

SALEM LIMESTONE AND ASSOCIATED FORMATIONS IN SOUTH-  
CENTRAL INDIANA

*by*

THOMAS G. PERRY, NED M. SMITH, AND WILLIAM J. WAYNE

Indiana Department of Conservation

GEOLOGICAL SURVEY

Field Conference Guidebook No. 7

1954

STATE OF INDIANA  
George N. Craig, Governor

DEPARTMENT OF CONSERVATION  
Doxie Moore, Director

GEOLOGICAL SURVEY  
Charles F. Deiss, State Geologist  
Bloomington

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IN SOUTH-CENTRAL INDIANA

By

Thomas G. Perry, Ned M. Smith, and William J. Wayne

CONFERENCE SPONSORED BY

Geological Survey, Indiana Department of Conservation,  
and  
Department of Geology, Indiana University,

CONFERENCE COMMITTEE

John B. Patton, Chairman; Ralph E. Esarey;  
Richard K. Leininger; William H. Moran;  
Thomas G. Perry; Arthur P. Pinsak; Ned M. Smith;  
William J. Wayne; and Gerald S. Woodard

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## SALEM LIMESTONE AND ASSOCIATED FORMATIONS IN SOUTH-CENTRAL INDIANA

By Thomas G. Perry, Ned M. Smith, and William J. Wayne

### INTRODUCTION

This field conference is sponsored jointly by the Geological Survey, Indiana Department of Conservation, and the Department of Geology, Indiana University. The primary purpose of the conference is to promote a better understanding of the geology of the Salem limestone and associated formations and of the physiography of the region in which these rocks are exposed. Since time will not permit a tour of the entire Salem outcrop belt, the conference has been limited to a tract which displays the characteristic lithologies and relationships of the Salem.

Both the geologist and the layman have recognized the excellence of the Salem as a dimension stone for more than a century. In recent years the Salem limestone has attracted the attention of petroleum geologists, some of whom may not have had the opportunity of studying surface exposures of this formation. The stops and their sequence have been carefully chosen to present a unified view of the geology of the Salem and associated formations; features of stratigraphic, economic, and paleontologic interest will be seen. Participants will have the opportunity not only of examining the Salem limestone but also of studying a significant part of the Harrodsburg and St. Louis limestones and a complete section of the Ste. Genevieve limestone. The Aux Vases, Paoli, and Beaver Bend formations of early Chester age also may be observed (pl. 1). In order that participants may obtain a broader conception of the geology of the conference area, a short summary of its physiography and many physiographic notations in the road log have been included in the guidebook.

Members of the Geological Survey have been studying the Salem and other limestones in an intensive manner for several years. This continuing research program includes a more detailed consideration of the chemical composition, petrology, mineralogy, stratigraphic nomenclature, and areal distribution of the Salem and other limestones. Representatives of the Survey will present short resumes of their studies during their talks which will precede the field examination of these rocks.

The authors extend their appreciation to all members of the Conference Committee who assisted in preparing this guidebook and in suggesting the route of the conference. All preparatory phases were coordinated by J. B. Patton, Principal Geologist, Indiana Geological Survey. Photographs were taken by George Ringer, Photographer, Indiana Geological Survey. Finally, the authors and the Conference Committee are deeply grateful to the owners and operators of the

quarries which will be visited during this tour. Their cordial assistance will contribute largely to whatever success this conference may enjoy.

### SUMMARY OF PROGRAM

A pre-conference tour through the mills of the Ingalls Stone Company has been arranged in order that conference participants may observe the methods and the machinery used in the cutting and milling of the renowned Salem building stone. A sign indicating the route to the office and mills of the Ingalls Stone Company, which are located in the western outskirts of Bedford (pl. 2), will be placed at the intersection of Indiana Highway 37 and Fifth Street, in the northern part of Bedford. The tour, which will be conducted by Mr. Robert Ingalls, will begin at the office of the company at 1:45 P. M. on Friday, May 7. (All time stated in this guidebook is Central Daylight Time.)

Registration will begin at the conference headquarters in Spring Mill Inn at 4:30 P. M., Friday, May 7. Dinner is served from 6:00 to 7:30 P. M., at the Inn but is not a part of the conference program.

Short welcoming addresses by Mr. Doxie Moore, Director of the Indiana Department of Conservation, and by Dr. Charles F. Deiss, State Geologist, will open the conference at 8:00 P. M. on Friday, May 7. Several brief talks on different aspects of the Salem and associated strata will follow. Professor Ralph E. Esarey, Department of Geology, Indiana University, will review the broader aspects of the geology and nomenclature of the Salem; Mr. Ned M. Smith, Indiana Geological Survey, will present the results of current investigations of the surface characteristics of the Salem limestone; Mr. Arthur P. Pinsak, Indiana Geological Survey, will comment on his recent subsurface lithofacies studies of the formation; Mr. Richard K. Leininger, Indiana Geological Survey, will summarize new information on the chemical composition and mineralogy of the Salem; Mr. J. H. Buehner, Ohio Oil Company, will discuss petroleum production from the Salem in the Illinois Basin; and Dr. J. J. Galloway, Professor Emeritus, Indiana University, will comment on the more striking paleontologic aspects of the formation. A brief discussion period will follow each talk. The remainder of the evening will be available for renewing acquaintance ships and informal discussion among the participants.

On Saturday morning at 8:15 A. M. the caravan will depart for the field from the parking lot near Spring Mill Inn, (pl. 2) and will proceed to the quarry of the Lehigh Portland Cement Company (Stop 1), which is located about 2 miles northeast of Mitchell, in Lawrence County. The section in this quarry includes the greater part of the Harrodsburg, a complete section of the Salem, and the lower strata

SYS- TEM	SER- IES	GROUP	FORMATION, MEMBERS, AND MARKER BEDS	LITHOLOGIC DESCRIPTION
MISSISSIPPIAN	CHESTERIAN	LOWER CHESTER	Sample ss. 16-42 ft.	Sandstone: Light-gray to light-brown, fine- to medium-grained, thick-bedded to massive. Shale commonly found in lower and upper part of formation and locally may occupy entire stratigraphic interval.
			Beaver Bend ls. 1-20 ft.	Limestone: Light-gray, crystalline, oolitic, thick-bedded to massive.
			Mooretown ss. 5-30 ft.	Sandstone: Light-brown, fine-grained, thin- to thick-bedded. In many places, this formation is brown to black, soft, fissile shale.
			Paoli ls. 0-38 ft.	Limestone: Light-gray, fine- to medium-grained, crystalline, oolitic. Greenish-gray, calcareous shale present near middle of formation.
			Aux Vases fm. 0-13 ft.	Argillaceous limestone: Light-gray; locally arenaceous.
	MERAMECIAN	UNNAMED	70-170 ft.	Limestone: Light-gray, lithographic to medium-grained, crystalline, oolitic; includes thin to massive beds. The Bryantsville marker bed is dark-gray, brecciated, cherty, rubbly limestone.
			Levias member 25-60 ft.	
			Bryantsville breccia 0-5 ft.	
			Rosiclar member 1-40 ft.	Limestone: Shades of gray, fine- to medium-grained, crystalline, oolitic. This interval in places is argillaceous, arenaceous, or conglomeratic, and beds of shale and sandstone occur locally.
			70-115 ft.	
			Ste. Genevieve ls. Fredonia member 30-115 ft.	
			Lost River chert 1-6 ft.	Limestone: Gray, very fine- to coarse-grained, crystalline, thin-bedded; locally contains massive beds of pure oolite. Lost River chert is blue or gray to white and distinctly vugular on weathered surfaces.
			St. Louis ls. 90-300 ft.	Limestone: Medium- to dark-gray, or cream to tan, lithographic to medium-grained, crystalline, argillaceous, dolomitic; beds are less than 2 feet thick. Thin shale beds and nodular chert are common.
			Salem ls. 20-80 ft.	Limestone: Light-bluish-gray, or buff in oxidized zone, even-grained, porous, massive, cross-bedded, and characterized by abundant small fossils and fossil fragments. Tan-gray, fine- to medium-grained, argillaceous, dolomitic strata are commonly found in lower and upper part and are present locally in the massive limestone.
			Harrodsburg ls. 60-80 ft.	
			Upper member 30-44 ft.	Limestone: Light-gray, coarsely crystalline, crinoidal; few geodes. Upper part is lighter gray, finer grained, more massive, and contains abundant fenestelloid bryozoans.
			Lower member 30-44 ft.	Limestone: Drab-gray, coarsely crystalline, crinoidal; has geodes that generally range from 1 to 6 inches but rarely reach 2 feet in diameter, chert nodules, and thin shale beds.
	OSAGIAN	BORDEN	Edwardsville fm. 40-200 ft.	Siltstone and shale interbedded: Gray and greenish-gray, soft, well bedded; contains geodes as much as 3 inches in size. Argillaceous sandstone is locally prominent in upper part.

GENERALIZED STRATIGRAPHIC COLUMN OF MISSISSIPPIAN  
ROCKS EXPOSED ALONG FIELD CONFERENCE ROUTECompiled by J.B. Patton  
and N.M. Smith, April 1954

in the St. Louis limestone.

The caravan then will proceed to Indiana Highway 37 and continue northward to the White River section (Stop 2), which exposes an excellent section of the Salem limestone. Many participants will be impressed with the conspicuous massiveness of the formation as revealed in these highway cuts. (Participants are urged to, exercise care in avoiding traffic accidents at this stop.)

The group then will travel northward to the Williams quarry, which is on the east edge of Bedford (Stop 3). This section of the Salem limestone is noteworthy because a prominent zone of impure limestone is bounded on either side by high-calcium limestone strata (pl. 3). Some participants may have erroneously believed that impure limestone strata occur only in the upper and lower parts of the Salem.

The caravan then will proceed northwestward to the Springville quarry, Ralph Rogers and Company (Stop 4). An impressive section (pl. 4) extends from the upper part of the St. Louis to the Beaver Bend limestone, inclusive. This exposure is particularly noteworthy because it reveals the only complete section of the Ste. Genevieve limestone that is known in Indiana. Picnic lunches will be brought to the participants at this stop. Sufficient time for examining the section and for lunch will be allowed.

After lunch, the participants will proceed to the P. M. & B. quarry (Stop 5), where representatives of the Indiana Limestone Corporation will greet the group. Participants may study the massive Salem limestone and the relationship of the formation with the overlying St. Louis limestone at this active quarry. Economic geologists will be interested in the quarrying methods that will be seen and explained.

After examining the P. M. & B. quarry, those participants who are interested in paleontology will travel northward to the abandoned Cleveland quarry near Harrodsburg, in southern Monroe County (Stop 6). This quarry is a classic collecting locality in the Salem outcrop belt; innumerable specimens of Endothyra and small molluscs are readily obtained. Those participants who are interested in examining an additional section of the Ste. Genevieve limestone and an exceptionally thick section of the Paoli limestone will drive southward to the Radcliff and Berry quarry (Stop 6A), which is about 1 mile northwest of Orleans, in northern Orange County.

The field tour for this day will conclude after participants have visited Stops 4 and 6A. Both groups will return directly to Spring Mill Inn for dinner. A formal program has not been scheduled for Saturday evening because members of the conference probably will wish to exchange views and observations concerning the exposures that they have visited.

On Sunday morning the caravan will depart from the parking lot near Spring Mill Inn at 8:15 A. M. (Some participants may wish to



bring chocolate bars or sandwiches as the conference will end shortly after noon in an area where restaurant facilities are not available.,) The Sunday excursion will feature the lithologic variability of the Salem limestone in surface exposures and the only active sand pit in the Ohio River formation.

The group will drive southeastward to the quarry of the Hoosier Lime and Stone Company (Stop 7), which is near Salem, in Washington County. The section (p1. 5) extends from the upper part of the Harrodsburg to the lower strata in the St. Louis limestone.

The caravan then will proceed southward to the Sears sand pit (Stop 8), which is near Greenville. The pit is on the Floyd-Washington county line. Participants may examine this excellent exposure of the Ohio River formation and reach their own conclusions concerning its origin.

The group then will travel southward to the Georgetown section (Stop 9), which is about 1 mile west-southwest of Georgetown, in Floyd County. This section has been included to illustrate conclusively the variations in lithology and thickness of the strata that form the Salem limestone. (Participants will be given ample warning of approaching trains.)

