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REPORT OF INVESTIGATIONS—NO. 17

THE LIMESTONE RESOURCES OF THE PONTIAC-FAIRBURY REGION

BY
J. E. LAMAR

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THE LIMESTONE RESOURCES OF THE PONTIAC-FAIRBURY REGION

By J. E. Lamar

INTRODUCTION

In the summer of 1928 the State Geological Survey received inquiries regarding the commercial possibilities of the limestone deposits in the vicinity of Pontiac for cement manufacture and other uses. In response to these inquiries the writer, assisted by Mr. Carl E. Dutton, made a reconnassiance study of the area, the results of which serve as the basis of this report.

SUMMARY

Within the Pontiac-Fairbury region in Livingston County, Illinois, it seems probable that test-drilling would outline considerable areas of limestone which have a thin overburden and are close to railroad transportation. The limestone is from 10 to 20 feet thick and is sufficiently extensive and of such purity and physical constitution as to be of commercial promise for cement, agricultural limestone, macadam roads, and possibly flux, lime, and railroad ballast.

GENERAL GEOGRAPHY

The city of Pontiac is located near the center of Livingston County on the Chicago and Alton Railroad, Wabash Railway and Illinois Central Railroad, 92 miles from Chicago and 192 miles from St. Louis by rail. The city has a population of 7,400 and is the center of an agricultural district.

Fairbury, with a population of 2,532 is located in the south central part of the county, on the Wabash Railway and Toledo, Peoria and Western Railroad which intersect trunk lines for Chicago and St. Louis. It is also the center of an agricultural district.

Figure 1 shows the location of the Pontiac-Fairbury region with reference to northern Illinois as a whole.

Transportation

The Pontiac-Fairbury region is crossed by four railroads (fig. 2). The main line of the Chicago and Alton Railroad between Chicago and St. Louis cuts diagonally across the northwest part of the area; the Kempton to Minonk branch of the Illinois Central Railroad crosses the north part; the Forest-Streator branch of the Wabash Railroad crosses the entire area diagonally from northwest to southeast and the Toledo, Peoria and Western Railroad from Effner, Indiana, to Keokuk, Iowa, touches the southern margin.

In addition to the ample railroad facilities, the region possesses many good roads. State Highways 4 and 2 parallel the Chicago and Alton and the Toledo, Peoria and Western railroads respectively, and many of the secondary roads are graveled or macadamized.

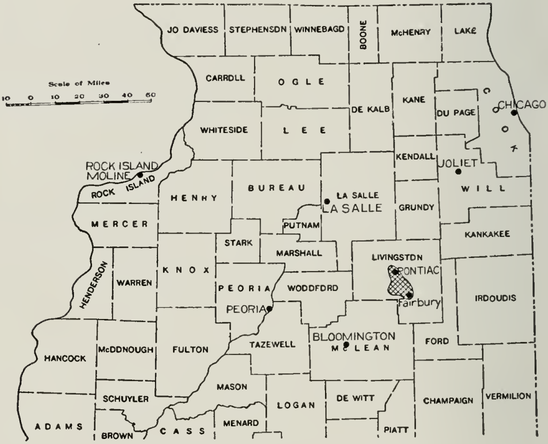

Fig. 1. Index map showing the location of the Pontiac-Fairbury region with reference to northern Illinois as a whole.

Topography

For the most part the topography of the Pontiac-Fairbury region is level to gently rolling. The total relief rarely exceeds fifty feet and in most localities is considerably less. The principal stream is Vermilion River which with its tributaries is chiefly responsible for much of the relief. Some undulations are due to glacial deposition.

GENERAL GEOLOGY

The limestone in question belongs to the upper coal measures which are composed chiefly of shales. Although the limestone member is probably the

Lonsdale or LaSalle, it is here called the "Pontiac" limestone because of the uncertainty of its identity.

