vide* volume IV, Owen's Geological Report, page 388.

The most abundant fossils are *Lithostrotion Canadense, Productus cora, Athyris subquadrata*, a *Spirifer* and *Pentremites Koninckiana.* As seen in this county, the beds are crossed in all directions by veins of calc. spar, some of them two inches wide. Calcite also occurs in masses throughout the rocks, (filling cavities), and is quite abundant.

Fluor-spar is also present in the rocks, but is less common than the calcite.

The general color of the limestones is dark drab; some of the beds, however, are dark blue and bituminous.

Towards the top of the group, beds of gray to white, beautifully oölitic, limestone occur; capable of being burned into excellent white lime, and answering admirably for building purposes.

The greatest measured thickness of this group, as displayed in this region, is about one hundred and eighty feet.* This, however, is not the total thickness; it may be twice as great.

The St. Louis Group is of special interest in the lead region, as it is in the vicinity of it that most of the lead is obtained.

SPECIAL GEOLOGY.

The Lead Deposits.—The lead deposits have attracted attention for a number of years, but only in the last ten have any systematic explorations for the mineral been made. More work has been done in the past two years than ever before. Although a number of shafts and pits have been sunk in various parts of the county in search of lead, the returns have been meagre indeed.

There have been, however, no *deep* shafts sunk, the deepest being one at the Royal mines, mentioned on a succeeding page. All others range in depth from 10 to 50 feet, rarely, if ever, more than 50 feet, and seldom exceeding 40 feet in depth. It cannot be said, therefore, that any extensive operations have been carried on; on the contrary, under the circumstances, the digging has been quite shallow.

* A shaft at the Royal mines shows it to be more than two hundred and fifty feet in thickness.

Mode of Occurrence.—As a general thing the lead occurs as aggregations of cubic crystals and granules of galena, disseminated through masses of fluor-spar, calc. spar, and limestone, all mingled together in red or greenish clay, filling a fissure between two walls of rock dissimilar in character.

One of the walls is limestone and the other a very hard, quartzose sandstone, often resembling chert, and striking fire with steel.

This silicious rock appears to be a wedge between limestones.

It always presents the appearance of a rock resting on edge; both sides are usually well defined, and it is seldom more than 25 feet across; occasionally the width is as great as 50 feet. It does not stand in a true vertical position, but is inclined at an angle varying from 60° to 80°.

Limestone is frequently exposed on both sides of it, not always in immediate contact with, but still near to it.

The strata are tilted on the one side or the other of it, and lie irregularly, sloping away from it.

The origin of this wedge-like mass possesses much interest, for it takes a prominent position in the solution of the problem concerning the origin of the lead, and, consequently, upon the question regarding the character of the deposits and their worth.

Its present position is evidently due to a dislocation in the rocks. At first view the rock has much the appearance of having been forced from below upwards, extending from as low down in the lower carboniferous series as can be seen, up to the base of the coal measures.

At one locality it is found resting against the St. Louis limestone, while at another it rests against the conglomerate, *apparently* cutting through the Chester limestones, etc. Certain facts connected with it, however, prove conclusively that a hypothesis that it was forced up from below is untenable. Although the strata are somewhat tilted on the one side of the rock, on the other they are horizontal, or dipping *with* the sandstone, and not away from it.*

* This is illustrated in the plate representing the sub-structure of the region at the Royal mines.

This fact is so well recognized by the miners that they term the sandstone the *hanging-wall* and the limestone the *foot-wall.* Again, the rocks on either side are seldom of the same age. On the west they may be St. Louis and on the east side Chester beds; such is the case at the Royal mines.

These facts, in connection with others made apparent in the course of the report, can lead to no other conclusion than that this wedge was originally a horizontal sandstone occupying a position above the St. Louis Group, near to if not immediately at the base of the Chester Group. By some such force as that exerted by an earthquake, it has been torn from its true position and precipitated in a previously existing chasm, carrying with it limestone beds belonging to the Chester Group.

It is not probable that this sandstone owes its present position to one movement of the earth, but to a combination or successive series of them.

It seems that at first great breaks were made in the rocks, caused possibly by the concussions produced by earthquakes, leaving the strata in a position something as represented in figure 2, plate II[a].

Subsequently a series of disturbances, resulting from a lateral movement of the earth, crossed the country. The first movement would dislodge the already disturbed rocks from their bedding and precipitate the superior ones into the chasm, while the succeeding one would bring them closer together, as represented in figure 3, plate II[a]. The upper beds on one side would be thrown down, while the lower ones, it seems, would merely receive an increased angle of inclination.

On the opposite side the upper beds would retain their position, except in the vicinity of another fracture.

In some instances the entire rocky mass on one side of the fracture seems to have been depressed, but still retaining a nearly horizontal position.

The fractures were of course quite deep, but narrowing all the while, the deeper in the earth they penetrate, and were at

least partially filled with extraneous material before the subsequent faulting occurred.

The quartzose sandstone has nowhere been recognized in a horizontal position; as it does not always present the same physical characters, however, it may occur so, and not have been noticed in my hurried journeyings across the country.

On the Cumberland river, opposite Smithland, a hard, gritty, thin-bedded sandstone is exposed, exhibiting a thickness of 5 feet or more. It dips at an angle of from 20° to 25°, course south 60° east, strike north 30° east. It is exposed for about two hundred yards up stream, and then disappears. At its northern extremity it becomes more quartzose in appearance, is in thicker beds, and seems to make a curve, the course of the strike changing to north 40° east. This sandstone is represented by figure I, plate II².

At Smithland, above the ferry, ten feet or more of jointed sandstone, underlaid by blue shale, is exposed in the river bluff, about 50 feet up from the water. It is quite hard, and in character much resembles the sandstone just mentioned, and probably is the same. It is nearly horizontal, though dipping slightly south, 15° or 20° east. If these sandstones are equivalent, and there is every reason to believe they are, and one is dipping as much as 25°, while the other is nearly horizontal, they give additional evidence towards solving the question as to the origin of the sandstone wedge.

It is a noteworthy fact that the sandstone on the north bank of the Cumberland river is in a line with, and has about the same strike of, the quartzose sandstone seen at the Woods' mines.

Taking into consideration all the facts collected, the only reasonable conclusion is, that the masses of sandstone seen in different parts of the county, jutting up from the ridges and resembling dykes, are not uplifts but *down-throws* caused by a remarkable faulting of the rocks.* The number of these

* Since the foregoing was written it has been learned from Mr. Joseph Walton, Superintendent of the "Royal Mines," that in one of the pits there the sandstone disappears at the depth of one hundred and fifty feet, and limestone is exposed on both sides of the shaft.

This is practical and conclusive proof that the sandstone came from above.

down-throws necessarily depends on the number of fractures in the first instance.

It will be seen from the foregoing that the lead occurs in masses of fluor-spar and calc. spar, filling fissures following the *line of a series of down-throws*.

Character and Derivation of the Deposits.—There can be no reasonable doubt that the fissures, in the upper part of which the lead is concentrated, have great depth; that they penetrate far into the crust of the earth.

That this must necessarily be the case, is displayed by the scale on which the rocks are faulted. There must also be some material filling these fissures, constituting veins; which, extending the full depth of the fractures, may be denominated *true veins*.

The origin of true veins is referred to dislocations of the rock strata, effected by some great mechanical force, such as is exerted by earthquakes; they, consequently, traverse a formation independently of its character or stratification, and are supposed to extend indefinitely downward.

True veins may be defined, in simple language, as indefinitely deep fissures filled with some material which may or may not be accompanied by lead or some other metal. But in passing from one character of rock to another, the vein-stone or filling matter of the fissure may change materially; it may be very poor in ore or entirely destitute of it.

There are, therefore, numbers of true veins, which, if not absolutely bare of metalliferous deposits, are nearly so.

There are, in fact, many instances in which a vein is rich in ore for only a certain depth, beyond which the ore entirely disappears, or is so lean as to preclude the working of it with profit.

There are, also, many true veins that are not metalliferous.

Consequently, the fact of the veins in question being true veins does not carry with it the conviction that the lead found in the upper part is coextensive with the vein. On the contrary, having in mind the peculiar derivation of the ore, it is fair to presume that its depth is limited to the base of the

lower carboniferous *limestones*, perhaps not extending below the St. Louis Group.

In other words, that the metalliferous matter filling the upper part of the fissure must be considered as forming a separate and distinct part of the vein, as it now exists, having no intimate connection with the matter below.

The metal originally existed either in bedded veins or segregations just at the top or near the top of the St. Louis limestone, or as impregnations in the rocks.

There are certain circumstances connected with the deposits which seem to give some basis for supposing the lead to have partly been in *bedded veins;* but I am disposed to consider, rather, that it occurred as *segregations* and *impregnations.*

Whether it was wholly inclosed in the upper beds of the St. Louis Group, which have been destroyed, or whether it was most abundant in the lower rocks of the Chester Group, is a question to be decided when the deposits may be studied in all their minutiæ.

It is probable that the galena was disseminated in greater or less quantities through the rocks of the St. Louis Group in its entire vertical extent. My impression is, however, that the major portion of the metal was in seams and bunches and impregnations in the upper rocks; which, perhaps, belonged in part to the Chester, but more particularly to the St. Louis Group.

This much is certain: where the veins occur that are rich in the metal (they are in the blue or geodiferous limestone, as it is termed in another report*), there is at least 75 feet of the upper division of the St. Louis Group entirely absent.

It is possible, therefore, that at the time of the faulting of the rocks, heretofore mentioned, these rocks *bearing the metal* were thrown down in the fractures.

That subsequently waters charged with solvents, possibly derived from organic matter (vegetable or animal), percolating through the mass, dissolved out the lead, which was precipitated, assuming the character it now presents.

*See report on the region adjacent the Louisville, Paducah and Southwestern Railroad.

It is not necessary, however, in demonstrating that the lead came from above, to assume that the rocks should have been thrown down in the fractures.

As the strata gradually wasted away under the destructive influence of chemical agents, and the solvents eliminated the lead, it would be deposited in the fissures open for its reception.

In fact this latter solution of the problem is more in accordance with the present state of the deposits, as they exist in this and Crittenden counties, than the former.

