GEOLOGICAL SURVEY OF MISSOURI.

ARTHUR WINSLOW, STATE GEOLOGIST.

BULLETIN No. 3.

CONTENTS:

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GEOLOGICAL SURVEY

OF MISSOURI.

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CONTENTS.

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THE CLAY, STONE,

LIME AND SAND INDUSTRIES

OF

ST. LOUIS CITY AND COUNTY.

By G. E. Ladd, assistant geologist.

CONTENTS.

LIST OF MAPS AND ILLUSTRATIONS.

PREFATORY REMARKS.

The field work for this report on the clays and structural materials of St. Louis was completed during the past summer. The preparation and publication of the results have, however, been delayed through successive interruptions caused by sickness and by the demands of a field season.

Special attention, it will be noticed, has been given to the statistics of the production, and truly surprising results have been reached. Within the area discussed the value of the respective products during the year 1889 is as follows: —

Structural brick	$2,288,795 00
Fire clays, sewer pipes and pottery	1,722,685 00
Stone	665,761 00
Lime	103,000 00
Sand and gravel	76,229 00
Total	$4,856,470 00

The principal object in obtaining these statistics was to demonstrate the magnitude of the industries dependent upon the natural products, which are Mr. Ladd's special subjects of work. The importance of the State of Missouri as a clay producer is recognized in a general way, yet there are no figures available by which that importance can be meas-

ured, nor is any adequate provision made by State or National government for the gathering of such figures. Nearly five millions of dollars seems a large sum to represent the production of St. Louis city and county alone; but this is undoubtedly far in excess of the value of the product from any other equal area in the State. St. Louis is not only the largest center of population, but it has also an exceptional supply of the raw materials, and is hence a large manufacturing center. Yet, though no one other place, and probably no three other places in the State combined, yield so great a product as does St. Louis, there is little doubt but that the product of these materials in the whole State is worth several times five millions.

Similarly with regard to the qualities of Missouri's clays. They have a high reputation and the refractory clays have been marketed in many States. But this reputation has been acquired through the use of clays handled by two or three firms which draw their supply from a very limited number of localities. Concerning the clay deposits of the State as a whole, and the qualities of the materials, little or nothing is known. Hence, among the considerations leading to an investigation of the St. Louis clays, an important one was the fact that a determination of the composition and an experimental test of the properties of some of these familiar clays would furnish an excellent local standard by which to measure the properties of clays occurring elsewhere in the State which are only partially or not at all developed. Such analyses and tests of these as well as of other clays of the State are now being carried on, but the results are reserved for the final report on the clays of the State, in which will be made a full exposition of the results.

ARTHUR WINSLOW,
State geologist.

INTRODUCTION.

This paper is a partial result of work done by the author during the past spring and summer in St. Louis and vicinity, in pursuance of the investigation of the clays and building stones of Missouri.

The materials discussed are of much importance to a great city, where, if they exist, they are sure to be extensively developed. With most of the ordinary structural materials needed by a city, St. Louis is, happily, well provided, and in the following pages the writer attempts to convey a fair impression of the nature and extent of the industries in the city and county which produce these materials; and also of the nature and extent of their sources of supply.

Objects of maps.

The sketch maps used have two purposes. One of these is to show in a rough way the distribution of the different geological formations, to which, in the text, the different kinds or grades of structural materials are referred. The other purpose is to show the location of all quarries, clay mines, brick and other works.

Two conventional sections are printed to show the reader at a glance the probable thickness, and the relative positions of the different geological formations.

Assistance.

A great part of the credit for whatever of value this paper may have is due to those who have lent their assistance to the author. Especially is he indebted to Mr. Elston H. Lonsdale for efficient aid in the field; to Mr. Amos E. Woodward for the analysis of many samples of limestone and clay, and to Mr. Leo Gluck for the drawing of maps and sections. A personal debt is also due Mr. J. D. Robertson and Prof. H. A. Wheeler for either valuable suggestions or aid in the field.

The report of Mr. B. F. Shumard on the Geology of St. Louis county, in 1855, has been an invaluable aid. The map showing the distribution of formations is mainly from Mr. Shumard's map, modified so much as the hurried observations of the author would warrant.

A LIST OF CLAY WORKS AND STONE QUARRIES IN ST. LOUIS CITY.

The locations of these quarries and works on the City Map are indicated by their respective coördinates.

Sewer Pipe, Fire Clay and Terra Cotta Works.

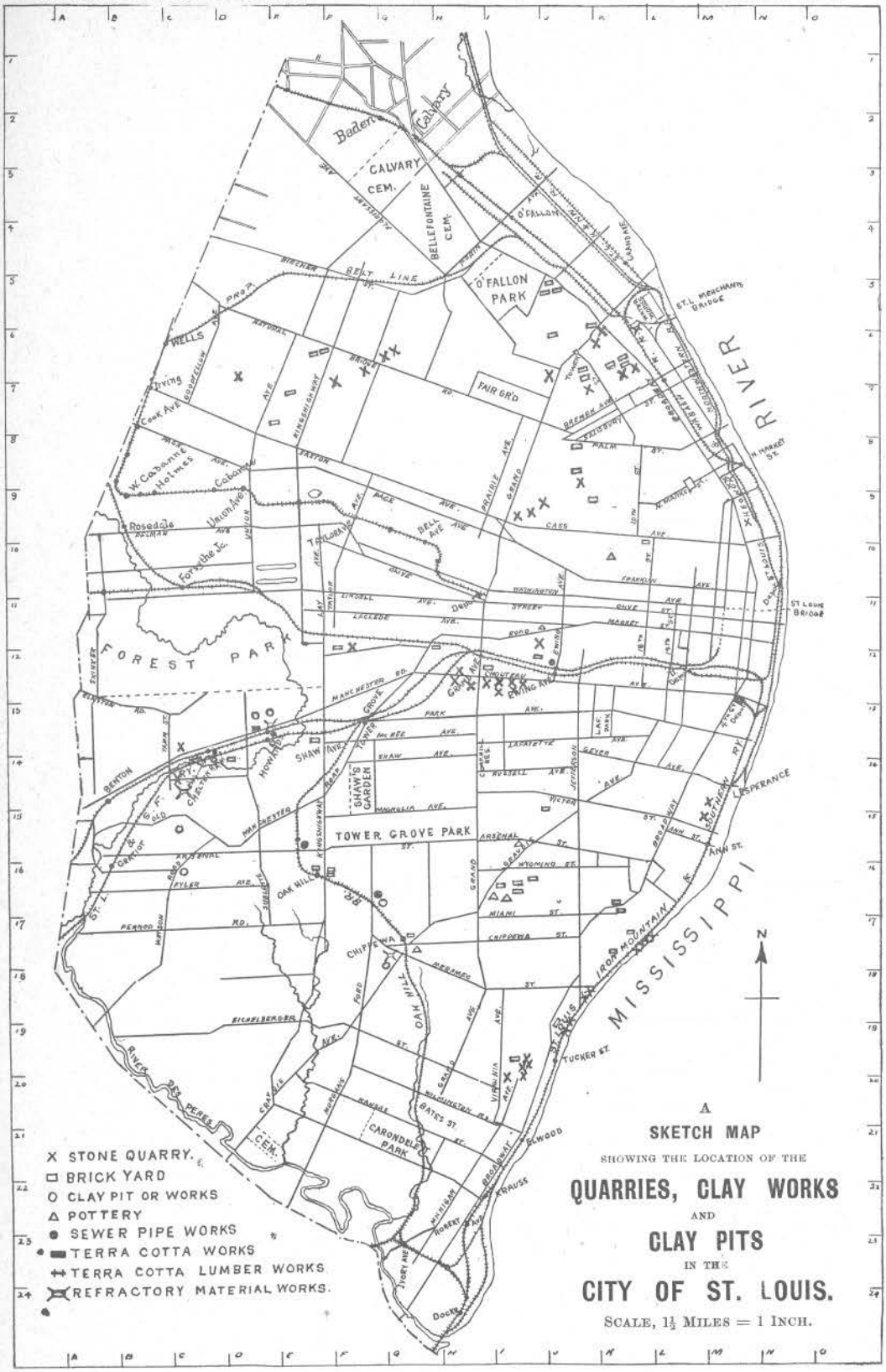
Proprietor.	Coördinates.	Proprietor.	Coördinates.
Blackmer & Post	E, 16 & J, 12	Mo. Fire Brick & Clay Co	D, 14
Christy Fire Clay Co	G, 18	Mo. Terra Cotta Lumber Co	D, 14
Coffin, Thos. & Co	L, 6 & C, 15	Parker & Russell M. & M. Co	G, 17
Evens & Howard	E, 14	Towle & Thorpe	C, 16
Jones, David	D, 13	Winkle Terra Cotta Co	D, 14
Laclede Fire Brick Mfg. Co.	D, 14	Wrisberg Mining Co	E, 13
Mitchell Clay Mfg. Co	E, 14		

Potteries.

Proprietor.	Coördinates.	Proprietor.	Coördinates.
Gnauk, Louis	G, 18	Seeber, August	I, 17
Muttig, Jno	J, 12	Uhlemeyer, August	I, 17
Schwarzkopf, Chas	I, 16	Wash Street Pottery	K, 10

Structural Brick Works.

Proprietor.	Coördinates.	Proprietor.	Coördinates.
Ballmann, Aug	L, 10	Lyon Press Brick Co	K, 17
Bergsicker & Bro	K, 7	Missouri Press Brick Co	K, 18
Branahl, Chas	E, 7	Nieman, Aug. H	J, 17
Buckwinkle, Frank	J, 6	Oehler, Paul	K, 17
College Hill Press Brick Works	J, 5	Pahl, Henry	F, 17
Compton Av. Brick Works	J, 12	Repping, J. H. & Son	J, 16
Eureka Press Brick Co	L, 7	Scales, Thos. H	K, 8
Excelsior Brick Co	K, 9	Schlingman, E	L, 7
Grote & Hilkerbaume	K, 7	Schlingman, Henry	L, 7
Hurman, Frank	E, 8	Schweer & Maes	J, 19
Hydraulic Press Brick Co., I, 13; H, 18; F, 16; D, 14; F, 14;	H, 12	Smith, T. S	K, 6
Ittner, Anthony	J, 15	Sprengemann, Edward	I, 20
Kuehn, August	J, 5	Steinkamper, F. W	J, 9 & F, 7
Kulage & Menke	J, 5	Stuckenberg, Jno	J, 17
Kuntz, Chas	L, 17	Tower Grove Brick Works	E, 17
Kuntz, Fritz	I, 17	Union Press Brick Co	F, 7
		Walkenhorst, F. W	F, 12



A

SKETCH MAP

SHOWING THE LOCATION OF THE

QUARRIES, CLAY WORKS

AND

CLAY PITS

IN THE

CITY OF ST. LOUIS.

SCALE, 1½ MILES = 1 INCH.

Stone Quarries.

Proprietor.	Coördinates.
Albernacius, Frank	L, 17
Allen, E	J, 19
Baldwin, Henry	I, 20
Bambrick-Bates	N, 9 (2)
Barnett, Wm. H	J, 12
Brocksmith, H	C, 14
Byrnes, Thos	J, 10
Cavanaugh, T. E	J, 10
Devereux & Sons	G, 7
Engleman, A. O	M, 15
Eyerman, G. (Estate)	I, 20 & I, 13
Friederichs, J	I, 20
Fruin-Bambrick & Co.	I, 13; H, 12; C, 14
Grund, Louis	K, 19
Heman Bros	C, 10
Hogan, E. W	K, 6
Hogan, M	L, 7
Hogan & Moran	J, 9
Kempf, Conrad	I, 20
Kern, Adam	L, 17
Kinealy & Sons	K, 7
Knaus & Willis	J, 19
Krug & Zesch	I, 20
Lohrum, Jno. C	L, 17
Lorentz, Martin	L, 17
Mohun, Patrick	I, 13
O'Meara, J. B	F, 17; F, 12; K, 9
Perkinson, J. E. & Bro	J, 7 & K, 6
Pickel, Conrad	I, 13
Pieper, Christian	I, 13
Prendergast, G. E	D, 7
Redemeyer	L 7
Stiefel & Ruckert	G, 6 & M, 15
"St. Louis Stone Masons"	I, 13
Watson Construction Co	H, 13
Wieman, William	G, 6
"Work House"	K, 19

A LIST OF THE STONE QUARRIES AND CLAY AND LIME WORKS IN ST. LOUIS COUNTY.

The locations of these quarries and works on the County Map are indicated by the numbers in the columns.

STONE QUARRIES.

PROPRIETOR.	MAP NUMBER.
Andrew, ——	68
Boem, Fritz	50
Bessen & Sons	64
Crystal Spring Quarry and Lime Co	47
Doering, J. H.	51
Dore & Wallace	67
Eureka Quarry Co	57
Exner, John	62
Fabrick, P. & Marshall	53
Glendale Quarry Co	55
Jefferson Barracks	63
Lauritzen, Jas	56
Madden, Thos	58
Munsen, ——	52
Pope, Andrew	59
Schwenn, John	66
Seifert, Henry	60
Shore's Quarry Co	54
Steffen, John C	61
Theby, Michael	48
Watson Construction Co	65
Zeiss, Henry & Mrs	49

CLAY WORKS.

PROPRIETOR.	MAP NUMBER.
Jameson, William	124

LIME WORKS.

PROPRIETOR.	MAP NUMBER.
Dorenheim, Herbert	76
Glencoe Lime & Cement Co	70 to 72
Goetz, Chas. W.	73 and 75
Thorn & Hunkins	74

GENERAL GEOLOGY.

St. Louis city and county are bounded on the north by the Missouri river, on the east by the Mississippi river, on the south by the Meramec river and a part of Jefferson county, and on the west by Franklin county. Boundaries of the area.

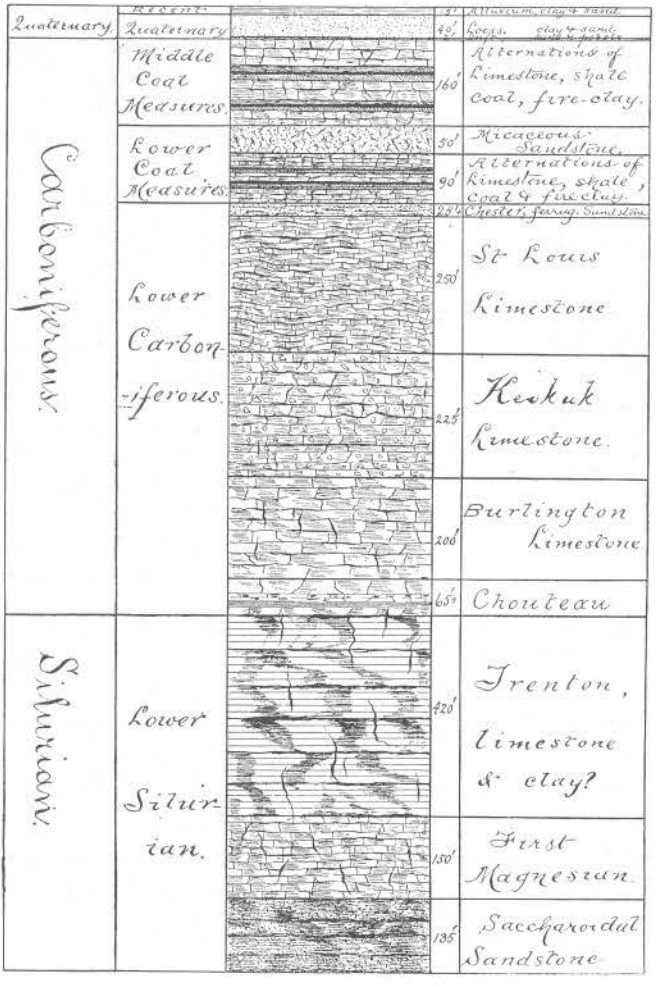
The geology of this area was described in a general way by B. F. Shumard, during the Swallow survey, in 1854. No detailed study has followed his work, and, in the absence of such a study, the writer has adopted, for the purpose of reference in this paper, Mr. Shumard's determinations of horizons. With reference to the distribution and extent of some of the formations, modifications have, however, been made. Determination of horizons.

A section of most of the local formations was constructed by Professor G. C. Broadhead, in 1875, from the borings and accompanying records of the St. Louis Insane Asylum well, which was sunk to a depth of nearly four thousand feet. This section does not include the Middle Coal Measures nor the Ferruginous Sandstone of the Chester Group. It includes, however, many of the older rocks which do not reach the surface in either the city or county. The section.

The formations are all of sedimentary origin. They represent a wide range of time and a considerable variety of conditions of deposition. They have nearly all been somewhat disturbed from their original positions.

On the accompanying map their distribution is provisionally shown. The Quarternary deposits, which are not outlined as a whole, cover nearly the entire area.

GENERAL GEOLOGICAL SECTION OF THE FORMATIONS IN ST. LOUIS CITY AND COUNTY.

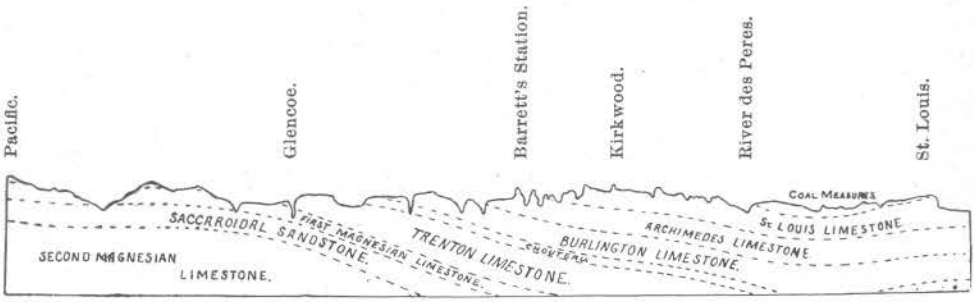


Some of these figures are estimated, others are taken from the record of the Insane Asylum well.

This general section is compiled from Shumard's and Broadhead's publications, and the author's observations. It includes only such formations as reach the surface within the described area. By reference to this section it will be seen that three grand divisions of time have been recognized here, viz., the

Quarternary, Carboniferous and Silurian. Between and within these divisions great thicknesses of formations belonging to the general section of the State are without representation. There is a clear gap in the section, from the Quarternary deposits to the Middle Coal Measures, a second from the Chouteau to the Trenton Limestone, and a third from the Trenton to the first Magnesian Limestone. The gap in the section.

The disturbances which are referred to above are manifested in the formations below the Coal Measures by a distinct dip in a northeasterly direction, gentle undulations, rather sharp anticlinal and synclinal folds, and occasional faults. The Coal Measures have been slightly flexed. The Quarternary deposits are undisturbed, save by erosive influences. Disturbances.



GENERAL CROSS SECTION THROUGH ST. LOUIS COUNTY, MODIFIED FROM SHUMARD'S.
Looking north.

The diagramatic cross section, above, shows approximately the relative positions of the various formations. It runs from the northern part of St. Louis, in a direction a little south of west, to a point near Pacific.

Topographic sheets of most of the area discussed in this paper have been already completed by the United States Geological Survey, and they will form the basis for detailed geological work in the future. Of much importance here are the questions of distribution, of relative position, and of the characteristics of the materials. The great industries which have arisen to handle these materials owe their origin largely to some accident of discovery, and they have grown in spite of the burden of much costly experiment. They have lacked always a local standard to which to refer their products, a working knowledge of the extent of their deposits and of their persistence in character.

THE CLAY INDUSTRY.

GENERAL REMARKS.

Sources of clay.

Geologically speaking, St. Louis has three local sources of clay. These are the Coal Measures, the Quarternary deposits, and the residuary product of decomposing limestones.

THE COAL MEASURE CLAYS.

Distribution.

The Coal Measures* which have an area approximating two hundred square miles in St. Louis county, and city, carry practically an inexhaustible supply of potter's, sewer pipe, and fire clays, of which the best of the latter have been long famous for their high refractory qualities. The mining and manufacturing of these clays has been carried on for many years, and to a large extent, in the immediate neighborhood of St. Louis, but so far as the writer knows, there has been no worthy attempt to even prospect for them in the great stretch of Coal Measure formation in the northwestern part of the county.

Conditions of occurrence and character of the clay.

Tile Clays: —The clay which is used largely for the production of sewer pipes, though low down in the Coal Measure series, is one of the uppermost layers in that portion of the formation which occurs along the western border of St. Louis. This tile clay bed overlies the fire clay bed described below and is separated from it by shale and sandstone six to twenty or more feet thick. It is usually covered with several feet of Loess clays, and is occasionally capped with beds of decaying limestone, which were not altogether denuded from above it before the Loess clays were deposited. It ranges in thickness from about eight to twelve or more feet. Its color varies, but is usually mottled red and brown, with bluish and greenish streaks. It is fissile, is quite free from grit, and has a soapy feel to the fingers. It is sometimes hard and shaly, but is usually soft when mined; growing hard on drying, after being exposed to

* See sections on pages 21, 22, 23 and 25.

the air. Crystals and thin coatings of gypsum, and nodules of limonite are scattered through the bed. The clay when used for sewer pipes is mixed in varying proportions with fire and other clays. Wherever produced at present it is dug in open pits.

Fire Clays: — The fire clays occur in beds ranging from a few inches to seven or more feet in thickness. They are occasionally so near the surface as to be mined by drifts, but usually they have to be sought by shafts. The deepest of these in St. Louis (that of Parker & Russell), is one hundred and twenty feet from the surface of the ground to the bottom of the clay bed. Conditions of occurrence.

These clays, even in the same bed, vary largely in character and composition. They are usually grayish in color, and are very hard when mined, but after exposure to the weather for a variable time the clay softens or slacks and falls into a loose mass of finely divided particles. Iron, an objectionable material in a fire clay, occurs largely in small pyrites crystals, called by the clay miners "shiners" and sometimes in large balls of pyrites. These "shiners" occur generally in aggregations, and either close to the top or bottom of the clay bed, so that they may be avoided to a great extent in mining. The best grades of clay, those suitable for making glass house pots in a raw and unwashed condition, are of limited occurrence and they are not continuous in the bed in which they are found; they may be considered as existing in "pockets," though there is no sharp line of demarkation of the deposit, but the transition from the best clay into the poorer grades is gradual. The only fossils found in the St. Louis fire clays are stigmaria, and calamites, fine specimens of which were obtained from the top of the bed at the mine of William Wrisberg and the adjoining one of Daniel Jones. Character of the clay. Pot clays. Stigmaria.

The fire clay is mined in chambers which are kept well timbered until they have been carried as far as possible, when the timbers are removed, and the roof is allowed to drop in, the debris forming a wall for a new chamber which will be run along the side of the old one. There are probably several miles of these chambers within the city of St. Louis. Immediately overlying the clay is generally either a hard shale or a bed of sand- Method of mining.

stone, which makes a very good roof. At some of the mines a bed of coal lies just above the fire clay, but it rapidly thins out and almost quite disappears at other mines. The clay is so hard that it is necessary to use powder to dislodge it from its bed.

Value of clays.

The fire clays sell in the market for from one dollar or less to about fourteen dollars per ton, according to their purity. Most of the clay sold for glass house pots has undergone a process of washing, for the purpose of removing iron and objectionable alkalies, and of giving uniform character to different shipments. Before being made into refractory materials it is exposed to the action of the weather, often for several years.

THE QUARTERNARY CLAYS.

Distribution.

The Quarternary deposits cover as a mantle nearly the whole area of the older formations in the city and county, and the great mass of the Quarternary is of the Bluff or Loess formation which is composed essentially of clay, and occasionally of sand.

This Loess is what is known as yellow clay, or common brick clay, and its supply for such brick baking, for which purpose it is well adapted, is inexhaustible, although it is being rapidly removed within the city limits. Bricks are made from it by both a dry and a wet process, but most largely by the dry one.

