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LIMESTONE RESOURCES OF SCOTT COUNTY, ILLINOIS

James W. Baxter

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LIMESTONE RESOURCES OF SCOTT COUNTY, ILLINOIS

James W. Baxter

ABSTRACT

Limestone strata of Valmeyeran (Mississippian) age crop out in and adjacent to the Illinois River bluffs in the western part of Scott County, Illinois. Outcrop descriptions, insoluble-residue data, and chemical analyses for the Burlington-Keokuk Limestone, Salem Limestone, and St. Louis Limestone Formations indicate that the basal part of the Burlington-Keokuk is the most likely source of crushed stone in the county and that the other formations are less promising. Strata of Pennsylvanian age in eastern Scott County include thin limestone members of limited economic interest.

INTRODUCTION

Scott County, Illinois (fig. 1), is located in western Illinois east of and adjacent to the Illinois River in an area glaciated during the Illinoian and probably the Kansan Ages of the Pleistocene. The bedrock surface in the eastern portion of Scott County comprises formations of Pennsylvanian age that include a few relatively thin limestone members of no more than local economic importance. Thick limestone formations of Valmeyeran (middle Mississippian) age crop out in the western part of the county, especially in and near the bluffs of the Illinois River and along its tributaries. These formations, and particularly the Burlington Limestone, have provided the bulk of the stone produced in Scott County to date, and future quarry sites will be confined essentially to the western outcrop area.

Two quarries have been operated recently in Scott County. The Krueger Quarry, located in the E 1/2 NE 1/4 SE 1/4 Sec. 27, T. 14 N., R. 13 W., is in the bluff of the Illinois River and has been developed in calcitic dolomite and dolomitic limestone beds assigned to the Salem Limestone. The rock quarried has served primarily as a source of agricultural limestone and road rock. The Thomas Quarry, located in the center of NW 1/4 SW 1/4 Sec. 35, T. 13 N., R. 13 W., in the Illinois River bluff, is in the Burlington Limestone and produces stone that meets specifications for base and surface aggregate and for certain grades of Class C

quality bituminous aggregate (Illinois Division of Highways, 1970, p. 77). The cooperation of the owners and personnel of these quarries is gratefully acknowledged.

STRATIGRAPHY

The stratigraphic succession of rock formations that reach the bedrock surface and overlying surficial deposits in Scott County are shown in figure 2. Beds of Mississippian age are separated from the overlying Pennsylvanian by a major sub-Pennsylvanian erosion surface. Pennsylvanian strata may therefore be found superimposed upon Burlington-Keokuk Limestone, Warsaw Shale, Sonora Sandstone, Salem Limestone, or St. Louis Limestone, depending upon the geology of the eroded surface upon which the lowermost Pennsylvanian strata were deposited. The lithologic character of each formation is illustrated by the use of appropriate symbols, for which an explanation is included (fig. 2).

Surficial deposits of drift of Illinoian and older ages commonly overlie the bedrock formations and in upland areas are in turn overlain by various thicknesses of wind-deposited silt. The latter material, loess, was blown up mainly from the flats of the Illinois River during the Wisconsinan glaciation and in general is thicker near the river and decreases in thickness toward the eastern part of the county. Loess thicknesses of as much as 25 feet are fairly common along the bluff of the Illinois River but decrease to thicknesses of 12 to 15 feet in eastern Scott County. The glacial deposits and Holocene alluvium tend to mask the pre-Pleistocene bedrock surface and limit rock outcrops to the bluffs of major water courses and to the beds and banks of lesser streams and gullies.

DISTRIBUTION OF BEDROCK FORMATIONS AND OUTCROP LOCALITIES

The approximate distribution of the various pre-Pleistocene formations at the bedrock surface is shown on plate 1 (in pocket). The precision with which the formational boundaries are drawn varies greatly from place to place on the map because of limitations imposed by thick surficial deposits, a paucity of exposures, and a limited number of drill holes. The map produced is an interpretation of the bedrock surface formations as they would appear if all surficial materials—glacial drift, loess, and alluvium—were stripped away.

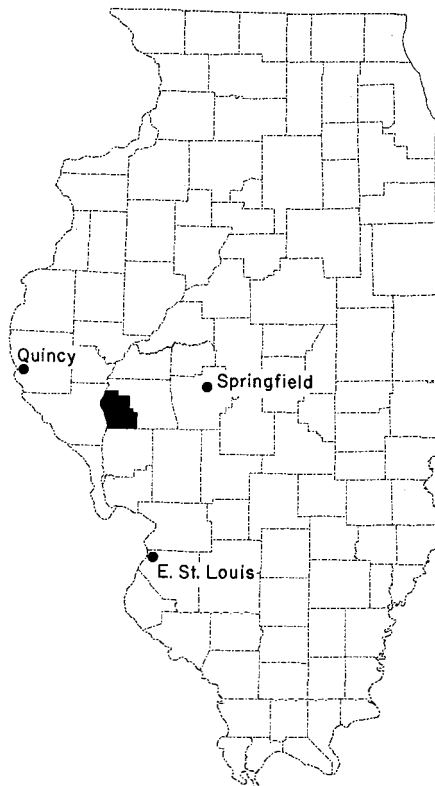


Fig. 1 - Index map highlighting Scott County in western Illinois.

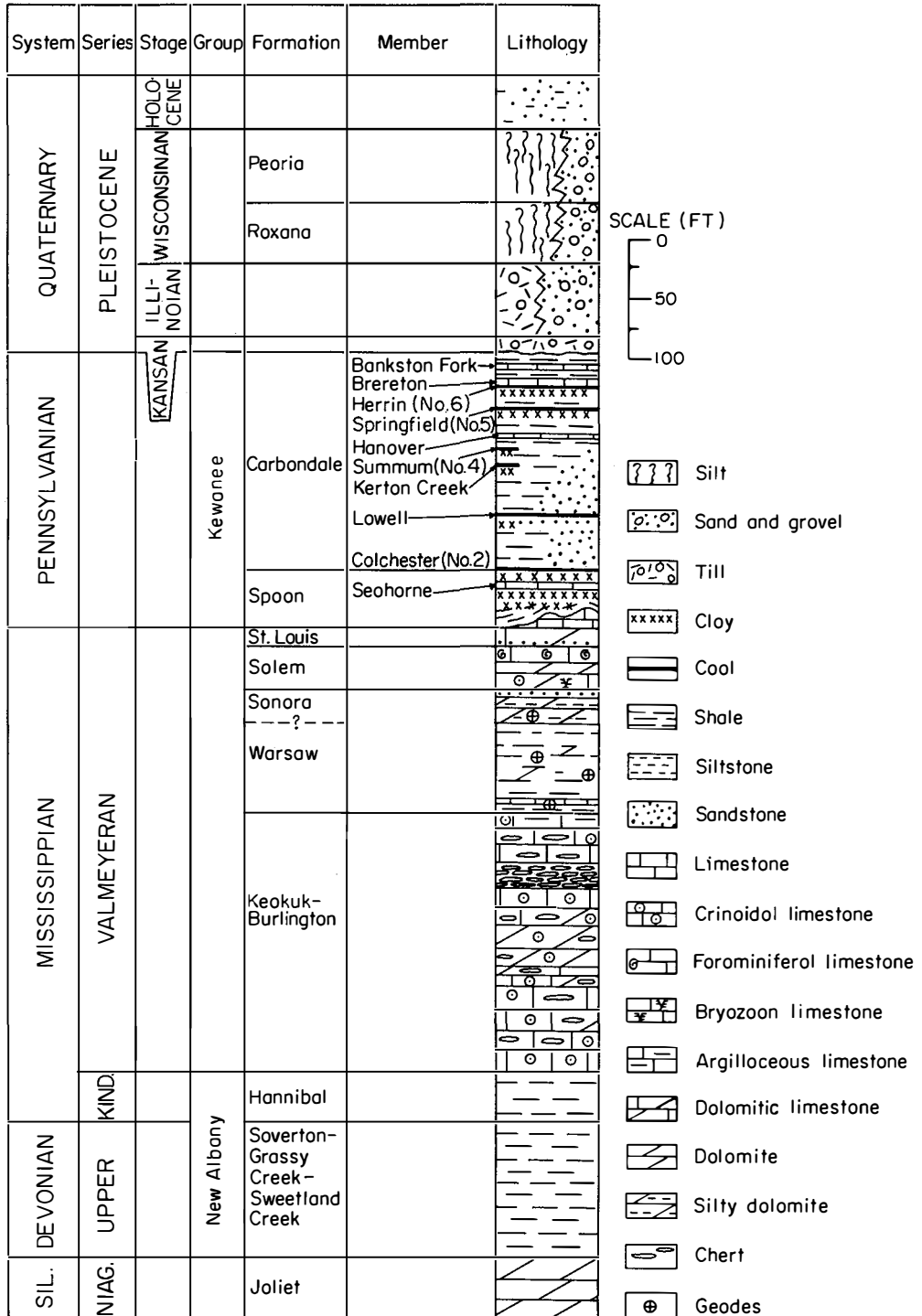


Fig. 2 - Stratigraphy of bedrock surface and surficial deposits in Scott County.

Known areas of limestone outcrop are shown on plate 1. Fifty measured sections sampled in the course of the present study are identified by numbers and described in the appendix. Twenty-eight limestone sections described in the appendix but not sampled are identified alphabetically.

SAMPLES AND TESTS

Limestone outcrops were sampled in such a way as to provide a representative sample of the various lithologic units present. In most instances the sample interval was about 1 foot. At other localities composite samples representing lithologic units were taken or in some places a single composite sample was taken to represent the full exposure. Chert was excluded from the sample when possible. However, the amount of chert present in individual rock units was ordinarily determined by measuring the thickness of chert bands and nodules encountered along several lines perpendicular to the bedding. An average chert content, in inches, was calculated from these measurements and converted to a percentage figure. In some cases the amount of chert was determined by visual estimation or its presence was merely noted.

Tests to determine the percentage of the sample soluble in hot hydrochloric acid were made on 496 samples. The average percent soluble from individual lithologic units or from combined units of similar lithology is tabulated in table 1. The average chert contents, as calculated from observations in the field, are also given. The percent of the sample which was soluble indicates the approximate content of calcite (CaCO_3) and/or dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$). Care was taken to limit dissolution of noncarbonate material such as clay.

Chemical analyses shown in table 2 were made on samples from selected quarries and outcrop localities. In general, only the purer and least cherty limestone beds were analyzed chemically. Some analyses previously reported by Lamar (1957, p. 28-29) are repeated in table 2. The chert content of a single cherty unit as calculated from field observation is tabulated with its chemical analysis.

LIMESTONE RESOURCES

The following discussion of the limestone resources of Scott County is essentially a stratigraphic treatment designed to present information about the general lithologic, chemical, and physical properties of the various carbonate formations and the carbonate portions of other formations. It is intended to serve only as a guide for more detailed investigations leading to site selection. Because of the thickness of unconsolidated overburden and its tendency to mask the surface of the bedrock, core drilling is frequently required to determine the full vertical and horizontal extent of a quarriable deposit.

Exposed stratigraphic units composed predominantly of carbonate rocks (plate 1) include strata as old as the Burlington Limestone (Mississippian) and as young as the Bankston Fork Limestone Member of the Carbondale Formation (Pennsylvanian). Limestone members in the Pennsylvanian are thin and are associated with layers of shale, siltstone, sandstone, coal, and underclay; some of these thin limestone units are discontinuous. The limestone formations of Missis-

