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ABSTRACT

This is a compilation of geological field guides prepared by undergraduates for the Ohio Intercollegiate Field Trips held annually since 1951. A total of eleven colleges have contributed, some contributing more than one guide, resulting in guides to eighteen different trips. Guides include trip logs, maps and sections, notes on formations, illustrations of fossils, notes on geological history, and lists of references. A generalized column of rocks in Ohio, a geologic map of Ohio, and a general bibliography are included. (EB)

OHIO INTERCOLLEGIATE FIELD TRIP GUIDES

1950-51 - 1969-70

B.G.S.U. D.U. K.S.U. M.C.

M.U. M.U.C. M.C. O.U.

O.W.U. C.W.R.U. W.U. W.C.

EDITED BY G.W. FRANK

OHIO INTERCOLLEGIATE FIELD TRIP GUIDES 1950-51 TO 1969-70

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and
PARTICIPATING SCHOOLS

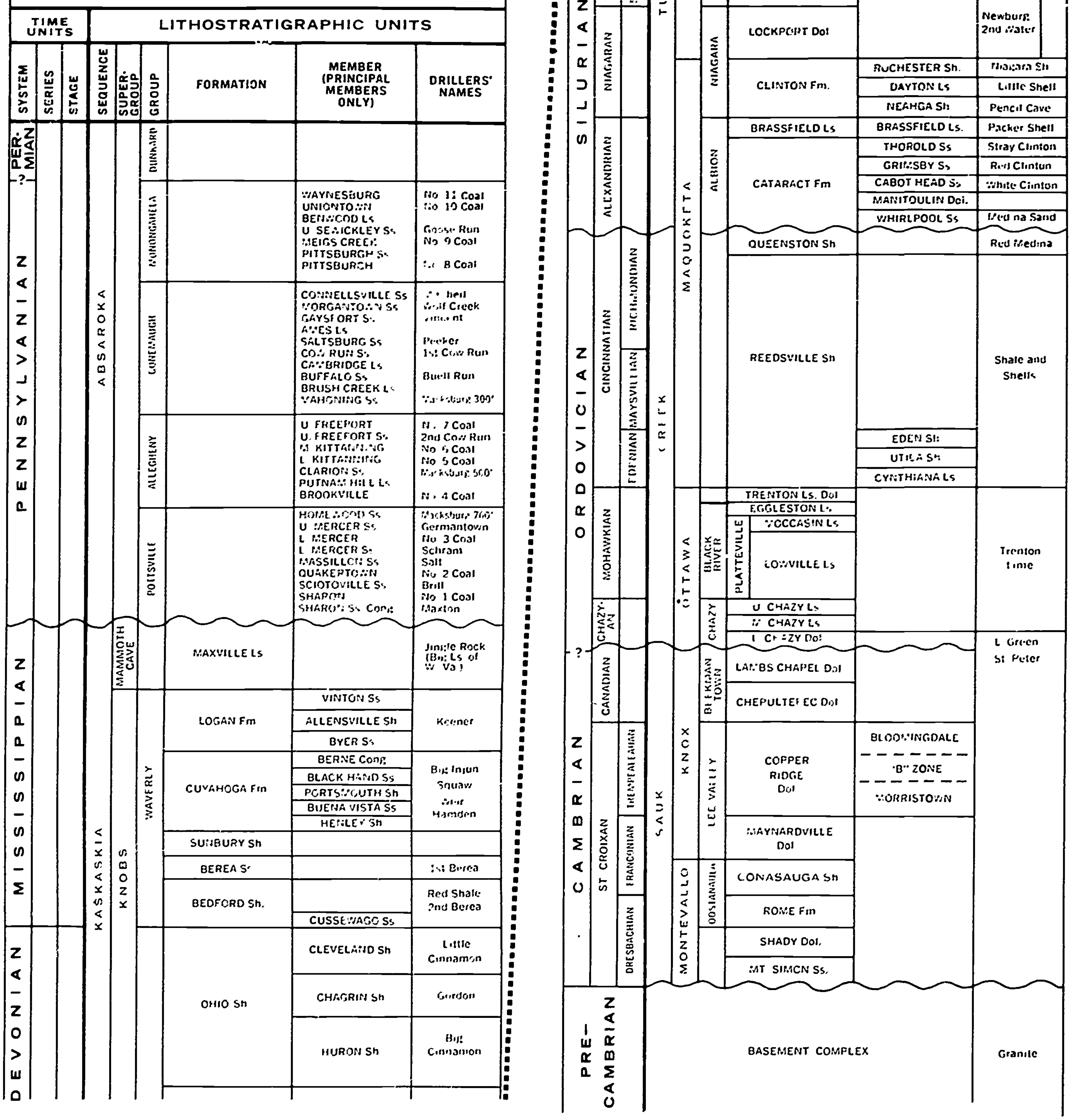
DIVISION OF GEOLOGICAL SURVEY

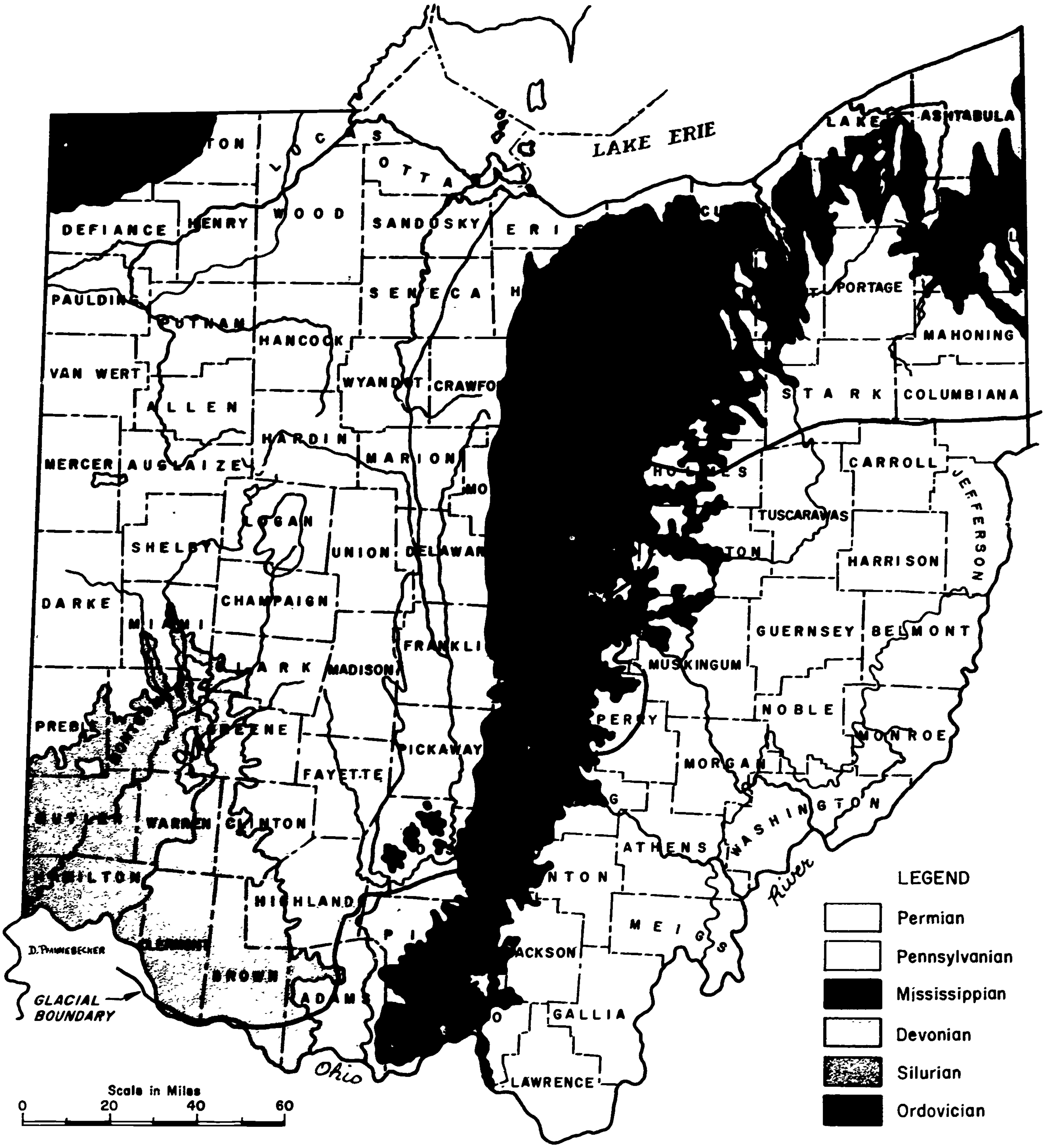
GENERALIZED COLUMN OF ROCKS IN OHIO

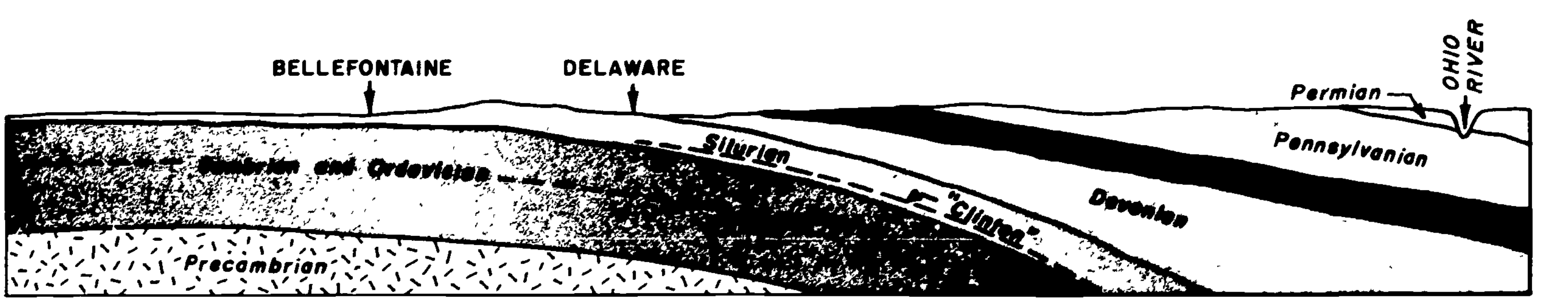
ABBREVIATIONS

Sh.	Shale	Cong	Conglomerate	U	Upper
Ss.	Sandstone	Dol	Dolomite	M	Middle
Ls.	Limestone	Fm	Formation	L	Lower

Unconformity



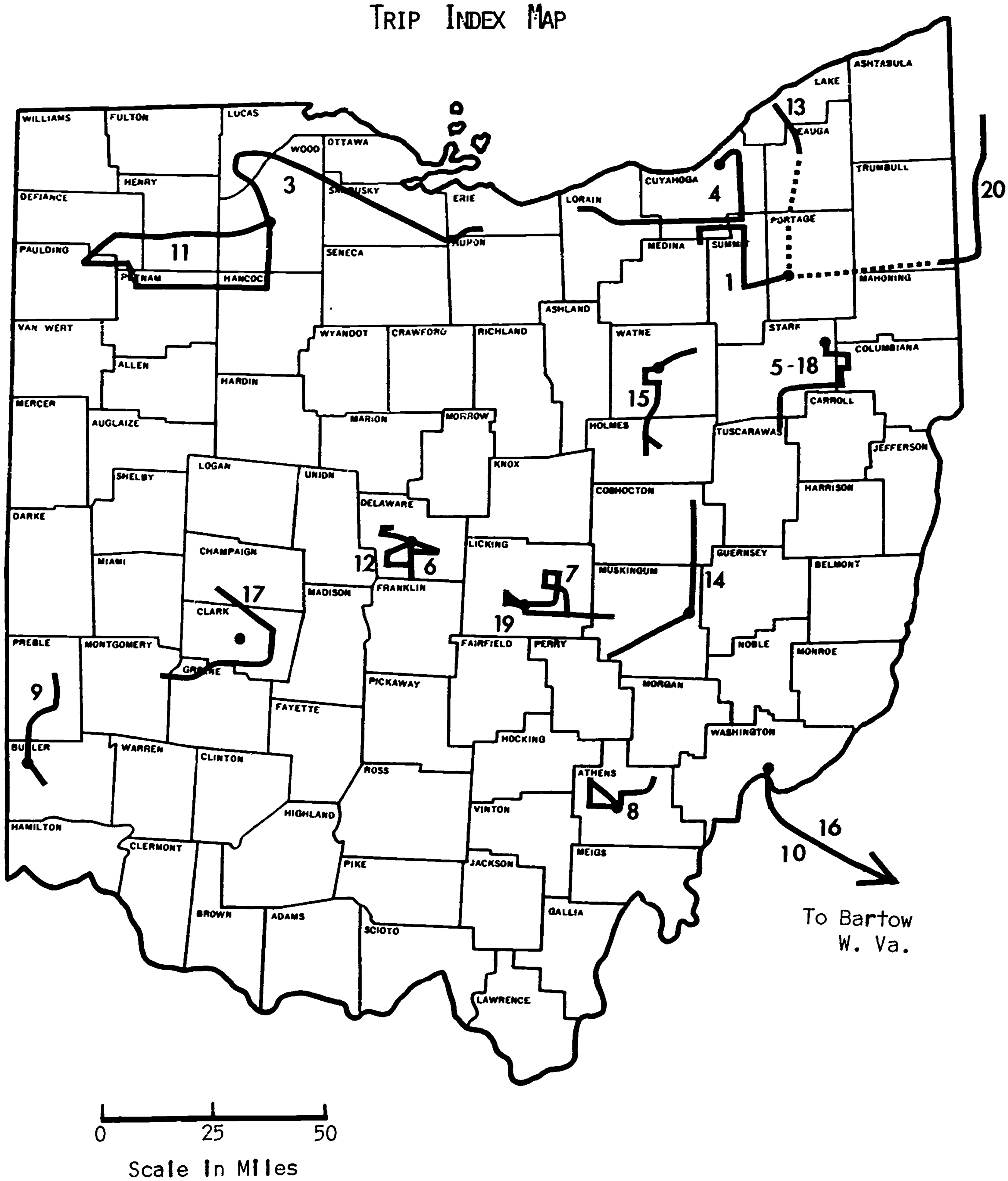




OHIO DIVISION OF GEOLOGICAL SURVEY

GEOLOGIC MAP OF OHIO

TRIP INDEX MAP



INTRODUCTION

Twenty years have elapsed since the first "Ohio Intercollegiate Field Trip" was organized and conducted in northeastern Ohio by the Kent State Geological Society. This school year (1969-1970) the K.S.G.S. volunteered to sponsor the 20th Annual Ohio Intercollegiate Field Trip and it was thought appropriate to publish a single collection of all previous guides. This volume commemorates these twenty years and honors all contributors and participants who made this annual field conference a worth while project.

Although it is recognized that highways, rock exposures and indeed geologic interpretation may change with time, each guide is presented herein as it was originally written. Only minor corrections have been made. In spite of errors or differences of opinion, it should be remembered that each guide was prepared and each trip was conducted by undergraduate students. The experience they gained in this endeavor and their sense of satisfaction in conducting a field trip for fellow students and geologists of the state is the true measure of the value of this annual event.

The Second Intercollegiate Field Trip did not materialize because of a conflict with the Ohio Academy of Science field trip in 1952. The Tenth field guide is not included because it is identical to the Sixteen field guide, both of which were conducted by Marietta College in the Appalachian region of West Virginia.

There are four reasons for compilation of the past Ohio Intercollegiate Field Guides into a single volume. First, copies of the older guides are becoming increasingly more difficult to obtain so that simple preservation was a consideration. Second, geology students find them very helpful when planning mineral and fossil collecting trips. Likewise the general public, particularly rock-hounds, often request information concerning local field trips and collecting localities. Third, and most important, the expansion of high school earth science in Ohio requires that all local geologic material be available to earth science teachers. This volume can be the starting point for a cursory survey of the local geologic literature and it should provide a basis for planning local field trips by earth science teachers. Finally, all profits obtained by the sale of the volume will be placed in the K.S.U. Foundation — Geology Fund to aid in the continued development and expansion of the departmental programs.

The editor would like to thank Dr. Rodney Feldmann and Mr. Arthur Wittine, both of Kent State, for their valuable assistance.

FORWARD

The following geologic resume of the Cuyahoga Gorge and Chippewa Creek sections, near Cuyahoga Falls and Brecksville, Ohio, respectively, is a project of the Kent State Geological Society. This is a student undergraduate group in geology at Kent State University, Kent, Ohio.

The purpose of the geology field trip for which this resume was prepared is wholly commendable, being a sincere effort to further knowledge of Ohio geology, and to promote better acquaintance and understanding among student and professional working in geology.

Science, December 8, 1950, under News and Notes, carries an account of the 42nd annual New England Intercollegiate geology field trip. Each year some New England college or group has sponsored such an informal field meeting and each year a new group has volunteered to take over to plan for the next trip. We should try to capture the spirit of such a group.

All who have attended the New England meetings will recall with warmth the whole hearted cooperation of professor and undergraduate. Many will recall them with a recollection of the first meeting with one who is now an old friend.

So, one hastens to endorse this project and to laud without embarrassment, the members of our student group who have envisioned this enterprise for over two years. Some have already gone on to graduate schools or other fields, but many with heavy schedules have taken time with what may be called a love of the labor, alone, to work on this job.

It is sincerely hoped that other groups will come forward to carry on this worthwhile program, and that undergraduate, graduate and professor will help keep enthusiasm burning. Eventually, we may be attending a "42nd Annual Ohio Intercollegiate Geology Field Trip". But let's hold them with an atmosphere of friendliness and sincere democracy, and keep them intercollegiate.

—C. N. Savage
Kent State University

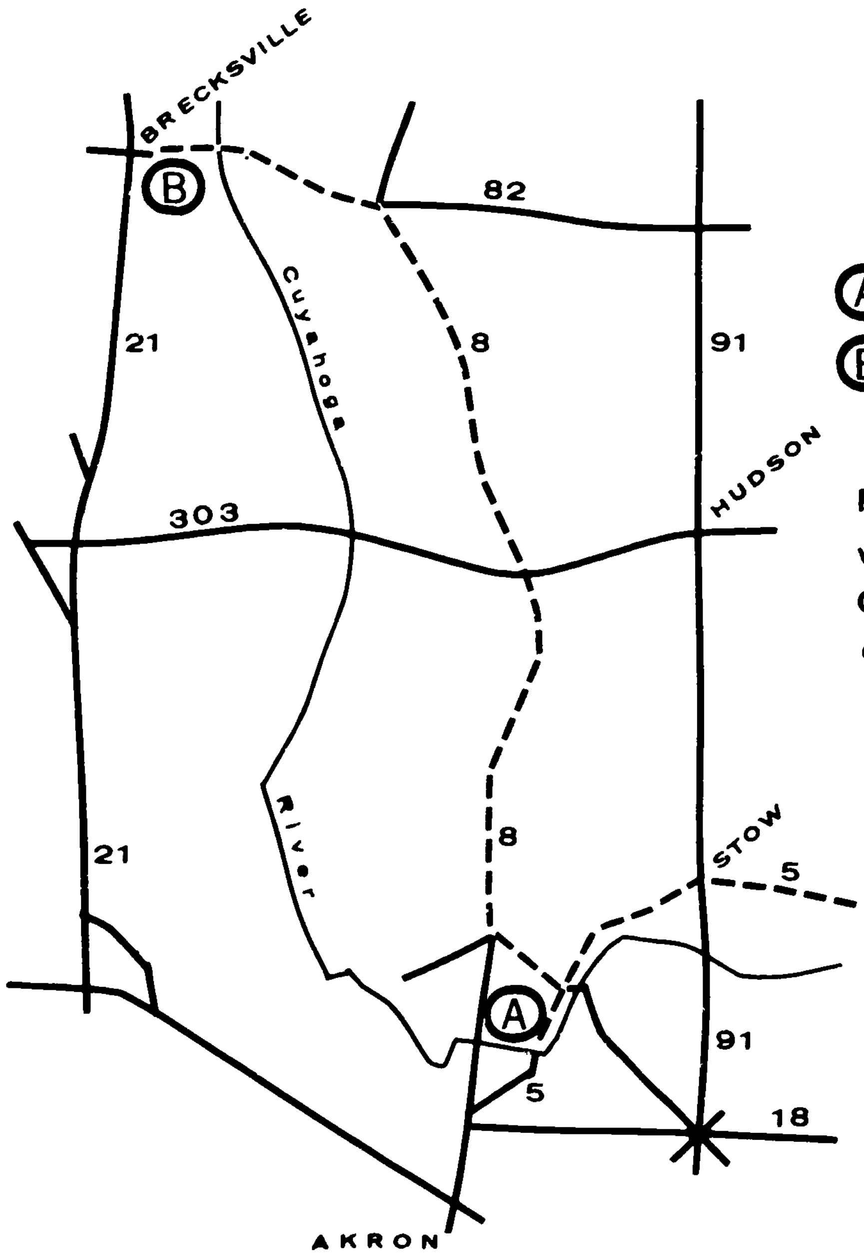
PREFACE

The Kent State Geological Society welcomes all who find it possible to participate in our intercollegiate field trip. We hope that everyone will make himself known and will contribute in his own way to the success of the project.

In respect to the following resume of the geology of the sections to be visited, we beg the kind indulgence of all concerned. We recognize that there will be errors and omissions, as well as differences of opinion, but wish to encourage discussion by participants.

As project chairman, I would like to thank Mr. C. N. Savage and Mr. H. H. Gray for their valuable assistance and guidance. Credit is also due the active and honorary members of the society whose contributions made this trip possible.

—Glenn W. Frank,
Project Chairman.



ROAD MAP
K. S. G. S. FIELD TRIP
MAY 5, 1951
(A) Cuyahoga Gorge
(B) Chippewa Creek

NOTE: Both locations are within municipal parks- Collecting is prohibited, except by permit.

GENERAL GEOLOGY

GLACIAL GEOLOGY — H. G. Stewart

The surface of the area included in this field trip resume is one of recent glaciation. The rugged Allegheny Plateau, so well exhibited south of the glacial boundary below Canton, has here been nearly erased by valley filling. The thickness of the drift varies from only 2-5 feet on the bedrock hills to over 250 feet in the pre-glacial valleys. The Pre-Wisconsin glacial history of Ohio is somewhat obscured by the masking effect of the Wisconsin ice sheets which reached to the outer glacial boundary in the greater part of the state.

Traces of Pre-Wisconsin drift are stated to exist along the shores of Lake Erie in the Cleveland area, and have been called Illinoian.[1] Also, a strip of Illinoian drift has been mapped along the glacial boundary from Canton eastward and along the glacial boundary in the central part of the state. However, within the area of this field trip, no outcrops of Pre-Wisconsin drift are known to the author, although it surely must exist in the filled valleys at some depth.

Till of Iowan age is not known at present, in Ohio, and it would appear that some Illinoian deposits were not covered until Tazewell time, and some perhaps not until Cary time. Deposits of till and great volumes of stratified drift in the Cuyahoga Falls-Akron-Wadsworth area have been recently classified as Tazewell by Dr. George W. White, who has done extensive field work in this area in the past several years.[2] These deposits remain as an island, so to speak, completely surrounded by later materials of Cary age.

The Tazewell deposits were nearly obliterated in northeastern Ohio by the Cary invasion which followed. The interglacial period was relatively short as is shown by the slight amount of weathering and soil profile development on the Tazewell drift which underlies the Cary. In this advance the ice front consisted of two sub-lobes in the northeastern part of Ohio, both of which were small shoulders of the larger Erie lobe. These were the Killbuck on the west, and the Grand River on the east. They are separated by a line trending southwest from Burton through Cuyahoga Falls and then southeast to Canton. It now seems likely that each of these two sub-lobes advanced to, or nearly to, the glacial boundary; retreated northward into the Lake Erie basin; and readvanced southward approximately to a line connecting Medina, Akron, Alliance, and Youngstown. A second major retreat and third advance resulted in the formation of the Defiance Moraine. This advance did not reach as far south as those previous to it. These movements were accomplished in Cary time and probably never resulted in the two lobes actually coalescing.[3] The exact sequence of the two lobes is at yet uncertain, but it is believed that a rather fluid situation existed throughout Cary time and the lobes trespassed as various times on the deposits of one another.

Mankato drifts are not recognized by Dr. White, in this area, and Mankato time is probably represented chiefly by destructive processes.

During this trip the group will observe in the Kent-Cuyahoga Falls area the broad extensive terminal moraine of the Grand River sub-lobe (Early Cary). In all respects it is typical of terminal moraines; striking kame and kettle topography with many lakes and swamps in various stages of extinction, steep slopes, insequent drainage, an abundance of erratic boulders, and numerous glacio-fluvial deposits such as kames, kame deltas, crevasse fillings, and outwash plains.

Leaving the Cuyahoga Gorge site, the trip route crosses deposits of the Killbuck sub-lobe. These are represented by a section of drift-covered bedrock hills and a broad area of ground moraine which continues along the route until approximately 2 miles south of Brecksville. Here one of the more prominent end moraines is encountered, the Defiance, of late Cary age. This moraine swings westward at this point and follows the south rim of Chippewa Creek valley in its upper reaches. The Defiance moraine may have been instrumental in establishing the course of the creek by forming a barrier to the southward drainage from the higher ground to the north. In this area, and immediately to the east, are many good examples of lee and stoss hills. Also eastward in the Twinsburg-Solon area are many good exposures of glacial striae, chattermarks, friction cracks on the upper surface of the Sharon conglomerate. Drumlins and eskers are not known in the ground moraine areas of either sub-lobe.

FOOTNOTES

[1] Cushing, Leverett, and Van Horn: *Geology & Mineral Resources of the Cleveland District, Ohio,* Bulletin 818, U.S.G.S., 1931, p. 59.

[2] White, George W., Chairman, Department of Geology, University of Illinois, personal communication.

[3] White, George W., *ibid.* (Much of this information on the Cary was given to the author in the form of written and oral communication and full use of Dr. White's field maps. This material is now in process for publication and its use here is greatfully acknowledged.)

End moraines younger than the Defiance are not prominent in the Cleveland area but are well shown to the east of the city. West of the city, on the Berea quadrangle, the beach terraces of the predecessors of Lake Erie are prominent landmarks.

ORIGIN OF THE CUYAHOGA RIVER — Don Gifford

The Cuyahoga River is approximately 100 miles long. It has its head waters in the highlands of Geauga County within 10 miles of the Lake Erie shore, and flows 60 miles southward and southwestward from its source to Cuyahoga Falls. Here, 30 miles southeast of Cleveland, the river flows northward to join Lake Erie. The river descends a total of 600 feet or an average of approximately 9 feet per mile.

The Cuyahoga may be separated into three sections: (1) the upper southwesterly course with no marked valley in a shallow and uneven channel through glacial topography; (2) a short middle course where the river falls 225 feet in a lower gorge 1.5 miles long and about 240 feet deep (known as the "Gorge of the Cuyahoga"); and (3) the lower northward course, paralleling the old pre-glacial Massillon River valley. The latter course is tortuous because of relatively low gradient. Its actual length is 40 miles, nearly twice the air distance along the valley. In this area the descent is less than 2 foot per mile.

The area we are concerned with is the Cuyahoga Gorge, Here the river has cut down through the bedrock into strata of Pennsylvanian and Mississippian age. Fine exposures of the Sharon conglomerate, Meadville shale and Sharpsville sandstone may be found, as well as a small section of Orangeville shale in the lower end of the gorge.

Two theories as to the origin of the gorge have been suggested. One assumes that the gorge is post-glacial and that the present Cuyahoga River has excavated or cut back the original bedrock wall of the old Massillon River gorge from a point downstream from the high level bridge on Route 8, to its present position.

An alternate theory[4] assumes that the gorge is pre-glacial, cut by a stream that was tributary to the much larger pre-glacial Massillon River. It is suggested that the present river has merely re-excavated the glacial drift which filled the tributary valley during the Pleistocene epoch. Glacial deposits in the lower part of the gorge appear to be plastered against an older rock wall. This tends to support the latter theory.

There probably has been some valley deepening in post-glacial time, since the installation of the dam which now stores water in the upper gorge.

ORIGIN OF CHIPPEWA CREEK — Glenn Frank

Chippewa Creek is one of the six larger streams which contribute water to the Cuyahoga River. Almost all of the larger rivers and streams of the Cleveland region flow at one time or another in a southerly direction and then turn north to flow into Lake Erie. This might indicate that the streams flowed south from a receding glacial margin until they reached the higher elevation of the present watershed or until the glacier had receded enough to permit the streams to flow north. Since the abrupt changes in course are quite near the present watershed it might also indicate that recession of the glacier was rapid.

Chippewa Creek starts at approximately 1220 feet in elevation and flows into the Cuyahoga at approximately 640 feet. In its upper reaches, the Chippewa cuts through the shales and sandstones of the Orangeville formation and then forms the rockwalled gorge in the Berea sandstone.

At a position beneath the bridge on Route #82 east of Brecksville, Ohio, the stream falls over a lip of resistant Berea sandstone and continues through the softer Bedford, Cleveland, and Chagrin shales until it reaches the flat flood plain of the Cuyahoga River.

Near the confluence of the Chippewa and Cuyahoga rivers, the bedrock floor of the drift filled Massillon river valley is nearly 700 feet below the surface.

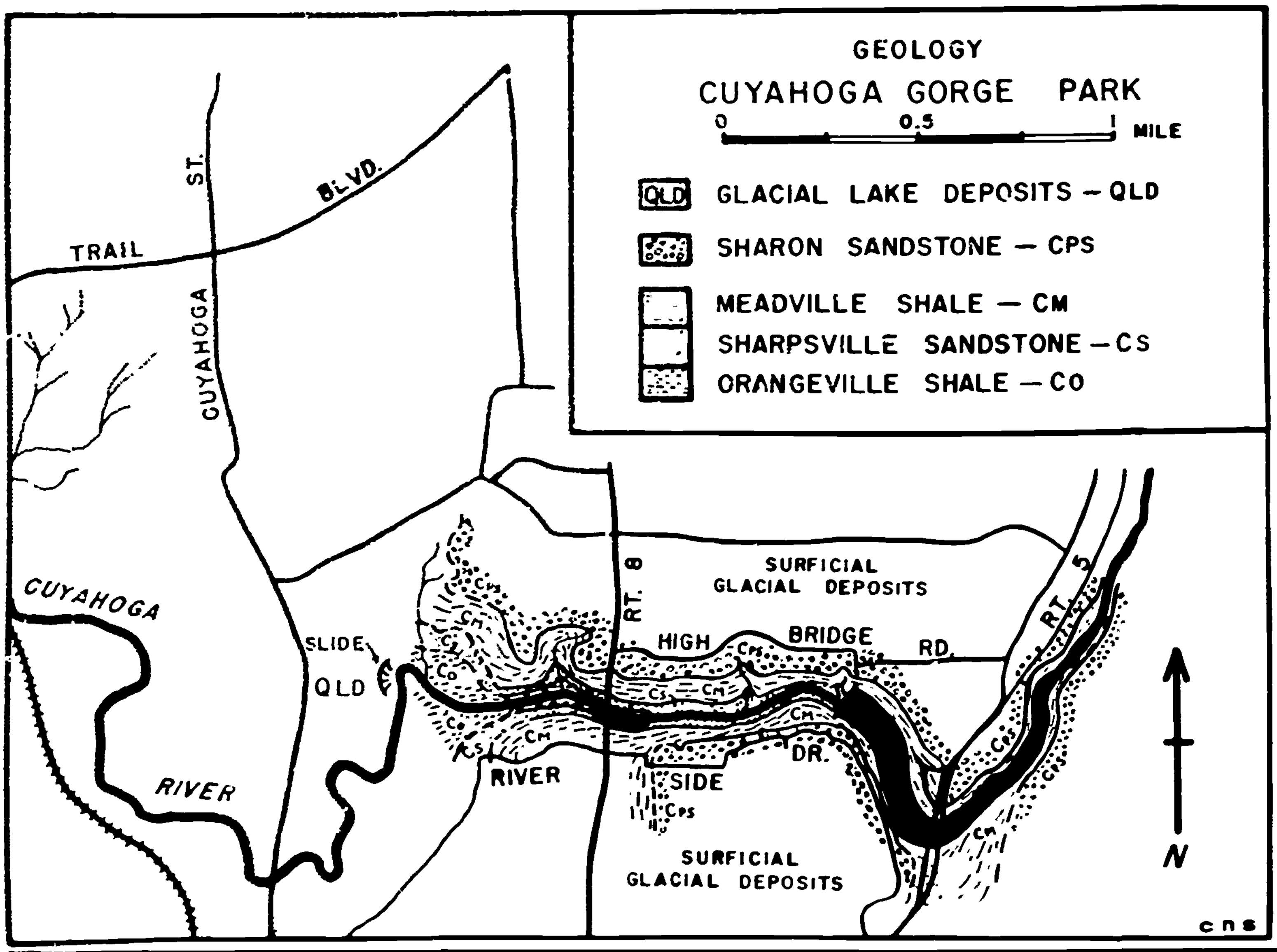
As mentioned earlier, the Defiance moraine may have acted as a barrier to south trending drainage forcing the Chippewa approximately into its present course.