From the manner of its distribution through the spar it would seem that in age, according as they were deposited in the fissures, the lead is the eldest, then the fluor-spar followed by calcite.

The fluor-spar nearly always has a bituminous odor, as have also some of the limestone beds.

Instances also occur where hardened bitumen fills cavities in the material which bears the galena. It would seem as if the bitumen was closely related to the lead in its deposition, and had participated to a large extent in the extraction of the metal and spars from the rocks.

The lead evidently did not come up from below in heated vapors, else the structure of the lodes would be more symmetrical.

That it came from above appears; from the irregularity in the nature and structure of the deposits; from the frequent occurrence of limestone fragments in the vein matter (some of them containing galena), and from the fact that at one locality the galena-bearing fluor-spar was found lying horizontally and then traced to where it enters a nearly vertical fissure.*

The history of the lead in all its details is certainly of interest. In a general reconnoissance, however, this subject, though an important one, could not receive that attention necessary for a clear exposition of the matter.

*The nature of certain of the deposits in Crittenden county also tend to verify the statement.

That the major portion of the ore came from above seems, at this date, with what light can be obtained on the subject, to be the most reasonable conclusion.*

Owing to the peculiar nature and derivation of the deposits, it is difficult to decide on a proper and descriptive name for them, in the ordinary classification of metallic deposits. However, considering them simply as aggregations of fluor-spar and galena in fissures limited in their depth, they approach very near to segregated deposits, and may be denominated, for the present at least, as *vertical segregations* (or segregated veins) occupying the upper part of true vein fissures.

General and Special Description of Deposits.—As indicated on the map, there are at least three faults, and consequently lodes, so to call them, crossing the county.

Two of them are nearly parallel, coursing north 30° to 57° east, while the third has a course about north 32° east. The latter is supposed to be the lode opened at Fair View, Illinois, which crossing into Kentucky at Carrsville recrosses the river, back into Illinois, near Bay City. It is known as the *Fair View Lode*, and is supposed to be the same as that at Rosiclare.† Of this, however, I have no personal knowledge. The other two are known respectively as the *Latrobe Lode* and the *Excelsior Lode*.

On these two the greatest amount of work has been done. Each lode may be traced across the country by the immense masses of quartzose sandstone, standing nearly vertically on the ridges, and in many instances forming the ridge line.

The Latrobe Lode is the one on which the shafts at the Royal mines are located.

Following the line of the fault, several shallow pits have been sunk.

Pits were sunk on the lode on the Donake, Coker, and Levan farms, all near each other, out of all of which lead and

* The supposition that it was all eliminated from the *inclosing* rocks would not explain the character of the deposits as they are found at a number of points in the lead district, especially in Crittenden county.

† The mines known as the "Rosiclare Lead Mines" are not immediately at the village, but to the west of it.

fluor-spar were obtained. The Donake pit has greater local celebrity than the others; it has been opened for a longer period, and more mineral obtained from it.

On Mrs. Mitchel's old place, now the possession of Messrs. Waller & Co., and on Mrs. Cox's property, near Salem, lead and fluor-spar have also been obtained. On the former place the quartzose sandstone forms the eastern and greater part of a ridge, and stands out in a huge mass with rough outlines, about 50 feet in width.

The rock pitches south 55° east, at an angle of from 75° to 80°, with a strike north 35° east.

On the west side of the hill, near the base, a pit was dug many years ago, and lead procured from it.

Fragments of limestone were found at the mouth of the pit (which is now almost entirely filled with debris) containing much fluor-spar.

The sandstone extends the entire length of the ridge, with limestone on the west side.

At Mrs. Cox's place no pit has been dug, but much fluor-spar and calc. spar occur in the quartzose sandstone. Some lead was also found in it. More spar was found in it at that place and on Rev. Collin Hodge's land (at the old "wash-hole") than at any other place in the county. At Mr. Hodge's, limestone is exposed on both sides of the sandstone, not immediately in connection with, but near to it. On the northwest side the limestone approaches within 20 feet of it, while on the opposite side the limestone is 300 feet away from it.

The Excelsior Lode has a general course parallel with the Latrobe Lode.

Pits have been sunk on it at Mr. Henry Woods', Mr. Robert Woods', and Mr. Tisdal's (now deceased); all of these places are near together, and from three to four miles south of Salem. Galena was obtained from each shaft sunk.

The quartzose sandstone forming the hanging wall of this lode is seen on the south side of the Cumberland river, about four and a half miles northeast of Smithland. No lead has yet been found in connection with it south of the river.

The only place at which any work has been done on the *Fair View Lode* is at Carrsville, and this will be noticed hereafter. On the farms of the Messrs. Lemen, about two miles west of Salem, there is an exposure of quartzose sandstone resembling that seen at the Royal mines and at the Messrs. Woods'.

The mass juts up to a level with the conglomerate, which lies on the east side of the sandstone. Passing over a low hill, from the place where the sandstone was seen, Chester limestones and sandstones are found, and though having no instrument with which to make exact measurements, they appeared to be on a level with the conglomerate, or even to occupy a higher topographical position.

The sides of the quartzose sandstone are striated in some places, as if having undergone severe friction. It seems that, subsequent to the down-throw of the quartzose sandstone, the rocks on the east settled down, bringing the conglomerate on a level with the Chester limestones and shales on the western hills, and, as a consequence, bringing the faulted sandstone on a level with the top of the conglomerate.

It may also be that the Chester rocks have been slightly elevated; they are found at one place dipping southeast, toward the point of fracture.

Whether the sandstone seen at Mr. Lemen's extends any considerable distance is not known, as no attempt was made to trace it.

Should it be found to have any extent, it is possible that lead may be found in connection with it, as it has the same physical characters as that seen at places where the mineral is known to exist. I do not, however, think it worthy any especial attention, particularly as it is high up in the series, and no galena of consequence has been found above the geodiferous limestone of the St. Louis beds.

On Mr. J. K. Hudson's place, the southeast corner of the old Jonathan Ramsey survey, a pit was dug about twenty years ago in the search for lead.

It was filled with debris when the locality was examined. Red clay and fluor-spar, both clear and purple, were taken from the hole. No lead was found. The hole was dug in a ravine by the side of grey limestone. The nature of the deposit could not be ascertained.

The following are special descriptions of those localities at which there has been the most work done in searching for lead.

Tisdall's Shaft.—This is on land belonging to the Tisdall heirs. It is located at a point about two miles north of Pinkneyville.

The pit was sunk to the depth of 57 feet on a ridge strewn with fragments of limestone and quartzose sandstone. The sandstone is broken off from a mass forming the backbone of the ridge. It has occasional threadlike seams of fluor-spar traversing it, but with no galena in connection with it. It extends in a line coursing north 45° east.

The shaft was sunk a short distance away from the sandstone. Fluor-spar bearing lead was reached at 20 feet below the surface. After penetrating about 16 feet in the spar it was found to be dipping towards the sandstone. Then passing down to the full depth of the shaft, red clay and rotten fluor-spar formed the material for the entire distance. Occasional masses of calc. spar were met with in the clay, some of them large and containing lead.

The limestone found on the surface, which seems to be the wasted beds of the St. Louis Group, is dark grey in color, emitting a bituminous odor when fractured. Masses and irregular seams of calc. and fluor-spar occur in the rock, crossing it in all directions. This shaft is on the Excelsior Lode.

Robert Woods' Shaft.—This shaft is about half a mile northeast of Tisdall's, and is sunk on the same lode. The shaft was sunk to the depth of thirty-five feet. Fluor and calc. spar mixed with a silicious material were reached at sixteen feet below the surface. Masses of agglomerated fluor-spar, calc. spar, limestone and silica, forming quite a hard rock, are found all through the vein. A little lead was found in them, but rather sparingly disseminated, and in small particles.

When the spar was first encountered, about a foot of red and black clay was found, passing over the top of it out towards the limestone, as represented in figure I, plate III[a].

The vein has not a regular, well-defined structure, but is composed of fluor-spar in irregular masses, mixed with silicious matter in an olive-green silicious clayey material.*

Some of the masses of spar are quite large, weighing, perhaps, thirty or forty pounds.

No clay occurs between the spar and the walls. On the southeast side of the shaft masses of limestone, with seams of fluor-spar traversing them, were found.

Not much lead was taken out from this shaft. It occurs widely disseminated through the spar, etc., but in small particles.

The vein is about eight feet wide.

Henry Woods' Shaft.—This shaft is near the former, about three miles nearly northeast from Pinkneyville.

It is sunk on the same lode (the "*Excelsior*") as the foregoing.

Limestone and sandstone were found on each side of the vein.

Two shafts were sunk, only a few feet apart, in each of which fluor-spar was reached.

In one shaft it was found in a horizontal position, reposing about two feet above the limestone, with clay between. In the other it filled a nearly vertical fissure.

The Messrs. Hewlett, who sunk the shafts, then cut an opening from one shaft to the other, following the fluor-spar, which was found to be connected. Figure II, plate III[a], exhibits a cross-section of the shafts

The vein is mostly red clay and fluor-spar mingled together. In places the fluor-spar predominates. An occasional silicious fragment cuts out the spar for a short distance. Masses of calc. spar and limestone occur throughout the vein; in their vicinity masses of amber-colored, cellular fluor-spar, with some

* This silicious matter, essentially quartz, has probably been taken from the sandstone by fluoric acid. This is probably the history of the silicious material found in all of the pits.

silicious matter, occur, accompanied by small particles of galena.

Where cavities occur in the vein they are usually filled with red clay.

Fluor-spar and a little galena were found in the quartzose sandstone ("silicious" or "hanging wall") near the exterior.

Several pits have been dug in this locality, near each other; galena was obtained in each of them.

