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LIMESTONE RESOURCES OF THE LOWER KASKASKIA VALLEY

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ABSTRACT

Limestones of Mississippian age, alternating with shales and sandstones, crop out along the lower Kaskaskia valley. In order to determine the extent, character, thickness, and possible uses of the limestones, field studies were conducted, and samples were taken from selected exposures for chemical and physical tests. Some shales and clayey silts were sampled for chemical analysis to determine their suitability for use in Portland cement making.

Although good exposures were scarce, sufficient information was obtained to indicate that some of the limestones are of adequate thickness and lateral extent to be of possible commercial significance. Other limestones appear to thicken only in places and may be suitable for local use. Suggestions for prospecting are made which point out certain areas that appear to be more promising with respect to comparatively thick limestone and relatively thin overburden.

The results of the physical and chemical tests are tabulated and discussed with respect to possible uses.

INTRODUCTION

The Kaskaskia River flows for the most part through an area that is underlain by rocks of Pennsylvanian age, chiefly shale and sandstone, with a few comparatively thin limestone strata. However, for approximately the lower 25 miles of its course, the river passes through an area underlain by strata of Mississippian age with more abundant and thicker limestones as well as shales and sandstones. It was the purpose of this investigation to determine the extent, character, thickness, and possible uses of the limestones of this latter area. Attention was given also to the shales and clays in the area as these materials are often combined with limestone in the manufacture of Portland cement. To this end, all available limestone and limestone-shale exposures were examined in the field, and samples were taken from selected exposures for physical and/or chemical testing. Three representative surficial deposits of clayey silt were also sampled.

Acknowledgements

Brief descriptions of the formations not studied but included in this report for sake of completeness, are taken largely from Weller and Weller (1939). Information on the character of the exposed rocks and on outcrop locations was obtained also from Weller (ca. 1914), Lamar (1923), Shrode (1949), and Rexroad (1957). In addition, D. H. Swann helped with correlation of rock units. John D. Sims assisted in laboratory and field work.

Previously published analyses of limestones from the lower Kaskaskia area are taken from Lamar (1957) and of shales from Lamar and Sellin (1930). These are listed in table 3. Other shale analyses from Randolph County may be found in White (1959), but no samples from the lower Kaskaskia valley are included.

AREA STUDIED

The area studied enbraces the valley of the lower Kaskaskia River from New Athens south to the Mississippi River, a distance of about 25 miles, and includes parts of St. Clair, Monroe, and Randolph Counties (fig. 1). The width of the area, east to west, is 12 miles, with the western boundary along a north-south line about 2 miles west of Red Bud and the eastern boundary along a north-south line intersecting the eastern edge of Baldwin. The eastern and northern limits of the area coincide roughly with the Mississippian-Pennsylvanian boundary (pl. 1A). The western limit was chosen so as to include virtually all of the outcrop belt of the Okaw Group, which underlies a large part of the lower Kaskaskia valley and includes limestone beds that might be worthy of commercial development.

CHARACTER OF VALLEY

The lower part of the Kaskaskia valley consists of gently rolling hills with steep bluffs in some places along the river. In general the relief of the area increases downstream and is greatest in the vicinity of the bluffs of the Mississippi River near Roots and Collins. The uplands are covered everywhere by a mantle of brown, clayey silt, a wind deposit called loess, that reaches a maximum thickness of 50 feet or more and probably is generally at least 25 feet thick. The loess effectively hides the bedrock throughout much of the area and makes a detailed assessment of limestone resources difficult. However, a sufficient number of outcrops is present to give a reasonably good idea of the probable general character and significance of the limestones in the area.

GEOLOGIC MAP

The geologic map, plate 1A, shows primarily the distribution of the formations that contain limestones of possible commercial significance. Geologic boundaries are drawn at the tops and bottoms of these formations and also at the top of the Mississippian rocks. Other formations, such as the Palestine and Cypress Sandstones, are shown individually merely because they occupy the interval between two significant units.

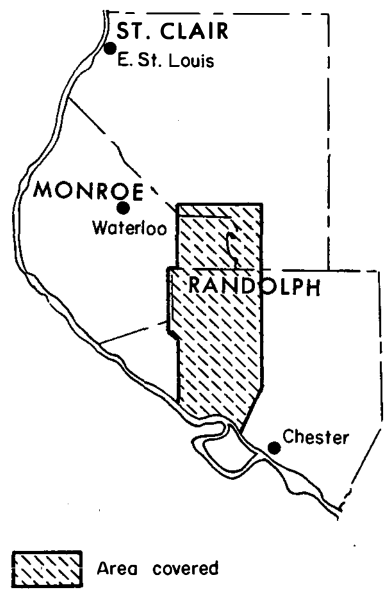

Fig. 1 - Area covered by report.

Certain formations are grouped together because they contain no limestones of consequence, or because one or more of the formations is too thin to be shown individually on the map. For example, the Waltersburg, Vienna, and Tar Springs Formations are not known to contain any limestones worthy of commercial development. The Hardinsburg Formation (sandstone and shale) is grouped with the Glen Dean Limestone because the Hardinsburg is too thin to be mapped separately. The Fraileys and Beech Creek Formations both contain limestone but are mapped together because the Beech Creek is too thin to be shown individually. The Ridenhower Formation (limestone and shale) at the top of the Paint Creek Group could have been mapped separately, but the remaining two formations together are not thick enough to justify splitting the Paint Creek Group on the map. The Yankeetown, Renault, and Aux Vases Formations, below the Paint Creek Group, are not known to contain any commercially exploitable limestones within the lower Kaskaskia area.

DESCRIPTION OF FORMATIONS

The rock strata exposed in the lower Kaskaskia valley area are shown diagrammatically in figure 2.

Aux Vases, Renault, and Yankeetown Formations

The roughly north-south outcrop belt of these formations lies mostly west of the lower Kaskaskia valley area but intersects the area in its western part along the valleys of Horse and Paint Creeks and again in the southwestern corner where the Aux Vases Sandstone forms a prominent cliff along the Mississippi River in the vicinity of Modoc (pl. 1A).

Lithology. - The Aux Vases Formation is a massive and cross-bedded, fine- to medium-grained sandstone. The overlying Renault Formation is extremely variable in its lithology, consisting of sandstone, limestone, and shale in proportions that differ markedly from place to place. The Yankeetown is a thin but persistent formation consisting principally of quartzite or cherty sandstone with locally some shale.