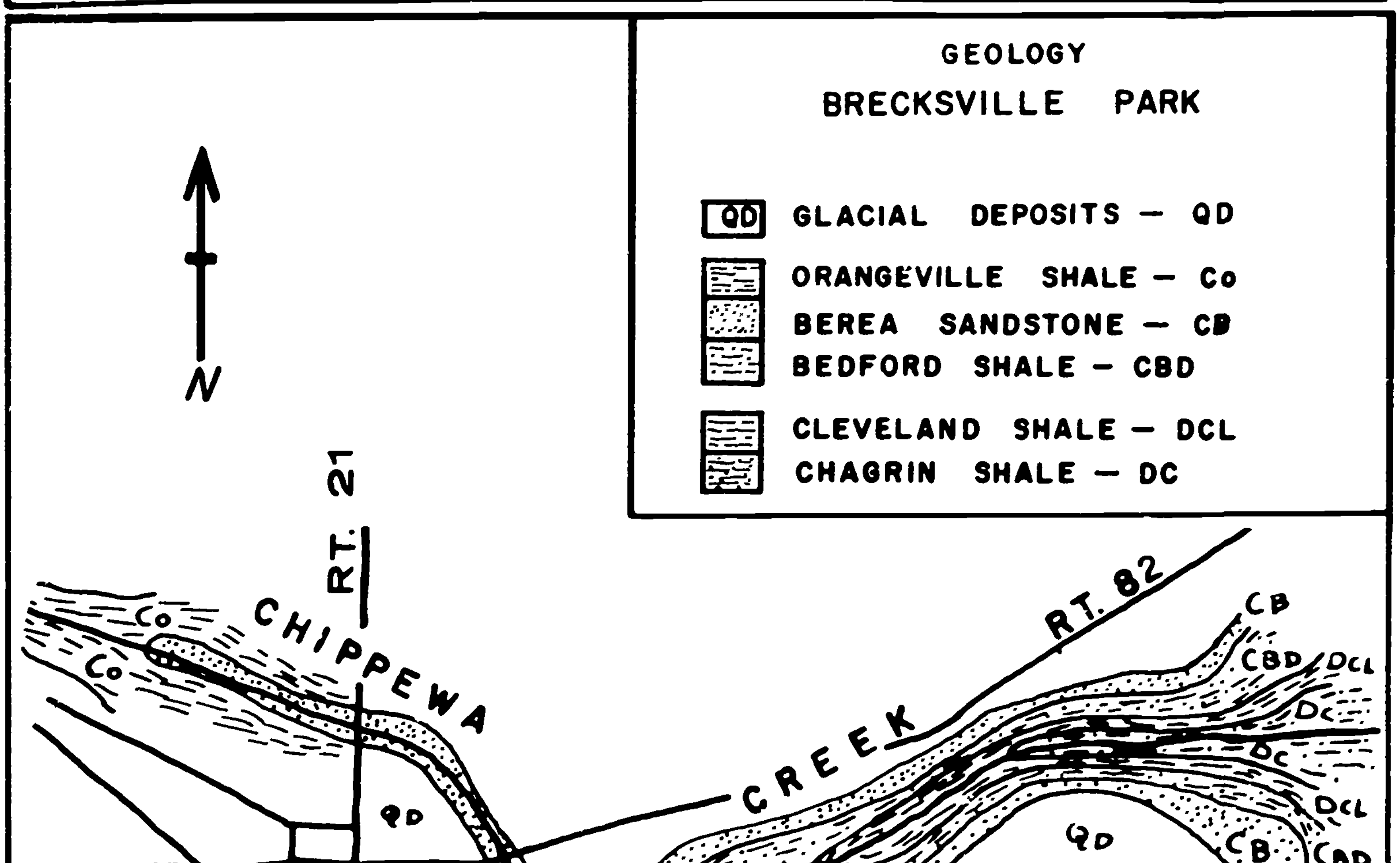
STRATIGRAPHY

SHARON CONGLOMERATE AND SANDSTONE — James Barkes

This is the youngest rock formation exposed in the region and takes its name from exposures at Sharon, Mercer County, Pennsylvania. It is the basal member of the Pottsville series of the Pennsylvanian period which outcrops with a northeast trend across Pennsylvania, Ohio, Kentucky, and Tennessee southward to Alabama.

[4]Savage, C. N., Personal communication.


GEOLOGY
CUYAHOGA GORGE PARK
0 0.5 1 MILE
QLD GLACIAL LAKE DEPOSITS – QLD
SHARON SANDSTONE – CPS
MEADVILLE SHALE – CM
SHARPSVILLE SANDSTONE – CS
ORANGEVILLE SHALE – CO
TRAIL BLVD.
CUYAHOGA ST.
CUYAHOGA RIVER
SLIDE
QLD
RT. 8
SURFICIAL GLACIAL DEPOSITS
HIGH BRIDGE RD.
RIVER SIDE DR.
RT. 5
N
cns


GEOLOGY
BRECKSVILLE PARK
QD GLACIAL DEPOSITS – QD
ORANGEVILLE SHALE – Co
BEREA SANDSTONE – CB
BEDFORD SHALE – CBD
CLEVELAND SHALE – DCL
CHAGRIN SHALE – DC
N
RT. 21
CHIPPEWA CREEK
RT. 82
BRECKSVILLE
BRECKSVILLE PARK
0 0.25 0.5 MILE
hgs

STRATIGRAPHIC SECTION
CLEVELAND, AKRON REGION

SYSTEM	FORMATION				SECTION	THICKNESS
CENOZOIC	Pleistocene Moraines and Glacial Lake Deposits				Qd	0-100'+
PENN.	Basal Pottsville	Sharon Conglom.			Cps	0-250'
	Unconformity					
MISS.	"Waverly Series"	Cuyahoga Group	Royalton	Meadville Shale	Cm	30-250'
MISS.	"Waverly Series"	Cuyahoga Group	Royalton	Sharpsville S. S.	Cs	5-50'
MISS.	"Waverly Series"	Cuyahoga Group	Orangeville Shale	Brecksville Shale	Cob	125'
MISS.	"Waverly Series"	Cuyahoga Group	Orangeville Shale	Aurora S. S.	Coa	
MISS.	"Waverly Series"	Cuyahoga Group	Orangeville Shale	Sunbury Shale	Cos	
MISS.	"Waverly Series"	Berea Sandstone			Cb	5-150'
		Unconformity				
MISS.	"Waverly Series"	Bedford Shale	Sagamore S. S.		Cbd	50' ±
MISS.	"Waverly Series"	Bedford Shale	Euclid S. S.			
DEV.	Cleveland Shale				Dcl	20-90'
	Unconformity					
DEV.	Chagrin Shale	LAKE ERIE LEVEL			Dc	615'+

Locally, the Sharon sand occurs in channels cut into the underlying lower Mississippian-Meadville shale, and is distinctly unconformable. The formation varies greatly in thickness because of the uneven surface of the Meadville shale upon which it has been deposited.

The Sharon is exposed 20-40 feet vertically, throughout the general area. The sand and gravel of the conglomeratic phase are quite loosely cemented and the rock is gray or brown in color.

The pebbly phase lies largely at the base of the formation, the upper horizons are more uniform sandstone. The pebbles are of white quartz, with an average diameter of one inch and are well-rounded by water action. They generally show poor sorting (size).

The quartz pebbles could not have come from any local source. The nearest source area is the crystalline rock of Canada, or they may have been derived from the old highlands of Appalachia which lay to the east during the Paleozoic era. It may be that the sands and gravels from the disintegration of that mass of rocks were spread far to the west by strong streams with great deltas and that sandstone and congrlomerate was thus deposited over a wide area. Cross-bedding is common and often its exposed surfaces exhibit pitting due to differential weathering.

After the deposition of these sands and gravels, swamps covered much of the area; plant remains occumulated; and later these formed the Sharon coal (No. 1) most of which has been removed by erosion from the region under consideration. Locally it may still be found, i.e. at Coal Hill, south of Cuyahoga Falls.

No fossils other than plant fragments have been found in the Sharon.

MEADVILLE SHALE — Don Gifford

The Meadville shale is the highest formation in the Cuyahoga group and is named for the type section in Meadville, Pennsylvania. Areally, it extends from the northwest part of Pennsylvania, to the northeast corner of Ohio. Exposures of the Meadville are not continuous and in several localities no exposures of the Meadville occur. This is due to the unequal pre-Pottsville erosion period which formed a conspicuous unconformity between the Sharon conglomerate and the Meadville. This unconformity makes the break between the lower Pennsylvanian and the lower Mississippian periods.

The thickness of the formation on the whole increases from east to west. In the Cuyahoga Gorge, the thickness exposed varies from 90-100 feet or more. The Meadville consists of alternating beds of shale and sandstone with shale predominating. The shale is composed of a blue gray very thin-bedded shale, which in some localities has a rotten appearance. In some places the shale is very sandy and in others it is limy. Many flattened, hard lime-iron concretions, blue within, but weathering reddish, occur in the shale horizon.

Throughout the formation as erosion proceeds, the various interbedded layers of sandstone stand out as flagstones. These alternating neds of sandstone are fine grained, usually fairly hard, and generally micaceous. They are blue to gray in color, weathering in some places to red or brown.

Fossils in the Meadville are locally abundant. Some may be found in the concretions, but they tend to be more common in the upper portions of the shale. Various brachiopods, pelecypods, crinoids and bryozoa may be found in the group section. Fragments of land plants also, are not uncommon in the same beds that contain marine fossils.

SHARPSVILLE SANDSTONE — Leerie Summers

The Sharpsville sandstone is middle Mississippian in age. It is the middle formation of the Cuyahoga group named from the outcrop at the village of Sharpsville, in Mercer County, Pennsylvania. It is a gray interbedded sandstone or siltstone and shale formation. The siltstone layers tend to predominate and the thickness of this formation varies from 5 to 50 feet. Locally it has limy layers. Approximately 40 feet are exposed in the Cuyahoga Gorge.

The Meadville shale is the overlying formation and the Brecksville member of the Orangeville shale is directly beneath the Sharpsville. The upper and lower contacts of this formation are not well defined and good outcrops in the area are scarce but the Cuyahoga Gorge is an exception.

Oxidation turns the fine grained sandstone layers to a variety of colors including gray, yellow, red, and a dark bluish purple. The sandstone layers are fairly massive near the top of the formation and their color varies from light to dark gray. A few marcasite concretions and a few spherical and cylindrical concretions are found in the limy horizons. Thickening and thinning of the siltstone layers is common in the Gorge section.

The shale layers look like rotten wood when weathered and feel somewhat sandy when crumbled up. This gray shale is very thin layered and it turns a reddish brown (iron oxide) when weathered.

The formation on the whole tends to weather out more near the base because of thinner and softer materials, while at the top the more resistant sandstone layers are 1-1 1/2 feet thick and the shale layers are 6 inches thick.

These interbedded layers of shale and sandstone well illustrate the instability of the land mass during the Carboniferous. Shales suggest quiet phases and the sandstones suggest fluctuating active phases of sedimentation.

Abundance of mica and sand indicate rapid land wasting and rock decomposition and bits of fossil vegetation show there was considerable land type plant life. Both facts point to a relatively humid climate.

The shale layers locally are very fossiliferous, containing the remains of marine bivalves.

In the Cuyahoga Gorge, on the north side of the dam an asymmetrical anticlinal fold occurs in the upper Sharpsville formation.

ORANGEVILLE FORMATION — Glenn Frank

The Orangeville shale lies directly on top of the Berea sandstone. At the base of the formation in the Chippewa section, approximately 5 feet of Sunbury shale occurs; it is the basal member of the formation in northeastern Ohio. This is a black, fine textured shale exposed along the creek bed above the Berea sandstone. The base is usually below water level but where the lower 2 inches are exposed one can usually collect quite a number of fossils. (Orbiculoidea and Lingula).

The middle member of the formation is the Aurora sandstone, which is fine-grained and resembles the Sharpsville sandstone in color and texture; the Aurora, however, has thinner bedding. There is from 5 to 10 feet of Aurora sandstone exposed at Chippewa but it is absent in the Cuyahoga Gorge section as is the Sunbury shale member.

The uppermost member, locally called the Brecksville shale, is the main body of the Orangeville formation. This member is deeply eroded, where exposed, because of its fine clayey texture. It is blue-black and where the Aurora sandstone is absent it is not always readily distinguished from the black Sunbury shale below it. About one foot of the Brecksville shale may be seen in the vicinity of the high level bridge on Route 8, in the Gorge Park section, and excellent exposures occur in the upper reaches of Chippewa Creek west of Route 21 near Brecksville, Ohio.

BEREA SANDSTONE — James E. Gray & Eldred Johnson

The Berea sandstone formation of Mississippian age, lies between two strata of shale; the Sunbury shale occurs above and the Bedford below.

This formation consists of medium to coarse grains of quartz sand. Locally there are conglomeratic phases containing small pebbles. The color before oxidation is light gray to buff, but upon weathering the rock turns light or dark brown in color. The grains of sands are often loosely cemented together.

The Berea was named by Newberry after the village of Berea, Ohio.

In the gorge of Chippewa Creek the Berea is approximately 40 feet thick. The bottom of this formation is thick-bedded and massive. The rest of the strata is more or less thin-bedded. Ripple marks and crossbedding are abundant; much of the crossbedding represents a torrential type of deposition.

The weaker Bedford shales that underlie the Berea are easily eroded by water action. Often the sandstone juts out over the water, huge blocks are undermined or sapped and eventually break off, falling down into the bed of Chippewa Creek. Potholes and current flutting are common in these blocks of detached sandstone.

A prominent erosional disconformity separating the Berea and the Bedford may be seen in quite a few places along the creek. The Berea sandstone forms the lip of a falls under the highway bridge on Route 82 east of Brecksville. Just below the falls on the western side of the gorge is a fine example of this disconformity.

Iron pyrite and marcasite form nodules and concretions in the upper layer of the Berea and has stained the surrounding rock layers as it decomposes.

Fossils have not been found in any great abundance in the Berea formation. Plant life and some evidence of fossil fish, also 4 or 5 marine fossils have been found in the Berea, but these were no doubt strays and it is suggested that the Berea formation is of fresh water origin.

BEDFORD SHALE — Edward E. Criley

The Bedford formation lies below the Berea sandstone and above the Cleveland shale. The U. S. Geological Survey places this formation in the Devonian or Mississippian period.

In Chippewa Creek the Bedford formation consists of interbedded sandstone and shale, ranging in thickness from 60 to 80 feet. The type section of the Bedford lies approximately 10 miles to the northeast in Tinkers Creek just outside the city of Bedford, Ohio. A chocolate colored shale occurs in the upper part of the formation and is very prominent in Chippewa Creek, but locally it is absent in the outcrops of the formations to the east.

Outcrops of the Bedford may be traced from the falls on the Chippewa downstream to its contact with the underlying Cleveland shale.

Penecontemporaneous deformation at the base of the Bedford has given the basal layers a wave-like and rolling appearance. This basal section of the Bedford consists of a few gritty shale layers which grade into blue, massive, fine graned sandstone called the Euclid lentil. The layers are thick at the bottom and grade upward into thinner layers. Thin layers of gritty blue shale separate the layers of sandstone. In places the Euclid sandstone closely resembles the Sharpsville sandstone in color (bluish-gray) and texture. This resemblance may suggest similar environment and deposition of the two formations. The Euclid formation has a thickness from 15 to 20 feet, and is succeeded by a zone of bluish, gritty shale averaging in thickness of about 20 feet. The shale is interbedded with thin layers of blue sandstone.

Lying above the blue shale is a 16 to 30 foot zone of chocolate colored soft argillaceous shale. The chocolate shale is very thin bedded, averaging one half inch or less in thickness. The shale crumbles to small mud-like fragments when handled. Locally, crumpling and complex faulting occurs. Just above this zone is a thin zone of soft, blue, argillaceous shale, which occurs under the Berea grit at the waterfall.

In other localities, near the top of the Bedford, a blue shale with blue sandstone forms the Sagamore lentil.

The unconformity between the Berea and the Bedford may be the boundary between the Devonian and Mississippian sediments.

CLEVELAND SHALE — James Gray

The Cleveland shale, along with the Chagrin shale, is part of the "Ohio Black shale group". The U. S. Geological Survey has placed the Cleveland formation in the Devonian or Mississippian period. In this area, a disconformity has been reported between the Cleveland and Chagrin shales, but it is very difficult to visualize.

The Cleveland shale is a dark, fairly resistant shale. When freshly broken it is a black color, but when weathered it is gray or reddish brown. The shale breaks into thin, sharp, slaty plates.

Pyrite or marcasite is scattered throughout this shale in the form of concretions, but a basal layer of this mineral may be found in some sections.

Fossils are not prominent in the formation, although some valuable remains have been found. In the Cleveland area, sharks teeth, spines, entire remains of small sharks, fish jaws, and scales, and the head of the great arthrodiro Dinicthys have been excavated.

Thirty-nine feet of the Cleveland shale is exposed in the gorge of Chippewa Creek.

THE CHAGRIN SHALE — Richard Thompson

The Chagrin shale is a soft blue-gray to greenish-gray shale which on weathering produces soft clay in rather steep gullied banks. The contact with the overlying dark Cleveland shale is irregular in some places and barely discernible in others. In the Chippewa section, a disconformity may be present. The Cleveland shales at the contact, range from black to blue-gray.

The Chagrin shale was deposited in late Devonian seas which did not accumulate deposits of noticeable thickness according to Cushing et al; this sea fluctuated over the basin, which included northeastern Ohio, at several intervals during the Devonian period, producing several unconformities in the sections now exposed. The Chagrin shale lies on the eastern flank of the Cincinnati Arch and it is not known definitely whether the formation pinches out to the west or grades laterally into the darker shales.

In the Chippewa Creek section, about 10 or 15 feet of the Chagrin is exposed at the base of the column. In one cliff two phases of the Chagrin are found; the lower blue-gray shale, and just below the contact with the Cleveland a layer of blue-gray to reddish sandstone. This may be the Olmstead member. Bands of sandy concretions of varying color are common in the section exposed.

Fossils may be found wherever the formation outcrops along Chippewa, but are more numerous in the upper layers. These consist chiefly of brachiopods of the Devonian period. It is difficult to obtain perfect specimens because they are soft and easily destroyed.

PALEONTOLOGY

Richard Thompson

There is little available detailed information on the paleontology of these two sites under discussion. However, several publications of the Ohio Geological Survey give listings of fossils found in the formation previously reviewed. Bulletin 818 of the U. S. Geological Survey also lists fossil types found at various locations. By using these published works and the material gathered by a former paleontology class at Kent State, the following selected lists and a plate of sketches has been prepared for this resume.

Chagrin shale Spirifer disjunctus* Athyris polita* Chonetes setiger Dalmanelia tioga Lingula sp. Orbiculoidea newberryi* Productella hirsuta*	Medium to highly fossiliforous in certain horizons only. Fossils in sandy, shale layer.
Cleveland shale. Orbiculoidea horzori* Lingula melio* Lingula cuyahoga* Conodonts	Rather barren of fossils. Many fragmentary fish remains in some places.
Bedford shale. Orbiculoidea horzori* Orbiculoidea newberryi* Lingula sp. Productus sp.	Rather barren as a whole. Fossils between some shaly partings.
Berea sandstone. Strophemena rhomboidalis Lingula sp.	Unfossiliferous in most horizons. Fish and plant remains predominate.
Orangeville shale. Lingula melio* Orbiculoidea horzori*	Lower pyritized horizon of Sunbury member highly fossiliferous in some locations. Other two members are mostly barren.
Sharpsville sandstone. Chonetes sp. Lingula sp. Orbiculoidea sp. Syringotheras sp.	Barren to medium fossiliferous in certain locations. Fossils in shaly horizons.
Meadville shale. Chonetes logani* Productella sp. Athyris lamellosa	Most fossiliferous of all the formations. Fossils occur in many horizons, usually in gray-blue shale.
Sharon conglomerate. Lepidodendron Sigillaria Stigmaria	Barren as a whole. Plant remains occur infrequently.

*Shown on accompanying plate. Key fossils underlined.

PLATE I

Frank Crawford

No. 1-2. Spirifer disjunctus. Chagrin shale.
Variable shape; semi-circular to semi-ovoid. Hinge line as long as greatest width. Vent.

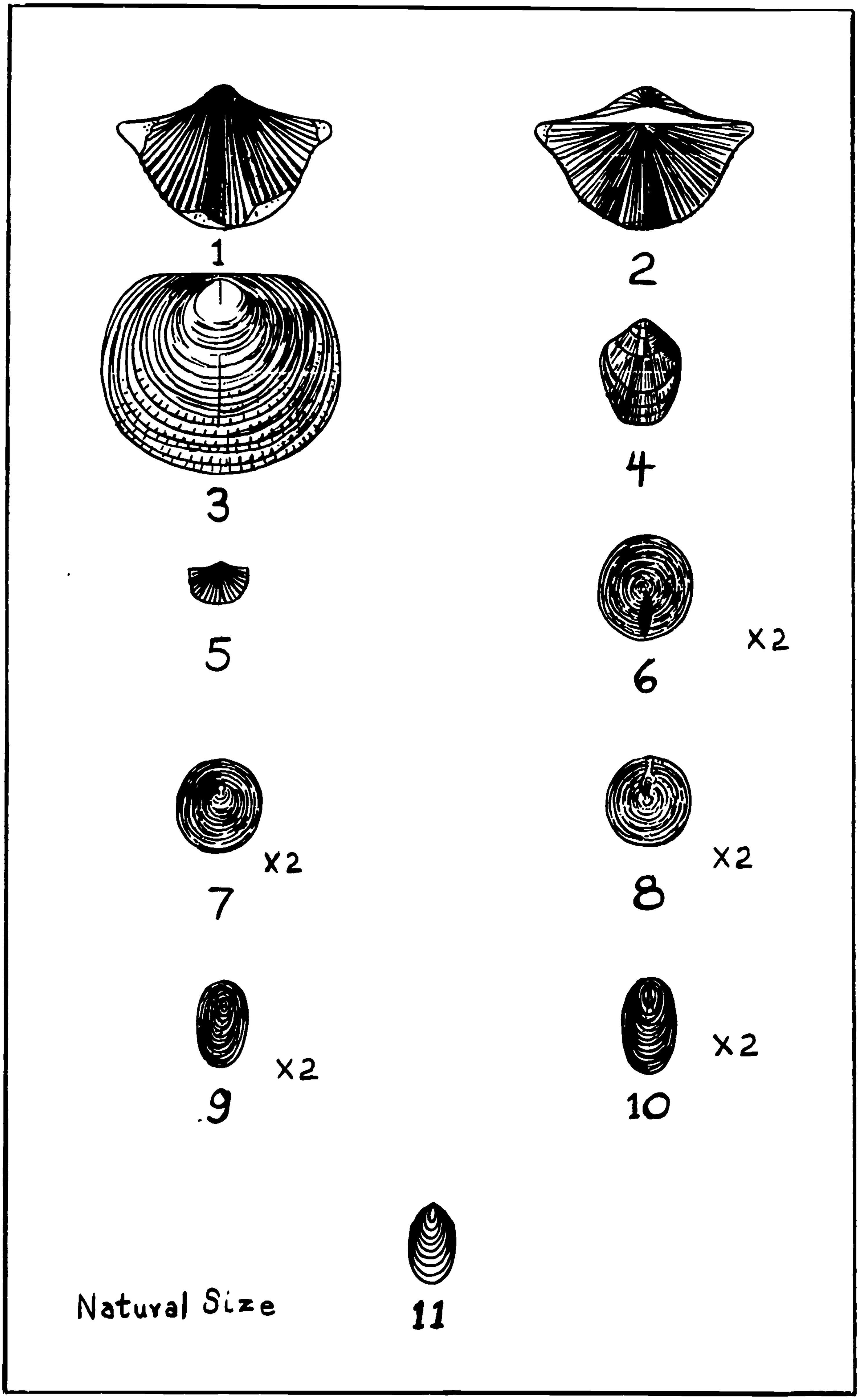


PLATE I

valve convex, sinus deep, beak elevated; dorsal valve less convex. medial fold. 30-35 rounded plications. 20-25mm. long, 35-40mm wide.

3. Productella hirsuta.
   Medium size; semi-elliptical; concave-convex. Hinge line equals width of shell. Vent valve convex in median portion, nearly flat near cardinal lateral margins. Dor valve concave, flattened near cardinal lateral margins. Fine, imbricating, concentric strictions; spines on some.

4. Athyris polita.
   Ovato; gibbous. Vent. valve with undefined sinus anteriorly, umbo incurved. Dor valve with undefined medial fold. Fine striae on surface. 15-20mm. long, 15-20mm. width.

5. Chonetes logani.
   Small; semi-circular. Hinge line straight, longer than width, fine to medium striations, evenly spaced 8mm. long, 5mm wide.

6. Obriculoidea newberryi.
   Valves flattened; pedicle groove posterior to apex in vent. valve. Circular shape, concentric growth lines. Dorsal valve with conical apex. 15-20mm. diameter.

7-8. Orbiculoidea horzori.
   Same as above, except pedicle groove extends nearer margin. Smaller in size. 10-12mm. diameter.

9-10. Lingula melio.
   Ovoid, elongate. Beak and pedicle ridge median and posterior. Beak less acute on Dor. valve. Concentric growth lines. 6x4mm.

11. Lingula cuyahoga.
   Same as above only larger. 10x12mm.

ECONOMIC GEOLOGY

WATER SUPPLY — Leerie Summers

The water supply in Cuyahoga Falls is derived chiefly from 5 wells which average 130 feet in depth and are in glacial material. All deep well tests below the Sharon encounter sulfur water or brine. The Berea sandstone in this area is contaminated with these brines and sulfur waters, plus hydrogen sulfide. The glacial drift is generally thin, averaging less than 25 foot.

In west Akron the deep entrenched valley of the Deep Stage Cleveland River yields much water; however, most of Akron's water supply comes from Lake Rockwell. Farther south, in Stark County, the Massillon sandstone of the Pottsville system is a prolific producer.

In the Brecksville area the glacial drift should offer the greatest possibilities. The Berea sandstone (where the water is potable) and Lake Erie are possible alternate sources. There are few streams locally, and the underlying Bedford, Cleveland, and Chagrin shales are unproductive.

SAND AND GRAVEL DEPOSITS — Bill Roots

Sand and gravel have many uses, in mortar and concrete, roofing gravels, railroad ballast, surfacing of roads and walks and as abrasives for stone cutting.

The sands and gravels of this area are largely composed of quartz, feldspar, garnet, and magnetite. There are also bits of granite, diorite, schist, gneiss and limestone.

In northeastern Ohio, sand and gravel are taken from glacial deposits, lake and river deposits, and from crushed bedrock. The largest supplies of these materials are in the glacial deposits which cover most of northeastern Ohio.

A typical glacial sand and gravel deposit is located along the Pennsylvania Railroad connecting Akron, Bedford and Cleveland near Garfield Park. The depth of this deposit of alternate layers of sand and gravel is about 60 feet.

The second largest supply of sand is from the shores or immediate vicinity of Lake Erie. It is found in old lake ridges and beaches, and is also taken from the lake bottom by scows known as "sand suckers". Lake sands are more rounded, smoothed and better sorted by constant wave action than are river and glacial sands.

The next largest suppliers of sands are associated with the rivers of this area, in flood plains and deltas. Most of the city of Cleveland now rests on an old sand delta of the Cuyahoga River, 20 to 30 feet in depth.

Sand and gravel may be obtained from some of the bedrock formations. The Sharon conglomerate is made up of quartz sand grains and pebbles loosely cemented together. This may be crushed and screened. The gravel so obtained is generally used for drives and walks, while the sand may be used for foundry or engine sand. Sand is also obtained from the Euclid bluestone by crushing and screening. To compare this product with natural sands, tests are made for the Euclid Concrete Company at the Case School of Applied Science. These tests have proved that the sand from the Euclid bluestone is superior to both bank (glacial) and lake sand. This may be due to the angular shape of the particles.

Four miles north of Kent, on Route 43, the Hugo Sand Company is obtaining sand and gravel by hydraulic methods, possibly from glacial outwash and ground moraine. They have a reported annual capacity of 500,000 tons.

Sand and gravel production in northeastern Ohio amounts to over a million dollars annually.

SILICA — Clyde Smith

In northeastern Ohio, the Sharon conglomerate, at the base of the Pennsylvania system, is the chief source of silica. The rock is open-pit mined in Medina, Summit, Portage and Geauga counties. Because of the high purity and easy workability, the Sharon conglomerate is valuable for industrial uses.

The Sharon contributes essential products to the great steel industries in this and adjacent states in the form of ferrosilicon and sand for silica brick and moulding sands. It has been also used for glass sand but is limited for this use because of the presence of some limonite and other undesirable minerals.

The Minnesota Mining Manufacturing Co., located six miles west of Akron, has in the past mined the pebbly phase of the Sharon, screened out the pebbles and crushed them for granules to surface roofing shingles.

By-products of the Sharon conglomerate are in demand for their use as driving gravel, filter bed sands, abrasives, sodium silicate and engine sand.

During the last war, production reached a peak but fell off sharply after the discontinuance of government subsidies. Lately, however, production has once again been on the increase.

CLAYS AND SHALES — Richard Thompson

The Cleveland and Chagrin shale of Devonian age and the Bedford shale of Mississippian age are used widely in this area for the making of brick and tile.

The Mississippian shales and clays of the Cuyahoga group are used by several plants in the area to make face-brick, building brick, sewer-pipe, drain tile, flower-pots and various other clay products.

Clays of high enough grade to be used for china-ware do not occur in this area, although farther to the south some of the Cuyahoga clays are mined for this purpose.

QUARRY STONE — John Higgins

The Cleveland area has been noted in the past for its fine quality grinding and building stones. These were quarried from the Berea sandstone, also known popularly as the "Berea Grit". In the Bedford formation a similar type rock has been exploited, the "Euclid bluestone".

The development of artificial abrasives and building material has contributed to the decline of quarrying operations in this area. Most of the quarries have been abandoned but one of the larger ones is still in operation at Berea, Ohio. At this quarry good building stone is produced as well as excellent grinding wheels. There are abandoned quarries to be found at Peninsula, Chagrin Falls, and in the Euclid Metropolitan Park.

The "Euclid bluestone" is found many places as a thin bedded flagstone. These flagstone have been quarried in the past because of their uniform thickness and excellent quality and can be found in many towns and villages of the Cleveland area as flagstone sidewalks.

NATURAL GAS AND PETROLEUM — Clark Mayhew

Two general modes of occurrence of natural gas are usually distinguished. Gas is found in shale and is called shale gas; it occurs also in sandstone, conglomerate, and dolomitic limestone, and this is known as rock gas. Both types are recognizable in the Cleveland district and a third type is also present, which might be called drift gas.

Drift gas is not very abundant and exists only in pockets in glacial clay or in layers of sand and gravel that lie between beds of such clay. The decomposition of organic matter either in the glacial drift or in the Cleveland and underlying Devonian shales, from which it may ascend into the drift is a possible source of this gas.

The entire thickness of the Chagrin and Cleveland shales contains small quantities of shale oil and gas. N. W. Lord, (Ohio Geol. Survey, vol. 6, p. 413, 1888) states that the black shales contain one-fifth of 1 per cent of petroleum and that an average thickness of 1,000 feet of shale would contain more than 10,000,000 barrels of petroleum to the square mile. However, the oil is present in such minute quantities and is so widely distributed it is not commercially extracted. It is possible that the decomposition of this oil forms the gas which migrates along bedding planes and cracks and finally accumulates.

A shale gas well usually produces enough fuel to supply one home for a period of years.

The West Richfield and Copley fields obtain their gas from the Clinton sandstone. The Clinton is a light gray to pink sandstone which ranges from 2000 foot to a mile in depth below the surface of west central Ohio.

The Newburg field is located near South Park, Ohio, just four miles north of Brecksville. The gas sand of the Newburg formation is 3-17 feet in thickness, grayish in color, soft, brittle, and shows abundant cleavage planes. In polarized light even the smallest fragments show high interference colors, which characterize certain minerals of very high double refraction.

One of the Newburg wells produced over 12 million cubic feet in 1914-1915 before being abandoned.

SALT — R. Carlson & F. Brady

The rock salt beds of Ohio are part of the Salina formation which is of Silurian age. Rock salt is one of Ohio's most abundant and important economic minerals. It underlies approximately 9,100 square miles of the eastern and northeastern part of the state. Portage County alone has an estimated 308 billion tons of available rock salt.

The total thickness of the beds in the general area around Kent is from 100 feet to over 300 feet, lying at depths between 1,800 feet at Cleveland and progressing to 3,000 feet at Akron.

Because of the large area of rock sale, salt industries have a wide choice of sites on which to build. The two largest producing plants in the area are the Colonial Salt Company at Akron and the Columbia Chemical Division of the Pittsburgh Plate Glass Company at Barberton.

At the present time, the International Salt Company of Scranton, Pa. is doing exploratory drilling at Strongsville, Ohio, and hopes in the near future to sink a major mine shaft.

WELL LOG

This well log was furnished by R. B. Wood of the Colonial Salt Company to the Ohio State Geological Survey. It is located 1/2 mile south of Kenmore, which is southwest of Akron. In the column headed "Driller" is listed the drillers description. The column headed "Survey" is an attempt to correlate the well log with that of the generalized rock section of Ohio.

SELECTED REFERENCES

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2. Cushing, Leverett and VanHorn, Geology and Mineral Resources of the Cleveland District, Ohio, Bulletin 818, U.S.G.S., 1931.
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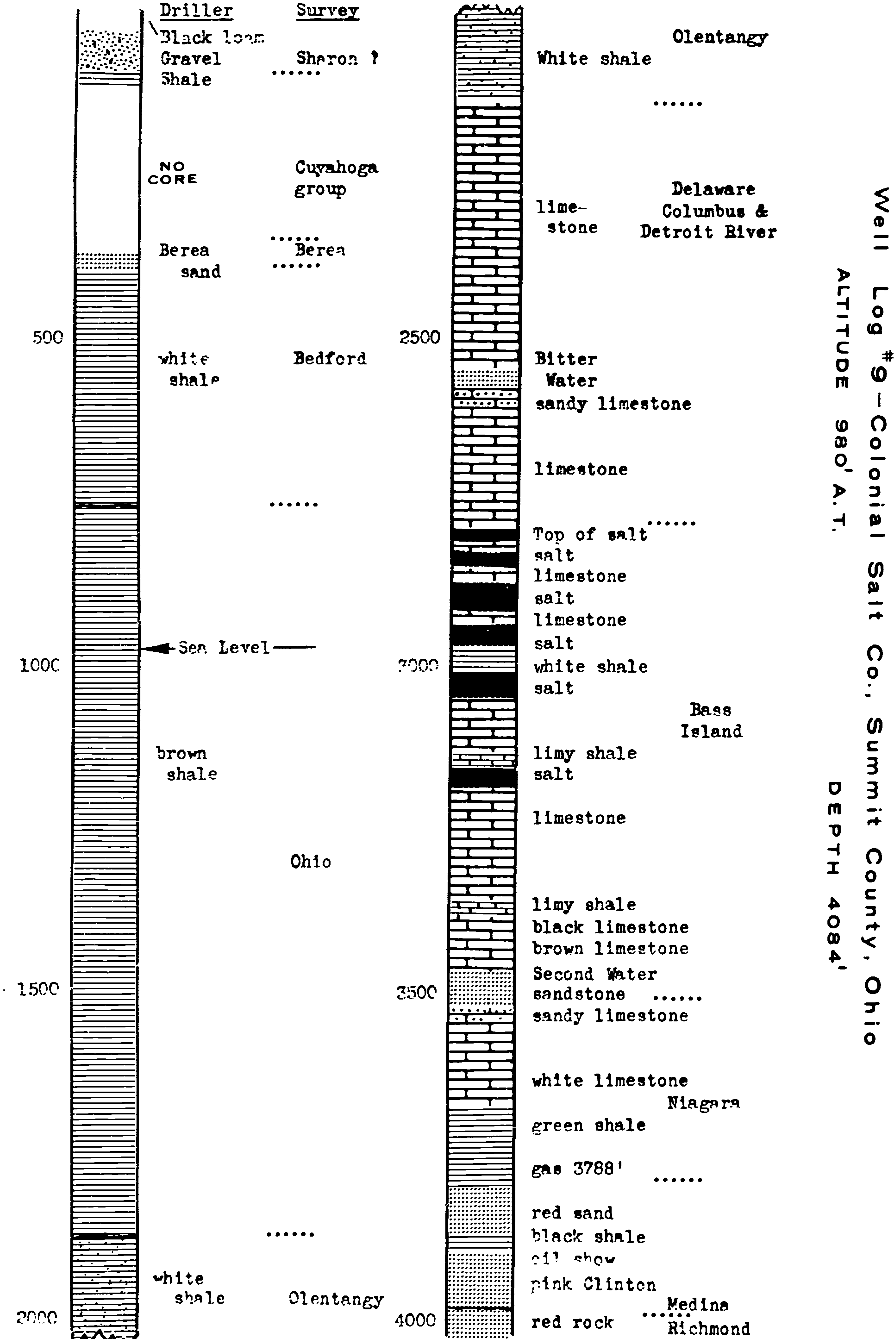
4. Girty, G. H. *Some Linguloid Shells from the Late Devonian and Early Carboniferous Rock of Pennsylvania and Ohio,* Geological Survey Professional Paper 193-C, 1939.
5. Herrick, C. L., Geological Survey of Ohio, Vol. VII, 1893.
6. Prosser, C. S., Bulletin 15, Geological Survey of Ohio, 1912.
7. Salt Report, by courtesy of the Baltimore and Ohio Railroad.
8. Savage, C. N. *Geology for the Springtime Naturalist,* Ohio Conservation Bulletin, May, 1951.
9. Schmidt, J. J. and Schaefer, J. E. *Underground Storage of Natural Gas in Wayne, Summit, and Stark Counties, Ohio,* Engineering Experiment Station News, O.S.U., Vol. XIX, No. 2, April, 1947.
10. Stout, VerSteeg, and Lamb, Water in Ohio, Bulletin 44, Geological Survey of Ohio, 1943.