TABLE 1 - ACID SOLUBILITY OF LIMESTONE SAMPLES

Locality (plate 1)	Formation or member	Unit nos.	Thick- ness (ft)	Location						No. of samples	Average solubility (%)	Height above base (ft)	Remarks	
				$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	Sec.	T.	R.					Near
1	Carbondale	1	1.0	SW	SW	SE	20	13N	11W	Manchester	1	87.7		
2	Carbondale	1	0-2.0	NE	SE	NW	34	13N	11W	Manchester	1	63.5		in hummocky pods
3	Salem	4	4.0	NW	NW	NE	5	13N	12W	Winchester	1	94.1	17.0-21.0	
		2-3	3.0								1	92.4	12.0-15.0	
		1	2.0								1	89.4	0- 2.0	
4	Burlington-Keokuk	3	7.5	SW	SW	NE	9	13N	12W	Aley	1	90.0	13.0-20.5	2-4% chert, excluded
		2	1.0								1	99.2	9.0-10.0	about 2% chert, excluded
		1	4.5								1	99.0	0- 4.5	
5	Burlington-Keokuk	1-4	18.5	SW	SW	SW	9	13N	12W	Aley	4	97.4	0-18.5	about 20% chert, ex- cluded
6	Warsaw	1	5.0	SW	SE	SW	12	13N	12W	Aley	1	59.6		
7	Seahorne	1	2-3	SE	SW	NW	14	13N	12W	Aley	1	97.6		
8	Burlington-Keokuk	10	4.5	NE	NE	NE	15	13N	12W	Aley	4	68.3	13.8-18.3	cherty
		6-9	6.1								6	70.1	7.7-13.8	cherty
		1-5	7.7								7	63.0	0- 7.7	cherty
9	Burlington-Keokuk	6-8	8.6	NE	NE	NE	18	13N	12W	Aley	5	98.8	15.9-24.5	about 7% chert, excluded
		5	5.3								5	98.7	10.6-15.9	chert excluded
		1-4	10.6								10	98.8	0-10.6	
10	Burlington-Keokuk	12-14	9.1	Cen.	W $\frac{1}{2}$	NW	31	13N	12W	Glasgow	10	89.2	43.0-52.1	cherty
		11	0.2-0.3								1	12.5	42.7-43.0	chert
		3-10	32.1								27	96.3	10.4-42.7	about 11.3% chert, ex- cluded
		1-2	10.4								10	99.3	0-10.4	essentially chert-free
11	Burlington-Keokuk	15	5.0	SE	SE	NE	31	13N	12W	Glasgow	5	98.8	42.5-47.5	11.7% chert, excluded
		10-14	5.7								6	95.6	36.8-42.5	
		8-9	2.5								2	96.7	34.3-36.8	13.3% chert, excluded
		6-7	5.0								5	97.7	29.3-34.3	
		4-5	7.3								7	98.8	22.0-29.3	13.6% chert, excluded
		1-3	22.0								22	98.2	0-22.0	3.8% chert, excluded
12	Burlington-Keokuk	9	10.0	SE	SE	NE	31	13N	12W	Glasgow	5	98.5	18.4-28.4	less than 4% chert, excluded
		3-8	15.1								15	80.2	3.3-18.4	cherty
13	Burlington-Keokuk	7-8	5.5		Cen.	S $\frac{1}{2}$	32	13N	12W	Glasgow	2	96.9	36.3-41.8	chert excluded
		6	14.5								14	97.8	20.3-34.8	little chert, excluded
		2-5	15.3								13	97.6	5.0-20.3	10.8% chert, excluded
		1	2.0								1	99.5	0- 2.0	chert excluded
14	Burlington-Keokuk	1	4.0	SE	SW	SE	33	13N	12W	Glasgow	1	94.5		much chert, excluded
15	St. Louis	1	0.3		Cen.	NE	1	13N	13W	Winchester	1	96.7		
16	Salem or St. Louis	1	2.0	SW	SE	NE	1	13N	13W	Winchester	1	90.5		
17	Warsaw	2	5.0	SE	NE	NE	12	13N	13W	Winchester	1	74.1		
18	Burlington	2-4	22.5		NE	SW	35	13N	13W	Glasgow	22	98.4	7.5-30.0	10.1% chert, excluded
		1	7.5								7	98.1	0- 7.5	
19	Seahorne		?	SE	SW	SW	18	14N	11W	Winchester	1	92.1		boulders
20	St. Louis	1	?	NE	NE	NE	18	14N	12W	Winchester	1	90.2		boulders
21	St. Louis	14-16	1.4	Cen.	W $\frac{1}{2}$	SE	28	14N	12W	Winchester	3	94.6	14.5-15.9	
		13	0.7								1	76.9	13.8-14.5	shaly
		9-12	4.8								4	90.4	9.0-13.8	
		8	0.7								1	46.4	8.3- 9.0	shale and limestone
		6-7	4.5								2	95.4	3.8- 8.3	
		1-5	3.8								5	89.7	0- 3.8	
22	Seahorne	1	2-3	NE	NW	NE	28	14N	12W	Winchester	1	96.5		
23	St. Louis	8-10	3.4	NW	SE	SE	29	14N	12W	Winchester	4	82.4	11.5-16.9	shaly

LIMESTONE RESOURCES OF SCOT COUNTY

Table 1 - continued

Locality (plate 1)	Formation or member	Unit nos.	Thick- ness (ft)	Location						No. of samples	Average solubility (%)	Height above base (ft)	Remarks	
				$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	Sec.	T.	R.					Near
		7	1.5							1	65.5	10.0-11.5		
		2-6	5.5							7	87.9	4.5-10.0		
		1	1.5							1	93.4	0- 1.5		
24	Salem	4	5.4-8.4	NW	SW	NE	32	14N	12W	Winchester	4	91.9	12.9-21.3	
		3	0-3.0								1	88.7	9.9-12.9	
		1-2	9.9								9	96.6	0- 9.9	
25	St. Louis	1	4.5-7.5	SE	NE	NW	32	14N	12W	Winchester	1	98.0		
26	St. Louis	6-8	3.6	NE	NE	NW	32	14N	12W	Winchester	3	81.5	20.7-24.3	
		4-5	3.0								2	46.2	13.7-16.7	cherty
		2-3	1.7								2	68.3	8.0- 9.7	
		1	3.0								1	72.6	0- 3.0	
27	Salem	1	4.0	Gen.	E $\frac{1}{2}$	SW	4	14N	13W	Oxville	1	89.7		
28	Salem	1	1.5	NE	NE	NE	9	14N	13W	Oxville	1	90.4		
29	Warsaw	1	4.0	NE	SW	NW	10	14N	13W	Oxville	1	45.4		
30	Sonora	2	4.0	SW	NW	NW	10	14N	13W	Oxville	1	53.7		sandy
31	Burlington-Keokuk	1	4.0	SW	NE	NW	16	14N	13W	Oxville	1	63.1		cherty
32	Salem	9-10	7.5	NE	NE	SE	27	14N	13W	Winchester	7	86.0	26.0-33.5	about 0.5% chert, ex- cluded
		8	4.0								4	92.9	22.0-26.0	
		4-7	11.5								10	94.4	10.5-22.0	
		2-3	9.2								10	95.1	1.3-10.5	
		1	1.3								1	69.1	0- 1.3	
33	Warsaw (?)	1	2.7(?)	SE	SE	SE	15	15N	12W	Merritt	1	74.0		from boulders
34	Carbondale	1	(?)	SE	SW	NE	25	15N	12W	Merritt	1	71.9		from boulders
35	Salem	7	4.0	Gen.	N $\frac{1}{2}$ E	SE	3	15N	13W	Bluffs	4	73.8	14.7-18.7	
		6	6.0								6	97.0	8.7-14.7	
		3-5	6.8								5	87.4	1.9- 8.7	
		2	1.9								2	71.1	0- 1.9	
36	St. Louis	9	2.0-3.5		SW	SW	14	15N	13W	Bluffs	1	98.7	8.5-12.0	
		5-8	4.0								5	95.4	3.5- 8.5	
		1-4	3.5								4	90.8	0- 3.5	
37	St. Louis	2-4	2.2	SE	NW	NE	14	15N	13W	Bluffs	3	91.4	2.0- 4.2	
		1	2.0								1	88.9	0- 2.0	
38	Salem	1-2	5.5	Gen.	NW	NW	14	15N	13W	Bluffs	2	89.4	0- 5.5	
39	St. Louis or Salem	9	2.7	NW	NE	NW	21	15N	13W	Bluffs	1	2.9	35.8-38.5	sandstone
	Salem	8	8.5								1	68.6	27.3-35.8	
		7	9.0								1	92.0	18.3-27.3	
40	Seahorne	2	3.5	SE	SE	SW	23	15N	13W	Exeter	1	98.8	9.0-12.5	
41	Seahorne	6	2.0-2.5	SE	SE	SE	24	15N	13W	Exeter	1	98.4	14.8-17.3	
	St. Louis	3-4	2.5								1	83.6	2.3- 4.8	
		1-2	2.3								2	92.0	0- 2.3	
42	St. Louis	7	5.0	NE	NE	NW	25	15N	13W	Exeter	1	85.3	6.7-11.5	
		1-6	6.7								6	96.1	0- 6.7	
43	St. Louis	2-8	8.5	SW	NW	NW	25	15N	13W	Exeter	7	95.0	5.0-13.5	
		1	5.0								5	91.4	0- 5.0	
44	St. Louis	12	0.5	NE	NE	NW	26	15N	13W	Exeter	1	83.8	14.7-15.2	
	St. Louis-Salem	6-9	7.8								7	89.3	5.9-13.9	
	Salem-Sonora?	1-5	5.7								7	44.7	0- 5.9	largely siltstone and shale
45	Seahorne	1	2-4	Gen.	W $\frac{1}{2}$	SE	26	15N	13W	Exeter	1	98.7		
46	Salem	4-5	9.2		NW	SE	27	15N	13W	Exeter	1	96.2	11.0-20.2	

	Sonora-Warsaw	2	0-9.0							1	24.3	0- 9.0	siltstone	
		1	0-9.0							1	69.5	0- 9.0	silty	
47	Salem	7	7.5±	SW	NW	SE	33	15N	13W	Oxville	1	87.5	13.4-20.9	
	Sonora-Warsaw		2.5-3.0								2	60.8	10.4-13.4	argillaceous
			6.4								2	90.4	4.0-10.4	
			4.0								2	76.1	0- 4.0	argillaceous or silty
48	Sonora-Warsaw	5	4.0	SE	NE	NE	33	15N	13W	Exeter	1	66.9	16.0-20.0	argillaceous
		3-4	9.0								2	74.6	7.0-16.0	silty in part
		1-2	7.0								2	83.6	0- 7.0	
49	St. Louis	9-15	9.5	NE	NE	NE	34	15N	13W	Exeter	7	67.2	27.0-36.5	shaly and siliceous
	Salem	8	8.0								8	95.7	19.0-27.0	
	Sonora-Warsaw	1-7	19.0								9	41.2	0-19.0	silty, part sandstone
50	Salem	9-10	11.2	NE	NW	SE	34	15N	13W	Exeter	9	90.3	23.3-34.5	
		8	1.2								1	4.7	22.1-23.3	siltstone
	Sonora-Warsaw	6-7	4.5								2	64.2	17.6-22.1	silty
		2-5	10.6								4	43.8	7.0-17.6	largely siltstone
		1	7.0								3	83.9	0- 7.0	

TABLE 2 — CHEMICAL ANALYSES

Locality	Formation or member	Unit nos.	Thick-ness (ft)	Location						
				¼	¼	¼	Sec.	T.	R.	Near
10	Burlington-Keokuk	1-2	10.4	Gen.	W½	NW	31	13N	12W	Glasgow
12	Burlington-Keokuk	9	10.0	SE	SE	NE	31	13N	12W	Glasgow
24	Salem	4	5.4-8.4	NW	SW	NE	32	14N	12W	Winchester
			0-3.0							
		1-2	9.9							
32	Salem	4-6	7.9	NE	NE	SE	27	14N	13W	Winchester
		3	5.2							
	Salem-Warsaw	1-2	5.3							
32 ³	Salem		25.7	NE	NE	SE	27	14N	13W	Winchester
36	St. Louis	1-9	10.5		SW	SW	14	15N	13W	Bluffs
40 ⁴	Seahorne Member of Spoon		3.0	SE	SE	SW	23	15N	13W	Exeter
43	St. Louis	3-8	7.7	SW	NW	NW	25	15N	13W	Exeter
		1-2	6.0							

¹All analyses by the Analytical Chemistry Section of the Illinois State Geological Survey.

²Calculated from CaO and MgO.

³Sample no. R122 as reported by Lamar (1957, p. 28-29).

⁴Sample no. R130 as reported by Lamar (1957, p. 28-29).

sippian age are relatively thick, but the quality and quantity of stone available vary considerably, depending primarily upon the amounts of deleterious material, physical properties of the stone, and thickness of overburden.

Pre-Valmeyeran Strata

Rocks of Silurian, Upper Devonian, and Kinderhookian (early Mississippian) age are assumed to underlie valley fill and alluvial deposits along the broad flood-plain of the Illinois River in western Scott County (plate 1). Only the Silurian is known to contain thick beds of carbonate rock; however, it occurs at the bed-rock surface in only a small area in the extreme southwest corner of the county where the excessive thickness of surficial materials (probably 100 to 150 feet) and the probability of adverse ground-water conditions appear to prohibit commercial development.

Burlington-Keokuk Limestone

The Burlington Limestone and the overlying Keokuk Limestone were not differentiated in preparing the geologic map (plate 1) nor in sampling. These formations are so similar in lithology that it is generally difficult to distinguish one from the other in isolated outcrops. They are both composed predominantly of cherty, gray or buff, crinoidal limestone and together have an aggregate maximum thickness of about 220 feet in the area of outcrop.