Thickness. - Drilling records from the lower Kaskaskia valley area show that the thickness of the Aux Vases-Renault-Yankeetown interval is quite variable, ranging from around 80 to approximately 160 feet. The Yankeetown is always thin, probably seldom exceeding 20 feet, but both of the other formations appear to vary between wide limits. However, the variations in Renault thickness may be more

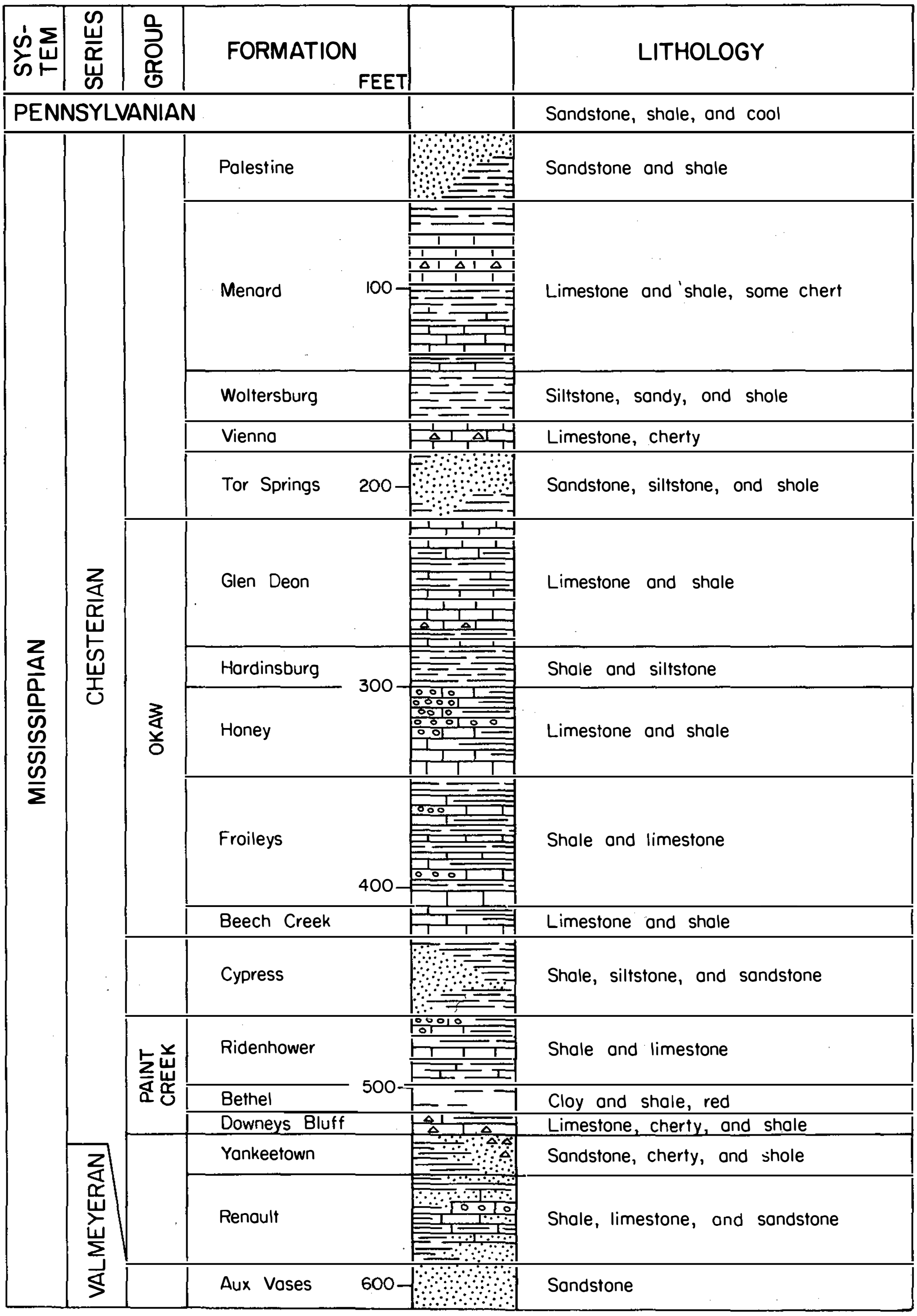

Fig. 2 - Diagrammatic column of strata exposed in lower Kaskaskia valley area.

apparent than real. In areas in which the Renault is largely sandstone, determination of the Aux Vases–Renault boundary is difficult, and there appears to be some justification for assigning most of the thickness variation to the Aux Vases.

Paint Creek Group

The Paint Creek Group, composed, from oldest to youngest, of the Downeys Bluff, Bethel, and Ridenhower Formations, crops out chiefly in two areas (1) along the tributaries of Horse Creek in the western half of T. 4 S., R. 8 W., and (2) in the southwestern corner of the study area, particularly in ravines in the Mississippi bluffs (pl. 1A). The Paint Creek is exposed also in an isolated inlier of older formations west of Evansville in the drainage basin of Camp Creek (pl. 1A).

Lithology. - The lowermost unit of the Paint Creek Group, the Downeys Bluff Formation, is a 10-foot thick succession of cherty limestone and greenish calcareous shale. It rarely is exposed chiefly because of slope wash from the overlying Bethel Formation, which is an approximately 15-foot thick bed of deep red structureless to poorly laminated clay. Good outcrops of the Bethel are seldom found because of its easily eroded nature, but its conspicuous red color can be useful as an identifying marker for the Paint Creek Group even in poor, heavily weathered exposures.

The Ridenhower Formation, at the top of the Paint Creek Group, consists of limestone and shale. The lower part of the formation is predominantly shale with thin dark-colored limestones, but in the upper part the limestones become more massive and lighter-colored, some showing a relatively high degree of purity (e.g. samples 583A and 583C, table 2). In places these upper limestones may form shale-free ledges up to about 15 feet thick, but in other places beds of shale or shaly limestone alternate with 2- to 5-foot ledges of the massive limestone. The total thickness of the Ridenhower is 30 to 35 feet.

Outcrops. - An exposure of the Ridenhower in which the massive limestones are well developed may be found in a small ravine in the Mississippi bluffs 2½ miles southeast of Modoc (sample site 583), where a solid ledge of limestone, 14 feet thick, creates a waterfall in the ravine. Exposures of the Paint Creek Group, west of Ruma in ravines draining northward into Paint and Horse Creeks in secs. 30 and 31, T. 4 S., R. 8 W. and sec. 36, T. 4 S., R. 9 W., show much more shale in the Ridenhower Formation. Solid limestone ledges appear to be only 4 to 5 feet thick. Similar conditions appear to exist in the vicinity of Earle School, about 2 miles southwest of Red Bud. In the south-draining valley in the eastern half of sec. 18, T. 4 S., R. 8 W., ledges of massive limestone have a maximum thickness of 4 feet between shaly intervals. Weller (1914) mentions a small abandoned quarry near Earle School in which the source of the rock appeared to have been a ledge of Paint Creek limestone no more than 4 to 5 feet thick.

Thickness. - The total thickness of the Paint Creek Group is probably 50 to 60 feet.

Samples. - The limestones in the upper part of the Paint Creek Group were sampled at two locations (pl. 1A). Results of chemical analyses are given in table 2. Following are descriptions of the outcrops sampled. Sample site 579, in a north-flowing tributary to Paint Creek, lies about ¼ mile west of the mapped area (pl. 1A) but was chosen, in preference to outcrops of the same beds in tributaries to Paint and Horse Creeks farther northeast, because the exposure was better.

Sample site 579

NE$\frac{1}{4}$, SW$\frac{1}{4}$, SE$\frac{1}{4}$, sec. 2, T. 5 S., R. 9 W., Randolph County, $3\frac{1}{4}$ miles west of Ruma. Stream bed ledges in north-flowing tributary to Paint Creek.