Well Log #9 – Colonial Salt Co., Summit County, Ohio
ALTITUDE 980' A.T.
DEPTH 4084'
Driller
Survey
Black loam
Gravel
Sharon ?
Shale
NO CORE
Cuyahoga group
Berea sand
Berea
500
white shale
Bedford
Sea Level
1000
brown shale
Ohio
1500
white shale
Olentangy
2000
Olentangy
White shale
lime-stone
Delaware Columbus & Detroit River
2500
Bitter Water sandy limestone
limestone
Top of salt
salt
limestone
salt
limestone
salt
3000
white shale
salt
Bass Island
limy shale
salt
limestone
limy shale
black limestone
brown limestone
Second Water sandstone
3500
sandy limestone
white limestone
Niagara
green shale
gas 3788'
red sand
black shale
oil show
pink Clinton
Medina
4000
red rock
Richmond

The Second Intercollegiate Field Trip did not materialize because of a conflict with the Ohio Academy of Science Field trip in 1952.

FALL FIELD TRIP — 1952 — BGSU

PRELIMINARY OUTLINE

Directions	Miles	Time	Remarks
Assemble at Van Buren Lake (Guides will be posted in Van Buren — on US 25 & 68 — to direct you to the lake)		8:15	Lake Maumee beach ridge. Defiance moraine.
Leave Van Buren Lake	0.0	8:30	
Proceed west on S 113	3.3		
Turn left on Co. 139	.6		
Turn right to McComb's gravel pit, Park on side.	.3	8:40	STOP 1. Lake Maumee beach ridge.
Leave McComb's gravel pit.		9:10	
Back to Jct. Co. 139 & S113.	.3		
	.6		
Continue north on Co. 139 to stop sign	2.1		Note rise ahead. Lake Whittlesey beach ridge.
Turn right on Co. 203 to Jct. S18.	2.0		
Turn left on S18, through N. Baltimore	1.5		Whittlesey ridge again.
Continue north to Oil Center road	1.3		
Turn right to Rudolph Rd.	.5		
Turn left to Sand Ridge Rd.	10.4	9:40	Warren beach ridge.
Turn right on Sand Ridge Rd. to Maple St.	1.0		
Turn left on Maple to Wooster St.	.6		
Turn left on Wooster to Haskins Rd., (S64)	.2		
Turn right on Haskins Rd. Continue NW	7.9	10:00	Headward erosion by small tributaries of the Maumee River.
Jct. S64 and S65	.8		
Turn left across river	.5		
Turn left in Waterville	.4		
Continue South, leaving S64 to France Stone Co. quarry	1.3	10:10	STOP 2.
Park on left side of road			Bowling Green fault. Tymochtee dolomite
Leave Stop 2.		10:40	
Turn right on to US 24, back toward Waterville; Turn left at Jct. S64	1.0		Former valley of Maumee River
Follow S64 to Whitehouse.	6.6		
Turn left into quarry.		11:00	STOP 3. Columbus ls Fossil collecting
Leave Whitehouse quarry.		11:30	
Out of quarry, turn right an go through Whitehouse on Lenderson St. to Weckerly Rd. Follow Weckerly Rd. (a projection of Lenderson St.) NE to Jct. US 20A	6.0		
Turn right on US 20A to Albon Rd.	1.5		

Turn left on Albon Rd. to France Stone Co. quarry.	1.0		
Turn right into quarry		11:50	STOP 4. Holland quarry. Devonian-Silurian contact
Leave Stop 4		12:30	
Out of quarry — turn left on Albon Rd. back to US 20A	1.0		
Turn left on US 20A into Maumee	4.2		
Turn right on US 20 and follow through town and across river	.6		
Turn right on S 270 immediately after crossing river and proceed to Ft. Meigs Monument — LUNCH	.6	12:45	Coffee and fire in the stone house.
Leave Ft. Meigs		1:45	
Go back to Rt. 20, via S 65	.2		
Continue straight at stop sign on to US 20, and follow US20 through Perrysberg to Woodville	15.4		Between Perrysberg and Woodville, especially at Stone Ridge, note bedrock exposures.
			Cross the axis of Cin-Arch
Go through Woodville, and turn right across the RR tracks to Ohio Rydrate & Supply Co. quarry.	1.0	2:15	STOP 5 Niagaran dolomite
Leave Stop 5.		2:45	
Back to US 20 — turn right	1.0		

NOTE — THE REMAINING TWO STOPS ARE OPTIONAL — INTENDED FOR THOSE GOING EAST AND SOUTHEAST.

Proceed east to Fremont	14.5		
Proceed east to Bellevue	14.0		
Turn left into France Stone Co. quarry		3:30	STOP 6. Upper and Lower Columbus ls Fossiliferous in upper layers.
Leave Bellevue quarry		4:00	
Back to US 20 — turn left and proceed through Bellevue — turn left at Jct. S113 on east side of town	1.7		
Follow S113 through north Monroeville — note ridge beginning about 2 mi. out of Bellevue.			beach ridge
Continue east to curve in road — take gravel road straight ahead	9.4		
Turn right after .1 miles on to Peru Center Rd. Proceed 1 mi. south to stop.	1.1		STOP 7. Huron shale

THIS WAS THE LAST STOP — PROCEED SOUTH 2.2 miles to get back on to US 20 at Monroeville.

WRU GEOLOGICAL SOCIETY WRU

WESTERN RESERVE UNIVERSITY LUX 1826

NOVEMBER 14. 1953

Western Reserve Geological Society
Western Reserve University
Cleveland 6, Ohio

November 14, 1953

Students and Faculty, Welcome:

We are honored as hosts for this annual field trip. We are pleased that you could join us.

The area we have chosen will extend over a distance of 70 miles beginning with a scene of stream capture at Euclid Creek Reservation. At Bedford Glens we get a good look at a cross-section of the areas sediments. In South Amherst we will visit the world's largest and deepest sandstone quarries and watch the dressing processes in operation.

If we have aroused sufficient interest in this area to warrent further study, we suggest these references:

The Geology of the Cleveland Region
—A. B. Williams
Cleveland Museum of Natural History; 1940

Geology and Mineral Resources of Cleveland, Ohio
—Cushing, Leverett, and Van Horn
U. S. Government Printing Office; 1931

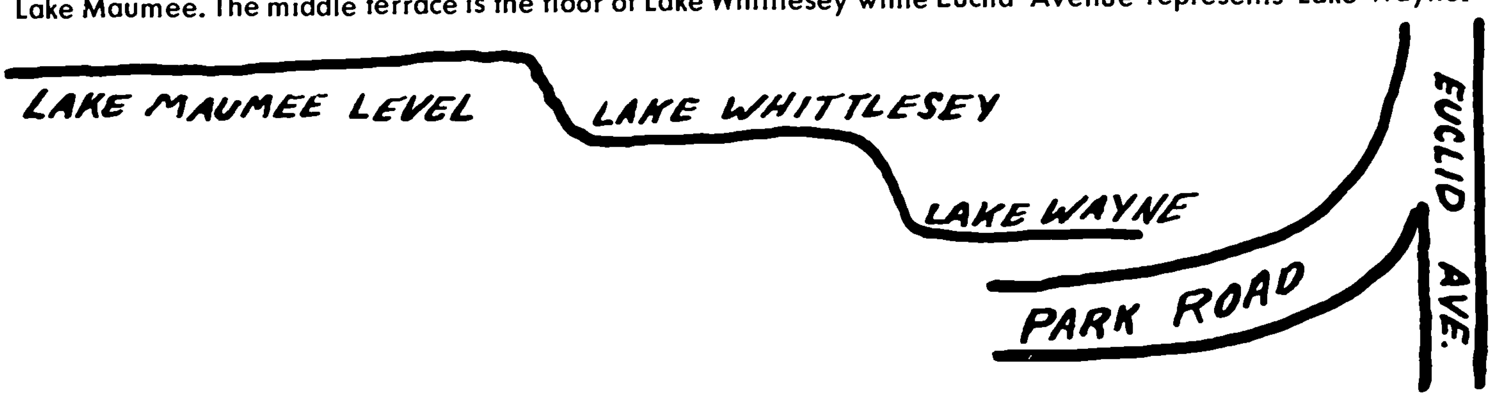
Devonian and Mississippian Formations of Northeastern Ohio
—C. S. Prosser
Geological Survey of Ohio, Fourth Series,
Bulletin 15; Columbus, Ohio; 1921

ROAD LOG

Location	Arrive	Leave	Miles	
Adelbert Parking Lot		8:30 a.m.	0.00	
1 Note Lake Levels			5.4	
				2.2
Cabin "X"	9:00 a.m.	9:45 a.m.	7.6	
				2.2
2 Note Bedford Bluestone Outcrop			9.8	
				13.2
Bedford Glens	10:30 a.m.	12:00 noon	23.0	
Lunch	12:00 noon	1:00 p.m.		
				47.3
South Amherst	2:30 p.m.	?	70.3	

OLD LAKE LEVELS — Jack Harrison

As you turn off Euclid Avenue into Euclid Creek reservation you will notice a large cliff to the right of the road. This cliff is an excellent example of three glacial lakes. The top of the cliff is the floor of Glacial Lake Maumee. The middle terrace is the floor of Lake Whittlesey while Euclid Avenue represents Lake Wayne.



There are several other glacial lake beaches that may be easily identified in the vicinity of Cleveland. Their location and a brief description is given in the following paragraphs.

The levels of the glacial lakes during the Pleistocene period were at first high; however, as lower outlets to the southern watershed were uncovered, their levels decreased. These different levels may be traced by the sandy beaches that formed along their shores. The first glacial lake was Lake Cuyahoga. To the north it was bounded by the ice front and extended south as far as Akron. As the ice continued to melt this lake merged with Lake Maumee which drained across the thumb of Michigan. Today you may see these levels as a sandy ridge which is now Lake Avenue west of Rocky River. To the east the beach runs along Warner Road.

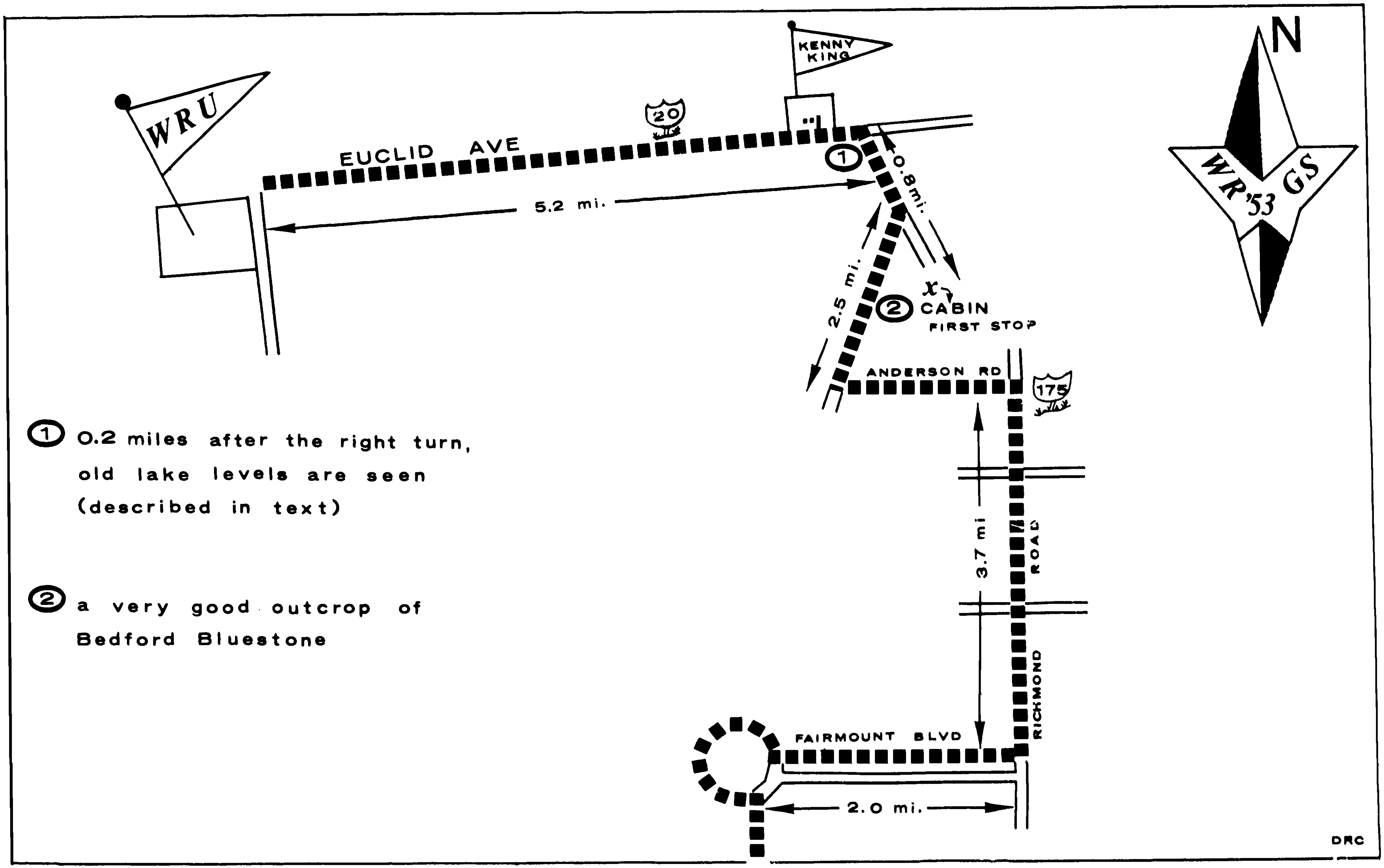
Lake Arkona, which drained into the Illinois River, was formed next. The bluffs on the north side of Center Ridge Road, on the west side of Rocky River were cut by this lake. The lake level then rose and Lake Whittlesey formed. The beach line of this lake is Center Ridge Road west of Rocky River. East of the Cuyahoga River the beach may be traced along Schaff Road to the Cuyahoga Valley. It lies near the base of the Portage Escarpment and may be seen as a terrace along Terrace Road in East Cleveland.

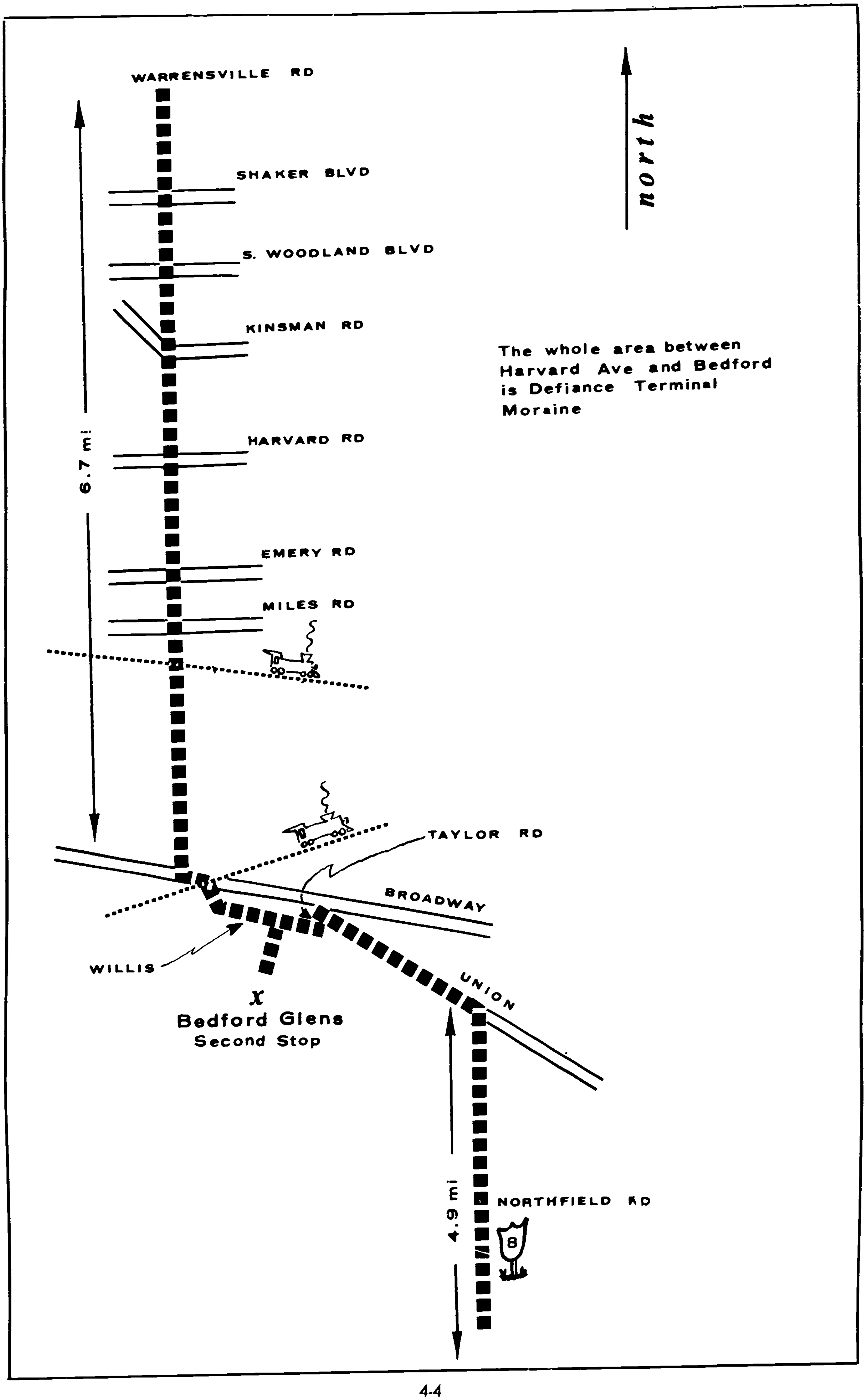
Lake Wayne formed next draining east along the Hudson River Valley. At this stage the lake had a low level and it may be seen at the base of Detroit Avenue and North Ridge Road west of Rocky River. East of the Cuyahoga River Woodland Avenue and Euclid Avenue follow this beach.

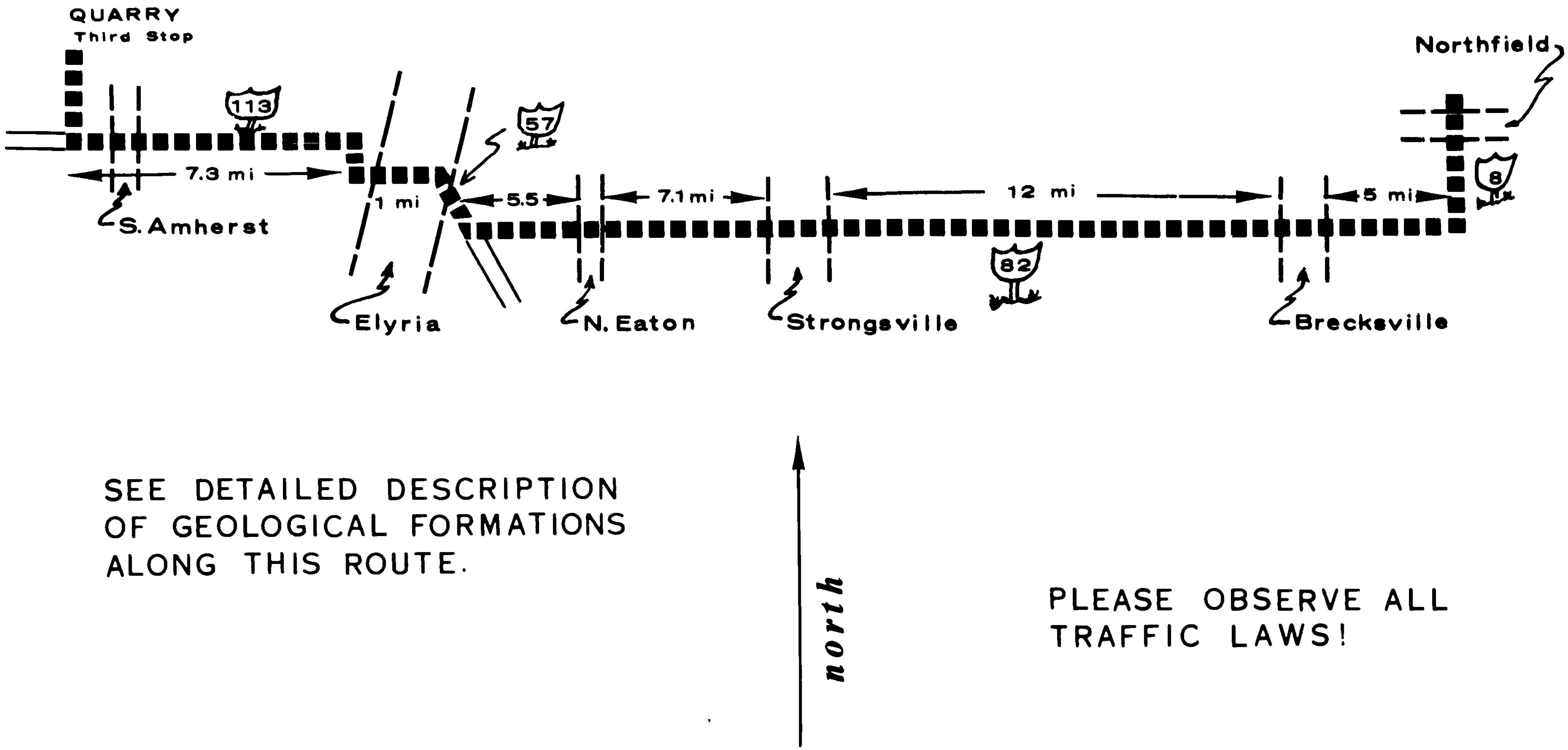
The last lake formed was Lake Lundy. The waters of this lake again drained down the Hudson and Mohawk Valleys. Only a few beaches remain from this glacial lake and they are located between Euclid Avenue and the present beach of Lake Erie, on the east side of Cleveland.

CLEVELAND BLACK SHALE — N. Cipolla

The Cleveland black shale having a bituminous quality is sometimes classified as belonging to the Carboniferous period, however, considering all factors involved it is held by general opinion to be Devonian in age.


WRU
KENNY KING
EUCLID AVE
20
5.2 mi.
0.8mi.
2.5 mi.
CABIN
FIRST STOP
ANDERSON RD
175
3.7 mi
RICHMOND ROAD
FAIRMOUNT BLVD
2.0 mi.
N
WR'53 GS
DRC
1 0.2 miles after the right turn, old lake levels are seen (described in text)
2 a very good outcrop of Bedford Bluestone


WARRENSVILLE RD
north
SHAKER BLVD
S. WOODLAND BLVD
KINSMAN RD
The whole area between Harvard Ave and Bedford is Defiance Terminal Moraine
HARVARD RD
6.7 mi
EMERY RD
MILES RD
TAYLOR RD
BROADWAY
WILLIS
UNION
X
Bedford Glens
Second Stop
4.9 mi
NORTHFIELD RD
8



SEE DETAILED DESCRIPTION
OF GEOLOGICAL FORMATIONS
ALONG THIS ROUTE.

PLEASE OBSERVE ALL
TRAFFIC LAWS!

Regardless as to what age it belongs, it is distinctly local in character, since the bed extends in a semi-circle around the Cleveland area, gradually decreasing in thickness as it progresses away and becomes wanting in Lorain and Huron counties.

The Cleveland shale consists of two distinct divisions, the upper and lower beds. The upper division, consisting entirely of black fissile shale, and the lower division, which is sometimes called the Olmstead shale, consisting of alternating blue and black shale with thin bands of sandstone.

The Cleveland shale bed lies above the argillaceous Erie (Chagrin) shale and is easily distinguished by its color, texture and sharp clear line of contrast between the beds.

Although the fossils in the Cleveland shale are rare, there are about twenty different species present. Of these the fish receive the greater attention.

Another point of interest is the fact that marcasite (iron sulphide) is scattered throughout. This can be seen by breaking up a piece of shale. At the same time you will be able to notice the dull-black color of the freshly opened surface as in contrast to the gray brown color of the weathered surfaces. If a sample of shale is taken from the under side of an outcropping it will be found to contain mottlings of thin crystals of gypsum known as pickeringite.

THE CHAGRIN SHALE — Jack Manning

The Chagrin shale was named from the Chagrin River which cuts through it and along which there are many cliffs that show excellent exposures of this unit.

This formation consists of soft, blue-gray shale with a few thin beds of sandstone. These sandstone layers become somewhat thicker and more numerous as one travels from east to west (from the Chagrin River to Rocky River). At its' easternmost part the Chagrin Shale is approximately 800 feet thick but only 175 feet of it are above lake level, and as one travels further westward beyond the immediate Cleveland area, this formation disappears below lake level.

Age and Correlation. Fossils are practically absent in the Chagrin shale save in a few uppermost beds. However, in these uppermost beds, especially in the eastern part of the formation, brachiopods are found in more or less abundance. These brachiopods permit a fairly definite correlation of the Chagrin shale with the upper Devonian Chemung formations in western New York state, and Pennsylvania.

COLUMNAR SECTION-CLEVELAND AREA* — Tom Houston

Chagrin Shale. This formation consists of very soft and pure greenish-grey or bluish-grey clay shales, with a few thin bands of flagstone and more numerous bands of flattened, hard reddish concretions. This formation is about 500 feet thick at Cleveland, but only 175 feet are above lake level.

Cleveland Shale. It is about 50 feet thick at its best exposures, and is a very black shale, which weathers rather rapidly, the thin slaty fragments staining brown. The lower few inches of the formation are rather rich in marcasite. This formation is especially well known for its excellently preserved remains of the great armoured shark, Dinichthys.

Bedford Shale. It has a thickness of about 85 feet and is a soft blue shale with bands of thin flagstone and hard calcareous concretions. Elsewhere it differs greatly from this description, and is the most variable formation in this section.

Berea Sandstone. A coarse formation with a general thickness of 60 feet, becoming locally much thicker. Rather prominent erosional surfaces are shown in nearly all sections where the Berea Sandstone rests on the Bedford Shale.

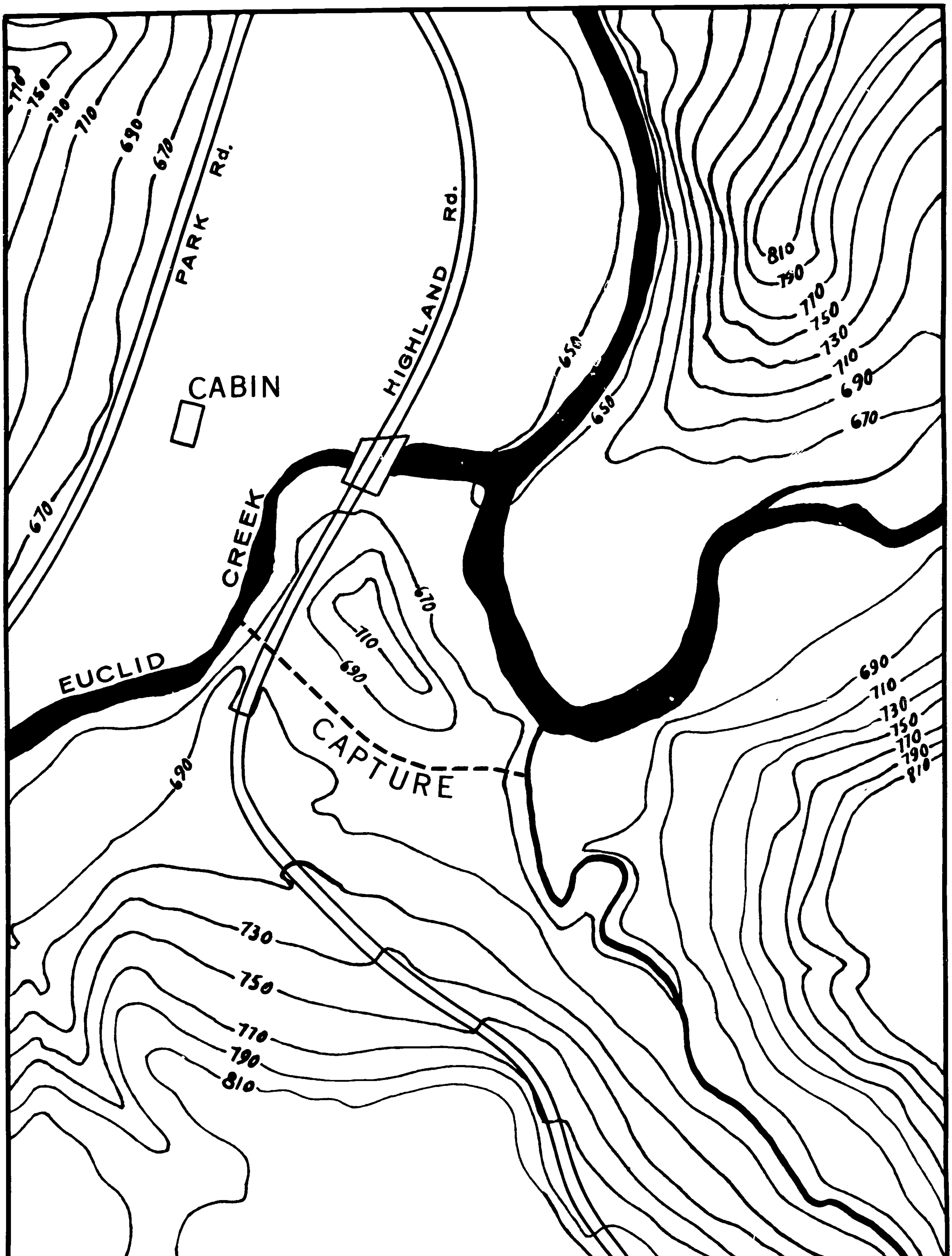
Cuyahoga Group. This has long been known as the Cuyahoga Shale, but is divided into three units. Which are, in ascending order, the Orangeville shale, the Sharpsville sandstone and the Meadville shale.

(A) The Orangeville is a soft blueblack clay shale, containing less bitiminous matter than the Cleveland shale. These beds are all rather weak and weather rapidly. The basal layer of this formation, generally not more than three inches thick, is a very hard black layer consisting largely of sand cemented by pyrite.

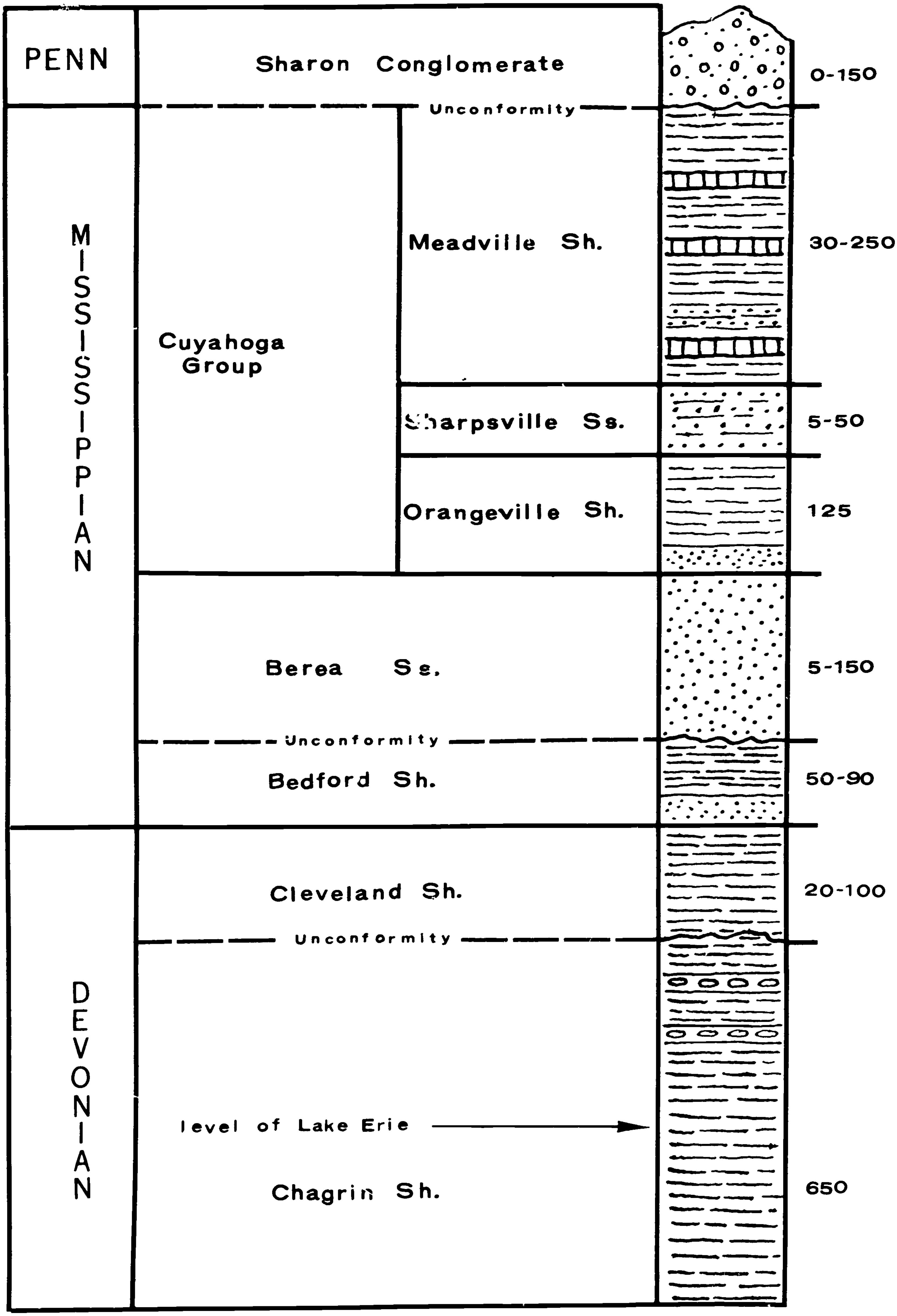
(B) The Sharpsville formation consists of grey-blue to grey-brown sandstone in beds from 1 to 2 feet thick, alternating with thin layers of grey shale and with a thin layer of blue limestone, near the base.