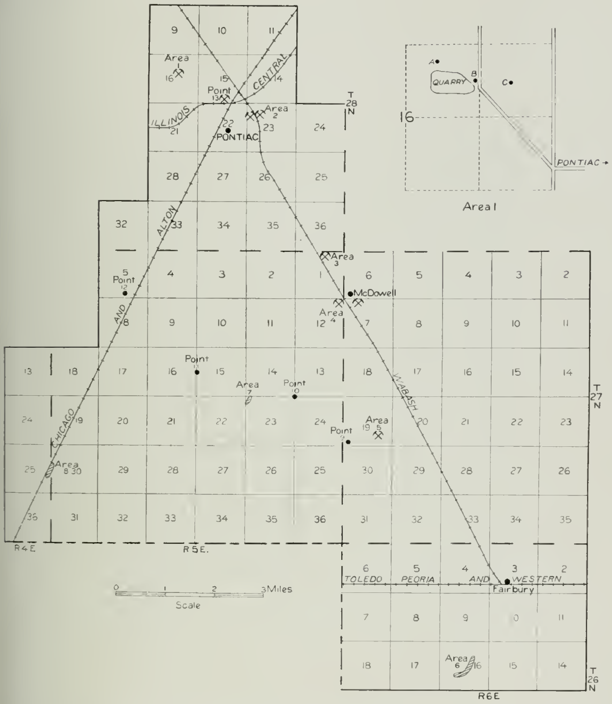

Fig. 2. Map of the Pontiac-Fairbury region showing areas and points mentioned in the text. In the upper right hand corner is an enlarged sketch map of Area 1 showing the location of bore holes A, B, and C, which are mentioned in Tables 2, 3, and 4 of the text.

Coal No. 7 is mined at Fairbury and was at one time mined at Pontiac. The record of the formations reported to have been penetrated in digging the mine shaft at Pontiac (Point 13, fig. 2) are shown in figure 3.

The local occurrence of the limestone is probably the result of the preservation from erosion of a tract of the stone in a saddle on the LaSalle anti-

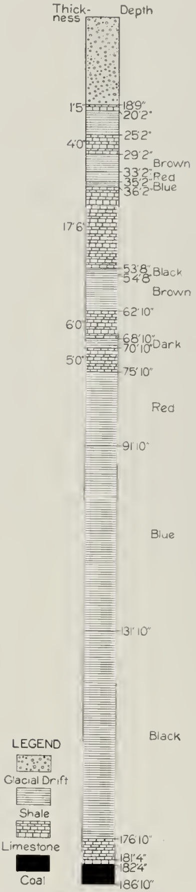

Fig. 3. Graphic log of shaft of the Murphy, Linsky and Kasher Coal Company. T
17½ foot bed of limestone is probably the equivalent of the Pontiac limestone.

cline. The main axis of the anticline extends from the LaSalle-Utica area in LaSalle County southeast through the Pontiac area.

The surficial materials consist of glacial drift and earth. The former is commonly a gray or brown clay, containing pebbles and locally boulders and cobbles. Its thickness varies from a few inches to probably about 30 feet. The drift is overlain by black soil which mantles the entire region and varies from 3 inches to about 3 feet in thickness.

Fig. 4. Near view of the Pontiac limestone in quarry in Area 1, showing the fractured and thin bedded character of the stone.

THE PONTIAC LIMESTONE

General Character

The general character of the Pontiac limestone is quite constant so that the bed is readily recognizable at its various outcrops. (See figs. 4, 5, 6 and 7.) The stone is nodular, fine-grained, brown, light gray or bluish-gray, containing numerous cavities lined with crystals of calcite. Irregular masses of hydrated iron oxide are also common in cavities and along joint-planes.

The limestone where unweathered is in beds 1 to 3 feet thick, but weathers commonly to slabs 1 to 2 inches thick. Where weathering has been severe water has dissolved channels along joints and bedding-planes which are now filled with brown earth. As a whole the limestone is much fractured, particularly the upper 10 to 12 feet. The principal variations found in the outcrops as observed at quarries is in the amount of iron hydroxide present and the extent to which the deposit has weathered.

The most extensive outcrop of the limestone is in the quarry in Area 1, sec. 16, T. 28 N., R. 5 E. (fig. 2) where the sequence of beds exposed is as follows:

Pontiac limestone exposed in quarry, Area 1

	Thickness	
	Feet	*Inches*
3. Limestone, gray, porous, locally spotted brown by iron hydroxide....	11	
2. Limestone, similar to limestone above but less porous and bluish-gray in color; grades into bed above....................................	3	
1. Limestone, bluish-gray, clayey, fossiliferous.........................	1	2

This three-fold division is common to most outcrops of the stone. Bed No. 2 is probably an unweathered phase of bed No. 3. In the deeper quarries bed No. 1 is almost invariably reported to occur below the bluish stone.

In the shaft of the Pontiac mine (fig. 3) the 17½ feet of limestone encountered at a depth of 36 feet is probably the equivalent of the limestone outcropping in the general region. Outside the immediate vicinity of the mine shaft the overlying limestone beds are absent; the underlying limestones are not known and may thin and disappear.