Uses of Quarternary clays.

The clay is plowed up, on a fair day, to the depth of a few inches, and, after several hours drying in the sun, it is scooped together and hauled to sheds, where it is stored for future use. It is usually of the proper composition for brick making throughout, without special mixing; but, in places, it is too sandy near the bottom.

THE RESIDUAL CLAYS.

Clays, residual from limestone, occur beneath the Loess or Drift. They are too plastic to be used alone, but are occasionally used by potters, mixed with other clays.

A DESCRIPTIVE LIST OF THE CLAY WORKS.

This list includes all of the miners of clay and manufacturers of clay products, who were found by the writer to handle the clays which occur within the area discussed in this paper. The descriptions are intended to include such obtainable matter as might have a general value for purposes of reference. Many details are omitted here, which are to be presented later in a more specific report on the clays, and the methods of manufacturing products from them. Following this list are statistical tables which give such additional information as could be conveniently classified and presented in tabular form, and which demands immediate publication. Scope of list.

By glancing at the accompanying maps it will be seen that the producers of sewer pipes and clay refractory materials are mainly located where railroad facilities for shipping their product could be had, and that they are also thickly grouped in the vicinity of the Cheltenham works, in the southwestern border of the Coal Measure formation. This latter fact is probably due, in a great measure, to the reputation of these Cheltenham clays, and not to the fact that equally good clays are wanting in other parts of the city, and in the county. The maps show no particular grouping for other clay works, for their markets are mostly local and the clays used are so widely distributed, easily tested, and easily obtained, that their situation is mostly due to accidental conditions. Distribution of works.

THE PRODUCERS OF FIRE BRICK, FIRE CLAY AND SEWER PIPE.

The industry to which these producers belong is one for which St. Louis has long been famous, particularly with regard to the Cheltenham fire clays. It is an industry which is constantly expanding; new factories are being built and old works are being enlarged and improved. Some of the works are magnificently equipped. They have fine clay beds almost touching their splendid factories, and railroad lines pass close Character of plant.

by or through their yards. The raw clay is almost tossed from the mine into the factory, to be set out into freight cars on the other side, a finished product, ready for the market.

At several of the works a great variety of sewer pipe and refractory materials is manufactured. Such works are indicated on the accompanying map as sewer pipe producers, because that product composes usually the greater part of their output.

Samples, when collected.

Whenever possible, a section of the formation in which the worked clay occurs, was obtained, and this is published with the description of works. At each of the works samples of the clays were taken, representing as nearly as possible an average of the workable part of their respective beds. These samples have been analyzed at the Survey laboratory; but the results are withheld from this paper, pending further investigations.

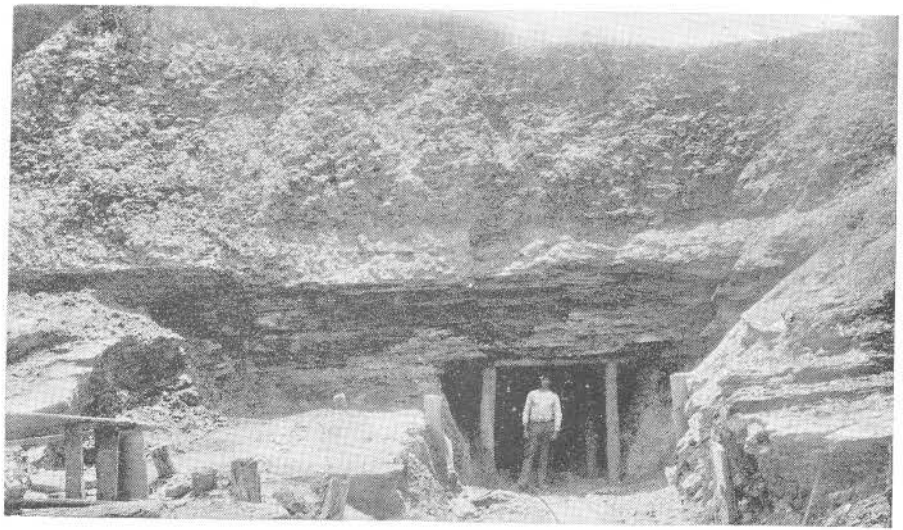
Laclede fire clay.

In the illustration of an entrance to the Laclede fire clay mine, on the opposite page, the bed of fire clay may be seen in its relation to the bed of sewer pipe clay. The entry, at the mouth of which a man is standing, is driven in the bed of fire clay. Above it is five feet of solid sandstone, with a few inches of intervening beds, and overlying the sandstone is the bed of clay and clay shale used so largely in the manufacture of sewer pipe, and less extensively for terra cotta, pottery and paint. Just at this point the Loess clay has been stripped off, to be used in a mixture for the production of sewer pipes. The results of disturbance in the beds here, exhibited by the dip and by faults, is due to the subsidence of the beds into deserted chambers of the mine.

In the following descriptive list of works the location of each is indicated either by a number with reference to the county map or by a number and a letter with reference to the city map; this number, or number and letter, are enclosed in brackets and follow immediately the name of the firm.

Location.

Blackmer & Post (E, 16 and J, 12): — This company manufactures sewer and culvert pipes exclusively. It has two factories, one of which, erected in 1880, is situated on Ewing avenue, at the intersection with the Missouri Pacific railway, and the other, erected in 1887, is situated on Arsenal street and St.



Entrance to the Fire Clay Mine of the Laclede Sewer Pipe Company, showing the sandstone roof and the beds of pipe clay above it.

Louis, Oak Hill and Carondelet railway. The company's clay pit is located on Cleveland avenue, just west of the Tamm road. Operations were begun in 1878. The capital invested amounts to about one hundred and fifty thousand dollars. In 1889 about thirty thousand tons of clay were consumed. Capital and output.

Christy Fire Clay Company (G, 18): — This company makes a specialty of washed pot clays, but it has lately undertaken the manufacture of fire brick, and kindred refractory materials, on a large scale. Its factories and clay mine are situated at "Christy," on the St. Louis, Oak Hill & Carondelet railway. In 1889 about five thousand tons of high grade clay were used and sold. Location.

The writer was unable to gain admittance to the mine, but obtained from the company the following section along the shaft, in descending series:—

1.	Loess, yellow clay	34 ft.
2.	Drift, gravel	1 ft. 5 in.
3.	Pipe clay	14 ft.
4.	Green shale	5 ft.
5.	Slaty shale	4 ft. 5 in.
6.	FIRE CLAY, the bed mined*	6 ft.

Coffin, Thomas, & Company (L, 6 and C, 15): — This company has its mine and one factory near Gratiot, on the Watson road, and one factory and its general office on the Wabash railway, at the Douglass street crossing. Its products are pot clays, glass-house pots, fire brick, and kindred refractory material. It began business in St. Louis, in 1884, as a branch of the Pittsburg works. The capital invested is two hundred thousand dollars. About twelve thousand tons of fire clay were sold and used in 1889. The section of the mine shaft was unobtainable.* Location. Product. Capital and production.

Evens & Howard (E, 14):—This firm has its works and mine at Howard Station, on the Missouri Pacific and Frisco railroads. It produces sewer pipes and all kinds of fire clay materials. It also sells a small amount of raw and washed clay. In 1889 it sold and consumed about 60,000 tons of clay, while at present it is con- Location. Product.

* An extensive "dump" near the shaft was sampled for analysis and test.

suming about 200 tons per day. The product is about one-half refractory material and one-half sewer pipes. Fire bricks and sewer pipes are exported to as remote points as Africa, South America and Mexico. The firm was established in 1857, but work had been carried on in a small way as early as 1855.

Product.

The following is a section, in descending order, from the surface to the clay mine from which this company obtains its fire clay: —

Section.

1.	Loess, gravelly at base	10 to 15 ft.
2.	Pipe clay, blue and red	8 ft.
3.	Shale	13 to 14 ft.
4.	Sandstone, cross bedded	7 ft.
5.	Shale	2 in.
6.	Fire clay, with bituminous stems	4 in.
7.	Sandstone	2 in.
8.	Coal	2 in.
9.	FIRE CLAY, the bed mined *	8 ft.
10.	Sandstone	8 ft.

Jameson, William (124): — Mr. Jameson's mine and works are situated at Barthold's valley, about one mile north of the Manchester road. He makes a specialty of fire and pot clays, and does not manufacture beyond washing the clay. He began work at this locality in 1886, and during 1889 he produced fourteen hundred tons of washed pot and crude fire clay.

Location.

Product.

The following section, in descending order, was made in the shaft of the clay mine: —

Section.

1.	Loess, yellow clay	11 ft.
2.	Pipe clay, nearly white	12 ft.
3.	Loose clay, containing balls of pyrites	2 ft.
4.	Red clay shale	9 ft.
5.	Shale, blue to yellowish	2 ft.
6.	Coal	1 ft. 6 in.
7.	Sandy slate	1 ft. 6 in.
8.	FIRE CLAY, the bed mined †	1 ft. 4 in.-6 ft.
9.	Sandstone	2 ft.-6 ft.
10.	Limestone, probably Lower Carboniferous.	

The bed of fire clay has been much squeezed, and the sandstone beneath it has been also affected, so as to make the floor

* From No. 9, mine run sample was taken for analysis and test.

† This bed of clay was sampled for analysis and test.

of the mine an undulating one. The fire clay is purest at the bottom of the bed, being full of iron pyrites at the top, while at other mines, the purest clay is found at the top and the impurities mostly at the bottom. Character of clay bed.

Jones, David (D, 13): — Mr. Jones has a fire clay mine, situated between Pierce, Cheltenham and Sublette avenues. He began work in 1883, and produced in 1889 about eight thousand tons of fire and potters clay, which was all consumed by the Evens & Howard firm. Location. Production.

There are two clay pits, and the geological section is probably the same as at the Wrisberg mine.

Stigmaria occur here also.

Laclede Fire Brick Manufacturing Company (D, 14): — This company makes a specialty of the manufacture of sewer pipes, fire bricks, and all kinds of fire clay material, and of a terra-metallic paving brick. The works are situated at Laclede, on the Missouri Pacific and Frisco railways. Operations were begun in 1855. In 1864 work was carried on by the firm of Hamilton & Green. The present company was incorporated in 1869. In 1889 from four to five thousand tons of crude clay were sold, and about ninety thousand tons of clay were consumed. Of the latter, a little over half went into refractory materials, and the rest into sewer pipes. Character of product. Location.

An extensive mine is opened by a drift in the bed of fire clay of the Coal Measures. From this bed the clay for the refractory products is obtained. The greater portion of the material which is used for sewer pipes, is obtained from the Loess, and from a heavy bed of pipe clay and shale which underlies the Loess. With this material, however, some fire clay is mixed. Source of material.

The following section, in descending series, was obtained here: —

Section.

1. Loess ..... 25 ft.
2. Clay shale, dark wine and sometimes greenish colored, very fissile, quite soft when mined, but hard and brittle when dry ..... 10 ft.
3. Sandstone to conglomorate, composed mainly of fine, white quartz grains, cemented with a ferruginous clay; contains many nodules of siliceous limonite; is frequently cross-bedded; and occasionally has a fissile character ..... 5 ft.

4. Fire clay		6 inches.
5. Coal		2 "
6. FIRE CLAY, the bed which is mined*	7 ft.	

Location. *Mitchell Clay Manufacturing Company* (E, 14): — The works of this company are at No. 5700 New Manchester road. The chief product is fire brick. A small amount of farm drain tile is manufactured, for which about three hundred tons of clay were used in 1889.

Product.

The present consumption of clay, none of which is produced by this company, is about one thousand tons per day. The value of the plant is about twenty thousand dollars.

Location. *Missouri Fire Brick and Clay Company* (D, 14): — The works of this company are situated at Cheltenham on the Missouri Pacific and Frisco railways. Work was begun in 1884,

Product. with a capital investment of about twenty thousand dollars. The product is almost wholly fire brick.

Location. *Parker and Russell Mining and Manufacturing Company* (G, 17): — This company has its works and mine on the Morgan Ford road and Parker avenue. It is a large producer of sewer pipes and refractory materials, and makes a specialty of the pro-

Product and capital. duction of gas retorts. In 1889 it produced about 1500 of the latter. The capital investment is about three hundred thousand dollars. Its business dates back to 1866.

The clay supply comes from the Coal Measures, and is raised from the mine through a double shaft which is one hundred and twenty feet deep. There was originally a coal mine here about

Source of clay. eighty feet below the surface. The section could not be obtained. The bed of clay† has been somewhat squeezed and flexed. It varies in thickness from fifteen inches to about seven feet. It is underlain by sandstone, and overlain by shale and sandstone.

At the railroad bridge just southwest of the mine the following partial section, in descending series, was obtained: —

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* From No. 6 a "mine run" sample of the fire clay was taken for analysis and test, and from No. 2 an average sample of the pipe clay (used here for manufacturing sewer pipes) was taken for the same purposes.

† A mine run sample was taken for analysis and test.

1. Typical Loess.....8 ft.
2. Jointed clay, seeming to pass into the Loess above.....20 ft. Section.
3. Ferrugenous sandstone.....3 ft.
4. Clay shale, variegated color.....14 ft.

No. 4 may be the same bed of clay as that used for sewer pipes at the Laclede works.

Towle and Thorpe Fire Clay Company:—This company began work in 1881. It does not manufacture, and sells crude clay only. In 1889 the production amounted to seven thousand tons. Product.

Wrisberg Mining Company (E, 13):—The mine of this company is situated between League and Cheltenham and Lilly avenues. The product is fire clay, pipe clay and "ocher" or paint clay. Work was begun in 1883, and in 1889 the production of all kinds of clay amounted to about twenty-five thousand tons. Location. Product.

The fire clay is taken from a mine, the shaft of which is forty-seven feet deep. The other clays are taken from open cuts in the hill side. Source of clay.

The fire clay bed is remarkable for fossil stigmaria and calamites, which are found at or near the top of the bed.

The following is a section, in descending series, of the Coal Measure deposit, here, down through the fire clay. It is made from personal observation, combined with information furnished by Mr. Wrisberg:—

1. Loess..... 0–20 ft.
2. Limestone, "tumble rocks"..... 0–5 ft.
3. Clay, white and yellow, used for sewer pipe manufacture, called "bastard fire clay"..... 3–4 ft.
4. Clay, yellow and red, sold for paint manufacture and for coloring plaster and mortar, called "ocher"..... 3 ft.
5. Clay, gray to white, used for paint manufacture and filling.. 1 ft. 6 in.
6. Pipe clay, variegated, reddish brown and greenish, called "keel"..... 12 ft. Section.
7. Sandstone..... 5–7 ft.
8. Slaty shale..... 3 in.
9. Coal..... 3 in.
10. FIRE CLAY, becoming sandy towards the base..... 5–20 ft.

THE PRODUCERS OF TERRA COTTA.

The terra cotta industry in St. Louis is one of the few successes of its kind west of the Mississippi river. Local clay is used, and an excellent grade of the ware is produced. The demand for the product is constantly increasing.

Terra Cotta Lumber.

Terra cotta lumber has been made until lately when the venture failed, probably on account of some mismanagement, as there is a growing market for the product, and an abundance of satisfactory clay material to be had.

Artistic terra cotta is made of a high grade, and some very large and handsome figures have been produced.

Location and product.

The Missouri Terra Cotta Lumber Company (D, 14): — This company has its works at Cheltenham in the yard of the Missouri Fire Brick and Clay company. In 1889 it produced about twenty thousand dollars' worth of material, most of which was fire proof structural lumber, roofing, tile and drain pipe. Work is at present suspended.

Location.

The Winkle Terra Cotta Company (D, 14): — The works of this company are situated at Cheltenham on the New Manchester road. All varieties of terra cotta and tile are manufactured to order. Operations were begun in November, 1883, and the company is now almost the only successful producer west of the Mississippi river. The clays used come from the Coal Measures and the Loess deposits. Some is shipped from the vicinity of Glencoe in St. Louis county.

Source of clay.

Consumption.

In 1884, 1885, 1886, about five hundred tons of clay per year were consumed, but in 1887, 1888 and 1889 the annual consumption amounted to about two thousand tons.

THE PRODUCERS OF POTTERY.

The pottery industry is at present confined to the city, where it is carried on in a small way by a number of producers. The clay used is a mixture, in varying ratios, of Coal Measure and Loess materials.

Material used.

The product consists mostly of brown stoneware, such as milk pans, jars, jugs, and flower pots.

There is one Art pottery in St. Louis where beautiful wares are produced. Only custom work, however, is done, and the material used comes mostly from a distance. Art pottery.

Louis Gnauk (G, 18):— Mr. Gnauk has a pottery on the south side of Chippewa street and Eudora avenues. He began work about one year ago. The production is flower, coffee, "patent" and milch pots and earthenware in general. The first year's product amounted to about twenty thousand flower pots, six thousand patent pots, and a small number of the other varieties. Product.

A mixture of one part pipe clay and nine parts fire clay is used for the production of the pottery. Both of these clays are obtainable on the spot. Material used.

John Muttig (J, 12):— Mr. Muttig has a pottery at No. 3675 Manchester road. He produces stoneware and earthenware, the former from fire clay brought from Union and Glencoe and the latter from the neighboring Loess clays. The value of his output for 1889 was about three thousand five hundred dollars. Product.

Charles Schwarzhoff (I, 16):— This pottery is situated at No. 3107 Michigan avenue. Flower pots and a few milch pots constitute chiefly the product. Work was begun in 1860 and has been carried on at intervals to the present date. In 1889 about one hundred and thirty-five pots, ranging from two to four inches in diameter, were produced.

Loess or pipe clay is mixed with fire clay in the ratio of one to two. The plant is valued at four thousand dollars. Material used.

August Seeber (I, 17):—Mr. Seeber's pottery is located on Virginia avenue, between Cherokee and Miami streets. The product consists of "patent," flower and milch pots, and a few flower vases. Work was begun about 1870. Product.

The output for 1889 consisted of twenty thousand "patent" and milch pots, and eighty thousand flower pots.

Local Loess clay is mixed with fire clay (purchased from a distance) in the ratio of one to nine, for the manufacture of the above pottery. The plant is valued at twelve hundred dollars. Material used.

August Uhlemeyer (I, 17):— Mr. Uhlemeyer's pottery is situ-

Product. ated at No. 3316 Gravois road. The principal product consists of flower and milch pots. Work was begun in 1867. In 1889, about eighteen thousand milch pots, and one hundred thousand flower pots were manufactured. Mr. Uhelemeyer mixes fire clay and the least sandy portion of the Loess clay, in about equal proportions, for his uses. The plant is valued at sixteen hundred dollars.

Material.

THE PRODUCERS OF STRUCTURAL BRICK.

Distribution. The structural brick works, with one or two exceptions, are confined to the city, from which, however, they will be driven before very long for want of available material. The Loess clays are used almost entirely, and an excellent building brick is produced. Very fine face and ornamental brick are also made, for local use, and for shipment to distant points.

Brick yards and quarries associated. Brick yards are frequently located at stone quarries, leading to an economical method of disposing of the Loess clays which would otherwise have to be moved simply as stripping. As these clays range from fifteen to forty feet in thickness, it occasionally happens that stone quarrying can be carried on at a profit, only through being so aided by a brick yard.

Prices of brick. Common brick bring in the St. Louis market from seven to eight dollars per thousand; front or face brick about twenty dollars per thousand, and ornamental brick, on an average, about fifty dollars per thousand.

Location and product. *Bollmann, August* (L, 10):— Mr. Bollmann has a brick yard on Eighteenth street, between Cass avenue and O'Fallon street. The product is common brick, which are hand-made. Work was begun in 1870. In 1889 about one million bricks were made.

Location and product. *Bergsicker & Bro.* (K, 7): — The works of this firm are situated at the junction of Florissant and Glasgow avenues. Hand-made common bricks constitute the product. Work has been carried on since 1870. The product for 1889 amounted to nine hundred thousand bricks. The clay used is hauled from Twentieth and Bissel streets.

Branahl, Charles (E, 7): — Mr. Branahl has a brick yard on St. Louis avenue and King's Highway. He produces common,

hand-made bricks only. Work was begun in 1870. In 1889 he produced about one-quarter of a million bricks.

Buckwinkle, Frank (J, 6):—Mr. Buckwinkle has a brick yard on Prairie avenue, just east of Twentieth street. Hand-made, common bricks only are produced. Work was begun in 1882. The annual production is a little less than two million bricks. Location and product.

College Hill Press Brick Works (J, 5):—These works are situated on Broadway at College avenue. The product consists of common, stock and ornamental brick, though but few of the latter are made. In 1889 the production of all kinds amounted to nearly twenty-six million bricks. Work was begun in 1884. The company has a plant and property valued at one hundred and thirty-five thousand dollars, including twenty-three acres of clay land and three dry press machines. The market is a local one. " Plant.

Compton Avenue Brick Works (J, 12):—These works are situated on the north-east corner of Atlantic and Compton avenues. The three principal varieties of brick are produced, the whole amount for 1889 being about eight million. Work was begun in 1886, with a plant valued at forty thousand dollars. The semi-dry process is used. Location and product.

Eureka Press Brick Company (L, 7):—The works of this company are at No. 4251 North Eleventh street. The company was incorporated in 1884, with a capital stock of twenty-five thousand dollars. It produces common and face brick, but almost wholly the former. Its production for 1889 amounted to about three million bricks. Two one-brick dry press machines are in use. Preparations are being made to manufacture ornamental brick. " Plant.

Excelsior Brick Company (K, 9):—This firm has a brick yard at the corner of Elliott avenue and North Market street. Work was begun in 1883. Wet and dry machines are used. In 1889 about three and a half million bricks were made. Location.

Grote & Hilkerbaume (K, 7):—This firm has a brick yard on the corner of Twentieth and Ferry streets. Hand-made, common bricks constitute the product. Work was begun by this firm in 1882, but the yard has been worked since 1875. In 1889 the product amounted to eight hundred thousand bricks. Location. Product.

Location and product.

Humann, Frank (E, 8):—Mr. Human has a brick yard on Union avenue, between Cote Brilliante and Spalding streets. Hand-made, common bricks constitute the whole product. Work was begun in 1884. In 1889 not quite half of a million bricks were made.

Location.

Hydraulic Press Brick Company:—This company has six yards which are located as follows: one at the intersection of Grand and Chouteau avenues (I, 13); one at the crossing of Kings Highway and the railway (F, 16); another at Cheltenham (D, 14); one at the crossing of the Wabash railway and the Manchester road (H, 12); one at the crossing of Kings Highway and the Frisco railway (F,14); and one at the corner of Gravois road and Chippewa avenue (H, 18). The product is common, face or stock, and ornamental bricks. Business was begun in 1868 with a capacity of ten million bricks, which has

Product.

been increased to nearly eighty million annually, and the company is now the largest producer in St. Louis. The dry process of manufacture is alone used. About thirty million bricks are carried from October to May, for winter work.

Markets.

St. Louis is the largest market the firm has, and Chicago, to which large shipments are annually made, is the next in importance. Bricks are sent to New York, British Columbia, Seattle, San Antonio, Galveston, and Alabama and other States.

Location.

Ittner, Anthony (J, 15):—Mr. Ittner's yard is situated on the south-west corner of California avenue and Sidney street. He produces common face and ornamental brick, but mostly the common variety. He began the business here about fifteen years ago. In 1889 his product amounted to thirteen million of

Product.

the three varieties of brick, and this number is a fair average per year since he began the business. Mr. Ittner uses the dry press method, and works from two to five machines. St. Louis is the place of principal consumption, but he sells brick from

Markets.

the Gulf states to the Pacific coast. The value of the plant is about one hundred thousand dollars.

Location.