(C) The Meadville shale has a thickness of 30 to 250 feet in the Cleveland area and consists of alternating blue shale, thin sandstone and sandy limestones.

*Taken from Bulletin 818.



STREAM CAPTURE



in part from Bulletin 818 Tom Houston

TINKERS CREEK NEAR BEDFORD — Andy Kazmer

Tinkers Creek enters the Cuyahoga River from the East about three-fourths of a mile South of South Park. From Bedford to the Cuyahoga River it is nearly four miles in length. The gorge was cut by water erosion to it's present depth of 190 feet. Tinkers Creek is one of the finest sections of the district's strata.

Starting in reverse order and beginning at the lowest outcrop we have the following formations:

Chagrin shale — Named for the Chagrin River, at Tinkers Creek this formation is about 32 ft. thick. It is composed of bluish argillaceous shale and thin scattered layers of calcareous rock. Fossils are almost totally absent from this formation.

Cleveland shale — Named for the city of Cleveland, the Cleveland shale consists of black compact shale which at Tinkers Creek is about 18 ft. thick. Fossils are rather scarce; those fossils that have been found are fish remains, fragments of plants, shell of a few species of brachiopods and tiny conodonts.

Bedford formation — Named for the excellent exposure at Tinkers Creek, Bedford, Ohio, this formation is divided into two groups. The upper portion consists of bluish-gray shales alternating with layers of sandstone. The lower portion composed of blue argillaceous and arenaceous shales, also layers of sandstone are present. The standstones in this section display ripple marks. Fossils in this section are somewhat plentiful, with plant fragments found in loose blocks in the calcareous layers.

Berea Grit — Thickness at Tinkers Creek about 39 ft., this formation is composed of sandstones and shales. The sandstones are bluish, fine grained and have very irregular bedding planes. Ripple marks can also be seen in the sandstones of this formation.

Cuyahoga group — This group is divided into three formations which in order are:

3. —*Meadville shale* is composed of alternating blue shale, thin sandstone and sandy limestone.

2. —*Sharpsville formation* consists of gray-blue to gray-brown sandstone alternating with beds of gray shale and blue limestone.

1. —*Orangeville shale* is a soft blue-black clay shale, containing very similar to the Cleveland shale. These beds are rather weak and weather rapidly.

GENERAL PALEONTOLOGY OF THE CLEVELAND AREA — Curtis P. Mabie, Jr.

The Cleveland area is rather unfossiliferous considering the vast quantity of sedimentary exposures in the region. Fossils that are present give us a clew to the reason, being generally smaller than those of the same species and age found elsewhere, indicating that this was a region unable to adequately support a flourishing shelled fauna. Probably the major causes of this inability were the cloudy seas and the rapid, muddy sedimentation which tended to stifle out the varied, non-motile, heavy skeletonized, filter feeders of clearer seas; such as corals, bryozoa, and sponges.

The proximity of the region to the emergent Cincinnati arch area, resulted in frequent oscillation of the epeiric seas, which gave to the sediments, periods during which oxidation, decay, and solution destroyed organic remains.

The megafossil forms found in the sediments of the area, the Upper Devonian and Mississippian, are almost entirely restricted to brachiopods, gastropods, pelecypods, cephalopods and some sponges. Brachiopods are by far the most numerous of the fossils present. Pelecypods are generally more numerous than gastropods but their poor condition makes identification of both classes very difficult. Very few definitely identifiable cephalopods are found because of the lack of preserved internal shell structures. However, on the basis of the straightness of their shells, they are referred to the *MICHELINOCEROIDS* or *PSENDORTHOCERAS*. Cephalopods, though, are extremely rare. Well preserved hexactinellid sponges have been found and have been identified in one sponge layer of the Chagrin Shale (by Dr. Bacon of Case Institute) as belonging to the genus *HYDNOCERAS*. Plant remains have also been found, especially in the bituminous layers of the upper part of the Berea Sandstone. *LEPIDODENDRON* is probably the most common.

The microfossils, such as ostracodes and conodonts, are rather numerous, especially in the Cleveland Shale. Fossil fish. in the form of scales, spines, and teeth — the plates of the armored fish *DINICHTHYS* — are common in this formation.

The brachiopods present are by far of the greatest importance in the study of the paleontology of this area. They are locally restricted to narrow beds which are often difficult to find. Genera of considerable importance are: *LEIORHYNCHUS, SYRINGOTHYRIS, SYRINGOSPIRA,* the tiny *AMBOCOELIA, ORLUCULOIDEA, LINGULA, RETIEULARIINA, DALMANELLA* and *SPIRIFER* and are of wide vertical distribution though locally, some horizontal distribution occurs intermittingly.

POINTS OF INTEREST FROM BEDFORD TO NORTH EATON — Allen Badertscher

Bedford 0.0 miles

5.7 miles —Town of Northfield; Defiance terminal moraine

8.3 miles —Cuyahoga River —Chagrin shale outcrop

8.4 miles —Town of Brecksville —West edge of town again on Defiance moraine

10.7 miles —Defiance moraine

11.8 miles —Leave Defiance moraine, enter till plain topography

16.7 miles —Town of N. Royalton —built on Defiance moraine

16.9 miles —Descend steep slope —Cuyahoga formation
East Branch of Rocky River on glacial till and valley fill deposits

22.2 miles —Town of Strongsville —built on till plain
Road from here to North Eaton mainly on till plain

29.3 miles — Note numerous gas wells —Gas is from "Clinton" sand, at average depth of 2700 feet.

BEREA SANDSTONE — Cecil A. Ryder, Jr.

The Berea Sandstone lies above the Bedford shale and its contact with the shale is usually seen to be irregular. It is named from the city of Berea, Ohio, where it has been extensively quarried, and where it occurs just beneath the surface of the ground.

The Berea sandstone is a hard stone, composed mainly of pure quartz sand, rather loosely cemented, so that the rock holds a great deal of water. The color is usually light gray, though on weathering, due to the oxidation of iron which it contains, it becomes buff, or even dark brown. Sometimes, for this reason, the gray stone may be flected with brown spots. Many layers are crossbedded, many are ripple marked. The lower portion of the formation is massive, while the upper part is thin-bedded. Due to the fact that the Berea sandstone strongly resists erosion, it often becomes the cap rock over which water-falls occur.

Fossils in the Berea sandstone consist largely of numerous plant fragments, though one deposit of the remains of fresh-water fishes has been discovered at Chagrin Falls.

At South Amherst, over 883 acres of quarry land bearing six pits are under constant operation.

The famous Buckeye Quarry has been worked since 1903 to an average depth of 230 feet. It is approximately 1800 feet long, 600 feet wide, being the world's *deepest* sandstone quarry.

At No. 7-X Quarry, an area of 660 ft. x 55 ft. has been stripped with a cored anticipation of 100 feet of Berea.

Quarry #6 has been in operation for over 100 years. During this time it has become the world's *largest* sandstone quarry, being 3090 ft. x 1056 ft., averaging depth 160 feet. It has produced 455,000,000 cubic feet of Berea! It is more than a mile and a half around its edges.

The stone is used chiefly for grindstones, curbing, block, bridge, and sawed stone, such as flagging, caps, sills, and steps. Some stone is made into moldings, cornices, columns, and carvings. Trimmings and refuse are sold riprap and rubble.

OHIO INTERCOLLEGIATE FIELD TRIP 10/23/54

Southeastern Stark County
Mount Union College Students and Staff

Meet at US 62 and Ohio 80 in Alliance, or US 30 and Ohio 80 in Minerva

Thanks to Jack Perskey for use of his parking lot

Thanks to Ohio Academy of Science and Ohio Geological Survey for prior mailing, and for use of unpublished data

Look — 1. East to city limits, north past pits of Alliance Clay Products and Alliance Brick. Cuts on left show #6 (M Kittanning) coal on thick underclay. Note predominance of shale in section over coal. Cuts not visible on right show #5 (L Kittanning) coal.

Look — 2. North to Lake Park Blvd., east across broad flats of Mahoning River. Perhaps a hundred feet of fill here. Upper 20 or 30 feet is clayey silt (probably lacustrine) and clay, capping a sandy aquifer which furnishes several flowing wells of small capacity.

Look — Continue to east edge of valley floor, follow into a pit. We think you can drive on through. Close view of #6 coal and its underclay which is desirable because it fires to a buff brick. Note that sandstone is channeled into and replaces most of shale over the coal. This sandstone is characteristic of Sebring area and probably accounts for hills projecting out into valley.

Smell — Out past Sebring city dump (formerly a dig for #5 coal and its underclay, but not now of geologic interest), and around south flank of hill.

Stop — Pit south of lane shows till, and interlayered washed sand and lacustrine clay. This is probably a near-shore or near-ice phase of the clay and silt of the Mahoning valley bottom. #5 (?) coal in bottom of pit probably under water. Pit north of lane for #6 coal.

Look — 3. South across US 62 (and they go like bats on this road). As you near and pass this intersection you can look ENE to a small stripping near top of prominent Knob Hill. Skyline about 1 1/2 miles away. The hilltop cut is in #6a (L Freeport) coal with about 6 feet of underclay carrying three distinctive concretionary zones. About 70 feet lower, near base of hill there are strip diggings for #6. Shale with very little ss between these two coals at Knob Hill.

Look — 4. Two miles south of 62, Pinch School on left. Coal in bank below schoolhouse, and clay below coal is very like top of Knob Hill which is about a hundred feet higher. Section here is not like #5 and #6 coals more nearly at same level to north. This is an isolated exposure, would be called 5 or 6 on basis of position, must be called 6a on basis of lithology.

Don't give up hope, you'll get a chance to dig in coal beds at later stops.

Stop — 5. South 6 miles to and through New Chambersburg. Through most of this stretch you will see no exposures, and none of us know much about this area. In the last mile or so you will see sandstone ledges, probably Mahoning ss. Stop on hilltop just south of "town".

Looking west across hilltops we see the general topographic position of stop 6 — a low isolated hill bounded by trenches. We are looking along what might be divide between Mahoning (north) and Sandy Creek (south) drainage.

Turn around at next drive south, come back through New Chambersburg and west down hill.

Look — Note #7 (Upper Freeport) coal under Mahoning sandstone on left as you come down steep hill. More than six feet thick.

Stop — 6. North end of isolated rock hill, near Wisconsin border and within Illinoian border. Valley east of hill rises to low divide at bend in valley. Valley west of hill slopes south all the way. Ravine from west drains perhaps 100 acres. Valley west of hill contains about 50 feet of fill. Your elevation on road is near 1140. Similar feature at 1180 elevation at southeast tip of Mahoning headwaters, but only one narrow valley, there.

Up hill to west the #7 coal is absent or very thin at or near a driveway entrance. A stripper about a mile southeast of here started on 7 feet of #7 and quit in disgust 50 yards later on less than 2 feet.

Stop
Walk

7. West to Ohio 80, south to underpass, west on lane. Look out for high crown, and allow a bit of time for stacking cars here. Base of cut in shale may be above 6a (L Freeport) or 6a may be absent here. Note channel with coaly streaks at base of U Freeport sandstone. Upper part of cut shows, ascending: gray, red, gray clay shale sequence with Bolivar (?) coal in upper gray; U Freeport limestone (brown and white ledges); clay; Traces of U Freeport coal; debris from Mahoning ss.

Comments: Red shale is Allegheny below Conemaugh?
Two Bolivar coal streaks?
Note same red visible in hilltop cut to east.
Lower brown of Freeport ls is top of next rr cut east.
Wind polished cobble from near surface near top of next cut east (small remnant of pre-Wisconsin till).

8. Next cut west — Rather typical expression of L Freeport (6a) coal and limestone near base of cut.

Walk

Comment — stops 7 and 8 are one car stop.

Railroad ballast is not local rock. Major fills are.

9. Hilltop stop to look down into cut — 6a (L Freeport coal) near middle of 90 foot section. Some shale near base of predominantly sandy section below coal.

Stop

Please watch out for planting of Pine seedlings.

10. Bridge stop, to look down into cut showing more of same shale below sandstone, and #6 (M Kittanning) coal below shale. This is a good place to go down to see a typical (or better than typical) development of the yellow kidneys.

Stop
Climb?

Streaks of 6a (L Freeport) in roadcut north of bridge as we drive away.

Mile and a half north along ridge, but not quite high enough to pick up the #7 coal.

West almost to Paris.

11. Roadcut east of Paris, 6a (L Freeport) coal and limestone. Note also a coaley streak down in the underclay zone. Railroad cut about half a mile north shows tongues of coal. Hilltop about half a mile north reaches on up to traces of Upper Freeport or Bolivar section, which helps bracket the locality where you are standing.

Stop

12. West and south from Paris. At low concrete bridge see #5 coal *in* creek, with red kidney ore in shale above it. Obvious mine dump is #6 coal about 25 feet higher.

Hesitate
Look

13. Through part of Robertsville, and back north on other side of same hill. About halfway up hill we pass trace of coal and underclay where 6a should be. (In ditch, at last kink in road before it straightens out due north.) Don't worry if you miss it.

14. On up to top of hill. Here we have Bolivar and Upper Freeport zone, plus another coal (or a glacial erratic) down in the top of the Mahoning sandstone.

Stop

Leaving this cut, driving north, we see the Upper Freeport in roadcut on right, with dark shale instead of the usual ss above it. Very little detail section discovered below coal here.

Look

6a pit beyond crossroad at left.
7 pit on hilltop to northeast (dark shale above it here too).

Turn east at crossroad and wind down past a clutter of 6a and 6 pits, and back into Robertsville.

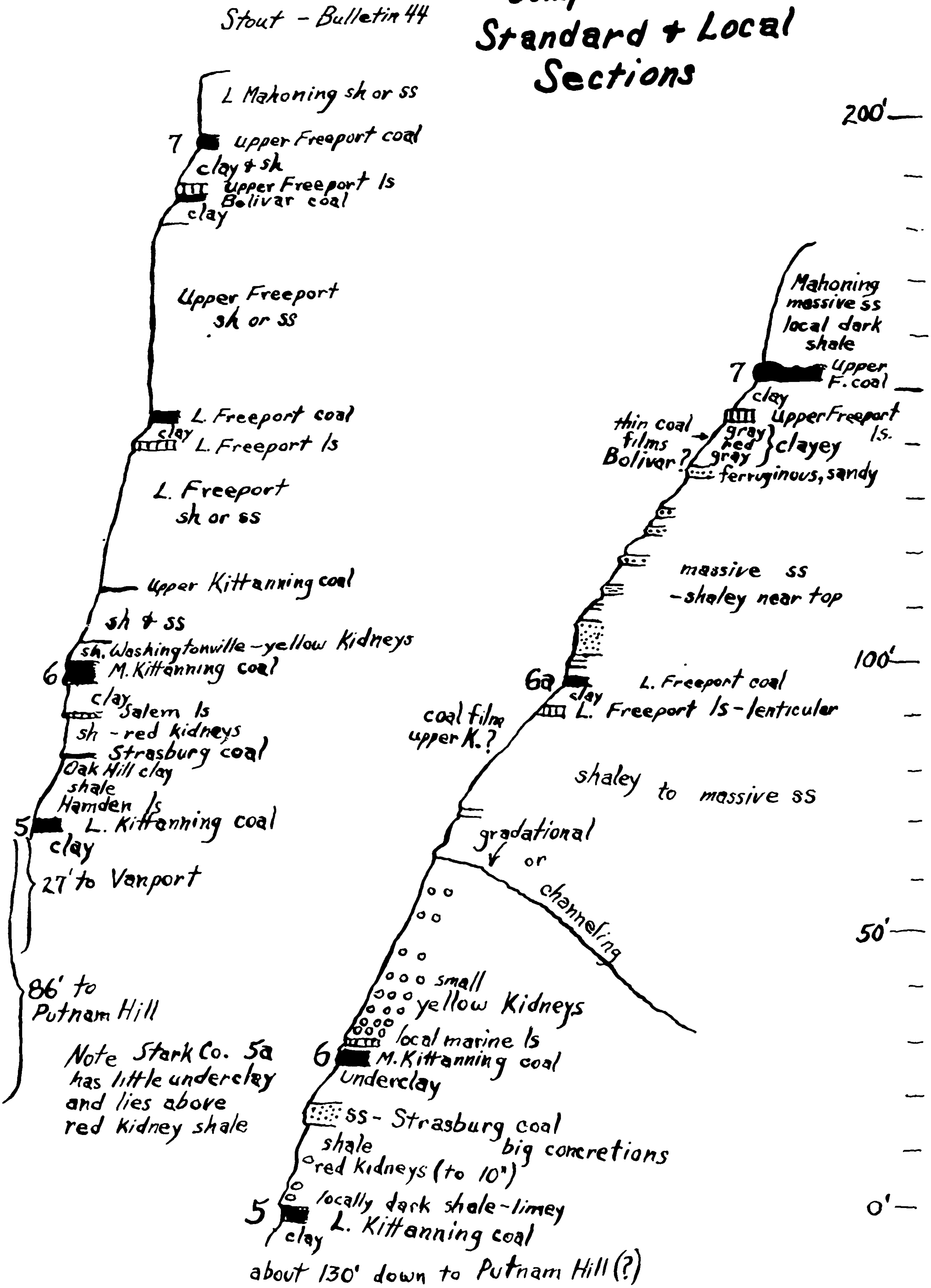
The hill you have just looped is of interest more for general perspective on the section than for good exposures. Also, on the basis of incomplete study, it seems probable that elevations are out of plumb here because of some form of disturbance.

West on US 30, and follow procession onto old 30 for parking. Numerous openings in sight are on #6 (M Kittanning) coal. Most of the underground entries have caved, but a geologist once found one in good repair being used as a wine cellar.

15. National Fireproofing pit east and down from Osnaburg (now known as East Canton). Brecciated folds in #5 reported by a former student to overlie glacial pebbles. Following along this pit to west we see the 5 (L Kittanning) 5a (Strasburg), and 6 (M Kittanning) rise and diverge to normal intervals.

Stop

Comparison of Standard + Local Sections



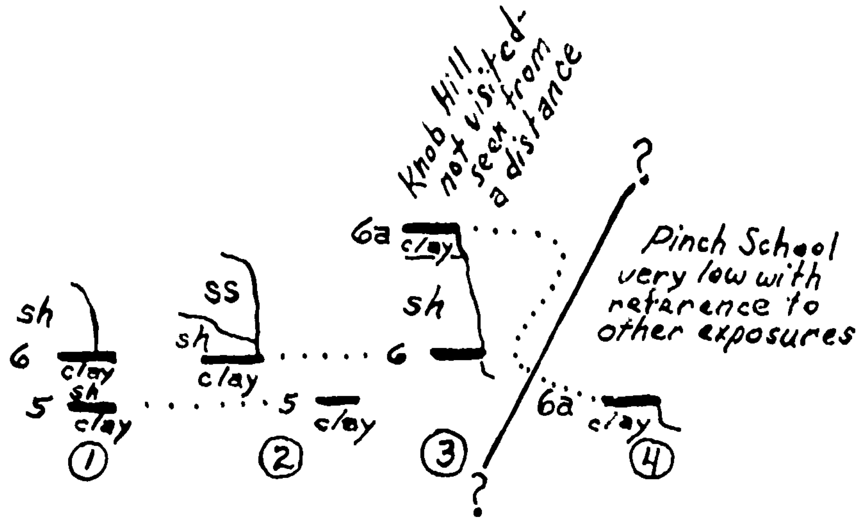
OIF trip 10/23/54

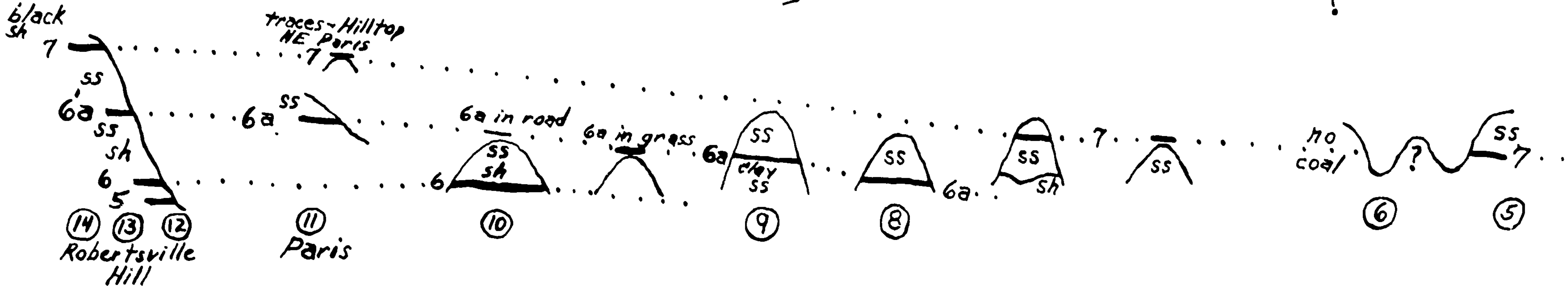
Sketch correlations

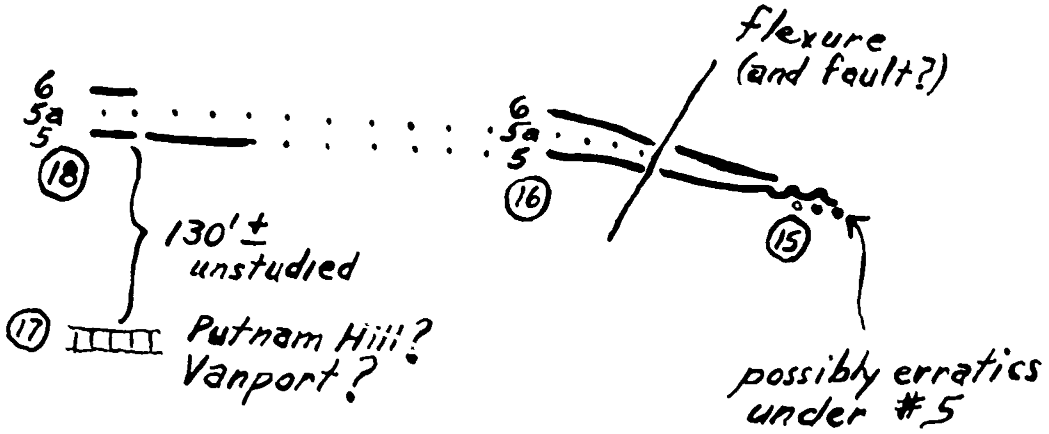
① circled numbers refer to itinerary

Probable Definitions

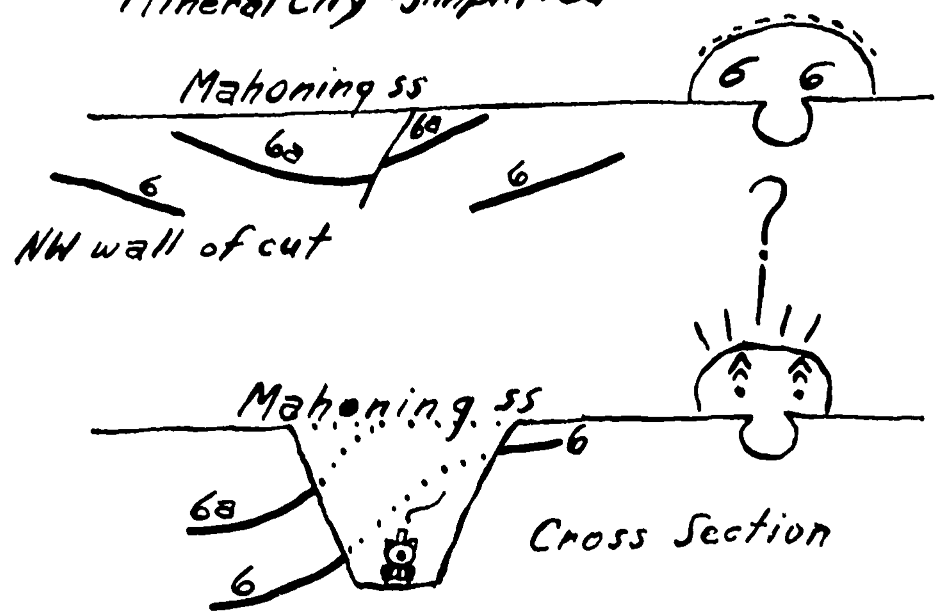
7 - U. Freeport Coal
6a L. Freeport Coal
6 M. Kittanning Coal
5a Strasburg Coal
5 L. Kittanning Coal



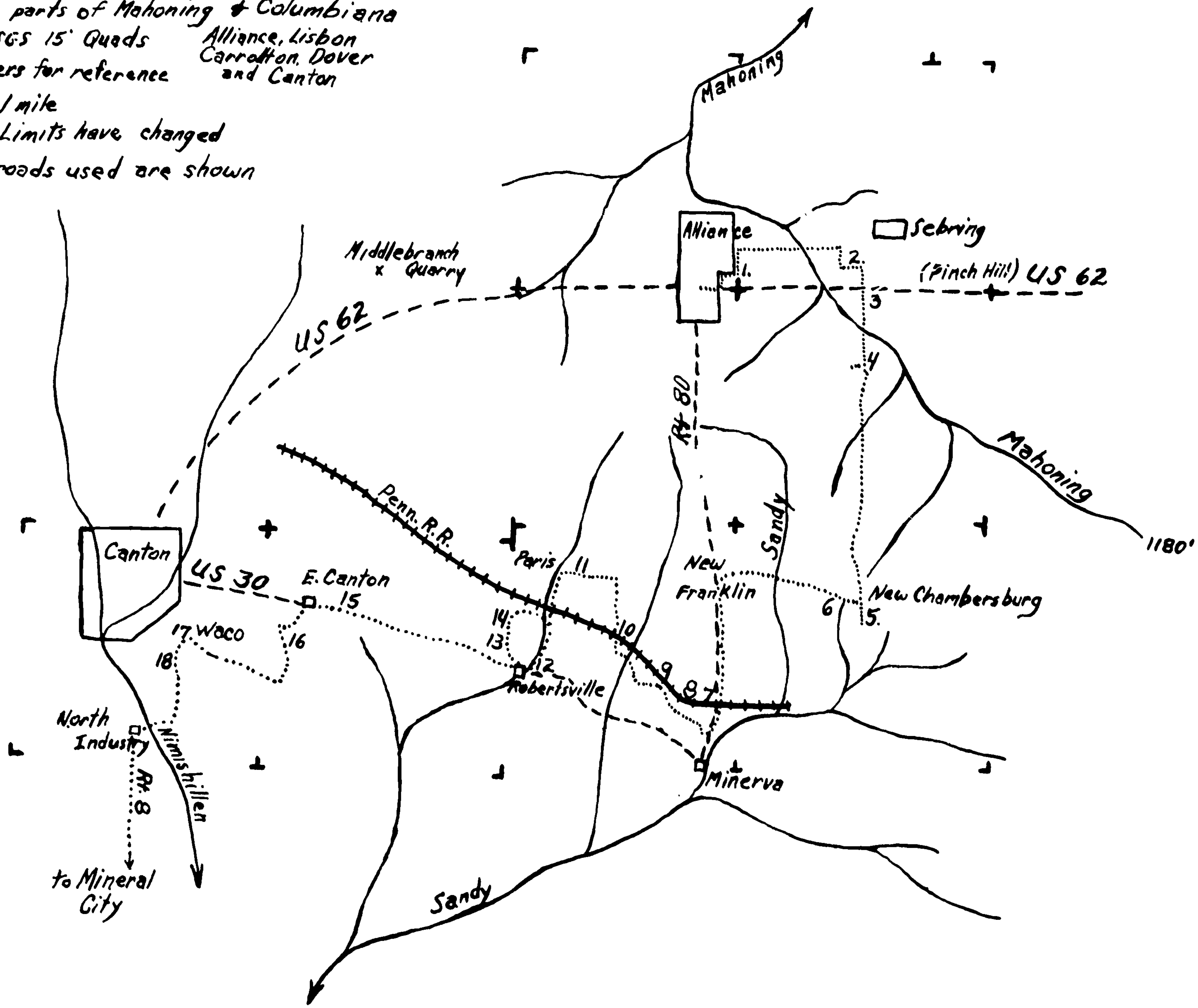




Mineral City - Simplified



Geology Trip 10/23/54 Mount Union College
SE Stark Co, parts of Mahoning & Columbiana
Base from USGS 15' Quads Alliance, Lisbon Carrollton, Dover and Canton
Township corners for reference
Scale 1/4" = 1 mile
Note - City Limits have changed
- Only roads used are shown



South across valley we see a hilltop dig terminated abruptly at east, though there is more hill to east. Rice unable to find continuation of the coal to east, suspects a fault. There are several disturbances in next two miles south.

16. West through East Canton, and south to pits of Stark Brick. *WATCH IT* and you go straight where US 30 goes north — a bad corner. We'll try to put a flagman there.

Stops

This two mile long series of pits shows the following:

#5 underclay (used for glazed tile) up through Strasburg and #6 coals.
Everything from shale to massive channel sandstone above #6 coal.
Fault with about 20 foot displacement (SE down).

What we see depends upon day-to-day condition of pit face and pit roads.

East side of same hill is much less mined, and shows some rather steep dips.

Stop

17. West to Waco, for what is generally called #4 (Brookville) coal under Putnam Hill limestone. We are about 130 feet down from #5 coal up hill to south. This unstudied section perhaps 9arries the key to the position of this and similar limestones farther north.

Incidentally — this is good limestone fossil collecting for this part of the state.

18. Hilltop stop simply for stratigraphic verification of Kittanning position. You have seen better exposures.

To Mineral City

South about 1 1/2 miles, west to and across Nimishillen Creek into North Industry. Pick up Ohio 8, and follow it south about ten miles into Residential Mineral City. When you are obviously in town, turn around, come back, and take old 8 which is the left hand branch of an asymmetric Y and winds up over the hill. About a mile from the fork you come to a bridge over a deep cut. This is it. Yes, there is a short cut without entering Mineral City, but this is easier to find.

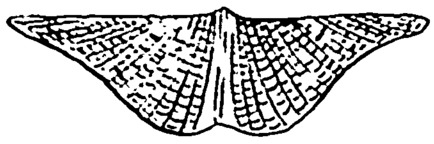
You crossed a large pre-glacial valley about three miles before Mineral City, and can cross another about two miles beyond Mineral City if you are going out by New Philadelphia.

Good Luck

THE GEOLOGY

OF

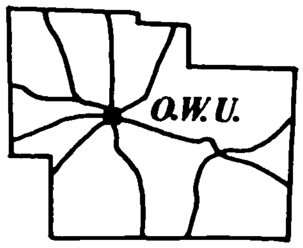
DELAWARE COUNTY

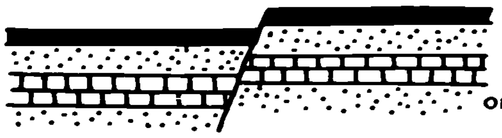


SIXTH OHIO

INTERCOLLEGIATE FIELD TRIP

November 5. 1955





Sponsored By The Ohio Wesleyan University Earth Science Club

ROAD LOG

Directions	Miles	Time	Remarks
Junction, Rts. 37 & 203	0.0	8:30	
Scioto River	2.4		Narrow bridge — be careful!
Crossroad	2.7		
Bokes Cr. Cemetery	3.6		STOP #1 — 10 min. Park, assemble quickly
Turn left on gravel road	4.2		
T-intersection, turn left (E)	7.0		
T-intersection, turn right (S)	7.6		
Turn right, turn left	8.0		
Turn left (E)	9.0		
Turn right (S)	9.1		
RR crossing, turn left	9.8		Watch for trains!
Curve left	10.9		
Curve	11.1		
White Sulfur Quarry	11.2		STOP #2 — 40 min.
Turn left — RR crossing	11.5		One-way bridge
Jct. Rt. 36, turn right			Watch traffic light
City of Delaware	16.4		
RR crossing	16.8		
Turn left	17.0		
Monnett Quarry, enter gate.	17.1		STOP #3 — 30 min.
From here follow the caravan to Merrick Hall for lunch.			
Leave Merrick Hall	0.0	1:00	Be prompt! We must leave on time.
Turn left, turn right at traffic light			
Cheshire St., turn right	0.7		
RR — bear right	0.8		
Turn left, then right	1.1		
Turn right on gravel road	1.4		
Olentangy River section	1.6		STOP #4 — 15 min. Park on right

Turn right — paved road	2.0	
Olentangy River	2.2	Delaware Is. in river bed
Turn left (S) on Rt. 23	2.4	Heavy traffic on 23, be careful!
Olentangy River	5.7	Traveling over Ohio Sh. Can you see it?
Crest of Powell moraine	14.2	
Turn right into parking lot	15.7	STOP #5 — 40 min.
Come out, get into left lane		Be careful — Rt. 23!
Turn sharp left	16.1	Dangerous turn
Turn right	16.6	
RR tracks	16.9	Danger! 3 tracks
Turn left	18.3	
	19.2	Look right, valley widening and terraces.
Curve, cross Alum Creek	20.6	
Stop, go straight ahead	21.2	
Crossroad	23.3	
T-intersection, turn right	24.8	
Turn left at intersection with Rt. 3		Be careful!
Turn right to Galena	26.7	
RR underpass	27.5	Rough road
Stop, turn right	27.7	
Stop again, cross highway, Turn left across bridge	27.8	Big Walnut Creek
Turn left	28.2	
Straight ahead on gravel road	28.5	
Park in field on left. Walk down hill to quarry	28.7	STOP #6 — 20 min.
Turn around, retrace Route to Galena		
Cross bridge, turn left (S)	29.6	
Turn left	31.6	
Turn right	32.6	
Park in barn lot	33.5	STOP #7 — 20 min.
Turn right	34.3	
Turn right, retrace route to Galena	35.3	
Construction area	35.9	Ohio Shale on left
Galena, bear right	39.0	
Stoplight in Sunbury, straight ahead	42.6	
Intersection Rts. 36 & 3	43.1	

Field party breaks up here. Those heading N. or S. follow Rts. 3 & 36. Those going W. or back to Delaware turn left.