Chemical Composition

Because the Pontiac limestone has been quarried locally in many places it is possible to secure a more complete set of samples for chemical and physical analysis than is normally the case for undeveloped limestone deposits of its type. In addition to the results of tests made on samples taken by the Survey, a very detailed set of analyses of the limestone in Area 1 (see inset fig. 2) are presented through the courtesy of Miss May H. Babcock, owner of the quarry in Area 1. They are significant in that they show the vertical differences in the composition of the limestone.

TABLE 1.—*Chemical analyses of samples taken by the Illinois Geological Survey*

Sample No.	Source[a]	Character	Calcium Carbonate $CaCO_3$	Calcium Oxide CaO	Magnesium Carbonate $MgCO_3$	Magnesium Oxide MgO	Ferric Oxide Fe_2O_3	Alumina Al_2O_3	Silica SiO_2
P. 2	Area 1	Limestone, gray.	93.50	52.52	0.28	0.13	0.64	1.39	1.33
P. 3	Area 1	Limestone, blue.	89.20	50.11	0.29	0.13	0.90	0.28	5.44
P. 4	Area 1	Limestone, blue, argillaceous..	68.75	38.59	0.90	0.43	0.51	1.13	25.34
P. 6	Area 8	Limestone, gray.	91.56	51.44	1.78	0.85	0.74	0.36	4.64
P. 8	Area 3	Limestone, gray.	95.05	53.40	0.40	0.19	0.65	0.29	1.12

[a] See descriptions of areas, pp. 17 to 22, for details regarding the position of the strata sampled.

TABLE 2.—*Chemical analyses of limestone from Area 1*
Test Boring A (See fig. 2)

Depth *(Feet)*	$CaCO_3$	$MgCO_3$	CaO	MgO	Fe_2O_3	Al_2O_3	SiO_2	Phosphorous	Total
6	87.2	2.02	48.82	0.96	0.99	2.13	8.30	.025	100.66
8	94.6	0.86	53.09	0.41	0.99	0.81	2.76	.019	95.90
10	94.6	1.74	53.03	0.87	0.70	1.58	1.40	.017	100.40
12	92.6	1.61	51.80	0.77	1.48	2.13	0.92	.019	98.76
14	91.6	1.40	51.36	0.67	1.60	2.58	1.16	.018	98.36
16	90.4	2.08	51.06	0.99	1.48	2.05	2.74	.024	98.77
18	75.0	3.11	42.0	1.48	1.72	4.86	13.84	.033	98.56
20	62.5	3.48	35.0	1.74	1.97	8.93	22.22	.042	99.14
22	46.1	5.38	26.81	2.56	3.90	14.63	27.64	.025	98.67
Average (6′-16′)	91.72	1.63	51.53	0.78	1.21	1.88	2.88	.020	100.30
Average (18′-22′)	61.58	3.99	34.60	1.93	2.53	9.47	21.23	.033	99.13

TABLE 3.—*Chemical analyses of limestone from Area 1*
Test Boring B (See fig. 2)

Depth (*Feet*)	$CaCO_3$	$MgCO_3$	CaO	MgO	Fe_2O_3	Al_2O_3	SiO_2	Phosphorous	Total
6	80.2	1.70	44.91	0.81	1.11	2.82	14.40	.034	100.26
8	87.5	2.46	49.09	1.17	0.99	2.27	6.24	.040	99.50
10	92.1	1.57	51.67	0.75	0.99	1.77	4.06	.025	100.50
12	91.6	2.59	51.30	1.23	2.34	0.74	2.32	.034	99.62
14	90.0	2.79	50.38	1.33	1.72	1.02	4.24	.025	99.80
16	90.8	1.46	50.81	1.17	1.72	1.64	3.36	.059	99.04
18	88.2	3.11	49.40	1.48	1.97	1.97	4.12	.058	99.43
20	84.2	3.45	47.24	1.64	1.84	1.84	4.76	.035	96.13
22	84.6	1.47	47.44	0.70	0.62	0.80	12.68	.052	100.22
Average (6′-16′)	88.45	2.26	49.69	1.08	1.48	1.71	5.77	.036	....
Average (18′-22′)	85.49	2.65	48.03	1.27	1.48	1.54	7.15	.048	....