The following is a description of different specimens of the material taken from the vein at Mr. Woods':

1. Ferruginous clay. Seems to be very silicious. Incloses fluor-spar, bearing galena.
2. *Fluor-spar* disseminated in a matrix of almost pure quartz. A few cubes of galena inclosed in the spar. A little *blende* disseminated in the silicious material.
3. Mostly fluor-spar (some silicious material), with cavities lined with mammillary incrustations of *silicate (?) of zinc.*
4. Like No. 3, but containing, besides the zinc, small cubes of galena distributed promiscuously through the mass.
5. Cellular mass of light amber-colored fluor-spar, with some of the cavities filled with red clay.
6. Cluster of purple fluor-spar crystals.
7. Cluster of purple fluor-spar crystals, with cubes of galena disseminated through it.
8. Like No. 7, but more silicious.
9. Light amber-colored cellular fluor-spar, with a little *Cerussite.*
10. Dolomitic limestone and calcite, with galena and blende.
11. Dolomite crystals from the limestone wall.
12. Silicious and calcareous material, with fluor-spar containing cubes and flattened masses of galena. (From "bowlders" in the clay and spar.)

Dupont's Shafts, at Carrsville.—Three shafts were sunk at Carrsville, on what is supposed to be the *Fair View Lode.* They are all in rocks of the Chester Group, and little lead was found.

Shaft No. 1 was sunk through greenish and dark colored marly clays of the Chester Group, overlying a heavy-bedded limestone. Neither lead nor fluor-spar was found.

Shaft No. 2 is eighty-one yards distant from No. 1, course south 40° west, and is south 34° west from the Fair View shaft (in Illinois).

It was sunk through drab to nearly white fine-grained sandstone to the depth of forty-five feet.

At that depth a drift was started and carried forty-five feet, with a course north 45° west.

At the end of that distance a hard, white, somewhat quartzose sandstone was encountered; this was contiguous to, but still distinct from, the sandstone first penetrated. This quartz-

ose sandstone was passed through and found to be four feet wide, apparently resting on edge. An opening six feet wide was then entered, filled with a heterogeneous mass of the following character:

No. 3 is an agglomeration of calcite, dolomite (?), and sandstone. Has the appearance of small fragments of quartzose sandstone cemented by calcite. Contains a little fluor-spar, blende, and galena; the latter occurs in small, rough, irregular granules.

4. Mostly calc. spar resting on quartzose rock. The calc. spar has tarnished, worn, irregular masses of lead distributed through it.

5. Extremely fine-grained sacharoidal, somewhat friable sandstone. Grains of sand invisible. Contains much dolomite (?) and some fluor-spar.

On the opposite side of this mass an extremely fine-grained sandstone, sacharoidal in texture, was encountered, containing dolomite and a little fluor-spar.

A few rough, irregularly shaped crystals of galena were attached to the surface, next to the fissure.

Shaft No. 3 is but a few feet distant from No. 2; nothing of importance was obtained in it.

We have here a practical demonstration of the fact that the lead is not wholly confined to the St. Louis beds, but is also present in the strata above. It is not so abundant as in the limestones below, however, occurring as mere strings and small particles in the rocks.

This discovery of lead in the rocks at Carrsville is of much interest; the manner of its occurrence is evidence of its having been held in solution, or rather to have been in still higher rocks than the ones now carrying it, and to have been deposited in its present place by the percolating fluids.

It is within the possibilities that traces of lead may be found even so high up as the base of the coal measures.

The Royal Mines.—These mines, formerly known as the "River Valley Mines," are situated on the Cumberland river, near a well-known knob designated as "Bissell's Mount."

They are about three miles from Smithland by land, and somewhat further by water. At the time the mines were visited they were not in operation; the shafts were in such a condition as to preclude the possibility of examining them, nor have they at any time since, up to the present writing, been in a suitable condition for descending them.

Three shafts were sunk; one caved in from lack of proper timbering (so it is stated), the other two had water in them. The examinations were, consequently, confined to the surface workings, the only knowledge of what was below being obtained from the material lying at the mouth of the old shaft and from those who had worked in it.

This kind of knowledge certainly is not so reliable as that obtained from a personal examination; but no opportunity for entering the shafts was afforded, and it will have to be used as being better than none.

Of the three shafts sunk, only one is open for work at present; it is 175 feet deep, being the deepest of any in southwest Kentucky.

The shafts are located on the Latrobe Lode, the character of which is well defined. On the west side of the fissure, which varies in width from 8 to 15 feet, the St. Louis limestone is exposed, showing a thickness of 105 feet. On the east side the quartzose sandstone is also well exposed, exhibiting a width of about 12 feet, and standing nearly vertically, inclined at an angle of perhaps 75 degrees.

Immediately east of the sandstone thin limestone beds of the Chester Group crop out, resting on edge. They occupy a breadth of about 150 feet. Then the limestone terminates and blue calcareous shale comes to view. One hundred feet beyond where the shale sets in the rocks are once more nearly horizontal, a jointed sandstone (equivalent to the sandstone seen at Smithland?), some 10 feet or more in thickness, coming to view, standing out in a vertical escarpment.

All the rocks included between the St. Louis limestone and this Chester(?) sandstone are tilted at high angles, dipping about southeast.

The St. Louis limestone, however, is almost horizontal, and the Chester sandstone dips very little, course southeast.

The sandstone is about on a level with the top of the St. Louis limestone. There is evidently a very considerable drop in the rocks where the sandstone is exposed, as the Bissell Mount shows at least seventy-five feet of additional limestone coming above that at the shaft.

The following figure is a rough profile sketch of the structure of the region in the immediate vicinity of the mines, looking south.

Very little knowledge concerning the new shaft was gained; but Mr. Walton, the Superintendent, states that the quartzose sandstone disappears at 150 feet from the top of the shaft, and limestone takes its place.

The lead is sprinkled through fluor-spar in granules, small cubes, and bunches.

The masses of galena vary from less than the size of a pea to crystals half an inch in diameter.

In some of the large pieces of spar lying at the mouth of the old pit the lead was apparently in sheet-like masses; but upon breaking the spar they were found to be aggregations of small crystals arranged in a line with each other and brought close together.

In some of the spar the cubes are large and thickly disseminated, but in most of it the mineral is sparsely distributed, and in small cubes. Sometimes almost imperceptible particles of the galena are all that is to be seen in a piece of spar many pounds in weight.

In working the vein it was found that the galena varied in quantity greatly, and in size from that of a small shot up to masses that would weigh from 10 to 12 pounds; these were rare, however.*

The pile of spar examined came from the old shaft, which was sunk to the depth of one hundred and forty-two feet.

Col. Callahan, formerly one of the proprietors of the mines, gives the following statement in regard to the structure of the

* These masses were doubtless collections of crystals.

vein in the old shaft, according as his memory served him. The new shaft being on the same vein as the old one, and not far from it, the description will, it is believed, be in a measure applicable to it.

According to the statement of Col. Callahan, the fluor-spar (carrying galena) was met with at sixteen feet below the surface.

The spar was about two feet wide, with blue clay on each side of it, making up eight feet, the width of the fissure. The clay had many "bowlders" of quartzose(?) rock with drusy cavities set with fluor-spar crystals. Thin seams of fluor and of calcite also occurred in them, as well as occasional particles of lead.

This was the structure of the vein for the first ten feet. At that depth the spar disappeared and the entire fissure was filled with the clay and bowlders. The lead disappeared with the spar, and was found on the hanging-wall.

This continued for about 50 feet. Then there was 40 feet of "porous rock," with a little clay on each side. No lead was found in it, but was still seen coating the hanging-wall. Upon passing through the "porous rock" a silicious bed containing spar—mostly fluor—was encountered, and constituted the vein for 25 feet. No lead was found in it.

At the termination of the 25 feet a dark green shale, 3 to 5 feet thick, full of iron pyrites, was entered.

Upon passing through the shale, fluor-spar, bearing galena, was once more obtained.

The foregoing is, of course, not presented as being strictly accurate, but is sufficient to show the great irregularity in the structure of the vein.

Subsequent to the visit to the mines, it was learned that lead was more abundant in the new shaft than in the old one.

So little personal knowledge could be gained at the mines, that it would be fair neither to the proprietors nor to the Survey to express an opinion as to the merits of the mines. The few facts at hand would convey the impression that the

prospects are not very bright. It is a matter certainly to be regretted that free access was not afforded to the new shaft.

The conclusions deducible from the observations made in Livingston, especially, may be summed up as follows:

1. The strata have undergone a system of faulting, the rocks overlying the St. Louis Group having been, in part, thrown down in great fissures in the rocks of that group.

2. These rocks included a conspicuous sandstone, which probably occurred near the base of the Chester Group, and which, where in connection with the veins of fluor-spar, has undergone a metamorphosis, becoming exceedingly compact and firmly cemented, quartzose in character and often cherty.*

Also, that this rock frequently forms one of the walls of a lead lode for a certain depth.

3. The lead occurs as aggregations of crystals and granules, carried in fluor-spar occupying the upper part of fissures along the course of some of the faults; which fissures are those of true veins.

4. That the lead in great measure came from above. That it was originally in the upper or grey limestone division of the St. Louis Group, and has been eliminated from it by chemical, assisted by mechanical operations, and deposited in fissures in the lower or geodiferous limestone.†

5. The deposits may be denominated vertical segregations or segregated veins.

6. There are at least three of these veins or lodes crossing the country, all nearly parallel with each other, and there may be more.

CRITTENDEN COUNTY.

This, the adjoining county on the east to Livingston, is, as a whole, very broken; perhaps more so than Livingston. On the tops of the ridges, however, and in the valleys between, there is much land that is fertile, yielding good returns to the farmer. Good timber is in abundance, and water plentiful.

* This is supposed to be due to the action of fluoric acid, which possesses the property of dissolving quartz.

† See report on the region adjacent the Louisville, Paducah and Southwestern Railroad.

GENERAL GEOLOGY.

The geological structure is the same as that in Livingston county, including the *Quaternary* formation, and rocks of the *Coal measures*, *Chester Group*, and *St. Louis Group*, of the carboniferous period.

Coal Measures.—The same divisions of this formation that are found in Livingston are present in this county. The rocks are more widely distributed, however, and beds of coal more abundant.

Coal is pretty generally distributed over the eastern third of the county, and is reported in a number of places in the southwestern part of the western half.

The conglomerate is exposed frequently throughout the entire county.

Chester and St. Louis Groups.—These groups present the same characteristics as in Livingston county.

The beds of the St. Louis Group are frequently found containing masses of calc. spar, and with seams of the same material traversing them.