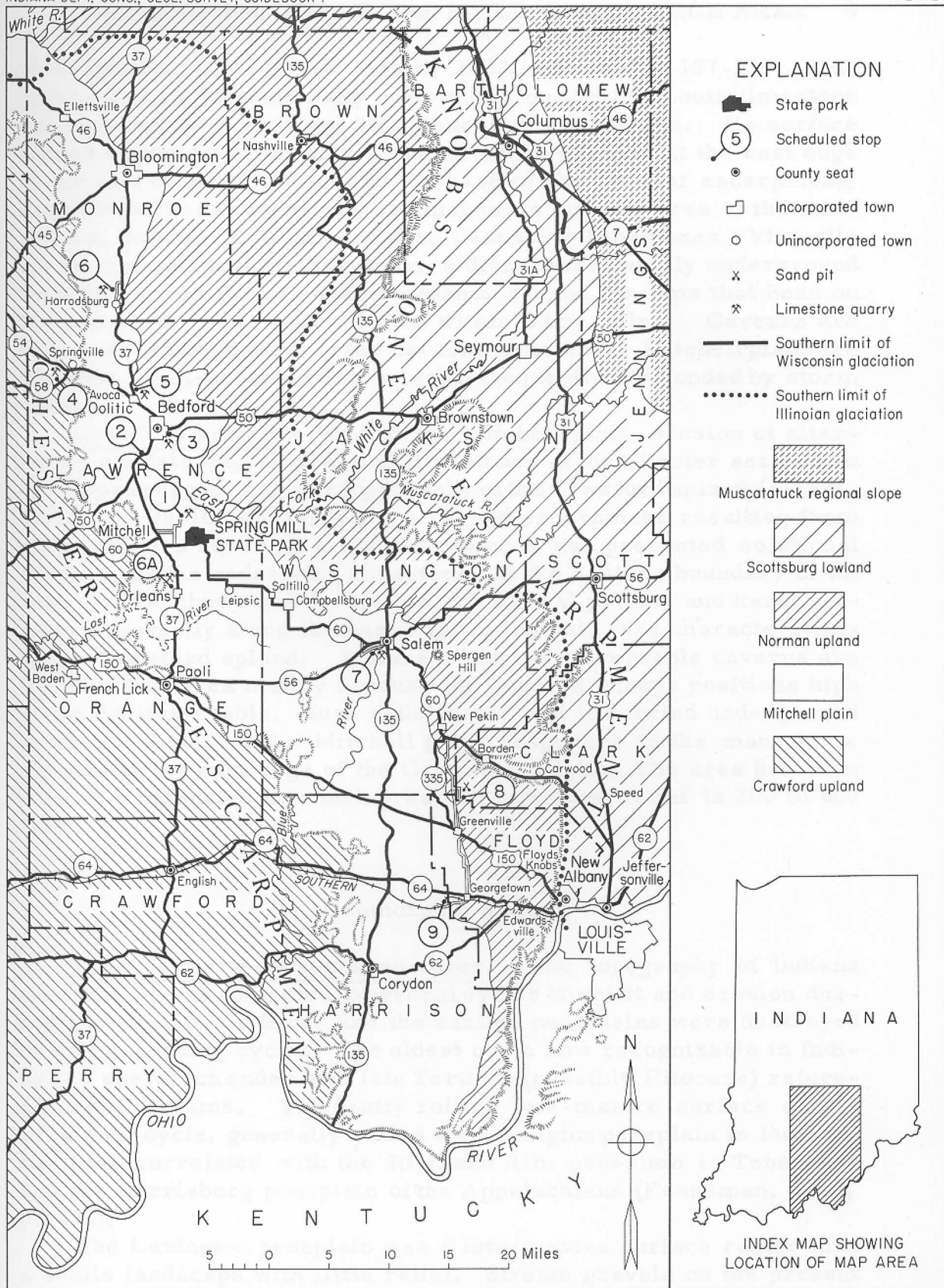
After this exposure has been examined, the group will assemble at the cars. Brief remarks by Dr. Charles F. Deiss, State Geologist, will formally conclude the conference.

## GEOMORPHOLOGY OF THE FIELD CONFERENCE AREA

### Physiographic units

Norman upland.--The Knobstone escarpment (p1. 2), the most prominent topographic feature of southern Indiana, rises 300 to 600 feet above the valleys and the lowland east of it and forms the east edge of the Norman upland (Malott, 1922, pp. 90-94). The Norman upland is a physiographic unit on the dip slope of a cuesta produced by greatly different rates of erosion of gently dipping siltstones and shales of the Borden (Lower Mississippian) group. Topographically, the Norman upland is characterized by great local relief. The area is maturely dissected by streams and consists of sharp ridges, uniformly steep-sloping valley sides, and narrow valley bottoms. Hilltops have altitudes ranging from 900 to more than 1, 000 feet and generally are considered to be the remnants of a peneplain which was uplifted in late Tertiary time.

Mitchell plain.-- Solution at the surface of the thick sequence of middle Mississippian limestones which is being examined during this field conference has given rise to well-developed karat topography. This area of sinkholes and relatively little relief is called the Mitchell



MAP SHOWING ROUTE OF FIELD CONFERENCE AND PHYSIOGRAPHIC UNITS

plain (Beede, 1910, p. 95; Malott, 1922, pp. 94-98, 187-215). The Mitchell plain is principally a dip slope on the St. Louis limestone but includes the Salem and Ste. Genevieve limestones. Its surface slopes westward from an altitude of about 900 feet at the east edge of the unit to about 750 feet at the base of the Chester escarpment. Karst features are especially common in the outcrop area of the thin bedded, jointed St. Louis and Ste. Genevieve limestones. Virtually all the rainfall that strikes the area disappears rapidly underground through dolines (funnel-shaped sinkholes), and streams that head on the plain sink into swallow-holes within a few miles. Caverns are common, although most of the caverns beneath the Mitchell plain are tortuous, joint-controlled tunnels that frequently are flooded by storm waters.

Crawford upland. --West of the Mitchell plain, erosion of alternating sandstones, shales, and limestones of the Chester series has developed rugged, angular topography of the Crawford upland (Malott, 1922, pp. 98-102, 215-247). A ragged escarpment resulting from the protective cover of a clastic cap rock has prevented solutional lowering of the underlying limestones at the eastern boundary of the unit. Entrenched meanders, local structural plains, and karst valleys, especially along the east edge of the unit, are characteristics of the Crawford upland. Indiana's largest traversable caverns are found in this area mainly because the caverns occupy positions high above the water table. Much of the water that is carried underground by the sinkholes of the Mitchell plain reappears in the many large springs at the east edge of the Crawford upland. The area has been maturely dissected by running water, and local relief is 200 to 400 feet.

### Geomorphic history

Late Tertiary erosional surfaces.--The topography of Indiana undoubtedly was subjected to several cycles of uplift and erosion during post-Paleozoic time, and the earlier peneplains were destroyed during succeeding cycles. The oldest cycle now recognizable in Indiana is one which ended with late Tertiary (possibly Pliocene) rejuvenation of streams. The gently rolling late-mature surface of this erosional cycle, generally called the Lexington peneplain in Indiana, has been correlated with the Highland Rim peneplain in Tennessee and the Harrisburg peneplain of the Appalachians (Fenneman, 1938, p. 432).

The Lexington peneplain was a late-mature surface rather than a senile landscape with little relief. Stream gravels on the present upland indicate that local relief was great enough to provide coarse debris for transport and deposition by streams. In addition, bedrock

uplands and lowlands in northern Indiana, where a mantle of glacial drift prevented extensive erosion during much of Pleistocene time, were well developed prior to burial. Some remnants of the peneplain now stand 900 to 1,000 feet above sea level in southern Indiana, and the entire surface slopes toward the major Tertiary drainage lines. Altitudes of the peneplain in the vicinity of Teays and Wabash Valleys are 500 to 600 feet.

Late Tertiary rejuvenation of streams that cross the peneplain began a new cycle of erosion in which streams eroded steep-walled valleys 200 to 300 feet below the peneplain. In areas influenced by glaciation, this level is marked by abandoned segments of valleys and is called the Parker strath (Fenneman, 1938, pp. 301-302).

Late Tertiary deposits. --Only scattered remnants of fluvial deposits are present to record the time interval between the withdrawal of Pennsylvanian seas and Pleistocene glaciation in Indiana. Our knowledge of these pediments must be combined with geomorphic evidence to obtain even a bare outline of that part of the geologic history of the state.

At several places in the unglaciated part of Indiana, thin deposits of rounded quartz and chert gravel cap areas of high topography. In some places the gravels are interbedded with sand, silt, and clay. Although these gravels have often been called the "Lafayette" formation, this name is not appropriate (Berry, 1911, p. 255).

The name Ohio River formation was used by Ashley (1903, pp. 68-70) for unconsolidated fluvial deposits that are older than the Illinoian glacial deposits of Indiana and that are associated with the late Tertiary erosional surfaces of southern Indiana. Over much of the area a veneer of sandy, ferruginous quartzose gravel is all that remains to mark former stream courses, but near the Knobstone escarpment south of Salem a discontinuous body of fine quartz sand as much as 55 to 60 feet thick overlies the St. Louis, Salem, and Harrodsburg limestones.

This sand occupies high ground but does not cap the highest hills. It is lenticular in cross section. In the few places where the base of the Ohio River formation has been observed, the uniform, fine quartz sand overlies a bed of green to maroon, tenacious clay. Conglomerate composed of rounded chert and quartz pebbles underlies the clay in places. Petrographic studies by Pinsak, (1953, pp. 33-42) indicate that the minerals in the sand are characteristic of granitic areas and that only minerals which are extremely stable under conditions of weathering remain.

Both the age and the origin of the sand deposits have long been in dispute. Workers have considered them as old as Chester (Ray, Butler, and Denny, 1947, p. 8) and middle Chester, (Richardson, 1920, p. 93, and 1927, p. 38). Ashley (1903, pp. 68-70), Malott (1922, pp. 132-136), and Leverett (1929, pp. 8-18) regarded the sand as

Tertiary in age but were in disagreement as to its origin. Suggested origins have included aeolian, fluvial, and marine beach deposition. The mineralogy, distribution, and internal structure of the sand are suggestive of fluvial origin. A source for the sand is still in dispute.

Topographically, the Ohio River formation rests upon an erosional surface generally considered to be late Tertiary (Pliocene) in age. The sand can be no older than that surface. The thickness of the soil profile on the sand requires that it be no younger than early Pleistocene. Unfortunately, no fossils from the sand have been described. At the present time, we regard the deposit to be late Tertiary (possibly late Pliocene) in age.

Pleistocene history and deposits.--At least one glacier prior to the Illinoian ice advance reached southern Indiana. Leverett (1929, pp. 33-49) described several pre-Illinoian erratics in northern Kentucky, and Kansas till has recently been found beneath Illinoian deposits in southwestern Indiana.

Illinoian ice overrode the Knobstone escarpment a short distance, although the scarp was an effective barrier south of the east fork of White River (p. 2). The margin of Illinoian glaciation is marked by attenuated till and scattered erratic boulders on the hilltops and ridge crests and by valley train deposits along some of the streams that head on the back slope of the Knobstone cuesta. Many small eastward-flowing streams were dammed, and terraces remain to show the extent to which their flooded valleys were filled with lacustrine sediments. At least a few drainage diversions were caused in this way. Westward-flowing valleys carried Illinoian outwash, and valleys such as Salt Creek, which were never reached by Wisconsin ice, have terraces composed of Illinoian gravel and sand.

Wisconsin ice reached the northeast corner of the area covered by plate 2, but the only effects of this glaciation that will be seen along the conference route are the outwash terraces along the east fork of White River. Glacial outwash sluiced through this valley during each of the glacial ages that affected Indiana, but only the last (Wisconsin) valley train can be recognized. Part of the gravel and sand deposited by the meltwater has been swept away by post-Wisconsin stream erosion, but terraces stand some 30 feet above the floodplain, particularly on the inside of the entrenched meanders.

## ITINERARY

Saturday, May 8, 1954

Mileage  
between  
stops

- |      |  |
|------|--|
| 0. 0 | The caravan will assemble on the parking lot at Spring Mill Inn (Mitchell quadrangle). Departure will be at 8:15 A. M. Please check mileage before leaving and at each scheduled stop in order that you may determine your location at any time.                         |
| 0. 2 | Junction with road to gate house; turn right.  |
| 0. 8 | Junction with Indiana Highway 60; turn west (right). Cross karat plain formed upon St. Louis limestone, which is exposed in low cuts. Note large number of dolines (funnel-shaped sinkholes) on both sides of highway. This is the typical Mitchell plain (see pp. 8-9). |
| 2.7  | Turn north (right) at intersection where sign points toward Mitchell business district.  |
| 3. 3 | Baltimore and Ohio Railroad yard crossing. Just north of last track turn west (left) to main office of Lehigh Portland Cement Company to sign registration book.   |
| 3.6  | Office of Lehigh Portland Cement Company. Return from office to road and turn north (left).  |
| 4. 2 | Turn east (right) on road to quarry along the valley of Rock Lick Branch.  |
| 5. 0 | Enter Bedford quadrangle. Abandoned New York quarry. This quarry is part of stop but will be examined on the way out.  |
| 5. 8 | Crushing plant at active Lehigh quarry. Cars will park near crushing plant.  |

STOP 1. Lehigh Portland Cement Company quarry. 40 minutes, Location: S½ sec. 30, T. 4 N., R. 1 E., about 2 miles northeast of Mitchell, in Lawrence County. (Bedford quadrangle)

The section in this quarry, which is located in the Mitchell plain,

includes the greater part of the Harrodsburg limestone and extends upward into the lower strata of the St. Louis limestone. The stop has been scheduled to permit the examination of the Harrodsburg limestone and its stratigraphic relationship with the lower part of the Salem; participants also may study a complete section of the Salem limestone. The Harrodsburg-Salem contact is best observed in a sequence of strata that is exposed along the cable railroad that leads to the crushing plant. Most of the Salem and its relationship to the overlying St. Louis limestone can be most conveniently examined in a nearby abandoned operation that locally is called the New York quarry.