Kuehn, August (J, 5):—Mr. Kuehn has a brick yard on College avenue and Von Phul street. He produces hand-made bricks, only. Work was begun in 1882. About half a million

bricks were made in 1889. The clay is dug in winter, and wet tempered and moulded, by hand, in the summer.

Kulage & Menke (Y, 5):—This firm has a brick yard situated on the north side of College avenue, and on the west side of Von Phul street. Hand-made brick only are produced. Work was begun in 1882. In 1889 about one million bricks were made. Location and product.

Kuntz, Charles (L, 17):—Mr. Kuntz has a brick yard on Marine avenue, at Chippewa street. One "mud machine" is used, and many bricks are made by hand. In 1889 about two and one-half million bricks were produced. "

Kuntz, Fritz (I, 17):—Mr. Fritz Kuntz has a brick yard situated on the corner of Nebraska avenue and Utah street. The product consists of hand-made common brick. Work was begun in 1887. In 1889 about one and a quarter million bricks were made. "

Lyon Press Brick Co. (K, 17):—This company has works situated between Potomac and Cherokee avenues, just east of Broadway. Stock and common brick are produced. In 1889, the year work was begun, a little less than three million bricks were made. A "Lyon Press Brick" machine is used. "

Missouri Press Brick Co. (K, 18):—The works of this company are situated on the corner of Osage and Marion avenues. The company was organized in 1886, but work had been done here since 1884. In 1889 about two and one-half million of common, stock and ornamental brick were produced. The wet and dry processes are used about equally. St. Louis is the only market. "

Nieman, August H. (J, 17):—Mr. Nieman's brick works are situated at Jefferson and Utah avenues. Work was begun there in 1885. Common and stock brick are made by hand. In 1889 the product amounted to a little over three and one-half million bricks. "

Oehler, Paul (K, 17):—Mr. Oehler's works are situated on the south side of President street, near Broadway. Work was begun here in 1863, and for the last twenty years the annual output has been about three and one-half million bricks, mostly of the common variety. All work is done by hand. "

Location and product.

Pahl, Henry (F, 17): — Mr. Pahl conducted a brick yard on Kings Highway, three blocks south of Arsenal street. Work was begun here in 1889, and about half a million common bricks were made, by hand. The establishment is now superseded by the *Tower Grove Brick Works.*

" *Repping and Son, J. H.* (J, 16): — This firm has works situated between Nebraska and Wyoming streets. Work was begun in 1885. In 1889 about three million bricks were produced, most of which were of the common variety. One "mud machine" is used. The plant is valued at five thousand dollars.

" *Scales, Thos. H.* (K, 8): — Mr. Scales has a brick yard situated on the east side of Jefferson avenue, between Herbert and Palm streets. The product consists wholly of hand-made common bricks. Work was begun in this yard in 1859. In 1889 about three-quarters of a million bricks were made.

" *Schlingman, E.* (L, 7): — The works of Mr. Schlingman are situated on Penrose street, between Blair and Fourteenth streets. Only common hand-made brick are produced. Work has been carried on since 1886.

" *Schlingman, Henry* (L, 7): — Mr. Henry Schlingman has a brick yard situated on Penrose street between Blair and Nineteenth streets. He produces only hand-made common brick. Work was begun in 1887. In 1889 he made nearly a million bricks.

" *Schweer and Maes* (J, 19): — The works of this firm are situated on the east side of Broadway near Osceola. Common and stock brick only are produced. Work has been carried on since 1888 and brick are made by hand and by machine. In 1889 three million bricks were made. The value of the plant is five thousand dollars.

" *Smith, T. S.* (K, 6): — Mr. Smith's brick works are situated on Broadway and Grand avenue. He produces mostly common brick, but a few stock and ornamental are made. The works have been operated for about eighteen years. The value

Plant. of the plant alone is about twenty thousand dollars, and including the land it is about sixty thousand dollars. Four machines are in use, of these, two are semi-dry hammer machines and

two are dry press machines. The production for 1889 for the three varieties of brick was a little over seven million bricks. St. Louis is the only market.

Spengemann, Edward (I, 20): — Mr. Spengemann has a brick yard on the east side of Michigan avenue and south of Termination street. Only hand-made, common bricks are produced. Work was begun in 1884. In 1889 about one and a quarter million bricks were made. Location and product.

Steinkamper, F. W.: — Mr. Steinkamper has two yards; one on Ashland avenue and Kings Highway (F, 7), and the other on Elliott avenue and Wright street (J, 9). In the latter he produces hand-made brick, and in the former, pressed brick by the wet process. He began operations in 1873, and in 1889 he produced three million common, and one million ornamental bricks. "

Stuckenberg, John (J, 17): — Mr. Stuckenberg's works are at Jefferson and Utah avenues. The chief product is common brick, but stock and a few ornamental bricks are manufactured. Work was begun in 1886. "

Tower Grove Brick Works.— See *Henry Pahl.*

Union Press Brick Company (F, 7): — This company has its works on the Natural Bridge road and the Kings Highway. The production consists of common, face and ornamental brick, and for 1889 the total of all kinds produced amounted to about thirty-eight million. The company was organized 1872 with an authorized capital of forty thousand dollars. Both the dry and wet processes of manufacture are used. St. Louis consumes the greater part of the product, but brick are sent to Washington, Minnesota, Texas and other states. Three hundred and fifty men and boys and eighty teams are employed. The company has sixty-five acres of clay land. "

Markets

Walkenhorst, F. W. (F, 12): — Mr. Walkenhorst has a brick yard situated on the north side of the Clayton road, east of Taylor avenue. The product consists entirely of common bricks, which are made by hand. Work was begun in the Spring of 1889, and during the remainder of the year six hundred thousand bricks were made. Twelve thousand bricks are now made daily, and a hand press is to be put in at once. Location and product.

STATISTICAL TABLES.

The following tables are compiled from the results of personal inquiry at each of the works. The totals which are given in the summary are undoubtedly smaller than similar ones for the present year would be, because of a natural growth of the clay industry, and because in 1889 building operations were not normally active.

Source of figures.

In the first table the statistics of production are not given for the individual works. Some of the figures obtained were given the writer with the request that they be not published in detail, and as inferences might be drawn from such figures which would wrongfully injure a business firm, they are here only used included in a statement of the figures for a class of producers.

The figures for the number of kilns used at the different works should be considered in connection with the amounts of production, or the capacity which the respective works have. Otherwise they have a relative value only in a limited way, because kilns vary so considerably in their size and style.

Locations of works.

Where more than one set of coördinates or number is given in the column of "Position on Map," the references are to the different factories, pits or brick yards which are conducted under the one proprietory head.

STATISTICS OF THE STRUCTURAL BRICK INDUSTRY OF THE CITY OF ST. LOUIS FOR THE YEAR 1889.

The location of brick yards may be found on the map of the city, accompanying this article, by the coördinates given in this table.

Position on Map.	PROPRIETOR.	Number of Kilns.	Output of Stock Brick.	Output of Ornamental Brick.	Output of Common Brick.	Value of Product.
L, 10	Bollman, Aug.	1	.....	.....	1,000,000	$5,750
K, 7	Bergsicker & Bro	2	.....	.....	900,000	5,850
E, 7	Branahl, Chas	1	.....	.....	215,000	1,183
J, 6	Buckwinkle, Frank	2	.....	.....	1,800,000	10,000
J, 5	College Hill Press Brick Wks.	6	9,000,000	500,000	16,000,000	354,000
J, 12	Compton Avenue Brick Wks.	4	1,500,000	500,000	6,000,000	50,000
L, 7	Eureka Press Brick Co	2	150,000	.....	2,800,000	20,900
K, 9	Excelsior Brick Co	7	.....	.....	3,500,000	23,625
K, 7	Grote & Hilkerbaume	2	.....	.....	800,000	4,800
E, 8	Humann, Frank	2	.....	.....	405,000	2,027
I, 13; H, 18; F, 17; D, 14; F, 14; H, 12;	Hydraulic Press Brick Co	69	20,000,000	4,000,000	50,000,000	975,000
J, 15	Ittner, Anthony	5	1,200,000	800,000	11,000,000	106,000
J, 5	Kuehn, August	1	.....	.....	480,000	2,880
J, 5	Kulage & Menke	1	.....	.....	1,000,000	5,500
L, 17	Kuntz, Chas	3	405,000	.....	2,000,000	14,430
I 17	Kuntz Fritz	2	.....	.....	1,285,000	7,080
K, 17	Lyon Press Brick Co	3	25,000	.....	2,250,000	14,000
K, 18	Missouri Press Brick Co	4	425,000	200,000	1,875,000	15,000
J, 17	Nieman, Aug. H	3	135,000	.....	3,500,000	20,000
K, 17	Oehler, Paul	4	200,000	20,000	3,000,000	22,800
F, 17	Pahl, Henry	1	.....	.....	500,000	3,350
J, 16	Repping, J. H. & Son	3	55,000	.....	2,500,000	21,565
K, 8	Scales, Thos. H	2	.....	.....	640,000	3,328
L, 7	Schlingman, E	2	.....	.....	1,155,000	6,640
L, 7	Schlingmann, Henry	2	.....	.....	900,000	4,950
J, 19	Schweer & Maes	3	50,000	.....	2,950,000	18,062
K, 6	Smith, T. S	4	500,000	50,000	6,500,000	42,750
I, 20	Spengemann, Edward	2	.....	.....	1,200,000	6,900
J, 9 & F, 7	Steinkamper, F. W	5	.....	1,000,000	3,000,000	32,250
J, 17	Stuckenberg, Jno	3	100,000	.....	2,500,000	14,625
E, 17	Tower Grove Brick Works	1	.....	.....	See Henry	Pahl.
F, 7	Union Press Brick Co	18	11,000,000	1,300,000	24,700,000	470,250
F, 12	Walkenhorst, F. W	2	.....	.....	600,000	3,300
	Totals	172	44,745,000	8,370,000	156,955,000	$2,288,798

TABLE OF PRODUCERS OF POT CLAY, CRUDE CLAY, SEWER PIPES, CLAY REFRACTORY MATERIALS &c., IN THE CITY AND COUNTY OF ST. LOUIS.

The location of clay works and mines may be found upon one of the maps accompanying this article by the co-ordinates or number given in this table.

Position on Map.	Proprietor.	Location.	Character of Product.	No. Kilns.	No. Clay Pits.
D, 14	Laclede Fire Brick Manufacturing Co	"Laclede," on the "Frisco" and Mo. P. ry	Sewer pipes, fire brick, paving, &c	27	1
E, 14	Evens & Howard	"Howard's," on the "Frisco" and Mo. P. ry	Sewer pipes, fire brick, paving, &c	25	3
G, 17	Parker & Russell Mining and Mfg. Co	Morgan Ford road and Parker avenue	Se'er pipes, gas retorts, fire brick, pot clay, &c	19	2
E, 16, & J, 12	Blackmer & Post	Ewing Ave. and Mo. P. ry.; also Arsenal St. and St. L., O. H. & C. ry	Sewer pipes	21	1
G, 18	Christy Fire Clay Co	"Christy," on St. L. O. H. & C. ry	Fire clays and clay refractory materials	6	1
L, 6, & C, 15	Thomas Coffin & Co.	Douglas St. and Wabash R. R.; also Watson road, near Gratiot	Fire clays and clay refractory materials	9	1
124 (county)	William Jameson	Barthold's Valley	Crude & washed pot clays	.....	1
E, 13	Wrisberg Mining Co	Between League, Cheltenham and Lilly avenues	Fire and potter's clay and ochres	.....	1
D, 13	David Jones	Between Pierce, Cheltenham and Sublette avenues	Fire and potter's clay	.....	1
D, 14	Missouri Fire Brick and Clay Co	"Cheltenham," on "Frisco" and Mo. P. ry	Fire brick	3	1
E, 14	Mitchell Clay Manufacturing Co	No. 5700 New Manchester road	Fire brick	4	.....
D, 14	Winkle Terra Cotta Co	"Cheltenham," New Manchester road	Terra cotta, tiles, &c	.....	.....
D, 14	Missouri Terra Cotta Lumber Co	"Cheltenham," on "Frisco" and Mo. P. ry	Terra cotta lumber and porous earthenware	.....	.....
C, 16	Towle & Thorpe	.....	Crude clay	.....	1

J, 12	John Muttig	No. 3675 Manchester road	Stoneware and earthenware	2	.....
H, 18.	Louis Gnauk	Chippewa and Eudora avenues	Stoneware and earthenware	1	.....
I, 17	August Seeber	Virginia avenue, bet. Cherokee and Miami	Stoneware and earthenware	1	.....
I, 17	August Uhlemeyer	No. 3316 Gravois road	Stoneware and earthenware	1	.....
I, 16	Chas. Schwarzkopf	No. 3107 Michigan avenue	Stoneware and earthenware	1	.....
K, 19	Wash Street Art Pottery	No. 2135 Wash street	Art pottery	.....	.....
Totals				120	14

STATISTICS OF THE INDUSTRIES MENTIONED IN THE ABOVE TABLE FOR THE YEAR 1889.

CHARACTER OF PRODUCT.	No. of Firms Engaged.	No. Tons of Clay Produced or Used.	Value of Product.
Washed pot clay	4	7,020	$ 58,000
Sewer pipes	4	112,000	672,000
Fire brick, retorts, &c	7	119,855	869,000
Crude clay	5	49,500	48,000
Terra cotta	1	3,000	50,000
Terra cotta lumber	1	6,000	20,000
Pottery	6	325	5,570
Totals	28	297,700*	$1,722,570*

* These figures include clay which was sold by local producers to local manufacturers in a raw state. The amount of such clay was perhaps thirty thousand tons, valued at seventy-five cents to a dollar per ton.

THE STONE INDUSTRY.

GENERAL REMARKS.

The geological formations of St. Louis City and county furnish to the industries handling stone, limestone, sandstone and a low grade of marble.

Uses of limestone.

Limestone: — The limestones have been largely quarried for common purposes, the most general use being for foundations, paving and macadam. Less extensively, they have been quarried and dressed for a variety of dimension work. They are also used largely for the production of lime.*

Uses of sandstone.

Sandstone: — The sandstones are used for foundations to a small extent, and have been quarried for dimension stone, but they are not durable.

Marble: — A number of the limestones are sufficiently crystalline to pass for marble. Some of these make an excellent dimension stone, but they have been little quarried.

THE COAL MEASURE STONE.

Character of the stone.

In the Coal Measures, limestones occur which answer for common uses, and the micaceous sandstone, which is supposed to constitute the superior part of the lower measures, furnishes a rather poor building material.

THE LOWER CARBONIFEROUS STONE

Character of the stone.

The Lower Carboniferous rocks furnish a sandstone (the Ferruginous Sandstone of the general section), which is scarcely better than the micaceous sandstone. Immediately below this Ferruginous Sandstone, however, come the important beds of the St. Louis Limestone, descriptive sections of which are given in the notes on stone quarries beginning on page 42.

*Some of the beds of the St. Louis Limestone have been successfully used for lithographic work. No bed however is uniformly of the requisite quality, and the cost of selection of available material would seem to preclude the development of an industry for the production of lithographic stone.

This formation is quarried most extensively for foundation material and macadam. Many of its beds are particularly well adapted for the production of the latter. The lower beds will furnish very large blocks of handsome and durable dimension stone, and it seems probable that in the near future there will be a considerable industry producing such material. Uses.

The Keokuk Limestone of the general section has workable beds of a semi-crystalline fossiliferous stone which is handsome, takes a fair polish, and is probably durable. Large blocks are obtainable from these beds.

THE LOWER SILURIAN STONE.

From the Keokuk to the Trenton formation no economically important stone occurs. In the Trenton are some thick beds of semi-crystalline, highly fossiliferous limestone, which will furnish an excellent dimension stone. Many of the Trenton beds which appear to be serviceable, are, however, unfit for use in building, owing to a structural peculiarity by reason of which the stone suffers rapidly under the influence of weather. On exposure it becomes thoroughly honey-combed and, in this condition, it is frequently used for ornamental purposes about lawns and gardens. Defects of Trenton stone.

From beneath the Trenton Limestone, in the western part of the county, the First Magnesian Limestone crops out and exposes some heavy beds of beautifully colored stone. The more crystalline of these will furnish a good dimension stone, but the greater part of the beds exposed seem prone to a rapid submission to the action of the weather. First Magnesian Limestone.

Beneath the First Magnesian Limestone there are occasionally exposed, in the extreme western part of the county, beds of the Saccharoidal Sandstone which are capable of furnishing, as they do at Pacific and Crystal City, the highest grade of sand for glass making. Saccharoidal Sandstone.

The following table shows the geological distribution of the different quarries. Each individual opening known to have been worked in 1889 is included and the quarries are assigned to formations according to Shumard's classification.

TABLE SHOWING THE GEOLOGICAL DISTRIBUTION OF ACTIVE STONE QUARRIES IN ST. LOUIS CITY AND COUNTY, FOR THE YEAR 1889.

KIND OF PRODUCT.	ST. LOUIS LIMESTONE.	KEOKUK.	BURLINGTON.	TRENTON.	FIRST MAGNESIAN.
STONE	67	3	0	0	1
LIME	2	0	1	10	0

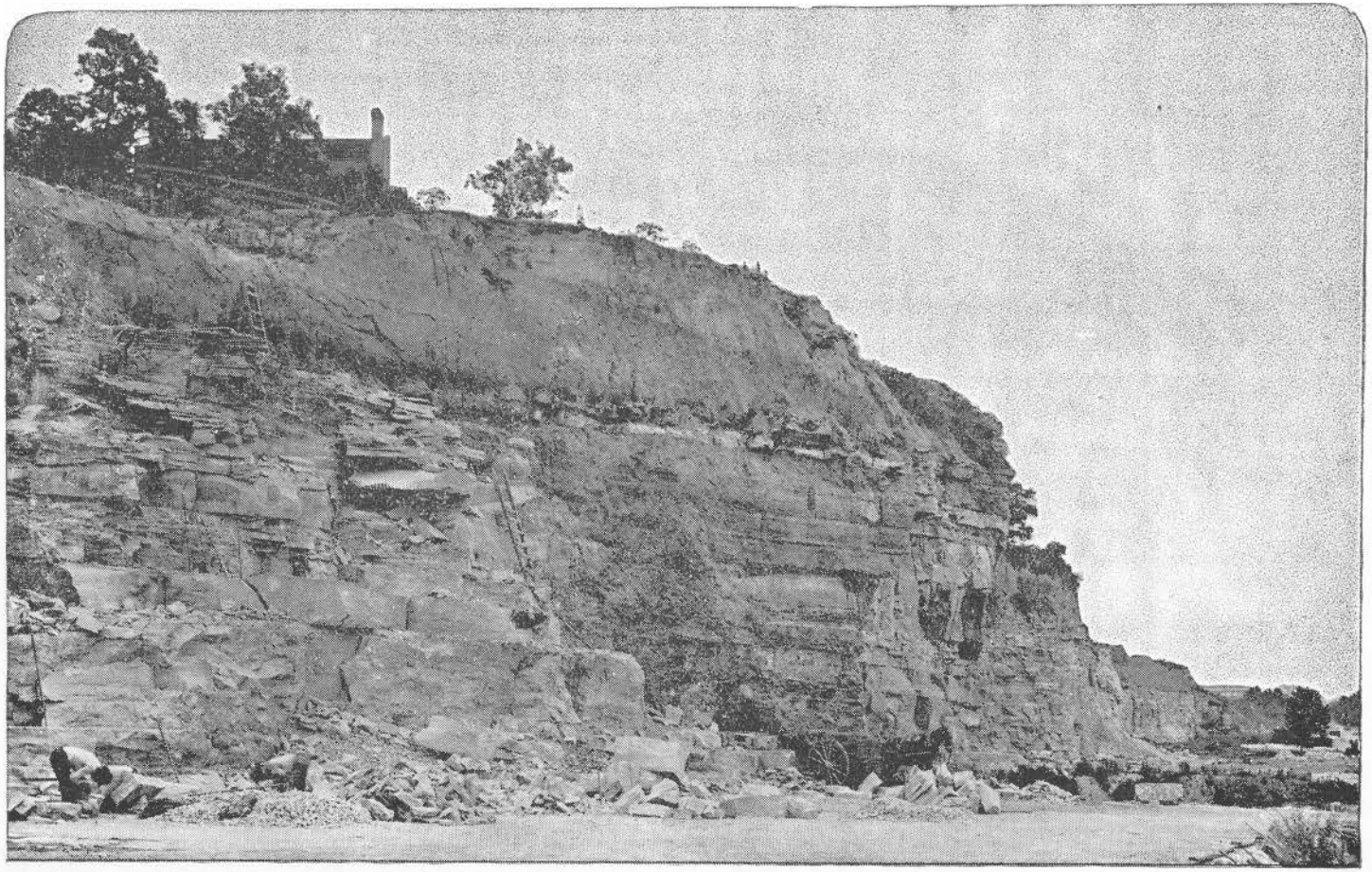
A DESCRIPTIVE LIST OF STONE QUARRIES.

The following descriptive list gives what general information the writer could obtain relating to the individual stone quarries. It is meant to be used in connection with other parts of the paper, such as the maps, where the geological and geographical location of quarries is shown, the table of analyses, where the composition of numerous beds of limestone is exposed, and the statistical tables, where the character, amount and value of the product of the quarries is given.

Plant of quarries.

A comparatively small amount of machinery is used at the St. Louis quarries. Many of the quarries are small, shallow openings, worked for macadam and foundation stone, without the aid of any machinery. Some of the large and deep quarries have a steep, winding road to the surface, up which all the product is hauled in wagons, and, as many of these quarries have a natural drainage through subterranean passages, it is possible to dispense with pumping machinery. A class, including a large number of quarries, is the bluff quarry, which are opened along the face of old river bluffs, as open cuts. Here, for the production of stone for common uses, machinery is not necessary. Many of these quarries are to be found along the bluffs of the Mississippi river, where railroad facilities are close at hand. Most of their output, however, goes to a local market, and is hauled to its destination in wagons. Similarly situated, but without an immediate local market, are the quarries near Vigus, in the old bluffs of the Missouri river. These latter quarries aim to produce dimension stone, and such stone can be shipped by rail from here at a profit.

Bluff quarries.



BLUFF QUARRIES ON THE MISSISSIPPI RIVER.

Near the foot of Cahokia Street.

Illustrating a bluff quarry, in distinction to a sunken quarry. The Loess stripping, the ledges of the limestone, and the manner of quarrying are also shown.

The working of the thick lower beds of the St. Louis formation into dimension stone, for which they seem to be well suited, calls for channeling machines. A few of these are now in use, and it is probable that they will be more extensively introduced in the near future. Use of channeling machines.

The distribution of quarries, excepting those in the river bluffs, seems to be determined largely by the thickness of the stripping which is found above the workable stone. The stripping is composed of the Loess clays and sands, the Drift (sand and pebbles), residual clay and decomposing limestone.

The illustration opposite this page is of a series of quarries in the bluff along the Mississippi river. This bluff is included in the cross section printed on page 74 in connection with the lime analysis, and one of the quarries shown is that of Martin Lorentz, where a section was sampled from summit to base for analysis, the results of which are given under analysis numbers 24 to 42, inclusive. The general character of the beds, the amount of stripping and the manner of working the quarry are shown in this illustration. Bluff quarries.

The illustration opposite the next page is intended to show the general features of one of St. Louis' largest sunken quarries. The view is of the south end of the quarry, and shows the stripping, the crushing machines with the wagons below it receiving their load of crushed stone, the building containing the engine room, etc., and the heaps of riprap and macadam lying about in the quarry. Sunken quarries.

In the sections which are given are descriptions of the important or striking features of all the exposed beds at a quarry. It is evident from a study of these sections that a considerable variety of products for a quarry is necessary. Usually only a few beds at any quarry are suitable for dimension work, except the lighter kinds, such as window sills, etc. Other beds are used for macadam, paving, riprap, building stone, etc., according to their qualities and adaptability to the production of a given class of material. It will be seen in the following descriptive list that the product of the individual stone quarries is generally of a very varied character. Information in sections.