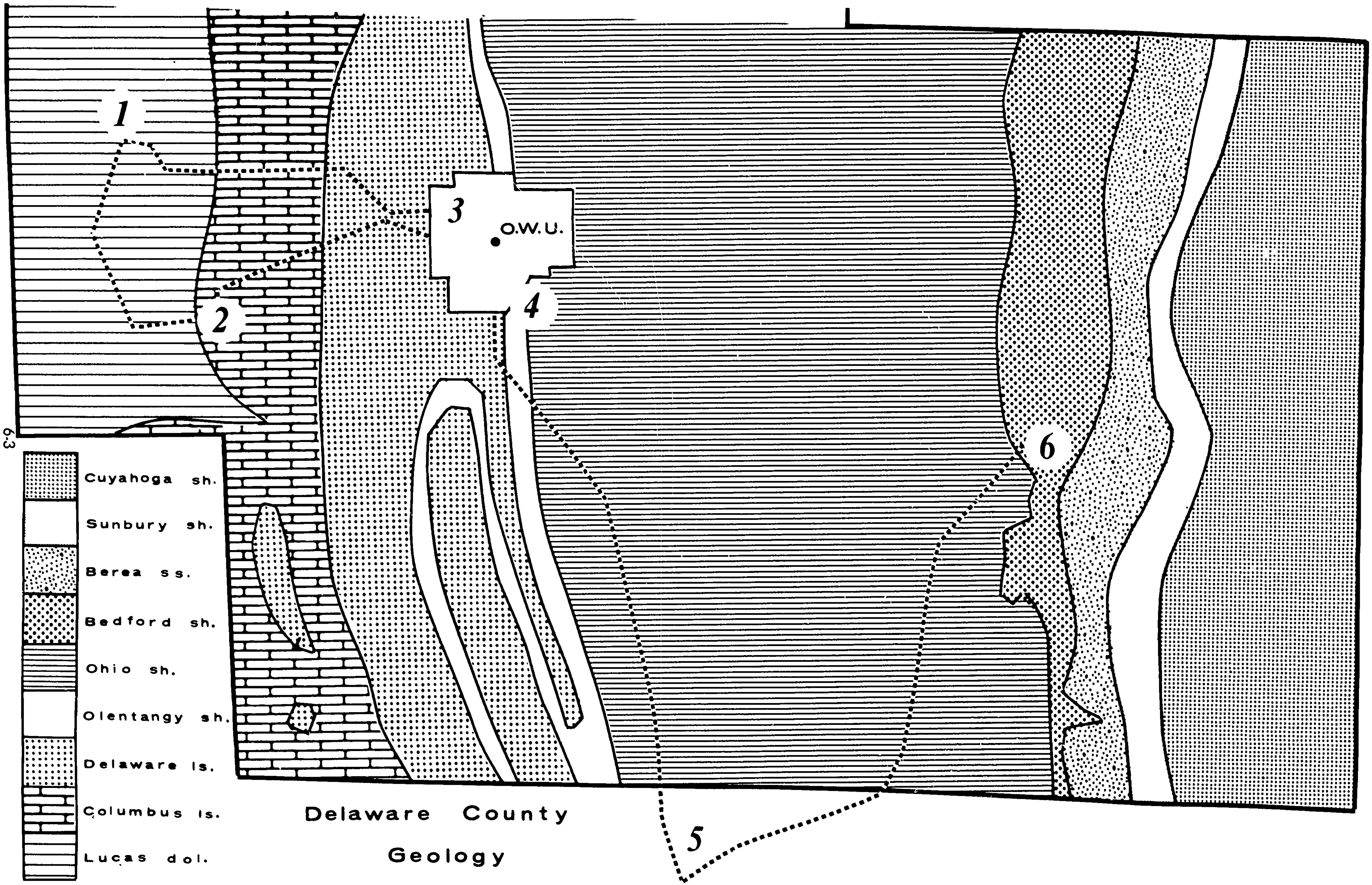
Stoplight, turn left for Delaware	43.5	
Berkshire	45.4	
	46.7	Alum Creek — Ohio Shale outcrop.

GENERAL GEOLOGY OF DELAWARE COUNTY

Delaware county lies almost exactly in the center of Ohio. Physiologically, the county lies in the Till Plains of the Central Lowlands, its eastern line about ten miles west of the western edge of the Allegheny Plateau.

The county is a part of the nearly level surface of the upper Scioto drainage basin. Departures from this level plain are noted in two directions.

1. Glacial moraine reaches heights of forty to fifty feet, but due to width are not conspicuous features. Glacial kames and eskers are prominent in several parts of the county.
2. Four streams, the Scioto, Olentangy, Alum Creek, and Big Walnut Creek cut valleys across the county in nearly parallel north-south courses.



Delaware County
Geology

COLUMNAR SECTION OF SURFACE ROCKS OF

DELAWARE COUNTY

	FORMATION		SECTION	FEET	ROCK CHARACTER
Mississippian	Cuyahoga			150	fine-grained gray sandstone alternating with soft gray shale.
Mississippian	Sunbury Shale			15	fissile black bit. shale
Mississippian	Berea Sandstone			30	massive gray to buff sandstone
Devonian	Bedford Shale			90±	gray and chocolate red clay shale
Devonian	Ohio Shale			650 ±	chocolate-black bituminous shale, showing limestone layers with cone-in-cone structure in upper part - large limestone concretions near base
Devonian	Olentangy Shale			30-35	soft, blue-gray calcareous shale with concretionary nodules and layers of gray limestone
Devonian	Delaware Limestone			45	blue to brownish-gray, cherty limestone
Devonian	Columbus Limestone	Klondike Member		81	gray fossiliferous limestone weathering thin-bedded - 40 feet
Devonian	Columbus Limestone	Bellapoint Member			brown, dolomitic limestone-conglomerate at base - 30 feet
Silurian	Lucas Dolomite			20	thin-bedded, fine-grained, gray, dolomitic limestone
			Total	1050	

Coral zone

sp. mocrothyris zone

heavy, gray limestone - 5 feet

brownish limestone - corals, 6 feet

Delaware county lies on the East limb of the Cincinnati Anticline. The layers of rock dip to the east at an average rate of 25 feet per mile. The level surface of the county cuts across the inclined rock formations which consequently occur at the surface in north-south belts, the oldest formations on the west side of the county, the younger occuring successively to the east. The formations from west to east (oldest to youngest) are in the Silurian, Devonian, and Mississippian Ages.

Stop #1 **LUCAS DOLOMITE — Paul Wagner**

The Lucas Dolomite member of the Detroit River Series represents the top of the Silurian in the county. This, the oldest and lowest formation in the county, is exposed along Bokes Creek behind the little cemetery on Rt. 37.

Only the highest part of the Lucas is found at the surface in Delaware county. Although the Lucas shows two facies, only one is present here: a thin-bedded, very fine-grained, dense, dove-colored dolomite in layers two to four inches thick. The rock is streaked and brecciated. Fossils are absent or infrequent and occur mainly as hollow casts in the brown beds.

Other outcrops near here demonstrate the unconformity between the Lucas Dolomite (Silurian) and the Columbus limestone (Devonian). A conglomerate, containing pebbles of fine-grained dolomite derived from the underlying Lucas, composes the lower one to six feet of the Columbus limestone.

Stop #2 **WHITE SULFUR QUARRY — Dick Helwig**

The Columbus limestone at White Sulfur Quarry is an excellent spot for collecting fossils. There, along the water's edge, numerous, large, perfect fossils have weathered out of the limestone.

Do not fail to notice the abandoned lime kilns at the quarry. The high calcium carbonate content of the Columbus limestone makes it particularly desirable for burning to agricultural and industrial lime. A modern rotary kiln is operating at the Klondike Quarry a few miles south of here.

The top of the quarry is in the *Spirifer macrothyris* and Coral zones near the middle of the Columbus limestone. These are Stauffer's zones C and D. The large brachiopods *Spirifer macrothyris* and the large coral *Zaphrentis giganteus* are most characteristic of zone D. Zone C is recognized by the great number and variety of simple and branching corals.

Stop #3 **MONNETT QUARRY SECTION — Gary Alberts**

The Delaware Limestone and a small fault are well exposed at Monnett Quarry, behind Monnett Hall in Delaware. We are interested mainly in the SW corner of the quarry, behind the broad limestone bench of the picnic area. This is city property, so do not collect samples from the edge of the lake or from the floor of the picnic area.

The lower two/thirds of the quarry is the medium to heavy-bedded, blue-gray limestone most characteristic of the Delaware. Thin bands of shaley limestone and layers of nodular chert occur frequently. The most conspicuous of the latter is an 18 inch layer of chert about 15 feet above the lake level and 20 feet above the base of the formation. About 3 feet above this the Delaware changes character. It becomes more variable, thin-bedded, and weathers to a light brown color.

The contact with the underlying Columbus limestone lies just below water level. Since the famous bone bed is almost absent here, the exact contact is hard to distinguish.

Tentaculites scalariformis and *Leptaena rhomboidalis,* the "washboard brachiopod," are common fossils near the base of the Delaware.

A small fault is exposed in the SW corner of the quarry, behind the picnic area. To find the fault, trace the 18 foot chert layer south from the edge of the lake. This chert layer is displaced about 8-1/4 feet downward to the left (SE). The fault dips about 65° E and strikes nearly N-S. Can you trace it northward? Stauffer says that this fault passes into a more complex distributive to the south.

Stop #4 **OLENTANGY RIVER SECTION — Dwight McBride**

Along the Olentangy River at the southeast edge of Delaware, is the type section of the Olentangy shale. Here this shale and the overlying Ohio shale are well exposed for 200 yards or more. The dark, platey Ohio shale forms a vertical cliff comprising about one third the height of the hill. Below this, the softer, lighter Olentangy shale forms the steep slope of the river.

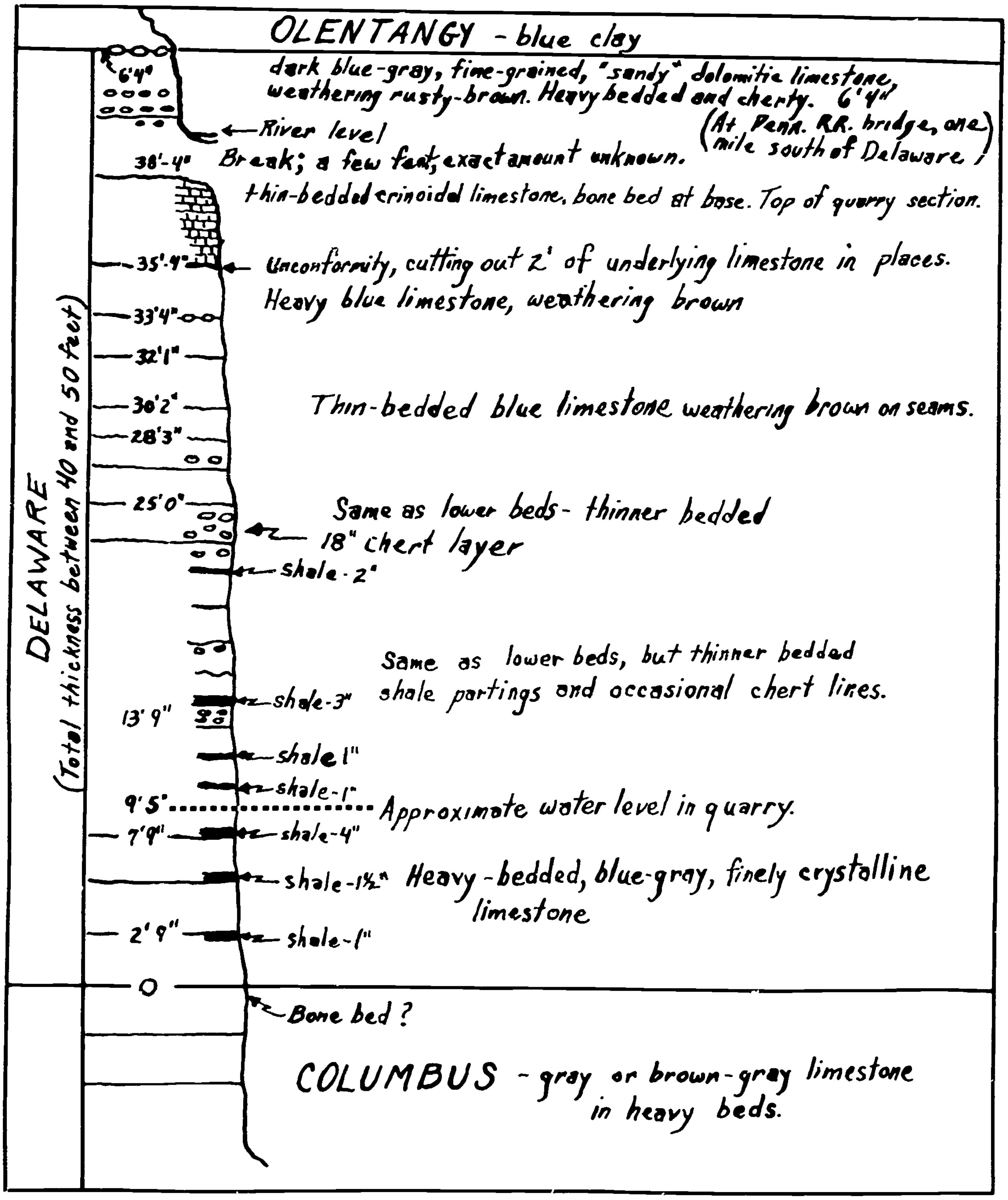
COLUMBUS LIMESTONE SECTION

	ZONE	THICKNESS	DESCRIPTION		
DELAWARE				80'-9"	Blue-gray, thinner bedded limestone
COLUMBUS	H	10'	Bone bed at top	77'	Klondike member, 40'-3" Buff to gray limestone, fossils abundant. Separated by prominent seams into heavy (5'-7') layers, which in ravines & on exposure, weather thin bedded. Prominent oblique jointing
	G	22'	Massive and gray. Large cephelopods common.	70'	
	F	5'	Spirifer gregarius zone	63'	
	E	20'	Massive and gray. Abundant fauna esp. Spirifer macrothyris & strophonella ampla	56' 50'6"	
	D	6'-8'	Great number and variety of fossils, excellently preserved	42'6"	Spirifer macrothyris Zone Fine-grained, brownish gray heavy-bedded limestone. Conchoidal parting, esp. on middle layer.
	C	4'-6'	At places a true coral reef	36'	Coral layer. Thin-bedded, brown limestone, more massive undercover Abundant corals and stromatoporoids.
	B	35'	Chert in upper part Calcite Fossils usually rare and poorly preserved	30'	Bellepoint member, 30' Fine-grained, brown, magnesian limestone marked by streaks and specks of carbonaceous matter and small masses of coarsely crystalline calcite. Fossils practically wanting. Heavy bedded. Scioto River level-Klondike
	A	1'-6'	Conglomerate		Limestone conglomerate 6" to 1'
LUCAS					Mill Creek level Gray dolomitic ls thin bedded

After Westgate and Stauffer

SECTION OF DELAWARE LIMESTONE IN DELAWARE QUARRIES

(Type Section)



Examine the Ohio shale concretions here. Notice the displacement of the bedding above and below them. Did the concretions grow in the shale, pushing the beds apart, or were the concretions there originally and the beds compressed around them? What's your answer?

At certain times of the year water issues from this contact. The highly fractured Ohio shale permits water to percolate down through it, but the solid, clay-like Olentangy shale prevents any further downward movement.

Pyrite is abundant here, forming nodules in the Ohio and crystal masses in the Olentangy.

OLENTANGY SHALE (Type section)

The Olentangy shale is a soft, bluish-gray clay shale which crumbles easily on exposure to the weather. Limestone and pyrite are the main impurities. The Olentangy is believed to be equivalent to part of the Ohio shale. The top of the Olentangy is a sharp transition from the blue clay of the Olentangy to the dark, slatey Ohio shale and the structural relations are conformable.

A strong argument for conformity is found in the layers of dark shale in the upper part of the Olentangy which has all the characteristics of the Ohio shale, and in the further fact that layers of blue-gray clay, indistinguishable from the Olentangy are in places found well up in the Ohio shale.

Apparently the Olentangy is a local basal facies of the Devonian shale series of Central Ohio, conformably underlying the Ohio shale in Central Ohio but running out before reaching northern Ohio. In Delaware County the Olentangy is about 34 feet thick. This shale series, with a blue shale base (Olentangy) in central Ohio and a black shale base to the north (Ohio), rests, going north, on successively higher Middle Devonian beds. Thus, the base of the Olentangy shale is considered to be an unconformity.

OHIO SHALE

The Ohio shale is dominantly a black or dark brown carbonaceous and somewhat arenaceous shale which splits into thin slate-like slabs or pieces. The numerous point planes are often stained a reddish or brownish tint with iron oxides. It is approximately 650 feet thick in Delaware County although only 25 feet are exposed at Stop 4. Concretions are a noticeable feature of the lowest part of the Ohio shale.

The concretions are composed mainly of dolomite. Two explanations of their origin have been offered.

1. The concretions were formed by the deposit of dolomite between the shale layers, forcing them apart, and at the same time displacing the layers of shale above and below.
2. The concretions were deposited before the shale was compacted. Later compression deformed the shale around the more rigid concretions.

They are related in some unknown way to water circulation through the Ohio shale just above the impervious Olentangy shale. Frequently the concretions contain masses of silicified wood or fragments of bones that served as nuclei around which they formed. With the exception of some trunks of tree ferns, the masses of silicified wood are the oldest remains of land vegetation yet found in the state.

The fossil fish, *Dinichthys hertzeri,* was the first obtained from the limestone concretions in the Ohio shale at Delaware. These fish were 20 feet in length and had a head 3 feet long by 2 feet broad.

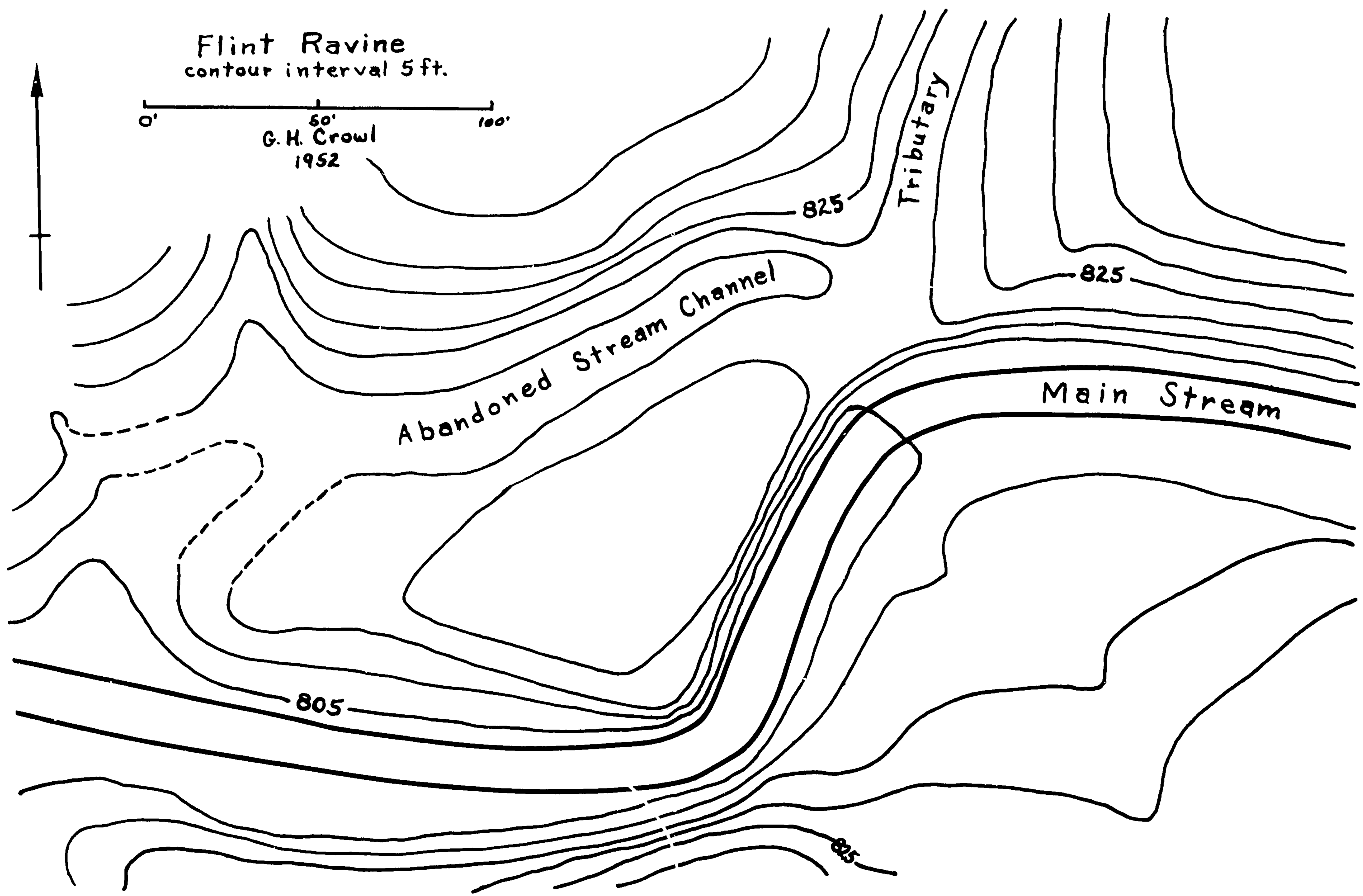
The Ohio shale was probably formed from black organic muds washed into the sea which covered central and eastern Ohio. These muds were derived from the black organic soils covering the adjacent lowlands.

Stop #5 **FLINT RAVINE**

At Flint Ravine on Rt. 23 north of Worthington outcrops of two concretionary horizons are found in the lower zone of the Ohio Shale. The uppermost horizon is first observed as the river valley is entered. The horizon here is about five feet above the stream level. Several hundred yards downstream, the lower concretionary level outcrops in the stream bed about 15 feet below the uppermost horizon.

The rectangular E-W, N-S joint pattern present here is easily discernible in the stream bed. The stream uses the joint system to great advantage.

A case of stream piracy occurs several hundred yards downstream from Rt. 23. Here an intermittent stream enters the main stream over a four foot falls. The main stream, flowing from the east, makes a fairly sharp turn at the falls and heads off in a southwest direction. At the level of the tributary bed, an abandoned channel bears west to a point about 300 feet downstream where it enters the main stream. A stream terrace stands as a knob between the abandoned channel and the main stream. On the lip of the falls, an additional closely spaced diagonal joint system shows quite clearly.


Flint Ravine
contour interval 5 ft.
0'
50'
100'
G. H. Crowl
1952
825
825
Tributary
Abandoned Stream Channel
Main Stream
805
825

The mechanism for the stream piracy has been explained by the following hypothesis: During a time when the valley floor was at the height of the tip of the present knob, the main stream followed a course corresponding to the present abandoned channel. The tributary flowed in the same channel it does today and entered the main stream near the falls. Later the main stream changed its course on the flood plain and eventually carved out its present channel. In doing so, the stream left behind a small channel in which the tributary continued to flow and downcut.

As the streams downcut, the floodplain was left as a flat between the two streams. Gradually, taking advantage of the closely spaced joints present at the falls, the streams wore away the flat allowing the tributary to abandon its old channel and flow into the main stream. This process was undoubtedly aided by the lateral cutting of both streams. Since the time of piracy, the main stream has been cutting down with greater rapidity than the tributary, thus creating the falls.

Stop #6 **BEDFORD SHALE**

The Bedford shale makes a north-south belt east of the Ohio shale, crossing Big Walnut Creek at Sunbury. The Bedford is a soft, gritless, laminated, argillaceous shale of gray or brownish-red color, weathering to a red or yellow clay. The most striking exposures of the formation are south of the county line. Total thickness in Delaware county varies from 60 to 90 feet. Some fossils are found in the lower 3 feet.

At this exposure the Bedford is overlain by 20-25 feet of till whose upper part is weathered. Notice the thickness of the weathered zone, the shape and material of the pebbles, and the sand layers in the till.

The top of the Ohio shale forms the vertical walls of the creek just below the east end of the till cut. The contact is sharp and conformable but unfortunately not well exposed.

Stop #7 **BEREA SANDSTONE**

The Berea sandstone crosses the county in a north-south belt from one to two miles wide. As it is a harder rock than the shales to the west, the ground surface stands about 100 feet higher here.

The rock is a medium to fine-grained sandstone. The beds are distinctly cross-bedded at low angles and many of the layers show ripple marks; both features are evidence of shallow water conditions. No fossils are found in the formation in the county. Total thickness in the county is 30 feet.

The Berea is unconformable on the underlying Bedford. In the northern part of the state it fills deep channels in the Bedford. It is in these deep channels where the Bedford reaches 100 feet in thickness that the large building stone quarries are located. None, however, is quarried in Delaware County.

The Berea ss here displays slumped bedding well. The ss beds, partly indurated, apparently slid down a sub marine slope and are highly contorted. For a detailed discussion, see John R. Cooper, Jour. Geol. 51: pp. 190-203, 1943.

GLACIAL GEOLOGY — Paul Landis

Delaware County has been covered by two ice sheets, the Illinoian and the Wisconsin. Only Wisconsin deposits are found, however, since any earlier deposits were swept away by the Wisconsin glaciation.

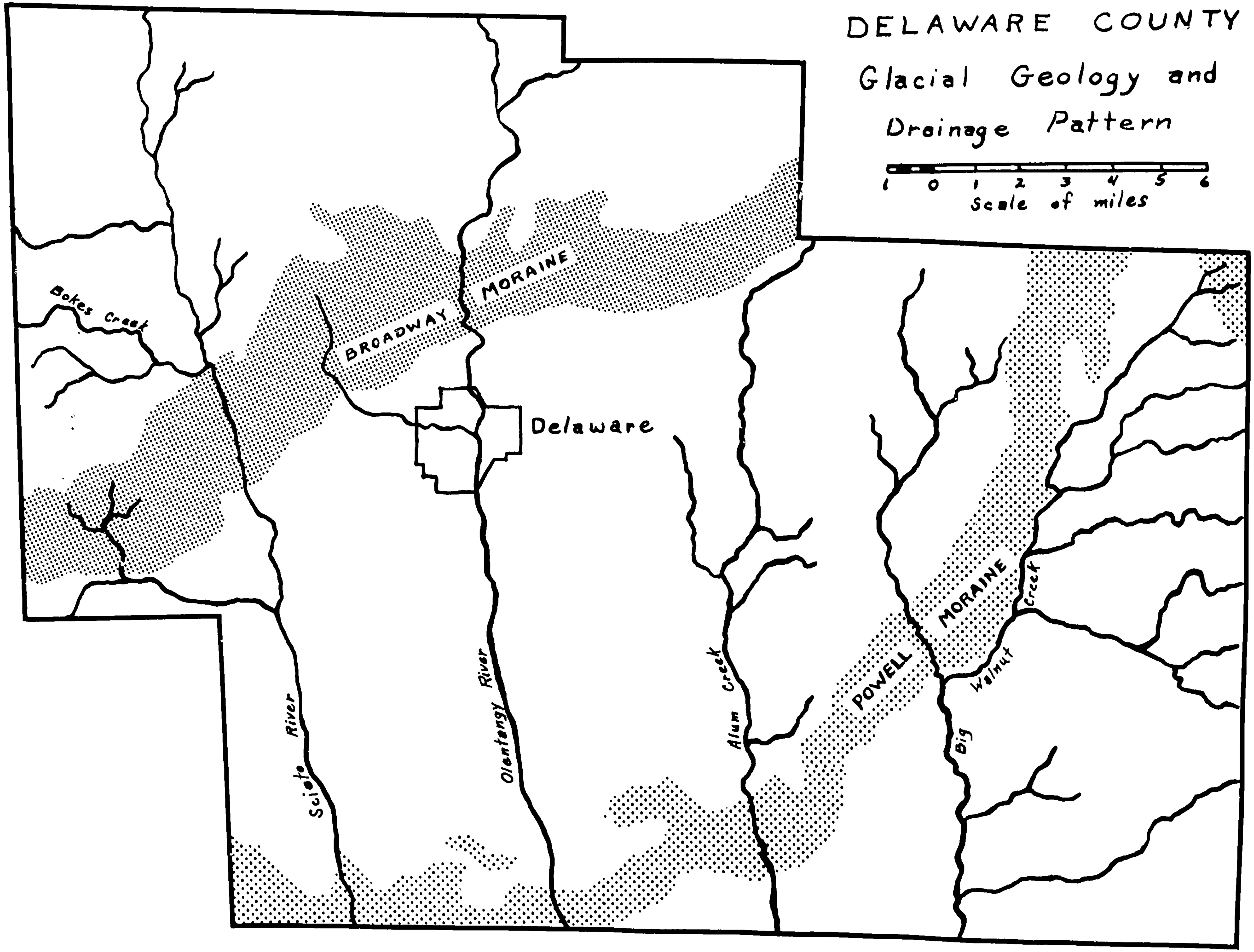
In the western half of the county, glacial straie are sometimes found on bedrock uncovered in advance of quarrying. At Meredith's quarry near Radnor (which we will not visit), sets of straie show; one N 20° W, and the other N 2° W. The two sets prove a shift in the direction of flow.

Compact, fine-grained, yellowish-brown clay makes up 95% of the total glacial deposit. It often contains calcium carbonate derived from the mechanical wear of limestone.

Throughout most of the county the till surface is a nearly level till plain, except for the areas cut by valleys. This slightly rolling landscape is characteristic of this part of the state.

Two belts of higher and more rolling land stand in contrast to the nearly level surface of the till plain. These are terminal moraine, areas of thicker drift accumulation. The Powell moraine follows the south border of the county to the Olentangy River, whence it takes a NE course to the Big Walnut Creek, which it follows to the northern line of the county.

The Broadway moraine enters the county near Ostrander and swings to the north; about three miles northwest of Delaware it turns again to a more easterly course which it holds to the county line. These moraines usually rise rather sharply from the south to a maximum height of 50 or 60 feet. From this crest they slope gradually north to the nearly level till plain.


DELAWARE COUNTY
Glacial Geology and
Drainage Pattern
1 0 1 2 3 4 5 6
Scale of miles
BROADWAY MORAINE
POWELL MORAINE
Delaware
Bokes Creek
Scioto River
Olentangy River
Alum Creek
Big Walnut Creek

ECONOMIC GEOLOGY — George Cox

LIMESTONE:

Lime is one of the most important products of the country. The main producer at the present time is the Scioto Lime and Stone Company located at Klondike, about 5 miles southwest of Delaware. The rock used is taken from the upper 40 feet of the Columbus Limestone and a few feet of the overlying Delaware Limestone.

Both the Columbus and Delaware Limestones are crushed and used as road material. The Delaware is said to be somewhat superior, however.

At the present time neither the Columbus nor the Delaware is quarried in the county for building purposes. In the past, though, the Delaware has been used, and a number of residences and buildings in Delaware are constructed of this stone. The Columbus has never been used for construction in Delaware County, although it has been in Franklin County to the south.

SAND AND GRAVEL:

Sand and gravel occur in both alluvial and glacial deposits at several places in the county. At present the only commercially used deposits are located in the northwestern corner of the county. Part of an extensive kame and esker system is in this area.

CLAY PRODUCTS:

Two companies in the county manufacture tile and bricks at the present time, both using the Bedford Shale. One, located in the city of Delaware, formerly used the glacial till clay in making bricks.

The Delaware Clay Company now produces about 9 million finished bricks a year, and uses about 20,000 tons of shale in the manufacture of this amount.

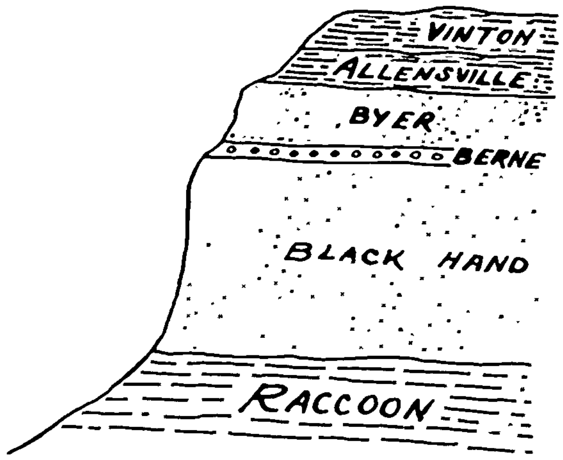
The Olentangy Shale has also been used in the past for the manufacture of tile and bricks in Delaware County. In Franklin County, the Ohio Shale was used in the manufacture of both tile and brick, but its use proved unsatisfactory due to the great variation of the composition of the shale and to the presence of large amounts of impurities in the form of organic matter, lime carbonate, and pyrite.

REFERENCES

1. Clifton, H. E., *The Carbonate Concretions in The Ohio Shale*, Ohio Jour. Sci '57: pp. 114-124.
2. Cooper, J. R., *Flow Structures in The Berea Sandstone and Bedford Shale of Central Ohio*. Jour. Geol. 51: pp. 190-203, 1943.
3. Pepper, J. F., and DeWitt, Wallace, Jr., and Demarest, D. F., *Geology of the Bedford Shale and Berea Sandstone in the Applachian Basin*, U. S. Geol. Surv. Prof Paper, 259.
4. Westgate, L. G., *Geology of Delaware County, Ohio*, Ohio Geol. Surv. Bull. 30, 1926.