The section listed below was measured in the modern workings by Carroll N. Roberts. (See p. 58 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Chip sample number
QUATERNARY		
16 Soil: Red-brown, residual.	10.0	--
MISSISSIPPIAN		
St. Louis limestone		
15 Limestone: White to light gray, dense, thin-bedded.	10.0	--
Salem limestone		
14 Limestone: Buff, fine-grained, crystalline. (The chip sample includes only the lower 7.2 feet of this unit.)	19.2	15
13 Limestone: Buff to gray, medium-grained, semi crystalline; minor amounts of bioclastic material are present.	5.5	14
12 Limestone: Light-gray, weathered surface buff yellow, medium- to coarse-grained, bioclastic. The massive unit is stylolitic and contains a small amount of crystalline material.	6.0	13
11 Limestone: Light-gray, medium- to coarse-grained, bioclastic; contains stylolites and is massive.	4.2	12

Unit	Description	Thickness in feet	Chip sample number
10	Limestone: Gray to buff, medium- to coarse-grained, crystalline. The soft rock of this massive unit is locally porous, stylolitic, and includes bioclastic lenses and wavy bands of carbonaceous material.	16.0	11
9	Limestone: Buff to light gray, medium-grained, crystalline and bioclastic.	4.7	10
8	Limestone: Gray, medium-grained, crystalline; contains streaks of carbonaceous material and is slightly fossiliferous.	2.8	9
7	Limestone: Brown to gray, coarse-grained, crystalline. Local concentrations of small fossils impart an oolitic appearance.	<u>4.3</u>	8
	Total thickness of Salem limestone .....	62.7	
	Harrodsburg limestone		
6	Limestone: Tan, blue, and brown, fine- to medium grained, crystalline.	2.8	7
5	Limestone: Blue coarse-grained, crystalline. Lenses of dark-brown, cherty limestone occur near the upper contact.	5.2	6
4	Limestone: Buff, coarse grained, crystalline. <u>Fenestella</u> and brachipods are abundant, as are calcite and gypsum-lined cavities.	4.4	5
3	Limestone: Buff, coarse grained, crystalline. Strata are exceptionally fossiliferous, and the lower 10 feet is composed largely of fenestellid remains.	23.9	4 (upper 11.9 feet) 3 (lower 12.0 feet)



Unit	Description	Thickness in feet	Chip sample number
2	Limestone: Buff, coarse-grained, crystalline, fossiliferous; dark brown lenses and masses of gypsum occur throughout.	12.1	2
1	Limestone: Light-gray to white, medium- to coarse-grained, crystalline; contains solution cavities, geodes, and clay seams. The upper contact is wavy and stylolitic.	<u>5.5</u>	1
	Total thickness of exposed Harrodsburg limestone .	<u>53.9</u>	
	Total thickness of measured section .....	136.6	

After examining this section, the group will return 0.8 mile along the entry route, where the following section was measured in the abandoned New York quarry by Ned M. Smith and Arthur P. Pinsak:

Unit	Description	Thickness in feet
QUATERNARY		
10	Soil: Largely covered by material discarded in quarrying.	Not measured
MISSISSIPPIAN		
St. Louis limestone		
9	Limestone: Medium-brown, very fine grained, noncrystalline; contains two beds of dolomitic siltstone, one near the middle and the other near the top of the unit.	3.6
8	Dolomite: Light-cream-tan, fine- to medium-grained, noncrystalline. Finely laminated, thin beds are distinctly undulatory; lithology gradational into unit 9, but upper boundary is delimited by nature of bedding.	2.0
	Total thickness of exposed St. Louis limestone .....	5.6
7	Limestone: Medium-gray, very fine-grained, bioclastic. Unit has deeply pitted weathered surface and is homogeneous except for elongate chert masses	

Unit	Description	Thickness in feet
	near the top.	3.4
6	Claystone: Red to purplish-gray, non bedded, nonlaminated.	0.2
5	Limestone: Tan-gray, very fine-grained, dense, bioclastic. The lower 2.0 feet is thin-bedded and is separated from a massive upper bed by a persistent stylolite.	5.7
4	Limestone: Medium-tan, fine-grained, bioclastic. The top of this massive unit generally is bounded by a stylolite; remainder of unit is somewhat stylolitic.	6.1
3	Limestone: Gray-brown, fine-grained, crystalline and noncrystalline, dense. Black shaly partings occur between the thin beds.	1.5
2	Limestone: Medium-tan, very fine grained, bioclastic; organic fragments are embedded in a dense, granular, calcitic matrix. Thin and thick beds are irregularly banded by carbonaceous material. Two undulating layers of nodules that are composed of silified organic remains occur about 4.5 feet above the base.	10.5
1	Limestone: Buff, fine- to coarse-grained, bioclastic. The unit is massive and stylolitic; grain size decreases upward. An undulating horizon is located about 10 feet above the base and has a relief of approximately 5 feet.	<u>30.2</u>
	Total thickness of exposed Salem limestone .....	57.6
	Total thickness of measured section .....	63.2

The Salem-St. Louis contact has a perceptible southerly dip in the New York quarry. The contact between units 1 and 2 may be observed in the wall of the stream that flows between the lower water-filled northern workings and the higher southern part of the quarry, where the remaining units are conveniently exposed.

Mileage  
between  
stops

- 0.0 Abandoned New York quarry. Enter Mitchell quadrangle.
- 0.8 Turn south (left).
- 1.0 Turn west (right) at city limits sign.
- 1.6 Monon Railroad. Route is offset to south (left) over railroad.
- 2.4 Turn north (right) on Indiana Highway 37. Hill immediately west (left) of highway is an outlier of the Crawford upland, capped with lower Chester rocks.
- 3.1 SLOW DOWN. Cut exposes 8 feet of Ste. Genevieve limestone.
- 3.2 Enter Bedford quadrangle.
- 3.3 SLOW DOWN. Cut exposes 91 feet of Ste. Genevieve limestone.
- 4.2 Enter Oolitic quadrangle.
- 4.4 SLOW DOWN. Cut exposes St. Louis limestone.
- 5.0 SLOW DOWN. Cut exposes St. Louis limestone.
- 5.7 SLOW DOWN. Cut exposes St. Louis limestone.
- 6.0 SLOW DOWN. Cut exposes St. Louis limestone.
- 6.8 SLOW DOWN. Cut exposes St. Louis limestone.
- 7.0 Junction Indiana Highway 37 and U. S. Highway 50.
- 7.3 SLOW DOWN. Cut exposes St. Louis limestone.
- 7.9 South end of bridge over east fork of White River. Wisconsin glacial outwash terraces can be seen imperfectly (see p. 11).

Mileage  
between  
stops

8.5                    SLOW DOWN. Base of wit on north side of valley.

8.8                    Base of middle exposure in cut.

STOP 2. White River section. 40 minutes. Location: NE¼ NE¼ sec. 34, T. 5 N., R. 1 W., about 0.5 mile north of the east fork of White River, along Indiana Highway 37, Lawrence County. (Oolitic quadrangle)

A series of road cuts along Indiana Highway 37 exposes the Salem limestone and the lower 4.0 feet of the St. Louis limestone. The composite section listed below was measured by Ned M. Smith. (See p. 60 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Chip sample number
QUATERNARY		
9 Soil: Tan, residual; contains chert.	- - - -	--
MISSISSIPPIAN		
St. Louis limestone		
8 Limestone: Gray, finely granular, very argillaceous; weathers tan and platy.	2.0	--
7 Limestone: Light-gray, finely granular, sublithographic; most of the unit is exposed as a single bed.	<u>2.0</u>	--
Total thickness of exposed St. Louis limestone . . . .	4.0	
Salem limestone		
6 Limestone: Light-gray, fine-grained, bioclastic; brittle, stylolitic, medium-bedded. Minor amount of coarse-grained bioclastic material is present.	18.8	20
5 Limestone: Light-gray to dark-buff, medium-bedded, argillaceous. Unit includes black fissile shale partings and minor amounts of fine-grained bioclastic material that commonly contains		

## ITINERARY

19

Unit	Description	Thickness in feet	Chip sample number
	specimens of <u>Endothyra</u> .	6.7	19
4	Limestone: Light-buff, fine- to medium-grained, bioclastic; contains abundant <u>Endothyra</u> in a dense, glassy matrix; stylolitic and medium-bedded. A few coarse-grained and porous zones are present.	12.9	18
3	Limestone and siltstone: Lower beds of fine- to medium-grained bioclastic material that grade upward into semicrystalline argillaceous limestone and tan calcareous siltstone.	9.9	17
2	Limestone: Light-buff, very coarse-grained, porous, bioclastic; changes upward to argillaceous limestone. Unit is deeply weathered and poorly exposed.	21.2	--
1	Limestone: Gray and buff, alternating fine- and medium-grained, bioclastic laminae that are inclined; stylolitic and strikingly massive. Common fossils are <u>Endothyra</u> , bryozoans, and brachiopods. Probable maximum thickness of exposed Salem limestone.	<u>27.0</u> <u>86.6</u>	16
	Total thickness of measured section .....	90.6	

Exposures of units 1 and 2 are in the first road cut north of the east fork of the White River and are best developed along the west side of Indiana Highway 37. Proceeding northward along the highway, units 3, 4, 5, and 6 are exposed in the next road cut, which is just north of a motel on the west side of the highway; parts of the same units also are exposed in the neighboring northward-trending cut. The fourth cut north of the east fork of White River reveals the upper 2.0 feet of unit 6 and units 7, 8, and 9. Because the beds cannot be traced between the two southern cuts, unit 3 is possibly a repetition of the upper part of unit 2; the lithology and other features of

the upper part of unit 2 bear a striking resemblance to those of unit 3.

The Salem-St. Louis contact in this section is drawn on the following grounds. Unit 6 is included in the Salem because of its bioclastic nature and the absence of argillaceous material. Unit 7 and the majority of unit 8 are assigned to the St. Louis because of their platy argillaceous beds and the lack of a significant amount of bioclastic material. Even though unit 8 does contain a thin zone in which specimens of Endothyra are abundant, units 7 and 8 cannot be included in the Salem because Endothyra is known in the St. Louis, as well as in rocks of Chester age, in Indiana (Patton, 1953, pp. 74, 119).

Participants should observe the massive appearance of unit 1.

This stratigraphic interval is quarried elsewhere for building or dimension stone and commonly is referred to as the "building stone facies" of the Salem. The operators of building stone quarries discard the beds above the massive part of the Salem, as exemplified by unit 1, during quarrying operations and picturesquely refer to these rejected beds as "bastard stone. " Nevertheless, that part of the Salem above the massive stone does include beds of high-calcium limestone that are lithologically similar to the lower, massive part of the formation. Thus, in this section, a stratigraphic interval consisting largely of argillaceous limestone and siltstone (units 2 and 3) intervenes between units 1 and 4, which are physically similar. Consequently, the geologist should not regard the Salem in its entirety as a massive, essentially homogeneous bioclastic formation but should recognize that the upper strata of the formation include a heterogeneous assembly of lithologies, among which are high-calcium limestone intervals.

#### Mileage between stops

0.0	Parking place at Stop 2; check mileage,
0.6	Salem-St. Louis boundary exposed in small outcrop on west side of road.
0.8	St. Louis limestone is exposed in cuts at intersection.
0.9	Enter Bedford quadrangle.
1.1	Salem and St. Louis limestones exposed in cut. Bedford city limits.

Mileage  
between  
stops

- 1.8 Junction Indiana Highways 37 and 450; turn east (right).
- 1.9 Separation of Indiana Highway 37 from U. S. Highway 50; continue east on 50.
- 2.6 Highway passes over railroad (at east city limits of Bedford).
- 2.7 Turn south (right) on first road east of highway overpass.
- 2.9 Entrance to abandoned Williams quarry.

STOP 3. Williams quarry. 15 minutes. Location: NW $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 24, T. 5 N., R. 1 W., near the east city limits of Bedford and approximately 500 feet south of U. S. Highway 50, Lawrence County. (Bedford quadrangle)

The Williams Limestone Company produced crushed stone from this site until 1950. The section listed below was measured by Carroll N. Roberts when the quarry was operative. (See p. 61 for analyses of samples from this stop.)