THE QUARRIES IN ST. LOUIS CITY.

All of the quarries within the city limits are in the St. Louis Limestone formation.

Location and product.

Albernacius, Frank, and Adam Kern (L, 17):— Mr. Albernacius and Mr. Kern operate small quarries in the bluff immediately adjoining Mr. Lohrum's quarry. The product consists of macadam, paving and dimension stone. These quarries have been worked eighteen and nine years respectively.

"

Allen, E., and Knaus and Willis (J, 19): —These quarries joining each other, are situated about a fourth of a mile south of Meramec street and just west of the Iron Mountain and Southern railway tracks. The product consists mostly of dimension and building stone. The quarries are in the face of an old river bluff.

Following is the section here, in descending series: —

Section.

	Feet.	Inches.
1. Stripping	6	
2. Limestone, gray, fine grained, in six inch layers	2	
3. Limestone, gray, fine grained, compact	2	6
4. Limestone, gray, fine grained, compact		6
5. Limestone, dark gray to drab, fine grained	1	8
6. Limestone, light gray	6	
7. Limestone, light gray	1	
8. Limestone, very thin layers		5
9. Limestone, thin layers, with shale partings	2	
10. Limestone, gray, compact	1	
11. Limestone, gray, fine grained, in two layers	3	6
12. Limestone, dark gray, rather coarse grained	2	6
13. Limestone, brownish, impure, thin layers	10	
14. Limestone, inaccessible, in beds six to thirty-six inches thick	6	2
15. Limestone, thin layers, jointed and weathered	7	
16. Limestone, gray, fine grained, in three layers	5	
17. Limestone, gray and brown	2	6
18. Limestone, gray, fine grained, in two twelve inch layers	2	
19. Limestone, gray, carries thin layers of chert	3	
20. Limestone, gray, fine grained, in two twelve inch layers	2	
21. Limestone, dark gray, fine grained		6
Total thickness of rock	67	3

Location.

Baldwin, Henry (I, 20):— Mr. Baldwin's quarry is situated between Itaska and Maeder streets, east of Pennsylvania avenue. It

STIEFEL AND RUCKERTS QUARRY—LOOKING SOUTH.

Illustrating a large and deep sunken quarry in distinction to a bluff quarry.

has been worked continuously since 1872, when it was opened. The product is mostly building and dimension stone. The quarry is two hundred and thirteen feet long, by one hundred and thirty feet wide, and exposes the following columnar section, in descending series: — Product.

	Feet.	Inches.
1. Loess	15	
2. Residuary clay mixed with the gravel of the drift	12	
3. Limestone partially decomposed	5	10
4. Limestone, gray and brown, siliceous, coarse-grained, contains patches of calcite, and, at the top and bottom concretions of chert	7	
5. Limestone, gray, very coarse-grained, crystalline and fossiliferous		3
6. Limestone, gray, fossiliferous in two or more layers	2	6
7. Limestone, gray, coarse-grained, in two or more layers	4	6
8. Limestone, gray, fine and coarse in grain in many layers	6	
Total thickness of rock	26	1

Section.

Bambrick-Bates Construction Co., First Quarry (N, 9–2): — This quarry is situated on Madison str e , between Main and Second streets. It was opened in 1867, and has, since, been worked continuously. It is three hundred feet long, one hundred and twenty feet wide, and eighty feet deep. Stone for all common purposes is quarried. Location.

Bambrick-Bates Construction Co., Second Quarry (N, 9): — This quarry occupies about one-half the block between Clinton, Madison, Main and Second streets. It was opened in 1886, and produces stone for all common purposes. Location.

The following columnar section is exposed, in descending series: —

	Feet.	Inches.
1. Residuary clay and soil	3	
2. Limestone, weathered and decomposing	9	
3. Limestone, gray to brownish, fine and coarse grained	1	8
4. Limestone, gray, coarse grained, in five or six layers	2	10
5. Limestone, gray, fine grained, cherty	1	2
6. Limestone, nearly white, very siliceous	1	2
7. Limestone, dark gray, coarse, sub-crystalline	1	4
8. Limestone, dark gray, coarse, numerous cavities lined with calcite crystals	2	3
9. Shale and limestone in thin layers		7
10. Limestone, gray, fine grained	3	6
11. Shale and limestone in thin layers		5

S

	Feet.	Inches
12. Limestone, gray, vary-grained	1	8
13. Limestone, gray, fine grained	1	8
14. Limestone, gray, coarse grained, fossiliferous	1	3
15. Limestone, gray, coarse grained, fossiliferous, in several layers	4	10
16. Limestone, lavender, very fine grained, chert concretions, two layers	1	8
17. Limestone, dark gray, fine grained		4
18. Limestone, brown and lavender, coarse grained, crystalline, in three layers	2	
19. Limestone, brownish, coarse grained, three layers	1	
Total thickness of rock	37	9

Section.

Barnett, Wm. H. (J, 12): — Mr. Barnett has a quarry which is situated just south of Bernard and east of Cardinal avenues. It was opened in 1889. The product consists of macadam, paving, dimension stone and riprap. The quarry is about three hundred and twenty-five feet long by three hundred feet wide. The stripping of Loess has been removed and made into bricks. It is soon to be worked on a much larger scale than it is at present.

Location and product.

The following section, in descending series, was obtained here: —

	Feet.	Inches.
1. Limestone, decomposing.	8	
2. Limestone, gray, uniform grain, contains corals	3	1
3. Shale, very soft		6
4. Limestone, gray, fine grained, calcite veins		6
5. Limestone, gray, crystalline, varying in texture	3	8
6. Limestone, gray, in two layers, calcite veins, fossiliferous.	3	4
7. Limestone, gray, varying in texture, concretionary at bottom, upper four or five feet coarse grained and fossiliferous	6	
8. Limestone, dark gray, concretionary		4½
9. Limestone, light drab, uniform fine texture		7
10. Limestone, light drab, very fine grained, concretionary near top	1	4
11. Limestone, very dark drab, fine grained, calcite veins		7
12. Limestone, dark gray, concretionary		8
13. Limestone, drab, lithographic		
Total thickness of rock	28	7½

Section.

The beds have a slight easterly or north-easterly dip.

Brocksmith, H. (C. 14): — Mr. Brocksmith has a quarry at Clifton Heights, just north-west of the Missouri Pacific Railway station. It was opened about thirty-five years ago, and has been worked by the present owner for the last eight years. The product consists of paving, macadam, building stone and a little dimension stone, in the quarrying of which two machine drills are used. The quarry is about one hundred feet long by thirty-five feet wide. The stripping of Loess is disposed of by making bricks of it. Location and product.

The following section, in descending series, was obtained here: —

Section.

	FEET.	INCHES.
1. Loess, lower two feet gravel	10–20	
2. Limestone, decomposing and weathered	6	6
3. Limestone, gray, soft, in three ten inch layers	2	6
4. Limestone, gray, fine grained, soft		8
5. Limestone, gray, soft, weathers into two twelve inch layers	2	
6. Limestone, light gray, compact, yellowish when weathered, in four to six inch layers	9	
Total thickness of rock	20	8

Byrnes, Thomas (J, 10): — Mr. Byrnes has a small quarry which is situated on Magazine street, just east of Mr. Cavanaugh's quarry. The product is small and consists mostly of building stone. Location and product.

Cavanaugh, T. E. (J, 10): — Mr. Cavanaugh has a quarry which is situated on the south-east corner of Magazine street and Garrison avenue. It was opened about twenty-three years ago. The product consists of building stone, paving stone and macadam. One three-inch Ingersoll drill is used. The stone is hauled to the surface in wagons, up an inclined road. "

The following section, in descending series, was obtained here: —

Section.

	FEET.	INCHES.
1. Loess	10-14	
2. Limestone, gray, even textured, good dimension stone, in four layers, from twenty to thirty inches thick	8	6
3. Limestone, weathers into layers about ten inches in thickness	5	
4. Limestone, gray, soft, weathers into a thirty inch top and an eighteen inch bottom layer	4	

		Feet.	Inches.
	5. Limestone, light gray, compact, divides in places into two layers. The upper one is six and a half feet thick, and has numerous concretions of chert arranged along a bedding plane. The lower one is three and a half feet thick, and is marked with stylolites	10	
Section.	6. Limestone, very dark gray, fine grained, but not uniformly so	1	
	7. Limestone, light gray, compact in two layers		10
	8. Limestone, dark gray, compact, soft	1	6
	9. Limestone, light gray, soft, in four layers	8	6
	Total thickness of rock	39	4

Location and product.

Devereux and Sons (G, 7): —The quarry operated by this firm is situated on Marcus avenue, between Osage and Loraine streets. Building stone is the chief product. The quarry was opened in 1870. It is about one hundred and twenty-five feet long, seventy-five feet wide, and exposes the following columnar section, in descending series: —

		Feet.	Inches
	1. Loess, drift, residuary clay and decomposing limestone	5–20	
	2. Limestone, light gray, even grained, in three to five layers, of which the upper ones are very fossiliferous	4	
	3. Limestone, drab, fine-grained, brittle, fossiliferous, in layers from three to ten inches thick	5	
	4. Limestone, drab, fine grained, brittle, calcite veins, fossiliferous, several layers	4	
Section.	5. Limestone, banded gray and brown, coarse grained	2	
	6. Limestone, drab, fine grained, dark colored chert concretions and layers	1	2
	7. Limestone, very dark gray, calcite patches, chert concretions	2	1
	8. Limestone, lavender, very fine grained and compact, brittle, lithographic, in four layers two to seven inches thick	1	6
	9. Limestone, gray, rather coarse grained	1	2
	10. Limestone, gray, fine grained	1	2
	11. Limestone, dark gray, in three to five layers	2	4
	Total thickness of rock	24	5

Location.

Engleman, A. O. (M, 15): — Mr. Engleman has a quarry which is situated at the foot of North Trudeau street, west of the Missouri Pacific railway tracks. It was opened in 1870, and for ten years was quarried for the purpose of producing lime. It is about two hundred and fifty feet long and one hundred and

twenty-five feet wide. The product now consists of dimension and building stone, macadam and paving. Two Ingersoll drills and a channeling machine are in use. Stone is handled by derricks. Product.

The following section, in descending series, was obtained here: —

	Feet.	Inches.
1. Clay and decomposing limestone	16	
2. Limestone, thin weathered beds	17	
3. Limestone, gray, hard, compact	2	3
4. Limestone in thin layers		10
5. Limestone, gray, hard, concretionary		10
6. Limestone, greenish, soft, chloritic	2	6
7. Limestone, grayish, in thin layers		10
8. Shale		4-6
9. Limestone, dark gray, fine grained		8
10. Limestone, light gray, fine grained, stylolites at top	3	6
11. Limestone, white, coarse grained, semi-crystalline	2	
12. Limestone, white, lithographic	2	
13. Limestone, gray, rather coarse grained, much jointed	1	
14. Limestone, gray, fine grained, hard, compact	4	
15. Limestone, light gray, fine grained	1	8
16. Limestone, yellowish		4
17. Limestone, very light gray, fine grained, compact	1	6
18. Limestone, gray, fine grained, compact, in two two foot layers	4	
19. Limestone, light gray, chert concretions	4	
20. Limestone, light gray, lithographic, much jointed	1	
21. Limestone, light gray, lithographic		6
Total thickness of rock	50	10

Section.

Eyerman, G., Estate, First Quarry (I, 20): — This quarry is situated east of Virginia avenue, near Maeder. The product is mostly building stone, but a little dimension stone, macadam and paving stone, is quarried. The quarry has been worked since 1882. It is about ninety feet wide and three hundred and twenty feet long. Location and product.

The following section, in descending series, was obtained here: —

	Feet.	Inches.
1. Loess	6-18	
2. Residuary clay, mined with the gravel of the drift	1	
3. Limestone, partially decomposed	2	
4. Limestone, light gray, fine grained	3	6

Section.

	Feet.	Inches.
5. Limestone, gray, coarse and fine grained, few fossils, several layers	5	6
6. Limestone, gray, compact, siliceous	5	
7. Limestone, gray, numerous concretions of chert	1	4
8. Limestone, dark gray, fine grained, compact and hard in two layers	4	4
9. Limestone, lavender, very fine grained, and compact, brittle, calcite veins	1	
Section. 10. Limestone, very dark gray, sub-crystalline	1	10
11. Limestone, gray and yellow, fine grained, siliceous	2	5
12. Limestone, light and dark gray, cherty		9
13. Limestone, drab, very fine grained	1	1
14. Shale, greenish blue, sandy		3-5
15. Limestone, gray and bluish, fine grained	1	2
16. Limestone, light gray, fine and coarse grained	3	4
17. Limestone, light gray, fine grained	1	
18. Limestone, white and grayish, fine grained	2	10
19. Like number 18, but contains much chert	3	2
Total thickness of rock	40	7

Eyerman, G. (I, 13):—Mr. Eyerman has a quarry which is situated on the corner of Carr Lane avenue and Rutger street. It was opened in March, 1889. The product consists of macadam, paving, building and dimension stone.

Location and product.

The section here is about the same as that at Christian Piepers quarry, given on p. 58.

Friederichs, Jacob (I, 20):—Mr. Friederichs has a quarry situated at the intersection of Minnesota avenue and Maeder street, which was opened about seven years ago. The quarry is rectangular in shape, is about sixty feet long by fifty feet wide, and is drained by a subterranean channel.

Location.

The following section, in descending series, was obtained here:—

	Feet.	Inches.
1. Soil and Loess	8–16	
2. Gravel and residuary clay	16	
3. Limestone, partially decomposed	2–6	
4. Limestone, light gray, soft	3	
Section. 5. Limestone, light gray, several layers interstratified with chert	4	4
6. Limestone, light gray, in thin layers, calcite veins	7	
7. Limestone, very light gray, chert concretions and layers near the top	1	3

	Feet.	Inches.	
8. Limestone, brownish, siliceous, numerous chert concretions and layers near the top and bottom	5		
9. Limestone, gray, fossiliferous, coarse grained, in two layers	3	8	Section.
10. Limestone, gray, fossiliferous, calcite veins	1		
11. Limestone, light gray, coarse grained, several layers	6		
12. Limestone, light gray, fine grained, soft, two layers	3		
Total thickness of rock	36	9	

Fruin, Bambrick & Co., First Quarry (H, 12):—This quarry is situated at the junction of Cabanne avenue and Papin street. There are two shallow openings, one on each side of the Missouri Pacific railway. Work was begun here about two years ago, and has consisted mainly of the removal of stone for the production of macadam. Location and product.

Fruin, Bambrick & Co., Second Quarry (C, 14):—This quarry is situated on the "Frisco" railway at Clifton Heights. The product consists mostly of macadam and building stone. Some paving is also produced.

The following section, in descending series, was obtained here:—

	Feet.	Inches.	
1. Loess	30		
2. Limestone, much broken and more or less decomposed	10	4	
3. Limestone, gray, fine grained, compact, in three ten inch layers	2	6	
4. Limestone, gray, full of dark colored flinty concretions		6	Section.
5. Limestone, gray, soft, occasional chert concretions		10	
6. Limestone (covered with debris)	2		
7. Limestone, light gray, compact, in two layers each thirty inches thick	5		
Total thickness of rock	21	2	

Fruin, Bambrick & Co., Third Quarry (I, 13):— This quarry is situated on the south-east corner of Grand and Chouteau avenues. Work was begun by the present operators in May, 1890, with the intention of producing paving stone, macadam and rubble. But little work has been done as yet. Location.

The following section, in descending series, was obtained here:—

Section.

	Feet.	Inches.
1. Loess	3	
2. Limestone, weathered in thin layers	20	
3. Limestone, yellow, soft and shaly		2
4. Clay, yellow, soft, laminated		6
5. Clay carrying flinty nodules		4
6. Shale, green, soft		6
7. Limestone, bluish gray, very fine grained, compact, in two layers, respectively three feet and a foot and a half thick	4	6
8. Limestone, gray, in six to ten inch layers	4	
9. Limestone, gray, rather coarse grained, in two eighteen inch layers	3	
10. Limestone, gray, hard, compact	5	
Total thickness of rock	38	0

Location and product.

Fruin, Bambrick & Co., Fourth Quarry (H, 12): — This quarry is situated near the junction of Cabanne and Chouteau avenues. The product consists of macadam, paving, building stone and rubble. The quarry is about thirty-five feet deep. There is a thin stripping of loess and decomposing limestone.

Grund, Louis (K, 19): — Mr. Grund has a large quarry which is situated west of the Iron Mountain and Southern railway track, near Meramec street. The quarry is two hundred feet long and sixty feet deep. The product consists of macadam, building stone and paving. The quarry is in the same bluff as the Work House* quarry and the sections at the two quarries are very similar.

Heman Bros. (O, 10): — This firm has a quarry which is situated in the block west of Main Street and south of Brooklyn. Stone for most all the common uses is produced. Following is the columnar section made at the quarry, in descending series: —

	Feet.	Inches.
1. Soil, loess and decomposing limestone	4–12	
2. Limestone, in thin layers	4	
3. Limestone, in two beds (inaccessible)	8	9
4. Shale, greenish, alternating with limestone	1	8
5. Limestone, gray to bluish, fine grained	1	8
6. Limestone, gray, vary-grained, cherty in upper part	2	
7. Shale, greenish, with nodules of limestone		4
8. Limestone, dark gray, rather coarse grained	3	10
9. Limestone, light gray, shaly	2	

* For note see p. 62.

	Feet.	Inches.	
10. Limestone, light gray, fine grained, occasional concretions of chert	1	9	
11. Limestone, gray, fine grained	1	6	
12. Limestone, gray, coarse grained crystalline	1		
13. Limestone, drab, shaly		3	Section.
14. Limestone, gray to white, fine grained, cherty	2	1	
15. Limestone, gray and brownish, in beds from one to six inches thick	7	6	
Total thickness of rock	38	7	

Hogan, E. W. (K, 6): —Mr. Hogan has a quarry which adjoins the Perkinson Second Quarry on the Eleventh street side. The product consists of macadam, building stone and paving. Stone is hoisted from the quarry by derricks. Location and product.

The section is the same here as that at the latter quarry.

Hogan, M. (L, 7): — Mr. Hogan has a quarry on Penrose " south of Blair avenue. The product consists of macadam.

Following is the section in descending series: —

	Feet.	Inches.	
1. Loess	20		
2. Limestone, gray, fine grained, compact, in three thirty-six inches layers	9		
3. Shale		1-3	Section.
4. Limestone, gray, fine grained	1	8	
5. Limestone, thin beds, in some places two to three feet thick, in others two to six inches thick	15		
Total thickness of rock	25	10	

Hogan and Moran (J, 9): — This firm has a quarry which is situated at the north-east corner of Magazine street and Garrison avenue. It was opened fifty-one years ago, and was worked by R. Kingen for seventeen years. Mr. Hogan then worked it for twenty-five years when it went into the hands of the present firm which has since operated it continuously. The product consists of macadam, building stone and paving. Stone is loaded, in the quarry, into movable wagon beds, hoisted to the surface and delivered to the wheels of the truck. Location. Product.

The upper part of the section is the same as that at Cavanaugh's, as given above. The entire section is as follows, in descending series: —

	Feet.	Inches.
1. Limestone, same as at Cavanaugh's	39	4
2. Limestone, gray to drab, hard, crystalline	3	
3. Limestone, full of chert concretions		10
4. Limestone, light gray, hard, considerably faulted	4	
5. Limestone, drab, lithographic, considerably faulted	2	6
Section. 6. Limestone, light gray, cherty, lithographic, in three layers	6	
7. Limestone, dark gray, siliceous, splits easily, in three layers	2	10
8. Shale, greenish, very persistent		2–4
9. Limestone, gray, hard, fine grained, compact, in two layers	5	
Total thickness of rock	63	9

Location and product.

Kempf, Conrad (I, 20): — Mr. Kempf has a quarry situated next to Mr. Friedericks, which was opened in 1883. Dimension and building stone, and macadam are produced. The quarry is drained by a subterranean stream. It is about one hundred and eighty feet long by one hundred feet wide, and exposes the following columnar section, in descending series:—

	Feet.	Inches.
1. Loess	10–20	
2. Residuary clay, mixed with the gravel of the drift		18
3. Limestone, partially decomposed	6	
4. Limestone, drab, uniform fine grained, highly fossiliferons, in two and sometimes three layers	5	
ection. 5. Limestone, gray and light brown, chert layers and concretions	3	
6. Limestone, light gray, uniform fine grained	1	2
7. Limestone, dark and light gray, rather fine grained, quite hard	1	10
8. Limestone, gray, coarse grained, in three layers	1	8
9. Limestone, dark gray, coarse grained, fossiliferous	4	10
10. Same as number 9		6
11. Limestone, gray, coarse and fine grained, in a variable number of layers	3	8
Total thickness of rock	27	8

Kern, Adam: — See *Albernacius.*

Location and product.

Kinealy and Sons (K, 7): — This firm has a quarry which is situated in the block between Florissant, Twenty-second, Penrose and Angelica streets. It was opened in the spring of 1889. Building stone, curbing and macadam are the chief products. The quarry is about sixty feet long, fifty feet wide and exposes the following columnar section, in descending series: —

	Feet.	Inches.	
1. Loess, drift and decomposing limestone	26		
2. Limestone, lavender, fine grained, very fossiliferous	1		
3. Limestone, gray, coarse grained, crystalline	1	6	
4. Limestone, gray to lavender, coarse grained in several layers	4		Section.
5. Limestone, gray to drab, fine grained, very fossiliferous	2	6	
6. Limestone, gray and lavender, fine and coarse grained, in layers from two to ten inches thick	6	6	
Total thickness of rock	15	6	

Knaus and Willis (J, 19):—See *Allen*.

Krug and Zesch (I, 20):—This firm has a quarry at the corner of Minnesota and Delor avenues. It was first worked in 1869. The output consists of macadam, paving, building stone and "furnace rock." The quarry is drained by a subterranean stream. It is about two hundred feet long, one hundred feet wide, and exposes the following vertical section, in descending series:— Location and product.

	Feet.	Inches.	
1. Loess, yellow clay	5–20		
2. Drift (gravel) and residuary clay	1		
3. Limestone, decomposed	3		
4. Limestone, very siliceous	5		
5. Limestone, in three beds, gray, fine grained, lower and upper beds rather siliceous	3–4		
6. Limestone, in two beds, almost white, rather coarse grained, suture joints	2	6	
7. Limestone, gray, very fine grained, compact, brittle, called "glass ledge"	1	3	
8. Limestone, dark gray and brown, numerous calcite crystals, disintegrates rapidly	1	10	Section.
9. Limestone, gray, compact	1	2	
10. Limestone, in thin layers, white and gray, cherty	4		
11. Limestone, in thin layers, white and gray	5		
12. Limestone, gray, fine grained, chert concretions and layers	4		
13. Limestone, gray, coarse grained, siliceous	4		
14. Limestone, gray, coarse grained	1	3	
15. Limestone, gray, coarse grained		4	
16. Limestone, gray, coarse grained, fossiliferous	1	8	
17. Limestone, gray, coarse grained, easily disintegrated		7	
18. Limestone, gray, rather coarse grained, hard	1	8	
Total thickness of rock	40	3	

Location and product.

Lohrum, John C. (L, 17):—Mr. Lohrum has a quarry, situated in the face of the Mississippi river bluff, near the foot of Cahokia street, and on the Iron Mountain & Southern railway. The chief product is macadam and building stone; but some paving and dimension stone is quarried. The section here is about like that given below, at Martin Lorentz' quarry, although it is a little higher in the series, and a few different ledges come in at the base. The quarry has a face of three hundred feet in length. It was opened in 1883.