The Burlington-Keokuk Limestone is exposed in and adjacent to the bluff of the Illinois River for a distance of about 2 miles, extending northward from the

OF LIMESTONE SAMPLES¹

Chemical analyses								Chert excluded	Feet above base
CaCO ₃ ²	MgCO ₃ ²	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	CO ₂		
96.30	1.99	0.53	0.64	0.08	53.95	0.95	43.39		0-10.4
97.51	0.88	1.04	0.35	0.07	54.63	0.42	43.15	less than 4%	16.2-26.2
80.09	15.37	3.00	1.48	0.03	44.87	7.35	43.03		9.9-18.3
56.92	36.11	5.02	2.38	0.03	31.89	17.27	43.40		9.9-12.9
86.13	3.43	9.18	0.86	0.09	48.25	1.64	39.73		0- 9.9
60.32	32.85	3.75	2.87	0.03	33.79	15.71	43.77		10.5-18.4
65.54	28.65	3.23	2.26	0.04	36.72	13.70	43.85		5.3-10.5
68.61	16.98	11.94	2.13	0.05	38.44	8.12	38.91		0- 5.3
75.49	16.83	4.07	1.42	1.65	42.30	7.95	41.30		
90.34	2.26	5.28	1.79	0.07	50.61	1.08	40.91		
95.48	0.63	0.47	1.36	1.05	53.49	0.30	42.05		
94.71	0.79	3.24	0.91	0.08	53.06	0.38	42.02		6.0-11.7
90.09	0.92	7.46	1.48	0.07	50.47	0.44	40.01		0- 6.0

Greene County line. Other exposures occur along Sandy Creek, both Little Sandy Creeks, and their tributaries for a distance of 5 to 6 miles east of the bluff. The Burlington-Keokuk consists of crinoidal limestone, commonly with considerable amounts of nodular and/or bedded chert. In general, two lithofacies predominate, each with variable amounts of chert. Light gray, crinoidal limestone that exhibits a marked coarse-crystalline appearance due to an interlocking fabric of sparry calcite in optical continuity with single-crystal crinoid fragments may occur throughout the formation. Many beds in the lower half of the interval consist of crinoid fragments in a buff to brown, fine-grained, dolomitic matrix. The limestones of the Burlington-Keokuk, with chert excluded, ordinarily have acid solubilities of 90 to 99 percent (table 1, localities 4-5, 9-14, and 18). The amount of chert varies and is unpredictable.

The basal high-calcium beds of the Burlington Limestone that are extensively worked in the vicinity of Quincy, Adams County, Illinois, cannot be adequately delineated in Scott County because of poor exposures and a paucity of subsurface data. Throughout its extent in Illinois, the basal unit varies in thickness from less than 10 feet to almost 40 feet. In Scott County the basal unit seems to be thin, from less than 10 to about 15 feet thick. Sampled at two localities where thicknesses of approximately 8 and 10 feet, respectively, are exposed, the basal limestone is 98 to 99 percent acid-soluble (table 1, locality 10, units 1-2 and locality 18, unit 1). Chemical analyses, excluding minor amounts of chert, show a calcium carbonate content of 96.30 percent; magnesium carbonate, 1.99 percent; and silica, 0.53 percent (table 2, locality 10).

The upper part of the Burlington-Keokuk becomes finer grained and thinner bedded, and it grades into the overlying Warsaw Formation.

The possible commercial uses for limestone of the Burlington-Keokuk Formation in Scott County are limited by the amount of enclosed chert and its abrasiveness on the crushing equipment. Some outcrops might serve as sources of crushed stone for use as road rock and agricultural limestone. Experience within the stone industry in Scott and neighboring counties has shown that the lowermost portions of the Burlington can be selectively worked to make products that meet specifications for some components of Class C, or in some cases Class B, quality aggregates used in the construction of bituminous road surfaces. Exploratory drilling within the area of outcrop may reveal in the lower part of the Burlington suitable thicknesses of stone that meets chemical specifications for the manufacture of portland cement. Economical operations for good quality stone for most purposes may require underground mining techniques.

Warsaw Shale and Sonora Sandstone

The Warsaw Shale in Scott County consists of approximately 100 feet of gray, argillaceous dolomite, dolomitic limestone, and gray to bluish dolomitic shale. Shale predominates, especially in the lower part of the formation.

The Warsaw is overlain by 2 to 10 feet of dolomitic sandstone or sandy dolomite that has been assigned to the Sonora Sandstone (Collinson, 1964) and may correlate with the Bilyeu Member of the Warsaw (Lineback, 1968, p. 17). The Warsaw and the Sonora are not differentiated on the geologic map (plate 1) because together they represent a predominantly clastic section not known to contain limestone or dolomite of acceptable quality or thickness for commercial use. Where sampled, the beds within the interval had acid solubilities that ranged from 4.7 percent to about 80 percent (table 1).

Salem Limestone

The Salem Limestone is poorly exposed and not well defined in the area of this report. Strata assigned to the Salem consist of gray to brown, relatively pure, partly dolomitic, fossil-fragmental limestone, and are commonly cross-bedded. However, this lithology appears to grade laterally into fine-grained dolomite and dolomitic sandstone. Where not removed by pre-Pennsylvanian erosion, the Salem appears to vary in thickness up to a known maximum of about 30 to 35 feet. However, uncertainty exists about the placement of the upper and lower boundaries of the formation.

Beds assigned to the Salem Limestone, sampled at 11 localities, varied from about 86 to 96 percent in acid solubility (table 1). Chemical analyses of selected outcrops show calcium carbonate contents ranging from approximately 57 to 86 percent, magnesium carbonate from 3 1/2 to 36 percent, and silica from 3 to 9 percent (table 2, localities 24 and 32).

The economic potential of limestone beds assigned to the Salem Limestone is handicapped by substantial vertical and lateral variation in the quality of the stone, which hinders the production of crushed stone of consistent physical and chemical character. Deposits of sufficient purity and thickness to qualify as possible sources of high-purity, low-magnesium limestone were not encountered. However, portions of the formation west of Sandy Creek southwest of Winchester could probably supply agricultural limestone and possibly some stone for secondary roads. The Salem of western Illinois is ordinarily not of a quality to meet specifications for use as either bituminous or concrete aggregate.

St. Louis Limestone

The St. Louis Limestone is present and well exposed in the immediate vicinities of Winchester and Exeter and probably underlies surficial deposits at intermediate points. However, over much of the county the St. Louis was completely removed by erosion prior to the deposition of rocks of Pennsylvanian age. The maximum observed thickness of St. Louis was 24 feet.

The St. Louis Limestone consists of dense, fine-grained limestone, portions of which are dolomitic. Parts of the St. Louis are shaly. Sampled at 12 localities, beds assigned to the St. Louis ranged from 46 to 98 percent in acid solubility (table 1) and most outcrops probably average about 90 percent in carbonate content. Purer portions of two sections had calcium carbonate contents from 90 to 95 percent, magnesium carbonate from 0.8 to 2.3 percent, and silica contents from 3 to 7 percent (table 2, localities 36 and 43).

The St. Louis Limestone in the vicinity of Exeter and south of Winchester could possibly supply an acceptable product for use as agricultural limestone. Exposed portions of the St. Louis contain notable shale in thin beds and partings and soft, somewhat porous dolomite, which tend to lower the quality of the stone.

The extent of the formation west and northwest of Winchester has not been adequately delineated and probably could be ascertained only by extensive subsurface testing. Drilling there and in areas of known St. Louis outcrops could aid in the evaluation of the formation as a source of marketable stone.

Seahorne Limestone Member of the Spoon Formation

The Seahorne Limestone is the oldest limestone of Pennsylvanian age outcropping in Scott County. It occurs near the top of the Spoon Formation, generally about 3 to 5 feet below the Colchester (No. 2) Coal Member. The Seahorne, sampled at five localities, consists of nodular, gray and buff, fossiliferous limestone. It varied from 92 to 99 percent in acid solubility (table 1, localities 7, 22, 40, 41, and 45), and a single chemical analysis showed a calcium carbonate content of 95.5 percent, magnesium carbonate 0.6 percent, and silica 0.47 percent (table 2, locality 40). However, the Seahorne is thin, varying from 1.5 to about 4 feet in thickness, and hence has little economic potential.

Limestone Members of the Carbondale Formation

Thin limestone members of the Carbondale Formation were sampled near Manchester and near Merritt. The exact position of these limestones within the formation is not well established and more than one stratigraphic unit is probably involved. Carbonate rock sampled at locality 2 was not in a discrete bed but in small discontinuous pods of limestone about 63 percent soluble in acid. Other occurrences had acid solubilities that ranged from 71 to 87 percent (table 1, localities 1, 33, and 34). All were less than 3 feet thick and thus, like the Seahorne, have little economic potential.

DISCUSSION OF RESOURCES

Factors, other than quality of stone, that affect the suitability of a limestone or dolomite deposit as a potential quarry site include thickness and type of overburden, thickness of quarriable stone, bedding characteristics, lateral

variation, availability of land, distance to markets, and transportation costs. Over much of the county outcrops are restricted to creek beds and the lower elevations in valley walls; therefore, bedrock is largely hidden by overlying glacial drift and loess. Extensive drilling would be required to adequately evaluate quarriable stone, and either drilling or geophysical investigations would be needed to determine overburden conditions.

Further exploration for quarry stone in Scott County will probably be most directly concerned with the Burlington-Keokuk and perhaps, but to a lesser extent, the St. Louis Limestone. More detailed studies of the Burlington-Keokuk may reveal areas where the high-purity, relatively chert-free basal part of the Burlington is thick enough to allow quarry or mining operations. A basal, almost chert-free zone about 20 feet thick occurs in the east bluff of the Illinois River just south of the Scott County line where a mine entry was started but abandoned. Such occurrences would be of interest, especially if the stone could be processed to remove or reduce the amount of chert to meet specifications for the various uses of limestone (Lamar, 1965).

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APPENDIX

OUTCROP DESCRIPTIONS

The appended outcrop descriptions that are arranged in numerical order are of localities from which samples were taken for this study. The order was determined by location by section, township, and range; the locality numbers correspond to those shown on plate 1 and in tables 1 and 2. Lithologic units are described in stratigraphic order and numbered. Unit 1 in each case represents the base of the outcrop. The average solubility for each lithologic unit is given (see text, p. 4). Chert contents are given for those units on which such determinations were made. Data tabulated in tables 1 and 2 can be directly correlated to the outcrop descriptions by reference to the numbered lithologic units.

Descriptions arranged in alphabetical order are of outcrops not sampled. These outcrops were generally of lesser extent and were more poorly exposed than those sampled.

LOCALITY 1: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 20, T. 13 N., R. 11 W., near Manchester; outcrop in ledge near gully branch.

Overburden: 20 to 25 feet, covered.

Carbondale Formation

Limestone, grayish brown, sublithographic, fossiliferous (brachiopods); 87.7 percent soluble (1.0 foot).

LOCALITY 2: NE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 34, T. 13 N., R. 11 W., near Manchester; in east bank of creek, about 200 feet downstream from old bridge foundation.

Overburden: undetermined

Carbondale Formation

Limestone, very silty, displaying intricate internal crenulations (algal?); 63.5 percent soluble; in discontinuous, hummocky pods enclosed by silty shale (0 to 2.0 feet).

LOCALITY 3: NW $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 5, T. 13 N., R. 12 W., near Winchester.

Overburden: 0 to 10 or more feet, covered; probably loess and soil.

Salem Limestone (?)

4. Dolomite, slightly calcareous, grayish brown, mostly fine-grained, porous; displays some sparkling crystal faces; 94.1 percent soluble; essentially one massive bed but has irregular partings 8 to 12 inches apart (4.0 feet).

Covered (2.0 feet).

3. Dolomite, calcareous, grayish brown, fine-grained (0.7 foot). 2. Limestone, dolomitic, yellowish brown, fine- to medium-grained; has somewhat crystalline appearance; 92.4 percent soluble (2.3 feet).

Covered (approximately 10.0 feet).

1. Dolomite, slightly calcareous, brown, fine-grained; 89.4 percent soluble; rather laminated and sugary (2.0 feet).

LOCALITY 4: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 9, T. 13 N., R. 12 W., near Alsey.

Overburden: 38 feet, covered hillslope containing chert float; probably partly underlain by cherty limestone.

Burlington-Keokuk Limestone

3. Limestone, slightly cherty, light brownish gray, fine- to coarse-grained, fossiliferous (crinoidal); 90.0 percent soluble; thin-bedded; 2 to 4 inches of chert near center (7.5 feet).

Covered (3.0 feet).

2. Limestone, slightly cherty, fine- to coarse-grained, crinoidal; 99.2 percent soluble; thin-bedded (1.0 foot).

Covered (4.5 feet).

1. Limestone, light gray to almost white, fine- to coarse-grained, mostly medium-grained; fossiliferous (crinoidal); 99.0 percent soluble (4.5 feet).

LOCALITY 5: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 9, T. 13 N., R. 12 W., near Alsey; outcrops occur in floor and sides of creek gully; basal beds exposed 150 feet north of fence located on north side of power line.

Overburden: 0 to 40 feet, covered hill-slope to east and west.

Burlington-Keokuk Limestone

4. Limestone, cherty, light gray, light brownish gray; 98.5 percent soluble; chert in large bodies 3 to 6 feet long and up to 9 inches thick; unit averages 20.8 percent chert; outcrop on east gully wall (8.0 feet). 3. Limestone, cherty, light gray to light brownish gray, fine- to medium-grained, fossiliferous; 93.8 percent soluble; top beds weather out 1/8 to 1/2 inch thick; chert in irregular bands and nodules; unit averages 20.0 percent chert (approximately 5.0 feet). 2. Limestone, cherty, light gray to light brownish gray, mostly fine- to medium-grained; fossiliferous (brachiopods); calcarenitic; 99.1 percent soluble; irregularly bedded, most beds about 2 inches thick; chert in bands and nodules; averages 25 percent chert; forms bench in creek at fence line (approximately 3.0 feet). 1. Limestone, cherty, light brownish gray, brownish gray, mostly fine- to medium-grained; 99.1 percent soluble; most beds 1½ to 2 inches thick; chert in nodules and bands; unit averages 20 percent chert and crops out for about 100 feet in gully; forms ledge approximately 50 feet north of fence (approximately 2.5 feet).