TABLE 4.—*Chemical analyses of limestone from Area 1*
Test Boring C (See fig. 2)

Depth (*Feet*)	$CaCO_3$	$MgCO_3$	CaO	MgO	Fe_2O_3	Al_2O_3	SiO_2	Phosphorous	Total
2	95.8	1.51	53.64	0.72	0.86	0.73	1.10	.024	100.20
4	94.6	1.68	53.02	0.84	1.84	0.81	0.74	.021	99.69
6	72.2	1.88	40.41	1.37	1.35	6.19	16.54	.012	98.17
8	88.1	2.04	49.34	0.97	1.11	2.54	6.14	.013	99.94
10	94.6	1.53	53.02	0.73	1.11	1.10	1.32	.014	99.67
12	93.9	1.41	52.66	0.67	1.35	0.95	1.96	.013	99.58
14	94.5	1.17	52.90	0.56	1.35	0.85	1.90	.015	99.79
Average	90.4	1.60	50.79	0.77	1.28	1.88	4.24	.016	99.56

TABLE 5.—*Chemical tests of limestone from Babcock quarry—Area 1*

	$CaCO_3$	$MgCO_3$	Fe_2O_3	Al_2O_3	SiO_2	Total
Upper limestone, including gray and blue	90.16	0.48	2.30	0.82	4.64	98.40
Lower limestone, clayey, blue	42.13	3.36	2.20	11.80	36.64	96.13

The outstanding features brought out by the analyses are: (1) the calcium carbonate content of the limestone is commonly above 90 per cent and is reasonably constant from place to place; (2) the magnesium carbonate content is with one exception consistently lower than 4 per cent and in over 3/5 of the samples tested was less than 2 per cent; (3) the ferric oxide, alumina, and silica contents vary considerably with the calcium carbonate content; and (4) the phosphorous content is small.

RESULTS OF PHYSICAL TESTS

In order to determine the value of the Pontiac stone for concrete aggregate, road material, and the like, two samples were taken for physical analysis. The results of the analyses are given in Table 6. These tests indicate the character of the limestone only in the places where the samples were taken. Nevertheless they give a general idea of various physical properties of the stone.

TABLE 6.—*Results of physical tests on Pontiac limestone* [a]

	Limestone From Area 1 (Sample P. 9)	Limestone From Area 8 (Sample P. 7)
Specific gravity	2.55	2.63
Weight, lbs. per cubic ft	159	164
Absorption (24 hrs.) *per cent*	2.0	0.6
Absorption, lbs. per cubic ft	3.2	1.0
Abrasion loss *per cent*	7.5	5.8
French coefficient	5.3	6.9
Soundness	2 pieces failed (5 runs)	O.K.

STRATA ASSOCIATED WITH THE PONTIAC LIMESTONE

According to the data available the beds immediately below the Pontiac limestone are shale, but there is no information as to the character of this material.

[a] Tests made by Division of Highways, Bureau of Materials, Springfield, Illinois.

Unconsolidated materials overlie the limestone at all the outcrops visited. In some places the rock is immediately overlain by a tough, greenish-brown clay, in others by a pebbly, gray or brown glacial clay which is usually thin but may be 15 or 20 feet thick in places. Where the overburden on the limestone is heavy this glacial clay is probably the dominant constituent of the overburden. In all places the uppermost material is black soil. Locally the soil rests directly on the limestone, elsewhere on the brown clay or pebbly glacial clay. Analyses indicating the general chemical composition of the various materials follow:

Table 7.—*Chemical analyses of clays*

Sample	$CaCO_3$	$MgCO_3$	CaO	MgO	Fe_2O_3	Al_2O_3	SiO_2	Loss on ignition
P1—Area 1; from 2 feet brown clay and 2 feet black earth..	1.50	0.11	0.84	0.06	4.31	5.31	77.72	6.80
P5—Area 8; from 5 feet brown clay....	3.79	0.11	2.12	0.06	6.45	16.33	58.74	12.43
Area 1; surface clay[a]	3.20	1.02	1.80	0.49	4.30	12.38	67.00	....

[a] Courtesy Miss May H. Babcock.

Distribution of the Pontiac Limestone

The areal distribution of the limestone in the region southeast of Pontiac as known from outcrops is shown in figure 2, page 9. In addition the limestone outcrops at intervals along Vermilion River northwest of Pontiac to approximately the township line. According to well drillers limestone is commonly encountered at a shallow depth in most of T. 28 N., R. 5 E., T. 27 N., R. 5 E., and the W. ½ T. 27 N., R. 6 E. There are without doubt sizeable bodies of limestone in most of the region outlined but these bodies are probably not continuous. This discontinuity is doubtless the result of stream channeling and glacial erosion.