		Ft.	In.
Paint Creek Group			
Ridenhower Formation			
9	Limestone, gray, fossiliferous, slightly oolitic	1	6
8	Shale, red and green	5	
	Covered	1	
7	Dolomite, brown to gray		3
6	Limestone, light gray, fossiliferous and oolitic, cross bedded	2	
5	Limestone, as above, interbedded with shale, greenish; shale totals 8"	2	
4	Shale, greenish, as above with occasional layers of limestone, gray, fossiliferous to fine and dense; limestone totals 18"	6	
3	Limestone, brownish gray, sublithographic, argillaceous		3
2	Shale, as above	1	
	Covered	9	
Bethel Formation			
1	Red Clay	15	

Sample NF 579L includes the limestones of beds 5, 6, and 9 and the dolomite of bed 7 representing 5 feet 9 inches.
Sample NF 579AS is from the red clay of bed 1.
Sample NF 579BS includes beds 2, 3, and 4, representing 7 feet 3 inches.
Sample NF 579CS is from the highest shale unit, bed 8.

Sample site 583

NE corner, NW$\frac{1}{4}$, NW$\frac{1}{4}$, sec. 9, T. 6 S., R. 8 W., Randolph County, $2\frac{1}{2}$ miles southeast of Modoc. Clifflike exposure 200 feet north of river road in small ravine in Mississippi bluff.

		Ft.	In.
Paint Creek Group			
Ridenhower Formation			
12	Limestone, brownish gray to light brownish gray, oolitic, fossiliferous in places; occasional pebble or streak of green, silty shale particularly in bottom and top 6"; oolites partly dolomitized	8	6
11	Limestone and shale interbedded; limestone, dark gray, finely crystalline, fossiliferous; shale, gray, poorly exposed	1	
10	Limestone, brownish gray, mostly finely crystalline, top 2" fossiliferous and oolitic; in beds 1" - 3" thick; ripple-marked with some interbedded greenish gray shale beds up to 2" thick; shale totals 8"	3	
9	Limestone, dark brownish gray with pink calcite and greenish argillaceous areas, fossiliferous		6
8	Shale, greenish gray with interbedded limestone, thin bedded, dark brownish gray, fossiliferous	1	
7	Dolomite, very argillaceous, pale yellowish brown, fine grained		8
6	Limestone, brownish gray, variable lithology, some very finely crystalline, some calcarenite with clear calcite matrix; interbedded with shale, greenish gray	1	6

5	Limestone, brownish gray with much pink and green coloration, fine to medium particulate, fossil fragments, very impure; shaly partings; irregularly bedded; knobby weathering	2
4	Limestone, brownish gray, medium particulate; fragments of bryozoans, crinoids, etc.; in 1" to 2" beds; at top is a lenticular bed extending laterally for about 20' with a maximum thickness of about 20"; thin bedded unit forms overhang	4
3	Limestone, light gray, finely particulate, sandy, massive; green shale pebbles in top 2"	5
2	Limestone, light brownish gray to brownish gray, finely to medium particulate; few discontinuous shale partings	5
1	Limestone, thin bedded, shaly; forms slight reentrant	1

Sample NF 583A represents bed 2.
Sample NF 583B represents bed 3.
Sample NF 583C represents bed 4.
Sample Sl-52 represents bed 12.

Cypress (Ruma) Formation

The Cypress Formation, formerly called the Ruma, overlies the Paint Creek Group and crops out chiefly in the western part of the area from near Red Bud to Modoc and for about $2\frac{1}{2}$ miles in the Mississippi bluffs below Modoc (pl. 1A). The Cypress in this locality appears to consist principally of variegated shale, with some sandstone beds. This formation was not sampled during the investigation because it is devoid of limestone. Good exposures are reported to occur west and northwest of Ruma (Weller, ca.1914). The thickness of the Cypress appears to be around 40 to 50 feet.

Okaw Group

The Okaw Group, formerly called the Okaw Formation, subdivided from the bottom upward into the Beech Creek, Fraileys, Haney, Hardinsburg, and Glen Dean Formations (Swann, in press). The Okaw Group underlies the major part of the lower Kaskaskia area. North of the Randolph County line Okaw strata are largely covered by Pennsylvanian beds, but within Randolph County the Okaw apparently underlies all but a small part of the area between the Kaskaskia River and a line connecting Red Bud and Ruma (pl. 1A), although no outcrops can be found from Red Bud south to Horse Creek because of thick glacial drift. South of Horse Creek to the Mississippi bluffs, Okaw strata underlie the whole of the area west of the Kaskaskia River, with the exception of the belt of older formations along Horse and Paint Creeks, the inlier of Paint Creek-Cypress along Camp Creek west of Evansville, and the older formations along the Mississippi bluffs in the southwestern corner of the area.

East of the Kaskaskia in the northern portion of the area Okaw beds underlie only a relatively narrow strip along the east bank to a point about 2 miles southwest of Baldwin where the river begins its swing southwestward. From this point, the Okaw strata occupy a belt of irregular width, varying from $\frac{1}{2}$ to 4 miles, to the

Mississippi bluffs between Reily Lake and Fort Gage, from which point they are exposed in the bluffs southeastward to and beyond Chester (Weller and Weller, 1939).

Beech Creek Limestone

This formation, the lowest of the Okaw Group, is a relatively thin, dark colored, fossiliferous limestone, shaly in places. Its thickness appears to vary from less than 10 to more than 15 feet. A limestone with the above characteristics was identified as Beech Creek in two ravines in the Mississippi bluffs, $1\frac{1}{2}$ and $2\frac{1}{2}$ miles, respectively, below Modoc. Ledges in the long eastflowing tributary to Camp Creek at the Marigold road bridge in sec. 20, T. 5 S., R. 8 W., are probably also Beech Creek. A fourth locality, described below as sample site 578, was the only place found where the Beech Creek was well enough exposed to make sampling worthwhile. Results of tests on the sample are given in tables 1 and 2.

Sample site 578

$SE\frac{1}{4}$, $NW\frac{1}{4}$, $NE\frac{1}{4}$, sec. 32, T. 4 S., R. 8 W., Randolph County, 1 mile northwest of Ruma. Eight-foot cut bank outcrop and stream bed ledges downstream for 150 feet in tributary to Horse Creek.

		Ft.	In.
Okaw Group			
Beech Creek Limestone			
2	Limestone, brown, very siliceous at top to moderately siliceous at bottom; some layers very fossiliferous with medium size fossil fragments.	1-3	
1	Limestone, brownish gray to gray, variable lithology ranging from sublithographic to medium crystalline, slightly oolitic, some layers fossiliferous; overhanging ledges suggest numerous thin shale beds	10	
	Covered		

Sample NF 578L represents the lower 10-foot limestone unit, bed 1.

Fraileys Shale

This formation, probably about 65 feet thick, consists chiefly of shale but contains limestone beds of varying thickness. In outcrop the limestones ranged from $\frac{1}{2}$-inch to 6 feet or so in thickness, but electric logs of two test borings, one in sec. 22, the other in sec. 27, T. 3 S., R. 7 W., indicated, respectively, 20 feet of limestone at a depth of 100 feet and 15 feet of limestone at a depth of 160 feet.