LOCALITY 6: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 12, T. 13 N., R. 12 W., near Alsey.

Overburden: undetermined

Warsaw Shale

2. Dolomite, silty, yellowish brown, fine, siliceous; 59.6 percent soluble; partly thin-bedded; contains small siliceous geodes; shale interbedded at center (5.0 feet). 1. Shale, greenish gray.

LOCALITY 7: SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 14, T. 13 N., R. 12 W., near Alsey; in clay pit at site of coal diggings.

Overburden: up to 35 feet of younger Pennsylvanian beds and/or up to 25 feet of till.

Seahorne Limestone Member, Spoon Formation

1. Limestone, medium to dark gray, weathers brown, somewhat fossiliferous; 97.6 percent soluble (3.5 to 4.0 feet).

LOCALITY 8: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 15, T. 13 N., R. 12 W., near Alsey.

Overburden: 40 to 50 feet, covered hillslope.

Burlington-Keokuk Limestone

10. Limestone, cherty, light gray with yellowish tinge, fine- to medium-grained; 68.3 percent soluble; thin-bedded; chert disseminated in angular fragments (4.5 feet). 9. Limestone, shale, and chert; 43.2 percent soluble (0.5 foot). 8. Limestone, cherty, light gray with slight yellowish tinge, fine- to medium-grained; 75.4 percent soluble; thin-bedded; chert in angular fragments (1.3 feet). 7. Chert, calcareous; contains large, calcite-filled geodes; 41.7 percent soluble (1.1 feet). 6. Limestone, cherty, light yellowish gray weathering yellowish brown, fine-grained; lenses of fossil-fragmental limestone in top part; 82.0 percent soluble; light gray and pink chert disseminated in angular fragments; unit contains numerous geodes (3.2 feet). 5. Dolomite, gray, earthy; 71.4 percent soluble (0.5 foot). 4. Limestone, light gray, fine- to medium-grained, calcarenitic; contains gray, dolomitic, earthy streaks in top half; 92.7 percent soluble; beds 1 to 2 inches thick (1.5 feet). 3. Chert and limestone, 25.2 percent soluble (2.5 feet). 2. Limestone, yellowish brown, mostly fine- to medium-grained; 93.8 percent soluble; beds 1 to 2 inches thick (2.7 feet). 1. Chert, calcareous; 14.0 percent soluble (0.5 foot).

LOCALITY 9: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 18, T. 13 N., R. 12 W., near Alsey; old quarry on side of wide curve on Chicago, Burlington and Quincy Railroad.

Overburden: 0 to 15 feet, covered; probably mostly loess and soil with some weathered rock.

Burlington-Keokuk Limestone

8. Limestone, light gray, medium- to coarse-grained, mostly medium; fossiliferous (crinoids and brachiopods); 98.5 percent soluble; beds 3 to 6 inches thick (4.0 feet). 7. Chert, 60 percent, and limestone, 40 percent; limestone 96.8 percent soluble (1.0 foot). 6. Limestone, pale brownish gray, medium- to coarse-grained, fossiliferous (crinoidal); 99.3 percent soluble; stylolitic partings 2 to 8 inches apart (3.6 feet). 5. Limestone, cherty, light brownish gray, medium- to coarse-grained; 98.7 percent soluble; closely spaced (1 to 6 inches) stylolitic

partings; chert occurs in flat nodules in lower part, in irregular distribution with limestone in middle part, and in a few nodules in upper part (5.3 feet). 4. Limestone, light brownish gray, mostly medium- to coarse-grained, fossiliferous; 97.9 percent soluble; essentially a single bed; chert in bands and in irregular distribution at top; unit averages 10.2 percent chert (3.3 feet). 3. Limestone, as above; 99.5 percent soluble; chert in bands and nodules; unit approximately 50 percent chert (1.0 foot). 2. Limestone, slightly cherty, light brownish gray, fine- to coarse-grained, mostly medium to coarse with some beds of darker, fine-grained limestone; 99.1 percent soluble; stylolitic; chert in anastomosing band and nodules; unit averages 2.5 percent chert (3.3 feet). 1. Limestone, very cherty, light brownish gray, fine- to medium-grained; 99.1 percent soluble; chert in nodules and discontinuous band; unit averages 33.3 percent chert (3.0 feet).

LOCALITY 10: Center W $\frac{1}{2}$ NW $\frac{1}{4}$ Sec. 31, T. 13 N., R. 12 W., near Glasgow; abandoned quarry operated by county.

Overburden: 0 to 30 feet, covered; probably largely loess and soil.

Burlington-Keokuk Limestone

14. Limestone, cherty, yellowish brown, mostly medium- to coarse-grained, fossiliferous (crinoidal); 98.8 percent soluble; essentially a massive bed; unit averages 2.3 percent chert (3.5 feet). 13. Chert, sample 5.9 percent soluble (0.2 to 1.0 foot). 12. Limestone, yellowish brown with slight greenish tinge in basal 2 feet, mostly medium- to coarse-grained; fossiliferous (crinoids and large brachiopods); 99.1 percent soluble; essentially a single bed, stylolitic (5.0 feet). 11. Chert, sample 12.5 percent soluble (0.2 to 0.3 foot). 10. Limestone, slightly cherty, yellowish brown; contains light gray fossil fragments, chiefly bryozoans; 92.7 percent soluble; chert in discontinuous sub-ovoid bodies 2 to 4 inches in diameter and in discontinuous band near top; unit averages 5.0 percent chert (2.5 feet). 9. Limestone, dolomitic, cherty, fine-grained; 84.1 percent soluble; indistinct beds 3 to 8 inches thick; contains calcite nests and small chert nodules; unit averages 10 percent chert (2.5 feet). 8. Limestone, cherty, brownish gray, medium- to coarse-grained, fossiliferous (crinoidal); 99.1 percent soluble; essentially massive but has faint bedding features, stylolitic; chert in elongate masses as much as 10 inches thick and 10 feet long; unit averages 14.3 percent chert (3.5 feet). 7. Limestone, cherty, dolomitic, brown, gray, fine- to coarse-grained; consists of coarse light gray fossil fragments in fine- to medium-grained brown matrix; 98.3 percent soluble; unit averages 10.7 percent chert (7.5 feet). 6. Limestone, cherty, light gray, fine- to coarse-grained, fossiliferous; 98.9 percent soluble; chert in large nodules; unit averages 8.9 percent chert (5.7 feet). 5. Limestone, very cherty, brown; contains light gray fossil fragments; fine- to coarse-grained, mostly medium to coarse; fossiliferous (crinoidal); grades to brown, fine-grained, dolomitic limestone in top half; 96.9 percent soluble; unit averages 36.4 percent chert (1.6 feet). 4. Limestone, very cherty, partly dolomitic, brown; contains white fossil fragments; fine- to coarse-grained; 98.4 percent soluble; beds 4 to 8 inches thick; chert in large light gray nodules; unit averages 9.4 percent chert (3.8 feet). 3. Limestone, cherty, gray and brown mottled, fine- to coarse-grained; 94.5 per-

cent soluble; beds 4 to 16 inches thick; chert in nodular bands; unit averages 7.8 percent chert (5.0 feet). 2. Limestone, light brownish gray, fine- to coarse-grained, mostly medium to coarse; 99.2 percent soluble; stylolites with amplitudes up to 4 inches; some areas weather yellowish brown; essentially free of chert but a few nodules present at base (6.0 feet). 1. Limestone, buff to gray, fine- to coarse-grained, mostly medium to coarse; fossiliferous (crinoids, brachiopods, and pelecypods); 99.5 percent soluble; consists of light gray fossil fragments in buff matrix; stylolitic; essentially chert-free but a few large nodules present at top (4.4 feet).

LOCALITY 11: SE $\frac{1}{2}$ SE $\frac{1}{2}$ NE $\frac{1}{2}$ Sec. 31, T. 13 N., R. 12 W., near Glasgow; outcrop in south bank of Little Sandy Creek, on or near east line of section.

Overburden: 0 to 11 feet, covered grassy slope rises gently to southeast, probably with increased surficial overburden.

Burlington-Keokuk Limestone

15. Limestone, cherty, brownish gray, yellowish gray, fine- to coarse-grained; fossiliferous (crinoidal); 98.8 percent soluble; unit averages 11.7 percent chert (5.0 feet). 14. Limestone, reddish brown to yellowish gray, fine- to coarse-grained, fossiliferous (crinoidal); 96.3 percent soluble (0.5 foot). 13. Limestone, yellowish brown, fine-grained; 99.3 percent soluble; single bed (0.5 foot). 12. Limestone, reddish brown; contains white fossil fragments; fine- to very coarse-grained; fossiliferous, containing much crinoidal debris; 95.7 percent soluble; deeply weathered (2.0 feet). 11. Limestone, dolomitic, brown, mostly fine-grained, vuggy; 98.2 percent soluble; especially vuggy along upper contact (1.5 feet). 10. Limestone, reddish brown; contains light gray to white fossil fragments; fine- to coarse-grained, mostly medium to coarse; 93.4 percent soluble; essentially in two beds with 1-foot bed at top (1.2 feet). 9. Limestone, cherty, reddish brown, fine- to medium-grained, largely fine; 93.2 percent soluble; forms slight reentrant; unit averages 16.6 percent chert (1.0 foot). 8. Limestone, yellowish gray, reddish brown, fine- to coarse-grained, fossiliferous (crinoidal); 99.1 percent soluble; contains geodes; wavy bedded; unit averages 11.1 percent chert (1.5 feet). 7. Limestone, grayish brown, fine- to coarse-grained; contains white crinoid fragments; 98.1 percent soluble; beds 2 to 12 inches, thinner bedded in top half; good bedding plane at top; discontinuous $\frac{1}{2}$ -inch chert band at top (4.4 feet). 6. Limestone, dolomitic, brown, fine-grained; 94.5 percent soluble; vuggy; good bedding plane at top (0.5 to 0.7 feet). 5. Limestone, cherty, brown; contains white crinoid fragments; fine- to coarse-grained, largely coarse; 98.9 percent soluble; indistinct bedding 12 to 24 inches thick; chert in discontinuous bands and nodules 0 to 8 inches thick; unit averages 12.5 percent chert (4.0 feet). 4. Limestone, cherty, yellowish brown; fine- to coarse-grained, mostly fine- to medium-grained; 98.6 percent soluble; chert in large nodules; unit averages 15.0 percent chert (3.3 feet). 3. Limestone, brown; contains white crinoid fragments; fine- to coarse-grained, largely coarse; 99.5 percent soluble; essentially a single bed (1.0 foot). 2. Limestone, slightly cherty, gray to brownish gray, fine- to coarse-grained; 98.9 percent soluble; unit lacks very coarse crinoid fragments seen in bed 1; chert difficult to measure; unit as measured averages 3.5 percent chert (12.0 feet). 1. Limestone, gray to brownish gray, fine- to very coarse-

grained; very crinoidal; contains a few large brachiopods; 97.5 percent soluble; partly cross-bedded, beds 3 to 5 inches thick; chert in isolated large nodules; unit appears to contain 4 to 5 percent chert (9.0 ft).

LOCALITY 12: NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 32, T. 13 N., R. 12 W., near Glasgow; outcrop in north bank of Little Sandy Creek, a few hundred feet west of bridge.

Overburden: 0 to 16 feet, covered for a distance of 100 to 150 feet north of outcrop. From that point slope increases rapidly to north.

Burlington-Keokuk Limestone

9. Limestone, slightly cherty, yellowish brown to light gray, fine- to very coarse-grained; fossiliferous (crinoids and brachiopods); 98.5 percent soluble; appears massive but weathers to thin beds; chert $5\frac{1}{2}$ feet from base in large nodules up to 8 by 20 inches; unit averages less than 4 percent chert (10.0 feet). 8. Chert, in almost continuous anastomosing band 0 to 18 inches thick; 5.5 percent soluble (average 1.0 foot). 7. Limestone, yellowish brown; contains white crinoid fragments; fine- to very coarse-grained; 97.9 percent soluble; beds 6 to 12 inches thick (3.5 feet). 6. Chert, 0 percent soluble (0.6 foot). 5. Limestone, yellowish brown to brownish gray, fine- to coarse-grained; crinoidal (white fragments in yellowish brown matrix); 95.2 percent soluble (3.5 feet). 4. Chert and dolomite, 39.2 percent soluble; soft; forms reentrant (0.9 foot). 3. Limestone, cherty, yellowish brown; contains white crinoid fragments; fine- to coarse-grained; stylolitic; 98.7 percent soluble; indistinct bedding, beds appear 2 to 10 inches thick; chert in band to 12 inches thick at base; unit averages approximately 10 percent chert (5.6 feet). 2. Dolomite, brown, soft; forms reentrant; not sampled (1.1 feet). 1. Limestone and chert, not sampled (1.0 to 2.0 feet).

LOCALITY 13: Center S $\frac{1}{2}$ Sec. 32, T. 13 N., R. 12 W., near Glasgow; abandoned quarry on east side of Little Sandy Creek.