At the Milford bridge, over Deer Creek, 4 miles above its mouth, 6 feet or more of fine-grained, dove and drab limestone, crops out in the banks of the stream. Small geodes of quartz, and drusy cavities set with quartz and calcite, are abundant in the rock. *Zaphrentis spinulifera* was the only fossil found; but it is very probable that the rock belongs to the geodiferous division of the St. Louis Group.

On Mr. D. J. Ellington's place, on Paddy's-row Creek, about four and a half miles due west from Carrsville, limestone, equivalent to that seen at Milford bridge, crops out.

Some little work was done there in the search for lead, but without success.

Thin seams of calc. spar and fluor-spar traverse the rock in all directions. Numerous cavities filled with calcite and small quartz druses also occur in the rock.

The Lead Deposits.—The character and origin of the lead deposits in general is the same as in Livingston county. There may be one exception.

The lead has not received the attention in this county that has been given it in Livingston; still, several pits have been dug in search of it.

The first shaft examined was *The Deer Creek Mining Company's Shaft*, on Robert Larue's land, five miles nearly due north from Salem.

Two shafts were sunk near each other.

No. 1.—This is abandoned. It was sunk to the depth of forty-eight feet. For thirty feet down the material was red clay, with masses of earthy, dirty-grey limestone, with much calcite disseminated in masses. A little galena was found in the calcite, in small particles and seams. The lower eighteen feet was in masses of reddish-colored limestone with much calcite attached, and an agglomeration of limestone and calcite, with a few particles of lead disseminated in it.

A little bitumen was also noticed in the mass. It is stated that at the bottom the calc. and fluor-spar were more abundant, and that the lead increased in quantity also.

Shaft No. 2 is the one at which work had been progressing shortly before the mines were visited. When the region was examined the shaft was partially filled with water, and as complete an examination as was desired could not be made. The shaft was sunk to the depth of 35 feet, passing down between quartzose sandstone and limestone. The crevice is filled with compact, massive fluor-spar, with particles of galena disseminated irregularly through it. The vein is 7 feet wide. Figure III, plate III*, exhibits the character of the vein at the upper part; all that was visible.

The galena, so far as known to me, and I judge from the heap of fluor-spar thrown out at the mouth of the shaft, is very sparingly distributed through the vein matter.

Mr. James states, however, that the quantity of lead seemed to increase somewhat towards the bottom of the shaft.

The quartzose sandstone is exposed just east of the shaft.*

The vein courses north 35° east, and inclines at an angle of 65° or 70°.

* The figure has the sandstone reversed.

On Wm. D. Coleman's land, three quarters of a mile north 37° east from the Deer Creek Mining Company's shafts, three or four shafts were sunk for lead. The quartzose sandstone seen at the Deer Creek mines is exposed on the hill above the shafts. No lead was obtained there. The shafts appear to have been sunk too far away from the sandstone.

At Mr. Robert Larue's place, near his house, about 500 yards northwest from the Deer Creek mines, a shaft was sunk to the depth of 20 feet, passing down by the side of limestone. The limestone is grey, crossed by veins of fluor-spar, and with masses of calc. and fluor-spar disseminated through it. Small cubes of galena are sparsely distributed through the spar and the limestone in the vicinity of the spar. Occasional masses of chert occur in the limestone, with seams of fluor-spar cutting directly across them.

Limestone is exposed on both sides of the shaft, but seems to be tumbled on one side.

On Mr. Holly's place, one quarter of a mile from Larue's shaft, course about southwest, three pits were sunk. They were filled with debris and water when visited. Mr. P. C. Barnett, who accompanied me, states that limestone was exposed on both sides of the shafts. At one, an opening occurred in the limestone, out of which large masses of purple and limpid fluor-spar were taken. When first seen, the opening was about 8 feet wide, but towards the bottom was closing, and diminished to 4 feet.

Galena is distributed through the fluor-spar in specks and small cubes, with occasional masses the size of an ordinary marble.

A few of the pieces of fluor-spar found at the mouth of the shaft will weigh thirty to fifty pounds. Fragments of limestone are also to be seen at the mouth of the shaft, with ramifying streaks and thread-like seams of fluor-spar through them.

The opening seems to be continuous for some distance, and courses north 25° to 35° west.

These deposits are no doubt simply *segregations* filling cavities in the limestone. It is possible that (for a limited time) a profitable deposit of lead may be found in the vicinity.

Columbia Mines.—These mines, the property of Messrs. Barnett, Blue, and Hodge, are the oldest lead mines in the southern part of the State. Lead was procured from them, and smelted in a primitive manner, by the early settlers.

The mines are situated near the Marion and Smithland road, about five miles from Marion. A number of shafts have been opened at one time or another, but are now either wholly or partially filled with debris. The only shaft in operation was, at the time the mines were visited (November 26th, 1874), partially filled with water, so that the examination was, in great degree, confined to the surface. No opening was in such condition as to fairly display the nature of the deposits.

There appears to be some complexity in the occurrence of the lead, and till more systematic explorations are made there will still exist difficulty in determining the true nature of the deposits.

That there is an extensive deposit of lead, and one that will last for a considerable time, there is no doubt.

My opinion is, however, that the lead does not occur in true vein fissures, as is generally supposed.

The limestone in which the lead occurs is very cavernous; so much so, that the whole country seems to be undermined. "Sink-holes" are numerous, caused by the roofs of caverns giving way, some of which give access to caverns.

We may reasonably suppose cavities and long fissures, extending in various directions, to have existed in the limestone (produced in the same manner as caverns, *i. e.* by the erosive action of water) previous to the formation of the lead deposits as they now exist.

There is, indeed, scarcely any other way to account for the fissures, and, consequently, determine the nature of the deposits, than that they are due partly to shrinkage of the strata, and in part to the action of water, in washing out cavities and cutting channels through the limestones, as the rocks in which

the greater portion of the lead occurs are pretty horizontal, showing no evidence of disturbance.

These fissures may extend for a mile or more or for only a few hundred yards, and, similar to caverns, have a general though irregular course. In a set of fissures all may not have the same course, but some may cross others at various angles.

From the manner in which the lead has been obtained at these mines, I am induced to believe that the greater portion, if not all of it, associated with fluor-spar, calc. spar, and blende, occupies just such irregular fissures and openings in the limestone, forming what may be termed segregated veins and deposits.

This would lead to the conclusion that the galena was originally inclosed in the overlying rocks, which have wasted away and allowed the lead to be precipitated in solution, filling the cracks, cavities, and fissures in the rocks below. The irregularity in the deposits, and the number of cross-fissures, lend force to this supposition.

It is not a settled fact, however, that there is not a downthrow near the mines, similar to those in Livingston county

Quartzose sandstone, apparently identical with that found in connection with the lead in Livingston, is found in the vicinity of the mines. It may form one of the walls of a vein similar to those in that county.

Should such a lead-bearing vein be found to exist here, these mines, in themselves, present a beautiful illustration of the origin of those deposits.

Plate IV[a], figure 4, is a rough-sketch map of the mines.

The lead is carried in fluor-spar and silicious matter, and is more abundant at some of the shafts than others.

At the *Glass shaft* (the one now in operation) the galena lies in large masses and cubes, distributed through fluor-spar, calc. spar, and silicious material, the latter predominating. The depth of the shaft, at the time when the mines were visited, was said to be 38 feet, the width of the vein varying from 1 to 5 feet.

In sinking the shaft, the material passed through in the first 19 feet consisted of red clay, with fragments of limestone and masses of galena inclosed in spar and silicious matter, distributed through it. According to Mr. Tompkins, two wall rocks were found at this depth, limestone on the west and sandstone on the east, continuing thus to the bottom of the shaft, with no clay between, except in cavities in the vein material.*

In the next 10 feet the crevice varied from 1 to 5 feet in width, entirely filled with spar and silicious matter, bearing galena.

About 20 per cent. of the material taken out of this space was lead. In the lower eight feet the vein averaged four and a half feet in width, with an increase in the per centage of lead. Judging from the appearance of the material piled near the mouth of the shaft, the per centage of lead may be estimated at one fourth or a little more. This may be an over-estimate, however, as there is much zinc blende accompanying the galena.

Work at this shaft was suspended when the locality was visited. Mr. Glass states that there was no perceptible decrease in the quantity of lead towards the bottom.†

Shaft No. 2 was sunk in the same fissure as was No. 1. The lead is distributed through hard silicious matter, filling a crevice about two and a half feet wide, between two walls of limestone. The vein has a course north 39° west, passing from shaft No. 1 (the Glass shaft) through No. 2 to No. 3 (the Barnett shaft), at which shaft it seems to end.

Four shafts were sunk on the fissure between Nos. 2 and 3, out of which lead and spar were obtained; they are now partially filled with debris.

At the *Barnett shaft* (No. 3), the course of the fissure is north 40° west, till it reaches the north end, where it is stopped by what is apparently another fissure crossing it, with a course

* At the time of my visit the shaft had 15 feet of water in it, and no opportunity was afforded me to see the sandstone. I cannot, therefore, account for its presence. It is not visible on the surface, and this is the only shaft in which sandstone is reported. The walls of the one just a few yards north, as well as of all the others, are *limestone*.

† As indicated on the map, Messrs. Henry and James Glass have purchased 55 acres of the land from Messrs. Barnet, Blue, and Hodge, with the expectation of mining extensively.

about north 10° east. The cross-fissure is filled with greenish shale, etc., from above.

The lead was distributed through fluor-spar and silicious material, between two walls of limestone.

Greenish silicious clay shale rests immediately against the ends of the limestone at the north end; next to this there is from six to eighteen inches of black clay, and then green shale for five feet or more.

On the west side (north end) of the shaft a vertical seam of fluor-spar is wedged in between the green clay and the black clay, extending nearly to the surface. It varies in thickness from one quarter of an inch to two inches; is thickest towards the top, becoming quite thin towards the bottom, and perhaps disappears entirely within a few feet.

The black clay accompanies it all the way, and resembles a seam. The green shale rests against the black clay with well-defined stratification, the strata showing a dip of 45°, course about northeast; this appears as if it had come from above the limestone.

Occasional very small particles of lead are found in the seam of fluor-spar, though they are scarce.