Outcrops of the Pontiac limestone shown in figure 2, together with the data from wells also indicated on the map, are listed and described below.

Area 1

SW. ¼ NE. ¼ sec. 16, T. 28 N., R. 5 E.

At this place a quarry about 300 by 350 feet has been a source of stone for crushed-stone roads and agricultural limestone. (Figs. 4 and 5.) The section exposed at the quarry is as follows:

Section in quarry at Area 1

		Thickness	
		Feet	*Inches*
6.	Soil, black, matted with roots	1	6
5.	Earth, black	2	
4	Clay, brown, breaks into gra'ns	2	
3.	Limestone, gray, spotted with iron hydroxide; numerous cavities lined with calcite crystals; fracturing and jointing prominent; beds before weathering are 1 to 3 feet thick, after weathering 1 to 2 inches; grades into bed below	11	
2.	Limestone, similar to limestone above but less porous, less iron-stained, and blue-gray in color; grades into bed above	3	
1.	Limestone, clayey, fossiliferous, slabby, blue-gray	1	2
	Floor of quarry		

The total thickness of limestone exposed is about 15 feet, but borings in the vicinity of the quarry indicate at least 22 feet of limestone (see pp.

Fig. 5. General view of the quarry in Area 1, showing the almost flat-lying Pontiac limestone with a comparatively level surface and thin overburden.

14 and 15). A former workman in the quarry states that in drilling blast-holes an average of about 11 feet of hard limestone was penetrated, underlain by a softer bluish limestone (bed No. 1 of above geologic section) which was 20 feet thick in a test hole drilled into it. There appears, therefore, to be a good thickness of limestone at this place.

The areal extent of this deposit is difficult to determine without test-drilling. From the topography it seems likely that limestone with a thin overburden underlies 120 to 160 acres and possibly more; other estimates are that it underlies 200 acres or more. Only thorough test-drilling will accurately delineate the extent of the limestone.

A large number of chemical analyses of stone from the quarry at Area 1 are shown in the tables of chemical analyses (pp. 13, 14, 15, and 16). Of the samples taken for chemical analysis by the Survey during the present studies, Sample P. 1 is from beds 4 and 5 in the preceding section of formations (p. 17); Sample P. 2 from bed 3, P. 3 from bed 2, and P. 4 from bed 1 (p. 13); Sample P. 9 was taken from beds 2 and 3 for physical analysis (p. 16).

Area 2

NW. ¼ sec. 23, T. 28 N., R. 5 E.

At the northeast edge of the city of Pontiac are two abandoned quarries in the Pontiac limestone. One is used as a city dump and is filled with rubbish; the other is full of water. Very little information is available, therefore, concerning the character of the stone but such as is obtainable indicates that the deposit and stone are generally similar to that at Area 1. The overburden on the stone is from 2 to 5 feet thick and is largely black or brown earth.

Fig. 6. General view of quarry in Area 3, illustrating the irregular surface of the limestone and the thin overburden.

In the most elevated parts of Pontiac, the limestone is commonly found in digging sewers and basements, so it appears that a considerable tract is underlain by limestone in this area.

Area 3

NW. ¼ NE. ¼ sec. 1, T. 27 N., R. 5 E.

About a mile northwest of McDowell a small quarry has been a source of road material and agricultural limestone. (Fig. 6.) About 15 feet of limestone is exposed which is much less weathered than most of the deposits. (Fig. 7.) Excepting the badly weathered upper 3 or 4 feet, the rock is dense, fine-grained and very hard. Fossils are common. The stone lies in beds 1 to 8 inches thick and is mostly white. The overburden is from 1 to 4 feet of black and brown earth.

Sample P. 8 was taken from this quarry for chemical analysis. The results of the test shown on page 13 indicate that this stone is among the best sampled.

There is very little data on which to estimate the size of the limestone body at this place, but the presence of two quarries at McDowell suggests that a fairly extensive tract may be underlain by the stone at no great depth.