Overburden: 0 to 15 feet, covered hillslope, probably mostly loess and soil.

Burlington-Keokuk Limestone

8. Limestone, light brownish gray, fine- to coarse-grained, fossiliferous (crinoidal); 99.2 percent soluble; beds 10 to 24 inches thick (4.0 feet). 7. Limestone, cherty, probably dolomitic, somewhat argillaceous; 90.6 percent soluble (1.5 feet).

Covered (1.5 feet).

6. Limestone, slightly cherty, brownish gray, fine- to very coarse-grained, fossiliferous; 97.8 percent soluble; beds 12 to 36 inches thick; chert in discontinuous nodules 6 feet below top and 1 foot above base (14.5 feet). 5. Limestone and chert; limestone, dolomitic, brown and yellowish brown, mostly fine-grained; 97.3 percent soluble; streaked with coarse crinoid debris; chert in somewhat discontinuous bed up to 16 inches thick; unit averages 27.7 percent chert (3.0 feet). 4. Limestone, cherty as above; 97.0 percent soluble; chert in small nodules and elongate discontinuous masses 0 to 7 inches thick and up to 10 feet in length; unit 8.6 percent chert; contains some geodes; beds 6 to 12 inches thick; forms slight reentrant (4.8 feet). 3. Limestone, cherty, buff to light

gray, fine- to coarse-grained, mostly medium; fossiliferous (crinoidal); 97.5 percent soluble; essentially a single bed but has irregularly spaced stylolitic partings; weathers brown; chert in large masses; unit averages 4.1 percent chert (6.0 feet): 2. Limestone, cherty, dolomitic, yellowish brown; fine-grained, especially at base; 98.9 percent soluble; unit laminated; contains calcite nests; unit averages 11 percent chert in nodules (1.5 feet).

Covered (3.0 feet).

1. Limestone, cherty, light gray, medium- to coarse-grained, largely medium; fossiliferous (crinoidal); calcarenitic; 99.5 percent soluble; forms sloping bench below main face in quarry; chert in large light gray to white masses (2.0 feet).

LOCALITY 14: SE $\frac{1}{2}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 33, T. 13 N., R. 12 W., near Glasgow.

Overburden: undetermined

Warsaw Shale

2. Limestone with interbedded shale.

Burlington-Keokuk Limestone

1. Limestone, very cherty; 94.5 percent soluble (4.0 feet).

LOCALITY 15: Near center NE $\frac{1}{4}$ Sec. 1, T. 13 N., R. 13 W., near Winchester; few inches exposed in gully.

Overburden: undetermined

St. Louis Limestone

1. Limestone, buff, very fine-grained to sublithographic; 96.7 percent soluble; limestone breccia in float (0.3 foot).

LOCALITY 16: SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 1, T. 13 N., R. 13 W., near Winchester; outcrop just south of road culvert.

Overburden: undetermined

St. Louis or Salem Limestone

1. Dolomite, calcareous, yellowish brown, fine-grained, porous; 90.5 percent soluble (approximately 2.0 feet).

LOCALITY 17: SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 12, T. 13 N., R. 13 W., near Winchester.

Overburden: undetermined

Warsaw Shale

2. Limestone, dolomitic, cherty, buff to gray, fine- to coarse-grained, crinoidal; 74.1 percent soluble; beds 3 to 6 inches thick; unit weathers yellowish brown; contains geodes (5.0 feet). 1. Limestone, dolomitic, yellowish brown, fine-grained, full of geodes; probably 60 percent noncarbonate (1.5 feet).

LOCALITY 18: NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 35, T. 13 N., R. 13 W., near Glasgow; Thomas Quarry in Illinois River bluff.

Overburden: surficial loess increasing as quarry is worked back.

Burlington-Keokuk Limestone

10. Limestone, very cherty, argillaceous, probably dolomitic, brown; fine- to medium-grained, largely fine; beds 2 to 5 inches thick (estimated 25 feet). 9. Limestone, slightly cherty, gray, fine- to coarse-grained; essentially a single bed but has stylolites (5.0 feet). 8. Limestone, cherty, brown to yellowish brown; consists mostly of coarse to very coarse crinoid fragments in argillaceous, dolomitic, fine- to medium-grained matrix; beds mostly 3 to 6 inches thick, have thin argillaceous partings; 4- to 5-inch chert band at base and chert nodules 1 foot below top (6.0 feet). 7. Limestone, slightly cherty, buff, fine- to very coarse-grained, fossiliferous; argillaceous streaks (5.5 feet). 6. Limestone, slightly cherty, gray, partly weathered brownish gray, fine- to coarse-grained, crinoidal, stylolitic; beds 16 to 24 inches thick (5.0 feet). 5. Limestone, gray, fine- to coarse-grained; crystalline appearance; thick-bedded, stylolitic; contains very little chert (21.0 feet). 4. Limestone, cherty, buff, fine- to very coarse-grained, fossiliferous; 98.8 percent soluble; chert in large masses; unit averages 8.7 percent chert (6.0 to 9.5 feet). 3. Limestone, gray, partly weathered brownish gray, fine- to coarse-grained, fossiliferous (crinoidal); crystalline appearance; 98.8 percent soluble; essentially a single bed forming gray band in face; a few large chert nodules near top; unit less than 1 percent chert (5.0 to 8.5 feet). 2. Limestone, cherty, mostly buff, fine- to coarse-grained, crinoidal; crystalline appearance; 97.6 percent chert; chert in large masses up to 1 foot thick and in smaller nodules; unit averages 18.7 percent chert (8.0 feet). 1. Limestone, gray, fine- to coarse-grained, fossiliferous (crinoidal); crystalline appearance; 98.1 percent soluble; beds 10 to 12 inches thick (7.5 feet).

LOCALITY 19: SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 18, T. 14 N., R. 12 W., near Winchester; boulders in bed and bank of creek.

Overburden: undetermined

Seahorne Limestone Member, Spoon Formation

Limestone, gray and buff mottled, mostly fine-grained, somewhat fossiliferous; limestone, dolomitic, buff, fine-grained, fossiliferous (brachiopods); grab sample 92.1 percent soluble.

LOCALITY 20: NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 18, T. 14 N., R. 12 W., near Winchester; boulders in bed of Walnut Creek.

Overburden: undetermined

St. Louis Limestone

Limestone, gray, sublithographic to lithographic; 90.2 percent soluble.

LOCALITY 21: NW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 28, T. 14 N., R. 12 W., near Winchester.

Overburden: covered (approximately 15 feet)

St. Louis Limestone

16. Limestone, brownish gray, fine-grained to sublithographic; stromatolitic laminations; 94.1 percent soluble (0.9 foot). 15. Limestone, brownish gray, fine-grained, visibly clastic,

fossiliferous (algal?); 97.4 percent soluble; wavy bedding plane at top (0.3 foot). 14. Limestone, as above; 92.7 percent soluble; shaly break at top (0.2 foot). 13. Limestone, shaly, 76.9 percent soluble (0.7 foot). 12. Limestone, brownish gray, fine- to medium-grained; 89.2 percent soluble; areas with fossils and clear calcite cement present; beds 1 to 2 inches thick (0.3 foot). 11. Limestone, brownish gray, fine-grained to sublithographic; 86.6 percent soluble; beds 2 to 3 inches thick; contains corals (2.4 feet). 10. Limestone, brownish gray, fine- to medium-grained, mostly fine; visibly clastic; 94.6 percent soluble; beds 2 to 5 inches thick; scattered fossil fragments on weathered surface (1.4 feet). 9. Limestone, brownish gray, fine-grained, visibly clastic; 97.9 percent soluble (0.4 to 0.7 foot). 8. Limestone, and shale: limestone, brownish gray, fine, obscurely particulate; weathers yellowish brown; shale, calcareous, green; unit 46.4 percent soluble (0.7 foot). 7. Limestone, brownish gray, fine-grained; displays sparkling crystal faces; 95.8 percent soluble (2.5 feet). 6. Limestone, pale brownish gray, fine-grained to sublithographic; 94.9 percent soluble; unit forms rough weathering ledge, part almost lithographic, upper 6 inches somewhat calcarenitic (2.0 feet). 5. Dolomite, buff, gray, fine-grained; 88.0 percent soluble; beds ½ to 2 inches thick (1.0 foot). 4. Dolomite, slightly calcareous, light gray, fine-grained; 92.0 percent soluble (1.0 foot). 3. Dolomite, dove gray, fine-grained to sublithographic, brecciated; 96.5 percent soluble; numerous worm borings? (0.4 foot). 2. Dolomite, slightly calcareous, light gray, fine-grained; 93.5 percent soluble; obscurely clastic with small sparkling crystal faces; minutely brecciated (0.4 foot). 1. Dolomite, argillaceous, greenish gray, fine-grained; 84.7 percent soluble; partly thin-bedded; green specks and streaks (1.0 foot).

LOCALITY 22: NE½ NW¼ NE½ Sec. 28, T. 14 N., R. 12 W., near Winchester; ledge and boulders of limestone along gully on north side of road.

Overburden: undetermined

Seahorne Limestone Member, Spoon Formation

1. Limestone, gray, buff; 96.5 percent soluble; weathers to knobby surface (approximately 2.0 to 3.0 feet).

LOCALITY 23: NW¼ SE¼ NE½ Sec. 29, T. 14 N., R. 12 W., near Winchester; beds exposed in and near small abandoned quarry on north side of Sandy Creek on south edge of Winchester.

Overburden: loess, probably with some till; 4 feet thick at quarry face; probably averages about 10 feet in general area but increases to north.

St. Louis Limestone

10. Limestone, brown to gray, in part with greenish tinge, fine-grained; 87.9 percent soluble; contains brachiopods and a few horn corals; beds mostly 4 to 6 inches thick but weather as a unit; natural "whitewash" (1.4 feet). 9. Shale, calcareous, green; 46.6 percent soluble (0.3 foot). 8. Limestone, brownish gray, mostly fine-grained, visibly clastic; 95.4 percent soluble; beds 3 to 10 inches thick; lower

3 to 4 inches weathers into thin slabs parallel to bedding (1.7 feet). 7. Dolomite, calcareous, brown, fine-grained, earthy; contains irregular beds and pockets of green, calcareous shale; unit 65.5 percent soluble (1.5 feet). 6. Limestone, brownish gray, fine-grained, obscurely clastic; 91.6 percent soluble; thin green shale break at base (0.5 foot). 5. Limestone, light greenish gray to medium gray with scattered gray specks, mostly fine-grained; 80.9 percent soluble; essentially a single bed but in lower 6 inches becomes sublithographic with calcite nests and green shale partings (1.4 feet). 4. Limestone, light gray, fine-grained to sublithographic; 98.0 percent soluble; essentially a single bed but has shaly break at top (2.2 feet). 3. Limestone, pale greenish gray, fine-grained; 91.2 percent soluble; gradational contact at base, thin shaly break at top (0.5 foot). 2. Limestone, greenish gray to light yellowish brown, fine-grained but obscurely clastic; slightly fossiliferous; 89.5 percent soluble; contains a few small shell fossils (0.9 foot).

Covered (3.0 feet).

1. Limestone, light gray with slight greenish tinge, sublithographic to lithographic; 93.4 percent soluble; fractures filled with calcite; a few nodules of pink chert at top of bed (1.5 feet).

LOCALITY 24: NW¼ SW¼ NE½ Sec. 32, T. 14 N., R. 12 W., near Winchester; outcrop on west side of Sandy Creek, just south of Winchester.

Overburden: Grassy slopes rise approximately 40 to 50 feet to crests on either side of gully entering Sandy Creek. Slopes are mostly covered but contain some limestone outcrop and limestone float.

Salem Limestone

4. Limestone, buffish gray, fine- to medium-grained, fossiliferous; 91.9 percent soluble; composed of finely comminuted bryozoans and crinoids and a few foraminifers; beds 6 to 12 inches thick; spalls parallel to bedding (5.4 to 8.4 feet). 3. Dolomite, calcareous, brown to grayish brown, mostly fine-grained; 88.7 percent soluble (0 to 3.0 feet). 2. Limestone, pale brownish gray to light gray, fine- to coarse-grained, mostly medium-grained calcarenite; very fossiliferous (crinoids, bryozoans, and endothyrids); 93.3 percent soluble; essentially a massive bed, slightly undulatory upper contact (4.4 feet). 1. Limestone, as above; 96.6 percent soluble; essentially a single bed, fairly consistent bedding plane at top (5.5 feet).

LOCALITY 25: SE¼ NE½ NW¼ Sec. 32, T. 14 N., R. 12 W., near Winchester; along south side of gully and in gully.

Overburden: undetermined

St. Louis Limestone

1. Dolomite, calcareous, brownish gray, fine-grained; 98.0 percent soluble; beds 10 to 20 inches thick (4.5 to 7.5 feet).

LOCALITY 26: NE¼ NE½ NW¼ Sec. 32, T. 14 N., R. 12 W., near Winchester; outcrop in west bank of Sandy Creek at big bend south of Winchester.

Overburden: up to 35 feet of grassy hillslope to upland; buildings on upland.