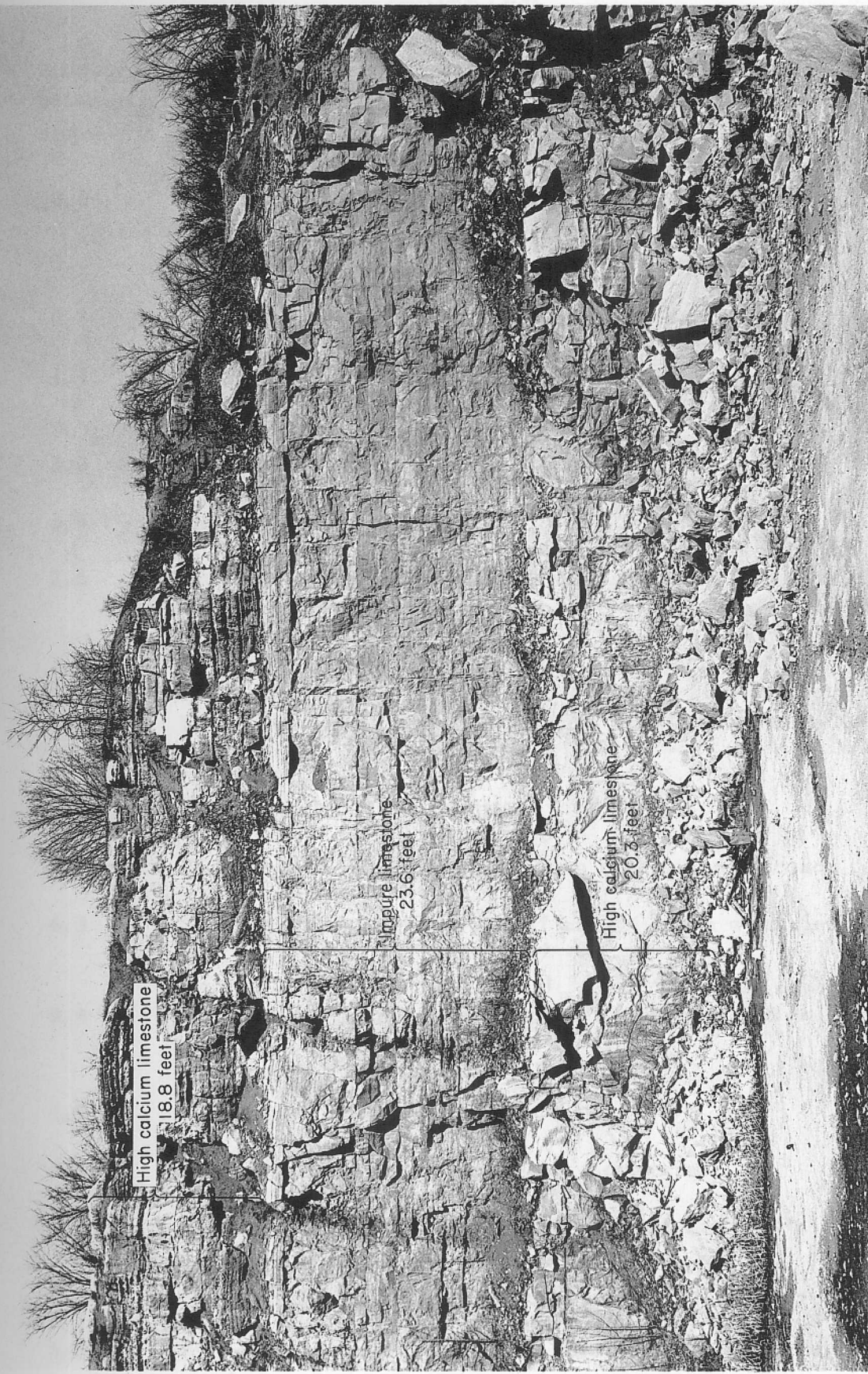
Unit Description	Thickness in feet	Chip sample number
QUATERNARY		
9 Soil: Yellow-brown, residual, clayey.	4.2	--
MISSISSIPPIAN		
Salem limestone		
8 Limestone: White, fine grained, medium-bedded; weathered surface is pitted. 7.9		--
7 Limestone: Gray, fine grained, crystalline; stone breaks with conchoidal fracture and is stylolitic. Unit contains deep, clay- filled solution depressions.	3.6	--
6 Limestone: Gray to tan, fine- to medium-grained, crystalline, medium- bedded, stylolitic, hard; weathers yellow and pitted.	7.3	27

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit Description	Thickness in feet	Chip sample number
5 Limestone: Gray to white, fine-grained, noncrystalline, hard. Unit is laminated and contains carbonaceous material.	3.5	26
4 Limestone: Gray to tan, medium- to coarse-grained, semicrystalline, massive. Unit is stylolitic, carbonaceous, and includes scanty bioclastic material.	8.6	25
3 Limestone: Mottled gray and tan, bioclastic, and crystalline; unit is soft, massive, stylolitic, and banded.	6.0	24
2 Limestone: Brown, medium grained, compact, argillaceous; emits fetid odor when struck.	5.5	23
1 Limestone: Gray in lower 4.0 feet, remainder buff; soft, stylolitic, massive, cross-bedded, even-grained, bioclastic. Weathered surface is pitted.	22 (upper 10.2 feet) <u>20.3</u> 21 (lower 10.1 feet)	
Total thickness of exposed Salem limestone .....	<u>62.7</u>	
Total thickness of measured section .....	66.9	

The fact that the lithologic divisions in this section (pl. 3) also are present in the White River section indicates that lateral continuity of identifiable rock types prevails in the Salem. Nevertheless, participants will be impressed during their examination of the Georgetown section with the local variability in thickness and lithology of the units that form the Salem limestone. The Williams quarry was abandoned mainly because the stone was too soft and porous for use as road metal; other contributing factors included blasting problems resulting from an urban location, an unsatisfactory market, and the high cost of production with the equipment in use.





EAST WALL OF ABANDONED WILLIAMS QUARRY SHOWING SALEM LIMESTONE

Mileage  
between  
stops

- |     |  |
|-----|--|
| 0.0 | Entrance to Williams quarry.   |
| 0.2 | Junction with U. S. Highway 50; turn west (left).                            |
| 0.3 | Bedford city limits and overpass.  |
| 1.1 | Junction U. S. Highway 50 and Indiana Highway 37; turn north (right) on 37.  |
| 2.3 | Pass Bedford city limits.  |
| 2.5 | Enter Oolitic quadrangle.  |
| 2.6 | McMillin Mill, Indiana Limestone Company, on west (left) side of road.       |
| 2.8 | Salem limestone outcrop.   |
| 2.9 | Harrodsburg limestone outcrops; Salt Creek Valley (see p. 11).               |
| 3.6 | South city limits of Oolitic.  |
| 3.7 | Cut exposes Salem limestone on both sides of road.                           |
| 4.3 | Junction Indiana Highways 37 and 54; turn west (left) on 54.                 |
| 4.4 | Milwaukee Railroad; grout piles straight ahead on south (left) side of road. |
| 4.5 | City limits on west edge of Oolitic.   |
| 4.7 | Road south leads to Dark Hollow quarries.                                    |
| 4.8 | Salem limestone exposures along roadside.                                    |
| 4.9 | Entrance to Diehl Hollow quarry on north (right).                            |
| 5.1 | Salem limestone is exposed along north (right) side of road.                 |

Mileage  
between  
stops

- 5.2 East village limits of Avoca.
- 5.6 Avoca State Fish Hatcheries on south side of road.
- 6.1 West village limits of Avoca.
- 6.7 Goose Creek.
- 7.7 Chester escarpment ahead, east margin of the Crawford upland (seep. 9); escarpment rises 160 feet above Mitchell plain at this place.
- 8.2 SLOW DOWN. Levias on both sides of road; Mooretown sandstone float.
- 8.5 This basin is a karst valley. Surface drainage from the surrounding hills, which are capped with clastic Chester strata, disappears into sinkholes upon reaching the limestone-floored valley.
- 8.7 Ste. Genevieve limestone exposures on both sides of road.
- 8.9 Ste. Genevieve limestone exposures (Levias) on north (right) side of road.
- 9.3 Crossroad at south edge of Springville.
- 9.6 Exposure of terra rossa that contains St. Louis chert as float on north side of road.
- 10.0 Cherty St. Louis limestone exposures on east (left) side of road.
- 10.4 St. Louis exposures on east (left) side of road.
- 10.8 SLOW DOWN. St. Louis-Ste. Genevieve contact is exposed on east (left) side of road.
- 11.0 Ste. Genevieve limestone is exposed in cuts.
- 11.2 Turn north (right) on road leading into quarry.

Mileage  
between  
stops

11.7          Park in quarry. LUNCH.

STOP 4. Springville quarry. 1 1/2 hours. Location: SE<sup>1</sup>/<sub>4</sub>SE<sup>1</sup>/<sub>4</sub> sec. 29, T. 6 N., R. 2 W., about 2 miles southwest of Springville, Lawrence County. (Oolitic quadrangle)

This quarry is operated by Ralph Rogers and Company. All stratigraphic units are exposed from the upper part of the St. Louis limestone to the Beaver Bend limestone, inclusive (pl. 4). The Sample sandstone does not crop out in this section, but weathered fragments of this formation are found in and below its expectable stratigraphic position. This is the only continuous section of the entire Ste. Genevieve limestone in Indiana. The size of the quarry is remarkable, as the first stone was removed in 1949.

The section listed below was measured by J. B. Patton and Ned M. Smith. (See p. 62 for analyses of samples from this stop.) Unit Description

		Thickness in feet	Chip sample number
QUATERNARY			
27	Soil: Upper 0.5 foot dark humus. Lower 0.6 foot mahogany, sticky, residual clay. Remainder of unit is reddish-brown, sticky residual clay that contains weathered fragments of Sample sandstone.	5.4	--
MISSISSIPPIAN			
Beaver Bend limestone			
26	Limestone: Upper 4.5 feet gray, medium- to coarse-grained, crystalline, massive, fossiliferous. Lower 4.1 feet brown, dense, tough, massive.	8.6	48
25	Covered interval: Arbitrarily included in Beaver Bend. Measured thickness of exposed Beaver Bend limestone .....	<u>1.6</u> 10.2	--

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit Description		Thickness in feet	Chip sample number
Mooretown sandstone			
24	Shale: Light-brown, soft, laminated.	0.6	--
23	Sandstone: Tan, soft, thin-bedded, argillaceous. Forms resistant ledge.	3.1	--
22	Sandstone: Tan, medium grained, thick-bedded.	1.5	--
21	Shale: Dark-gray, thin parted, soft, very pyritic; weathered surfaces are tan-brown and commonly show selenite. Upper 0.3 foot is white, soft clay. Upper 2.5 feet contains thin, hard layers of arenaceous shale and sandstone.	<u>20.9</u>	--
	Total thickness of Mooretown sandstone .....	26.1	
Paoli limestone			
20	Limestone: Gray-tan, fine- to coarse-grained, crystalline; upper 0.9 foot brown, dense.	6.3	
	Light-gray, dense; upper 0.3 foot shale and thin, platy oolitic limestone.	5.5	47
Aux Vases formation			
19	Limestone and shale: Limestone: Light-gray, argillaceous; weathered along upper bedding plane.	1.3	
	Shale: Light-gray, firm, calcareous.	1.1	
	Limestone: Light-gray, argillaceous, noncrystalline.	1.7	
	Shale: Brown, sticky; contains plates of crystalline limestone.	0.5	46

# ITINERARY

27

Unit Description	Thickness in feet	Chip sample number
Ste. Genevieve limestone		
Levias member		
18 Limestone: Light-brown, dense; brecciated and re- cemented by anastomosing veinlets of dark calcite. Weathers rubbly. (Bryants- ville breccia bed)	3.2	45
17 Limestone: White to gray, granular to dense, massive, extremely oolitic. Oolites break free in upper part and cleave in lower part. 3.2 Light-gray to tan, lithographic, thin- and wavy-bedded, oolitic. 0.9 White to light-gray, granular to dense, massive, oolitic. 7.8	11.9	44
16 Limestone: Mottled gray, tan, and brown, fine-grained and dense. Fractures in the two massive beds of the unit are cemented by brown limoni- tic calcite.	4.5	43
15 Limestone: White to gray, oolitic, thin- and irregular- bedded; an undulating stylolite forms the upper surface.	6.0	42
14 Limestone: Gray, dense to granular; fractures are cemented by calcite.	4.5	41
13 Limestone: Brown, sub- lithographic, dense, thin- bedded; weathered along bed- ding planes.	15.0	40
12 Limestone: Gray, dense; fractures cemented by calcite. Total thickness of Levias Member.....	<u>8.0</u> 53.1	39
Rosiclare member		
11 Shale and limestone: Shale: Green, soft, platy, arenaceous. 0.7		

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit	Description	Thickness in feet	Chip sample number
	Limestone: Gray, granular, tough, arenaceous and locally conglomeratic. 0.9 Shale: Tan, platy, silty to conglomeratic, 0.6 Limestone: Gray, oolitic, arenaceous and conglomeratic. 0.5	2.7	38
10	Limestone: Upper 3. 8 feet white, crystalline, pure oolite; lower 3. 2 feet gray, dense, suboolitic. unit is massive.	7.0	37
9	Dolomite: Gray-brown, massive. Near outcrop dolomite is apparently a secondary deposit in solution zone and consists of a reticu- late mass of brown, coarsely vugular, soft dolomite built up on a framework of brown, dense dolomite.	5.7	36
8	Limestone: Gray, granular, fossiliferous. Unit contains a 0.3-foot chert zone at top and an 0.8-foot cheat bed at base and locally is largely chert. (Lost River chert)	1.7	35
7	Limestone: Light-gray, granular, massive, and showing vestigial oolites. Coarsely fragmental oolite occurs in upper few feet.	12.8	34
6	Lime stone: Gray and tan, granular to crystalline, stylolitic. Thin shale part- ings are present on bedding planes.	<u>23.9</u>	33
	Total thickness of Fredonia member .....	<u>51.1</u>	
	Total thickness of Ste. Genevieve limeston.....	106.9	

Unit Description	Thickness in feet	Chip sample number
St. Louis limestone		
5 Limestone: Tan, litho- graphic, dense, glauconit- -ic. Unit forms a single thick bed that has a stylolite at the base, a 0.2-foot chert bed at the top, and small fos- sils and fossil fragments, in horizontal layers.	2.4	32
4 Limestone: Tan, finely granular, saccharoidal. Unit is a single arenaceous glauconitic bed that contains spherical chert.	3.7	31
3 Limestone: Tan, mainly lithographic, dense, glauconit- ic. Unit bears a few oolites, many stylolites, and small fos- sils and fossil fragments.	1.9	30
2 Limestone: Gray, fine-grained, crystalline, saccharoidal. Altered (green) and unaltered pyrite, as well as nodular chert, is present. Upper surface is undulatory.	5.1	29
1 Limestone: Tan to gray, litho- graphic to finely granular, dense. Unit is thin-bedded and contains pyrite, glauconite, in- terbedded chert, and brachio- pods.	<u>9.5</u>	28
Thickness of exposed St. Louis limestone .....	<u>22.6</u>	
Total thickness of measured section .....	187.6	

The geologist must have an intimate knowledge of the lithologic characteristics of the St. Louis and Ste. Genevieve limestones in order to establish the contact between these formations with stratigraphic consistency. A number of criteria have been used for the recognition of this contact, which should be placed only after a careful consideration of all lithologic and stratigraphic evidence. Nevertheless, equally competent geologists probably would disagree as to the location of this contact in the same section. Field studies in



Indiana have shown that lenticular and bedded chert is more abundant in the upper strata of the St. Louis than in the lower beds of the Ste. Genevieve and that the St. Louis is typically darker gray or tan than the Ste. Genevieve. Approximately 20 feet of strata intervene between the top of the St. Louis and the Lost River chert in the Fredonia member of the Ste. Genevieve limestone. Oolites, are more abundantly developed in the Ste. Genevieve than in the St. Louis, and a higher degree of crystallinity is more characteristic of the Ste. Genevieve than the St. Louis. The colonial coral Lithostrotion canadense occurs about 25 feet below the St. Louis-Ste. Genevieve contact. Finally, the Ste. Genevieve is a purer limestone than the St. Louis. Few sections display all the preceding recognitional criteria, and in some sections the criteria may appear contradictory.