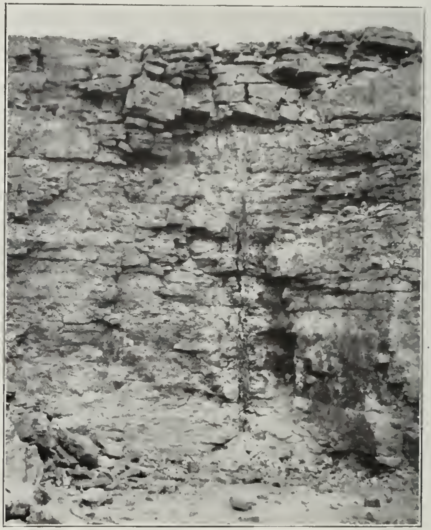

Fig. 7. Near view of limestone in quarry, Area 3. The rock is thicker bedded than in most exposures.

Area 4

SW. ¼ sec. 6, T. 27 N., R. 6 E., near McDowell.

In the NE. corner of sec. 12, T. 27 N., R 5 E. and the NW. corner NE. ¼ NW. ¼ sec. 7, T. 27 N., R. 6 E. respectively, are abandoned quarries in the Pontiac limestone. The quarry in sec. 7 exposes 11 feet of gray limestone with 3 to 5 feet of earth overburden. The limestone is underlain by an unknown thickness of blue shaly limestone. Well drillers report 18 to 20 feet of limestone underlain by blue shale (probably shaly limestone) in this vicinity.

The quarry in sec. 12 is partly filled and shows only 6 feet of weathered limestone overlain by 3 to 5 feet of earth.

These exposures, though small, are significant because they suggest a limestone body of considerable size in this area having an overburden averaging less than 5 feet.

Area 5

Center SE. ¼ sec. 19, T. 27 N., R. 6 E.

A small quarry at this place which has been a source of crushed rock for local roads shows 12 feet of typical weathered gray Pontiac limestone underlain by about 1 foot of blue shaly limestone. The overburden ranges from practically nothing to about 2 feet in thickness.

There are no data on the extent of this deposit.

Area 6

Sec. 16, T. 26 N., R. 6 E.

Limestone similar to that in the Pontiac region outcrops for about a third of a mile along a creek in sec. 16, about 1½ miles southwest of Fairbury. At one place the stone was once quarried for foundations and well walls. In the old quarry the limestone is said to have been 15 to 20 feet thick, though only about 10 feet are now exposed because the quarries are filled with water. Another partly covered outcrop was noted in a barnyard near the center of the SW. ¼ sec. 16 and is probably a continuation of the same deposit seen along the creek.

The outcrops in this area are due to stream erosion of a broad, flat hill composed of Pontiac limestone. The rock hill is apparently of considerable extent.

Area 7

NW. corner sec. 23, T. 27 N., R. 5 E.

At this place typical Pontiac limestone outcrops for a short distance in the bed of small gully. The extent of the limestone is not known.

Area 8

Center E. line, sec. 25, T. 27 N., R. 4 E.

In digging a drainage ditch in this area typical Pontiac limestone was cut through for a distance of about 1200 feet. The limestone was first encountered about a mile and a half north of the south line of Livingston County; it extends in a northeast direction, paralleling the Chicago and Alton Railroad and State Route No. 4. In the ditching operations the limestone bed was not penetrated for more than about 3 feet. The section exposed near the center of the outcrop follows:

Formations exposed in drainage ditch, Area 8

	Thickness Feet	Inches
5. Soil, black	2	0
4. Clay and gravel, brown clay and fine chert gravel		4-6
3. Clay, greenish-brown, tough, irregular fracture; containing a few chert pebbles	5	0
2. Gravel and clay; limestone and igneous pebbles up to 3 inches in diameter in a clay matrix		0-8
1. Limestone, gray, porous, iron-stained	3	

Sample P. 5 was taken from bed No. 3, P. 6 from bed No. 1 for chemical analysis. Sample P. 7 was taken for physical analysis. The results of the analyses are given on pages 17, 13, and 16.

The fact that the limestone outcrops for 1200 feet at a shallow depth in the drainage ditch suggests a good sized body of stone in this area.

Other Data of Interest

In addition to the outcrop data presented the following information described as occurring at various "Points" is of interest.

Point 9

SW. corner sec. 19, T. 27 N., R. 6 E.

Limestone is reported at a very shallow depth in wells.

Point 10

SW. corner sec. 13, T. 27 N., R. 5 E.

In the vicinity of the adjoining corners of secs. 13, 14, 23, and 24 limestone is reported at a shallow depth.

Point 11

Center W. line, sec. 15, T. 27 N., R. 5 E.

Limestone is reported at a depth of 15 feet.

Point 12

S. ½ S. ½ sec. 5, T. 27 N., R. 5 E., at County Farm.

Six feet of limestone was encountered at a depth of 20 feet in well.