Lorentz, Martin (L, 17): —This quarry is situated by the side of the Iron Mountain & Southern railway track, near Cahokia street. It is one of the series of quarries which are worked in the face of the Mississippi river bluffs, and may be seen in the illustration on page 41. The principal product is building stone and macadam. The following section,* in descending series, shows the character of the material used:—

Section.

	Feet.	Inches.
1. Loess, the stripping	10-30	
2. Drift of pebbles	1	
3. Limestone (Analysis No. 20), light gray, darker towards top, fine grained	1	6
4. Limestone (Analysis No. 21), like No. 3	1	10
5. Limestone (Analysis No. 22), light, yellow and gray, soft		8
6. Limestone (Analysis No. 23), light and dark gray, varying texture, compact, brittle, hard	2	10
7. Limestone (Analysis No. 24), gray, fine grained, jointed	2	6
8. Limestone (Analysis No. 25), light gray, fine grained, color and texture somewhat variable	2	6
9. Limestone (Analysis No. 26), dull gray to yellowish, harder towards base	4	2
10. Limestone (Analysis No. 27), brownish and gray, coarse grained, shaly near top, two layers varying in thickness	3	
11. Limestone (Analysis No. 28), like No. 10	2	4
12. Limestone (Analysis No. 29), dull gray, very fine grained.		5
13. Limestone (Analysis No. 30), drab, hard, brittle, lithographic		11
14. Shale		1
15. Limestone (Analysis No. 31), gray, hard		9
16. Limestone (Analysis No. 32), light drab, with dark bands.	1	10
17. Limestone (Analysis No. 33), dark gray, carries layer of chert	3	11

* For the results of analyses of average samples of the beds of this section, see page 76.

	Feet.	Inches.	
18. Limestone (Analysis No. 34), light drab, fine grained, layer of chert three feet from base varying in thickness	8	2	
19. Limestone (Analysis No. 35), dark gray, geodes, lined with calcite crystals		8	
20. Limestone (Analysis No. 36), light gray, soft chert, concretions near top	2		
21. Limestone (Analysis No. 37), gray, coarse grained	1	10	Section.
22. Limestone (Analysis No. 38), like last, but poorer quality		10	
23. Limestone (Analysis No. 39), dark gray to brownish, lower sixteen inches cherty	4		
24. Limestone (Analysis No. 40), brown, otherwise like No. 23	3	9	
25. Limestone (Analysis No. 41), drab, hard, brittle, fine grained, lithographic	1	6	
26. Limestone (Analysis No. 42), dark gray, coarse grained, hard, in three ledges	3	4	
Total thickness of rock	56	4	

Mohun, Patrick (I, 13):—Mr. Mohun's quarry adjoins that of Christian Piepers, and occupies about half of the same opening, which is two hundred and seven feet long and one hundred and fifty feet wide. Work is at present suspended. Location.

O'Meara, John B., First Quarry (F, 17):—This quarry is one of three which are conducted by Mr. O'Meara. It is situated on the south side of Euclid, and on the west side of Ashland avenues. It has been worked since 1876. The product consists of dimension stone, paving, macadam, foundation stone, etc. Steam saws have been used for about five years, and at present a channeling machine is in use. " Product.

The outline of the quarry is roughly circular at the surface, and is about four hundred yards in circumference. The following section in descending series, is exposed:—

	Feet.	Inches.	
1. Stripping, Loess, drift and decomposing limestone	20		
2. Limestone (inaccessible)	10		
3. Limestone, gray, jointed in four layers	3	8	
4. Limestone, gray, lithographic, in many layers	11		
5. Limestone, gray at top, growing very dark downwards, containing much chert, especially at the top	2	6	Section.
6. Limestone, gray, fine grained		10	
7. Limestone, dark and light gray, concretionary		3-5	
8. Limestone, gray, uniform texture, best dimension stone in quarry	2	9	

Section.		Feet.	Inches.
	9. Limestone, brownish, coarse grained, fossiliferous, several layers	3	9
	10. Limestone, gray to bluish, fine grained, many layers, fossiliferous	7	3
	11. Limestone, dark gray, fine grained, many layers	7	6
	12. Limestone, gray, fine grained, fossiliferous, numerous cavities	1	6
	13. Limestone, gray to brown, coarse grained	1	
	14. Limestone, brownish, quite soft	1	4
	15. Limestone, dark gray, coarse grained, siliceous	1	
	16. Limestone, dark gray, with horizontal streaks of brown, fine grained	5	8
	17. Limestone, gray, fine grained, concretions of chert at top	3	8
	18. Limestone, dark gray, fine grained	3	
	19. Limestone, very dark gray, coarse grained		5
	20. Limestone, gray, fine grained		11
	21. Limestone, dark gray, fine grained		7
	22. Limestone, gray, vary in texture from coarse to fine	2	6
	23. Limestone, dull gray, coarse grained	3	8
	24. Limestone, light gray, fine grained, soft, dresses to white	3	2
	25. Limestone, gray, with greenish tinge, breaks into thin layers	1	4
	26. Limestone, gray, coarse grained	2	
	Total thickness of rock	81	4

The beds have distinct northeasterly dip.

Location and product.

O'Meara, John B., Second Quarry (K, 9): — This quarry is situated at the corner of Twenty-fifth and Montgomery streets, and occupies nearly a whole block. It was opened about twenty-five years ago. No dimension stone is quarried at present, although formerly a considerable amount of it was produced. The output is mostly paving, foundation stone and macadam. One four inch Ingersoll drill is used. Stone is hoisted from the quarry in the movable beds of wagons by derricks. The stripping varies here from a few inches to thirty feet in thickness. The upper twenty-five feet of limestone are very flinty, and are worth but little, though a few of the layers may make good curbing.

"

O'Meara, John B., Third Quarry (F, 12): — This quarry is situated at number 4400 Clayton road. The product consists mostly of curbing and paving, and a small amount of building stone. Hand drills and a derrick are used.

The following section was made in the quarry, in descending series: —

	Feet.	Inches.	
1. Loess	40		
2. Limestone, decomposing	5		
3. Limestone, irregular, cherty and hard layers	5		
4. Limestone, in layers, varying from two to ten inches	10–11		Section.
5. Limestone, dark gray, hard, in four layers, used for curbing	3		
6. Limestone, gray, hard, chert concretions, stylolites	2	6	
7. Limestone, gray, fine grained, used for paving altogether		10	
8. Limestone, gray, fine grained, in two layers, used for curbing	1	6	
9. Limestone, gray, uniform fine texture, weathers into several layers	2	6	
Total thickness of rock	31	4	

Perkinson, J. E. & Bro., First Quarry (J, 7): — This quarry is situated near the corner of Harrison and Grand avenues. It was opened in 1870, and has been worked by the present owners for sixteen years. It is about one hundred and thirty-five feet deep. Stone for all the common purposes is quarried. Location.

The following section, in descending series, was obtained here: —

	Feet.	Inches.	
1. Loess	40		
2. Limestone, decomposing and weathered	10		
3. Limestone, gray, compact, in two layers	5		
4. Limestone, in thin layers	20		
5. Limestone, gray in two thirty inch layers	5		
6. Limestone, in thin layers	4		
7. Limestone, dark gray	1		
8. Limestone, several layers	10		
9. Limestone, very thin layers	1		
10. Limestone, gray, variable texture	6–7		
11. Limestone, gray, chert concretions, in three layers	6	6	Section.
12. Limestone, white, compact, uniform texture, weathers dark in places	1	6	
13. Limestone, gray, coarsely crystalline	3	6	
14. Limestone, light gray, compact	1	6	
15. Limestone, white and greenish, in alternating layers which vary from ten to twenty-four inches in thickness	5	6	
16. Limestone, light gray, compact, in three layers	4	10	
Total thickness of rock	86	4	

Location.

Perkinson, J. E. & Bro., Second Quarry (K, 6): — This quarry is situated near the corner of Bissell street and Broadway. Stone for all the common purposes is quarried.

Following is the section, in descending series, obtained here: —

Section.

	Feet.	Inches.
1. Loess	15	
2. Limestone, weathered	5	
3. Limestone, shaly	1	6
4. Limestone, gray	3	
5. Limestone, dark gray and blue, crystalline, calcite veins, flinty in places	3	
6. Limestone, yellow and brown, changes color abruptly, cross bedded	1	8
7. Limestone, light and dark gray, in layers varying in thickness from twenty to thirty-six inches	9	8
8. Limestone, gray, in two to ten inch layers	15	
9. Limestone, dark gray, fine grained	4	
10. Limestone, light gray, fine grained	1	
11. Limestone, gray, coarse grained, in four layers	1	8
12. Limestone, light gray, in three layers	2	6
13. Limestone, gray, fine grained, in two layers		10
14. Limestone	1	8
15. Limestone, in six to twelve inch layers	15	
Total thickness of rock	65	6

Location and product.

Pickel, Conrad (I, 13): — Mr. Pickel has a quarry which is situated on the northeast corner of Hickory street and Theresa avenue. It was opened in 1883. The product consists of macadam and building stone.

Section.

The section here is about the same as that at Christian Pieper's quarry, given below, except that the shale layer changes into a shaly limestone.

Location and product.

Pieper, Christian (I, 13): — Mr. Pieper has a quarry which is situated on the southeast corner of Carr Lane avenue and Hickory street. It was opened in 1886. The product consists of macadam and building stone.

The following section, in descending series, was obtained here: —

Section.

	Feet.	Inches.
1. Loess	2	
2. Limestone, gray, decomposing, in thin beds	10	
3. Limestone, dark gray, soft	1	6
4. Limestone, gray, fine grained, compact, in four layers	4	

	Feet.	Inches.	
5. Limestone, dark gray, compact, in three eighteen inch layers	4	6	
6. Shale	1	6	Section.
7. Limestone, gray, fine grained, jointed, three layers	5		
8. Limestone, light gray, compact, in two twelve inch, and one thirty-six inch layer	5		
Total thickness of rock	31	6	

Pendergast, George (D, 7):—Mr. Pendergast has a quarry which is situated on Florence avenue, three or four blocks north of Easton avenue. It is a small shallow quarry about three hundred feet long by one hundred and twenty-five wide. It was opened in 1889. The product consists of building stone, macadam, dimension stone and riprap. Location and product.

The following section, in descending series, was obtained here:—

	Feet.	Inches.	
1. Loess	4–6		
2. Drift		6	
3. Limestone, decomposing	5		
4. Limestone, drab, lithographic		5	
5. Limestone, brownish, numerous crystals of calcite		8	
6. Limestone, gray, fine grained, on weathering exposes many crinoid stems	2		Section.
7. Limestone, light and dark gray, uniform texture	1	10	
8. Limestone, light gray and brown, numerous calcite crystals and corals, fine grained	4	10	
9. Limestone, gray and brown, fine grained, siliceous	1	3	
10. Limestone, light gray, finely crystalline	2		
Total thickness of rock	17	0	

The beds here dip southeasterly.

Ridemeyer (L, 7):—Mr. Ridemeyer has a quarry which is situated at Newhouse avenue and Nineteenth street. The quarry is about seventy-five feet square and forty-four feet deep. The product consists of rubble and macadam. Location and product.

Following is the section here, in descending series:—

	Feet.	Inches.	
1. Loess	30		
2. Limestone, irregular thin layers	5		Section.
3. Limestone, gray, coarsely crystalline	2	6	
4. Limestone, gray, coarse grained	2	6	

		Feet.	Inches.
	5. Shale		6–10
Section.	6. Limestone, gray, compact	2	6
	7. Limestone, irregular thin layers	15	
	Total thickness of rock	28	2

Location. *Stiefel and Ruckert, First Quarry* (G, 6): — This quarry is situated between Cora and Marcus avenues, on the north side of the Natural Bridge road. Stone for all common purposes is quarried. It was opened in 1888. It is three hundred feet long, sixty-four feet wide, and exposes the following columnar section, in descending series: —

		Feet.	Inches.
	1. Loess	14	
	2. Residuary clay mixed with the gravel of the drift	1	
	3. Limestone, partially decomposed	1	
	4. Limestone, brown, coarse grained	2	
	5. Limestone, drab, fine grained, compact, hard and brittle		9
	6. Limestone, gray, coarse grain		3
Section.	7. Limestone, light drab, fine and coarse grained, lithographic in places	6	
	8. Limestone, bluish, fine grained	2	6
	9. Shale, bluish and green, hard, merges into number 8		2–7
	10. Limestone, dark brown to drab, contains numerous crystals of pyrites		8
	11. Shale, bluish green, in layers, with thin layers of limestone	1	
	12. Limestone, very dark gray, coarse grained, quite large masses of pyrites		11
	13. Limestone, dark gray, fine grained, suture joints, fossiliferous, pyrites especially near top	5	
	14. Limestone, light gray, fine grained	3	8
	15. Limestone, gray, coarse grained	2	
	Total thickness of rock	26	2

Location. *Stiefel and Ruckert, Second Quarry* (M, 15): — This quarry is situated in the city at the foot of Barton street, on the north side of the Iron Mountain and Southern Railway. It is one of the largest quarries in the city, being very deep and having a large rock face to be worked. Its shape is somewhat oval. A view of the south end of the quarry is illustrated opposite page 42. It was opened in 1863. At present its chief product is macadam. Two Rand drills and a No. 4 Gates' crusher are in use.

Plant.

The following section,* in descending series, shows the character of the beds:—

Section.

	Feet.	Inches.
1. Loess, the stripping of this quarry	4	
2. Limestone, much jointed and weathered	20	
3. Limestone (Analysis No. 1), light gray, coarse grained, stylolites at bottom	2	5
4. Limestone (Analysis No. 2), gray and drab, finer grained, splits into layers, lower third lithographic in character, fossiliferous	3	11
5. Limestone (Analysis No. 3), gray, fine grained, highly fossiliferous	3	10
6. Limestone (Analysis No. 4), gray, much jointed, granular	1	4
7. Limestone (Analysis No. 5), soft drab, lithographic, brittle, conchoidal fracture	1	3
8. Limestone (Analysis No. 6), gray to brownish, coarse, granular, stylolites	4	7
9. Limestone (Analysis No. 7), same as No. 8, but variable in grain, few fossils	2	3
10. Limestone (Analysis No. 8), soft drab to brownish, irregularly bedded, brittle, conchoidal fracture	3	2
11. Clay shale, soft greenish		3
12. Limestone (Analysis No. 9), almost white, fine grained, conchoidal fracture, decomposes readily		10
13. Limestone (Analysis No. 10), soft drab and brownish, irregularly bedded, fine grained, conchoidal fracture	4	3
14. Limestone (Analysis No. 11), soft drab and brownish, fine grained, conchoidal fracture	4	6
15. Limestone (Analysis No. 12), almost white, irregularly bedded, brittle, conchoidal fracture, stylolites	1	8
16. Limestone (Analysis No. 13), like number 15, but slightly darker	3	3
17. Clay shale, greenish		2
18. Limestone (Analysis No. 14), gray to drab, fine wavy bedding lines, fine grained, stylolites		10
19. Limestone (Analysis No. 15), light drab, brittle, conchoidal fracture	1	11
20. Limestone (Analysis No. 16), light brown, many bedded, lithographic, cross bedded in places	4	5
21. Limestone (Analysis No. 17), drab, coarse grained, granular stylolites	2	9
22. Limestone (Analysis No. 18), same as No. 21, but finer grained	1	10
23. Limestone (Analysis No. 19), two or more beds, dark gray, easily dressed	6	
Total thickness of rock	75	5

* For analyses of average samples of the stone from the respective beds of this section, see page 76.

Location.

St. Louis Stone Masons Quarry (I, 13): — This is a small quarry situated on the north-east corner of Carr Lane avenue and Hickory street.

The following section, in descending series, was obtained here:—

Section.

	Feet.	Inches.
1. Loess	3	
2. Limestone, thin weathered layers	12	
3. Shale	1	
4. Limestone, gray, compact	7	
5. Limestone, light gray, compact, in two twelve inch layers	2	
6. Limestone, light gray, crystalline	5	
7. Limestone, thin shaly layers	8	
Total thickness of rock	35	0

Location and section.

Watson Construction Company (H, 13): — This firm has a quarry which is situated on the south-west corner of Grand and Chouteau avenues. It was opened in December, 1889. The section here is the same as that given of the Fruin, Bambrick & Company's Third Quarry, p. 50.

Location and product.

Wieman, William (G, 6): — Mr. Wieman's quarry is situated on the south-west corner of Cora and Margaretta avenues. The product is mostly building stone and macadam. The quarry was opened in 1880. It is sixty feet long, thirty feet wide and exposes the following columnar section, in descending series: —

Section.

	Feet.	Inches.
1. Loess	5–30	
2. Residuary clay and decomposing limestone	5	
3. Limestone, light gray		4
4. Limestone and chert in thin alternating layers	1	6
5. Limestone, light gray	4	
Total thickness of rock	5	10

Location.

Work House Quarry (K, 19): — This quarry is situated at the foot of Meramec street, on the Iron Mountain and Southern railway. It has been opened about forty years. The most important product is macadam. The laborers employed are all convicts. The quarry is deep, large and somewhat oval in shape. The following section,* in descending series, shows the character of the beds:—

* For analyses of the stone from the respective beds of this section see page 77.

	Feet.	Inches.	
1. Loess as stripping	5–20		
2. Limestone (Analysis No. 43), in broken and weathered beds	6	6	
3. Limestone (Analysis No. 44), dark drab, fine grained	2	9	
4. Limestone (Analysis No. 45), light drab, fine grained, two inch layer of chert near top	2	4	
5. Limestone (Analysis No. 46), drab and yellowish, fine grained grades in places to No. 4 without separation	1	3	
6. Limestone (Analysis No. 47), cross bedded, alternating layers of chert and limestone	6	6	
7. Limestone (Analysis No. 48), gray and brown, rather fine grained, several beds of limestone from two to twelve inches thick, two layers of chert two to six inches thick	3	10	
8. Limestone (Analysis No. 49), gray, brown and drab, coarse grained	4	2	
9. Limestone (Analysis No. 50), gray, fine grained, laminated, four to five beds from one to six inches thick	2		
10. Limestone (Analysis No. 51), lavender, lithographic, hard, brittle, conchoidal fracture, very fine grained	1	4	Section.
11. Limestone (Analysis No. 52), very dark gray, rather fine grained, slightly cross bedded	1		
12. Limestone (Analysis No. 53), same as No. 11	3	9	
13. Limestone (Analysis No. 54), gray and drab, fine grained hard, carries oblong and spherical masses of chert	2	4	
14. Limestone (Analysis No. 55), and chert in alternate but non-continuous layers	12		
15. Limestone (Analysis No. 56), dark gray, considerable chert	3	6	
16. Limestone (Analysis No. 57), dark and light gray, overlaid by two feet of chert with little limestone, laminated, cross bedded	3		
17. Shale		1	
18. Limestone (Analysis No. 58), gray, drab and greenish, coarse grained, stylolites, fossiliferous, chert band at top	2	3	
19. Shale		½	
20. Limestone (Analysis No. 59), light yellow, drab and gray, large balls of chert a foot or more in diameter near top, fossiliferous and geodal	6		
21. Limestone (Analysis No. 60), gray to brown, line of chert at top, stylolites, soft, fine and coarse grained	4	9	
Total thickness of rock	69	4½	

QUARRIES IN ST. LOUIS COUNTY.*

Location. *Boehm, Fritz* (50) :— Mr. Boehm has a quarry near Bobring, in the St. Louis Limestone. It has about four hundred feet of rock face, in which the following section, in descending series, is exposed : —

Section.

	Feet.	Inches.
1. Loess	10	
2. Limestone, much decomposed	2	
3. Limestone in several layers, with shaly partings, several layers are about 10 inches thick, suture joints	6	
4. Limestone, lavender, fine grained, scattered concretions of bluish chert		8
5. Limestone and Shale, like No. 3, except layers not so thick.	6	6
6. Limestone, gray to lavender, fine grained, crystalline, fossiliferous, in three layers	2	
Total thickness of rock	17	2

Location. *Crystal Spring Quarry Co.* (47) : — This firm quarries stone, which is probably of the St. Louis Limestone, in an old bluff of the Missouri river, near Vigus Station, on the St. Louis, Kansas City, and Colorado railway. Work was begun in 1889. The

Product. product consists of building stone, riprap, etc., but is soon to include dimension stone which the company intends to produce on a large scale. The quarry is connected with the railway by a switch about one half of a mile long. The company controls several hundred yards face of workable stone. There are three openings in the bluff from each of which stone is removed by the use of derricks to freight cars on which it is shipped.

Section. The section here is the same as given below for the quarry of the Watson Construction Co., which is close at hand. A sample for analysis was collected here from beds numbers 4 to 10 (inclusive) of this section.

Location. *Doering, J. H.* (51) : — Mr. Doering has a quarry situated on the Carondelet Branch railway, southwest of Bobring, in the St. Louis Limestone. It is connected with the railway by a half mile switch. The quarry has a workable face about eight hun-

* A few of the county quarries mentioned in the tables do not appear in this descriptive list. None of such are, however, large producers, so far as could be learned.

dred feet long. The product consists of dimension stone, macadam and riprap.

Eureka Quarry Co. (57): — This company has a quarry which is situated on the Gravois road about an eighth of a mile northeast of Afton, in the St. Louis Limestone. Work was begun in 1889. The product consists of building stone and macadam. Location and product.

The following section, in descending series, was obtained here: —

Section.

	Feet.	Inches.
1. Stripping, residuary clay and decomposing limestone	5	
2. Limestone, lavender, lithographic	1	1
3. Limestone, gray, crystalline	1	10
4. Limestone, same as last but fossiliferous	2	
5. Limestone, light gray, crystalline, calcite veins, fossiliferous, in several layers	3	
6. Limestone, light gray, crystalline, in four layers	3	6
7. Limestone, gray, coarse grained, crystalline, calcite, in thin layers	2	3
8. Limestone, gray, fine grained, crystalline		6+
Total thickness of rock	14	2

Fabrick, Philip, and Marshall (53): — This firm has a quarry situated about one-fourth of a mile west of the Doering and Munsen quarries, and about three hundred yards from the Carondelet Branch railway. The stone quarried belongs to the St. Louis Limestone. Location.

The following section, in descending series, was obtained here: —

Section.

	Feet.	Inches
1. Soil and residuary clay	6	
2. Limestone, partially decomposed	5	
3. Limestone, dark gray, fine grained	1	6
4. Limestone, gray to brown, coarse grained, soft	3	
5. Limestone, dark gray, coarse grained	1	10
6. Limestone, gray to brown, vary grained	1	8
7. Limestone, dark gray, lithographic, in three layers	2	6
8. Limestone, buff, shaly and soft	1	8
9. Limestone, dark drab, lithographic	1	9
10. Limestone, very dark drab, fine grained, crystalline, calcite veins, two layers separated by a thin bed of brown shale	2	10
11. Limestone, dark gray, lithographic, in three layers	2	4
12. Limestone and shale, in three alternating layers		3-6
13. Limestone, dark gray to lavender, fine grained	1	2
Total thickness of rock	25	8

Location and product.

Glendale Quarry Co. (55): — This company has a quarry on the Carondelet Branch railway about half way between Kirkwood and Webster, in the St. Louis Limestone. It was opened in 1889. The product consists mostly of dimension and building stone. The quarry has a workable face of about three hundred feet and operates two channeling machines.

The following section, in descending series, was obtained here: —

Section.