In the walls of this quarry considerable difficulty is experienced in establishing the St. Louis-Ste. Genevieve boundary. Participants may disagree with the location of this contact as indicated in the measured section. The lithology of unit 5 is typical of that found in the St. Louis limestone, whereas the lithology of unit 3 resembles that of the Ste. Genevieve limestone; the lithology of unit 4 is suggestive of both formations. Consequently, a transitional zone (pl. 4) consisting of units 3, 4, and 5 separates typical St. Louis strata from indisputable Ste. Genevieve beds. This transitional zone commonly is found in Indiana limestones, and the problem of establishing the St. Louis-Ste. Genevieve boundary is resolved by including those beds that are characterized by bedded chert in the St. Louis.

The Rosiclare member of the Ste. Genevieve limestone is characterized by its lithologic variability, a feature well shown in this section. Elsewhere in Indiana, the Rosiclare may be gray, sandy, cross-bedded oolitic limestone that is less pure than the underlying and overlying strata.

The top of the Ste. Genevieve is marked by the thin Bryantsville breccia, a term proposed by Malott (1952a, p. 9). This section shows a characteristic development of the Bryantsville; the brecciated nature of the Bryantsville may not be as obvious in other localities in Indiana. The Bryantsville breccia is a satisfactory stratigraphic marker bed provided it is not confused with similar strata that locally are found higher and lower in the section. Moreover, because of its thinness, the Bryantsville is readily concealed. As shown in this section, a brecciated zone also may appear locally in the Paoli limestone. Consequently, because of recurrent brecciated and breccia-like intervals in this part of the Mississippian section, the top of the Ste. Genevieve is most reliably located in quarries or natural exposures which reveal a virtually continuous stratigraphic section of late Meramecian and early Chesterian rocks.



NORTH FACE OF SPRINGVILLE QUARRY, RALPH ROGERS COMPANY

A variety of minerals has been found in the upper part of this section. Participants probably will find excellent specimens of selenite on the weathered surface of the dark shale in the Mooretown and on fracture surfaces in the upper part of the Paoli limestone. Masses of travertine have been collected from the lower part of the Paoli and the upper beds of the Ste. Genevieve.

Mileage  
between  
stops

0.0	Entrance to Springville quarry. Check mileage.
1.3	Junction with Indiana Highway 54; turn east (right). 2.7 Karst valley.
2.9	Chester escarpment.
5.6	Fish hatcheries at Avoca.
6.7	West city limits of Oolitic.
6.8	Junction Indiana Highways 54 and 37; turn north (left) on 37.
7.1	Salem limestone outcrop.
7.3	Entrance to Hoosier-Joiner Mill, which manufactures split face ashlar building stone.
7.4	Walsh quarry of Indiana Limestone Corporation on west (left) side of road.
8.0	Turn east (right) on road to P. M. & B. quarry of the Indiana Limestone Corporation.
8.1	West end of north opening of P. M. & B. quarry, next to cemetery.

STOP 5. P. M. & B. quarry. 30 minutes. Location: NW¼ NE¼ sec. 33, T. 6 N., R. 1 W., about 1 mile north of Oolitic, in Lawrence County. (Oolitic quadrangle)

The Perry, Matthews, and Buskirk quarry, owned and operated by the Indiana Limestone Corporation, commonly is referred to as the P. M. & B. quarry. This stop has been included in order that

participants may see an active dimension stone quarry, which shows a thick section of typical Salem limestone. The lower strata of the St. Louis limestone are discarded during quarrying operations.

The section listed below was measured by Arthur P. Pinsak and Ned M. Smith. (See p. 65 for analyses of samples from this stop.)

Unit Description		Thickness in feet	Chip sample number
QUATERNARY			
18	Soil: Red-brown, sandy, clayey; contains evidence that lower part was derived from fissile shale.	5.0	--
MISSISSIPPIAN			
St. Louis limestone			
17	Limestone: Light-gray brown, medium-grained, noncrystalline, argillaceous. Unit contains sparse fossil fragments and rare calcite crystals.	0.3	--
16	Dolomite: Yellowish-tan, fine- to medium-grained, noncrystalline, argillaceous; shale partings occur in upper 0.7 foot.	5.6	--
15	Shale: Purplish-brown, fissile.	0.6	--
14	Limestone: Light-grayish tan, fine-grained, noncrystalline; stone is thin-bedded and somewhat argillaceous.	5.6	--
13	Limestone: Dark-gray, medium-grained, noncrystalline. Stone contains scattered fossil fragments and a few pores that approximate 1 mm in diameter.	1.4	--
12	Limestone: Gray to gray-brown, fine- to medium-grained, noncrystalline; fossil fragments are oriented parallel to bedding planes. Unit has two brown-gray shale beds, 0.9 foot and 1.8 feet thick, that are separated by a 0.6-foot limestone bed.	4.6	--

Unit	Description	Thickness in feet	Chip sample number
11	Shale: Drab-gray-brown, fissile; has thin, discontinuous lenses of reddish-brown, fine-grained, non-crystalline limestone that is very porous.	4.6	--
10	Limestone: Dark-blue-gray, fine-grained, noncrystalline. Stone displays alternating light and dark, thin laminae and black fissile shale partings.	8.4	--
9	Limestone: Blue-gray, medium-grained, noncrystalline; unit consists of an argillaceous dolomitic bed that weathers tan.	2.2	--
8	Strata covered: Arbitrarily included in St. Louis.	<u>0.7</u>	--
	Total thickness of exposed St. Louis limestone.....	34.0	
Salem limestone			
7	Limestone: Gray, fine-grained, noncrystalline. Medium-bedded argillaceous stone has conchoidal fracture and contains a few microfossils.	10.0	--
6	Limestone: Gray, fine-grained, noncrystalline. Unit consists of one bed that contains a few crystals of calcite and has a banded appearance because of the inclusion of darker material.	8.2	--
5	Limestone: Buff to tan, medium-grained, crystalline, slightly argillaceous. Gray, coarser grained, and porous lenses occur in association with stylolites. Fossils more sparse than in underlying units.	11.9	53

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit	Description	Thickness in feet	Chip sample number
4	Limestone: Very light-buff, fine-grained, crystalline and bioclastic. Unit consists of a massive, homogeneous bed whose crystallinity and induration increase upward; a stylolite bounds the top of the unit.	13.7	52
3	Limestone: Light-buff, coarse-grained, bioclastic, porous; organic remains are cemented by finely crystalline material. Variation in size of bioclastic grains in inclined beds indicates sorting.	5.7	51
2	Limestone: Dark-gray and buff, fine- to coarse-grained, bioclastic, porous. Crystalline material partially fills the interspaces in this bioclastic rock.	18.6	50
1	Limestone: Buff-brown, coarse-grained, bioclastic; inclined bedding occurs in upper 2.5 feet.	<u>7.8</u>	49
	Total thickness of exposed Salem limestone .....	<u>15.9</u>	
	Total thickness of measured section .....	114.9	

The bioclastic nature of the Salem limestone is well shown in this section. The over-all lithology in this exposure is repeated in other dimension stone quarries in the Salem outcrop belt of Indiana.

After Stop 5 the group will be divided into two parts. Persons who wish to visit Stop 6, the Cleveland quarry, will follow this road log. Participants who prefer to visit Stop 6A, the Radcliff and Berry quarry, should turn to page 40.

Mileage  
between  
stops

0.0

Leave P. M. & B. quarry.

Mileage  
between  
stops

- 0.1 Turn north (right) on Indiana Highway 37.
- 0.7 Needmore village.
- 0.8 St. Louis limestone exposed in top of road cut.
- 1.0 Salem limestone.
- 1.2 Harrodsburg limestone; Gullett's Creek.
- 1.9 Entrance to Needmore quarry of the Heltonville Limestone Company. Quarry is half a mile east of highway.
- 2.0 Massive Salem limestone on west side of road is capped by quartzose Pliocene (?) gravel.
- 4.0 Chester escarpment can be seen rising above Mitchell plain about 3 miles to west. Mitchell plain here may be remnant of Lexington peneplain.
- 4.9 St. Louis limestone exposures on west (left) side of road.
- 5.0 Lawrence-Monroe bounty line.
- 5.2 Judah's Hill to northeast (right) includes strata from upper Borden to lower St. Louis. The hill is capped by a veneer of weathered siliceous Pliocene (?) gravel. The altitude of the top of the hill is 745 feet.
- 5.3 Harrodsburg limestone exposures in road cut and in small quarry on east (right) side of road are in the type area of the formation as described by Hopkins and Siebenthal (1897, p. 297).
- 5.4 Judah's Creek. Abandoned quarry in Harrodsburg on west (left) side of road.
- 5.5 Enter Bloomington quadrangle.
- 5.8 Salem limestone exposures are in cut on east side of road.

Mileage  
between  
stops

- 5.9      Note bedrock meander core in valley of Salt Creek, east (right) of road.
- 6.3      South village limits of Harrodsburg. Borden-Harrodsburg contact is exposed in cut on east side of road.
- 6.4      Turn west (left) on road into Harrodsburg.
- 6.6      Turn north (right).
- 6.8      Turn right.
- 7.1      Monon Railroad crossing.
- 7.6      Park along roadside; abandoned Cleveland quarry is west of road.

STOP 6. Cleveland quarry. 1 hour. Location: SE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 20, T. 7 N., R. 1 W., about 1 mile north of Harrodsburg, Monroe County. Bloomington quadrangle)

The section of the Salem limestone that is exposed in this abandoned quarry should be of particular interest to paleontologists because of the myriads of Endothyra baileyi and other small fossils that can be readily collected. Specimens should be sought in the highly weathered walls of the quarry and in the fine-sized detrital material on the quarry floors.

The section listed below was measured by Ned M. Smith. (See p. 66 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Chip sample number
QUATERNARY		
7 Soil: Reddish-brown, clayey, residual.	8.0	--
MISSISSIPPIAN		
Salem limestone		
6 Limestone: Light-buff, finely bioclastic. Unit is massive and complexly cross-bedded,, porous, soft, and contains a few large microfossils. Bio- clastic particles are coated		



Unit	Description	Thickness in feet	Chip sample number
	by white, dense, calcitic material.	17.2 to 18.4	59
5	Limestone: Light-buff to buff, medium to coarsely bioclastic. Unit is soft, stylolitic, very porous, and has fossils that are covered by thick, light-gray to white, dense calcitic material that weathers chalky; cross bedding that involves layers of varied textures is prominent.	17.1 to 17.5	58
4	Limestone: Buff, medium-grained, bioclastic, deeply weathered. Unit is massive, cross-bedded, and lacks stylolites. The soft, highly weathered material in this unit yields abundant and well preserved fossils; the material coating the organic remains is not as conspicuously developed as in unit 5.	12.0 to 12.4	57
3	Limestone: Dark-buff, medium-grained, bioclastic; unit is porous, soft, massive, and apparently nonstylolitic. Bioclastic particles are covered by light-buff calcitic material.	12.8	56
2	Limestone: Dark-buff, coarsely bioclastic and partially crystalline; unit is stylolitic and has been in part removed by solution.	4.5	55
1	Limestone: Tan, finely bioclastic in upper part		

Unit Description	Thickness in feet	Chip sample number
and grades to fine-grained, crystalline, dolomitic, and argillaceous in lower part; unit is deeply weathered and iron-stained	<u>9.0</u>	54
Total thickness of ex- posed Salem limestone .	<u>72.6 to 74.6</u>	
Total thickness of measured section . . .	80.6 to 82.6	

Units 1 and 2 are exposed along an abandoned railroad cut near the southwest extremity of the quarry; these units were not quarried. All other units may be observed in the quarry proper. The highest exposures are in the northeast corner of the site.