The green shale is occasionally banded with a soft ochreous-yellow material; two or three fragments of limestone, with the edges rounded, were also seen towards the top.

At the north end a large limestone fragment extends across the end of the shaft. It was probably brought down with the shale which rests against it.

The green clay becomes quite silicious and hard, and is about two and a half feet wide in the middle of the end of the shaft, containing much purple fluor-spar and calc. spar, the former predominating. Figure I, plate IV[a], is a sketch of the end of the shaft on the west side. A is the limestone; B, green clay; C, black clay; D, fluor-spar; E, green shale.

On the east side (north end) the black clay is quite thin, while the green clay is two feet wide, with patches of bright ochreous-yellow silicious clay.

That part of the limestone abutting against the clay is porous and quite silicious near the surface. Lead occurs in this portion of the rock in irregular masses, following its edge, from as far down in the shaft as could be seen to the top, in some instances assuming the character of small veins, quite limited in extent.

Figure 3, plate IV[a], is a sketch of the east side of the shaft. A is the limestone; B, green clay; C, black clay; E, green shale.

Except in that portion lying directly across the end of the shaft, no lead was found in the green clay, and there it is in the lower part, in the vicinity of calc. spar. The limestone forming the sides of the shaft is cherty, and on the exposed surfaces is soft.

Galena occurs in the limestone on either side of the shaft in thin vertical seams, cutting the rock transversely, or in irregularly distributed masses.

The fissure crossing at the north end of the shaft has an irregular course, on one side bearing north 8° east, and on the other north 30° east.

Nineteen yards from No. 3, course north 37° west, *Shaft No.* 4 was sunk in the endeavor to catch the vein worked at No. 3, but without success. Neither lead nor spar was obtained, the material taken out being a dark to nearly black shale.

Ninety-nine yards from shaft No. 3, course north 8° east, a shallow shaft, No. 5, was sunk.

Hard quartzose sandstone is exposed in the west side, with purple fluor-spar clinging to the sides and occupying cavities.

This rock much resembles the "hanging-wall" of the lodes in Livingston county and in the western part of this county, and it may be an indication of such a lode crossing this property. This can be definitely settled only by sinking shafts. There is no well-defined exposure of the sandstone, so that the direction of its course could not be accurately determined. At the shaft it appears to have a course south 20° to 30° east; but the black shale at shaft No. 4 resembles the shale generally found in the proximity of the quartzose sandstone in Liv-

ingston county. Such may be the case in this instance, and the lode (if one exists) would then pass north of the Barnett shaft in a direction about south 20° west. As limestone is exposed on the creek, across the course which the sandstone *apparently* takes, the latter is probably near the correct course.

At the *Old Mill Shed*, considerable spar containing lead and blende was taken from a crevice between limestone walls. Blende is much more abundant than the galena.

The spar is said to have exhibited a width of three feet; it was covered with water when the locality was examined.

Fluor-spar occurs in vertical seams, and in crystals studding the sides of cavities in the limestone; also in small irregularly distributed masses. Some of the seams are an inch in width, while many are mere thread-like veins.

The zinc is quite abundant, and, in the greater portion of the limestone, is disseminated in minute, but closely-connected particles, without being associated with spar.* The limestone is always quite silicious in the vicinity of the spar.†

Attempts have been made to prove this crevice a continuation of that at the Glass shaft, but there seems to be no reason for considering it as such. It is more presumable that two distinct fissures exist, and that the fissure at the Glass shaft (should it extend so far) crosses this, or coincides with it, at a point near where the limestone is marked on the map, north of the Marion road.

Much lead is said to have been taken from shafts Nos. 6, 7, and 8. It occurred in large masses, inclosed between limestone walls.

These shafts are not exactly on a line with each other; but they are, without doubt, connected, the fissure having an irregular course.

From the Old Mill Shed, within twenty-five yards of the Whim shaft (No. 6), limestone is exposed at intervals along the creek.

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* A little *cadmium* is combined with the blende.

† This is an instance of replacement; the lime has been dissolved out, and the silica, carried by the fluor-spar, taken its place. This limestone is interesting as forming another link in the history of the lead—additional evidence that it came from above.

Up the creek, about 130 yards above the shed, masses of fluor-spar, with some silicious matter bearing galena, are seen occupying an opening in the limestone forming the bed of the creek. The limestone has been cut away from them by the running water, leaving a fissure twelve feet wide, the course of which is north 8° east. The limestone lies horizontally, and, no doubt, the spar was formerly in immediate connection with it, as a sort of vein; this gives a tolerable idea of the nature of the deposits. This may extend for some distance on either side of the creek, perhaps coinciding with other fissures.

More excavating has been done south of the Glass shaft, in a ravine, than elsewhere on the property. A number of shallow pits were dug promiscuously in the hollow, out of every one of which lead and fluor-spar were obtained in variable quantities.

It would seem as if the lead occurred in pockets, or that there was an extraordinarily large cavity filled with the mineral.

Just how the lead occurred, whether between limestone walls or not, could not be learned. The digging was done many years ago. Although the lead does not occur in the fissures of true veins, still its abundance is a matter undoubted.

There is a better showing of the ore near the surface at these mines, and in their vicinity, than in any other part of the county, and there is little doubt that it will last for a considerable time. It is probable, however, that its vertical extent is more limited than generally supposed.

Memphis Mines.—These mines, also known as the *Belt mines*, are located on the old Belt property, about 4 miles northeast of the Columbia mines. Very little galena has been procured from them, their interest centering in the large deposits of fluor-spar occurring at them.

It is nearly all of the clear, massive variety. The deposits are of the same nature as those at the Columbia mines.

The mines were not in operation when visited, and my conclusions are mostly based on information received from Rev.

Isaac McMurray (who accompanied me), and from Mr. J. C. B. McMican.

The first shaft visited is No. 1, four miles northeast from the Columbia mines.

It was sunk to the depth of 60 feet in limestone, no spar being found.

A few yards north of the shaft, masses of clear fluor-spar occur in red clay. At an opening about 30 feet south 60° west of the shaft, large masses of nearly pure white fluor-spar were also found in a crevice. These lie in a line south 45° west from the pit north of the shaft, and are, no doubt, connected with the spar at that place.

A shaft, known as the "*Rye Field Shaft*," was sunk in a field south of No. 1, and much fluor-spar obtained.

The course of the crevice south of shaft No. 1 is south 45° west, and there is little doubt that the Rye Field shaft is sunk on it.

The Beck Shaft (No. 2).—This is about one quarter of a mile nearly due west from No. 1. More work has been done at it than elsewhere on the property. It was partially filled with water; Messrs. McMurray and McMican, however, furnished the desired information.

The latter gentleman lives near the mines, was a frequent visitor to them, and descended the shaft several times.

The shaft was sunk to the depth of 160 feet, in limestone. A large quantity of remarkably fine fluor-spar was taken out; some of it is still to be seen piled near the mouth of the shaft. It is beautifully clear, almost wholly without impurities.

The spar was reached at ten feet below the surface, and continued until a depth of seventy-five feet was reached; it was then passed through and very little obtained below.

Mr. McMican says: "The spar occurred in large masses in the limestone, and a great quantity was taken out." Very little lead was obtained; that found was distributed in small particles through the fluor-spar.

The limestone is drab and light grey in color, and filled with seams and masses (filling cavities) of calc. spar.

Shaft No. 3.—This is about three hundred yards from the Beck shaft, course south 30° east, as well as could be estimated.

It was abandoned when visited. It was sunk to the depth of about fifty feet, and appears to be entirely in limestone, the color of which is drab and light grey, probably a continuation of the bed at the Beck shaft.

Scarcely any lead was obtained. Fluor-spar and calc. spar occur in seams and masses in the rock.

On the west side of the shaft, a little below the level of the top, a pit was dug down through red clay to the depth of ten feet.

A drift was then started with a course south 18° west, under a sandstone.

Everything was in a tumbled condition, so that the drift could not be entered.

Fragments of fluor-spar carrying particles of galena were found on the pile of material taken from the pit, but whether they came from the clay in the pit or from under the sandstone could not be determined.

Nor could any satisfactory conclusion concerning the sandstone be arrived at. It may have been brought down by a slide, or by a settling of the strata, as the region abounds in sink-holes, or it may be merely a large mass tumbled from its true position.

Again, it may be in place, and overlie the limestone at the shaft; in this case it is probably the sandstone at the base of the Chester Group.

The lead deposits at, and in the vicinity of, the Belt mines seem to be very small, but there is a vast quantity of first-rate fluor-spar. With an increasing demand for this mineral as a flux, by the various manufacturing industries, there is reason to suppose that the spar alone will pay for the working.

The Grace Shaft.—This is located on land belonging to Messrs. McMurray and Blue, one mile and a quarter northeast of the Crittenden Sulphur Spring.

This is an old pit, sunk probably thirty years ago. It is now nearly filled with debris. Near the surface, red clay with

masses of fluor-spar and fragments of sandstone intermingled, was passed through.

Considerable fluor-spar, but no lead, was obtained.

The Campbell Shaft.—This is about seventy-five yards nearly due west from the Grace shaft, and is on Mr. W. Spring's land, near the line of McMurray and Blue.

It was sunk to the depth of thirty feet. Much fluor-spar and calc. spar were obtained. Calc. spar predominated; large masses made up of crystals of the "nail-head" variety, some of them weighing fifty pounds or more, were seen lying near.

The shaft was sunk by the side of a limestone outcrop, on the west. Whether there is limestone on all sides could not be determined.

The spar seen at the top occurs in red clay, between horizontal layers of limestone; it also seems to lie in heavy horizontal beds below the limestone, with red clay between. Some parts of a bed are entirely limestone, and this passes laterally into calc. spar.

The following is the general arrangement of the beds for the depth visible, which, however, is but for a few feet:

1. Grey, sub-oölitic limestone, with red clay between the layers.
2. Red clay, with masses of calc. spar at the lower part.
3. Masses of limestone, calc. spar, and fluor-spar combined.

This section is a very pretty illustration of the derivation of some of the fluor-spar deposits.

Near the Campbell shaft there are numerous sink-holes, one forming the entrance to a cavern.