	Feet	Inches.
1. Stripping, clay and decomposing limestone	6	
2. Limestone, yellow to lavender, lithographic, concretions in places (has been used by lithographers)	2	6
3. Limestone, dark gray, soft	1	6
4. Limestone, almost white, soft, weathers into two layers	2	10
5. Limestone, dark gray, coarse grained, crystalline	2	
6. Limestone, dark gray, fine grained, in two layers	2	2
7. Limestone, dark gray, fine grained, chert concretions occasionally	4	
8. Limestone, mottled gray to brown, coarse grained, crystalline	1	
9. Limestone, brownish gray, soft, in two layers of equal thickness	4	
10. Limestone, gray, coarse grained	2	
Total thickness of rock	22	0

Location and product.

Lauritzen, James (56): — Mr. Lauritzen's quarry is situated at Webster. The product consists of building and dimension stone, and macadam. The quarry is in the St. Louis Limestone.

The following section, in descending series, was obtained here: —

Section.

	Feet.	Inches.
1. Stripping, soil, residuary clay and decomposing limestone	5	
2. Limestone, almost white, fine grained, crystalline, conspicuously cross bedded	5	
3. Limestone, dark gray, coarse grained, suture joints, chert concretions, in numerous layers	2	6
4. Limestone, drab, lithographic, in eight layers	3	9
5. Limestone, chocolate to gray, fine grained, fossiliferous.		9
6. Limestone, lavender, fine grained, chert concretions	1	
7. Limestone, lavender, fine grained, fossiliferous, in four layers	2	
8. Limestone, varying in color and texture, in layers one or two inches thick	3	
9. Limestone, lavender, fine grained, in layers from six to eight inches thick	2	6
Total thickness of rock	20	6

Munsen (52):—Mr. Munsen has a quarry in the immediate neighborhood of Mr. Doering's, with the same railway connection. The product consists of "furnace rock." The quarry was opened in 1880. Its face is about seven hundred and fifty feet long. The stone quarried is of St. Louis Limestone. Location and product.

The following section, in descending series, was obtained:— Section.

	Feet.	Inches.
1. Soil and residuary clay	5	
2. Limestone, decomposing	12	
3. Limestone, gray, fossiliferous, in several layers	5	10
4. Limestone, buff, alternately fine and coarse grained, soft, fossiliferous	3	
5. Limestone, gray, crystalline	1	10
6. Limestone, blue to yellowish, vary grained	3	9
7. Limestone, gray, coarse grained, fossiliferous, in two layers.	1	4
8. Limestone, gray, fine grained		9
9. Limestone, gray, crystalline, fossiliferous, in three layers.		10
10. Limestone, gray, fine grained, brittle, fossiliferous, small chert concretions near middle	4	10
11. Limestone and shale in thin layers		8
12. Limestone, gray, fine grained, numerous small concretions of chert	1	6
13. Limestone, light gray, hard, siliceous		7
14. Limestone, light gray, soft	1	4
15. Limestone, dark gray, lithographic		8
16. Limestone and shale		8
17. Limestone, grayish to brown, coarse grained, crystalline, three layers	3	5
18. Limestone, lavender, fine grained, brittle	1	1
19. Limestone in thin layers, with shale partings, gray to lavender, fine grained		10
20. Limestone, dark gray, concretionary, in three layers	2	9
21. Limestone, light lavender, fine grained, hard and brittle		
22. Limestone, suture joints		3
23. Limestone, light lavender, fine grained, hard and brittle, in three layers, respectively thirty, twenty-four and eight inches thick	4	6
Total thickness of rock	52	5

Shores Quarry Co. (54):—This quarry is situated on the Kirkwood Branch railway, five miles from Carondelet, in the St. Louis Limestone. It was opened March, 1889. The product consists of "furnace rock," paving, building and dimension stone. The quarry is an open cut in a hill-side. Location and product.

The following section, in descending series, was obtained here :—

Section.

	Feet.	Inches.
1. Soil and residuary clay	4	
2. Limestone, decomposing	2	
3. Limestone, gray to brown, coarse grained	3	9
4. Limestone, lavender, lithographic, in three layers, the two lower of which are separated by a thin layer of shale	3	2
5. Limestone, gray, coarse grained, crystalline	1	2
6. Limestone, lavender, lithographic, in four layers	8	
7. Limestone, gray, fine grained, chert concretions, several layers	4	
8. Limestone, brownish, siliceous, chert concretions	1	6
9. Limestone, gray, crystalline, almost a solid mass of fossils.	1	4
10. Limestone, brownish to gray, coarse grained	1	8
11. Limestone, dark lavender, numerous chert concretions		10
12. Limestone, light gray, lithographic, chert concretions	1	8
13. Limestone, lavender, lithographic, calcite veins	1	3
14. Limestone, dark gray, rather coarse grained	1	
15. Limestone, mottled, vary grained, concretionary	2	3
16. Limestone, gray, crystalline, fine grained toward bottom	3	7
17. Limestone, lavender, lithographic, in three layers	1	8
18. Limestone, yellow, shaly	1	6
19. Limestone, lavender, lithographic	1	1
20. Limestone, gray, fine grained, soft	1	2
21. Limestone, light gray, fine grained, weathers white	2	2
22. Limestone, drab and pinkish, lithographic	1	8
Total thickness of rock	46	5

Theby, Michael (48) : — Mr. Theby has a quarry which is situated on the west of South Broadway, near the river Des Peres, in the St. Louis Limestone. The product consists mostly of "furnace rock," which is sold to iron furnaces for fluxing purposes; but a small amount is used as macadam, building stone, and dimension stone. The quarry is in a bluff, and has about one hundred yards of workable face. No machinery is used.

Location and product.

The following section in descending series was obtained here : —

Section.

	Feet	Inches.
1. Loess and residuary clay	16	
2. Limestone, much decomposed	4	
3. Limestone, drab, coarsely crystalline in two layers of equal thickness	4	8
4. Limestone, grayish, coarsely crystalline in three layers	1	10

	Feet.	Inches.	
5. Limestone, gray, drab, compact, brittle, splintery fracture suture joints, fossiliferous, in two layers	3	3	
6. Limestone, buff to bluish, in beds two to six inches thick	3		
7. Limestone, lavender, lithographic	1		
8. Limestone, lavender, grading to buff towards the bottom, harder and finer grained towards the top	2	1	
9. Limestone, buff, rather fine grained, calcite veins, in layers varying from three to eighteen inches in thickness	5		Section.
10. Limestone, mottled buff and bluish, blotches of calcite, very fossiliferous		3	
11. Limestone, mottled buff and bluish, blotches of calcite, suture joints	2	8	
12. Limestone, lavender, compact, siliceous	1	6	
Total thickness of rock	29	3	

Zeiss, Henry (49): — Two quarries belonging respectively to Mrs. James Zeiss and to Henry Zeiss, are at present worked as one quarry. They adjoin each other in the bluff of St. Louis Limestone, in the neighborhood of Mr. Theby's quarry, mentioned above. There is about two hundred and fifty yards of workable face to the quarry. It was opened in 1872. The product consists of macadam, dimension stone, "furnace rock," etc. Location. Product.

The following section, in descending series, was obtained:—

	Feet.	Inches.	
1. Loess	6		
2. Limestone, decomposing, and residuary clay	10		
3. Limestone, lavender, with mottled appearance, vary grained, calcite blotches at bottom, very fossiliterous	2	4	Section.
4. Limestone corresponding to numbers 3, 4, 5 and 6 of the Theby section as given above	12	9	
Total thickness of rock	25	1	

The beds here dip slightly in a southerly direction.

Watson Construction Company (65): — This company has a quarry which is situated in the bluffs of the Missouri river, at Vigus Station. The stone quarried is probably St. Louis Limestone. The quarry is connected with the St. Louis, Kansas City & Colorado railway. Stone is swung from the quarry by derricks directly to the freight cars. The product is mostly riprap. Location.

The following section,* in descending series, was obtained here : —

Section.

	FEET.	INCHES.
1. Soil and Loess	9–11	
2. Residuary clay	4–5	
3. Limestone, partially decomposed	4–5	
4. Limestone, drab, fine grained, hard, brittle, conchoidal fracture, in thin layers, one to three inches thick	2	6
5. Limestone, like No. 4, but coarser grained and has calcite veins		8
6. Limestone, drab, coarse grained, brittle, sub-conchoidal fracture, suture joints, specked with calcite and chert, occasional chert concretions, quarries as one bed in some places, but in others it splits into two beds	3	10
7. Limestone, like No. 6, but contains pyrite crystals		8
8. Limestone, gray, coarse grained, many calcite blotches	1	1
9. Limestone, like No. 8, but in layers three or four inches thick	2	
10. Limestone, gray, coarse grained, specked with calcite, very fossiliferous, often quarries in solid blocks, but in places splits into many beds	4	5
11. Limestone, in heavy beds, much weathered, and covered mostly with talus	10	
Total thickness of rock	27	7

* The same section is exposed at the Crystal Spring quarry.

STATISTICAL TABLES.

The figures, which are given below, of the production of stone quarries, although not complete, are as nearly so as they could be made under the circumstances which governed their collection. Many of the small producers of stone keep no books, and have scarcely any idea of what their annual output amounts to. Others who had the desired figures were unwilling to give them to one who had not the authority to demand them. In some of such cases estimates have been made by the author which are based upon the fragments of information gathered about the stone quarries. Where this was not feasible figures are omitted altogether. Figures estimated by the author are marked by an asterisk. The figures which are omitted would not, probably, affect the total result to any considerable extent.

Source of statistics.

Omissions.

The totals given are undoubtedly below those for an average year, because of the labor strikes which injured the quarry business noticeably during 1889. It is claimed by one of the largest contractors and producers in St. Louis that in 1889 the production of stone in the neighborhood of St. Louis was at least thirty per cent. below the normal amount.

Production below the average.

The production is given by different quarrymen in many different terms, but for the purpose of the writer, the figures of production obtained have been reduced to those terms which are most commonly used. These terms are perches, squares and cubic feet.

Where values were not obtainable with the amounts of production, they have been filled out by the use of the average market prices for 1889, determined from the figures which were obtained elsewhere.

In the class of rubble, riprap and spall, used for ballast and such purposes, is included the class of stone, called, "furnace rock" which is sold to the iron furnace companies to be used as a flux.

Furnace rock.

The heading "Building Stone" in the table is the term used locally for foundation material, and it is here applied with that local meaning.

Building stone.

STATISTICS OF THE STONE QUARRIES OF ST. LOUIS CITY AND COUNTY FOR THE YEAR 1889.

THIS LIST DOES NOT INCLUDE LIME PRODUCING QUARRIES.

The location of quarries may be found upon one of the maps accompanying this article by their respective coördinates, or numbers.

Position on Map.	PROPRIETOR.	No. Squares of Macadam Produced.	No. Perches of Building Stone Produced.	No. Squares of Paving Produced.	No. Perches of Spall, Riprap, Rubble Produced.	No. Cubic Ft. of Dimension Stone Produced.	Value of Total Product.
L, 17	Jno. C. Lohrum	2,000	5,000	300	600	1,500	$19,975
L, 17	Frank Albernacius	350	.....	75	.....	500	2,075
L, 17	Adam Kern	.....	.....	.....	.....	.....	.....
I, 20	Krug & Zesch	1,075	3,316	177	780	4,598	12,649
I, 20	G. Eyermann (estate)	300*	4,839	350*	.....	.....	7,258
I, 20	J. Friederichs	.....	.....	.....	.....	.....	.....
I, 20	Conrad Kempf	60	4,580	.....	.....	2,000	7,862
I, 20	Henry Baldwin	15	3,200	.....	.....	900	5,500
L, 17	Martin Lorenz	300*	4,342	.....	.....	.....	8,313
G, 6	Stiefel & Ruckert	.....	.....	.....	.....	.....	.....
G, 6	Wm. Wieman	.....	200	.....	.....	.....	300
N, 9 (2 quar's)	Bambrick-Bates	500*	25,000*	2,000*	10,000*	3,000*	55,000*
O, 10	Heman Bros	2,000*	6,000*	.....	1,000	1,000	16,000
K, 7	Kinealy & Sons	.....	.....	.....	.....	.....	.....
G, 7	Devereux & Sons	575	1,500	.....	.....	.....	3,500
F, 17, F, 12-K, 9. (F, 12—19) (K, 9—12)	J. B. O'Meara	5,574	11,993	1,156	1,000	34,200	73,806
D, 7	G. E. Prendergast	.....	.....	.....	.....	.....	.....
J, 12	Wm. H. Barnett	1,200	.....	300	1,200	15,000	21,600
J, 10	T. E. Cavanaugh	3,500	4,000	700	.....	.....	27,300
J, 9	Hogan & Moran	5,000	7,000	300	1,000	.....	32,020
I, 13,—H, 12,—C, 14 (3 quar's)	Fruin, Bambrick & Co.	8,205	19,722	1,308	1,030	.....	69,060
C, 14	H. Brocksmith	100	1,200	200	.....	.....	4,025
M, 15	Stiefel & Ruckert	4,500	100	250	.....	.....	19,400
M, 15	A. O. Englemann	1,000*	3,500	550	1,500	2,000	15,250
K, 19	"Work House"	9,030	.....	.....	7,779	.....	43,053
H, 13	Watson Const. Co	.....	.....	.....	375	.....	407
I, 13	Christian Pieper	300	1,000	.....	.....	.....	2,800
I, 13	Patrick Mohun	.....	.....	.....	.....	.....	.....
I, 13	St. Louis Stonemasons	.....	.....	.....	.....	.....	.....
I, 13	G. Eyermann (estate)	5,000	1,500	300	.....	2,000	26,800
I, 13	Conrad Pickel	400	3,000	.....	.....	.....	6,200
J, 10	Thos. Byrnes	100	300	.....	.....	.....	875
J, 7	J. E. Perkinson & Bro	4,000	.....	500	4,000	3,000	14,700
K, 6	E. W. Hogan	6,900	12,000	850	.....	.....	54,975
L, 7	—— Redemayer	.....	.....	.....	.....	.....	.....
L, 7	M. Hogan	900	.....	.....	.....	.....	3,825
K, 19	Louis Grund	300	3,273	200	100	.....	6,809
J, 19	E. Allen	20	800	.....	.....	500	1,550
J, 19	Knauss & Willis	.....	2,000	.....	.....	1,000	3,400
47	Crystal Spring Co	.....	.....	.....	3,450	10,000	8,000
48	Michael Theby	100	600	.....	200	200	1,355
49	Henry & Mrs. Zeiss	400	1,200	.....	1,200	4,500	5,310
50	—— Boem	.....	.....	.....	.....	.....	.....
51	J. H. Doering	.....	1,000*	.....	12,000	5,000	10,140
52	—— Munsen	.....	.....	.....	30,000	.....	15,000
53	P. Fabrick & Marshall	.....	.....	.....	.....	.....	.....
54	Shores Quarry Co	.....	800	850	10,000	450	14,117
55	Glendale Quarry Co	100	.....	.....	11,000	13,000	22,425
56	Jas. Lauritzen	200	700	.....	.....	.....	1,120
57	Eureka Quarry Co	100*	300*	.....	.....	.....	875
58	Thos. Madden	.....	.....	.....	.....	.....	.....
59	Andrew Pope	.....	.....	.....	.....	.....	.....
60	Henry Siefert	.....	.....	.....	.....	.....	.....
61	Jno. C. Steffen	.....	.....	.....	.....	3,000	800
62	Jno. Exner	200*	3,240	100*	.....	.....	5,212
63	Jefferson Barracks	.....	2,000*	.....	.....	.....	3,000
64	Bessen & Sons	.....	.....	.....	4,000	12,000	3,870
65	Watson Construc. Co	.....	.....	.....	8,200	.....	4,000
66	Jno. Schwenn	95	300	.....	.....	.....	850
67	Dore & Wallace	.....	.....	.....	.....	.....	.....
68	—— Andrew	.....	.....	.....	.....	.....	.....
	Totals	64,399	139,505	10,466	110,414	119,348	$661,351

* Estimated.

The figures given in the above table include only 54 of the 69 active quarries.

THE LIME INDUSTRY.

GENERAL REMARKS.

A large portion of the lime which is consumed and sold in St. Louis is produced in distant portions of the State. There are a number of "active" lime kilns in St. Louis county, but none at present within the city limits. Stone from the St. Louis, Keokuk, Burlington and Trenton formations has been burned, to some extent, but the Trenton rocks seem to have given the most satisfaction, and are now most extensively used. The Burlington formations, where accessible, furnish perhaps the best quality of limestone, but the limestone beds are so intimately mixed with layers and concretions of chert, that the sorting of the materials has proved too great an expense for the extensive use of these beds.

Formations furnishing lime.

ANALYSES OF LIMESTONE.

For the purpose of determining the value of the local materials for the manufacture of cement and lime, a large number of samples of limestone have been analyzed. Wherever a formation is now being quarried for the manufacture of lime, there, samples of stone were collected. The analyses were made with two specific objects in view. The first was a determination of the absolute value of the rock; the second was the establishment of a standard for comparison with the collections from horizons which are not worked for lime production.

Objects of analyses.

The St. Louis Limestone, within the city limits, is not at present used for lime making. Were the fact established that beds of the requisite quality for this purpose existed within these limits, these beds could be used to great advantage, first, because of their proximity to the local market, and, secondly, because great quantities of waste rock at the numerous quarries could be utilized. Hence, for the purpose of collecting a complete series of samples, a section was selected in this formation

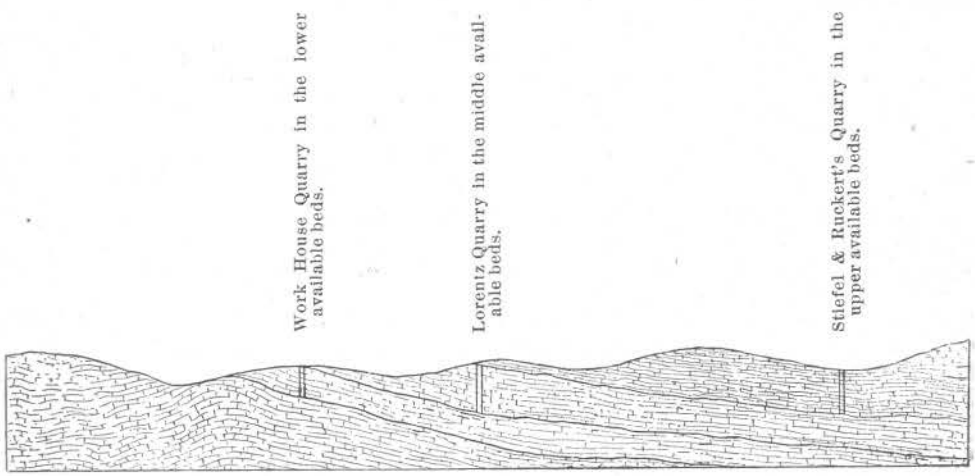
No lime kilns in city limits.

Typical section chosen.

which should represent as nearly as possible all of the different beds which could be made available. This section of the St. Louis Limestone was constructed from measurements made at three quarries along the Mississippi river. Going south each section is thought to be approximately a continuation of the preceding one. That at the Stiefel and Ruckert quarry represents the higher part of the formation, that at Martin Lorentz', the next lower, and that at the Work House quarry, the lowest available part. At the outset it was hoped that sufficient analytical work could be done to determine whether the qualities of the various beds were persistent throughout their extent; but, owing to a considerable dip of these beds a much larger section was found than had been anticipated, and, consequently, the number of analyses to be made grew so large as to make this attempt impracticable, at least, for the time being. The results of the analyses can, therefore, be applied with exactness only to those outcrops from which the samples were actually taken; they only suggest what may be expected in other portions of the beds they represent.

Results to be reached.

The following conventional cross section, running a little west of south, will illustrate the conditions of occurrence and the interpreted relations of the sections:



Diagramatic cross section in the St. Louis Limestone, indicating the relative position of the rocks in the quarries where the beds were sampled for analysis. Looking west.

The samples for the analyses given in the following tables were collected mostly from active stone quarries. They were taken so as to represent as nearly as possible an average of the beds, vertically and laterally, in the immediate vicinity of the section. In addition to such samples collections were made from different geological formations as follows:— Character of samples.

From the Keokuk Limestone at the second tunnel of the Missouri Pacific railway, the sample for analysis No. 64 was taken as an average of the exposed strata, which amount to about thirty feet in thickness. Keokuk Limestone.

From the Burlington Limestone near Valley Park, an average sample of the beds was taken for analysis No. 66, at an old quarry which was formerly worked for lime production, and near which an old kiln is still standing. The abundance of chert in the beds has caused the abandonment of work. Burlington Limestone.

From the heavy beds of the First Magnesian Limestone, near Glencoe, an average sample was taken for analysis No. 77. First Magnesian Limestone.

In the following tables of analyses reference is made under each title to the page where the section is described from which samples were collected; further the stratum number is given with each analysis number. In the descriptions of sections thus referred to, analyses numbers accompanying the respective strata, again refer back to the tables of analyses. Reference numbers.

ANALYSES OF LIMESTONES FROM ST. LOUIS CITY AND COUNTY.

In the following table of analyses the term "insoluble silicious residue" means that portion of the limestone which is insoluble in dilute Hydric Chloride (1 to 3), exclusive of organic matter. The existence of the latter was recognized in all samples, but it was burned off before weighing. These residues consist for the most part, of clear transparent quartz; but, with the higher percentages of "insoluble residue," some clay and other insoluble matter is presumably present. The term "combined oxides" is meant to include alumina and ferric oxide which were weighed together. The lime and magnesia found by analysis were calculated as carbonates and are so tabulated. The percentages are of samples dried at 100° C. Percentages marked with an asterisk (*) were determined by difference. Explanation of tables.

A. E. WOODWARD.

Samples Nos. 1 to 60 inclusive are of successive beds of the St. Louis Limestone, taken in a descending order.

STIEFEL & RUCKERT'S QUARRY, St. Louis Limestone.

(*For description of section see p. 61.*)

Analysis Number.	Stratum No.	Insoluble Siliceous Residue.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
1	3	3.39	0.99	78.98	14.12
2	4	9.00	0.83	83.53	3.91
3	5	2.24	0.35	91.33	4.20
4	6	1.20	0.16	96.02	0.72
5	7	1.53	0.25	96.34	0.86
6	8	1.40	0.25	96.65	0.76
7	9	3.57	0.31	93.73	0.86
8	10	3.41	0 27	94.00	0.76
9	12	18.70	4.24	45.00	31.51
10	13	8.56	0.95	72.05	17.29
Analyses. 11	14	1.83	0.32	89 80	5.90
12	15	2.57	0.35	96.40	0.50
13	16	0.76	0 17	97.36	0.58
14	18	12.73	3.84	56.10	26.69
15	19	3.35	0.85	71.52	20.03
16	20	5.36	0.52	87.10	7.02*
17	21	4.71	0.22	94.15	1.48
18	22	2.47	0.31	92.30	1.88
19	23	4.05*	0.30	92.55	3.10

MARTIN LORENTZ' QUARRY, St. Louis Limestone.

(*For Description of Section, see p. 54.*)

Analysis Number.	Stratum No.	Insoluble Siliceous Residue.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
20	3	6.53	0.83	83.85	8.16
21	4	8.02	1.01	79.40	10.81
22	5	9.97	1.07	70.80	10.86
23	6	3.44	0.37	92.05	3 67
24	7	4.61	0.34	93.85	0.99
25	8	6.08	0.61	78.15	15.81
26	9	11.63	3.10	52.85	29.25
27	10	2.83	0.19	94.75	0.97
28	11	6.79	0.55	90.55	1.06
29	12	8.77	1.35	56.45	31.95
30	13	7.64	0.80	84.75	5 27
Analyses. 31	15	11.02	2.50	57.80	26.33
32	16	6.29	0.95	84.95	5.98
33	17	1.97	0.35	87.60	8.66
34	18	10.40	11.75	68.30	17.22
35	19	3.20	0.40	93.20	1.44
36	20	19.96	4.80	51.60	19.22
37	21	2.32	0.26	94.35	1.70
38	22	1.64	0.25	95.70	1.10
39	23	5.77	0.43	89.95	2.23
40	24	2.84	0.25	93.60	2.23
41	25	2.72	0.35	93.75	2.38
42	26	2.77	0.40	92.40	3.22

WORK HOUSE QUARRY, St. Louis Limestone.