Limestone lithologies vary from fine grained and dense to coarse and fossiliferous, and from argillaceous or sandy to fairly pure carbonate. Some beds are light colored and oolitic and resemble the limestones of the overlying Haney.

The Fraileys is exposed best south of Horse Creek in the southwestern part of the Lower Kaskaskia area, particularly along the western part of Camp Creek and its tributaries (pl. 1A). In the northern part of the area, thin limestone ledges, probably mostly within the Fraileys, crop out along the small streams between Red Bud and Prairie du Long Creek 3 miles to the north. The former Red Bud City Quarry, near the west edge of town, contained "8 to 12 feet of blue crystalline limestone with shaly partings" (Weller, 1914), which may be either Fraileys or Beech Creek. Following are descriptions of Fraileys exposures that were sampled for analysis. Results of tests are given in table 2.

Sample site 573

NE$\frac{1}{4}$, SW$\frac{1}{4}$, SE$\frac{1}{4}$, sec. 29, T. 2 S., R. 8 W., St. Clair County, 1$\frac{1}{2}$ miles northwest of Hecker. Quarry of Quality Stone Company.

Okaw Group

Fraileys Formation

		Ft.	In.
6	Limestone, more or less weathered, brown, medium particulate, fossil fragments	5	
5	Limestone, greenish gray, argillaceous, thin bedded; shale, gray, calcareous, totals 2" as thin partings	1	
4	Limestone, light brownish gray, fine grained, dense; scattered coarse brachiopods	3	
3	Limestone, brownish gray, sublithographic, in beds 1-4" thick; shale, calcareous, as $\frac{1}{2}$" partings, totals 4"	2	
2	Limestone, light brownish gray, very oolitic; occasional $\frac{1}{2}$" streaks limestone, fine grained, dense, with brachiopods	5	
1	Limestone, as above, in quarry floor		

Sample NF 573A is from bed 2.
Sample NF 573B is from beds 3, 4, and 5, representing 6 feet of limestone.
Sample NF 573C is from top limestone unit, bed 6.

Sample site 580

NW$\frac{1}{4}$, SW$\frac{1}{4}$, SW$\frac{1}{4}$, and SW$\frac{1}{4}$, NW$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 7, T. 5 S., R. 8 W., Randolph County, 2$\frac{1}{2}$ miles northwest of Marigold. Nearly continuous ledges exposed for 500 feet in bed and bank of Camp Creek. Strata dip downstream so that lowest beds are at upper end of outcrop.

Okaw Group

Fraileys Formation

		Ft.	In.
8	Limestone, brownish gray, medium particulate, fossil fragments; some more or less shaly layers as lenses	4	
7	Shale, dark gray; interbedded with limestone, dark gray, fine grained, fossiliferous, in $\frac{1}{2}$ - 3" layers; may be lenticular	4	
6	Limestone, gray to brownish gray, fine to coarse grained, fossiliferous, cross bedded; apparently lenticular	$\frac{1}{2}$-2	
5	Limestone, brownish gray to gray, fine to coarse grained, fossiliferous, knobby weathering	4	
4	Shale, brownish gray, interbedded with limestone, brown, argillaceous, thin bedded		6
3	Limestone, gray, fine grained, fossiliferous	1	
	Covered		3
2	Limestone, very sandy	1$\frac{1}{2}$	
1	Limestone, thin bedded, very silty and argillaceous		6

Sample NF 580L includes beds 3, 5, 6, and 8, representing 11 feet of limestone.
Sample NF 580S includes beds 4 and 7, representing 4$\frac{1}{2}$ feet of shale.

Haney Formation

Outcrops of the Haney Formation may be found at several places south of Horse Creek to and including the Mississippi bluffs and at a few places on the east side of the Kaskaskia River (pl. 1A). North of Horse Creek, outcrops of Okaw Group strata are small and rare because of the cover of glacial drift, and none of the exposures can be identified specifically as Haney. The limits of the Haney north of Horse Creek, therefore, are known chiefly from only a few widely scattered drill holes, and the gently curving dashed lines on the geologic map (pl. 1A) reflect the uncertainty of the Haney boundaries.

Lithology. - The Haney Formation is, in general, a massive light gray to light brownish gray limestone with varying amounts of interbedded greenish gray shale. The limestone is composed largely of small- to medium-sized fossil fragments and is oolitic in places. The amount of shale varies widely from none in a 42-foot face of limestone in a quarry near Roots (sample site 576) to as much as one-third of the formation in drill holes east of the Kaskaskia River. Because of the interbedded nature of the shale, the Haney in places may contain no shale-free limestone units greater than 10 feet in thickness.

A light gray to white, richly oolitic unit within the Haney was noted by Weller (1914) and was named the Marigold Oolite by Sutton (1934). Careful studies during the present investigation and by Shrode (1949), however, indicate that the interval defined by Weller, from exposures near Marigold, is not uniformly oolitic throughout the lower Kaskaskia area. In places a considerable portion of it may be non-oolitic, or it may include alternating oolitic and nonoolitic beds or even shale, and it is not clear whether the term Marigold Oolite should be applied only to the oolitic beds or to the entire interval. As the Marigold Oolite does not appear to constitute a practical unit, these strata will be referred to in this report as oolitic portions of the Haney.

Thickness. - The thickness of the Haney Formation in Randolph County can only be approximated because of the indefinite nature of the lower boundary of the formation. Although the underlying Fraileys contains more shale than the Haney, the Haney may also contain some shale beds. Futhermore, some of the limestones in the Fraileys resemble limestone typical of the Haney and in many places it is extremely difficult to know whether a limestone bed is lowermost Haney or uppermost Fraileys. However, from outcrop and drilling data, it appears that a thickness of 40 to 50 feet is a reasonable figure for the Haney.

Outcrops. - In addition to the three sampled exposures described below, outcrops of the Haney west of the Kaskaskia River are found (1) in some of the sink holes (pl. 1B) in sec. 34, T. 4 S., R. 8 W., and sec. 11, T. 5 S., R. 8 W.; (2) in the two main forks of Crooked Creek, one near the north line, and the other near the south line (extended), sec. 29, T. 5 S., R. 8 W.; and (3) in a sinkhole (pl. 1B) in the SW$\frac{1}{4}$ sec. 2 (extended), T. 6 S., R. 8 W. East of the Kaskaskia, outcrops of the Haney may be found in a southwest-flowing ravine in the SE$\frac{1}{4}$ sec. 13 (extended), T. 6 S., R. 8 W., about 1$\frac{1}{2}$ miles west of Ellis Grove. Weller (1914) describes a quarry in white oolite in the eastern part of Evansville. The white oolite, no longer exposed, was described as probably equivalent to that exposed in the vicinity of Marigold, putting it in the Haney by present terminology. Several other sinkholes in Evansville, none of which contain outcrops, probably also were formed in the Haney.

Sample site 575

SE$\frac{1}{4}$, NW$\frac{1}{4}$, NW$\frac{1}{4}$, sec. 12 (extended), T. 6 S., R. 8 W., Randolph County, 3/4 mile northeast of Collins. Abandoned quarry east side Illinois Southern Railroad tracks at curve.