Mr. McMican states that spar (whether fluor or calc. he did not know) is to be seen clinging to the walls, and in little "pockets" in limestone forming the sides of the cavern.

Indeed fluor-spar and calc. spar are found nearly everywhere in this region, either strewn over the surface or connected with limestone.

It does not, however, always have lead in connection with it; so that, although deserving attention, it is not a certain guide to lead deposits.

As a conclusion concerning the lead deposits of this region, it may be stated, that in some instances they may be worked at a limited profit.

It would be best, however, that no expensive machinery be erected; but rather that the ore, when in sufficient quantity, be carried to such places at which crushers and furnaces are already built; the most profitable arrangement, perhaps, being to dispose of it to the smelters in its crude form.

Rosiclare and Fair View, Illinois, offer these facilities.

According to analyses by Dr. Peter and Mr. Talbutt, it is useless to mine the ore for the amount of silver contained in it; the per centage is so small that the amount obtained would not pay for the separation.

CALDWELL COUNTY.

GENERAL GEOLOGY.

The geological formations in the county include the quaternary and carboniferous.

Quaternary.—The usual divisions as indicated in the Livingston county report are present. The *drift* is more fully developed towards the western part of the county, however. It is the repository of excellent iron ore, of the limonite variety. So far as my observation extends, the drift is mainly composed of rounded pebbles of chert mingled with red clay, and is the result of the wasted beds of the lower carboniferous rocks, mostly from the St. Louis Group. Typical fossils of the St. Louis Group are frequently found in it.

Occasional pebbles of quartz and fragments of sandstone are also met within it. The quartz pebbles probably came from the conglomerate; the sandstone may have come either from the coal measures or lower carboniferous.

Without attempting an elaborate discussion as to the history of the iron ore, it is suggested that it may possibly have an intimate relation to the chert, as that has always a ferruginous tinge, is usually somewhat cellular, and accompanied by a deep red ferruginous clay.

This clay is quite silicious, and there are instances which seem to clearly indicate that it was derived from the chert.

Carboniferous.—The rocks of this age occurring in Caldwell county belong to the coal measures and sub-carboniferous.

The Coal Measures are represented by the conglomerate and associate coals, near the railroad, and by higher sandstones and coals (possibly two), towards the north, in the vicinity of Tradewater river.

Caldwell is really richer in coal than is generally supposed, the limits of the coal field extending further to the west than has heretofore been estimated.

The conglomerate coals are near to the surface at several places on Tradewater, displaying a thickness of four feet in some localities.

There is reason to consider the coals of Caldwell as worthy of further attention, and to believe that some benefit to the county may be derived from them.

Lower Carboniferous.—The St. Louis Group and the Chester Group are both present in the county. They are fully described in the report on the region adjacent the Louisville, Paducah and Southwestern Railroad.

The St. Louis Group is distinguished as being the lead-bearing formation, and for affording the beautiful oölitic limestone so well adapted for building purposes.

There is, perhaps, no better building stone to be found in the western portion of the State than is to be obtained in this county; not excepting the celebrated Bowling Green oölite.*

Besides the oölite for fine work, the lower blue limestone will answer for ordinary purposes, and some of the beds towards the top are admirable for such masonry as foundations, bridge piers (light work), and culverts.

Much interest has been manifested as to whether or not limestone suitable for *lithographic* purposes exists in the county. None was observed that in any way could be used for that purpose.

* It is probable that they occupy *about* the same geological level.

The typical fossil corals of the St. Louis Group, *Lithostrotion Canadense* and *L. proliferum*, are quite abundant in some parts of the county. A fine specimen of the *Lithostrotion* was presented to the Survey by a young lady of Princeton; huge masses of it were also seen on the Wilson Warehouse road, about one mile from Princeton.

As is the case wherever it is known to occur in this part of the State, this division of the lower carboniferous is quite cavernous. A cavern extends under part of the town of Princeton through which a stream of water flows, gushing forth at the "Big Spring." A number of wells are said to have been sunk through the roof of the cavern, and a seemingly inexhaustible supply of water obtained in this stream.

The Lead Region.—Galena is reported to have been discovered in a number of places in Caldwell county, generally as bunches clinging to the walls of caverns or filling small cavities in the rocks. No place of importance is cited, however, except in the northern part of the county on the head waters of Donaldson Creek, about nine miles northwest of Princeton.

There has been, indeed, very little attention given to the lead deposits; much less than in either Livingston or Crittenden county.

The occasional reports circulated to the effect that lead has been discovered in fabulous quantities at various localities are all traceable to one common source—legend. From our present knowledge it is deemed safe to say that galena occurs in more or less abundance throughout the St. Louis Group, in its entire extent, and is liable to be found wherever rocks of that group are exposed. With one exception, no systematic explorations for the mineral have been made in the county; this was on the property of Judge Marble, of Princeton.

Mr. Marble's shaft is on the head waters of Donaldson Creek, about four miles a little north of east of Fredonia, and about nine miles nearly northwest from Princeton. The rocks belong to the St. Louis Group, with the Big Clifty sandstone? (base of the Chester Group) capping the high ridges in the vicinity.

Several veins cross the property, all having about the same general course—nearly east and west. The width of the fissures is not uniform, however, nor are they always filled with metal, but are sometimes designated merely by streaks of fluor-spar. When the locality was visited the weather was very unfavorable, so that no attempt was made to trace the several fissures, and they may not be so extensive as supposed. A fairly accurate knowledge of the nature of the deposits in the adjoining counties, Livingston and Crittenden, aided considerably, however, in the comprehension of the character of the veins, or more appropriately (because not so distinctive), deposits of this region.

The vein on which Mr. Marble's shaft is located is said to be from three to four feet in width, coursing nearly due east and west. When examined, the pit was nearly filled with water, so that no personal knowledge as to the appearance of the vein was obtained. Both walls are limestone, the sides inclining at an angle of about 25 degrees.

According to the affirmation of one of the miners, the fissure was gradually widening towards the bottom, and the lead becoming more concentrated. The material taken from the fissure consists of fluor-spar, with galena distributed through it in small cubes and in masses about an inch in diameter. Towards the bottom the lead is said to have occurred in larger masses, some of them weighing from seven to eight pounds; the general size, however, was not much over a pound.

The galena is distributed pretty generally throughout all the material taken from the fissure, but in such small particles that the aggregate is but little when compared with the amount of fluor-spar in which it is inclosed.

Zinc sulphide and some galena were found in fragments of the wall rock.

In the lead region of Caldwell the character of the deposits seems to differ somewhat from the typical ones of Livingston and Crittenden counties.

The metal seems to fill crevices and openings in the limestone, produced by shrinkage of the rocks, and by erosion.

They approach more nearly in character to those at the Columbia mines (Crittenden county) than to any others.

There appears to be two classes of veins in the lead region of southwestern Kentucky, both deriving their lead from the same source. In one the lead occupies the upper part of a true vein, as is the case at the Royal mines, Livingston county, and in the other the metal fills incidental cracks, fissures, and cavities in the limestone. This latter class is not so persistent in longitudinal distance as the former, nor is there any definite calculation to be made as to the depth to which the lead extends. But when at all rich in lead, they seem to be more valuable, in proportion to their extent, than the first class, in that the lead is more concentrated. It is to the second class that the deposits of Caldwell county belong.

So far, no true veins (in the strict sense of the word) bearing galena have been found in the United States, except in the manner of those in Livingston and Crittenden counties, and in the southwestern portion of Illinois. All our lead deposits extend to a comparatively shallow depth.

In Missouri, one of the principal lead-producing States, two classes are distinguished, the gash vein and the segregated deposit, with their several modifications.

In southwest Missouri, where an immense amount of lead has already been obtained, and as yet without any apparent diminution in the quantity, the lead occurs (using a general and collective term) as segregations. In northwestern Illinois, Iowa, and Wisconsin, the galena occurs as gash veins, with local modifications, none of them extending to any great depth. In the southwestern part of Kentucky and Illinois the lead occurs in the upper part of true veins, or rather the *fissures* of true veins, as segregated deposits and in veins approaching gash veins in character.* It will be seen, therefore, that it is not necessary for the lead to occur as a true lode to be of value,

* *Gash vein* is a term designating mineral deposits occupying fissures confined to a single member or set of strata of a formation, and is always limited in depth to where a marked change in the chemical and lithological character in the strata occurs.