The Cleveland quarry is located in an outlier that includes the Salem and St. Louis limestones. Although the year in which this quarry was opened is not cited in the literature, the operation has been abandoned for at least 58 years (Hopkins and Siebenthal, 1897, p. 376). The extent of the quarry and the former presence of a rail line to the site indicate that this was a large venture; few abandoned quarries of this vintage are of comparable size. Quarrying operations ceased because many stylolites, vertical fissures, and soft, probably highly weathered intervals made quarrying unprofitable (Hopkins and Siebenthal, 1897, p. 377)

A prominent lithologic characteristic of the Salem limestone is well displayed in this section. That part of the Salem from which dimension stone generally is obtained is composed of fine to coarse bioclastic material, as revealed by examination under a hand lens. The small fossils and fossil fragments that form the bioclastic rock are commonly coated by white, gray, or buff, dense calcitic material that imparts a pseudo-oolitic appearance to the stone; subdivisions in the Salem are, in part, based on the nature of this coating.

The fauna of the Salem limestone has received considerable attention from paleontologists of past decades, but further systematic faunal studies have not been made in recent years. The most recent embrative study of the Salem faunan was made by Cumings et al. (1906), who collected extensively from this formation, and who thoughtfully aggregated descriptions of Salem forms that had appeared previously in diverse publications. Cumings and his associates recognized the uniqueness of the Salem fauna by their comment, "The fossils of this limestone in its typical development are characterized by their stunted form...." (1906, p. 1190). The same authors (Cumings et al., 1906, pp. 1190-1200, 1237-1242) speculated at same length concerning the physical conditions that existed during the deposition of the Salem

limestone. In fact, their discussion is one of the earlier considerations of environmental conditions of deposition.

As suggested by Cumings and his colleagues (1906, p. 1190), presence of a large number of small fossils is an outstanding and prominent aspect of the Salem fauna. Paleontologists customarily allude to such a fauna as being “dwarf” or “diminutive,” but all paleontologists are not in complete agreement as to the precise meanings of these terms. The problems associated with such faunas still remain intriguing to paleontologists (Cloud, 1948; Lalicker, 1948; and Scott, 1948).

Note the grikes (solution-enlarged joints) and small caverns in the quarry face. The high ground visible to the west is the Chester escarpment (pl. 2), which has a crest 950 feet in altitude. The Mitchell plain (pl. 2) at the base of the escarpment is 650 feet above sea level.

Mileage  
between  
stops

- |     |   |
|-----|---|
| 0.0 | Parking area at Cleveland quarry. Proceed north.  |
| 0.2 | Turn east (right).  |
| 0.3 | Junction with Indiana Highway 37. Turn south (right) on 37.   |
| 0.6 | Salem limestone outcrop.  |
| 0.9 | <u>SLOW DOWN</u> . Road cut exposes entire section of Harrodsburg limestone. Dr. J. J. Galloway intends to designate this section as the new type section of the Harrodsburg in a future publication. |
| 1.0 | Monon Railroad passes under highway.  |
| 1.4 | North village limits of Harrodsburg.  |
| 1.5 | Junction with road into Harrodsburg; continue on 37.  |
| 2.0 | Judah's Hill shows best in profile from this place.   |
| 2.4 | Enter Oolitic quadrangle.   |
| 2.9 | Enter Lawrence County.  |

Mileage  
between  
stops

7.9	Entrance to P. M. & B. quarry (Stop 5).
9.1	Junction Indiana Highways 37 and 54 in Oolitic; remain on 37.
10.9	Enter Bedford quadrangle.
14.1	Junction Indiana Highway 37 and U. S. Highway 50 in Bedford; turn west (right).
14.2	Turn south (left); remain on 37.
15.5	Enter Oolitic quadrangle.
16.3	Bridge over east fork of White River.
23.6	Junction Indiana Highways 37 and 60 at south edge of Mitchell; turn east on 60.
26.6	Entrance to Spring Mill State Park.
27.4	Parking lot at Spring Mill Inn.

## Route from Stop 5 to Stop 6A

0.0	Entrance to P. M. & B. quarry. Check mileage.
1.2	Junction Indiana Highways 37 and 54 in Oolitic; continue on 37.
3.0	Enter Bedford quadrangle.
6.2	Junction Indiana Highway 37 and U. S. Highway 50 in Bedford; turn west (right) at stop light.
6.3	Turn south (left) at stoplight, following Indiana Highway 37.
7.6	Enter Oolitic quadrangle.
8.4	Bridge over east fork of White River.

Mileage  
between  
Stops

- 15.7 Junction Indiana Highways 37 and 60 at south edge of Mitchell; remain on 37.
- 17.8 Enter Orange County.
- 18.6 Turn west (right) on macadam road.
- 19.2 Entrance to Radcliff and Berry quarry; turn north (right).

STOP 6A. Radcliff and Berry quarry. 1 hour. Location: SW $\frac{1}{4}$  Sw $\frac{1}{4}$  sec. 24, T. 3 N., R. 1 W., approximately 1 mile northwest of Orleans, in Orange County. (Mitchell quadrangle)

The section that is exposed in this quarry extends from the upper beds in the Fredonia member of the Ste. Genevieve limestone to the uppermost strata of the Paoli limestone, inclusive. Participants have the opportunity of examining one of the thickest known sections of Paoli limestone in Indiana.

The section listed below was measured by J. B. Patton, Arthur P. Pinsak, and Ned M. Smith. (See p. 67 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Chip sample number
<b>QUATERNARY</b>		
26 Soil: Reddish-brown, residual, clayey; locally contains weathered blocks of Moore-town sandstone.	6.0	--
<b>MISSISSIPPIAN</b>		
Paoli limestone		
25 Limestone: Light-gray, sub-lithographic, oolitic; calcite crystals occur in vertical stringers near top. Oolites are found throughout unit but are most conspicuously developed in thin, discontinuous lenses.	8.5	--
24 Limestone: Light-gray, oolitic, dense. Unit is thick bedded and contains streaks of crystalline calcite that are more abundant in upper part.	5.2	--

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit	Description	Thickness in feet	Chip sample number
23	Limestone: Tan and gray, mottled, coarse-grained, crystalline; fossil fragments are abundant.	1.1	--
22	Limestone: Light-tan, medium-grained, granular, thin-bedded.	3.9	--
21	Limestone: Light-gray, medium-grained, crystalline. Unit is thick-bedded, oolitic, and locally cross-bedded.	3.7	--
20	Limestone: Light-gray, fine-grained, crystalline. Beds range from 0.2 to 0.8 foot in thickness and contain oolites and fossil fragments. (The chip sample includes only the lower 6.9 feet of this unit.)	9.5	68
19	Shale: Light-greenish-gray, soft, calcareous, fossiliferous.	0.9	68
18	Limestone: Light-gray, fine grained, crystalline. The oolitic, fossiliferous beds are 0.5 foot to 2.0 feet thick. Total thickness of exposed Paoli limestone .....39.0	<u>7.1</u>	68
Aux Vases formation			
17	Limestone, sandstone, and shale: Upper 0.2 foot brown-stained, fine-grained, calcareous sandstone. Remainder of unit, excepting lower 0.2 foot, consists of light-gray, granular, massive, argillaceous dolomitic limestone; lower 0.2 foot is light-gray, soft calcareous shale.	3.0	67
Ste. Genevieve limestone			
Levias member			
16	Limestone: Brown, dense, brecciated; weathers rubbly.		

Unit	Description	Thickness in feet	Chip sample number
	(Bryantsville breccia bed)	2.2	66
15	Limestone: Tan, dense to fine-grained, crystalline, suboolitic. Lower 1.0 foot contains interbedded soft, green shale.	6.6	66
14	Limestone: Light-gray, dense to fine-grained, crystalline; unit is massive and oolitic.	6.5	65
13	Limestone: Gray, crystalline.	1.5	65
12	Limestone: Tan, fine grained, crystalline. A clay seam occurs at the top of this massive unit.	3.4	64
11	Limestone: Gray, coarse-grained, crystalline.	4.8	64
10	Limestone: Dark-gray, dense. The massive unit has a banded appearance because of moisture in porous zones. A thin clay parting marks the base.	8.6	63
9	Limestone: Dark-gray, dense. The upper 3.8 feet has a banded appearance because of moisture in more porous streaks. The massiveness of the unit is broken by a prominent bedding plane 3.9 feet from the base.	<u>9.4</u>	62
	Total thickness of Levias member .....	43.0	
Rosiclare member			
8	Shale: Gray, platy, calcareous; weathers tan. Contains oolites and round, frosted sand grains.	0.3	61
7	Limestone: Lower 1.0 foot tan, dense; upper 2.8 feet tan, dense, oolitic, and brecciated in the upper 1.0 foot.	3.8	61

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit	Description	Thickness in feet	Chip sample number
6	Limestone: Gray, crystal line; stone is oolitic, cross bedded, and brecciated.	0.9	61
5	Limestone: White, oolitic, dense; lower 0.5 foot gray.	2.7	61
4	Shale and sandstone: Gray, platy arenaceous shale at top; gray, hard calcareous sandstone at base.	<u>0.2</u>	61
	Total thickness of Rosiclare member .....	7.9	
	Fredonia member		
3	Limestone: Tan, dense.	1.1	61
2	Limestone: Light-gray, coarse-grained, crystalline; unit is oolitic and fossiliferous.	2.6	61
1	Limestone: White, extremely oolitic, massive, cross-bedded.	<u>15.2</u>	60
	Measured thickness of exposed Fredonia member . ....	<u>18.9</u>	
	Total thickness of exposed Ste. Genevieve limestone .....	<u>69.8</u>	
	Total thickness of measured section .....	117.8	

The quarry is floored in the Fredonia member of the Ste. Genevieve limestone. Unit 1 is noteworthy because of its purity, as indicated by chemical analysis (p. 68).

Participants may observe that strata which border the Meramecian-Chesterian contact dip perceptibly into the northeast corner of the quarry, where an abnormally thick section of Paoli limestone is exposed.

The hill in which this quarry is located lies on the Mitchell plain and has sufficient topographic expression to include lower Chester strata.

Mileage  
between  
stops

0.0                      Entrance to Radcliff and Berry quarry; turn east (left).



Mileage  
between  
stops

- 0.6 Turn north (left) on Indiana Highway 37.
- 1.4 Enter Orange County.
- 1.7 Outcrop of Fredonia member of the Ste. Genevieve limestone, about 8 feet thick.
- 2.1 Outcrop of Fredonia member, 10 feet thick.
- 2.5 Outcrop of Fredonia member, 5.5 feet thick.
- 3.9 Junction Indiana Highways 37 and 60; turn east (right) on 60.
- 4.4 All outcrops along Indiana Highway 60 as far as entrance to park are St. Louis limestone.
- 6.9 Gate house at entrance to Spring Mill State Park. Turn north (left).
- 7.7 Parking lot, Spring Mill Inn.

#### Sunday, May 9, 1954

- 0.0 Parking lot be side Spring Mill Inn. (Mitchell quadrangle)
- 0.2 Junction with road to gate house; turn right.
- 0.8 Gate house at entrance to park; turn east (left) on Indiana Highway 60.
- 1.3 The route passes above Twin Caves at this point. Note dolines.
- 1.6 Sinkhole pond west of road about 100 yards.
- 2.1 Note gullies in cherty terra rossa.
- 2.6 Uvala (coalesced sinkholes).

Mileage  
between  
stops

- 3.6 The Mitchell plain (see pp. 8-9) is well developed in this area.
- 3.9 Enter Lawrence County.
- 4.4 Liberty Christian Church; turn east (left).
- 5.8 CAUTION. One lane bridge.
- 5.9 Leave Mitchell quadrangle. (Enter unmapped area.)
- 6.0 Turn south (right); follow Indiana Highway 60.
- 6.3 Flat surface of Mitchell plain.
- 8.4 Monon Railroad on south.
- 9.7 Flat surface of Mitchell plain here may be a remnant of the Lexington peneplain (see pp. 9-10).
- 10.0 Enter Washington County.
- 10.9 Saltillo village limits.
- 13.0 Campbellsburg city limits.
- 14.5 Bridge over Lost River. Geomorphology of the Lost River area has been studied in detail by Malott (1932, 1949, 1952b).
- 15.1 Turn east on Indiana Highway 60.
- 15.7 Enter Beck's Mill quadrangle.
- 17.6 Smedley Church of Christ.
- 17.7 Enter Smedley quadrangle (south edge).
- 18.0 Note severe gully erosion on north side of road.
- 18.8 Enter Beck's Mill quadrangle.

QUATERNARY

ST. LOUIS

SALEM

Building stone

HARRODSBURG

LOOKING WEST ACROSS HOOSIER LIME AND STONE COMPANY QUARRY



Mileage  
between  
stops

- 19.1      CAUTION. One lane bridge.
- 22.0      Turn south (right) on county road.
- 22.4      Cross Indiana Highway 56.
- 22.7      Turn east (left) on mapadam road.
- 23.1      Enter Salem quadrangle.
- 23.3      Entrance to Hoosier Lime and Stone Company.

STOP 7. Hoosier Lime and Stone Company quarry. 1 hour. Location: NE¼ sec. 24, T. 2 N., R. 3 E., about 0.8 mile west of Salem, in Washington County. (Salem and Beck's Mill quadrangles)

The section that is exposed in this quarry extends from the upper part of the Harrodsburg limestone to the lower strata of the St. Louis limestone, inclusive (pl. 5).