		Ft.	In.
Okaw Group			
Haney Limestone			
5	Limestone, gray, fine to medium particulate, very fossiliferous, somewhat oolitic,	7	
4	Limestone, finely crystalline, slightly fossiliferous, argillaceous, thin bedded, shaly		6
3	Limestone, brownish gray, medium particulate, slightly argillaceous, very fossiliferous, somewhat oolitic	5	
2	Limestone, finely crystalline, argillaceous, slightly fossiliferous, thin bedded, shaly		6
1	Limestone, light brownish gray, very fossiliferous, partly oolitic	12	
	Covered		

Sample NF 575 from entire 25-foot exposure.

Sample site 576

SE$\frac{1}{4}$, NE$\frac{1}{4}$, NE$\frac{1}{4}$, sec. 15 (projected), T. 6 S., R. 8 W., Randolph County, $\frac{1}{4}$ mile west of Roots. Quarry in bluff, 50 feet above road level at Y intersection.

		Ft.	In.
Okaw Group			
Hardinsburg Formation			
5	Shale, greenish, with thin beds of siltstone, greenish	3	
Haney Limestone			
4	Limestone, light gray, very oolitic, fossiliferous in upper part	29	
3	Limestone, yellowish brown, fine grained, dense, dolomitic, argillaceous	1	
2	Limestone, light gray to gray, partly oolitic, fossiliferous	5	
1	Limestone, gray, mostly medium fossil fragments	7	
	Quarry floor		

Samples for physical testing; see table 1
NF 576A from bed 1.
NF 576B from beds 2, 3, and 4 representing 35 feet of stone.
Samples for chemical analysis; see table 2
NF 576C from beds 1 and2 representing 12 feet of limestone.
NF 576D from bed 4.

Sample site 582

SE$\frac{1}{4}$, SE$\frac{1}{4}$, NE$\frac{1}{4}$, sec. 20, T. 5 S., R. 8 W., Randolph County, $\frac{1}{2}$ mile north of Marigold. Abandoned quarry 100 yards east of Roots-Marigold road.

		Ft.	In.
Covered to top of hill		10	
Okaw Group			
Haney Limestone			
2	Limestone, light brownish gray, composed mostly of medium fossil fragments largely bryozoan debris; some beds partly oolitic; cross bedded	13	

	Covered	2	
1	Limestone, light gray with brownish spots, very oolitic, somewhat soft		6
	Covered to spring at base of hill	25	

Sample NF 582B from bed 2; chemical analysis only, table 2.

Hardinsburg Formation

This formation is chiefly a shale with some thin interbedded sandstone or siltstone layers. Because of its lack of resistance to erosion and its relative thinness, the Hardinsburg is seen rarely in outcrop. The thickness of the Hardinsburg in the lower Kaskaskia area is not known accurately but is probably 20 feet or less.

Glen Dean Formation

The outcrop belt of this formation lies in the eastern part of the lower Kaskaskia area. South of the point at which Horse Creek flows into the Kaskaskia, the Glen Dean is entirely east of the river except for a small area on the ridge leading northwest from Roots. North of Horse Creek exposures of the Glen Dean are found only on the east side of the river, but drill holes in sec. 28, T. 3 S., R. 8 W., and sec. 30, T. 4 S., R. 7 W., indicate that it also underlies the glacial drift on the west side of the river.

Lithology. - The Glen Dean consists of ledges of limestone with intervening beds of shale, the proportions of limestone and shale within a given stratigraphic interval changing from place to place. In the vicinity of Menard, which lies southeast of the area of study, massive limestone free of interbedded shale attains thicknesses up to 40 feet in the Mississippi bluffs. Within the lower Kaskaskia area, however, the thickest shale-free limestone ledge observed in outcrop was 13 feet at sample site 581, in the Mississippi bluffs 1 mile above Reily Lake. Elsewhere in the area, the Glen Dean is poorly exposed, and the thickness and distribution of limestones within it are not well known.

Evidence from drilling also is meager. Limestone and shale thicknesses in the Glen Dean are accurately known from only one electric log (Newmark and Zemlyn No. 1 Nitzsche, NW$\frac{1}{4}$ NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 27, T. 5 S., R. 7 W.), which shows a 20-foot thickness of limestone in the upper part of the formation at a depth of 160 to 180 feet. Drill cuttings from this hole showed the 20-foot interval to be a light colored, generally fine-grained limestone. Samples of cuttings from other borings indicate that, in general, the upper part of the Glen Dean contains light colored, relatively pure limestone and some shale, while the lower part contains much dark colored, silty limestone with shale partings or thin interbedded shales. The amount and distribution of shale in the upper part could not be determined with any certainty, but it appeated that, in some places at least, there should occur 15-to 20-foot thicknesses of shale-free limestone.

Thickness. - From all available data, the thickness of the Glen Dean appears to be 60 to 70 feet.

Samples. - The Glen Dean was sampled at two localities, descriptions of which follow. Results of tests are given in tables 1 and 2.

Sample site 577

SW$\frac{1}{4}$, SW$\frac{1}{4}$, SE$\frac{1}{4}$, sec. 16, T. 4 S., R. 7 W., Randolph County, 1$\frac{1}{2}$ miles west of Baldwin. Ledges in bed of west-flowing tributary to Kaskaskia River; head of ledges directly south from barnyard; end of outcrop 1/8 mile downstream at waterfall.

		Ft.	In.
Okaw Group			
Glen Dean Formation			
7	Limestone, brownish gray, particulate, fossil fragments and oolites	1	
6	Shale, gray; interbedded with limestone, gray, somewhat fossiliferous, thinner beds more impure and silty	6	
5	Limestone, gray, thin bedded, silty	1	
4	Limestone, gray, finely crystalline, dense, partly fossiliferous	1	
3	Limestone, brownish gray, fine to medium grained, somewhat fossiliferous, slightly to moderately oolitic	6	
2	Shale, gray, calcareous; limestone, thin bedded, very argillaceous, in lower part	5	
1	Limestone, dark gray, argillaceous	3	
	Water		

Sample NF 577L from beds 3, 4, and 5, representing 8 feet.
Sample NF 577AS from bed 2.
Sample NF 577BS from bed 6.

Sample site 581

SE$\frac{1}{4}$, NW$\frac{1}{4}$, SW$\frac{1}{4}$, sec. 24, T. 6 S., R. 8 W., Randolph County, 3/4 mile northwest from road intersection at Reily Lake. Bluff along Mississippi River 75 feet in from River road.

		Ft.	In.
Okaw Group			
Glen Dean Formation			
2	Limestone; upper part light brownish gray, fine grained, slightly fossiliferous, partly oolitic; lower part brownish gray, moderately oolitic; interbedded shale, gray, calcareous, totals about 2 feet; shale very poorly exposed and not included in sample	6	
1	Limestone, dark brownish gray, fossiliferous, little oolitic	13	
	Covered; apparently mostly shale.		

Sample NF 581A from bed 1.
Sample NF 581B represents limestone portion of bed 2.