Point 13

SW. corner SE. ¼ sec. 15, T. 28 N., R. 5 E.

Approximate location of Pontiac coal shaft. (See figs. 2 and 3.)

Testing for Areal Distribution

In view of the likelihood of local discontinuity of the Pontiac limestone it is advisable to thoroughly test the extent of the deposit by drilling either with core or churn drills, though preferably the former because they yield a better record for study and analysis of the strata penetrated. The test borings will also give critical information as to the thickness of the limestone which doubtless varies considerably from place to place.

Uses of the Limestone

The uses of the Pontiac limestone may be divided into two groups: (1) those requiring simply crushing and screening of the limestone; and (2) those necessitating burning in addition to crushing and screening. The first group includes agricultural limestone, concrete aggregate, railroad ballast, flux, and other minor uses; the second includes lime and cement.

AGRICULTURAL LIMESTONE

The function of agricultural limestone is to neutralize soil acidity and thereby promote the growth of bacteria, some of which convert nitrogen from the air into a form available to plants and others of which aid in the decomposition of humus materials in the soil. Inasmuch as both calcium and magnesium carbonates are effective in neutralizing soil acidity the total of these carbonates is an approximate measure of the effectiveness of a limestone in correcting acidity. As will be seen from the tables of chemical analyses (pp. 13-16) the total carbonate content of the Pontiac limestone varies from 90 to 95 per cent in the non-shaly part. A stone of this carbonate content is ordinarily considered a good agricultural limestone and this, therefore, is an important use for the stone in the Pontiac-Fairbury area.

CONCRETE AGGREGATE

The physical analyses given on page 16 indicate that the limestone in the Pontiac-Fairbury area is on the borderline as aggregate for concrete roads and concrete for construction purposes. Regarding Sample P. 9, V. L. Glover, Engineer of Material of the Illinois Division of Highways, says, "This rock fails to meet our requirements as the abrasion loss exceeds the maximum permitted by our specifications. Our specifications permit a loss of 7 per cent whereas the tests on the rock show 7.5 per cent.

"The rock contained streaks of iron carbonate and oxide caused apparently by the infiltration of these compounds through the voids. These streaks are rather soft and are, no doubt, partially responsible for the high abrasion loss which we obtained in the tests. These soft spots are rather undesirable, especially if the rock is to be considered as an aggregate for concrete. I would not consider this rock satisfactory for use in concrete road or bridge work, but it may be used in macadam construction on secondary roads."

Concerning Sample P. 7 (see p. 16) the report is. "According to our tests the limestone is satisfactory. The specific gravity, absorption, and abrasion loss are well within the limits of our specifications. The soundness test also showed satisfactory results."

From the foregoing it is apparent that though parts of the Pontiac limestone are suitable concrete aggregate other parts are not. Inasmuch as there is considerable variation in the character of the limestone from place to place in the same quarry it seems probable that the stone can not be used extensively for this purpose. Of the outcrops visited, the limestone in Area 3 seemed most likely to be an acceptable aggregate stone.

MACADAM ROADS

Water-bound macadam roads, popularly known as crushed-rock roads, can be satisfactorily constructed from the Pontiac limestone of the Pontiac-Fairbury region as indicated in the interpretation of the results of tests on Sample P. 8 given above under the discussion of "Concrete Aggregate." The limestone in general is probably slightly too soft and friable to be used in primary macadam roads carrying a heavy traffic, but for secondary roads the stone should give good service either in water-bound or bituminous macadam.

RAILROAD BALLAST

The specifications for first-class limestone railroad ballast are about the same as for concrete aggregate, and the Pontiac limestone is therefore slightly on the borderline in this regard. However, the bulk of the stone would probably be satisfactory to many railroads.

FLUX

The specifications for limestone to be used as flux vary to some extent with the particular requirements of the user, but in general limestone flux should contain over 90 per cent calcium carbonate, less than 5 per cent silica (most fluxes contain less than 3 per cent) and be low in pyrite, alumina and phosphorous. Some of the Pontiac limestone meets these requirements and can probably be used as flux.

LIME

Most limestones burned for lime contain over 95 per cent total carbonates. If the lime resulting contains less than 5 per cent magnesia it is known as a "high-calcium lime"; if it contains over 30 per cent magnesia it is known as a "high-magnesium lime."[2] If the lime contains over 5 per cent of impurities such as silica, iron oxide, and alumina it is usually dark in color and is known as a "lean" or "poor" lime.[3] The Pontiac limestone, because of its impurities, high iron oxide content, and slightly low carbonate content, would probably make a lean lime.