The section listed below was measured by J. B. Patton, Dallas Fiandt, and Duncan J. McGregor. (See p. 69 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Chip sample number
<b>QUATERNARY</b>		
18    Soil: Red at top, olive-drab at base, residual.	3.5	--
<b>TERTIARY (PLIOCENE ? )</b>		
17    Gravel: Weathered, stream worn; pebbles are embedded in sandy matrix.	1.0	--
16    Clay: Mahogany; weathers blocky. (Units 16 and 17 may be early Pleistocene in age.)	<u>0.5</u>	--
Thickness of exposed Plio- cene (?) deposits .....	1.5	
<b>MISSISSIPPIAN</b>		
<b>St. Louis limestone</b>		
15    Limestone: Blue to gray, fos- siliferous; bedding ranges from 0.8 foot to 1.2 feet in thickness. Unit includes interbedded blue- gray, platy shale.	20.5	--

## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit	Description	Thickness in feet	Chip sample number
14	Limestone: Lower 0.8 foot buff, upper 0.7 foot blue. Wavy, banded strata grade upward into blue calcareous shale.	1.5	--
13	Limestone: Blue-gray, coarse-grained, crystalline, oolitic.	2.8	75
12	Shale: Gray to black. Measured thickness of exposed St. Louis limestone.	<u>0.6</u> 25.4	
Salem limestone			
11	Limestone: Light-gray to tan. Calcite-lined cavities occur near the top of this porous, massive unit.	9.2	74
10	Limestone: Dark-gray, argillaceous; appears banded because of many black streaks. Brown argillaceous limestone is present in lenticular zones.	2.0	--
9	Limestone: Dark-gray to brown, argillaceous; emits a fetid odor when struck. A black shale parting marks the top of the unit.	2.2	--
8	Limestone: Brown, granular, porous; beds range from 1.2 to 2.0 feet in thickness. A freshly broken surface emits a fetid, sulphurous odor.	16.1	73 (upper 8. 2 feet) 72 (lower 7. 9 feet)
7	Limestone: Light-tan, porous, soft, fossiliferous, massive; lower 0. 3 foot gray, fossiliferous, unsampled. Total thickness of Salem limestone .....	<u>24.7</u> 54.2	71 (upper 12. 7 feet) 70 (lower 11.7 feet)
Harrodsburg limestone			
6	Limestone: Blue and gray, mottled, fine-grained, crystalline. Cross-bedded unit has nodular gypsum and a shale parting at the base.	6.5	69

Unit	Description	Thickness in feet	Chip sample number
5	Limestone: Blue-gray, fine- to coarse-grained, crystalline, argillaceous. Contains nodular gypsum and calcite-lined cavities.	3.0	69
4	Limestone: Gray to tan, very coarse-grained, crystalline, crinoidal; contains nodular gypsum.	5.1	69
3	Limestone: Dark-gray, coarse grained, crystalline, fossiliferous.	4.2	68
2	Limestone: Dark-gray, soft, porous; contains many bryozoans. Unit displays horizontal gradation from intensely cross-bedded, fossiliferous beds to strata that show insignificant cross bedding and decrease in fossil content.	7.7	68
1	Limestone: Dark-gray, crystalline. Masses of calcite crystals and stylolites occur in this fossiliferous unit.	<u>4.0</u>	68
	Total thickness of exposed Harrodsburg limestone.....	<u>30.5</u>	
	Total thickness of measured section .....	115.1	

Cumings (1901, pp. 232-233) did not specify a type section for the Salem limestone, although he quoted a measured section, from an earlier report by Gorby (1886, p. 143), of a quarry that the Salem Lime and Stone Company had operated at this locality. The original description of the Harrodsburg limestone (Hopkins and Siebenthal, 1897, pp. 296-298), which was accepted by Cumings, would place the Harrodsburg -Salem contact at the top of unit 2, but the contact is here considered to be the top of unit 6.

Mileage  
between  
stops

0.0                      Entrance to Hoosier Lime and Stone Company quarry.

Mileage  
between  
stops

- |      |   |
|------|---|
| 0.1  | Monon Railroad.   |
| 1.3  | Court house square in Salem; leave south side of square on Indiana Highways 60 and 135.   |
| 1.5  | Blue River (west fork).   |
| 2.8  | <u>SLOW DOWN</u> . Outcrop of Salem limestone on both sides of road. Exposure is 13.8 feet thick and includes 1.8 feet of shale at top.   |
| 4.8  | Harrodsburg limestone outcrops.   |
| 4.9  | <u>SLOW DOWN</u> . Outcrops on both sides of road expose 17.4 feet of lower Harrodsburg and 26.5 feet of Edwardsville formation.  |
| 5.8  | Middle fork of Blue River.  |
| 7.5  | Hills southwest of highway (in SW $\frac{1}{4}$ sec. 11, T. 1 N., R. 4 E.) are capped with Ohio River formation, the base of which is 910 to 920 feet in altitude.  |
| 10.  | Junction Indiana Highways 60 and 335 at New Pekin; remain on 60.  |
| 10.9 | Enter Palmyra quadrangle.   |
| 11.0 | South fork of Blue River.   |
| 11.4 | This broad col through which the Monon Railroad grade runs is an abandoned valley. Headwaters of the former tributary of the south fork of Blue River that flowed in this valley have been pirated by Muddy Fork of Silver Creek (Malott, 1922, pp. 180-186). |
| 11.9 | Turn south on county road.  |
| 14.0 | Sandy soil exposed in small gullies indicates that Ohio River formation probably underlies hilltop.   |
| 14.9 | Enter Borden quadrangle.  |

Mileage  
between  
stops

- 15.6 Emmanuel Church.
- 16.3 This broad, flat hilltop is underlain by Ohio River formation sand. The boundary between the Norman upland (see p. 8) and the Mitchell plain is on the west, edge of the area underlain by this sand.
- 16.5 Turn east (left).
- 16.8 Turn south (right) at T road junction.
- 17.9 Exposures of Ohio River formation in cuts along road.
- 18.1 Turn east (left) into lane.

STOP 8. Sears sand pit. 30 minutes. Location: SE $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 20, T. 1 S. , R. 5 E., about 4 miles southwest of Borden, Clark County. (Borden quadrangle)

The age and the origin of the, Ohio River formation have long been in dispute. (See discussion on pp. 10-11). The sand in the Ohio River formation has been utilized for glass and molding sand and for plastering purposes. This is the only pit in the formation that is currently active.

The section listed below was measured by W. J. Wayne. (See p. 70 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Sample number
QUATERNARY		
9 Soil: Brown, sand and sandy loam; contains weathered material from the Ohio River formation.	5.0	--
TERTIARY (PLIOCENE ? )		
Ohio River formation		
8 Sand: Reddish-orange, fine grained, moderately clayey. Unit has a thin zone of iron oxide cementation at base.	2.5	4
7 Sand: Yellow-orange, fine grained, gross-bedded, and moderately compact.	3.3	3



## SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Unit	Description	Thickness in feet	Sample number
6	Sand: White, except for pale-yellow streaks along bedding, fine-grained, compact; cut and fill cross bedding is conspicuous.	11.0	2
5	Sand: Pale-yellow, stained orange to brown along bedding, unconsolidated; cross bedding indicates southward-flowing current. Limonite and dead oil stains are common. A spring is found at base where unit overlies clay.	6.0	1
4	Gravel: White, upper 1.0 foot brownish, conglomeratic; sand fills interstices between rounded pebbles and cobbles of chert and quartz. Fossiliferous pebbles contain <u>Lithostrotion canadense</u> and <u>L. proliferum</u> . Unit pinches out at west side of it.	2.3	--
3	Sand: White, coarse; crops out only in drainage ditch.	0.8	--
2	Clay: Upper 1.5 feet green to tan. Lower part is brown, plastic, and contains sand partings near base.	<u>3.2</u>	--
	Total thickness of exposed Ohio River formation .....	29.1	
MISSISSIPPIAN			
Salem limestone			
1	Limestone: Dark-gray, medium-grained, crystalline.	<u>5.0</u>	
	Total thickness of measured section .....	39.1	

On the high (west) face of the pit, units 3 and 4 are not present, and unit 5 directly overlies unit 2.

Mileage  
between  
stops

- 0.0 Entrance to Sears pit; turn north (right).
- 0.1 Turn west (left); note Ohio River formation in cuts.
- 0.4 Turn south (left) on road to Greenville.
- 0.6 SLOW DOWN. Large, angular blocks of chert in subsoil over Ohio River formation at this cut indicate that at one time cherty limestone cobbles were deposited by streams that crossed the sand. The chert contains St. Louis fossils.
- 2.7 SLOW DOWN. Abandoned, trash-filled quarry east (left) of road exposes 8 feet of Salem limestone and 12 feet of upper Harrodsburg limestone.
- 3.1 Junction with U. S. Highway 150 at Greenville; turn east (left).
- 3.2 Enter Georgetown quadrangle.
- 3.8 Turn south (right) on Buttontown Road at east edge of Greenville.
- 5.2 Buttontown cemetery.
- 6.1 Borden rocks are exposed on east side of road.
- 6.2 One lane bridge over Big Indian Creek.
- 6.4 Road T; turn south (right) at sign to Indian Creek Baptist Church.
- 7.0 Road T; turn east (left) at sign to Indian Creek Baptist Church.
- 7.2 Road T; turn south (right) at sign to Indian Creek Baptist Church.
- 8.0 Thick cherty terrarossa overlies the limestone bedrock in this area.

Mileage  
between  
stops

- 8.2 Old quarry about 500 feet east of crossroad exposes Salem limestone.
- 9.8 Junction with Indiana Highway 64 in Georgetown; turn west (right).
- 10.0 Turn south (left) off Indiana Highway 64 on a macadam county road at the west edge of Georgetown.
- 10.2 Cross Georgetown Creek.
- 10.5 Road Y; turn west (right) on gravel road.
- 10.9 Road Y; turn west (right).
- 11.2 Enter Harrison County; continue west (straight) at road T.
- 11.6 Grade crossing with Southern Railroad. Turn south (left) through gate at approach to crossing and park in pasture.

STOP 9. Georgetown section. 30 minutes. Location: SE $\frac{1}{4}$  SE $\frac{1}{4}$  sec. 31, T. 2 S., R. 5 E., Harrison County. The exposure is approximately 1 mile west-southwest of Georgetown, in Floyd County. (Georgetown quadrangle)

This section, which is exposed along a cut of the Southern Railroad, is the southernmost exposure of the Salem limestone that will be examined during this conference.

Warning will be given of approaching trains. The cut must be vacated promptly if a train passes during the examination of this stop. The section listed below was measured by Ned M. Smith. (See p. 71 for analyses of samples from this stop.)

Unit Description	Thickness in feet	Chip sample number
QUATERNARY		
6 Soil: Red, sandy, residual; chert fragments are abundant.	10 to 30	--
MISSISSIPPIAN		
St. Louis (?) limestone		
5 Limestone: Tan, granular,		

Unit Description	Thickness in feet	Chip sample number
<p>dolomitic, argillaceous; bedding essentially massive but is deeply weathered into thin plates. Bedded chert nodules and silicified specimens of <u>Endothyra</u> and macrofossil fragments occur throughout the unit; where these organic remains have, been removed by weathering, their former position is marked by cavities,</p>	16.8	--
Salem limestone		
<p>4 Limestone: Gray, excepting tan-weathered streaks, coarse-grained, crystalline. Fossils include many specimens of <u>Endothyra</u>, pentremites, bachiopods, and crinoid columnals. Cross bedding is conspicuous in the lower 8.9 feet of this massive unit.</p>	10.0	79
<p>3 Limestone: Gray-buff, some what reddish, coarse-grained, crystalline. The great abundance of <u>Endothyra</u> and fragments of other fossils locally imparts a bioclastic character. The unit is lenticular, and the rock is soft and porous.</p>	0.0 to 6.9	78
<p>2 Siltstone: Tan to brown, calcareous, dolomitic. Unit consists of a lenticular, macro fossiliferous bed.</p>	0.0 to 6.5	77
<p>1 Limestone: Gray to buff, medium-grained, bioclastic. Unit is massive and displays abundant cross bedding on a small scale; top of unit is gently undulatory. Full thickness is revealed only at the north end of the cut.</p>	<u>10.9</u>	76

Unit Description	Thickness in feet	Chip sample number
Maximum composite thickness of measured Salem limestone .....	34.3	
Composite thickness of measured section.....	61.1 to 81.1	

A composite thickness is stated for the Salem limestone because of the lenticular nature of units 2 and 3. Thickening of either unit is invariably accompanied by a corresponding thinning of the other.

Many geologists erroneously believe that the Salem limestone is homogeneous. This exposure clearly shows the variations in lithology that are found in the formation, the lenticular nature of these lithologies, and the intergradation of crystalline and bioclastic material.

The irregular lenticularity of the strata that form the Salem limestone is the outstanding feature of this exposure. At the north end of the cut, unit 2 is present in the northwest wall but does not occur in the southeast face. In the central part of the cut, unit 2 thins remarkably along the southeast face and is absent locally in the opposite wall. Further, as participants have observed in other sections, high-calcium strata may be separated by less pure beds. This concluding stop of the conference has been included to impress geologists with the lithologic heterogeneity of the Salem limestone.

The identity of unit 5 is somewhat conjectural. The abundance of *Endothyra* in silicified masses and the observation that this unit is essentially massive would lead some geologists to assign this unit to the Salem limestone. On this basis this unit may be referred with much justification to the upper "bastard stone facies" of the Salem. Nevertheless, the over-all lithology of this unit does not resemble the upper "bastard stone facies" of the Salem, which generally is darker gray, more argillaceous, and has a banded appearance because of carbonaceous material. The presence of chert in these upper strata under consideration also suggests that these beds are more properly included in the St. Louis limestone.