Tar Springs, Vienna, and Waltersburg Formations

These formations were not investigated in detail as they are principally sandstone and shale. The Tar Springs is chiefly sandstone, the Vienna consists of dark gray, cherty limestone, and the Waltersburg includes siltstone and shale. Their total thickness is 60 to 75 feet.

Menard Formation

The outcrop belt of this formation lies in the eastern part of the area east of the Kaskaskia River and extends from Little Plum Creek, 4 miles south of Baldwin, to the Mississippi bluffs at Fort Gage, thence southeastward along the Mississippi. The Menard is about 70 to 85 feet thick and consists of ledges of limestone, partly cherty, generally dark colored and fine grained, separated by beds of shale and shaly limestone of varying thicknesses. No exceptionally thick shale-free limestone ledges were found, the thickest (6 feet) being the lowest ledge in the quarry, sample site 574.

The only Menard exposure found of sufficient thickness and continuity to be worth sampling is described below. Results of tests on the samples are given in tables 1 and 2.

Sample site 574

SE$\frac{1}{4}$, NW$\frac{1}{4}$, NE$\frac{1}{4}$, sec. 2, T. 6 S., R. 7 W., Randolph County, 4 miles northeast of Ellis Grove. Quarry, abandoned and partly water-filled, along Ninemile Creek.

Menard Formation		Ft.	In.
14	Limestone, light brownish gray, finely crystalline, dense, siliceous; chert, chiefly in two beds, totals 5 inches	3	
13	Shale, dark gray, fossiliferous		6
12	Limestone, brownigh gray, dolomitic, slightly fossiliferous	1	
11	Limestone, dark gray, argillaceous, shaly		6
10	Limestone, brownish gray, finely crystalline, dense, massive	2	6
9	Shale, gray, fossiliferous		6
8	Limestone, dark gray, argillaceous	1	
7	Shale, as above		6
6	Limestone, brownish gray, finely crystalline, dense, dolomitic	6	
	Water		

Strata below water level in the quarry are exposed in bed and banks of a stream along south side of quarry and make a continuous section with strata exposed in quarry.

		Ft.	In.
5	Limestone, gray, argillaceous, shaly, thin bedded	1	
4	Limestone, gray, finely crystalline, dense	1	
3	Limestone, brownish gray, argillaceous, finely laminated	1	
2	Shale, dark gray, calcareous		4
1	Limestone, as above	1	
	Water		

Sample NF 574A from beds 1, 3, 4, and 5 representing 4 feet.
Sample NF 574B from beds 6, 8, 10, 11, 12, and 14, representing 14 feet.

Palestine Sandstone

This formation, a thin bedded shaly sandstone, crops out only in the far southeast corner of the area and was not investigated.

Surficial Materials

In addition to the bedrock formations, glacial silts were sampled and tested to determine if they were suitable for use as the shale component in the manufacture of Portland cement. Four samples were taken from 3 exposures. Three of the samples were of loess, a wind-deposited silt, and one was of a water-laid silt; all were of glacial origin. Descriptions of the occurrences follow. Results of chemical analysis are given in table 2.

Sample site L-1

SE¼, NE¼, SE¼, sec. 17, T. 6 S., R. 7 W., Randolph County, 1 mile east of Ellis Grove. West bank northeast-flowing tributary to Little Ninemile Creek just west of bridge.

	Ft.	In.
Pleistocene Series		
Peoria Loess		
Silt, brown, clayey (Sample L-1)	13	
Colluvium, brown; sandy lenses and patches of gravel; fragments of coal, shale, and carbonized wood.	22	
Till, brown, very sticky	4	

Sample site L-2

SW¼, SE¼, sec. 10 (extended), T. 6 S., R. 8 W., Randolph County, 3/4 mile west of Roots. Road cut west side Roots-Marigold road on slope ascending Mississippi bluff.

Pleistocene Series	
Peoria (?) Loess	
Silt, light brown, clayey; contains small (less than .1 cm.) calcareous concretions. (Sample L-2)	40
Covered to bottom of hill	60

Sample site L-3

NE¼, SW¼, SE¼, sec. 29, T. 2 S., R. 8 W., St. Clair County, 1½ miles northwest of Hecker. Exposure of overburden at quarry of Quality Stone Company.

	Ft.	In.
Pleistocene Series		
Peoria Loess		
Silt, brown, clayey, fine sandy (Sample L-3B)	8	
Roxana Silt		
Silt, reddish pink, slightly to very sandy; contains pebbles of chert and metamorphic rocks (Sample L-3A)	10	
Mississippian System		
Limestone (described as sample site 573 under section on Fraileys Formation)	16	

LIMESTONE AREAS FOR PROSPECTING

The data afforded by the outcrops and available well records in the lower Kaskaskia valley area do not permit a detailed assessment of limestone resources. However, it appears that limestone units, consistently more than 20 feet thick, are not generally to be expected. In all upland areas an overburden of glacial drift 25 or more feet thick is probable except in limited tracts along streams. Outcrops are too infrequent to permit selection of specific quarry sites without a program of test drilling. Certain areas, however, appear to hold some promise of comparatively thick limestone and relatively thin overburden. In the following paragraphs each of the formations sampled is discussed in terms of these more promising areas for prospecting.

Haney Formation

The ridge extending northwesterly from Roots to Marigold apparently contains a good thickness of Haney Limestone, and the east flank of the ridge does not appear to have excessive overburden. The areas with many sinkholes (pl. 1B), particularly, probably have thin overburden. However, sinkholes and possible associated tunnels and caves in the limestone may offer problems in quarrying.

Sinkholes also suggest the presence of a comparatively thick limestone layer. The sinkholes containing small outcrops of the Haney Limestone east of Ruma and south and west of Horse Creek, in sec. 34, T. 4 S., R. 8 W., and secs. 2 and 11, T. 5 S., R. 8 W., probably are the result of the presence of a reasonably thick limestone in that vicinity. The sinkholes in the eastern part of Evansville, chiefly in the SE$\frac{1}{4}$ sec. 13 and the NE$\frac{1}{4}$ sec. 24, T. 5 S., R. 8 W., and east and northeast of Evansville in the W$\frac{1}{2}$ sec. 18 and NW$\frac{1}{4}$ sec. 19, T. 5 S., R. 7 W., also suggest a good thickness of Haney Limestone. Weller (1914) reported that a white oolite was quarried from a sinkhole in the eastern part of town but did not mention its thickness.

Two other areas where a limestone within the Haney appears to be close to 20 feet thick are at the abandoned quarry on the railroad 1 mile north of Collins (sample site 575) and in the ravine in the SE$\frac{1}{4}$ sec. 13 (extended), T. 6 S., R. 8 W., 1$\frac{1}{2}$ miles west of Ellis Grove. However, the quarry on the railroad appears to have considerable overburden, and the other area lacks good access roads.

Glen Dean Formation

Little information could be gained on thicknesses and distribution of limestones in the Glen Dean because of scarcity of outcrops and drilling data. It is not known if the massive limestone exposed in the vicinity of Menard attains the same shale-free thickness within the study area. However, the small amount of drilling data available suggests that chances are good for encountering limestone layers 10 to 20 feet thick, perhaps thicker in places, in the upper part of the Glen Dean. Two areas of sinkholes (pl. 1B), one just east of Collins in sec. 12 (extended), T. 6 S., R. 8 W., and the other 1$\frac{1}{2}$ miles south of Evansville in sec. 25, T. 5 S., R. 8 W., and sec. 30, T. 5 S., R. 7 W., probably are developed on the Glen Dean and suggest the presence of a relatively thick limestone in those areas.