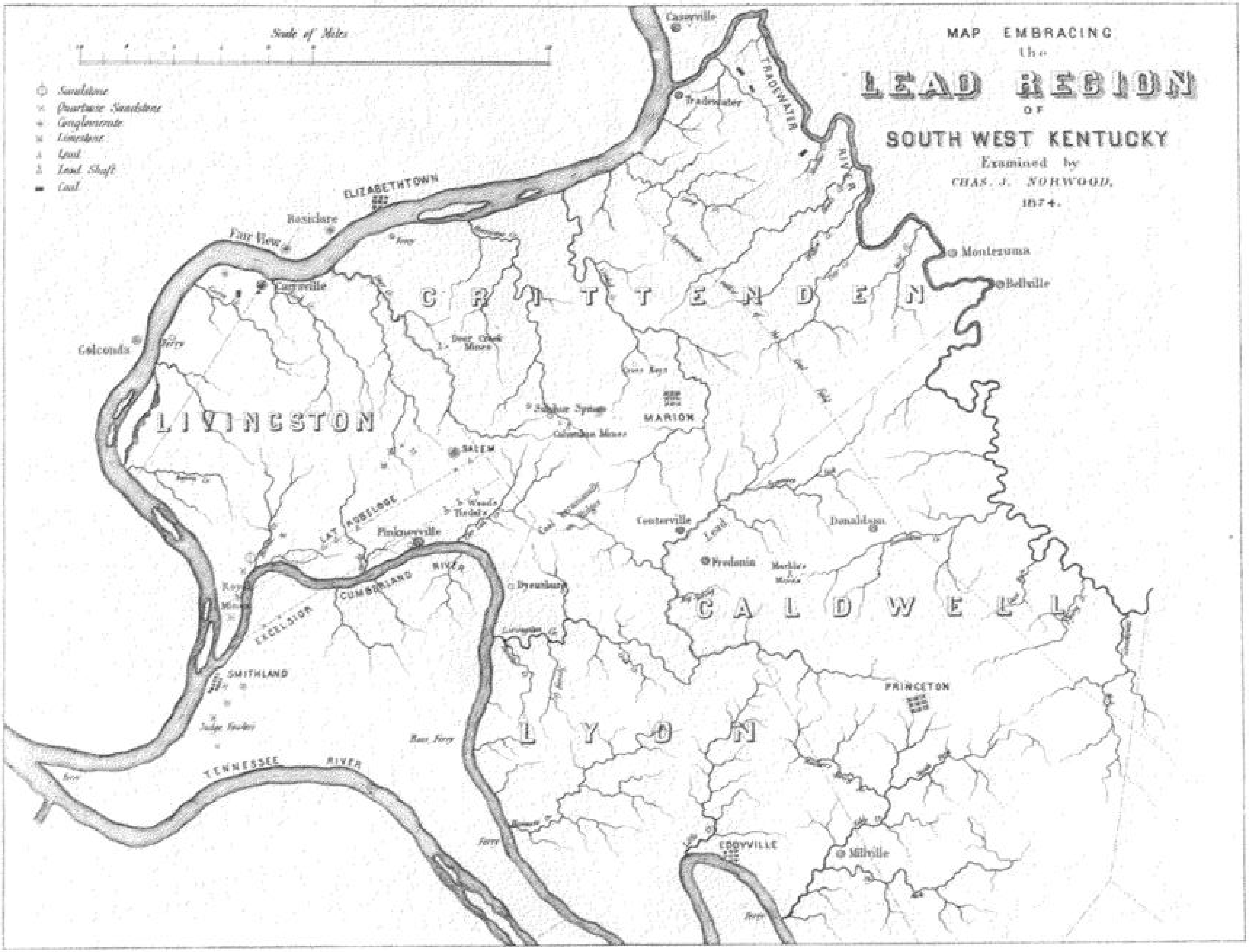
It holds an intermediate position between segregated and true veins, and is sometimes hardly distinguishable from a segregated vein.

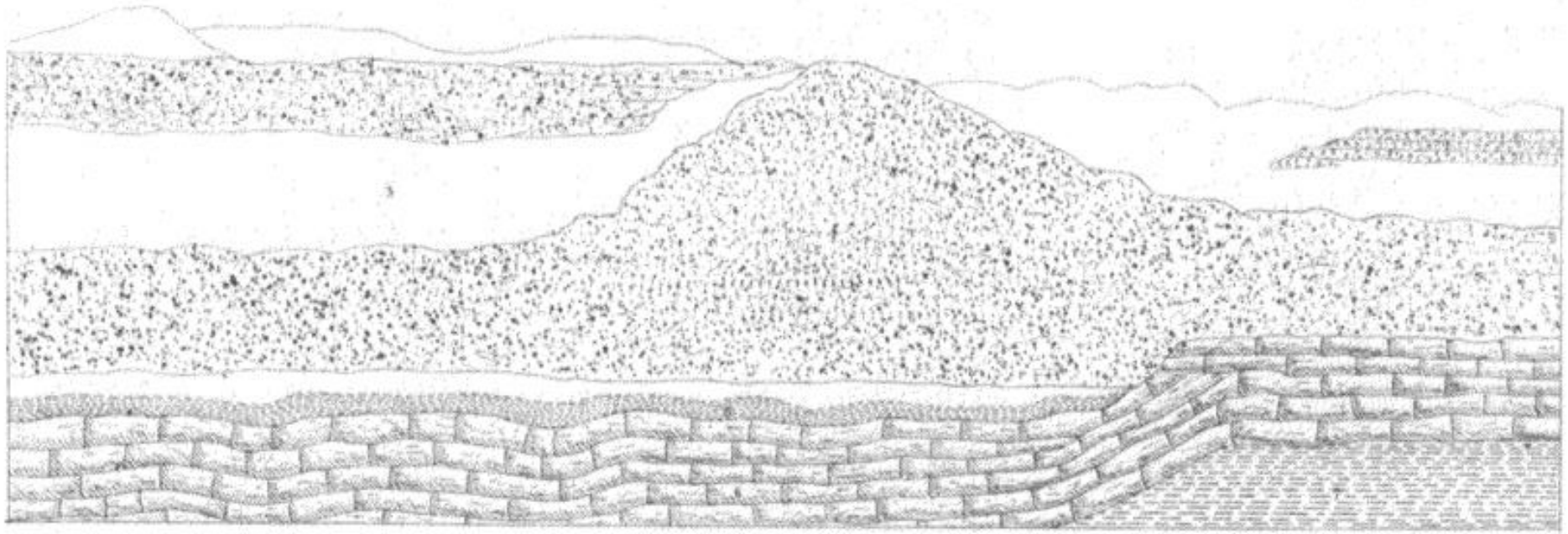
which fact does not seem to be understood by those interested in mining in this region. The typical deposits in Caldwell would, perhaps, take an intermediate position between a true vein and a gash vein, extending to a depth greater than the latter, but not so deep as a true vein; approaching more nearly in character to a gash vein, however.

As a conclusion, it may be said, that it is by no means impossible for a profitable deposit of lead to be found in this region; but, forming an opinion from the past results, there does not seem to be much probability that such will be the case. The mines at Rosiclare, Illinois, are located on veins similar to, if not identical with, some of those in Livingston county, in this State. If the mines there are not remunerative, ours certainly will not be. It is recommended, therefore, that no great expense be incurred in further prosecuting the search for lead, but rather that those already interested in mines which do not really offer solid inducements, be content to let the matter rest as it is.

This advice is given with the earnest desire to save the people of Kentucky from any useless expenditure of their money, and not with a wish to needlessly depreciate our mineral wealth.

As long as Missouri and other lead-producing States can afford lead at such little cost for mining and smelting, neither Kentucky, nor any other State with similar deposits, will be able to successfully enter the market with them.


MAP EMBRACING
the
LEAD REGION
OF
SOUTH WEST KENTUCKY
Examined by
CHAS. J. NORWOOD.
1874.
Scale of Miles
Sandstone
Quartzose Sandstone
Conglomerate
Limestone
Lead
Lead Shaft
Coal
CRITTENDEN
LIVINGSTON
CALDWELL
LYON
TRADEWATER RIVER
CUMBERLAND RIVER
TENNESSEE RIVER
LAT MOBSLOGE
EXCELSIOR
Caseyville
Tradewater
ELIZABETHTOWN
Rosiclare
Fair View
Carrsville
Golconda
Deer Creek Mines
Sulphur Springs
Columbian Mines
MARION
SALEM
Woods
Pinkneyville
Centerville
Fredonia
Marble Mines
Donaldson
Dycusburg
SMITHLAND
Montezuma
Bellville
PRINCETON
EDDYVILLE
Millville
Lead
Ferry



Outline sketch of the Rocks from

Carrsville to a point ½ mile Below

Livingston Co.

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Fig. 1.

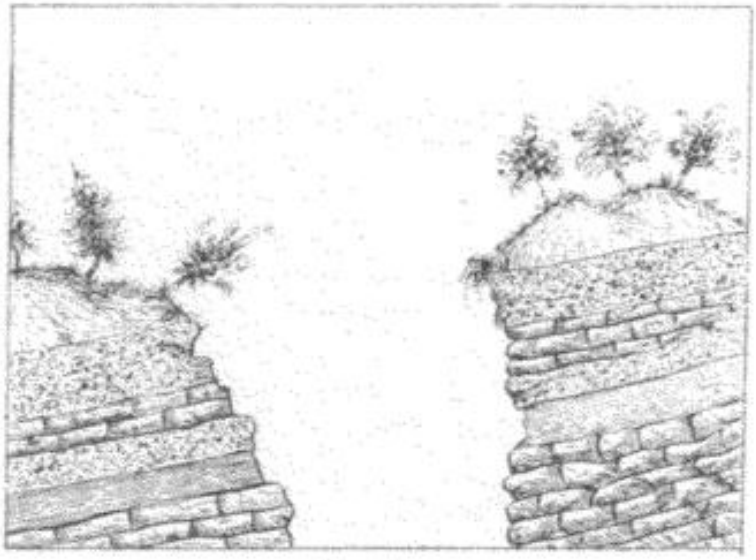

Fig. 2.

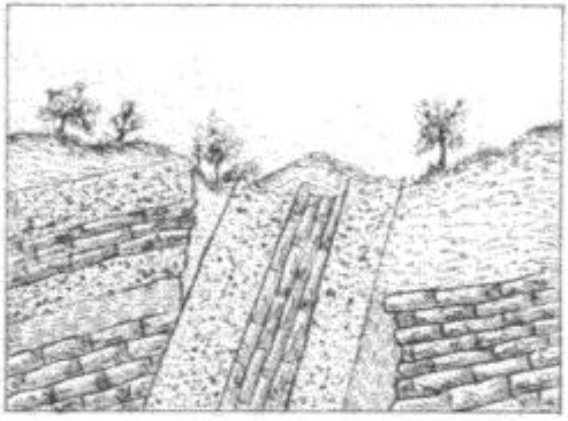

Fig. 3.

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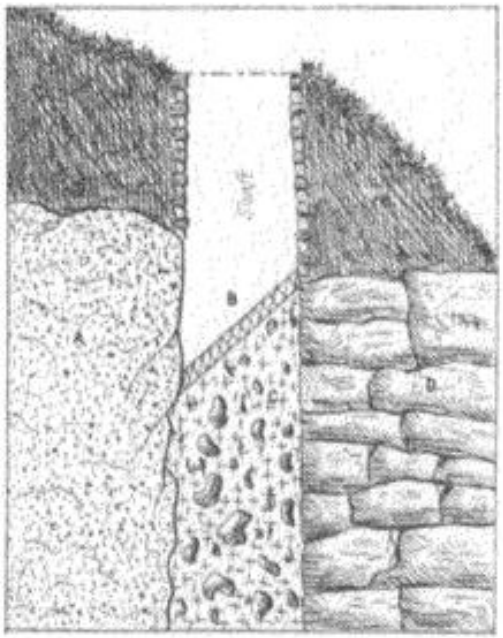
A. Quartzose Sandstone.
B. Clay.
C. Flour Spar, Limestone fragments & Lead.
D. Limestone.