St. Louis Limestone

8. Limestone, light gray with slight greenish tinge, fine-grained; 91.5 percent soluble; crenulated laminations probably of stromatolitic nature (1.6 feet). 7. Limestone, cherty, gray with pink siliceous spots; has nodules of light gray lithographic; unit 90.7 percent soluble; $\frac{1}{2}$ - to 1-inch shale break at top, wavy basal contact (1.5 feet). 6. Chert, and limestone breccia, 23.4 percent soluble (0.5 foot).

Covered (4.0 feet).

5. Chert and siliceous limestone, 39.0 percent soluble; in two beds, each 2 to 3 inches thick (0.5 foot). 4. Limestone, dolomitic, gray, fine-grained; beds $\frac{1}{4}$ to 3 inches thick; a few chert nodules, especially at top; sample of unit was 47.6 percent soluble (possibly not representative); probably less than 1.7 percent chert (2.5 feet).

Covered (4.0 feet).

3. Siltstone, argillaceous, calcareous, brown, fine-grained; 40.8 percent soluble; has vesicular porosity; wavy lower contact, top of bed not exposed (0.7 foot). 2. Dolomite, calcareous, silty, argillaceous, brownish gray, fine-grained; 87.5 percent soluble; beds 1 to 6 inches thick (1.0 foot).

Covered (5.0 feet).

1. Dolomite, silty, argillaceous, brownish gray, fine-grained; 72.6 percent soluble; beds 12 to 24 inches thick (3.0 feet).

LOCALITY 27: Center E $\frac{1}{2}$ SW $\frac{1}{4}$ Sec. 4, T. 14 N., R. 13 W., near Oxville; outcrop in creek bed and in bank.

Overburden: 5 to 20 feet, covered hillslope.

Salem Limestone

1. Limestone, light gray, light brownish gray, medium-grained biocalcarenite; 89.7 percent soluble; massive cross-bedded unit; cross-beds dip S58W at 19 degrees (4.0 feet).

LOCALITY 28: SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 9, T. 14 N., R. 13 W., near Oxville.

Overburden: undetermined; well on farm to southwest encountered rock at 32 feet.

Salem Limestone

1. Limestone, light gray, medium-grained biocalcarenite; 90.4 percent soluble; contains bryozoans, crinoids, and endothyrids; bed partly weathered deep brownish red (1.5 feet).

LOCALITY 29: NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 10, T. 14 N., R. 13 W., near Oxville.

Overburden: undetermined

Warsaw Shale

2. Shale, with interbedded limestone lenses (15.0 feet). 1. Shale, very dolomitic,

slightly calcareous, dark gray, fine-grained; 45.4 percent soluble (4.0 feet).

LOCALITY 30: SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 10, T. 14 N., R. 13 W., near Oxville.

Overburden: undetermined

Sonora Sandstone

1. Dolomite, very sandy, gray, greenish gray, brownish gray; very fine-grained; 53.7 percent soluble; may grade in part to sandstone (4.0 feet).

LOCALITY 31: SW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 16, T. 14 N., R. 13 W., near Oxville; outcrop on south-east side of Plum Creek.

Overburden: undetermined

Burlington-Keokuk Limestone

1. Limestone, cherty, buff to gray, fine- to coarse-grained; fossiliferous; 63.1 percent soluble; beds 2 to 3 inches thick (4.0 feet).

LOCALITY 32: Center NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 27, T. 14 N., R. 13 W., near Winchester; Krueger Quarry. Located in the east bluff of Illinois River.

Overburden: loess, 40 to 60 feet thick.

Salem Limestone

10. Limestone, dolomitic, yellowish brown, fine- to medium-grained but mostly fine-grained; 83.7 percent soluble; thin-bedded, has discontinuous, thin, closely spaced, light gray shale partings (4.5 feet). 9. Limestone, dolomitic, yellowish brown; fine- to medium-grained, mostly fine; 89.3 percent soluble; beds mostly 2 to 5 inches thick (3.0 feet). 8. Limestone, dolomitic, brownish gray, fine- to medium-grained; 92.9 percent soluble; beds 12 to 20 inches thick, even-bedded; a few chert nodules along bedding plane 20 inches above base; chert averages less than 0.5 percent (4.0 feet). 7. Limestone, dolomitic, brownish gray, mostly fine-grained but becomes medium-grained at top; 91.0 percent soluble; very consistent bedding planes at base and scattered light gray weathered fossiliferous chert along basal plane and other partings (3.6 feet). 6. Limestone, dolomitic, yellowish brown, mostly fine-grained; 96.0 percent soluble; thick-bedded; a few vugs in lower 1 foot (4.0 feet). 5. Limestone, dolomitic, yellowish brown, fine- to medium-grained, fossiliferous; 95.6 percent soluble; contains numerous large brachiopods; pebbles and streaks are fine-grained dolomite (1.6 feet). 4. Limestone, dolomitic, brownish gray, mostly fine-grained; 93.7 percent soluble; contains porous, quartz-lined vugs up to 3 inches in diameter (2.3 feet). 3. Limestone, dolomitic, yellowish brown, fine- to medium-grained, mostly fine; 96.2 percent soluble; unit has vesicular porosity and numerous large silica-lined vugs; fossiliferous (contains bryozoans, brachiopods, and abundant large brachiopods in 1.5-foot zone 2 feet above base); unit is partly cross-bedded and has appearance of partially dolomitized calcarenite (5.2 feet). 2. Limestone, light yellowish gray, fine- to coarse-grained, fossiliferous, calcarenitic; 93.7 percent soluble; essentially a single massive bed but has some irregular partings; endothyrids abundant (4.0 feet).

Warsaw Shale (?)

1. Dolomite, slightly calcareous, very argillaceous, light brown, fine-grained; 69.1 percent soluble; irregular upper surface contains pockets of green clay (1.3 feet).

LOCALITY 33: SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 15, T. 15 N., R. 12 W., near Merritt; large boulders apparently near outcrop.

Overburden: undetermined

Carbondale Formation

1. Limestone, dolomitic, buff, mostly fine-grained; contains many large brachiopods; 74.0 percent soluble; boulders from ledge apparently 30 to 32 inches thick.

LOCALITY 34: SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 25, T. 15 N., R. 12 W., near Merritt; boulders of limestone float in gully.

Overburden: undetermined

Carbondale Formation

1. Limestone, 71.9 percent soluble.

LOCALITY 35: Center N $\frac{1}{2}$ SE $\frac{1}{4}$ Sec. 3, T. 15 N., R. 13 W., near Bluffs; outcrops along Eagle Run.

Overburden: covered slopes form gully walls on north and south sides of Eagle Run.

Salem Formation

7. Limestone, dolomitic, silty, yellowish brown, fine-grained; 73.8 percent soluble; beds 2 to 4 inches thick, badly weathered; spalls off into thin slabs (4.0 feet). 6. Limestone, dolomitic, silty, yellowish brown, mostly fine-grained, slightly micaceous; 97.0 percent soluble; cross-bedded unit, weathered into thin slabs; solution channel at base (6.0 feet). 5. Limestone, dolomitic, yellowish brown, fine- to very coarse-grained, fossiliferous; 86.0 percent soluble; unit consists of light gray fossil fragments in yellowish brown dolomitic ground mass; appears thin-bedded on weathered outcrop (2.3 feet). 4. Limestone, same, fine- to coarse-grained; 93.3 percent soluble (2.0 feet). 3. Limestone, dolomitic, grayish brown, fine-grained; 84.1 percent soluble; essentially a single bed but has faint internal bedding features, in part obscurely cross-bedded; contains a few geodes (2.5 feet). 2. Limestone, dolomitic, yellowish brown; contains light gray fossil fragments (crinoids); fine- to coarse-grained; 71.1 percent soluble; unit is in part cross-bedded and contains scattered glauconite specks (1.9 feet). 1. Dolomite, argillaceous, silty, slightly calcareous, medium to blue gray, fine-grained; contains carbonaceous specks; not sampled (Warsaw Shale?).

LOCALITY 36: SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 14, T. 15 N., R. 13 W., near Bluffs; outcrop in stream gully and up tributary gully to southwest.

Overburden: 10 to 40 feet in general area. Presence of shale that is probably of Pennsylvanian age and of large boulders of Seahorne limestone indicate that at least a part of this thickness is Pennsylvanian bedrock.

St. Louis Limestone

9. Limestone, light gray with slight brownish tinge, medium-grained, oolitic, stylonitic; 98.7 percent soluble (2.0 to 3.5 feet). 8. Limestone, perhaps slightly dolomitic, yellowish brown, fine-grained; 95.5 percent soluble; perhaps discontinuous (1.2 feet). 7. Limestone, brownish gray with slight greenish tinge, fine-grained; 95.8 percent soluble; laminated, weathered to form peculiar red-stained shallow depressions several feet in longest dimension (0.9 foot). 6. Limestone, gray to olive gray, fine-grained; 94.3 percent soluble; essentially a single laminated bed, weathering to smooth surface; this entire bed largely a jumble of disoriented boulders possibly because of solution accompanying brecciation and/or effect of pre-Pennsylvanian erosion; contains some pockets of greenish gray shale (0.9 foot). 5. Limestone breccia, consists of angular to sub-rounded fragments of limestone of variable lithology: sublithographic, stromatolitic, dense to sparsely porous, fossiliferous; 96.2 percent soluble; slickensided slump structures; variable thickness, thinning on crests and thickening in troughs formed by undulatory structure on underlying bed (0 to 2.0 feet). 4. Limestone, olive gray, very fine to sublithographic; 92.6 percent soluble; faintly laminated; grades upward into breccia that in some places extends to sublithographic bed (0.6 foot). 3. Limestone, olive gray, fine-grained; 87.3 percent soluble; beds 1/16 to 1/2 inch thick; bed at base contains numerous algal nodules, many of which have pink siliceous centers, enclosing matrix is slightly argillaceous with some medium to coarse rounded quartz sand grains (0.7 foot). 2. Limestone, breccia, fine to sublithographic; 90.6 percent soluble; unit has pockets and streaks of green clay and/or shale, scattered areas of pink chert, variable thickness possibly due to differential brecciation and/or solution; overlying beds undulate sharply (1.0 to 1.5 feet). 1. Limestone, greenish gray, fine-grained to sublithographic; 93.4 percent soluble; in part, has closely spaced argillaceous partings (0.7 foot).

LOCALITY 37: SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 14, T. 15 N., R. 13 W., near Bluffs; outcrop in south bank of creek.

Overburden: approximately 120 feet in steep hillslope on south; lesser slopes on north side of road; all covered.

St. Louis Limestone

4. Limestone, gray, very fine- to fine-grained, stromatolitic; 94.9 percent soluble (1.0 foot). 3. Limestone, gray, sublithographic to fine-grained; 88.5 percent soluble; thin-bedded (0.8 foot). 2. Limestone, somewhat shaly, gray, sublithographic to fine-grained; 88.6 percent soluble; thin-bedded (0.4 foot). 1. Limestone, cherty, gray with greenish tinge, partly brecciated, fine-grained; 88.9 percent soluble; bed pinches and swells and has algal nodules on irregular, hummocky upper surface (1.0 to 2.0 feet).

LOCALITY 38: Center NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 14, T. 15 N., R. 13 W., near Bluffs; outcrop in creek at railroad bridge.

Overburden: approximately 105 feet of steep covered hillslope to south; more gently rising gullied slopes on north side.

Salem Limestone

3. Shale, calcareous, gray, with interbedded limestone; mostly slumped material that may be essentially in place (approximately 1.0 foot). 2. Limestone, brownish gray, fine- to coarse-grained, fossiliferous, calcarenitic; 84.9 percent soluble; cross-bedded; contains numerous endothyrids (3.5 feet). 1. Limestone, slightly dolomitic, medium gray, fine-grained; 97.3 percent soluble (2.0 feet).

LOCALITY 39: NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 21, T. 15 N., R. 13 W., near Bluffs.

Overburden: 0 at edge of bluff to more than 60 feet at highest point; Pleistocene drift and loess.

St. Louis Limestone

13. Limestone, medium brown to gray, medium- to fine-grained, fossiliferous; has sparkling crystalline appearance; beds mostly 2 to 4 inches thick; not sampled (2.5 feet).

12. Limestone, very silty, bluish gray weathering buff, fine- to medium-grained; essentially a single bed but has obscure internal bedding planes (0.5 foot). 11. Limestone, brownish gray, fine- to medium-grained, calcarenitic; cross-bedded unit (1.7 to 2.0 feet).

St. Louis or Salem Limestone

10. Sandstone, conglomeratic, gray; consists of medium to coarse subrounded sand grains in light gray siliceous cement. Some light gray silica appears to be secondary replacement of bryozoan debris. Unit contains fragments of bluish gray chert that may represent replacement of very fine calcarenite. Not sampled (0.3 foot). 9. Sandstone, silty, slightly argillaceous, light bluish gray weathering brown; 2.9 percent soluble; thin-bedded; becomes calcareous toward base (2.7 feet).