Menard Formation

No thick shale-free limestones in the Menard Formation were observed in the lower Kaskaskia area. Southeast of the area in the Mississippi bluffs between Fort Gage and Menard, Lamar (1923) found limestone ledges 20 feet thick in the Menard Formation, and it may be that like thicknesses, obscured by glacial drift, also underlie the eastern part of the study area. Sinkholes (pl. 1B) in secs. 5 and 7, T. 6 S., R. 7 W., are thought to occur in the Menard and may indicate relatively thick limestone intervals.

Paint Creek, Fraileys, and Beech Creek Formations

The Paint Creek Group and Fraileys and Beech Creek Formations do not appear to be particularly promising as commercial sources of limestone because of a lack of persistently thick limestone units. In places, however, relatively thick limestones are known to occur in the upper part of the Paint Creek and in the Fraileys, and it is possible that stone for local use may be obtained if such occurrences can be found without too much overburden.

USES OF LIMESTONE

Physical and chemical tests were made on samples taken from the lower Kaskaskia area with the results shown in tables 1 and 2. The discussion of the use possibilities of these samples is based on the test data only and does not consider the availability or workability of the deposits that have been previously discussed. The physical tests of samples NF 574B, NF 578L, and NF 581AB, table 1, suggest that these samples would be satisfactory for concrete aggregate and the higher types of bituminous work and crushed stone for road rock, railroad ballast, and other purposes. Samples NF 576A, NF 576B, and NF 577L had high soundness losses and would have only limited use in road construction. Of the three, only NF 576A was under the 25 percent limit required of stone for surfacing and base course. Sample NF 575, with a soundness loss just over 15 percent, would be suitable for surfacing and base course, and, if other samples from the deposit should show that the soundness loss is consistently under 15 percent, the stone could be satisfactory for concrete aggregate and bituminous work.

The samples reported in table 2 show a great variation in chemical composition ranging from impure limestones with a carbonate content of only 57 percent to pure limestone with a carbonate content of 99 percent. All of the samples, except those of low carbonate content, probably could be used for agricultural limestone. Some of the samples that are high in calcium carbonate may meet specifications for making certain kinds of glass, blast furnace flux and other fluxing purposes, lime making, and for other purposes requiring limestone of high purity. Sample NF 576D is particularly promising because of its low silica and iron content.

Portland cement is commonly made from a mixture of about 4 parts limestone and 1 part clay or shale. The limestone should contain less than 3.2 percent magnesium oxide. A goodly number of the limestone samples reported on in table 1 meet this requirement. All of the shales have silica ratios (relation of amount of silica to iron plus alumina) that are within or close to probable limits for cement materials, roughly 2 to 3 percent, but the silts have a ratio that is thought to be normally too high. Alkali content, or Na_2O equivalent, of the shales and limestones probably is within the acceptable range for cement making. There is a possibility that some of the limestone and shale deposits might supply both types of raw materials for cement making. It is likely, however, that such deposits will ordinarily contain an excess of shale.

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TABLE 1 — PHYSICAL TESTS OF LIMESTONES

(Tests by State Division of Highways, Bureau of Materials)

Sample No.	Thick-ness, ft.	Part of outcrop	Hardness, Mohs	Specific gravity	Absorp-tion, %	Abrasion loss, %*	Sodium sulfate soundness loss, %*	Geological unit
NF 574B	14	Upper part	4	2.62	2.0	21.9	7.6	Menard
NF 577L	8	Middle part	4	2.64	1.1	27.1	28.8	Glen Dean
NF 581AB	19	Entire exposure	4	2.68	0.5	27.8	4.4	Glen Dean
NF 575	25	Entire exposure	4	2.63	1.0	30.0	15.7	Haney
NF 576B	35	Upper part	—	2.54	2.2	33.3	27.6	Haney
NF 576A	7	Lower part	4	2.63	1.0	33.6	24.8	Haney
NF 578L	10	Lower part	4	2.66	0.8	26.2	7.9	Beech Creek

* State Division of Highways Specifications:

Crushed stone for use in Portland Cement concrete and I–11 bituminous work:
Abrasion loss limit 35%
Sodium sulfate soundness loss 15%

Crushed stone for Grade 8 for surfacing and base course:
Abrasion loss limit 45%
Sodium sulfate soundness loss 25%

TABLE 2 - CHEMICAL ANALYSES OF

(Analyses by L. D. McVicker in the laboratories

Sample no.	Geological unit	Location 1/4 Sec.-T.-R., County	Thick-ness ft.	$CaCO_3$	$MgCO_3$	CaO	MgO	SiO_2
		SHALES						
NF580 S	Fraileys	SW NW SW 7-5S-8W, Randolph	5	35.25†		19.70	1.98	37.56
NF579 CS	Paint Creek	NE SW SE 2-5S-9W, Randolph	5	1.50†		1.51	2.16	56.59
NF579 BS	Paint Creek	NE SW SE 2-5S-9W, Randolph	7	18.58†		10.40	2.05	54.03
NF579 AS	Paint Creek	NE SW SE 2-5S-9W, Randolph	15	11.28		6.63	1.77	58.08
		SILTS						
L1	Peoria loess	SE NE SE 17-5S-7W, Randolph	13			0.73	1.14	76.64
L2	Peoria (?) loess	SE SE SE 10-6S-8W, Randolph	40	5.55#	1.11#	3.11	2.27	75.15
L3 B	Peoria loess	NE SW SE 29-2S-8W, St. Clair	8			0.14	1.21	78.91
L3 A	Roxana silt	NE SW SE 29-2S-8W, St. Clair	10			0.05	0.84	82.19
		LIMESTONES						
NF574 B	Menard	SE NW NE 2-6S-7W, Randolph	14	75.19*	7.01*	42.13	3.35	15.50
NF574 A	Menard	SE NW NE 2-6S-7W, Randolph	4	74.72*	3.39*	41.87	1.62	18.98
NF577 BS	Glen Dean	SW SW SE 16-4S-7W, Randolph	6	60.28*	3.58*	33.78	1.71	24.68
NF577 L	Glen Dean	SW SW SE 16-4S-7W, Randolph	8	75.86*	4.43*	42.51	2.12	15.55
NF577 AS	Glen Dean	SW SW SE 16-4S-7W, Randolph	5	49.11*	8.62*	27.52	4.12	32.73
NF581 B	Glen Dean	SE NW SW 24-6S-8W, Randolph	6	95.74*	1.00*	53.65	.46	2.22
NF581 A	Glen Dean	SE NW SW 24-6S-8W, Randolph	13	95.31*	1.69*	53.41	.81	2.06
NF582 B	Haney	SW SE NE 20-5S-8W, Randolph	13	97.05*	1.04*	54.38	.50	1.38
NF575	Haney	SE NW NW 12-6S-8W, Randolph	25	96.21*	1.75*	53.91	0.84	1.86
NF576 D	Haney	SE NE NE 15-6S-8W, Randolph	29	98.43*	1.00*	55.16	.48	.72
NF576 C	Haney	SE NE NE 15-6S-8W, Randolph	12	96.15*	1.61*	53.88	.77	1.56
NF573 C	Fraileys	NE SW SE 29-2S-8W, St. Clair	5	96.97*	0.69*	54.34	0.33	1.47
NF573 B	Fraileys	NE SW SE 29-2S-8W, St. Clair	6	87.87*	1.65*	49.24	0.79	7.01
NF573 A	Fraileys	NE SW SE 29-2S-8W, St. Clair	5	96.53*	1.25*	54.09	0.60	1.69
NF580 L	Fraileys	SW NW SW 7-5S-8W, Randolph	11	76.32*	4.14*	42.77	1.98	13.04
NF578 L	Beech Creek	NW NE NE 32-4S-8W, Randolph	10	89.71*	4.48*	50.27	2.14	3.70
NF579 L	Paint Creek	NE SW SE 2-5S-9W, Randolph	6	90.73*	2.45*	50.84	1.17	4.72
SL52	Paint Creek	NE NW NW 9-6S-8W, Randolph	8½	91.66*	4.70*	51.36	2.25	2.21
NF583 C	Paint Creek	NE NW NW 9-6S-8W, Randolph	4	96.48*	1.21*	54.06	.58	2.07
NF583 B	Paint Creek	NE NW NW 9-6S-8W, Randolph	5	85.16*	0.96*	47.72	.46	13.21
NF583 A	Paint Creek	NE NW NW 9-6S-8W, Randolph	5	95.90*	1.11*	53.74	.53	2.54