(For Description of Section, see p. 63.)

Analysis Number.	Stratum No.	Insoluble Siliceous Residue.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.	
		Per Cent.	Per Cent.	Per Cent.	Per Cent.	
43	2	4.05	0.37	93.21	0.79	
44	3	10.05	1.73	80.12	5.49	
45	4	9.56	1.82	61.89	24.53	
46	5	6.51	0.78	80.49	10.45	
47	6	9.17	0.78	74.79	11.10	
48	7	2.17	0.35	89.94	1.61	
49	8	3.88	0.67	73.49	19.93	
50	9	2.86	0.35	89.26	4.73	
51	10	1.85	0.28	94.84	1.38	
52	11	3.19	0.55	85.62	9.20	Analyses.
53	12	1.10	0.30	96.15	0.59	
54	13	2.26	0.42	94.97	0.94	
55	14	5.76	0.52	92.21	0.73	
56	15	9.22	0.65	82.05	7.37	
57	16	6.66	0.66	88.87	3.12	
58	18	1.48	0.35	94.03	2.33	
59	20	2.40	0.53	78.97	13.36	
60	21	1.07	0.31	93.25	4.30	

CHAS. W. GOETZ' QUARRY, St. Louis Limestone.

(For Description of Section at Barthold Valley, see p. 82.)

61	2	2.00	0.61	*96.81	0.58
62	3	0.70	0.27	*98.41	0.62
63	4	1.24	0.37	*97.71	0.68

RAILWAY CUT, 2D TUNNEL, Keokuk Limestone.

64		4.35	1.75	77.95	14.84

CRYSTAL SPRING QUARRY, VIGUS STATION, St. Louis Limestone.

(For Description of Section, see p. 70.)

65		2.00	0.40	95.15	0.64

RAILWAY CUT, VALLEY PARK, Burlington Limestone.

(See p. 75.)

66		1.10	0.40	94.00	3.18

HERBERT DORENHEIM'S QUARRY, ST. PAUL, Trenton Limestone.

(*See p. 80.*)

Analysis Number.	Stratum No.	Insoluble Siliceous Residue.	Combined Oxides.	Calcium Carbonate.	Magnesium Carbonate.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
67		0.35	0.35	97.75	0.45

THORN AND HUNKINS' QUARRY, MINCK STATION, Trenton Limestone.

(*See p. 83.*)

68		12.15	0.45	86.00	0.46

GLENCOE COMPANY'S SOUTH QUARRY, GLENCOE, Trenton Limestone.

(*For Description of Section, see p. 81.*)

69		2.25	0.30	89.40	6.96

GLENCOE COMPANY'S MIDDLE QUARRY, GLENCOE, Trenton Limestone.

(*See p. 81.*)

70		0.45	0.65	97.20	0.46

GLENCOE COMPANY'S NORTH QUARRY, GLENCOE, Trenton Limestone.

(*For Description of Section, see p. 82.*)

71	2	6.00	1.05	82.55	9.27
72	3	1.00	0.55	96.40	0.42
73	4	0.46	0.40	*98 60	0.34
74	5	0.70	0.25	97.40	0.42
75	6	0.35	0.30	97.75	0.27
76	7	0.55	0.60	96.75	0.27

RAILWAY CUT, GLENCOE, First Magnesian Limestone.

77		12 35	1.10	48.75	37 09

Discussion of analyses.

While not attempting here an exhaustive discussion of the results contained in the preceding tables, a brief reference will be in place to some of the more salient features developed. An analysis of the contents of these tables results in the following classification:—

Total number of analyses 77
Number of samples of stone not at present used for lime production 65
Number of samples from St. Louis city 60
" " " " county 17
Number of samples from the St. Louis Limestone 64
(*Three of these are from beds at present used.*)

Number of samples from the Keokuk Limestone..... 1
(An average of all the beds exposed.)
Number of samples from the Burlington Limestone 1
(An average of the beds formerly used.)
Number of samples from the Trenton Limestone..... 10
(Nine of these are of beds now used.)
Number of samples from the First Magnesian Limestone..... 1
(An average of beds aggregating about 30 ft. in thickness.)

The limestones used commercially for the manufacture of lime rarely contain less than eighty-nine per cent. of calcium carbonate. Applying this fact here, we are able to separate those limestones which are probably of value for this purpose, from those which are not, at least so far as the lime contents is concerned. Of the analyses of the twelve beds or series of beds which lime producers are now using there is but one the results of which show the amount of impurity to exceed ten per cent., and in that case the excess is only a fraction of one per cent. To be compared favorably with these twelve, there are of the remaining sixty-five limestone samples, thirty-four in which the amount of calcium carbonate is above eighty-nine per cent. The beds represented by these thirty-four are those of Valley Park and Vigus Station, twelve at the Stiefel & Ruckert quarry, eleven at Martin Lorentz' quarry, and nine at the Work House quarry.

Limestone with 89 per cent. of lime.

The beds at Valley Park seem to be rendered useless by the immense amount of chert which they contain. At Vigus Station the six successive beds (which are quarried for building stone) were sampled at the Crystal Spring quarry. They have a total thickness of a little over fifteen feet, and would be available for the manufacture of lime. At the Stiefel & Ruckert quarry the twelve beds, Nos. 5 to 10, 14 to 16 and 21 to 23, have a total thickness of 36½ ft., and they occur in one group of six beds, and two groups of three beds each. The total thickness of the group of six beds is 16½ ft. At Martin Lorentz' quarry the eleven beds, Nos. 6, 7, 10, 11, 19 and 21 to 26, have a total thickness of 26½ ft., and six of these having a total thickness of 15¼ ft. are successive beds. At the Work House quarry the nine beds, Nos. 2, 7, 9, 10, 12, 13, 14, 18, 21 are somewhat separated, but six of them have a total thickness of 25¼ ft., and are separated

Distribution of lime beds.

by only two beds, of inferior quality, which have a total thickness of $4\frac{1}{6}$ feet. The total thickness of the nine beds is 39 feet.

Final results postponed.

The final settlement of the question of the adaptabilities of these limestones is, however, left for future investigation and experiment. Some of the limestones are remarkably pure and are worthy of being experimented with, in connection with some of the neighboring clays, for the production of hydraulic cement.

A DESCRIPTIVE LIST OF LIME WORKS.

The following descriptions include only the works of producers which are situated within the county or city of St. Louis; some of the firms mentioned have extensive works in other parts of the State.

Dorenheim, Herbert (76): — Mr. Dorenheim began producing lime with one kiln, at St. Paul, in May, 1890. Since that time he has produced about six thousand bushels per month.

Product.

The stone, which burns to a black lime, is taken from the quarry of the old firm of Goetz & Cobb, which now has here (owing to some litigation) three idle kilns.

Formation.

The formation quarried is Trenton Limestone, and the sample for analysis number 67, was taken as an average of the beds used for lime making.

Glencoe Lime and Cement Company (70 to 72): — This company has two sets of works at present operating, which are located respectively about two and four miles north-west of Glencoe. Both are connected with the main line of the Missouri Pacific railway by a branch track.

Location.

Two kinds of lime, known as white and black lime, are produced. The former is a finishing lime and commands a high price, but has a comparatively small sale. The latter is used for many purposes, and constitutes the bulk of the product, selling at a much lower price than the white lime. The two varieties differ very much in character; the black lime being said to slack slowly and coolly, and to set rapidly, while the white lime acts in an opposite way.

Character of product.

Trenton stone.

All of the limestone used at both places comes from the Trenton formation. At the works nearest Glencoe there are two

quarries and two kilns.* One of the quarries, which we term the southern one, furnishes a stone which burns to a white lime. Product.

Following is a section at this quarry in descending series. Analysis No. 69 is of an average sample of all the beds:—

	Feet.	Inches.	
1. Slope of stripping			
2. Limestone, gray to lavender, fossiliferous, vary-grained, vermiform cavities, very cherty	5		
3. Like No. 2, but more cavities	3	9	
4. Limestone, brown, very cherty, coarse grained, fossiliferous, vermiform cavities	3		
5. Limestone, brown to gray, granular		2–4	
6. Limestone, thin beds, gray to lavender, fossiliferous, coarse grained vermiform cavities	3		
7. Like No. 6, but finer grained		4	
8. Like No. 6, but vary-grained	4	4	Section.
9. Limestone, brown, granular, fossiliferous		2	
10. Slaty shale, fossiliferous		½–½	
11. Limestone, lavender, vary grained, fine to very coarse		8	
12. Shale		½	
13. Limestone, gray and brown, vermiform structure in grain, very fossiliferous	2	1	
14. Same as No. 13, but less fossiliferous	3		
Total thickness of rock	25	8	

About an eighth of a mile north of this quarry a new quarry has been recently opened, from which a stone is taken which burns to a black lime. The opening is not yet sufficiently developed to expose a good section. The rock is very fossiliferous, semi-crystalline, and colored light and dark gray. An average sample of this rock was used for analysis No. 70. Product.

At the works, about four miles north-east of Glencoe, are the two "north" quarries and three kilns. The quarries are higher stratigraphically and topographically than those described above. The stone taken from them burns to a black lime.

The following section, in descending series, was made at these quarries. Numbers 4, 5 and 6 are but imperfectly separated.

* Some of the beds here will furnish a good dimension stone, while some that would appear to do so are worthless for that purpose because of their tendency to weather into a honey-comb condition, as previously described.

Section.

	Feet.	Inches.
1. Slope of stripping		
2. Limestone (analysis No. 71), decomposing and clayey	3	
3. Limestone (analysis No. 72), gray turning to almost black towards top, irregular chert layer, sub-crystalline, fine grained, hard, fossiliferous	1	2
4. Limestone (analysis No. 73), bluish, mostly fine grained but coarse in patches, sub-crystalline, calcite blotches, hard, suture joints, splintery fracture	1	1
5. Limestone (analysis No. 74), gray, soft at base but harder toward top, fine grained	7	4
6. Limestone (analysis No. 75), light gray, highly fossiliferous, semi-crystalline, coarse grained, irregular fracture, suture joints, cherty in places	6	9
7. Limestone (analysis No. 76), dark gray, ferruginous bands, extremely fossiliferous, soft, granular, coarse grained	7	
Total thickness of rock	26	4

Mode of quarrying

In each of these quarries the rock is dislodged from the face of the quarry, and more or less shattered by powder blasts. It is then broken into quite small pieces by the use of hammers, and hauled in carts up an inclined plane, whence it is dumped into the kilns to be burned. After the burning it is shoveled directly into freight cars.

Product.

Goetz, Charles W. (73 and 75): — Mr. Goetz has lime works at Bartholds valley, and at a point on the county line near Port Royal. At the former place there are two kilns and three quarries, only one of which is, however, at present worked. A high grade of white finishing lime is produced. The section here, presumably in St. Louis Limestone, is as follows, in descending series: —

Section.

	Feet.	Inches.
1. Stripping	10	
2. Limestone (analysis No. 61), dark gray, fine grained, hard	4	8
3. Limestone (analysis No. 62), light gray, fine grained, soft, fossiliferous	3	
4. Limestone (analysis No. 63). Like No. 3 but harder	5	
Total thickness of rock	12	8

The works at Port Royal have been only recently started. Stone from the Trenton horizon is to be used, and two kilns are in the process of construction.

Thorn and Hunkins (74): —This firm has its works located at Minck, on the "Frisco" railroad, just across the Meramec river from St. Paul. One kiln is use, and stone is procured from two quarries, in the Trenton Limestone, which are situated at different elevations in an old bluff of the river. The formation is characteristically Trenton. The sample for analysis No. 68 was taken as an average of the beds here quarried which represent a total thickness of about thirty feet. Location.

STATISTICAL TABLES.

The facts given in the following table are the results of personal inquiry of the proprietors of the works. The production of lime in the vicinity of St. Louis has much increased since 1889, and the totals given below will probably fall far short of the figures for the present year.

STATISTICAL TABLE OF THE LIME PRODUCING WORKS IN ST. LOUIS COUNTY WITH STATISTICS FOR THE YEAR 1889.

The location of the works may be found on the County Map, accompanying this article, by their respective numbers.

Map Number.	Proprietor.	Location.	No. of Kilns.	No. of Quarries.	Production in Bushels.	Value of Product at Kiln.
70	Glencoe Lime and Cement Co	About 2½ miles N. of Glencoe.....	3	2	400,000	$60,000
71	Glencoe Lime and Cement Co	About 4 miles N. of Glencoe	2	3		
72	Glencoe Lime and Cement Co .... (In Litigation.)	St. Paul.....	3	1	*Not operating in 1889.*	
73	Chas. W. Goetz...	Barthold's Valley.	2	3	75,000	30,000
74	Thorne & Hawkins	Minck.....	1	2	87,000	13,000
75	Chas. W. Goetz...	On county line at Port Royal.....	2	1	*Not operating in 1889.*	
76	* Herbert Dorenheim	St. Paul.....	1	1	*Not operating in 1889.*	
		Totals.....	14	13	562,000	$103,000

* Produces now about 6,000 bushels per month.

THE SAND AND GRAVEL INDUSTRY.

GENERAL REMARKS.

Source of sand and gravel.

The great mass of sand and gravel which is consumed in St. Louis comes from the Meramec river. A smaller amount is taken from the Mississippi river, and, comparatively, a very little from gravel deposits in the northern part of the city, which seem to belong, geologically, to the assorted drift of the glacial period. Red and gray gravel are shipped to St. Louis from Robertsville and other points in Franklin county.

The sand from the Meramec river is superior in quality to that from the Mississippi, which contains black, probably carbonaceous particles, which are said to "pop" in pointing. It is rather coarse and the grains are somewhat rounded.

A DESCRIPTIVE LIST OF SAND AND GRAVEL WORKS.

St. Louis Dredging Co.: — This company was organized in 1883, with a capital stock of $50,000. It furnishes all the sand and gravel to the following companies, viz.: Griffith & Adams Sand and Gravel Transit Co., The New Missouri Sand Co., New St. Louis Sand Co., and the Eagle Sand Co.

In 1889 it sold 117,048 loads of sand and gravel, at an average price of 60 cents per load at the boat. A few barges full have been taken to the Illinois side.

The Eagle Sand Co.: — Previous to March this company did its own dredging. In 1889 it sold about 6,000 loads.

The Griffith & Adams Co.: — This company was organized in 1874, with a capital stock of $12,000. Its sand is obtained from the area in the Mississippi river between the Eads and Merchants bridges.

THE MINERAL WATERS

OF

Henry, St. Clair, Johnson and Benton Counties.

BY

A. E. WOODWARD, ASSISTANT GEOLOGIST.

CONTENTS.

PREFATORY REMARKS.

This report upon the mineral waters of Henry and adjoining counties is the result of field work done during last April and May The report was ready for publication during the early summer, but has been withheld pending the preparation of the accompanying report on the St. Louis clay and stone industry. Since this time the work has been extended into many counties and the final report on the mineral waters of the State can probably be issued next year.

ARTHUR WINSLOW,
State geologist.

INTRODUCTION.

Scope of article.

The following article includes a description of the important springs and wells of Henry, St. Clair, Johnson and Benton counties, together with the results of analyses of their waters, made in the laboratory at Jefferson City. These waters may be grouped as follows:—

Characteristics.

1. *Alkaline and Alkaline Chalybeated Springs:* These are non-thermal springs containing small quantities of the carbonates of the alkalies and of the alkali earths in solution. Many of this class of waters contain, besides, noticeable quantities of iron carbonate, and where this is the case the water is known as chalybeate or iron water.

Distribution.

Representatives of the alkaline and alkaline chalybeate springs are found at "Windsor Spring" and Sand Creek Spring in Henry county, and at Pertle, Reed and Electric Springs in Johnson county.

Iron contents.

The principal ingredient of the alkaline waters here considered is calcium carbonate (or bicarbonate); with this occur carbonates of magnesia and of the alkalies together with some alkaline sulphates. As previously mentioned iron is present in many of these waters, from which it is deposited as the brownish red hydrate along the courses of the stream, or in any vessel in which the water is exposed to the air. Hence any beneficial effects which may result from the iron contents of these waters will be diminished by exposure of the water to the air, and the effects will be greatest when the waters are taken fresh from the springs.

2. *Alkaline Saline Springs:* These are represented by the artesian wells at Clinton, Henry county; Monegaw springs at Monegaw, St. Clair county; and Boling spring in Benton county. With these may also be classed the small undeveloped and unused spring north of Warrensburg in Johnson county, known as the "Sulphur spring," and also the well at Montrose, Henry county. With the exception of the latter, these alkaline-saline waters are characterized by the presence of chlorides of the alkalies together with the carbonates and sulphates of lime and magnesia. The Montrose water contains sulphates instead of chlorides and carbonates. All of the alkaline-saline waters excepting the Montrose water contain hydrogen sulphide gas and are termed "sulphur waters." Distribution. Characteristics.

The origin of these two classes of waters cannot be definitely stated at present; but the differences already determined to exist between them offer suggestions in this direction. Origin suggested.

First, by reference to the following table it will be seen that the temperatures of the waters of the same class do not vary much and further that the alkaline waters are invariably colder than the alkaline-saline waters. This indicates, at least, similarity in conditions of origin of the waters of the same class, and difference in conditions of origin between waters of the different classes. Differences in temperature.

	Alkaline-Saline, Muriated.					Alk.-Saline, Sulphated.	Alkaline.				
Temperature in Degrees, Fahrenheit.	Boling Spring, Benton Co.	Monegaw Spring, St. Clair Co.	Sulphur Spring, N. of Warrensburg, Johnson Co.	Clinton Artesian Well, Henry Co.	Water Works Well, Henry Co.	Ford Well, Montrose, Henry Co.	Sand Cr'k. Spring, Henry Co.	Windsor Spring, Henry Co.	Reed's Spring, Johnson Co.	Electric Spring, Warrensburg, Johnson Co.	Perlle Spring, Warrensburg, Johnson Co.
Temp. air....	57°	59°	59°	68°	68°	48°	65°	74°	54°	70°	72°
" water.	58°	61°	56°	58°	56°	49°	49°	47°	52°	51°	52°
Av. of water.	57.8°					49°	50.2°				
	Accompanied by Sulphuretted Hydrogen and free Carbonic Acid.					Not accompanied by Sulphuretted Hydrogen. With free Carbonic Acid.					

Differences in composition.

Second, the distinguishing constituents of the alkaline waters are carbonates of lime and of iron; those of the alkaline-saline waters are hydrogen sulphide gas and chloride of sodium. Now, all natural waters which flow from the ground, either from springs or from wells, have passed through various rocks. The waters may pass through these rocks either by a slow process of percolation or may flow through them along joints, cracks or fissures, or the two processes may be combined. The waters may seep through rocks which lie near the surface and flow out at the face of the rock within a short distance, or they may sink to great depths and reach the surface only through a long natural or artificial opening. All waters of surface springs and most waters from deep sources were originally derived from the rain-fall. As the rain water soaks through the rocks it dissolves out various constituents in amounts proportional to their solubilities and to the length of time the water is able to act on them. Rocks near the surface suffer most from this solvent action of rain water and any very soluble constituent will be removed in a comparatively short time. The flow of water at great depths is, on the contrary, more sluggish and the soluble materials endure longer. The alkaline waters here referred to contain in solution, such materials as could be supplied from the rocks which we find at the surface, and are further, frequently seen to issue directly from these rocks. The alkaline-saline waters, on the contrary, are seldom seen to issue directly from surface rocks, and they further contain an extremely soluble substance, chloride of sodium (common salt), which we do not recognize in the surface rocks, and which, by the above reasoning, would not probably exist there at this date. Hence we have reason to assign to the alkaline waters a shallow source, and to the alkaline-saline springs a deep source.

Subterranean flow of water.

Alkaline waters, shallow source. Alkaline-saline a deep source.

Explanation of Analyses.

The analyses of the waters have been expressed in terms of the compounds probably present. In the analyses of the alkaline-saline water, the carbonate of lime given in the table is the amount of lime actually precipitated on boiling away the free carbonic acid. In other cases the usual method of combining the acids and bases actually found, has been employed. Thus

in the alkaline waters chlorine is combined with the bases in the order potash and soda; sulphuric anhydride with the bases in the order potash, soda, magnesia, lime; the remainder of the bases have been combined with carbonic anhydride as neutral carbonates. The amount of carbonic anhydride required for this, subtracted from the amount actually found by analysis, yielded an amount assumed to be either free or combined with the carbonates of lime, magnesia, and iron to form bicarbonates. In this way results are obtained which are readily comparable with each other and with other analyses; but the extent to which they express the actual combinations is subject to the inaccuracies inherent in the method.

Explanation of analyses.

In the present condition of knowledge of the therapeutic value of the mineral constituents of waters, no definite conclusion can be offered from a consideration of these analyses. It is commonly supposed that the presence of bromides and iodides, and of lithia gives a mineral water valuable medicinal properties. Be this as it may it is certain that if these exist in the waters examined, they do so in such small quantities as to make them at least unimportant constituents.

Therapeutic value.

The "totals" given in the table of analyses were obtained by adding the amounts of the individual constituents found in analysis. This quantity was checked in every case by comparison with the weight of the residue from a measured quantity of the water, and the two were found to agree very closely in every case.

THE MINERAL WATERS OF HENRY COUNTY.

THE WELLS AT CLINTON.

The Clinton Artesian Well. — During the summer of 1887, an eight inch well was drilled south of Clinton (in N. W. $\frac{1}{4}$ of S. W. $\frac{1}{4}$ section 10, township 41 north range 26 west.) At the depth of 310 feet, the rate of flow of water from the well is reported to have been 75 gallons per minute, which increased to 200 gallons per minute at 425 feet: this water was termed "sulphur water." At the latter depth the diameter of the drill

History of well.

bit was decreased to $5\frac{5}{8}$ inches, and the drilling continued to 800 feet. The flow down to 425 feet was then separated from that at greater depths by a casing so that two distinct flows were obtained; one, from around the casing, of sulphur water, at 425 feet, at the rate of 200 gallons per minute; the other, through the casing, of fresh water, from 425 to 800 feet, at the same rate of 200 gallons per minute, thus making the combined flow about 400 gallons per minute. The casing is now removed and the waters mix in the well. The well is tubed above the surface of the ground to a height of, perhaps, ten feet. Through this the water rises and flows over into a sheet iron basin, escaping from this into the artificial pond by means of a trough, as is illustrated in the cut on the opposite page. The flow of the water through this trough was measured and found to be about 370 gallons per minute. Part of the water is, however, conveyed directly from the stand-pipe to the bath houses and, considering this, the present flow of the well may fairly be given as 400 gallons per minute. The well is reached by a line of horse cars from Clinton.

Volume of flow.

Improvements.