SEVENTH ANNUAL INTERCOLLEGIATE
GEOLOGY FIELD TRIP

GEOLOGY OF GRANVILLE NEWARK VICINITY
LICKING COUNTY, OHIO



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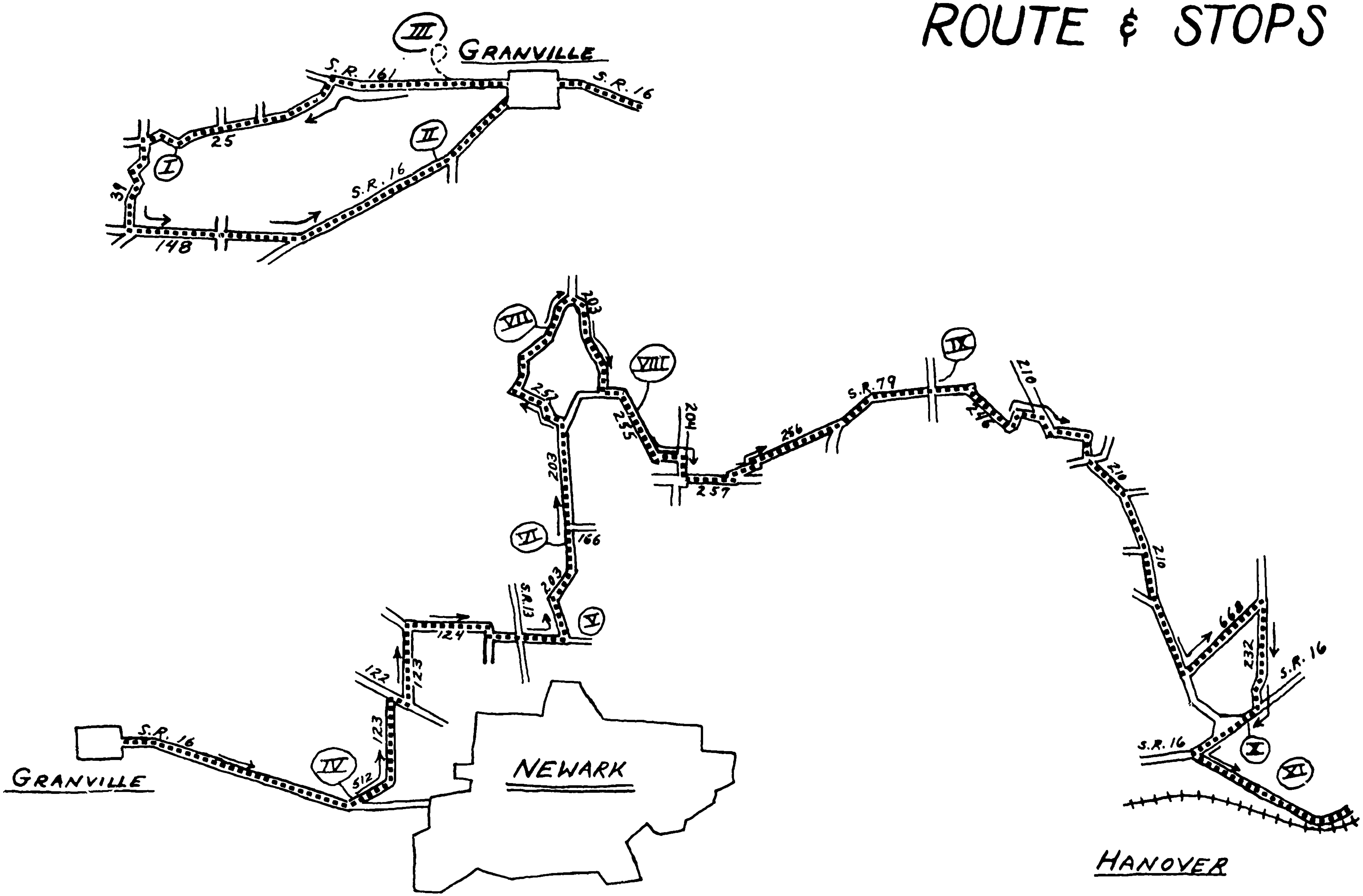
C.L. HERRICK GEOLOGICAL SOCIETY
DENISON UNIVERSITY
GRANVILLE, OHIO OCTOBER 20, 1956

ROAD LOG

Student Caravan Leader — Graeme Hammond

Direction	Cumulative Mileage	Increments	Remarks
Road in front of Barney Science,	00.0		*Starting Point*
Denison Campus		0.1	
Turn left down Thresher St.	00.1		
Byer & Allensville in old quarry			A better exposure will be
on right		0.2	seen later
Turn right on W. Broadway (Rt. 37)	00.3	0.8	
Pure Oil Station, take left fork	01.1		CAUTION: Watch for abrupt
		1.3	left turn just over hill
Turn left on County Rd. 25	02.4	1.7	
Stop street; continue straight ahead	04.1		
on County Rd. 25		0.4	
	04.5		STOP #1 — 15 min.
Stop, turn left on County Rd. 39	05.0	0.5	
Turn left on St. Albans Twp. Rd. 148	06.2	1.2	
Stop road, Rt. 16, turn left	07.2	1.0	
with CAUTION		1.5	
Turn right on old road off Rt. 16	09.8	0.4	
	10.2		STOP #2
Contact between Byer and Berne Col.			
Approx. elevation of Berne 1000 ft.			
Continue on Rt. 16 toward Granville		1.3	
City limits of Granville	11.5	0.2	
Turn left on W. Broadway and go	11.7		
out Rt. 37		1.1	

ROUTE & STOPS


GRANVILLE
S.R. 161
S.R. 16
25
39
148
I
II
III
GRANVILLE
S.R. 16
IV
512
123
122
124
S.R. 13
V
203
VI
166
VII
257
VIII
235
204
257
256
S.R. 79
IX
246
210
210
210
668
232
S.R. 16
S.R. 16
X
XI
NEWARK
HANOVER

Turn right on dirt road. Go straight up the hill, past the first turn then curve around to the right	12.6	0.4	
Turn right at T-intersection	13.0	0.1	
	13.1		STOP #3 — 15 min.
Continue down steep hill. CAUTION: use low gear!		0.2	
Turn left on Rt. 37. Continue on straight through town on Rt. 16 towards Newark.	13.3	4.2	
Turn left into Roadside Park — use CAUTION!	17.5	0.2	
	17.7		STOP #4 — 40 min.
Continue on Rt. 16			
Turn left on Rt. 512	17.8	0.1	
Turn left on County Rd. 123	18.1	0.3	
Turn right on Sharon Valley Rd. (Rt. 123)	19.2	1.1	
Turn left on King Rd. (Rt. 123)	19.3	0.1	
Owen's Potato Farm	19.3	0.0	An irrigation well, which can be seen at the distant end of the line of poles in the center of this field penetrates the gravel fill in the valley to a depth of 80 feet and has a diameter of 10 inches. The well produces a sufficient supply of water to cover the entire field (100 acres) with an inch of water within a period of 24 hours. Observe small Indian mound preserved in field.
Turn right on Goose Pond Rd.	20.3	1.1	
Stop road, turn right	21.1	0.8	
Turn right	21.15	0.05	
Stop road, turn left for slight jog across main route. Newark Water Works on left.	21.6	0.05	

LUNCH TIME! PROCEED STRAIGHT AHEAD AND ENTER HORNS HILL PARK.
PROCEED UP HILL TO PICNIC AREA! HOORAY FOR STOP #5!!

Turn right at bottom of Horns Hill and proceed northward on County Rd. 203	22.1	1.2	
	23.3	1.2	STOP #6 — 6 min. Stay in cars!
Continue straight on County Rd. 203			
Go straight through at crossroads	23.7	0.4	
Turn left on Newton Twp. Rd. 252	25.	1.3	
Drainage divide on left side of road	25.7	0.7	
Turn to the right	26.0	0.3	
Float of Sharon (?) cgl. on right	26.3	0.3	
	26.8	0.5	STOP #7 — 5 min.
Continue straight ahead			
Turn to right on County Rd. 203	27.6	0.8	
Turn to left on Newton Twp. 255	29.0	1.4	
Turn to right	29.2	0.2	
	29.4	0.2	STOP #8 — 5 min.

Continue straight ahead			
Newton Chapel Valley	29.7	0.3	
Turn right on County Rd. 204	30.3	0.6	
Turn left on Newton Twp. 257	30.5	0.2	
Turn left on Newton Twp. 256.	31.2	0.7	
Observe high level outwash flat on the right			
Stop, intersection of Rt. 79	31.6	0.4	
Wilkins Run, continue on Rt. 79	32.8	1.2	
Turn right on Mary Ann Twp. Rd. 246.	34.2	1.4	High level gravels on the left just after turn off. Stop after all cars are clear of main road STOP #9
Turn right on County Rd. 210	35.7	0.5	
Rocky Fork Creek			
Byer outcrop?	36.5	0.8	
Continue through crossroads on County Rd. 210	36.8	0.3	
Continue to the right on County Rd. 210	37.4	0.6	
Stop, turn left on Rt. 668 in Hanover	40.0	2.6	
Move up into high level valley	40.5	0.5	See STOP #8 explanation
Take a sharp right off Rt. 668 on to Hanover Twp. Rd. 232	41.2	0.7	
Turn right	42.3	1.1	
	42.4	0.1	STOP #10—20 min. Park in Quarry
Turn left out of quarry			
Turn left off Rt. 16 to Black Hand	43.7	1.3	
Turn left on path	44.1	0.4	
	45.0	0.9	STOP #11 Final Stop! Party disbands!

To return to Newark leave Black Hand Gorge area and return to Route 16. Turn left, 7 miles to Newark.

Glad you came! Come back again!

GEOLOGIC SETTING OF GRANVILLE & NEWARK IN LICKING COUNTY OHIO and FIELD TRIP OBJECTIVES

Granville is located approximately ten miles east of the western margin of the Appalachian Plateau. The escarpment marking the plateau margin is perhaps best seen when looking eastward from the Ohio highway #16 railroad overpass near Columbia Center. The escarpment which may approximately be called a cuesta (the regional dip is approximately 2 degrees eastward) coincides approximately with the appearance in the geologic column of the Mississippian sandstones which have been more resistant to erosion than the underlying shales of the Lower Mississippian and the Upper Devonian.

The topography of the Granville and Newark areas is characterized by sharp contrast between maturely dissected plateau areas of considerable scenic beauty but dubious agricultural potential, and striking valley flats underlain by deep glacial drift deposits. Wells drilled in the flat valley floor of Raccoon Creek at Granville have penetrated more than 200 feet of silt, sand, and gravel before reaching bedrock. More than 300 feet of drift lies beneath the central portion of the city of Newark. The valley flats have been the site of excellent farms and at present Newark's industrial growth is aided by suitable terrain for industry and housing. The water resources of the gravels is only beginning to be tapped and undoubtedly will be an even more important resource in the future. Unfortunately two of Newark's important industries unknowingly built their plants right atop a shallowly buried and probably quite small Wisconsin till deposit, and they've learned to their sorrow that glacial till may be porous but its quite impermeable!

The Licking County hill tops are characterized by accordancy at between 1000 and 1300 feet. The even skyline composed of many such hills has been interpreted as a peneplane correlated with the Harrisburg

level of the Ridge and Valley Province. This peneplane had suffered deep dissection before the onset of glaciation. Indeed it may well be that the Central Ohio area was most "mountainous" just prior to the onset of Illinoian glaciation. During the so called "deep stage" time the region may have been characterized by quite wide spread areas of 500 feet of relief which compares quite well with the relief of many areas of West Virginia today. Where Newark now stands was the site of the gorge-like valley of the south west flowing Newark River one of the main tributaries of the ancient Teays River system. The Newark river and its tributaries were dammed and reversed during the advance and retreat and/or stagnation of the eastern margin of the Scioto lobe of the Illinoian ice sheet. This earlier glacier pushed farther eastward than the later Wisconsin sheet. The boundary between Wisconsin and Illinoian drift has not been adequately studied in the Licking County area but probably comes close to coinciding in trend and location with the valley of the North Fork of the Licking.

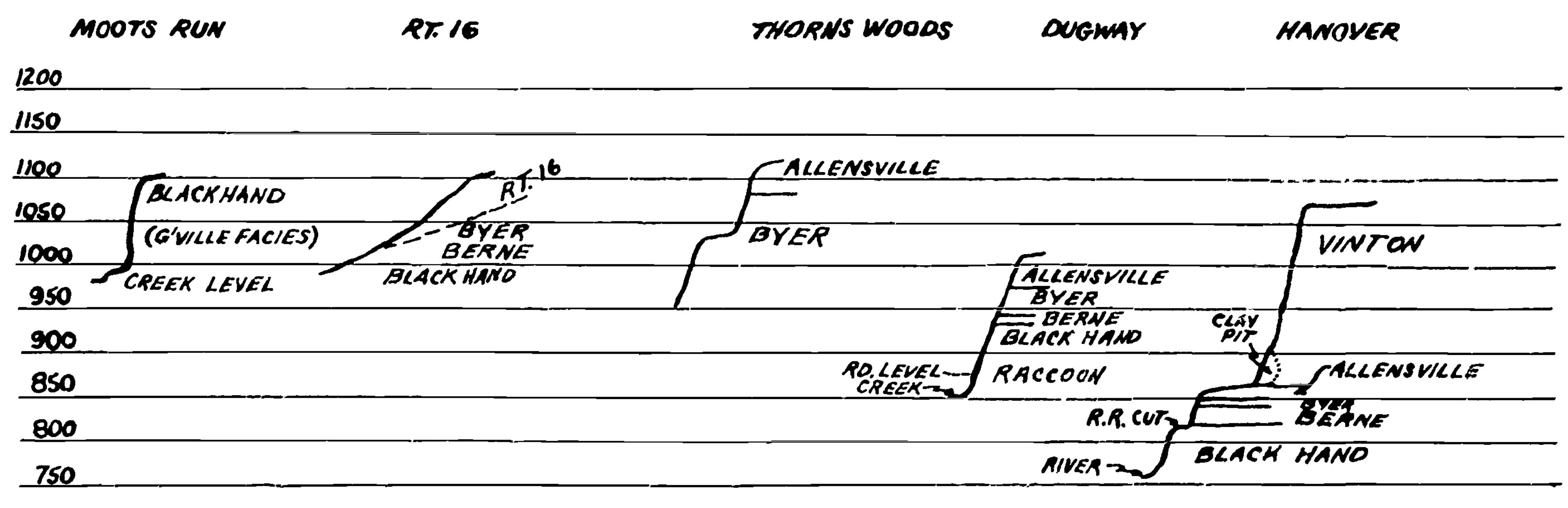
In addition to study of the above described general features of the Licking County landscape, today's field trip will emphasize the facies change of the Black Hand member of the Cuyahoga. Farthest west, at Moots Run (Stop #1), the Black Hand is chiefly shale with some siltstone. At the Dugway (Stop #4), siltstones predominate. Farthest east at Black Hand Gorge, the type locality, the rocks are chiefly conglomerate and sandstone. At Moots Run and the Dugway are typical exposures of the Granville facies, that of Black Hand Gorge is typical of the so-called Toboso facies.

The Hocking Valley facies (unfortunately not to be seen on this trip) was laid down during this same epoch of sedimentation and outcrops strikingly S.E. of Columbus. Upon this facies are developed many of Ohio's most famous scenic localities (Old Man's Cave, etc.)

In general these sediments were laid from a source to the southeast as a series of deltas or lobes with a long axis trending S.E.-N.W. The coarser facies (i.e. the Hocking Valley and the Toboso) probably represent the crest deposits of the "delta" lobe and the finer facies (i.e. the Granville) represent the interlobate thinner, finer deposits. If this picture of deposition conditions is held in mind, it is easy to understand that the problem of time, fauna, and facies correlation is extremely difficult and the "final exact word" on this interesting problem in geology is not yet in.

Bibliographic Notes

The Mississippian strata of the Waverly series were studied by such early and notable Ohio geologists as Newberry, Orton, and Prosser. This early research was carried forward by Hicks, Herrick, and Carney (all of Denison University). The classic study by Jesse E. Hyde, "Mississippian Formations of Central and Southern Ohio," the most complete ever done and for years unavailable, is fortunately now published as Bulletin 51 of the Ohio Division of Geological Survey. A study was published by F. T. Holden "Lower and Middle Mississippian Stratigraphy of Ohio" in the Journal of Geology, Vol. 50, 1942. The latest study on the Licking County Mississippian rocks is now finished and soon to be published by George Franklin of the Ohio Division of Geological Survey.



STRATIGRAPHIC POSITIONS OF STOPS

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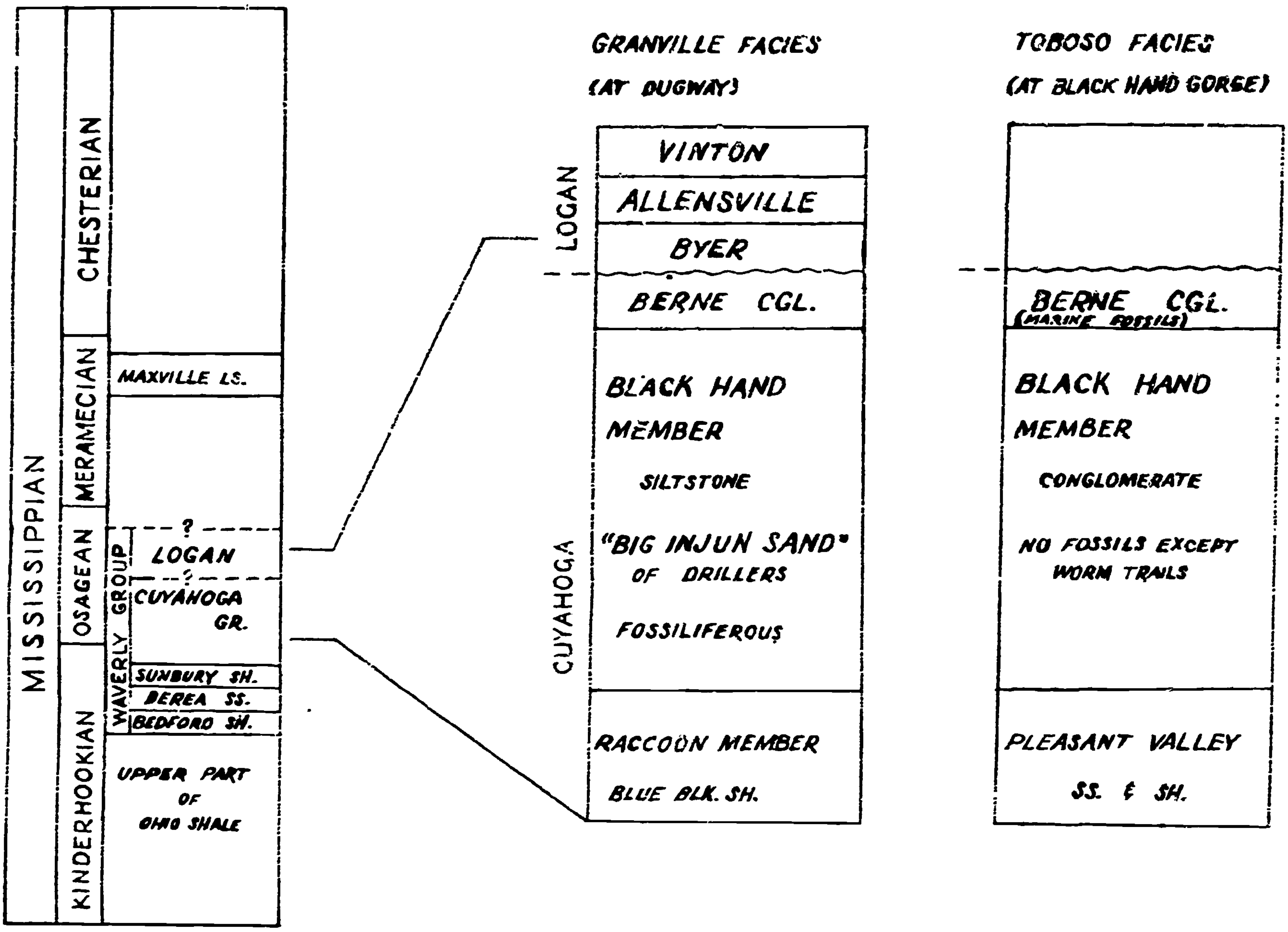


STOP #1

MOOTS RUN — Student Leader: Bill Hoett

The strata exposed at Moots Run is the Black Hand member of the upper Cuyahoga group. Moots Run evidences three layers. The bottom exposure, which is evidenced for perhaps 150 yards upstream from the bridge before it goes beneath the stream is a siltstone which is slightly massive in spots. (A piece of this siltstone can be difficult to break by hand). Above the siltstone base, and quite well in evidence, is a silty-shaly middle zone. Near the bridge, this zone extends from about three-to-four feet above the stream bed, where it sits on the siltstone base, up the side of the hill as far as we can see before being buried underground. This silty-shaly exposure becomes more shaly as it goes upward although siltstone masses appear in lentils. Small pieces of the shale in this zone are fairly easy to break by hand. The third exposure evidenced in Moots Run is another siltstone layer, which is on top of the silty-shaly zone. This top siltstone however, can not be seen near the bridge, but one must travel upstream to the ravines to see the exposure.

STOP #2

ROUTE 16 EXPOSURE — Student Leader: Jim Sebring
(1 mile S.W. of Granville)

The massive sandstone forming the greatest part of this outcrop, is the Byer. It is a member of the Logan formation, with an average thickness of 70 feet. The Byer is very fossiliferous, with crinoid stems being extremely prevalent.

Beneath the Byer lies the top of the Cuyahoga formation. A member of this formation is slightly exposed here. This is the Black Hand sandstone. It is a massive, coarse-grained sandstone which contains very few fossils at this outcrop. Its average thickness is 120 feet, but it varies from 50-200 feet in various locations.

The most interesting feature is the Berne conglomerate, which marks the top of the Black Hand. This conglomerate consists of rounded quartz pebbles, the largest being about 1/4 inches in diameter. At some exposures these pebbles are quite a bit larger. The overall average thickness for this layer is about 4 feet, but it is not a foot thick at this exposure. In some locations the Berne is very fossiliferous, with brachiopods dominating. The Berne is easily recognized and, hence, constitutes a useful horizon marker throughout the Licking County area. A better exposure of this conglomerate will be seen at the Dugway Stop.

Another interesting feature is the deposition limonite in all three of these formations. Cracks in the rock are often filled by this mineral; which also composes many of the fossil casts.

STOP #3

THORNS WOODS QUARRY — Student Leader: Lowell Hamilton

This stop is in an abandoned quarry in the slope of the bedrock hill overlooking the glacially aggraded and now terraced valley floor of Raccoon Creek. The quarrying operation has exposed 15 feet of the Allensville member of the Logan formation which is underlain by the massive Byer member. Both members are here typically developed and this is the best locality for observing the easily recognized contrast between these two members.

> N.B. It is an interesting fact that although molds of crinoid stems and stem sections are extremely abundant in these sandstones and siltstones, one seldom finds evidence of a crinoid calyx. One such, however, was found at this quarry some months ago. A DOLLAR BILL, COURTESY OF DENISON UNIVERSITY, TO THE FIRST FINDER OF ANOTHER!

STOP #4A

THE DUGWAY SECTION — Student Leader: Ron Taylor

At this location, three miles West of Newark, Raccoon Creek is thrown sharply against the North wall of its valley just before it flows onto the floor of the Licking Valley, and has under cut its bank so that a most important section is excellently exposed. This is the locality frequently referred to as "The Dugway."

The Byer member, outcropping here at approximately 30 feet thickness, is the topmost member. It is composed of an upper 5 ft. to 8 ft. thin-bedded layer of sandstone. The remainder is exposed massive, fine-grained sandstones which are quite fossiliferous in streaks.

Below the Byer is the Berne member of the Cuyahoga formation which is composed of coarse reddish sandstone. This sandstone varies considerably in texture and occasionally carries thin streaks of fine-grained sandstone or a thin bed of well assorted pebbles from 1/8 to 1/2 inch in diameter, only the basal foot or two are well shown.

The Berne is underlain by the Black Hand member of alternating sandstones and shales. These sandstones are moderately fine-grained, yellow, buff, or gray in color. The shales are sandy, in places almost gritless, gray in color, and reach a thickness of 5 ft. to 8 ft. with thin sandstones scattered through them. This bed is the direct equivalent of the Black Hand of Hanover, but is altered decidedly in its character. At the top is a bed of hard platy sandstones two or three feet in thickness which carries an abundant lamellibranch fauna.

The Raccoon member is the sandy shale upon which Raccoon Creek flows. This shale is thin, fine-grained, and gray in color. At several places grayish concretionary sandstone can be seen.

STOP #4B

SUPERPOSITIONING OF RACCOON CREEK AT DUGWAY — Student Leader: Jay Griffiths

From the high level gravels of the valley fill, Raccoon Creek has been superimposed upon the bedrock spur of Dugway Hill. It can be seen cutting into the Raccoon shale member of the Cuyahoga formation.

This 150 to 200 yard stretch of the stream exhibits a noticeably steeper gradient (steeper than in the drift portions of the valley) which is illustrative of the fact that the gradient of a stream depends upon the nature of the material underlying the channel. The "accident" to Raccoon Creek at this point has resulted in a local baselevel of a sort which, of course, affects the erosional activity of the stream from here on upstream.

STOP #6

(Remain in cars)

At this point it is possible to look westward across the valley of the North Fork of the Licking River. During Illinoian time this valley was occupied by a tributary of the 'Newark River' which was itself tributary to the gigantic Teays River system. The convoy is stopped right opposite a break in the bedrock valley wall. This break was produced by a tributary which came from the northeast. Later the field party will examine the Newton Chapel area of outwash which lies opposite this break.

STOP #7

The low rounded hills seen at this point are interpreted as kames or possibly crevasse fillings. This identification is based on topographic appearance alone because it has not been possible to study their internal composition or to determine what relationship the hills have to the gravel of the valley floor — They may sit on top of the valley gravels or they may be inundated by the valley gravels. What do you think?

Note the appearance of these hills on the topographic map. A sharp "map interpreter" should pick them up as unusual from the map alone.

STOP #8

NEWTON CHAPEL VALLEY OVERLOOK — Student Leaders: Jim Scatterday
Tom Roehl

The topography of this area is due, in part to an outwash plain deposited from the margin of the Scioto lobe of the Illinoian ice sheet which stood to the west. (See sketch map of Newark Quadrangle). Previous to the advance of the ice sheet, the drainage was to the Southwest as shown by records of gas wells drilled through the gravels to the bedrock of the old valley floor. This drainage was dammed by the lobe and reversed to the Northwest. The present drainage, Wilkins Run and tributaries, has developed on the northeast sloping apron of outwash deposits. The gravels reached considerable height but never completely inundated the bedrock hills. In several places, dissection has been negligible, and the original surface of the outwash plain may be preserved. Attention is drawn to such a high level outwash flat in the road guide. (mile 34.2).

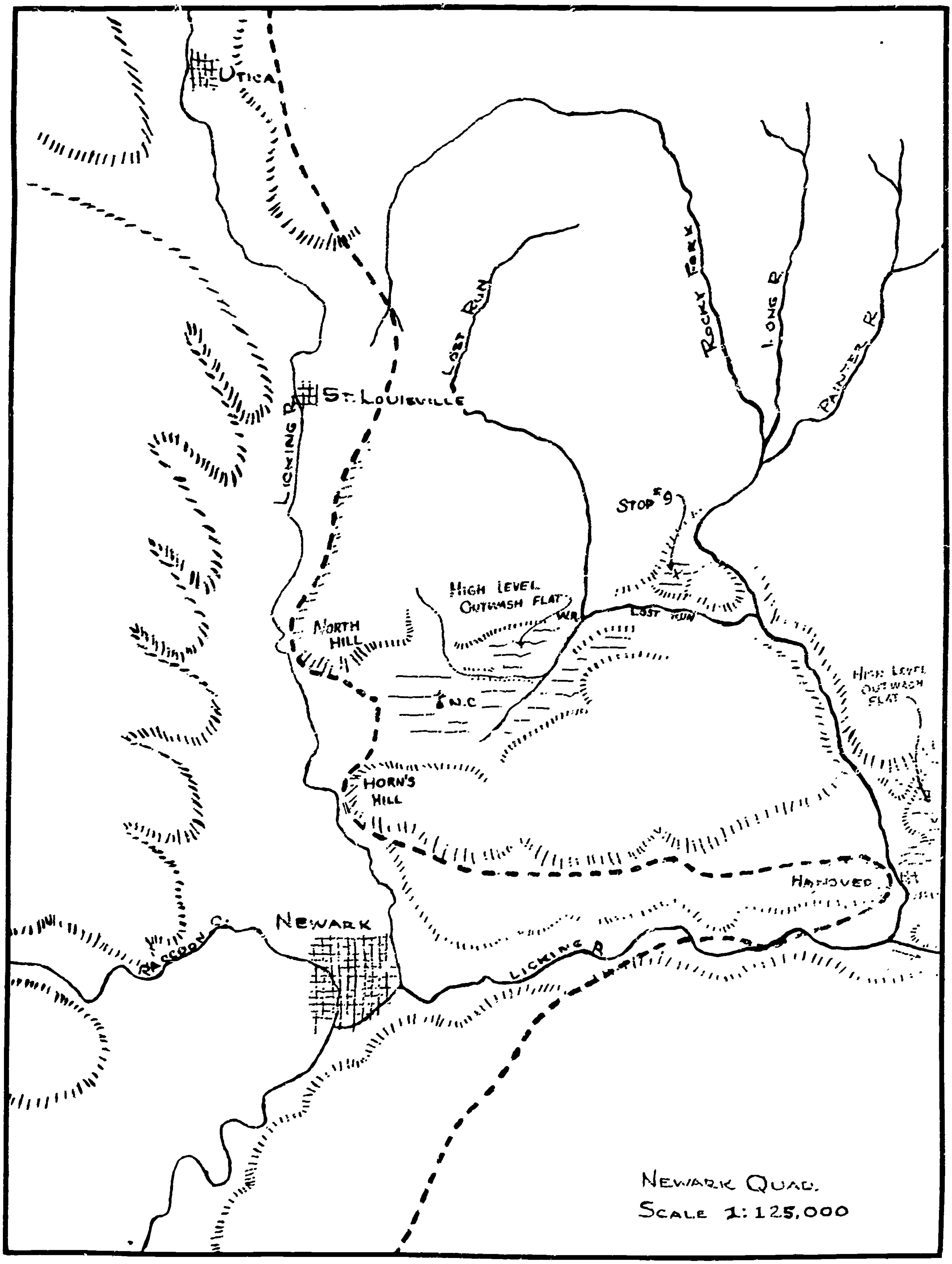
It should be mentioned that the reversal of drainage was not limited to the Newton Chapel area but occurred extensively throughout the Licking County area east of the Illinois ice margin. Thus many large rivers were reversed. A case in point was the old Newark River which formerly flowed westward from Hanover: it was blocked by a tongue of ice which extended up the old valley to Hanover. High level outwash flats resulting from deposition by melt water from this tongue can be observed just east of Hanover (mile 40.5). It is believed that a stream marginal to this ice tongue may have been superposed across the south bedrock valley wall thus bringing Black Hand Gorge into existence.

STOP #9

GRAVEL PIT ALONG ROUTE 79 NEAR
WILD CHERRY SCHOOL, MARY ANN TWP. — Student Leaders: Jim Scatterday
Tom Roehl

This gravel pit marks the northeasternmost extent of the existing outwash gravels of the Newton Chapel area. It was near this point that the melt water from the glacier plus the dammed drainage from the northeast was able to find exits over two low saddles in the bedrock hills and flow southward down Rocky Fork. Lost Run is a descendant of one of the overflow streams and since Illinoian time has deepened the saddle to form the gorge easily seen from this stop. The convoy of cars will proceed eastward through this gorge on its way to Rocky Fork.

The gravel deposits at this stop exhibit cross-bedding and sorting characteristic of deposits of overloaded, braided streams. The quantity of limonite deposited in the gravel may be an indication of its greater age compared to the commonly seen Wisconsin age gravel deposits.


UTICA
ST. LOUISVILLE
LOST RUN
ROCKY FORK
LONG R.
PAINTER R.
LICKING R.
STOP #9
HIGH LEVEL OUTWASH FLAT
W.R.
LOST RUN
NORTH HILL
N.C.
HORN'S HILL
HIGH LEVEL OUTWASH FLAT
HANOVER
RACCOON C.
NEWARK
LICKING R.
NEWARK QUAD.
SCALE 1:125,000

STOP #10

HANOVER BRICK PIT SECTION — Student Leader: Irv. Waters

The floor of the quarry is approximately the contact between the Vinton and Allensville members of the Logan formation. The Vinton member is exposed in the walls of the clay pit and it contains 25 ft. of sandy shales, used in the manufacture of brick, and overlain by 15 ft. of hard, fine-grained sandstones. The Vinton is commonly blue in color when unweathered but when seen in large exposures it is yellow, buff, or light gray in the upper part.

The thickness of the Vinton in Licking County is variable due entirely to the occurrence of an erosion plane which forms its upper surface and separates it from the Coal Measures.

The sediments stratigraphically below compare to the Allensville formation and contain approximately 20 ft. of coarser sandstones, buff to reddish in color.

Five hundred yards to the north across Route 16, a massive section of the Byer formation is well exposed in the Pennsylvania Railroad Cut. It is a moderately fine-grained, yellow or buff sandstone as usually seen, but here it is stained by soot.

STOP #11

BLACK HAND GORGE — Student Leader: Tom Rodgers

A coarse, massive sandstone, with prominent structural features, notably steeply inclined bedding (10° to 20°), numerous erosion planes and abundant cross-bedding. Its thickness varies between 100 ft. and 150 ft. in this central area.

Throughout most of its thickness the Black Hand is characterized by a northward inclination of the bedding at right angles ranging commonly from 10° to 20°. The top 10-25 feet lie horizontally, suggesting the topset beds of a delta above the inclined foreset beds.

This sandstone is commonly a buff color but locally this changes to light, light gray, reddish and brown.

This sandstone produces both petroleum and natural gas, but largely the latter.

It has been quarried for building stone and heavy masonry. It also finds its way on the markets for mortar sand, sandblasting and glass sand.