† Calculated by converting CO_2 to $CaCO_3$

Calculated by satisfying CaO with CO_2 and combining excess CO_2, if any, with MgO

* Calculated by factoral multiplication of CaO and MgO data

LIMESTONES, SHALES, AND CLAYEY SILTS

of the Illinois State Geological Survey)

TiO_2	Al_2O_3	Fe_2O_3	Na_2O	K_2O	CO_2	Ignition loss	Silica ratio	Na_2O Equivalent	Part of outcrop
						SHALES			
.95	15.23	2.67	.12	1.49	15.50	20.53	2.1	1.1	Upper part
1.02	21.28	6.66	.17	3.99	.66	6.92	2.0	2.8	Upper part
.82	13.52	4.46	.15	3.01	8.17	11.82	3.0	2.1	Middle part
1.09	15.07	5.60	.16	2.92	4.96	9.03	2.8	2.1	Lower part
						SILTS			
.76	11.28	3.51	1.63	2.28	.00	2.45	5.2	3.1	Entire exposure
.67	10.44	3.09	1.66	2.21	3.02	4.70	5.3	3.1	Entire exposure
.83	10.08	3.12	1.29	2.04	.00	2.50	6.0	2.6	Upper part
.66	9.26	2.87	.57	1.60	.00	2.52	6.8	1.6	Lower part
						LIMESTONES			
<.01	1.42	.93	.06	.18		36.66	6.6	0.2	Upper part
.06	1.86	.73	.08	.22		34.55	7.3	0.2	Lower part
.32	8.13	1.78	.12	.90		28.60	2.5	0.9	Upper part
.09	2.65	1.07	.12	.36		35.50	4.2	0.4	Middle part
.23	6.01	2.14	.24	.79		26.60	4.0	0.8	Lower part
<.01	.76	.33	.03	.05		42.54			Upper part
<.01	.77	.48	.03	.06		42.69			Lower part
<.01	.88	.40	.03	.05		43.07			Entire exposure
<.01	.71	.39	.03	.06		42.70			Entire exposure
<.01	.41	.21	.03	.04		43.42			Upper 30 feet
<.01	.67	.37	.03	.06		42.96			Lower 12 feet
<.01	.84	.63	.03	.05		42.77			Upper one-third
.11	2.50	.70	.06	.44		39.60			Middle one-third
<.01	.56	.51	.02	.07		42.84			Lowest one-third
.13	4.16	1.46	.08	.43		36.21	2.3	0.4	Middle and upper parts
<.01	1.16	1.05	.05	.13		41.79			Lower part
<.01	1.43	.68	.05	.25		41.10			Upper and middle parts
<.01	.73	1.38	.02	.05		42.57			24-32½ ft. above base of outcrop
<.01	.78	.33	.02	.07		42.66			10-14 ft. above base of outcrop
<.01	1.07	.28	.05	.09		37.67	9.8	0.1	5-10 ft. above base of outcrop
<.01	.93	.33	.03	.09		42.42			0- 5 ft. above base of outcrop

TABLE 3 - CHEMICAL ANALYSES FROM EARLIER REPORTS

Sample no.	Geological unit	Location 1/4 Sec.-T.-R., County	Thickness ft.	$CaCO_3$	$MgCO_3$	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	Ignition loss	Misc.	Silica ratio	Remarks
						SHALES								
S17†	Chester	NE SW NW 30-6S-7W, Randolph				1.85	2.43	56.86	18.96	7.22	7.53	SO_3 0.69	2.2	No outcrop description
S28†	Paint Creek	SW NW 5-6S-8W, Randolph	7			5.45	2.56	60.25	16.06	6.07	8.16	SO_3 0.46	2.7	Red Clay, lower part of Paint Creek
S29†	Lower Chester	SW NW 5-6S-8W, Randolph	23			5.70	2.63	59.39	16.77	5.35	6.85	SO_3 0.58	2.7	Six beds, lower part of ravine of S28
S30†	Cypress	SW NW 5-6S-8W, Randolph	13			7.06	1.73	61.11	10.93	6.41	9.34	SO_3 0.14	3.5	Two beds, middle part of ravine of S28
S25†	Cypress	NW NE NW 9-6S-8W, Randolph	15			4.73	1.98	62.80	16.94	5.99	7.11	SO_3 0.18	2.7	One bed, middle part of ravine
S26†	Fraileys	NW NE NW 9-6S-8W, Randolph	12			15.01	3.92	39.24	20.92	7.91	10.45	SO_3 2.22	1.4	Two beds, upper part of ravine of S25
						LIMESTONES								
W254‡	Okaw	NW 4-4S-8W, Randolph	8	96.42	1.09	54.04	0.52	1.50	2.00		42.72			Williams Quarry
W253‡	Okaw	SW 5-4S-8W, Randolph	10	81.76	7.61	45.82	3.64	4.54	5.12		41.26			Red Bud City Quarry
S27‡	Paint Creek-Okaw	SW NW 5-6S-8W, Randolph	38	90.71*	3.47*	50.83	1.66	5.38				R_2O_3 0.46		All limestone beds in ravine of S28
S24‡	Paint Creek-Okaw	NW NE NW 9-6S-8W, Randolph	55	94.37*	2.3 *	52.88	1.10	2.52			42.42	R_2O_3 0.76		All limestone beds in ravine of S25

† From Lamar and Sellin (1930)
‡ From Lamar (1957)
* Calculated from CaO and MgO data.

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