PORTLAND CEMENT

Portland cement is made by heating to incipient fusion an intimate mixture of limestone and shale or clay or their equivalents, in the proportion of about three parts of limestone to one part of shale or clay. The principal substance to be avoided in cement materials is magnesium carbonate, which should not exceed about 5 per cent.

The Pontiac limestone offers a good combination for cement manufacture. Though the limestone does not contain the requisite amount of clay itself, there are overlying clays and an underlying shaly limestone which may be combined with the purer limestone to yield the raw cement mix desired. For example in Area 1 a cement mix composed of the top earth and clay (Sample P. 1, p. 17), the gray limestone (Sample P. 2, p. 13) the blue limestone (Sample P. 3, p. 13) and the blue shaly limestone (Sample P. 4, p. 13) in the ratio of their thicknesses, which are 4, 11, 3 and 3 feet respectively (see p. 18) would have the following composition:

Approximate composition of cement mix, Area 1

	Per Cent
$CaCO_3$	71.83
$MgCO_3$	0.34
SiO_2	19.89
Al_2O_3	1.94
Fe_2O_3	1.35

According to Eckel[4] the ratio of silica to alumina plus iron for ordinary purposes should be about 3 to 1. In the above analysis the ratio is about 6 to 1, but by the addition of shale from the bed underlying the shaly limestone in the bottom of the quarry, or by employing a surface clay of somewhat different composition, as Sample P. 5, page 17, any common raw mix for cement can be produced.

In Area 8, a cement mix composed of the limestone (Sample P. 6, p. 13) and the clay (Sample P. 5, p. 17) in the proportion of 11 to 5, which is their approximate thickness, would have about the following composition:

[2] Eckel, E. C., Cements, limes and plasters, Wiley and Sons, New York, p. 118. 1905.
[3] Idem, p. 117.
[4] Op. cit. p. 394.

Approximate composition of cement mix, Area 8

	Per Cent
$CaCO_3$	64.13
$MgCO_3$	1.26
SiO_2	21.55
Al_2O_3	3.35
Fe_2O_3	2.52

This, though not quite fulfilling the requirements mentioned by Eckel, indicates that a suitable mix might readily be obtained.

Other areas also offer opportunities for obtaining suitable materials for cement manufacture.

FUEL FOR BURNING CEMENT

The manufacture of Portland cement requires a large amount of fuel; that used in Illinois is mostly powdered coal. The coal formerly mined by the Murphy, Linsky and Kasher Coal Company (Point 13, fig. 2; fig. 3) appears to be a potential fuel source. According to observations made by Dr. G. H. Cady of the Survey staff in 1918 the coal is from 48 to 66 inches thick, averaging about 57 inches.

A clay band about 3 inches thick occurs 2 or 3 inches above the floor. A band of pyrite (iron sulphide) about ½ inch thick occurs 18 inches above the floor, and locally concentrations of pyrite occur in the coal itself. When the mine was in operation the pyrite was removed by hand-picking. The pyrite was of excellent quality, hard and stony, and it is estimated that 2 or 3 car-loads could have been produced monthly when the daily output was 175 tons of coal. An analysis made of the coal "as received" follows:

Analysis of coal from the mine of the Murphy, Linsky, and Kasher Coal Company

Moisture	9.41
Ash	13.81
Volatile matter	35.69
Fixed carbon	41.09
Sulphur	4.74
B. t. u.	11,258

Conclusions

1. In the Pontiac-Fairbury region there are tracts, some of them probably 200 acres or more in extent, underlain by limestone. A 200-acre tract underlain by 11 feet of limestone would contain about 3,500,000 cubic yards or about 7,500,000 tons of limestone.

2. Many of these tracts are located on or close to a railroad.

3. The overburden on the limestone varies from 1 to 5 feet in thickness and probably averages about 3 feet.

4. The limestone is suitable for agricultural limestone, macadam roads, Portland cement, probably railroad ballast, flux and lime.

5. Of these uses the outstanding one for which the limestone is not now employed is the manufacture of Portland cement, which is favored by the presence of a suitable limestone and associated clay, shale and argillaceous limestone which provide conveniently the necessary raw materials.

6. Fuel for cement burning can probably be obtained locally.

7. The local labor supply is regarded as adequate.

CHER'S"
BRARY BINDERS
507 S. Goodwin
Urbana, Ill.