**CONCLUDING ASSEMBLY.** The group will assemble at the cars, and members will be given the opportunity to discuss the geology that has been exhibited during this conference. Brief remarks by Dr. Charles F. Deiss, State Geologist, will formally conclude the conference.

Eastbound cars should return to Indiana Highway 64 at Georgetown. Westbound cars should proceed westward across the Southern Railroad to a T-road intersection and turn right to reach Indiana Highway 64 west of Georgetown.

## ANALYSES

The following tables show analyses of samples taken from the sections visited during this conference. The tables are arranged according to stop number. The lithologic units are those which appear in the measured sections.

Analyses have been run on chip samples of limestone and channel samples of sand. Chip samples were collected by removing small chips of rock from the outcrop in such a way as to give nearly continuous samples from the bottom to the top of the rock unit. The chips were taken from unweathered surfaces and were kept free of clay and other contamination. Chips of equal size were taken from equal thicknesses of rock within a given unit.

The analyses of limestone have been made by chemical methods for determinations of total sulfur (S), phosphorus pentoxide ( $P_2O_5$ ), and carbon dioxide ( $CO_2$ ) and by spectrographic technique for other determinations.

The analyses of sand have been made by spectrographic technique except for the determination of silica ( $SiO_2$ ) for which an indirect chemical method was used.

In the tables an asterisk (\*) signifies that the constituent was detected and is present in the sample in an unmeasured amount but not necessarily in an amount less than for other samples. Similarly, a hyphen (-) signifies that the constituent was not detected, but that the constituent is not necessarily absent nor less than the least quantity listed.

A table of particle size analysis of the sand samples is presented. In general, the method of size analysis employed is that prescribed in A. S. T. M. Designation C 136-46.

All determinations were made in the laboratories of the Geological Survey, Indiana Department of Conservation.

Analyses for samples at Stop 1  
Lehigh Portland Cement Company quarry

58

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
15	14	Salem	81.6	15.0	2.42	.33	.20	43.3	.029	*	.061	.006
14	13	Salem	86.0	11.2	1.91	.22	.16	43.2	.027	*	.25	.007
13	12	Salem	96.4	.84	2.33	.097	.11	42.3	--	*	.21	.009
12	11	Salem	89.2	.88	9.19	.081	.13	39.2	--	*	.12	.008
11	10	Salem	78.4	18.0	2.39	.39	.27	43.3	.034	*	.074	.013
10	9	Salem	96.8	.92	1.63	.086	.32	43.0	--	*	.19	.009
9	8	Salem	85.3	10.8	2.29	.62	.38	42.5	.032	*	.12	.041
8	7	Salem	88.6	8.66	1.65	.27	.32	43.3	.026	*	.13	.016
7	6	Harrodsburg	93.6	3.07	2.06	.49	.57	42.4	.029	*	.46	.022
6	5	Harrodsburg	89.7	4.94	3.32	.98	.46	41.9	.039	.023	.23	.058
5	4	Harrodsburg	97.1	1.02	1.09	.31	.26	42.6	.024	.028	.25	.035

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Analyses for samples at Stop 1 (Continued)

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
4	3	Harrodsburg	96.9	1.76	.70	.18	.27		-	.018	.13	.041
3	3	Harrodsburg	97.3	1.39	.73	.13	.20		-	.016	.18	.033
2	2	Harrodsburg	93.8	1.85	2.11	.38	.32		.028	.020	1.1	.066
1	1	Harrodsburg	94.6	1.37	2.53	.74	.56	42.2	.037	.038	.28	.044

ANALYSES



Analyses for samples at Stop 2  
White River section

60

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
20	6	Salem	92.4	4.81	1.89	.26	.11	43.2	.030	*	.026	
19	5	Salem	89.4	6.80	2.59	.34	.29	42.7	.039	.0069	.11	
18	4	Salem	97.2	1.15	1.24	.080	.12	43.2	-	*	.023	
17	3	Salem	87.3	9.60	2.00	.24	.33	43.4	-	.0096	.034	
16	1	Salem	98.0	1.08	.53	.052	.16	43.6	-	.0072	.037	

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Analyses for samples at Stop 3  
Williams Quarry

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
27	6	Salem	95.2	2.69	1.50	.27	.080	42.6	.028	*	.14	.002
26	5	Salem	71.6	20.0	6.02	1.24	.65	41.2	.071	*	.38	.004
25	4	Salem	86.8	10.0	2.08	.33	.22	43.0	.027	*	.10	.005
24	3	Salem	83.4	13.7	1.79	.35	.24	43.5	.030	*	.12	.008
23	2	Salem	86.2	11.2	1.51	.27	.20	43.3	.027	*	.070	.008
22	1	Salem	97.6	1.22	.78	.044	.16		-	.0054	.034	.008
21	1	Salem	97.7	1.39	.49	.057	.15		-	.0059	.085	.005

ANALYSES

Analyses for samples at Stop 4  
Springfield quarry

62

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
48	26	Beaver Bend	94.6	1.07	2.38	.55	1.10	41.8	*	.078	.024	.024
47	20	Paoli	95.8	.96	2.24	.51	.21	42.4	*	.038	.033	.019
46	19	Aux Vases	63.3	8.48	24.0	1.97	1.18	31.2	.12	.033	.20	.038
45	18	Ste. Genevieve (Levias)	94.0	.98	3.11	1.01	.34	42.0	.036	.010	.029	.011
44	17	Ste. Genevieve (Levias)	97.4	.59	1.35	.25	.12	43.0	-	.0093	.011	.004
43	16	Ste. Genevieve (Levias)	88.7	7.07	2.70	.55	.48	43.0	.037	*	.009	
42	15	Ste. Genevieve (Levias)	97.2	.77	1.26	.17	.086	42.9	-	*	.004	
41	14	Ste. Genevieve (Levias)	92.2	3.74	2.85	.65	.25	42.1	.037	*	.034	.014

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Analyses for samples at Stop 1  
Lehigh Portland Cement Company quarry

63

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
40	13	Ste. Genevieve (Levias)	94.0	3.42	1.84	.34	.12	43.3	.027	*	.013	.009
39	12	Ste. Genevieve (Levias)	94.9	.70	3.08	.84	.23	42.0	.036	*	.12	.011
38	11	Ste. Genevieve (Rosiclare)	68.2	4.52	22.0	2.96	1.16	30.4	.14	*	.31	.041
37	10	Ste. Genevieve (Fredonia)	99.2	.38	.28	.090	.031	43.6	-	-	.019	.005
36	9	Ste. Genevieve (Fredonia)	67.2	22.0	8.56	.86	.37	41.4	.054	*	.064	.017
35	8	Ste. Genevieve (Fredonia)	253.4	.3	73.7	.19	.075	12.0	*	-	.012	.034
34	7	Ste. Genevieve (Fredonia)	95.9	.52	3.12	.16	.073	42.4	*	*	.011	.038
33	6	Ste. Genevieve (Fredonia)	91.2	4.44	3.16	.66	.23	42.2	.037	*	.073	.202

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

## Analyses for samples at Stop 4 (Continued)

64

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
32	5	St. Louis	92.0	2.66	4.13	.54	.14	41.9	.031	-	.019	
31	4	St. Louis	75.0	6.49	17.4	.46	.17	36.8	.034	-	.035	
30	3	St. Louis	92.5	1.96	4.43	.43	.14	41.9	.036	-	.040	
29	2	St. Louis	83.1	12.5	3.26	.46	.18	42.7	-	-	.079	
28	1	St. Louis	83.7	6.33	8.26	.84	.27	40.1	.046	*	.068	

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Analyses for samples at Stop 1  
Lehigh Portland Cement Company quarry

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
53	5	Salem	94.3	3.41	1.41	.14	.24	43.2	-	.0068	.037	
52	4	Salem	97.2	1.46	.91	.066	.13	43.3	-	.0055	.033	
51	3	Salem	97.6	1.21	.70	.044	.18	43.4	.040	.0052	.050	
50	2	Salem	98.0	1.14	.51	.037	.089	43.4	-	.0058	.049	
49	1	Salem	97.7	1.11	.76	.046	.17	43.5	-	.0066	.028	

ANALYSES

Analyses for samples at Stop 6  
Cleveland quarry

66

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
59	6	Salem	97.4	1.19	.89	.17	.12	43.4	-	*	.018	.011
58	5	Salem	98.1	.98	.50	.096	.087	43.5	-	*	.015	.008
57	4	Salem	97.9	1.00	.78	.075	.076	43.6	-	*	.013	.008
56	3	Salem	97.4	.91	1.30	.085	.076	43.5	-	.0075	.022	.008
55	2	Salem	94.3	1.06	3.97	.10	.084	42.7	-	.0085	.019	.012
54	1	Salem	87.0	8.96	3.05	.23	.25	42.8	-	.010	.027	.016

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Analyses for samples at Stop 6A  
Radcliff and Berry quarry

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
68	18-20	Paoli	94.6	.80	3.38	.90	.15	42.2	.038	.018	.019	.011
67	17	Aux Vases	48.0	32.2	14.9	2.25	1.76	38.6	.089	.034	.50	.026
66	15-16	Ste. Genevieve (Levias)	95.4	.91	2.55	.76	.14	42.6	.029	*	.050	.006
65	13-14	Ste. Genevieve (Levias)	97.4	.66	1.44	.24	.067	43.6	-	*	.007	.004
64	11-12	Ste. Genevieve (Levias)	93.8	3.89	1.64	.24	.091	43.2	*	*	.004	.012
63	10	Ste. Genevieve (Levias)	90.0	6.85	2.08	.36	.12	43.2	*	*	.017	.005
62	9	Ste. Genevieve (Levias)	89.1	7.92	2.21	.26	.10	43.4	*	*	.020	.006

ANALYSES



## Analyses for samples at Stop 6A (Continued)

68

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
61	2-8	Ste. Genevieve (Rosiclare and Fredonia)	94.8	.69	3.59	.56	.098	42.4	.032	*	.022	.007
60	1	Ste. Genevieve (Fredonia)	98.8	.80	.13	.048	.047	44.1	-	*	.011	.003

SALEM LIMESTONE AND ASSOCIATED FORMATIONS

Analyses for samples at Stop 7  
Hoosier Lime and Stone Company quarry

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
75	13	St. Louis	88.2	2.43	7.48	.78	.57		.071	.0053	.49	.019
74	11	Salem	94.6	2.11	2.46	.12	.19		-	*	.088	.003
73	8	Salem	95.6	2.28	1.58	.21	.14	43.1	*	*	.033	.005
72	8	Salem	79.0	17.1	2.49	.52	.35	43.6	.030	.020	.18	.009
71	7	Salem	97.0	1.06	1.56	.064	.14	43.2	-	*	.038	.008
70	7	Salem	96.7	1.14	1.80	.072	.095	43.5	-	*	.031	.009
69	4-6	Harrodsburg	89.0	2.82	5.76	1.16	.69	40.1	.055	*	.41	.039
68	1-3	Harrodsburg	94.9	1.12	2.94	.15	.36		-	.013	.22	

ANALYSES

Analyses for samples at Stop 8  
Sears sand pit

Chip sample number	Unit	Formation	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CaO (pct.)	MgO (pct.)	TiO <sub>2</sub> (pct.)	Na <sub>2</sub> O (pct.)	ZrO <sub>2</sub> (pct.)	MnO (pct.)
4	8	Ohio River	91.3	5.3	2.8	<.05	.19	.35	<.1	.023	.001
3	7	Ohio River	98.1	1.3	.23	<.05	.037	.062	<.1	.009	.0003
2	6	Ohio River	98.1	1.4	.079	<.05	.032	.073	<.1	.012	<.0003
1	5	Ohio River	97.9	1.2	.12	.06	.036	.050	<.1	.008	.001

Sieve size – percent by weight retained on U.S. Standard sieve

Sample number	Unit	Formation	20	30	40	60	80	Mesh size		200	270	325	-325
								100	140				
4	8	Ohio River	0	1.4	3.8	33.4	39.4	7.8	5.0	1.8	0.8	1.8	4.2
3	7	Ohio River	0	<0.2	1.0	45.6	37.4	6.2	5.0	1.4	0.4	0.6	2.2
2	6	Ohio River	<0.1	<0.2	0.4	48.6	33.8	5.8	5.4	1.6	0.6	0.8	2.4
1	5	Ohio River	<0.1	<0.2	0.2	54.8	31.0	5.0	4.0	1.0	0.6	0.6	2.4

Analyses for samples at Stop 1  
Lehigh Portland Cement Company quarry

Chip sample number	Unit	Formation	CaCO <sub>3</sub> (pct.)	MgCO <sub>3</sub> (pct.)	SiO <sub>2</sub> (pct.)	Al <sub>2</sub> O <sub>3</sub> (pct.)	Fe <sub>2</sub> O <sub>3</sub> (pct.)	CO <sub>2</sub> (pct.)	TiO <sub>2</sub> (pct.)	MnO (pct.)	S (pct.)	P (pct.)
79	4	Salem	86.6	2.07	9.27	.51	.97	39.3	.042	.014	.061	.030
78	3	Salem	90.8	3.61	4.22	.37	.44	41.4	.039	.014	.077	.016
77	2	Salem	78.0	14.3	5.75	.75	.65	41.4	.053	.017	.12	.014
76	1	Salem	93.4	1.01	4.70	.13	.30	41.1	-	.011	.084	.017

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