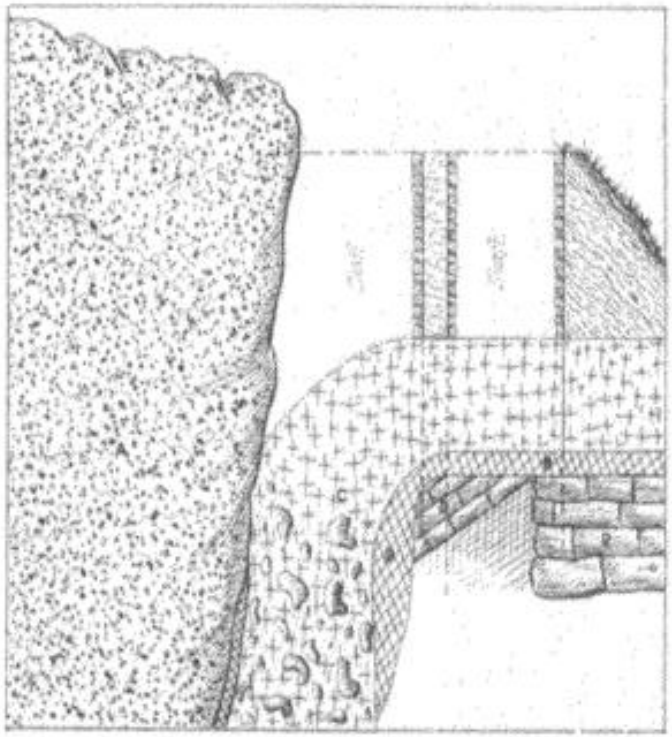


ROBERT WOODS'
LEAD SHAFT
3 Miles South of Salem

LIVINGSTON CO.

Fig I.

A. Quartzose Sandstone.
B. Clay.
C. Rotten Flour Spar & Lead.
D Limestone.

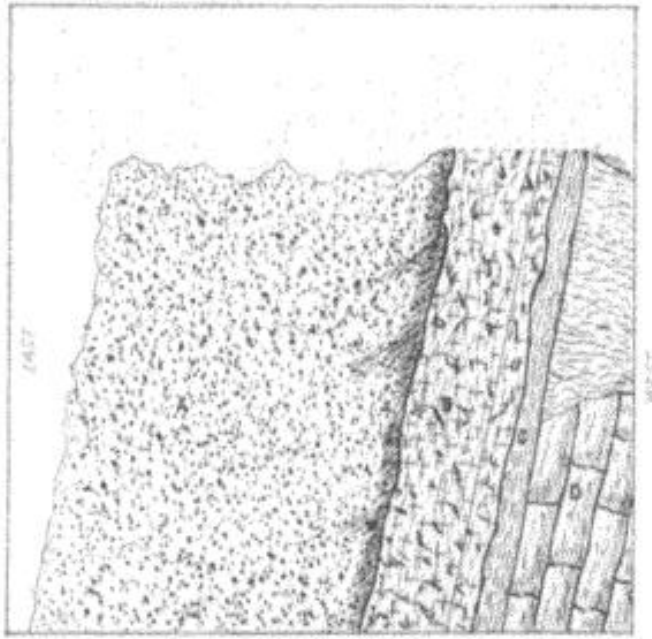


HENRY WOODS'
LEAD SHAFT
3 Miles South of Salem

LIVINGSTON CO.

Fig. 2.

A. Quartzose Sandstone
B. Calc & Flour spar with Galena.
C. Shale.
D. Limestone.



DEER CREEKMINING CO'S
LEAD SHAFT

CRITTENDEN. CO.

Fig 3.

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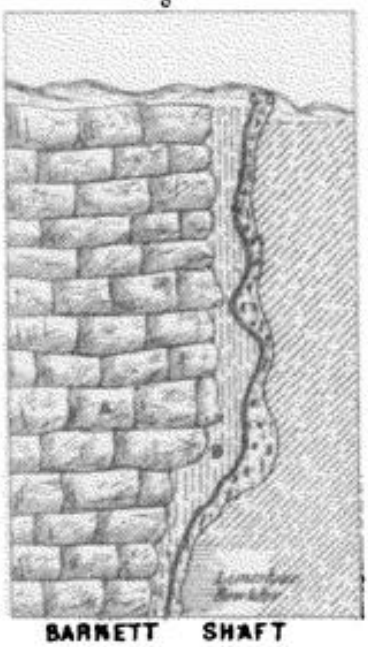
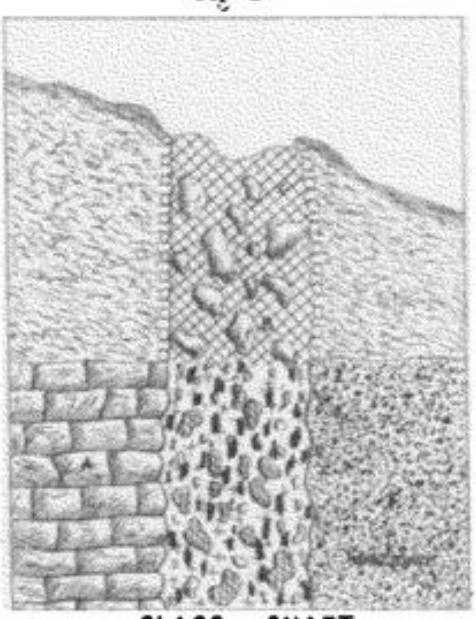
Fig. 1



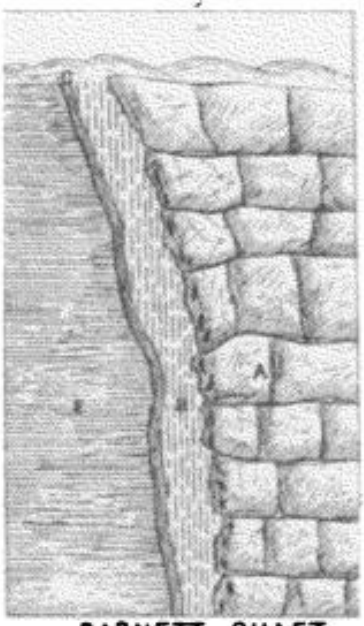
BARNETT SHAFT

Fig 2



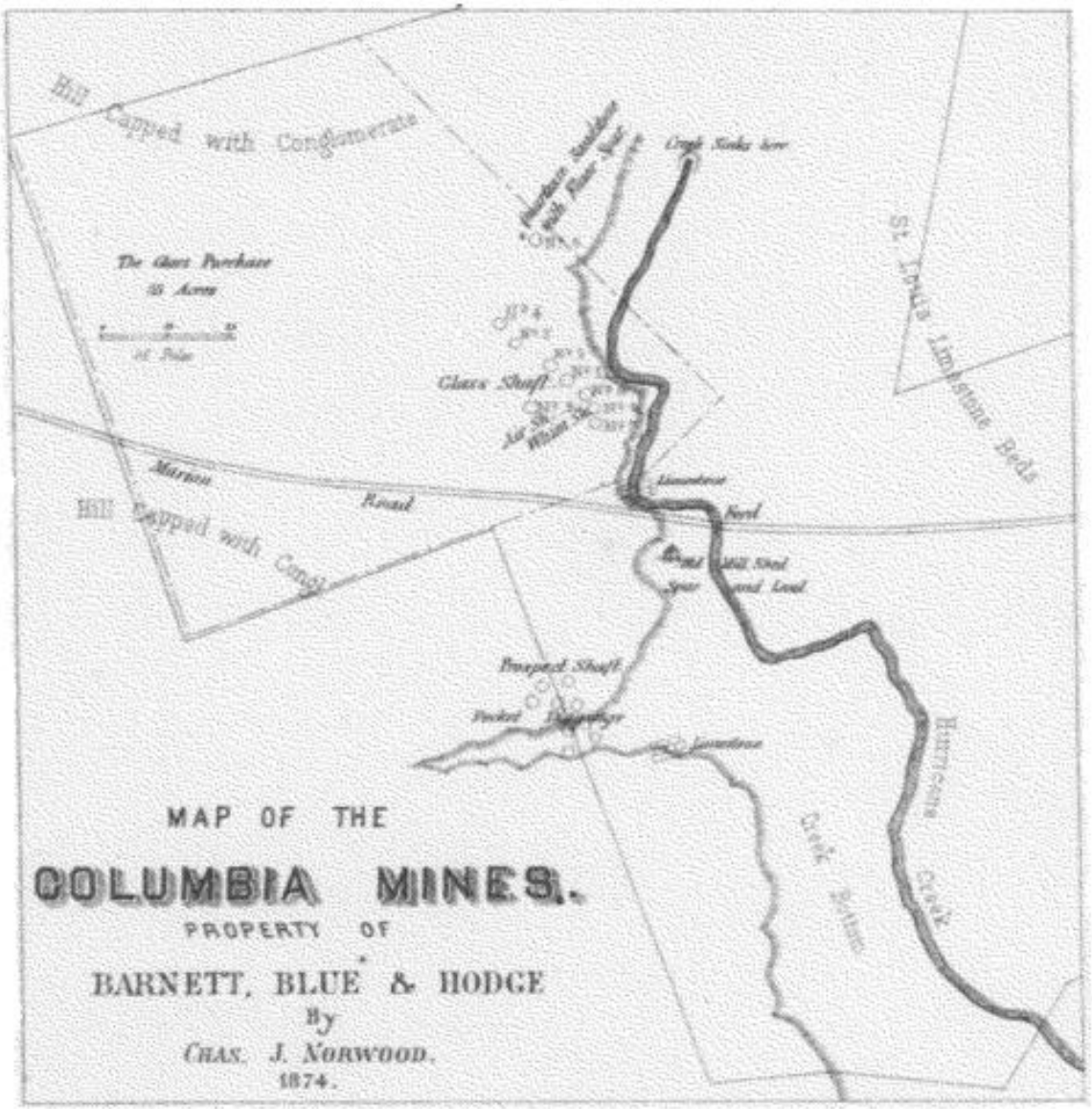
GLASS SHAFT

Fig 3



BARNETT SHAFT

Fig 4



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