Salem Limestone

8. Limestone, light brownish gray, fine- to medium-grained, calcarenitic, becoming finer grained at top; 68.6 percent soluble; thin slabby bedding, appears gently cross-bedded; fossiliferous (crinoids, bryozoan debris, and endothyrids); scattered green specks (8.5 feet). 7. Limestone, yellowish gray, fine- to coarse-grained, fossiliferous (crinoids, bryozoans, and brachiopods); 92.0 percent soluble; indistinct bedding; outcrops spall at angle to bedding (9.0 feet). 6. Dolomite, slightly calcareous, argillaceous, gray weathering buff, fine-grained, massive; forms reentrant; not sampled (6.5 feet). 5. Limestone, gray to brownish gray, fine- to coarse-grained, fossiliferous (crinoids, bryozoans, and brachiopods); single massive bed; not sampled (3.0 feet).

Warsaw Shale

4. Dolomite, argillaceous, gray, fine; beds 6 to 10 inches thick; not sampled (2.5 feet). 3. Dolomite, argillaceous, gray, silty, thin-bedded; not sampled (1.6 feet). 2. Dolomite, gray, fairly massive; not sampled (0.7 foot). 1. Shale, bluish gray, dolomitic?; not sampled (4.0 feet).

LOCALITY 40: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 23, T. 15 N., R. 13 W., near Exeter; pit of Alsey Refractory Company.

Overburden: approximately 20 feet of higher Pennsylvanian strata, predominantly shale, overlain by 14 feet of Illinoian drift and 15 feet of Wisconsinian loess and silt.

Colchester (No. 2) Coal Member, Carbon-dale Formation

4. Coal (0 to 2.3 feet).

Spoon Formation

3. Underclay (3.0 feet).

Seahorne Limestone Member, Spoon Formation

2. Limestone, dark gray to black and light brownish gray, conglomeratic, nodules and boulders in gray matrix; 98.8 percent soluble (3.5 feet).

Cheltenham Clay Member, Spoon Formation

1. Clay (9.0 feet).

LOCALITY 41: SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 24, T. 15 N., R. 13 W., near Exeter; outcrop in gully just south of Mauvaise Terre Creek.

Overburden: undetermined

Seahorne Limestone Member, Spoon Formation

6. Limestone, dark gray; medium-grained, partly fine-grained; 98.4 percent soluble; knobby surface; has conglomeratic appearance (2.0 to 2.5 feet).

Cheltenham Clay Member, Spoon Formation

5. Clay (7.0 to 10.0 feet).

St. Louis Limestone

4. Limestone, calcareous, yellowish brown with dark specks, fine-grained; with unit 3 averages 83.6 percent soluble; dove gray on fresh surfaces (2.0 feet). 3. Limestone, dolomitic, mottled gray with slight greenish and pinkish tinge; with unit 4 averages 83.6 percent soluble; hard (0.5 foot). 2. Limestone, gray, fine-grained, 91.1 percent soluble; beds 2 $\frac{1}{2}$ to 6 inches thick. Upper 2 $\frac{1}{2}$ -inch bed conglomeratic (approximately 1.0 foot). 1. Limestone, gray, mostly fine-grained; 93.5 percent soluble; thinly crenulated bedding, conglomeratic; contains large corals (1.3 feet).

LOCALITY 42: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 25, T. 15 N., R. 13 W., near Exeter; just above creek level on either side of old bridge abutment, $\frac{1}{4}$ mile northeast of Exeter.

Overburden: 120 feet, covered to top of hill; contains higher Pennsylvanian and Pleistocene gravel, loess, and soil. Much black shale from old coal diggings on hillside.

Seahorne Limestone Member, Spoon Formation

8. Limestone, Seahorne lithology seen in large blocks essentially in place (2.0 feet).

Covered (13.0 feet).

St. Louis Limestone

7. Limestone, dolomitic, brown, fine-grained; 85.3 percent soluble; beds 12 to 24 inches thick (5.0 feet). 6. Limestone, light gray with slight brownish tinge, very fine-grained to lithographic; 98.4 percent soluble; haphazardly fractured; has hackly surface; essentially a single bed (2.0 feet). 5. Limestone, light gray, fine-grained, obscurely clastic; 91.7 percent soluble; essentially weathering into slabs about 1 inch thick (0.7 foot). 4. Limestone, light gray with slight greenish tinge, fine- to medium-grained, mostly fine-grained; visibly bioclastic; 95.1 percent soluble; essentially a single bed with internal partings 2 to 6 inches apart (0.9 foot). 3. Limestone, light gray with slight brownish tinge, fine-grained to sublithographic; 94.1 percent soluble; beds $\frac{1}{2}$ to 4 inches thick; thicker bedding at base; pebbles of lithographic limestone at base (1.0 foot). 2. Limestone, light gray with slight brownish tinge, very fine-grained to lithographic; 95.6 percent soluble; essentially a single bed with wavy partings, more uniformly lithographic at top (1.1 feet). 1. Limestone, light gray with slight brownish tinge, fine-grained to sublithographic; 97.9 percent soluble; essentially a single bed, uneven upper surface, in part has slightly crenulated laminations (1.0 foot).

LOCALITY 43: SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 25, T. 15 N., R. 13 W., near Exeter; outcrop in creek gully below bridge.

Overburden: excessive over much of extent.

St. Louis Limestone

8. Limestone, light gray, very fine-grained to lithographic; 95.9 percent soluble; intricately fractured, giving hackly weathered surface (3.0 feet). 7. Limestone, light gray with slight greenish tinge, fine-grained; 92.1 percent soluble; at base of top ledge under bridge; beds mostly 1 to 2 inches thick (0.7 foot). 6. Limestone, pale yellowish gray, very fine-grained; 95.0 percent soluble; essentially a single bed (0.7 foot). 5. Limestone, light brownish gray, fine- to very fine-grained, mostly fine; 95.9 percent soluble; beds $\frac{1}{2}$ to 2 inches thick; one bed contains abundant brachiopods (0.9 foot). 4. Limestone, light brown to gray, fine-grained to sublithographic; 96.4 percent soluble; essentially a single bed in part obscurely brecciated, irregular lower contact (0.1 to 1.3 feet). 3. Limestone, breccia, light brown to gray, very fine-grained to sublithographic; 94.7 percent soluble; contains recentemented angular fragments 1 to 6 inches in diameter (1.2 feet). 2. Limestone, light brownish gray, fine-grained; 92.2 percent soluble; thin-bedded, mostly less than 1 inch thick (1.0 foot). 1. Limestone, pale brownish gray, very fine-grained to sublithographic, in part almost lithographic; 91.4 percent soluble; partly brecciated; contains a few irregularly shaped chert nodules; irregular and disturbed bedding, some beds discontinuous, giving way to shale; shale abundant in upper 16 inches (5.0 feet).

LOCALITY 44: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 26, T. 15 N., R. 13 W., near Exeter; outcrop in gully just north of road near old gravel pit.

Overburden: on east side of gully limestone is overlain by 7 to 16 feet of clay and

shale capped by Seahorne Limestone. East-west ridge to west is underlain by 3 to 35 feet of loess and up to 35 feet of gravel.

St. Louis Limestone

12. Dolomite, breccia; consists of angular particles of greenish gray, fine-grained dolomite in brown, very fine-grained matrix; somewhat vuggy; 83.8 percent soluble (0.5 foot). 11. Shale, dark greenish gray; not sampled (0.4 foot). 10. Dolomite, slightly calcareous, argillaceous, light brownish gray, fine-grained; not sampled (0.4 foot).

Salem Limestone

9. Limestone, brownish gray to brown, very fine-grained; 97.5 percent soluble; hard, dense (0.7 foot). 8. Limestone, brownish gray, mostly medium-grained, calcarenitic, fossiliferous; 94.0 percent soluble; contains crinoid fragments, bryozoan debris, endothyrids, and a few green specks (2.7 feet). 7. Dolomite, slightly calcareous, light brownish gray with greenish tinge, fine-grained; 85.6 percent soluble; single bed (0.9 to 1.9 feet). 6. Dolomite, light buff, fine-grained; 84.9 percent soluble; essentially a single bed weathering to very rough surfaces, some evidence of reworking, discontinuous prominent shale partings approximately 1 foot from base; 0.2 foot greenish gray shale at top (2.7 feet). 5. Shale, very dolomitic, obscurely laminated, micaceous; contains carbonaceous specks; 29.9 percent soluble; more dolomitic at base (1.6 feet). 4. Dolomite, argillaceous, silty, buff to gray; 66.4 percent soluble; irregularly thin-bedded, becoming even-bedded and varve-like in upper half; small amount of geodes and chert in lower half (1.5 feet). 3. Dolomite, silty, argillaceous, medium gray to bluish gray, fine-grained; 77.1 percent soluble; very slightly micaceous; contains a few white specks of silica (0.5 foot).

Sonora Formation (?)

2. Siltstone, argillaceous, yellowish gray to brown, fine-grained, micaceous; 2.7 percent soluble; forms ledge in creek bed (0.3 to 0.6 foot). 1. Siltstone, dolomitic, argillaceous, bluish gray, fine-grained; 34.3 percent soluble; uneven bedding, weathered into smooth slabby fragments $\frac{1}{2}$ to 2 inches thick (1.7 feet).

LOCALITY 45: Center W $\frac{1}{2}$ SE $\frac{1}{4}$ Sec. 26, T. 15 N., R. 13 W., near Exeter.

Overburden: undetermined

Unnamed shale member of Spoon Formation

3. Shale (approximately 4.0 feet).

Seahorne Limestone Member, Spoon Formation

2. Limestone, 98.7 percent soluble (2.0 to 4.0 feet).

Cheltenham Clay Member, Spoon Formation

1. Clay (approximately 15.0 feet).

LOCALITY 46: NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 27, T. 15 N., R. 13 W., near Exeter; described section in east bank of gully.

Overburden: 0 to 50 feet, covered.

Salem Limestone

5. Limestone, brownish gray, fine- to medium-grained, calcarenitic; with unit 4 averages 96.2 percent soluble; cross-bedded, individual cross-bedded units about 10 inches thick; unit becomes lighter gray at top (5.2 feet). 4. Limestone, brownish gray, fine- to medium-grained, calcarenitic; with unit 5 averages 96.2 percent soluble; cross-bedded but appears more massive than higher beds; contains brachiopods (4.0 feet).

Sonora Formation (?)

3. Dolomite, silty, micaceous, light gray to light greenish gray; beds 4 to 8 inches thick; laminated at top; probably grades laterally to calcareous or dolomitic siltstone or fine sandstone (2.2 feet). 2. Siltstone, argillaceous, dolomitic, greenish gray to brown; 24.3 percent soluble; laminated, micaceous (0 to 9.0 feet). 1. Dolomite, silty, light gray to brownish gray, fine-grained; 96.5 percent soluble; laminated in upper half (0 to 9.0 feet).

LOCALITY 47: SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 33, T. 15 N., R. 13 W., near Oxville.

Overburden: 0 to 50 feet, covered; increases rapidly to west.

Salem Limestone

7. Limestone, dolomitic, yellowish brown, fine- to coarse-grained, fossiliferous; 87.5 percent soluble; massive cross-bedded unit (approximately 7.5 feet).

Sonora-Warsaw Formations

6. Dolomite, argillaceous, 60.4 percent soluble; earthy, badly weathered (1.0 to 2.0 feet). 5. Limestone, dolomitic, gray, fine- to coarse-grained; 61.1 percent soluble; lenses out and becomes sandy to north (0.1 to 1.5 feet). 4. Dolomite, silty, argillaceous, medium gray, fine-grained; in part, has fine crystalline appearance; 89.9 percent soluble; numerous zones of geodes; discontinuous laminated beds up to 10 inches thick; good bedding planes at top; fossiliferous (bryozoans) (5.4 feet). 3. Limestone, dolomitic, gray weathering yellowish brown, very fine- to coarse-grained, fossiliferous; 93.2 percent soluble; badly weathered (1.0 foot). 2. Dolomite, gray and brownish gray, very fine-grained; 83.6 percent soluble; crenulated zone (probably not continuous) consists of dense gray dolomite bands to 1 in. thick alternating with brown granular dolomite bands less than $\frac{1}{2}$ in. thick (approx. 1.0 ft). 1. Dolomite, silty, argillaceous, gray, very fine-grained; 73.6 percent soluble; beds 4 to 16 in. thick; contains geodes (3.0 ft).

LOCALITY 48: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 33, T. 15 N., R. 13 W., near Exeter; outcrop in small gully in horse pasture at bend of road southwest of Exeter.

Overburden: 0 to 60 feet, gently sloping hillside; fairly broad area at head of gully with overburden 0 to 10 feet, covered.

Sonora-Warsaw Formations

5. Dolomite, very argillaceous, gray, fine-grained; 56.9 percent soluble; beds 6 to 10 inches thick, weathering into thin slabs; becomes more massive at top (4.0 feet). 4. Dolomite, dark buff, fine- to medium-grained but mostly

fine-grained, fossiliferous (brachiopods and bryozoans); 83.5 percent soluble; beds 2 to 12 inches thick; some beds show thin wavy internal bedding features on weathered surface (4.5 feet). 3. Dolomite, silty, argillaceous, gray to medium gray, fine-grained; 65.6 percent soluble; in part obscurely laminated; contains geodes; forms reentrant in east side of gully (4.5 feet). 2. Dolomite, argillaceous, silty, medium gray weathering brown, fine-grained, interbedded with dolomite similar in texture to basal unit; unit 83.6 percent soluble; occurs in ledges making floor of gully; beds 6 to 12 inches thick (5.0 feet). 1. Dolomite, gray to brownish gray, in part with greenish tinge; mostly fine-grained; 83.2 percent soluble; for the most part, has vesicular porosity; in part has obscure laminations weathering into thin beds; obscurely fossiliferous (bryozoan debris); has appearance of dolomitized biocalcarenitic (2.0 feet).