SOME PENNSYLVANIA CYCLOTHEMS IN ATHENS COUNTY, OHIO

8th Annual Ohio Intercollegiate Geology Field Trip
Earth Science Club
Ohio University
Athens, Ohio

October 12, 1957

INTRODUCTION

The Pennsylvanian system includes the coal-bearing rocks of Eastern Ohio and is divided on basis of important minable coals into the following series or formations:

4. Monongahela —Upper Productive Series of old reports
3. Conemaugh —Lower Barren Series of old reports
2. Allegheny —Lower Productive Series of old reports
1. Pottsville

Pennsylvanian sediments were deposited under a more or less regular succession of varying conditions that was repeated many times during that Period. As a result a definite cyclic succession of strata corresponds to one sequence of varying sedimentary conditions during the Pennsylvanian. One cyclic succession of strata is known as a cyclothem and, if complete, has the following members:

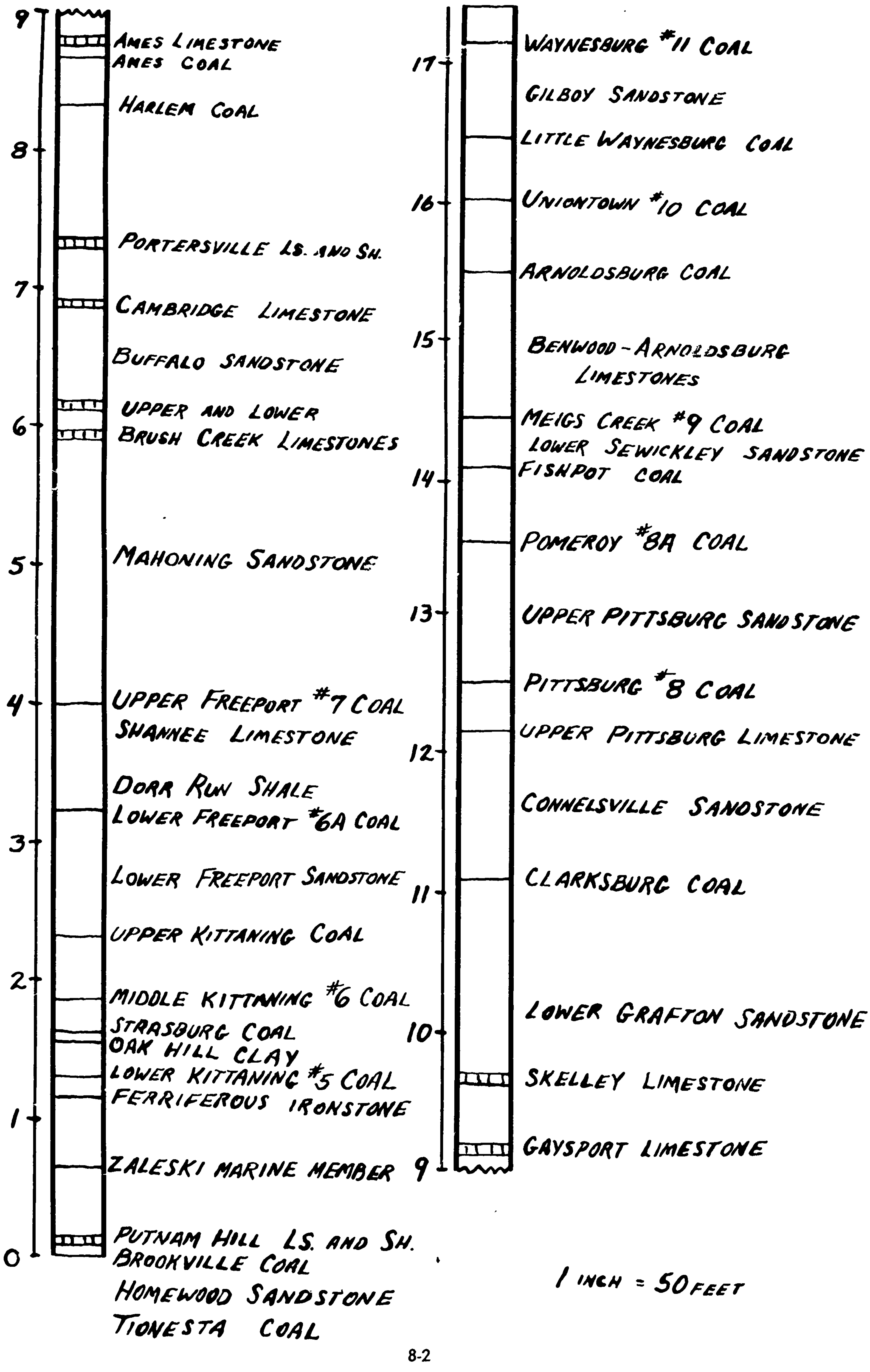
1\. Sandstone — continental
Disconformity)
8\. Shale)) Members usually thin, thick-
7\. Limestone) — marine) ness measured in few feet,
6\. Black shale)) inches, or fractions of an inch;
5\. Coal)) total thickness of cyclothem
4\. Underclay)) often 25 feet.
3\. Limestone)—continental)
2\. Shale)))
1\. Sandstone) or "Redbed"))
Disconformity
8\. Shale — marine

Cyclothems in Ohio are largely non-marine in thickness and very few are as complete as the typical cycle shown above. Lithology of any cyclothem varies laterally from place to place, and members are commonly entirely or locally absent. Eastward from Ohio Pennsylvanian cyclothems have even larger proportion of non-marine thickness, while west and south across the United States marine strata comprise more and more of the thickness. The varying environmental conditions responsible for each cyclic succession of strata were not only successive but also contemporaneous and hence at all times each lithology of a typical cyclothem was likely being deposited somewhere.

In Ohio cyclothems change somewhat in lithology from the Lower Pennsylvanian upward into the Upper Pennsylvanian and Lower Permian. Pottsville and lower Allegheny cyclothems differ somewhat from those in the upper Allegheny and lower Conemaugh. Cyclothems in the upper Conemaugh, Monongahela, and Permian are more or less alike but vary from the types occurring below. The only nearly complete Ohio cyclothems are between the Middle Kittanning and Duquesne coals, in which interval several occur. Cyclothems below the Strasburg cyclothem lack freshwater limestones, and those above the Skelley limestone lack marine members excepting thin inconspicuous brackish members. Many cyclothems above the base of the Conemaugh are characterized locally by a facies of calcareous vari-colored — gray, green, yellow, brown, red or purple but predominantly red — shales and mudstones, herein termed "redbeds", and by thin coals and underclays. It is thus apparent that cyclothems are quite variable associations of members and that an ideal cyclothem must be selected arbitrarily. Since cyclothems are cyclic associations, boundaries can be selected arbitrarily between several different members — at the base of the sandstone, at the base of the coal, at the top of the coal, etc. Boundaries here are drawn at the base of the sandstone member. Names are usually taken from the coal member.

In spite of the limitations and problems in considering the cyclic concept in Pennsylvanian stratigraphy, cyclothems have definite uses. The purpose of this conference is to acquaint those unfamiliar Pennsylvanian strata with some introduction to those rocks and their cyclic nature, problems, and uses.

GENERALIZED STRATIGRAPHIC SECTION



Athens County Fairgrounds

Fairground and barrack buildings at right on Wisconsin terrace, Rt. 56 and racetrack on Hocking River floodplain.

Leave Fairgrounds, TURN RIGHT on Rt. 56 and cross Hocking River bridge in about 9.2 mile.

Miles	
0.00	INTERSECTION RTS. 56 and 682, TURN RIGHT, Starting point of itinerary, CHECK CAR MILEAGE.
0.10	Bridge over Margaret Creek
0.20	Grosvenor RR crossing
0.25	Hope Dairy farm on left ahead remnants of Wisconsin terrace along Little Factory Creek.
0.60	Straight ahead, Rt. 682 turns right.
0.70	Little Factory Creek bridge.
0.80	Upper Brush Creek ss on right.
0.90	Upper Brush Creek 1s on right.
1.10	Tennessee Gas Transmission Company's pipeline. Ahead on ridgetops are remnants of Lexington erosion surface, note more or less even summit level.
1.70	Blocks of Ames 1s on right. Ames 1s shows at several places ahead. Watch for them.
2.90	Descend into abandoned Luhrig Valley. Teays stage, Pliocene valley.
3.00	TURN RIGHT on black top road, travel along Luhrig valley.
3.60	Salem Methodist Church, Luhrig Valley well developed on right, and on both sides of road ahead.
4.40	TURN LEFT downhill on gravel road.
4.70	SHARP LEFT TURN, rather rough topography ahead, note uses.
5.00	Concrete bridge over Hamley Run, TURN RIGHT, abandoned coal mines on left are in Upper Freeport #7 coal.
6.2	Pine plantings and Poston Electric Generating Plant on right.
6.3	Concrete bridge, TURN LEFT.
6.6	Sandstone and Upper Freeport #7 in road cut on right.
7.1	Rood follows along an abandoned Teays valley. Erosion gullies on left side.
7.2	Kampf orchard on right.
7.6	Massive Lower Mahoning ss. on right.
7.8	Abandoned strip mines on Upper Freeport #7 coal on left.
8.0	TURN LEFT, on right polluted mine ponds, beginning conveyor belt to Poston Station generating plant at tipple across pond. Continue ahead, abandoned stip mines on both sides of road.
8.4	Active deep mine on left in Upper Freeport #7 coal.
8.5	Note erosion on spoil banks. Massive ss. in Lower Mahoning.
8.6	Upper Freeport #7 on right side.
8.7	Shawnee 1s. in ditch on right side.
9.0	Note abandoned strip mines.
9.5	Note polluted mine waters on left.
9.7	Follow Rt. 691 LEFT.
10.3	Crest of hill, strip mines on either side of road across Minkers Run. Coals stripped here are: Middle Kittanning #6 (lowest), Lower Freeport 6a, Upper Freeport (highest).
10.9	Kimberly —concrete bridge over Minkers Run, TURN RIGHT.
11.3	C. & O. Railroad on Wisconsin terrace.
11.5	Drop from Wisconsin terrace to Hocking River floodplain.
12.0	Bridge over Hocking River, *STOP*, TURN LEFT on Rt. 33.
13.6	Edge of Nelsonville, TURN LEFT, follow Rt. 33 bypass.
14.2	Stop in Nelsonville for addition to caravan, continue through Nelsonville on Rt. 33 bypass.
15.0	Entrance to Mt. St. Mary Hospital on right.
15.2	Homewood ss. right side of road.
15.4	TURN RIGHT on brick road.
15.45	TURN RIGHT on oil surfaced road.
15.6	Homewood ss. on bank at right followed by alluvial or lacustrine clays and silts. (Illinoian?)
15.65	TURN AROUND at Dorr Run Community Chapel and park wherever possible without blocking road. Lock cars.

STOP #1

15.9 TURN RIGHT on brick road across Dorr Run bridge.
16.1 Rejoin Rt. 33, TURN RIGHT.
16.3 Abandoned Middle Kittanning #6 above road on right.
17.8 Brookville coal and Putman Hill 1s. 10 to 15 feet above road on right.
18.0 TURN RIGHT on farm and strip mine road.
18.2 TURN AROUND at forks of road. Park along but off driveway.

STOP #2

18.4 TURN LEFT on Rt. 33.
20.5 Dorr Run bridge.
20.9 Nelsonville, TURN RIGHT on Rt. 33 bypass.
21.8 Leave Nelsonville, continue STRAIGHT AHEAD on Rt. 33.
24.4 Kimberly Bridge on right, continue STRAIGHT AHEAD on Rt. 33.
24.5 Strip mine on left above new house, Lower Freeport 6A coal. Sandstone on left under Middle Kittanning #6 coal.
25.2 Sandstone on left still below Middle Kittanning #6 coal.
25.5 C. & O. RR at Doanville, large cemetery on left.
25.7 Valley of Monday Creek on left, Hocking River Valley on right.
26.1 Hill of circumalluviation on left, between valleys of Monday Creek and Hocking River. Middle Kittanning #6 coal and Lower Freeport sandstone in road cut along this hill.
26.6 Bridge over Monday Creek.
26.8 Lower Freeport ss. at the pines on left.
27.3 Floodwood on left. Lower Freeport #7 coal, formerly extensively mined in this side valley and former location of 2 blast furnaces.
27.5 Large farm pond on right.
27.7 Lower Freeport ss., ahead on left abandoned strip mine in Upper Freeport #7, note plantings.
28.8 Farm buildings on left, abandoned Upper Freeport #7 coal mines on either side of buildings.
29.4 Circle Hill —Ahead and above on left white houses sit on Illinoian terrace above Walker's Cafe.
30.4 TURN RIGHT on Rt. 682.
30.6 Bridge over Hocking River, TURN RIGHT, in cuts along C. & O. RR, sh and ss in Mahoning cycles, Upper Freeport #7 coal reported under bridge.
31.3 Spring and trough on right approaching The Plains.
31.5 Large Indian mound on right at the edge of The Plains.

NOTE: The Plains lies on an abandoned portion of the Hocking River Valley, underlain by Illinoian outwash.

33.0 Leaving The Plains, descent into valley between rock hills to the right and The Plains to the left, note springs to left.
33.3 Curve to right, continue ahead.
33.4 Slater's Gravel Pit on left.
33.5 Ascend to level of abandoned Teays Valley of former Chauncey Creek.
33.8 Abandoned Chauncey Creek valley on either side.
34.0 Zion Baptist Church. Teays sands and gravels on right side of road at church.
34.3 Curve to left and over concrete bridge. Upper Mahoning ss. in creek bed.
34.4 Little Factory Creek on right, follow road ahead.
35.0 Bridge over Little Factory Creek.
35.2 Bridge over Little Factory Creek.
35.3 TURN LEFT
35.7 Hope Dairy farm and Grosvenor RR crossing ahead.
35.9 Bridge over Margaret Creek.
36.0 Junction Rts. 56 and 682. STRAIGHT AHEAD across Rt. 56. Note rough road ahead. DRIVE CAREFULLY.
36.8 Shale and ss. between Lower and Upper Brush Creek limestones on right.
37.2 Athens State Hospital Grounds. DRIVE SLOWLY AND CAREFULLY.
37.7 TURN LEFT from brick road to black top.
37.75 Junction of Hospital Rd. and Rts. 50 and 33. STOP. TURN LEFT CAREFULLY. Go ahead toward Athens.
38.1 Hocking River bridge, cross bridge, TURN RIGHT on Mulberry St. along river and railroad.

38.3 STOP: proceed ahead on Park Place, a divided street.

38.4 STOP. Red brick building on right is Music Building, TURN RIGHT on University Terrace, and again TURN RIGHT between Music Building and Natatorium into parking lot.

STOP #3 — LUNCH. Lunch will be available in Room 7 in southeast corner of Ellis Hall basement. Washrooms for both men and women are located in basement. *2 HOUR.*

38.5 Drive across Campus to Court St. STOP. TURN RIGHT and continue through 4 lights to dead end at 5th light.

39.1 TURN LEFT at 5th light onto U.S. 33 & 50A and continue straight uphill through 2 lights. The group will pause along side road at top of hill to allow all cars to clear lights and form convoy.

39.8 PASS THROUGH cut in Lower Grafton ss., Anderson coal and marine Portersville sh and ls on right near foot of hill. Continue ahead to junction of Rts. 33 and 50A.

41.7 Valley Drive-in Theater on left. WATCH FOR TURN AHEAD.

41.8 Cross Sugar Creek.

41.9 TURN RIGHT. Park as directed.

STOP #4 — SEE PAGE 8-12

42.2 Old Mine #210 Dump on right. Abandoned shaft of Middle Kittanning #6 coal about 150 feet deep.

47.5 Upper Brush Creek ls. on left of curve, sandstone on left ahead is Cow Run.

49.0 Old Mine #211 Dump on right.

49.6 Cambridge ls. on right.

50.0 Ames ls. and Lower Grafton ss. may be seen in fields to left.

50.6 Uphill through Ames to Pittsburgh interval, freshwater limestone is below Connelsville ss.

50.8 Pittsburgh ss. is in field above road level on top of hill, coal only 1" thick.

51.5 Ames ls. in creek on right.

52.6 TURN LEFT uphill on gravel road by farm house, prominent exposure of Ames ls. and Lower Grafton ss. on this hill, continue over hill noting repeat of section on other side.

STOP #5 — SEE PAGE 8-14

53.6 Continue ahead to white house, TURN RIGHT just past house. Note Pittsburgh red beds and limestone on hill to left above road.

54.3 Note limestone and red beds of Pittsburgh horizon along road.

54.7 Uphill to Road Junction, TURN RIGHT and watch for LEFT TURN in short distance.

54.9 Continue along Summit level. Note deep youthful valley on left. This level is between the Pomeroy and Meigs Creek horizon with the Fishpot limestone showing in several places along the road.

55.9 Descend to Hyde Fork Valley noting same units in the section.

56.2 Varicolored mudstones just below Meigs Creek coal horizon.

56.6 Fishpot ls.

56.8 Pittsburgh ls. and red beds. Quite prominent due to bright colors.

57.0 Ames ls. at spring level on left.

57.2 TURN RIGHT and continue across abandoned NYC RR to Ohio Rt. 280.

57.3 STOP. TURN RIGHT on Rt. 280 and continue to Amesville.

58.6 Junction US 50A in Amesville. STOP. TURN LEFT on 50A, and continue to Sharpsburgh noting numerous abandoned Pittsburgh coal mines and outcrops of Pittsburgh ls. along both sides of road.

62.0 Lathrop.

62.8 Sharpsburgh. TURN RIGHT uphill and into parking space on mine spoil pile.

62.9 STOP #6 — SEE PAGE 8-16

Exposure east from 653 road junction up Sharpsburg hill in NE 1/4, section 29, Bern Twp., Athens Co., Ohio.

Thanks for coming. The conference disbands at this stop. Return home by whichever route is best: Route 50A eastward to Marietta and westward to junction with Route 33 at Stop 4, Route 377 northward to McConnelsville. We trust that you have had an enjoyable and profitable day and that you will visit us again whenever opportunity permits.

STOP #1 Abandoned strip mine at first tributary valley above mouth of Dorr Run on east side of Dorr Run Valley, NE 1/4, 30, York, Athens County, Ohio.

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
38		Bolivar (underclay) & Shawnee (limestone)	Underclay and limestone, light gray, plastic clay and light nodular to massive ledge of limestone, exposed	2-4		114-9
37	Bolivar	Shawnee	Limestone, light gray with limonite stain and zones, dense, partly crystalline	0-6	18-6	112-5
36		Bolivar	Shale, olive drab, with some medium grained sandstone, covered in part	15-8		111-11
35			Coal, badly weathered, thickness only approximate	1-0		96-3
34			Underclay, full gray below and lighter above but with carbonaceous streaks in upper half and much limonite stain in base, massive, plastic more so upwards	4-4		95-3
33	Lower Freeport	Lower Freeport	Clay shale, full gray with limonite stain and nodules, massive	2-1		90-11
32			Ironstone, clay ironstone-limonite nodules 4-6 inches in size embedded in clay shale matrix	1-6	22-1	88-10
31			Clay shale, light olive to gray with limonite stain and some ironstone nodules near top, well bedded	4-0		87-4
30			Shale, olive drab with yellow limonite stain and limonite nodules, silty, thin bedded	10-2		83-4
29			Underclay, light gray, plastic	0-½		73-2
28			Coal, dull, shaly	0-2½		73-1½
27			Underclay, light gray to gray with limonite stain and many carbonaceous zones, plastic at top	0-9		72-11
26			Coal, bright, blocky	0-5		72-2
25	Upper Kittanning ?	Upper Kittanning ?	Coal, dull, shaly, with much pyrite	0-1½	13-7	71-9
24			Clay shale, full gray with limonite stain and some carbonaceous streaks, somewhat bedded with angular fracture	1-7		71-7½
23			Shale, olive drab to gray with limonite stain, thin bedded with zones of coaly material, plant	10-5		70-½

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
			fossils, and sandstone, more excellent plant fossils 8 ft. from top in slightly clayey zone			
22			Shale, black, carbonaceous, thin bedded, with few plant fossils and some melanterite	0-11		59-7½
21			Coal, some bright and blocky, shaly in part	1-10		58-8½
20			Underclay, carbonaceous, breaks with angular fracture	0-4½		56-10½
19	Middle Kittanning	Middle Kittanning	Coal, similar to that below	2-9	19-4	56-6
18			Clay shale, firm, carbonaceous	0-2		53-9
17			Coal, mostly bright, blocky	1-4		53-7
16			Clay shale, light bluish gray with some limonite stain, mostly bedded, some massive and plastic	1-0		52-3
15		Middle Kittanning	Shale, light gray to olive drab with much limonite stain, silty, well bedded, similar to shale below but lacking ironstone and fossils	3-6		51-3
14	Middle Kittanning	Snow Fork	Shale, olive drab with some limonite stain, well bedded, numerous good plant fossils, carbonaceous streaks and several clay ironstone-limonite nodular layers	1-8	19-4	47-9
13		?	Coal zone, two 1-inch dull, irregular coal streaks separated by clay shale	0-5		46-1
12			Clay shale, light gray much stained and mottled yellow & orange, massive, somewhat plastic	2-7		45-8
11		Middle Kittanning ?	Sandstone, olive drab to brownish gray, heavily stained especially at top, slightly micaceous, mostly fine, bedded to massive, ironstone nodules near top	2-10		43-1
10		Oak Hill	Underclay and clay shale, similar to that above sandstone in color, massive except near top, with starchlike fracture, plastic and carbonaceous zones, grades in coal zone below	9-6		40-3
9	Strasburg		Coal zone, dark gray, very carbonaceous, slickensided, starchlike fracture	0-7	13-5	30-9

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
8			Underclay, gray stained in zones, especially near base, silty, massive, starchlike fracture, plastic at top	0-11		30-2
7		Strasburg	Sandstone, light gray weathers yellow, fine to medium, massive, micaceous, a prominent layer	2-5		29-3
6	Lower Kittanning	Lower Kittanning	Shale, dark gray to black with limonite stain especially toward top, lighter and more silty upward, carbonaceous with fossil plants and one upright tree stump bedded, slickensided, with nodules of clay ironstone	5-9	?	26-10
5			Coal, bright and blocky with thin dull partings, with traces of fossil plants, pyrite, and prominent limonite stain	2-0		21-1
4	?	?	Underclay, full gray at top to lighter gray below, massive breaks with starchlike fracture, slickensided, plastic		?	19-1
3			Underclay and clay-shale, clay grading downward light olive gray bedded shale, somewhat limonite stained	18-1	?	
2	Lawrence ?	Lawrence ?	Shale and sandstone, olive drab with much limonite stain, silty, sandy shale with thin layers of micaceous, medium grained sandstone	1-0		1-0
1	?	?	Sandstone, olive drab, limonite stained, more stain toward top, massive below and bedded above fine, micaceous, partly covered, unmeasured			

STOP #2 Exposure in roadside ditch, along haul road, in strip pit, and along slope above pit wall, SW 1/4, SW 1/4, 36, York, Athens County, Ohio.

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
37		?	Clay shale, much weathered, somewhat plastic, exposed	1-0		181-6
36		Dorr Run	Shale, black, fissile, fossiliferous, marine, thickness estimated	0-3		180-6
35			Coal, almost completely weathered, black and sooty, thickness estimated	0-5		180-3

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Tt. In.
			Underclay, light gray, darker gray at top, silty, micaceous, moderately plastic	4-0		179-10
34	Lower Freeport		Shale and ironstone, light gray, bedded, slightly micaceous shale containing nodules of ironstone, nodules less abundant than in next unit below	9-0	40-10	175-10
33		Lower Freeport	Shale, underclay, and ironstone, nodules with calcareous veins, rather massive	11-6		166-10
32			Sandstone, light gray, weathers tan, fine, micaceous, massive to thin bedded, irregular limonite deposits along joints and bedding planes, thickness variable with irregular top	15-6		155-4
31	Upper Kittanning ?	Upper Kittanning ?	Shale, tan to light gray with considerable limonite stain on surfaces, light gray zone in top 6 inches, massive, starchlike fracture with appearance of flint clay	13-0	13-0	139-8
30	Middle Kittanning ?	Middle Kittanning ?	Clay shale, medium gray stained brown along bedding planes, slightly silty, with plant fragments	2-0		121-8
29			Coal, shaly weathered coal with some bright coal and interbedded clay	0-4		119-8
28	Middle Kittanning	Middle Kittanning	Underclay, light gray to gray with considerable limonite stain, some carbonaceous fragments, very plastic	1-0	9-4	119-4
27			Shale and sandstone, variable shale ranging from gray, finely micaceous in basal 2 ft. to tan and buff shale and fine sandstone above, thickness variable	6-0		118-4
26		Strasburg	Coal, shaly, some bright, locally present	0-2		112-4
25	Strasburg	Oak Hill (underclay) & Hamdem (limestone)	Underclay and limestone, underclay, light gray with dark zones at top and bottom, massive with numerous slickensides and starchlike fracture, locally with lenses of gray to light gray, dense to partly crystalline limestone, thickness quite variable, 1-12 ft.	8-0	16-2	112-2
			Sandstone & shale, light gray, fine, very micaceous, bedded to			

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
24		Strasburg	irregularly interbedded sandstone with beds of gray sandy shale, thickness variable, where unit above thickens and thins this one reciprocates	8-0		104-2
23			Shale, dark gray to black, similar to underlying shale but lighter in color and with irregular layers of flattened ironstone nodules, locally cut out by overlying sandstone	1-3		96-2
22	Lower Kittanning	Lower Kittanning	Shale, black, bony, carbonaceous, fissile, selenite crystal and/or mica flakes on bedding planes, thickness variable	0-5	13-9	94-11
21			Coal, bright and blocky with thin irregular partings of shale, fusain, and pyrite	2-3		94-6
20	? Lawrence ?	Lower Kittanning & Lawrence ?	Underclay, light gray and sandy below, darker and carbonaceous above, plastic	9-10		92-3
19	Scrubgrass	Scrubgrass	Sandstone, light gray with some limonite stain, fine, micaceous, massive showing shaly appearing bedding on weathering, with scattered grainy ironstone masses at top representing *Ferriferous* ironstone, exposed	4-10	16-2	82-5
			Covered interval	7-10		77-7
18			Sandstone, similar to sandstone beneath underlying underclay, exposed	3-6		69-9
17			Underclay, light gray with some limonite stain, micaceous, plastic	2-1		66-3
16	Clarion ?	Clarion ?	Sandstone, similar to sandstone below underlying shale, slightly more micaceous, shaly toward top	3-4	5-5	64-2
15	Winters ?	Winters ?	Shale, gray with much yellowish brown stain, slightly sandy below and carbonaceous and clayey at top, a coal zone	1-9	3-2	60-10
14			Sandstone, light gray with buff limonite stain, fine, micaceous, rather heavily bedded	1-5		59-1
13		Zalewski	Shale, medium gray with much limonite stain, micaceous, with several zones of flattened ferruginous concretions, very sparingly fossiliferous, marine	1-4	22-8	57-8

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
12	Ogan	Ogan	Shale and sandstone, gray, sandy, silty, micaceous shale with considerable limonite stain, grades upward through shaly sandstone into similarly colored medium grained, micaceous, arkosic, heavy bedded sandstone	21-4		56-4
11	?	?	Covered interval	17-3	17-3	35-0
10		Putnam Hill	Clay shale, gray with some limonite stain, much weathered and probably slumped, exposed	1-0		17-9
9			Coal, badly weathered, slumped	0-2		16-9
8	Tionesta	Brookville	Underclay, dark gray below to light gray above, sandy, micaceous, shaly below, somewhat plastic above	3-0	6-2	16-7
7		Homewood	Sandstone, very light gray with yellow to brown stain on surfaces, medium to coarse, slightly micaceous, with few plant fragments, kaclinitic, one massive bed	2-0		13-7
6			Underclay, gray to light gray, with dark carbonaceous zone in basal 6 inches, silty, slightly sandy, micaceous, moderately plastic	1-3		11-7
5			Shale, black, fissile, carbonaceous with scattered plant fragments, finely micaceous	2-9		10-4
4			Sandstone, gray with some limonite stain, fine to medium, micaceous, silty, with many plant fragments	0-10		7-7
3	Tionesta	Tionesta	Shale, dark gray to black, carbonaceous, finely micaceous, silty and clayey	0-2		6-9
2			Underclay, gray to light gray, silty, micaceous, and sandy toward base, somewhat bedded, slickensided, only moderately plastic	1-5		6-7
1			Sandstone, very light gray with much limonite stain, fine to medium, micaceous, bedded in alternate zones of fine, silty, shaly sandstone up to 12 inches thick and zones of fine to medium sandstone up to 18 inches thick, with few ripple marks and plant fossils, exposed	5-2		5-2

STOP #2A Prospect pit above high wall of strip mine on NW side of ridge, center, NW 1/4, 36, York, Athens County, Ohio

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
10	Bolivar	Shawnee	Limestone float blocks	1-0	20-9	37-0
9			Covered interval	7-6		36-0
8		.	Sandstone, silty, buff, slightly micaceous, medium-to coarse, exposed	12-3		28-6
7	Lower Freeport	Dorr Run	Clay shale, buff to gray, weathered brown, clayey base, breaks with hackly fracture	1-1	16-3	16-3
6			Shale, dark gray, carbonaceous, fossiliferous, marine	11-8		15-2
5			Shale, black, bony carbonaceous, fossiliferous, marine	1-4		3-6
4		Lower Freeport	Coal, shaly	0-5		2-2
3			Shale, black, carbonaceous	0-2		1-9
2			Coal, bright, with dull partings, somewhat weathered	1-7		1-7
1			Underclay, light gray, plastic, exposed, unmeasured			

STOP #4 Exposures along northeast side of Route 33 about 0.3 mile northwest of junction with Route 50 (alternate) at Sugar Creek. Elevation at base of section: 667 Section unnumbered, Athens, Athens County, Ohio

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
26	?	?	Shale, poorly exposed, unmeasured			
25	Ames	Ames	Limestone, light gray, partly crystalline, fossiliferous, marine	1-0	12-0	136-0
24			Covered interval	5-0		135-0
23			Sandstone and shale, gray, medium sandstone and gray, silty shale interbedded in layers 8 to 20 inches thick, exposed	6-0		130-0
22	Ames & Harlem	?	Covered interval	20-3	20-3	124-0
21	Harlem	Round Knob	Shale, gray, silty, with layers of fine, silty sandstone, exposed	3-0	11-6	103-9
20			Clay-shale, full gray to lighter yellowish gray in basal 18 inches starchlike fracture, with small, scattered, limestone nodules throughout	8-6		100-9

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
19		Upper Bakerstown	Clay, gray to gray drab with considerable limonite stain on surfaces, flinty, numerous slickensides	1-10		92-3
18	Upper Bakerstown	Ewing	Limestone and clay-shale, gray, dense, nodular limestone embedded in silty and finely sandy clay-shale, limestone nodules more abundant in upper half	2-6	26-1	90-5
17			Shale, gray drab with small amount of limonite stain, argillaceous, rather soft	1-0		87-11
16	Upper Bakerstown	Cow Run	Sandstone, gray, medium, micaceous, massive	13-6		86-11
15			Shale, gray, argillaceous, with layers of medium sandstone, partly covered	7-3		73-5
14			Clay, dark gray	0-2		66-2
13	Anderson	Anderson	Clay, light gray, with nodules of ferruginous limestone, breaks starch-like fracture	1-6		66-0
12	Anderson	Bakerstown	Sandstone, gray drab, calcareous	0-8	5-5	64-6
11			Shale, gray, silty	3-1		63-10
10		Cambridge	Limestone, gray, weathers yellowish to brownish, ferruginous fossiliferous, marine	0-9		60-9
9	Wilgus		Shale, gray, silty	9-4	27-1	60-0
8		Buffalo	Shale, gray, silty to sandy, with numerous layers and thin lenses of fine silty sandstone	7-5		50-8
7			Shale, gray, argillaceous to silty, with scattered siderite concretions	9-7		43-3
6			Limestone, gray, weathers yellowish and brownish at top, granular, fossiliferous, marine	2-0		33-8
5	Upper Brush Creek	Upper Brush Creek	Shale and sandstone, gray, silty, micaceous shale with upward gray, silty, micaceous sandstone weathering into thin layers with scattered siderite concretions	28-4	30-4	31-8
4			Limestone, gray, ferruginous, fossiliferous, marine	0-1		3-4
3		Lower Brush Creek	Shale, gray, dense, fossiliferous, marine	0-4		3-3

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
2	Lower Brush Creek		Limestone, gray, dense, ferruginous, fossiliferous, marine	1-2	3-4	2-11
1			Underclay, gray, starchlike fracture exposed	1-9		1-9

STOP #5 Exposure up road and past road junction 770, in the W 1/2, SE 1/4, NW 1/4, 21, Ames Township, Athens County, Ohio. Handleveled to road junction 770.

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
22	Elk Lick	Upper Grafton	Shale and sandstone, gray to reddish orange, limonite stained, micaceous, fine, shaly to medium bedded sandstone in gray to olive drab, micaceous, silty shales, exposed	15-0	29-4	105-0
21		Birmingham	Clay-shale, maroon to red, limonite stained, micaceous, silty	7-3		90-0
20			Shale, light gray to tan, with limonite stains and mottling red to purple, maroon, argillaceous, micaceous, with irregular beds of nodules freshwater limestone	7-1		82-9
19	Duquesne	Skelley	Limestone, gray to greenish gray, weathers yellow to dark brown, nodular and irregular bedded, badly weathered in part, fossiliferous, marine	0-4	33-3	75-8
18			Shale and sandstone, light gray to tan and olive drab, limonite stained, thin bedded, micaceous sandstones, in argillaceous, silty shales	5-4		75-4
17		Duquesne	Clay-shale, gray to greenish gray, mottled red to purple and maroon, silty, micaceous	8-4		70-0
16		Lower Grafton	Sandstone, gray to buff, limonite stained on surfaces, fine, medium to massive, bedded, some cross bedding, micaceous	9-5		61-8
15			Shale, gray to tan, limonite stained, argillaceous to silty and sandy upward, micaceous	3-11		52-3
14		Lower Grafton	Shale, gray to olive drab, some limonite stains, mottled maroon to purplish, argillaceous, fossiliferous, marine in base	5-11		48-4

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
13	Gaysport	Gaysport	Limestone, gray to blue gray, weathers yellow to brown, nodular, irregular, fossiliferous, marine, 734 ft.	0-4	10-0	42-5
12			Shale, gray to olive drab, limonite stained, mottled maroon to purplish, argillaceous, silty, micaceous	9-8		42-1
11	Ames	Ames	Limestone, light gray to gray, stained on surface, dense to partly crystalline, massive ledge, fossiliferous, marine	1-6	12-10	32-5
10			Shale, gray to dark gray, carbonaceous, grades upward to argillaceous light gray clay shale, silty, micaceous	1-9		30-11
9			Coal, mostly dull, some bright, limonite stained on bedding planes, shaly with free sulphur and selenite on surfaces, somewhat bony	0-11		29-2
8			Clay-shale, and clay, light gray to gray, some limonite stains, micaceous, silty, somewhat plastic	0-11		28-3
7			Shale and sandstone, light gray to buff, limonite stained, micaceous, sandstone ledges up to 1 inch in micaceous sandy, thin-bedded, shales	7-9		27-4
6	Harlem ?	Harlem ?	Shale, gray to dark gray, some limonite stains, argillaceous, slightly silty, micaceous, variable	3-0		19-7
5	Harlem	Harlem	Coal, mostly dull with some bright, soft, fusain, poorly developed	0-4	16-7	16-7
4			Clay, dark gray to gray, limonite stained, silty, micaceous, somewhat plastic	0-3		16-3
3		Round Knob	Clay-shale, gray green to olive drab, some limonite stains, micaceous, silty, thin-bedded, slickensided surfaces	10-6		16-0
2		Saltsburg	Sandstone, gray to olive drab, limonite stained on surfaces, calcareous, weathers to nodule appearance, micaceous	3-10		5-6
1			Shale, gray to buff, limonite stained, micaceous, argillaceous, silty, exposed	1-8		1-8

STOP #6 Exposure east along Route 50A east from 653 road junction up Sharpsburg Hill, NE 1/4, 29, Bern, Athens County, Ohio.