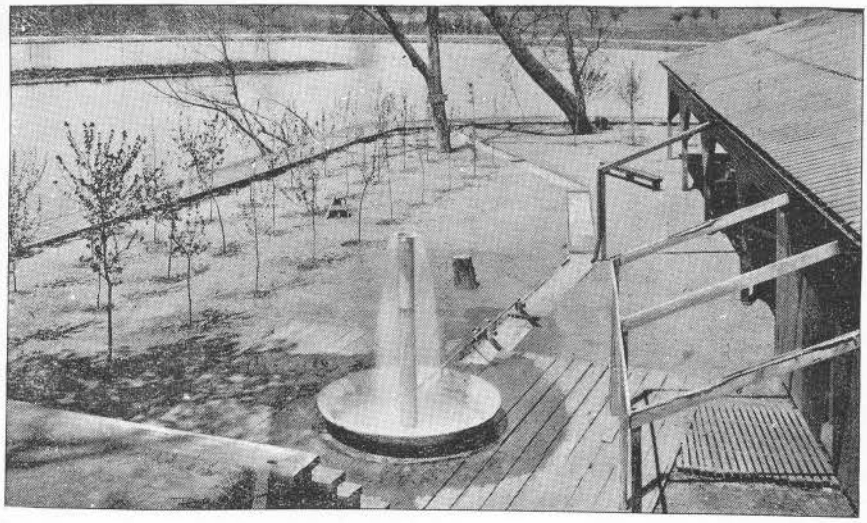
An artificial lake receives the overflow from the well where boating and bathing are engaged in. Other improvements, in the way of bath houses and pavilions, have been made, and a large hotel is in process of erection. The water is used extensively both for drinking and bathing, and for the latter purpose is furnished to the bath rooms either hot or cold.

The sample for analysis was obtained by plunging the gallon bottle into the mouth of the stand pipe and allowing it to fill with the water. It was then immediately stoppered and sealed with melted paraffine. The analysis given in the table shows the water to be distinctly a saline water with a small percentage of carbonates present. It is interesting to compare this analysis with the following made from the water of the well which supplies Clinton with water, situated about 500 feet south of the one just described.

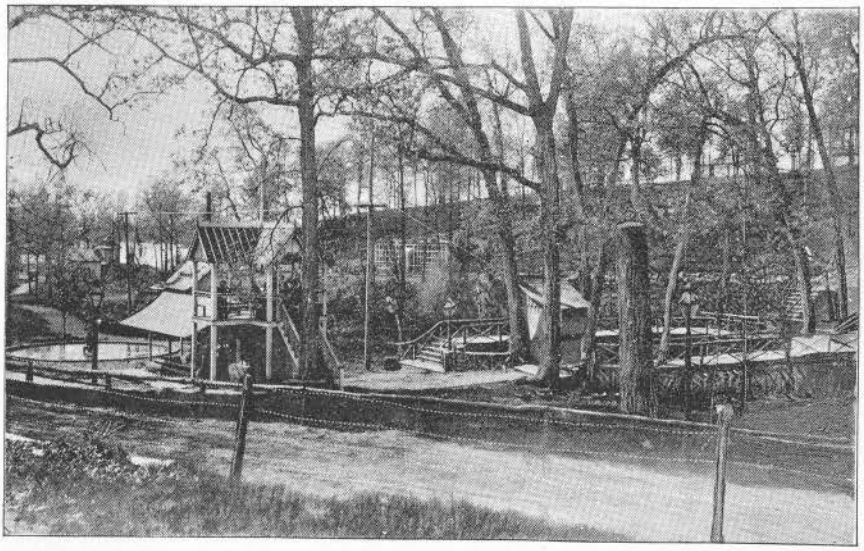
Mode of sampling.

The Water Works Well — This well was drilled to a depth of 800 feet with a five inch drill. The present flow, owing to leakage and to the form of the overflow pipe, could not be ascertained, but is certainly less than that of the "Artesian" well.

Volume of flow.



THE CLINTON ARTESIAN WELL.



PERTLE SPRING, NEAR WARRENSBURG.

The water supply of Clinton is derived entirely from this well, the overflow from the well being collected in a reservoir. The sample for analysis was taken, as before, by plunging the bottle into the stand pipe, and the bottle was sealed immediately with paraffine. Since the two wells are but a short distance apart and were both drilled to the same depth, a correspondence between the analyses of these waters is to be expected. A very considerable difference is found to exist, however. Thus, though both are characterized by a large percentage of sodium chloride the water of this well differs from the Artesian well water by containing larger amounts of carbonates and sulphates. These differences are produced, probably, by the mixing in the water works well of a greater quantity of surface waters with the chloride water, thereby decreasing the amount of total solids and increasing at the same time the amount of alkaline constituents. The following table will show exactly the relation between the two wells: —

Clinton water supply.

Comparison of two wells.

PERCENTAGE COMPARISON OF THE CLINTON ARTESIAN AND THE WATER WORKS WELL.

	Clinton "Artesian."	"Water Works Well."
Total Solids	1.6271 pts. per 1000	.9628 pts. per 1000
Free Hydrogen Sulphide	.0041 " " "	.0011 " " "
Free Carbonic Acid and combined as bicarbonate.	.1748 " " "	.1468 " " "
Potassium Chloride	1.94 % of solids.	8.40 % of solids.
Sodium Chloride	65.47 % " "	50.90 " " "
Calcium Chloride	.08 " " "	.....
Magnesium Chloride	4.64 " " "	.....
Calcium Sulphate	9.59 " " "	7.17 % " "
Magnesium Sulphate	.....	2.52 % " "
Sodium Sulphate	...	3.59 % " "
Magnesium Carbonate	6.78 " " "	11.41 % " "
Calcium Carbonate	10.78 " " "	15.58 % " "
Chlorides present	72.13 " " "	59.30 % " "
Sulphates present	9.59 " " "	13.28 " " "
Carbonates present	17.56 " " "	26.99 " " "

Results of analyses of other well or spring waters directly comparable to these Clinton waters are not easy to find. The

Fort Scott, Kansas Artesian well water yielded 109.13 grains per gallon. The Clinton Artesian, 95.16. The composition of the two may be compared in the general table.

Other Henry Co. Springs.

Other springs of note in Henry county are few in number and are for the most part alkaline in character, and are distinguished by the presence of iron carbonate. The list includes the following: —

Location.

1. *The Jordan Artesian Well*, three miles south-east of Clinton, in the south-west quarter of section 19, township 41 north, range 25 west. This is a well of slightly chalybeate water, with a very weak flow. The water flows from the Carboniferous shales and sandstones of the region, and is probably related in composition to the other alkaline springs of the county. Thewater was formerly much used but is now entirely neglected, and the well is rapidly filling up.

2. A weak "iron" spring, reported to be in or near section 2, township 40 north, range 25 west, on Pretty Bob creek. This spring was not visited.

Location.

3. *The Sand Creek Spring* is situated in the south-west quarter of the north-west quarter of section 28, township 43 north, range 25 west, on a branch of Sand creek, four miles north of Lewis station. It is found in a picturesque valley with sandstone bluffs on either side. There are here two springs emerging from the sandstone, but the one sampled is more important on account of its greater flow (perhaps between 50 and 100 gallons per hour). The iron contained in the water is rapidly oxidized, and is found in the spring and along its course as a brown sediment. It often forms on the surface of the spring as an iridescent scum, which has frequently been mistaken for oil. The flow is reported to be constant and the water is said never to freeze, even in the coldest weather.

Iron in water.

Location.

4. *The Windsor Medical Spring*. This well is found in a grove one mile south of the town of Windsor, in the south-east quarter of the north-east quarter of section 14, township 43 north, range 24 west; it is excavated from a bed of sandstone. The amount of flow could not be determined but the well furnishes water to a very large number of people during the summer months. A hotel of forty-two rooms has been built here, on

elevated ground near the well. Other and more extensive improvements were contemplated but have not, as yet, been begun.

As a mineral water it is remarkable rather for the small amount of solids in solution than for its high mineralization. Among the constituents of the water the alkaline carbonates seem to predominate in place of the carbonates of lime and magnesia. Character of water.

5. *The Ford Spring at Montrose.* This well (probably supplied by a spring) is situated in the town of Montrose at the corner of Seventh street and Missouri avenue. The well is about twenty-five feet deep and the water is obtained by pumping. It has been improved to some extent and is used a great deal by people living in the vicinity. The water is remarkable as containing a large amount of the sulphates of the alkalies and alkali earths in solution, which are probably derived from the oxidizing pyrites in the shales below. Location. Character of water.

These five springs with the two wells at Clinton represent the mineral waters of Henry county; but it is probable that nearly all of the true springs in the county contain small amounts of lime and magnesia salts in solution and also iron where the conditions are favorable. The artesian wells at Clinton, without doubt, furnish the most important and desirable mineral water to be found in the county, and in volume of water far surpasses every thing else.

THE MINERAL WATERS OF ST. CLAIR COUNTY.

St. Clair county, which lies directly south of Henry county, has the following springs which have now or have had in the past a local reputation:—

1. *The Salt Creek Sulphur Springs.* This is an unimportant spring on Salt creek in the south-west quarter of the north-west quarter of section 27, township 38 north, range 26 west. It is reported to be a weak sulphur water and is probably of similar composition to the water of Monegaw spring (No. 7). Sulphur water.

2. An unimportant sulphur spring in section 6, Township 37 north, range 27 west, on the south side of the Osage river.

3. *The Iuka Spring*, near Johnson post-office, in the south west quarter of the south-west quarter of section 32, town-

ship 39 north, range 27 west. This is said to be a "fresh water" spring slightly chalybeate. It is now neglected, but considerable money has been spent on the spring and its surroundings.

4. *The Taberville Spring.* This is a large fresh water spring at Taberville in lower half of north-west quarter section 3, township 37 north, range 28 west. This is much resorted to during the summer.

5. *The Guller Spring.* This is reported to be a fresh water spring in section 34, township 36 north, range 25 west.

Location. 6. On the west side of Little Monegaw Creek, in the north-east quarter of the north-east quarter of section 14, township 38 north, range 27 west, is an alkaline spring containing iron. The water flows from the limestone bluff. The yellow hydrate of iron is deposited around this spring and for years past this has given it a reputation as an "iron water" and has caused the spring to become a resort for such by visitors from Monegaw Springs. The water flows at the rate of about one hundred gallons per hour. The poor condition of the roads made the spring difficult of approach and improvement in this respect would much increase its value to the frequenters of Monegaw Springs.

ron water.

Location. 7. *The Monegaw Springs.* These springs are situatedon the north side of Little Monegaw creek in the south-east corner of the south-west quarter of the north-west quarter of section 30, township 38 north, range 26 west, perhaps three quarters of a mile from the Osage river. On the north side of the creek the bluff rises abruptly to a height of 150 feet above the level of the creek and from the summit of this bluff there is a magnificent view across the Osage valley. There are here about nine springs in all, situated in the very bed of Monegaw creek, so that at times of high water they are all flooded. The difficulty in obtaining water caused by this could, however, be easily obviated by forcing the spring water to flow up through an iron pipe, as has been successfully done with one spring in the vicinity. The most important spring, and the largest, is termed "Old Black." At the time of the writer's visit to Monegaw all of the springs were flooded, but a sample was obtained by carefully forcing a corked empty jug down into the spring water and then, by pulling the

Natural advantages.

Mode of sampling.

cork out, the jug was filled while totally immersed. The analysis given in the table was made of a sample from Old Black spring taken in this manner. The locality has many natural advantages for a summer resort, and it has been favorably known for a long time. The analysis indicates it to be an alkaline-saline water. Other analyses given in the table offer the means of comparing the water with others of more or less note. The small amount of free carbonic acid is due to the manner of taking the sample. Character of water.

Monegaw Springs is evidently destined to be the prominent mineral water resort of St. Clair county, and it is certainly admirably situated for such. It is reached either from Osceola or from Clinton in Henry county.

THE MINERAL WATERS OF BENTON COUNTY.

Boling Spring. This is situated in the west central part of Benton county on the north side of the Osage river. It is in a remote part of the county in a rugged country, and the roads leading to it are in poor condition. Nevertheless it is made a resort by parties during the summer and has a local reputation. Its exact location is very near where Benton, Henry and St. Clair counties meet or about section 30, township 40 north, range 23 west. The flow of water is strong, about 5000 gallons per hour. The composition is given in the table of analyses. It contains a small amount of free hydrogen sulphide at the spring but not enough to show in analysis. It is an alkaline-saline water. Location. Volume of flow. Character of water.

The remaining springs of Benton county will be noticed in another report.

THE MINERAL WATERS OF JOHNSON COUNTY.

The most important springs of Johnson county are the alkaline springs containing iron carbonate. Sulphur springs exist and one which was visited and sampled is found on the Post Oak Creek branch of the Black Water river in or near section 11, township Character of springs.

46 north, range 26 west, but most of the springs of this character are unimportant. A spring, the existence of which has been known for a long time in this county, is found about eight miles south of Warrensburg in the north-east quarter section 29, township 45 north, range 26 west, on land of D. W. Reed. It is a weak alkaline spring, flowing at a rate of perhaps 200 gallons per hour, the water of which deposits the yellow ferric hydrate. It is used to a small extent, locally. An analysis of the water is given in the table.

Location.

The Sulphur Spring north of Warrensburg is situated in the alluvial plane of Post Oak creek. The rate of flow is about 150 gallons per hour. It is very weak in mineral matter and weak in hydrogen sulphide. It receives very little attention but is interesting as belonging to an entirely different class of waters from that of the other springs of the vicinity. The excess of sodium chloride above the other substances present, together with the temperature of the water and the presence of hydrogen sulphide, at once indicate a different origin from that of the alkaline springs of the county.

Character of water.

Location.

The Colburn or Electric Spring. This spring is situated in the northern part of the town of Warrensburg, in a small valley cut into the sandstone of the region. The spring and surrounding grounds are owned by the Electric Spring company. The spring itself has been improved and a hotel has been built on a neighboring hill. It is frequented as a health resort. The water of the spring flows at a rate of 104 gallons per hour and is alkaline, deriving its carbonate of lime from the beds immediately underlying the Warrensburg sandstone. It carries, for this class of springs, an exceptional amount of mineral matter in solution.

Character of water.

The Pertle Spring. This spring is situated about one mile south of Warrensburg and is at present a very popular resort. The grounds about the spring have been improved by the construction of a spring house, hotel, summer houses and an artificial lake. The cut opposite p. 90 gives a view of some of the surroundings. The water emerges from sandstone, but this is in close association with coal and limestone beds and thus one is led to expect the predominance of carbonates and sulphates proved

Improvements.

by the analysis, which shows it to be an alkaline water with quite a large proportion of iron carbonate. It is reached from Warrensburg by a dummy line. Character of water.

A spring at Grand Pass, which supplies that town with water, was visited during March and sampled for analysis. It is an alkaline (carbonate) water containing a small amount of iron in solution. The water from another similar spring a few yards away is used in the locomotives of the Missouri Pacific railway.

TABLE OF ANALYSES OF HENRY COUNTY MINERAL WATERS.*

	"Artesian Well" Clinton.		"Water Works Well," Clinton.		Sand Creek Spring.		Windsor Spring.		Montrose Well.	
	Pts. in 1000	Grs. per Gal.	Pts. in 1000.	Grs. pr Gal.	Pts. in 1000.	Grs. pr Gal.	Pts. in 1000.	Grs. pr Gal.	Pts. in 1000.	Grs. pr Gal.
Potassium Chloride	.0317	1.85	.0809	4.75	.0102	.60	.0021	.12	.0027	.16
Sodium Chloride	1.0653	62.32	.4901	28.67	.....	.....	.....	.....	.....	.....
Calcium Chloride	.0014	.08	.....	.....	.....	.....	.....	.....	.....	.....
Magnesium Chloride	.0752	4.40	.....	.....	.....	.....	.....	.....	.....	.....
Potassium Sulphate	.....	.....	.....	.....	.0433	2.53	.0138	.81	.0317	1.85
Sodium Sulphate	.....	.....	.0346	2.02	.....	.....	.0018	.11	.3340	19.54
Calcium Sulphate	.1561	9.12	.0690	4.03	.....	.....	.....	.....	1.1404	66.71
Magnesium Sulphate	.....	.....	.0243	1.42	.....	.....	.....	.....	.3490	20.42
Potassium Carbonate	.....	.....	.....	.....	.0311	1.82	.....	.....	.....	.....
Sodium Carbonate	.....	.....	.....	.....	.....	.....	0253	1.49	.....	.....
Calcium Carbonate	.1754	10.26	.1500	8.76	.1147	6.71	.0093	.54	.2527	14.78
Magnesium Carbonate	.1103	6.45	.1099	6.43	.0567	3.32	.0088	.52	.....	.....
Iron Carbonate	.....	.....	.....	.....	.0031	.18	.....	.....	.0583	3.41
Alumina	.....	.....	.....	.....	.0016	.09	.0072	.42	.....	.....
Silica	.0117	.68	.0040	.23	.0184	1.08	with some .0120	ferric oxide .70	.0088	.51
Total Solids found by Analysis	1.6271	95.16	.9628	56.31	.2760	16.15	.0805	4.71	2.1193	123.97
Gases { Carbonic Acid free and combined as bicarbonates	.1748	10.23	.1468	8.59	.1439	8.42	.0318	1.86	.2016	11.79
Gases { Free Hydrogen Sulphide	.0041	.24	.0011	.06	.....	.....	.....	.....	.....	.....
Temperature of Water	58° F.		56° F.		49°		47°		49°	
Temperature of Air	68° F.		68° F.		65°		74°		48°	
Flow in Gallons per hour	24000		10000–20000		100		.....	.....	.....	.....

* The samples from which analyses of Missouri waters were made, were collected by the Survey, and the analyses were conducted in duplicate.

TABLE OF ANALYSES OF JOHNSON COUNTY MINERAL WATERS.*

	Reed's Spring.		Electric Spring.		Pertle Spring.		Post Oak Sulphur Spring.	
	Parts per 1000.	Grains per Gallon.	Parts per 1000.	Grains per Gallon.	Parts per 1000.	Grains per Gallon.	Parts per 1000.	Grains per Gallon.
Potassium Chloride	.0160	.94	.....	.....	.....	.....	.0208	1.22
Sodium Chloride	.....	.....	.0018	.11	.0021	.12	.1596	9.34
Calcium Chloride	.....	.....	.....	.....	.....	.....	.....	.....
Magnesium Chloride	.....	.....	.....	.....	.....	.....	.....	.....
Potassium Sulphate	.0157	.92	.....	.....	.....	.....	.....	.....
Sodium Sulphate	.....	.....	.1216	7.11	.0772	4.52	.0569	3.33
Calcium Sulphate	.....	.....	.....	.....	.....	.....	.....	.....
Magnesium Sulphate	.....	.....	.0812	4.77	.....	.....	.....	.....
Potassium Carbonate	.0154	.90	.....	.....	.....	.....	.....	.....
Sodium Carbonate	.0147	.86	.....	.....	.0603	3.53	.0256	1.50
Calcium Carbonate	.0718	4.20	.3543	20.73	.1654	9.68	.1225	7.17
Magnesium Carbonate	.0154	.90	.0476	2.78	.0665	3.89	.0756	4.42
Iron Carbonate	.0137	.80	.0017	.10	.0124	.73	.....	.....
Alumina	.0020	.12	.0070	.41	.0044	.26	.....	.....
Silica	.0168	.98	.0268	1.57	.0258	1.51	0099	.58
Total Solids found by analysis	.1678	9.82	.6403	37.48	.4017	23.51	.4709	27.56
Gases: Carbonic acid free and combined as bicarbonates	.1478	8.65	.1762	10.31	.1159	6.78	.1195	7.00
Gases: Free Hydrogen Sulphide	.....	.....	.....	.....	.....	.....	trace.	trace.
Temperature of Water	52° F.		51° F.		52° F.		56° F.	
Temperature of Air	54° F.		70° F.		72° F.		59° F.	
Flow in Gallons per hour	100		100		60		150	

* The samples from which analyses of Missouri waters were made were collected by the Survey and the analyses were conducted in duplicate.

TABLE OF ANALYSES OF WATERS FROM ST. CLAIR AND BENTON COUNTIES AND ONE FROM GRAND PASS, SALINE CO.*

	"Old Black," at Monegaw Springs, St. Clair Co.		"Boling Spring," Benton Co.		Town Spring, at Grand Pass, Saline Co.	
	Parts in 1000.	Grains per Gallon.	Parts in 1000.	Grains per Gallon.	Parts in 1000.	Grains per Gallon.
Potassium Chloride	.0466	2.73	.0261	1.53	.0008	.05
Sodium Chloride	1.9055	111.66	.6051	35.40	.....	.....
Calcium Chloride	.1554	9.11	.0137	.80	.....	.....
Magnesium Chloride	.0290	1.70	.0689	4.03	.....	.....
Potassium Sulphate	.....	.....	.....	.....	.0109	.64
Sodium Sulphate	.....	.....	.....	.....	.....	.....
Calcium Sulphate	.0545	3.19	.0683	4.00	.....	.....
Magnesium Sulphate	.....	.....	.....	.....	.....	.....
Potassium Carbonate	.....	.....	.....	.....	.0159	.93
Sodium Carbonate	.....	.....	.....	.....	.0531	3.11
Calcium Carbonate	.1929	11.30	.1967	11.51	.1525	8.92
Magnesium Carbonate	.1876	10.99	.0872	5.12	.0455	2.66
Iron Carbonate	.....	.....	.....	.....	.....	.....
Alumina	.....	.....	.....	.....	.0156 with iron	.91 with iron
Silica	.0111	0.65	.0106	.62	.0192	1.12
Total solids found by analysis	2.5826	151.38	1.0766	63 01	.3135	18.34
Gases: Carbonic Acid free and combined as bicarbonates	.0622	3.64	.1759	10.29	.1062	6.22
Gases: Free Hydrogen Sulphide	.0036	.21	trace.	trace.	.....	.....
Temperature of Water	61° F.		58° F.		53° F.	
Temperature of Air	59° F.		57° F.		28° F.	
Flow in Gallons per hour	10000		5000		200	

* The samples from which analyses of Missouri waters were made were collected by the Survey, and the analyses were conducted in duplicate.

TABLE OF ANALYSES OF COMPARABLE WATERS FROM OTHER STATES.

	Blount Mineral Springs. "Red Spring," Alabama.[1]	Bethesda Spring, Waukesha, Wisconsin.[2]	Artesian Well, Prairie du Chien, Wisconsin.[3]	Artesian Well, Fort Scott, Kansas.[4]	"Gettysburg Lithia Spring," Pennsylvania.[5]	Stribling or Augusta Springs, Virginia. No. 1, Chalybeate Spring.[6]
	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.	Grs. per Gal.
Potassium Chloride			3.81	trace.		
Sodium Chloride	32.32	1.16	90.20	79.47	.32	
Calcium Chloride			Sodium bromide. .13	0.79		
Magnesium Chloride	6.00			7.99		
Potassium Sulphate		.46		Sodium biborate. 2.20	.15	
Sodium Sulphate		.54	12.80	trace.	Calcium phosphate. .01	
Calcium Sulphate			15.37	0.83	.48	.22
Magnesium Sulphate	1.60			Sodium hydro-sulphide .19	3.30	
Potassium Carbonate						.35
Sodium Carbonate		bicarb. 1.26			bicarb. 3.38	.76
Calcium Carbonate	6.80	bicarb. 17.02	bicarb. .62	bicarb. 14.23	bicarb. 9.96	1.50
Magnesium Carbonate	4.40	bicarb. 12.39	10.97	bicarb. .31	bicarb. 5.83	.98
Iron Carbonate	1.92	bicarb. .04	bicarb. .23	1.00	bicarb. .04	.07
Alumina		.12	.06		.02	
Silica		2.72 & organic matter.	2.84	2.12 & organic matter.	1.76	1.33
Total Solids found by analysis	53.04	35.71	137.03	109.13	25.25	5.21
Gases: Carbonic Acid free & comb. as bicarb.	present.			trace.		24.00
Gases: Free Hydrogen Sulphide	present.			trace.		
Temperature of water	60° F.	48° F.	56° F.	67.5° F.		
Temperature of air						
Flow in gallons per hour	900	4200	3620	416		

[1] R. Brumby, Analyst. [2] C. F. Chandler, Analyst. [3] G. Bode, Analyst (1876). [4] E. H. S. Bailey and E. W. Walters, Analysts (1884).
[5] F. A. Genth, Analyst (1875). [6] D. K. Tuttle, Analyst (1859).