LOCALITY 49: NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 34, T. 15 N., R. 13 W., near Exeter; outcrop in upper branch of gully below small waterfall. Description starts at base of section, which is exposed southwest of branching.

Overburden: 0 to 60 feet, covered; gentle slope.

St. Louis Limestone (?)

15. Shale, green, soft; 13.5 percent soluble; weathered (0.6 foot). 14. Limestone, dolomitic, greenish gray, fine-grained with interbedded shale; in some places shale predominates; 43.8 percent soluble (1.0 foot). 13. Dolomite, calcareous, light greenish gray to light bluish gray, fine-grained; 85.7 percent soluble (0.6 foot). 12. Dolomite, very siliceous, gray to greenish gray; bed consists predominantly of massive geode quartz in dolomitic matrix; 39 percent soluble (1.0 foot). 11. Dolomite, greenish gray to light gray, fine-grained; has glauconitic streaks; 1-inch shale streak at base; 75.1 percent soluble (1.8 feet). 10. Dolomite, buff to grayish brown with reddish specks; fine-grained; 89.3 percent soluble; most beds are 1 to 10 inches thick (2.5 feet). 9. Dolomite, calcareous, argillaceous, light gray to light greenish gray, fine-grained; 64 percent soluble; laminated; weathers into thin beds mostly $\frac{1}{2}$ to 2 inches thick; prominent shale break at top (2.0 feet).

Salem Limestone

8. Limestone, light brownish gray mostly fine- to medium-grained calcarenite; fossiliferous, composed of a few foraminifers and other fossil fragments in a clear calcite matrix; 95.7 percent soluble; fragments of sublithographic limestone in loose boulder (8.0 feet).

Sonora-Warsaw Formations

7. Shale, silty, gray to green; 6.5 percent soluble; micaceous, fissile, soft (2.0 feet). 6. Sandstone, or quartz siltstone, argillaceous, dolomitic, greenish gray; 4.8 percent soluble (0.2 foot). 5. Shale, greenish gray weathering brown; 8.2 percent soluble; soft (0.3 foot). 4. Siltstone, dolomitic, gray to brownish gray, medium- to coarse-grained, perhaps grading to very fine sand; 36.0 percent soluble; micaceous; irregular beds 6 to 24 inches thick weathering to slabs that spall at an angle to the bedding; lower 1 foot in thin slabs parallel to bedding (4.0 feet). 3. Dolomite, very silty,

argillaceous, medium gray to yellowish brown, fine-grained; 58.7 percent soluble; irregular discontinuous dark laminations (4.5 feet). 2. Shale, very silty, very dolomitic; 28.2 percent soluble; micaceous, somewhat fissile and softer than beds above and below; gradational contact at top (2.5 feet). 1. Dolomite, very silty, very argillaceous, medium gray, fine-grained; 52.4 percent soluble; forms smooth spalling surfaces; unit has earthy appearance; grades upward into next unit; differentiation may be largely due to weathering differences (5.5 feet).

LOCALITY 50: NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 34, T. 15 N., R. 13 W., near Exeter; outcrop in creek gully.

Overburden: to the southwest steep covered slope rises 40± feet above top of outcrop; to the northeast ground slopes more gently and there is a considerable area where limestone may occur with 5 to 20 feet of overburden, probably mostly surficial.

Salem Limestone

10. Limestone, light gray with pale brownish tinge, fine- to medium-grained; calcarenitic, foraminiferal (?); 91.4 percent soluble; sharply undulating base, in part obscurely cross-bedded, weathers into thin slabs fraction to 2 inches thick; becomes coarser towards top (8.5 feet). 9. Dolomite, yellowish gray to yellowish brown; 86.9 percent soluble; unevenly bedded; green shale partings present along planes, especially at base; reddish brown ferruginous streaks with secondary quartz; irregular upper contact (2.7 feet).

Sonora-Warsaw Formations

8. Siltstone, light medium gray with slight greenish tinge; with much interbedded green silty shale; unit 4.7 percent soluble; beds mostly 1 to 2 inches thick; indistinct contact at base; sharp contact with 3- to 5-inch shale break at top (1.2 feet). 7. Siltstone, dolomitic, light medium gray with slight greenish tinge; contains specks and streaks of carbonaceous matter and glauconite; 41.8 percent soluble; obscurely laminated (1.1 feet). 6. Dolomite, silty, light medium gray, fine-grained; 71.5 percent soluble; contains numerous black carbonaceous specks up to $\frac{1}{4}$ inch maximum diameter and a few geodes; beds 10 to 13 inches thick, locally becomes thinner bedded (3.4 feet). 5. Siltstone, dolomitic, argillaceous; 41.5 percent soluble; less weathered than below (2.1 feet). 4. Siltstone, dolomitic, argillaceous, medium to dark gray; 30.3 percent soluble; micaceous; contains geodes (4.4 feet). 3. Dolomite, slightly calcareous, very silty and very argillaceous, medium to dark gray, fine-grained; 54.1 percent soluble; massive bed containing geodes (2.3 feet). 2. Dolomite, slightly calcareous, silty, argillaceous; 66.9 percent soluble; essentially a single bed with gradational contact at base, sharp contact at top; faintly laminated; contains many geodes (1.8 feet). 1. Limestone, very dolomitic, silty, argillaceous, bluish gray to yellowish brown, fine- to medium-grained; 83.9 percent soluble; beds 1 to 6 inches thick (7.0 feet).

LOCALITY A: SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 1, T. 13 N., R. 11 W., near Manchester; concentration of limestone boulders.

LOCALITY B: NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 6, T. 13 N., R. 12 W., near Manchester; outcrop in bank in bed

of gully; shale, slightly calcareous and/or dolomitic, silty, gray to greenish gray; some thin beds of siltstone (Warsaw Shale).

LOCALITY C: Center SW $\frac{1}{4}$ Sec. 10, T. 13 N., R. 12 W., near Alsey; limestone with heavy-bedded chert (Burlington-Keokuk Limestone); approximately 10 feet exposed with up to 40 feet of surficial overburden.

LOCALITY D: NE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 11, T. 13 N., R. 12 W., near Alsey; sandstone, brown, medium-grained; beds 1 to 3 inches thick; approximately 4 feet exposed (Warsaw Shale).

LOCALITY E: NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 11, T. 13 N., R. 12 W., near Alsey; dolomite, argillaceous, silty, dark gray to dark brownish gray; interbedded with soft, fissile shale; 8.8 feet exposed (Warsaw Shale).

LOCALITY F: Center N $\frac{1}{2}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 11, T. 13 N., R. 12 W., near Alsey; interbedded shale and dolomite containing geodes; approximately 10 feet exposed (Warsaw Shale).

LOCALITY G: SW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 12, T. 13 N., R. 12 W., near Alsey; heavy limestone rubble (Seahorne Limestone).

LOCALITY H: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 16, T. 13 N., R. 12 W., near Alsey; siltstone, argillaceous, coarse, micaceous; thin-bedded (Pennsylvanian).

LOCALITY I: SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 19, T. 13 N., R. 12 W., near Glasgow; limestone interbedded with brown dolomite, medium-bedded; chert in bands and nodules and irregularly distributed; large calcite-filled geodes fairly abundant; exposed intermittently in floor and walls of gully; vertical section of perhaps 50 feet exposed in area, all cherty (Burlington-Keokuk Limestone).

LOCALITY J: NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 32, T. 13 N., R. 12 W., near Glasgow; mostly weathered chert; 10 to 12 feet exposed; limestone containing geodes at base (Burlington-Keokuk Limestone).

LOCALITY K: NW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 32, T. 13 N., R. 12 W., near Glasgow; cherty limestone; approximately 15 feet exposed (Burlington-Keokuk Limestone).

LOCALITY L: Center SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 33, T. 13 N., R. 12 W., near Glasgow; interbedded shale and limestone; limestone beds 2 to 15 inches thick; thicker beds have shale partings; approximately 4.5 feet exposed.

LOCALITY M: SW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 33, T. 13 N., R. 12 W., near Glasgow; limestone, cherty, yellowish gray, mostly medium- to coarse-grained containing white crinoid fragments; beds 1 to 3 inches thick; 1 to 3 feet exposed (Burlington-Keokuk Limestone).

LOCALITY N: NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 33, T. 13 N., R. 12 W., near Glasgow; cherty limestone similar to that at M; 5 to 6 feet exposed (Burlington-Keokuk Limestone).

LOCALITY O: NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 33, T. 13 N., R. 12 W., near Glasgow; deeply weathered cherty limestone containing geodes (Burlington-Keokuk Limestone).

LOCALITY P: Center E $\frac{1}{2}$ SE $\frac{1}{4}$ Sec. 1, T. 13 N., R. 13 W., near Winchester; dolomite crops out in creek and is here overlain by about 3 feet of

conglomerate composed largely of Warsaw geodes, chert, and cherty limestone; grades upward into sandstone (Sonora-Warsaw Formations?).

LOCALITY Q: SE $\frac{1}{2}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 32, T. 14 N., R. 12 W., near Winchester; limestone, gray, medium-grained calcarenite, beds 2 to 3 inches thick; approximately 1 foot exposed; overlain by chert conglomerate (St. Louis Limestone).

LOCALITY R: NE $\frac{1}{2}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 32, T. 14 N., R. 12 W., near Winchester; dolomite, calcareous, brown, fine-grained; beds about 1 foot thick; approximately 2.6 feet exposed; overlain by limestone, slightly dolomitic, fine- to medium-grained, somewhat calcarenitic; 1.5 feet exposed (Salem Formation).

LOCALITY S: SE $\frac{1}{2}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 2, T. 14 N., R. 13 W., near Exeter; siltstone, dolomitic, argillaceous, gray, fine-grained, micaceous; contains geodes; beds 24 to 30 inches thick; weathers in thin slabs; 5 feet exposed (Warsaw Shale); overlain by approximately 3 feet of clay, silt, and fine sand plus approximately 15 to 20 feet of additional surficial materials, probably loess and soil.

LOCALITY T: NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 9, T. 14 N., R. 13 W., near Oxville; limestone, argillaceous, bluish gray, fine- to very coarse-grained, fossiliferous (brachiopods and bryozoans); irregularly shaly; 1.3 feet exposed; overlain by 5.5 feet of calcareous, bluish gray, fossiliferous shale containing discontinuous lenses of bluish gray, fine- to coarse-grained, fossiliferous limestone containing bryozoans and brachiopods (Warsaw Shale).

LOCALITY U: NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 9, T. 14 N., R. 13 W., near Oxville; 4 feet of dolomite, very argillaceous, very fine-grained; overlain by interbedded shale and limestone (Warsaw Shale).

LOCALITY V: SE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 9, T. 14 N., R. 13 W., near Oxville; sandstone, dolomitic, very fine-grained, brownish to greenish gray,

micaceous; beds 3 to 5 inches thick; 4 feet exposed; overlain by till (Sonora Formation).

LOCALITY W: Center S $\frac{1}{2}$ NE $\frac{1}{4}$ Sec. 10, T. 14 N., R. 13 W., near Oxville; approximately 16 feet of dolomite, very argillaceous, bluish gray weathering yellowish brown, very fine-grained; beds 6 to 30 inches thick; grades to shale in zone approximately 1.3 feet thick about 5 feet above base of outcrop; 2-inch shale break approximately 8 feet from base; outcrop contains geodes (Warsaw Shale).

LOCALITY X: SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 24, T. 14 N., R. 13 W., near Winchester; dolomite, silty, argillaceous, brown, fine; geodes at base; approximately 5 feet exposed; overlain by shale, silty, dolomitic, containing geodes; approximately 4 feet exposed (Warsaw Shale).

LOCALITY Y: SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 16, T. 15 N., R. 13 W., near Bluffs; 4 to 6 feet of limestone and dolomite exposed in foot of bluff east of building and for short distances up nearby gullies; poor exposures (Salem Limestone).

LOCALITY Z: NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 26, T. 15 N., R. 13 W., near Exeter; limestone, conglomeratic, brecciated, jumbled mass of broken beds; pink chert present in a few nodules near base; beds with vertical striations, some irregular narrow fissures with greenish gray clay; unit becomes less brecciated in top half, where beds are about 1 foot thick and are composed of gray, fine-grained to sublithographic limestone; 7 feet exposed (St. Louis Limestone).

LOCALITY AA: NW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 33, T. 15 N., R. 13 W., near Oxville; approximately 32 feet of interbedded shale, siltstone, and dolomite exposed in stream gully. Dolomite becomes more predominant in upper 10 feet (Warsaw Shale).

LOCALITY BB: SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 35, T. 15 N., R. 13 W., near Exeter; abundant rubble from siliceous limestone; some brown dolomite blocks present in bank of creek (St. Louis Limestone).

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