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
26	Elm Grove ?	Waynesburg	Sandstone, coarse below to medium above, massive, exposed to hilltop	7-1	9-0	271-0
25		Cassville ?	Shale, medium, argillaceous, thin-bedded	1-11		263-11
24	Waynesburg	Waynesburg	Coal, shaly or shale, coaly	0-1	31-10	262-0
23		Gilboy	Shale, variable reddish to olive gray above and olive brown to olive gray, silty below	29-5		261-11
22			Shale, variegated red to gray, platy above, clayey below	2-4		232-6
21	Little Waynesburg	Little Waynesburg	Shale, carbonaceous, coaly smut	0-1	25-3	230-2
20		Waynesburg	Shale, dusky red, massive, with zones of limestone nodules and pellets	10-9		230-1
19		Uniontown	Shale and sandstone, varying shades of gray, brown, reddish bedded	14-5		219-4
18	Uniontown		Shale, carbonaceous, coal zone	0-1	28-2	204-11
17		Uniontown	Shale, gray below and dusky red to olive gray above, with numerous limestone nodules and pellets throughout	19-10		204-10
16		Arnoldsburg	Sandstone and shale, gray to brown, fine to medium, with shaly partings	8-2		185-0
15			Shale, reddish to olive gray interbedded, silty to sandy upward, gray clay shale at base	12-4		176-10
14	Arnoldsburg and Benwood	Arnoldsburg ?	Shale, coaly, smut streak	0-1	68-2	176-9
13		Arnoldsburg and Benwood	Shale and limestone, variegated (gray, red, brown, yellow, purple) shale interbedded with light to dark gray, variable (dense, brecciated, etc.) limestone beds or nodular zones in layers 4 inches to several feet thick, shale zones with or without limestone nodules and pellets, middle part weathers predominantly white, lower and upper parts weather red, brown, or yellow, some beds with non-marine gastropods, ostracodes, and *Spirorbis*.	61-3		176-8

NO.	CYCLOTHEM	MEMBER	DESCRIPTION	Member Ft. In.	Cycle Ft. In.	Total Ft. In.
12		Upper Sewickley	Sandstone, olive brown, micaceous, somewhat lenticular, massive with some shaly sandstone zones above and below, conspicuous ledge	5-2		115-5
11			Shale and clay shale, gray to olive gray with considerable limonite stain in base	1-8		110-3
10	Meigs Creek	Meigs Creek	Shale and clay shale, carbonaceous	0-1	16-1	108-7
9		Lower Sewickley	Shale, olive to medium gray above to varicolored with limestone nodules below, massive prominent limonite crust at top, transitional into bed below	3-11		108-6
8			Sandstone, siltstone, and shale, shades of brown to gray, silty micaceous, bedded, some interbedded, thin zones	12-1		104-7
7	Fishpot	Fishpot ?	Clay shale, olive gray to olive brown, poorly bedded, coal zone?	0-10	40-3	92-6
6		Fishpot	Shale and limestone, varicolored massive shales with layers of limestone 1 to several feet thick or with scattered nodules and pellets of limestone, one 2-foot layer of very calcareous sandstone	39-5		91-8
5	Pomeroy or Redstone	Pomeroy Redstone	Shale, carbonaceous, coal zone	0-1	51-7	52-3
4		Redstone	Shale and limestone, varicolored (red, green, gray) calcareous, massive shale, in part with nodules and pellets of limestone, and light gray to olive gray, silty, nodular limestone (may in part represent a sandstone)	20-0		52-2
3		Upper Pittsburgh	Shale in two zones, an upper olive green weathering to various shades of red, brown, and yellow, silty to sandy, much distorted, rolled, etc. and varicolor-colored lower zone, mostly red, massive, crumbly with irregular to conchoidal fracture	31-6		32-2
2	Pittsburgh	Pittsburgh	Coal zone	0-1	0-8	0-8
1			Clay shale, greenish gray, bluish cast when wet, exposed	0-7		0-7

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OHIO INTERCOLLEGIATE FIELD TRIP

MIAMI UNIVERSITY
1958-1959

ACKNOWLEDGEMENTS

The department of geology at Miami University wishes to thank Kenneth E. Caster for donating prints of the fossil plates used in this field guide.

A plate has been adapted from "Elementary Guide to the Fossils and Strata in the Vicinity of Cincinnati, Ohio" (1955) by Caster, Dalve and Pope, published by the Cincinnati Natural History Museum.

The cross section was drawn by Carl Lind (1956).

The faunal lists were compiled by W. H. Shideler (1953).

ROAD LOG

Mileage

0.0 Loading of the bus will take place near Benton Hall (corner of Campus and Walnut Sts.) at 8:00 A.M. Drive south on Campus Street and

0.1 Turn East (left) onto Spring Street at intersection.

0.6 Turn South (right) onto Patterson Ave. (U.S. 27).

2.6 Turn East (left) onto Wallace Rd.

2.8 *STOP #1:* At the corner of Wallace and Woodruff Roads, disembark and walk east along gravel road down to Tallawanda (Four Mile) Creek.

Stream bank section shows an exposure of the Arnheim formation and is almost completely made up of the Sunset member. The contact between the Sunset and the Oregonia members is exposed at the top of the lower waterfalls in the stream, which parallels the road on the way to the creek. Water level is about six feet above the base of the Arnheim formation.

Return to bus and proceed back to Route 27 and turn north (right).

4.5 *STOP #2:* Near concrete bridge over Bull Run. Disembark and walk upstream along south bank to first high bluff occurring on north side of stream (approximately 0.4 miles).

Bedrock in the stream (and approximately one foot up the bank) is the Ft. Ancient member, above this is the Clarksville member of the Waynesville formation. *Onniella meeki* are abundant here. The glacial till in the bluff is probably late Wisconsin in age and contains many sizable pieces of well preserved wood.

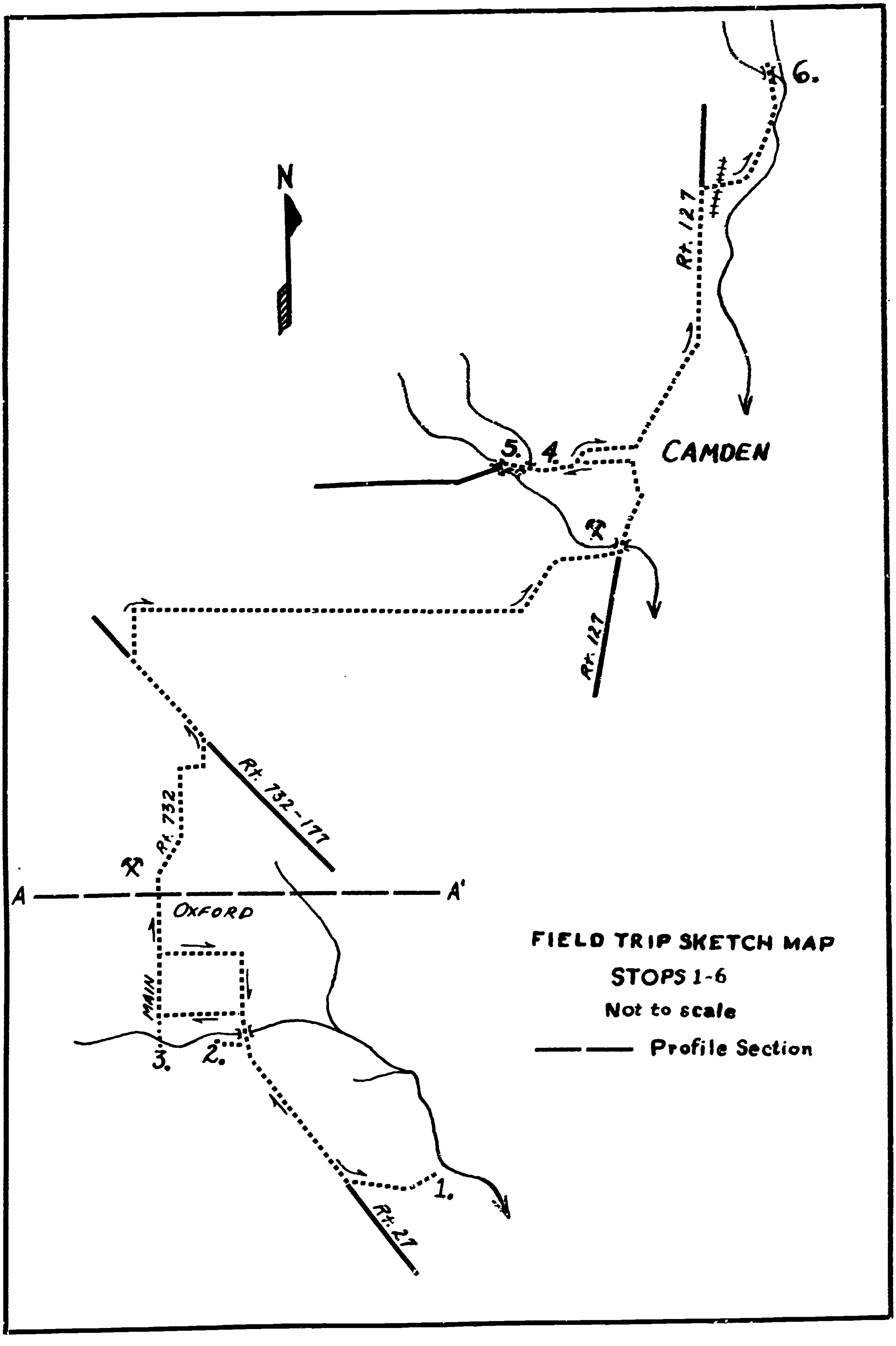
Return to Route 27 and board the bus. Proceed to the crest of the hill on Route 27, to Chestnut Street. Turn west (left), continue west across B& O RR to the Tallawanda School parking lot.

5.4 *STOP #3:* Clarksville member of the Waynesville formation. Board the bus. Proceed north on Main Street through Oxford and north on Route 732. The bridge crossing is over Tallawanda Creek. Eight village owned wells are to the right (east) in the valley bottom made of spillway gravels. The wells derive their water from the gravels at depths between 40 and 80 feet. Upstream, approximately one mile, the State has constructed a large earth fill dam that impounds the water of Tallawanda Creek to form a large lake (Acton Lake). The area around the new lake is now one of the State's new parks.

8.7 Observe a gravel pit to the left of the highway. This pit is operated by the Central Gravel and Ready Mix Company of Oxford. It has been in operation since 1926. Gravel is now obtained by a dragline or power shovel down to a depth of 25 feet. The old workings are flooded over six acres and some parts are under 60 feet of water. Core test holes have been made to a depth of 92 feet with gravel below. The deposit is glacial spillway gravel. The valley was undoubtedly excavated by Wisconsin and probably earlier glaciers to a depth of at least 157 feet in this area. The Waynesville is exposed in the streamcut to the northwest.

11.5 Turn left onto Route 177.

12.7 Turn north (right) onto Eaton-Oxford Road. At the first intersection of the road with a gully note on the left two poor exposures of the Elkhorn formation.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CAMDEN
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Rt. 127
Rt. 732-177
Rt. 732
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OXFORD
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3.
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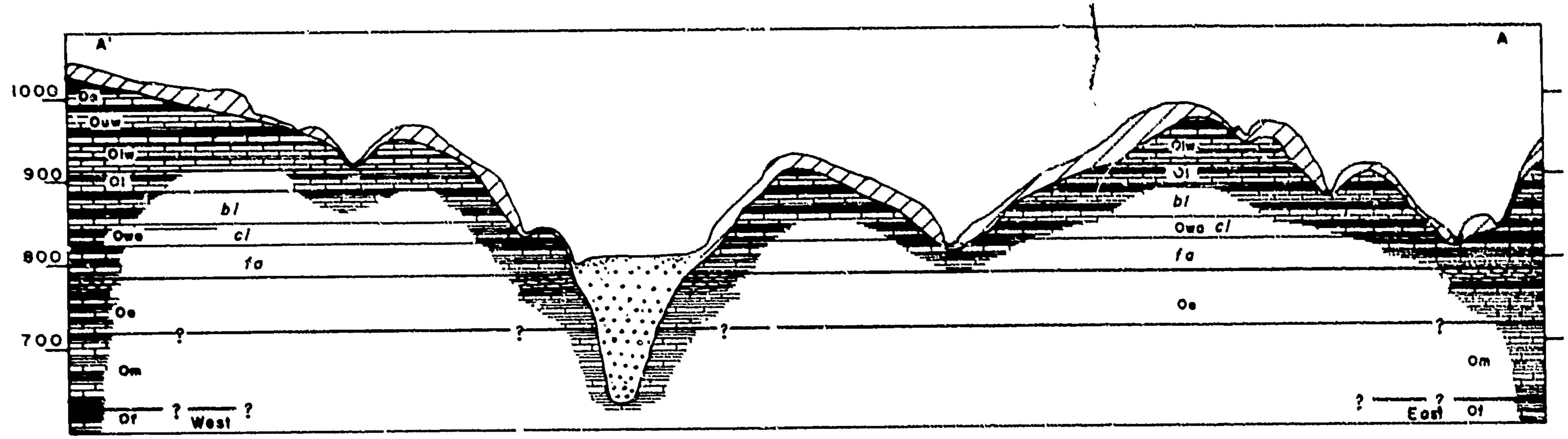
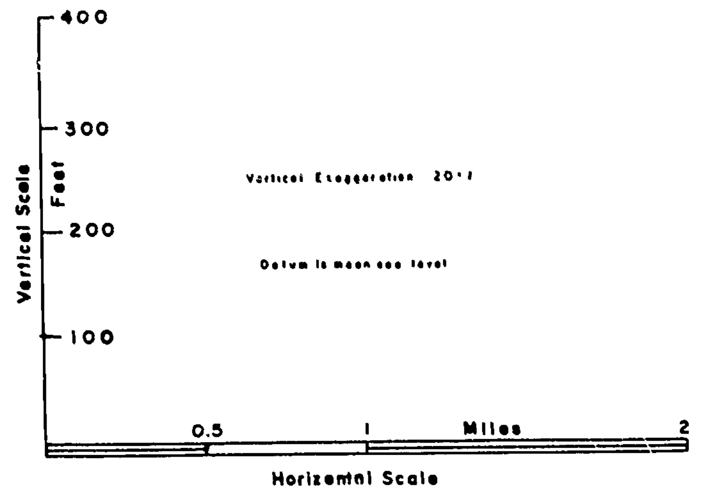
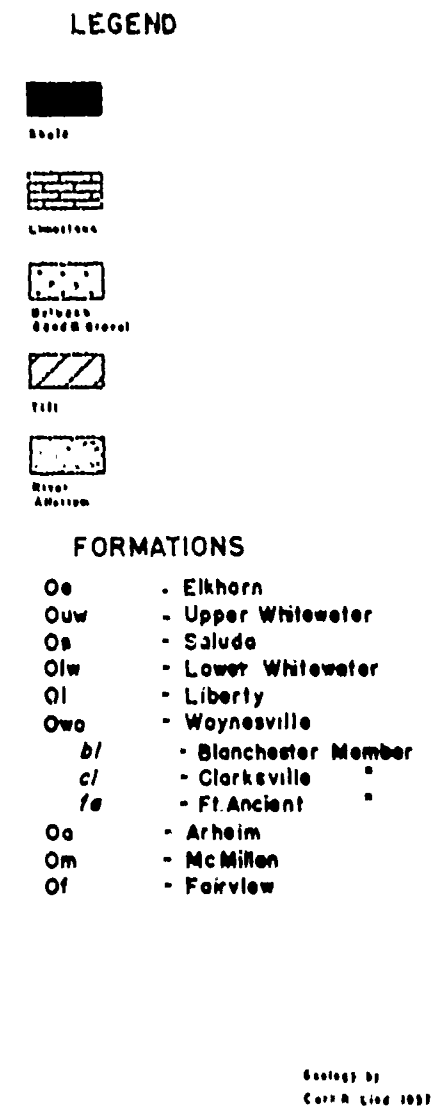
Rt. 27
FIELD TRIP SKETCH MAP
STOPS 1-6
Not to scale
Profile Section



Profile Section along line A-A'





13.5 Turn east (right) onto Camden-College Corner Road.

17.1 Note till deposits to the north and gravel valley fill ahead in Seven Mile Creek Valley. Cross Pennsylvania RR tracks.

17.8 Turn north (left) onto Route 127 and note large gravel pit of the White Gravel Company on left. It has been operated over 25 years. The ponded area is the abandoned area of five acres which was worked to a depth of 55 to 60 feet. The new pit was opened about two years ago. The deposit is glacial spillway gravel of the Seven Mile Creek.

18.2 Having crossed Pennsylvania RR tracks continue straight on South Lafayette Street rather than continuing slight right on Route 127 at edge of Camden.

18.5 Turn west (left) onto W. Hendricks Street and continue uphill past water tower.

19.0 Turn left onto Route 725.

19.4 *STOP #4:* Exposure of Liberty formation in all of the stream cuts.

19.6 *STOP #5:* Exposures in road cut and nearby stream are of the Whitewater formation. Board the bus.

Return east on Route 725 into center of Camden.

20.8 At traffic light turn north (left) onto Route 127.

22.3 Lunch and rest stop at roadside park.

Proceed north on Route 127.

26.0 Turn east (right) onto Brower Road, and cross RR tracks.

26.2 Turn north (left) onto old Camden Pike.

26.7 *STOP #6:* Elkhorn-Brassfield contact. Exposure on east side of road across stream, 0.1 mile south of two-lane covered bridge. The contact is approximately 30 feet above the level of the stream. The Brassfield here is a coarse-grained, buff, quartzose sandstone.

END OF TRIP. The bus will return to Oxford.

THE ORDOVICIAN STRATA OF THE OXFORD AREA

Within the Oxford area the strata are Upper Ordovician in age. They are almost exclusively representative of the Richmond group. The plate on page 6 shows the various formations in their stratigraphic relationship. The illustration also lists some of the guide fossils of each formation or member. The plate on page 3 is a cross section constructed to show the strata just to the north of Oxford.

Description of Formations
Richmond Group

The passage from the Maysville into the Richmond shows no distinct evidence of any break in sedimentation. The first Richmond sea is thought to have encroached from the south. Casual inspection indicates little faunal difference, but careful study shows the early Richmond fauna to be quite different.

Arnheim: The Arnheim is divisible into a lower or Sunset member with three very different facies and faunas, and an upper or Oregonia member. When traced into the Nashville Basin, the Arnheim becomes typically Richmond in its fauna, corals are especially notable, as well as typical middle Richmond brachiopods, etc. Northward, the Arnheim becomes less fossiliferous and apparently pinches out under cover.

The Sunset in Ohio is mostly even-bedded limestones and shales topped by the well-known zone of *Retrorsirostra carleyi* and *Leptaena richmondensis* above which are the irregular, lumpy limestones and shales of the Oregonia. At the top of the Oregonia is a 2 to 4 foot zone practically composed of *Cyclora, Microceras, Ctenodonta, Clidophorus,* and other phosphatic microfossil casts.

Waynesville: The Waynesville is usually thin even-bedded limestones and shales. The lower or Ft. Ancient member is composed of even-bedded limestones and shales. At the top is a six foot shale bed which is THE trilobite zone of the Richmond. Above this is the *"Dalmanella" (Oniella meeki)* zone or Clarksville member, which in the Cincinnati area begins the first of a series of northern (Arctic) faunas found in a shifting pattern of marine embayments. The very fossiliferous Blanchester member, again largely shaly, ends the Waynesville.

Liberty: The division between the Waynesville and the Liberty is a purely paleontologic one, marked by a zone of *Glyptorthis insculpta.* The lower Liberty is lithologically quite like the upper Waynesville, but the rest of it is made of 3 inch to 4 inch limestones with thin interbedded shales. Its very prolific fauna is largely composed of brachiopods.

Whitewater: Limestones continue into the Lower Whitewater, and here begins a rather marked faunal break. Also at this level may sometimes be found filled erosion channels, in one case four feet thick. A great variety of cephalopods appears here for the first time, as well as new types of bryozoa, etc., introducing a very characteristic Whitewater fauna.

Thirty feet above the base is a zone of *Tetradium approximatum,* traced by continuity into the basal coral zone of the Saluda as it occurs in Indiana. A total of six feet of heavy limestones represents the basal Saluda of Indiana, all of the rest of the Indiana Saluda changing into the lumpy limestones and shales of the middle Whitewater. At the top of the Whitewater are strata which in Indiana are above the typical Saluda. These strata include the *Rhynchotrema dentatum* zone, and the *Tentaculites richmondensis* zone at the top.

Elkhorn: The Elkhorn begins with 20 to 30 feet of apparently barren, smooth shale followed by 30 to 40 feet of largely heavy limestones, often looking distinctly sandy. Close examination will show however, that the basal shales sometimes carry thin local lenses with a prolific number and variety of microfossils, mostly ostracods. The apparent sandy appearance of the heavier strata is due to the development of dolomite crystals. Prolific faunas that are usually very local in distribution are an interesting feature, and this is especially true at both top and bottom. Some of these faunas carry an ostracod element that is recurrent Black River, and which is well developed under cover in Michigan as shown by examination of oil well samples.

FAUNAL LISTS OF RICHMOND FORMATIONS

By W. H. Shideler (1953)

CASUAL SPECIES THROUGH MOST OF CINCINNATIAN.

Dermatostroma scabrum
Iocrinus subcrassus
Ceramoporella ohioensis
Hebertella occidentalis
Hebertella occidentalis sinuata
Petrocrania scabiosa
Philhedra laelia
Rafinesquina sp.
Trematis millepunctata
Zygospira modesta
Pterinea demissa
Byssonychia radiata
Hormotoma gracilis
Liospira micula
Lophospira bowdeni
Lophospira tropidophora
Sinuites cancellatus
Endoceras proteiforme
Flexicalymene meeki
Isotelus maximus

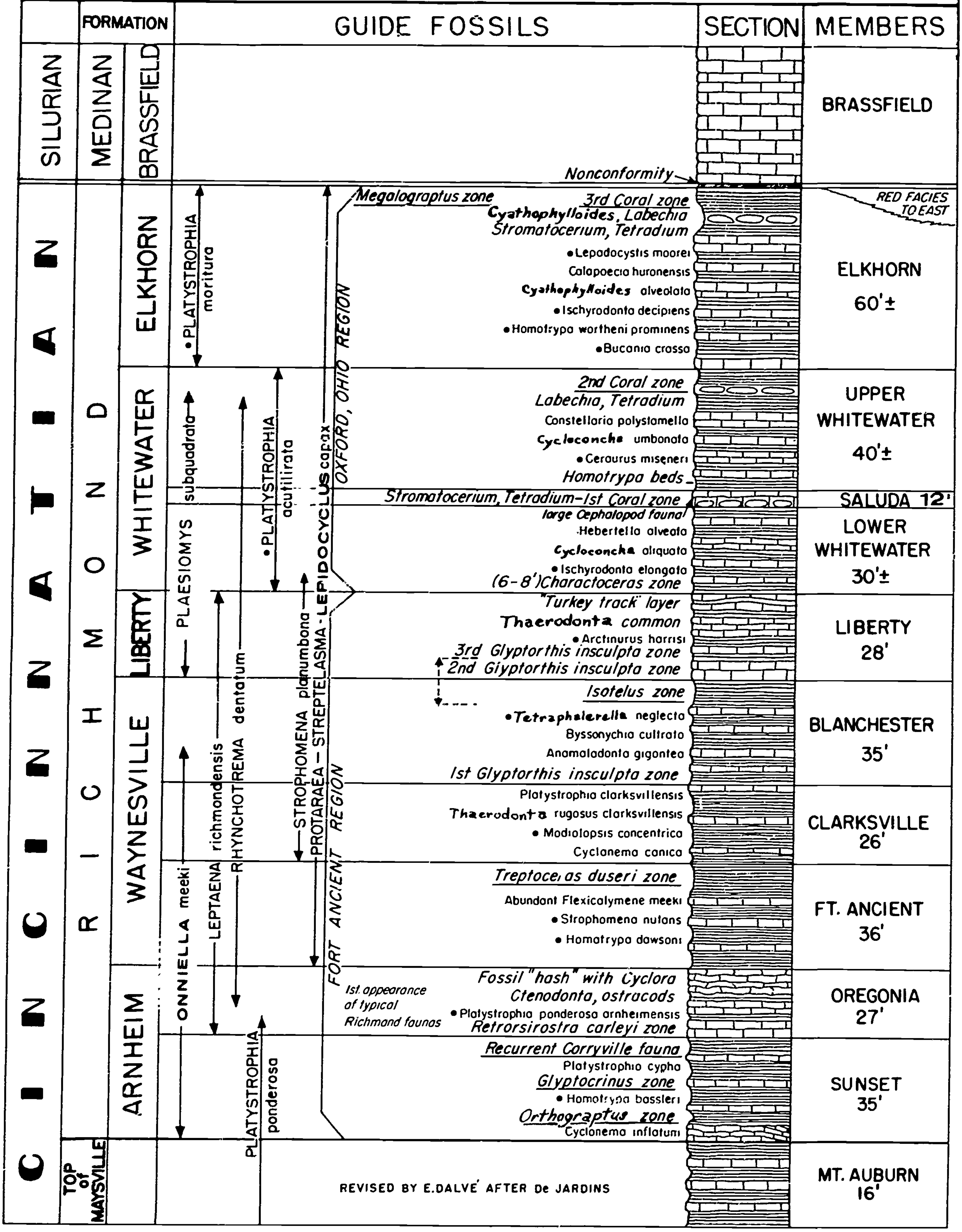
SPECIES FOUND THROUGH MOST OF RICHMOND.
*(*in all but Arnheim)*

*Stromatocerium huronense
*Cyathophylloides alveolata
*Protarea richmondensis
*Streptelasma divaricans
*Streptelasma rusticum
*Tetradium approximatum
Paraconularia formosa
Bythopora delicatula
Bythopora striata
Bythopora meeki
*Fenestrellina granulosa
Hallopora subnodosa
Heterotrypa subramosa
Heterotrypa subramosa prolifica
Homotrypa flabellaris
Homotrypella hospitalis
Peronopora decipiens
*Rhombotrypa quadrata
Rhopalonaria venosa
Leptaena richmondensis
Anomalodonta gigantea
Cyclonema bilix

ARNHEIM SPECIES.

Orthograptus recurrens
Glyptocrinus dyeri
Amplexopora pustulosa
Batostoma varians
Stigmatella dychei
Onniella meeki
Retrorsirostra carleyi
Anomalodonta alata

GEOLOGIC FORMATIONS IN BUTLER AND PREBLE COUNTIES, OHIO



Coeloclema oweni
Homotrypa bassleri
Mesotrypa orbiculata
Stigmatella catenulata
Stigmatella crenulata
Anomalodenta costata
Ospisthoptera concordensis
Orthodesma canaliculatum
Cyclonema humerosum
Cyrtolites ornatus

WAYNESVILLE SPECIES.

Atactoporella schucherti
Batostoma varians
Constellaria polystomella
Cyphotrypa clarksvillensis
Eridotrypa simulatrix
Heterotrypa microstigma
Homotrypa communis
Homotrypa dawsoni
Homotrypa nicklesi
Leptotrypa ornata
Spatiopora corticans
Catazyga headi
Glyptorthis insculpta
Platystrophia clarksvillensis
Onniella meeki
Lepidocyclus capax
Thaerodonta rugosus clarksvillensis
Tetraphalerella neglecta
Strophomena nutans
Strophomena planumbona
Holtedahlina sulcata
Strophomena vetusta
Byssonychia subrecta
Byssonychia richmondensis
Cuneamya miamiensis
Cuneamya neglectus
Cymatonota cylindrica
Cymatonota typicalis
Modiolodon subovalis
Modiolopsis concentrica
Opisthoptera fissicasta
Orthodesma canaliculatum
Orthodesma rectum
Whiteavesia pholadiformis
Cyrtolites ornatus
Lophospira perlamellosus
Treptoceras ("Orthoceras") duseri
Odontopleura onealli
Isotelus brachycephalus

LIBERTY SPECIES.

Dendrocrinus casei
Heterocrinus juvenis
Batostoma prosseri
Constellaria limitaris
Constellaria polystomella
Peronopora decipiens
Plaesiomys subquadrata
Platystrophia annieana
Platystrophia cumingsi
Strophomena planumbona
Holtedahlina sulcata
Strophomena vetusta
Pterinea corrugata
Isotelus brachycephalus

WHITEWATER SPECIES. (Including Saluda)

Dystactospongia madisonensis
Hindia subrotunda
Cupulocrinus polydactylus
Xenocrinus baeri
Batostoma variabile
Constellaria limitaris
Constellaria polystomella
Homotrypa nodulosa
Homotrypa ramulosa
Homotrypa richmondensis
Homotrypa wertheni
Homotrypella rustica
Pachydictya fenestelliformis
Rhombotrypa quadrata
Hebertella alveata
Plaesiomys subquadrata
Platystrophia annieana
Platystrophia acutilirata
Rhynochotrema dentatum
Holtedahlina sulcata
Strophomena vetusta
Byssonychia obesa
Byssonychia richmondensis
Byssenychia robusta
Ischyrodonta elongata
Ischyrodonta truncata
Opisthoptera casei
Ortonella hainesi
Pterinea corrugata
Bellerophon simulatrix
Salpingostoma richmondensis
Charactoceras baeri
Diestoceras eos
Diestoceras indianense
Ceraurinus icarus
Chasmops breviceps

ELKHORN SPECIES.

Aulacera undulata
Cyphotrypa stidhami
Platystrophia meritura
Ischyrodonta decipiens
Ortonella hainesi

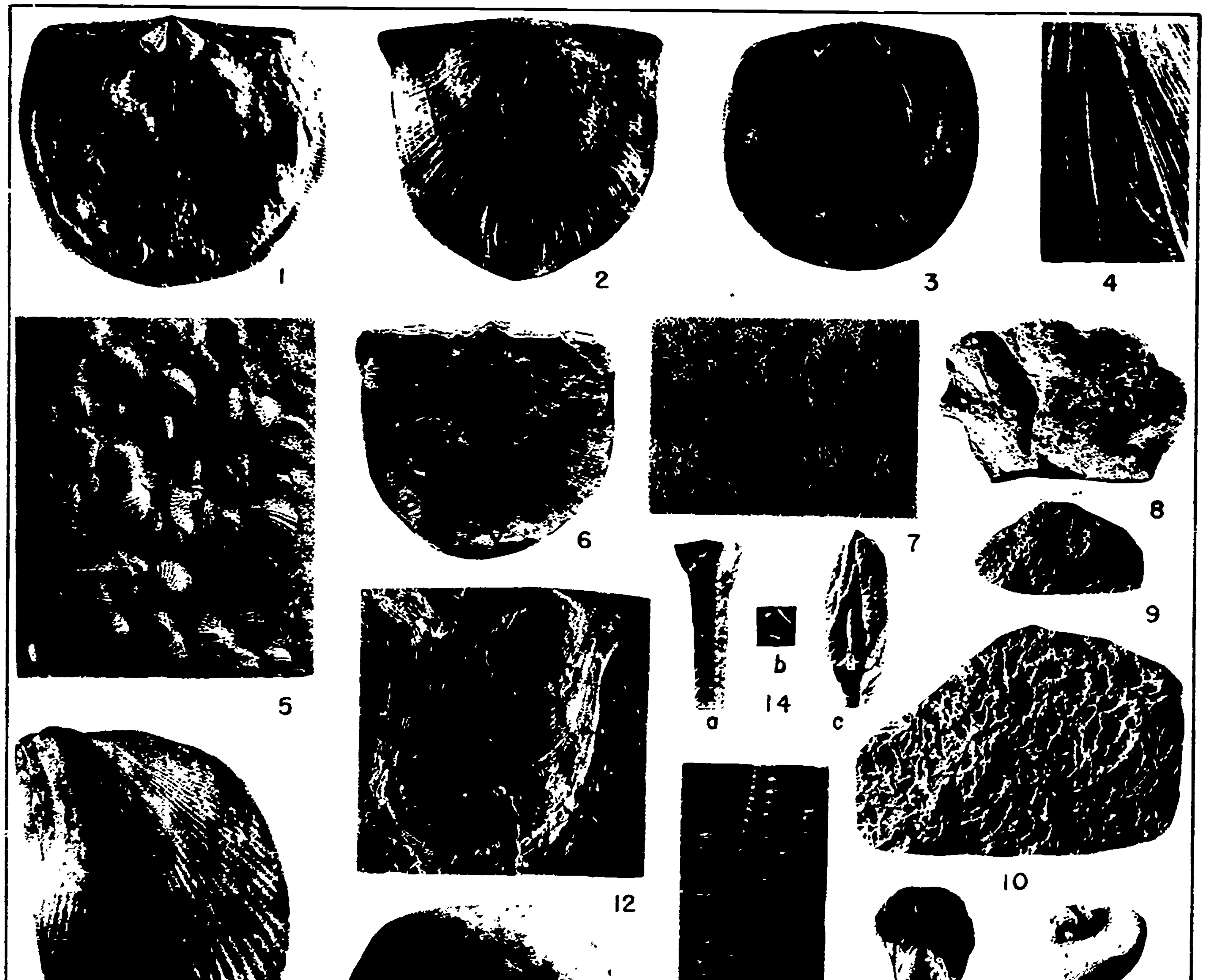


PLATE I

PLATE I

Fossils found in almost all Cincinnatian formations

Fig.

1-4 *Rafinesquina sp.* Articulate brachiopod. Fig. 1: Interior, brachial valve. Fig. 2: Outside, pedicle valve. Fig. 3: Interior, pedicle valve. Fig. 4: Enlargement, shell surface.

5 *Zygospira modesta.* Articulate brachiopod. Slightly enlarged illustration.

6 *Petrocrania scabiosa.* Inarticulate brachiopod. Grew on *Rafinesquina alternata* valve.

7-8 *Peronopora vera.* Bryozoan. Fig. 7: Surface enlarged. Fig. 8: Typical fan shape.

9-10 *Stomatopora arachnoidea.* Bryozoan. Forms network of zooecia on surface of different bryozoan. Fig. 9: Nat. size. Fig. 10: Enlarged. Found in Eden and Maysville.

11 *Byssonychia radiata.* Pelecypod. Maysville and Richmond.

12 *Pterinea demissa.* Pelecypod. Flattened vaive on a limestone slab.

13 *Modiolopsis modiolaris.* Pelecypod. Interior mold. Genus found throughout Cincinnatian, this species restricted to Fairmount.

14 *Iocrinus subcrassus.* Crinoid. a: Stem with portion of calyx; b: Columnal, c: Calyx and arms (crown).

15 Fragments of crinoid columns on surface of a limestone slab.

16-17 *Sinuites cancellatus.* Gastropod. Fig. 16: View toward aperture. Fig. 17: Side view.

18-19 *Loxoplocus (Lophospira) bowdeni.* Gastropod. Fig. 18: Interior mold. Fig. 19: Exterior of shell. Maysville and Richmond.

20 *Isotelus maximus.* Trilobite. Largest specimens exceed 2 feet in length.

21 *Isotelus gigas.* Trilobite. Differs from *I. maximus* in being proportionately broader.

22-23 *Felxicalymene meeki.* Trilobite. Fig. 23: Front of enrolled specimen. Maysville and Richmond.

24 *Endoceras proteiforme.* Cephalopod. Fragment of straight, conical shell, broken lengthwise. Interior mold. Exact range unknown, thought to be entire Cincinnatian.

25 *Treptoceras ("Orthoceras") sp.* Cephalopod.

(All figures natural size unless stated otherwise.)

PLATE II

Some fossils found in the Richmond formations

Fig.

1-5 *Platystrophia acutilirata.* Articulate brachiopod. Limited to Whitewater formation.

6 *Streptelasma rusticum.* Cup coral. Richmond except lower Arnheim.

7-13 *Lepidocyclus capax.* Articulate brachiopod. Richmond except Arnheim.

14 *Byssonychia grandis.* Pelecypod. Waynesville to Whitewater.

15-18 *Cyclonema bilix.* Gastropod. Entire Richmond.

19-23 *Rhynchotrema dentatum.* Articulate brachiopod. Waynesville through Whitewater.

24-25 *Hebertella occidentalis.* Articulate brachiopod. Maysville and Richmond.

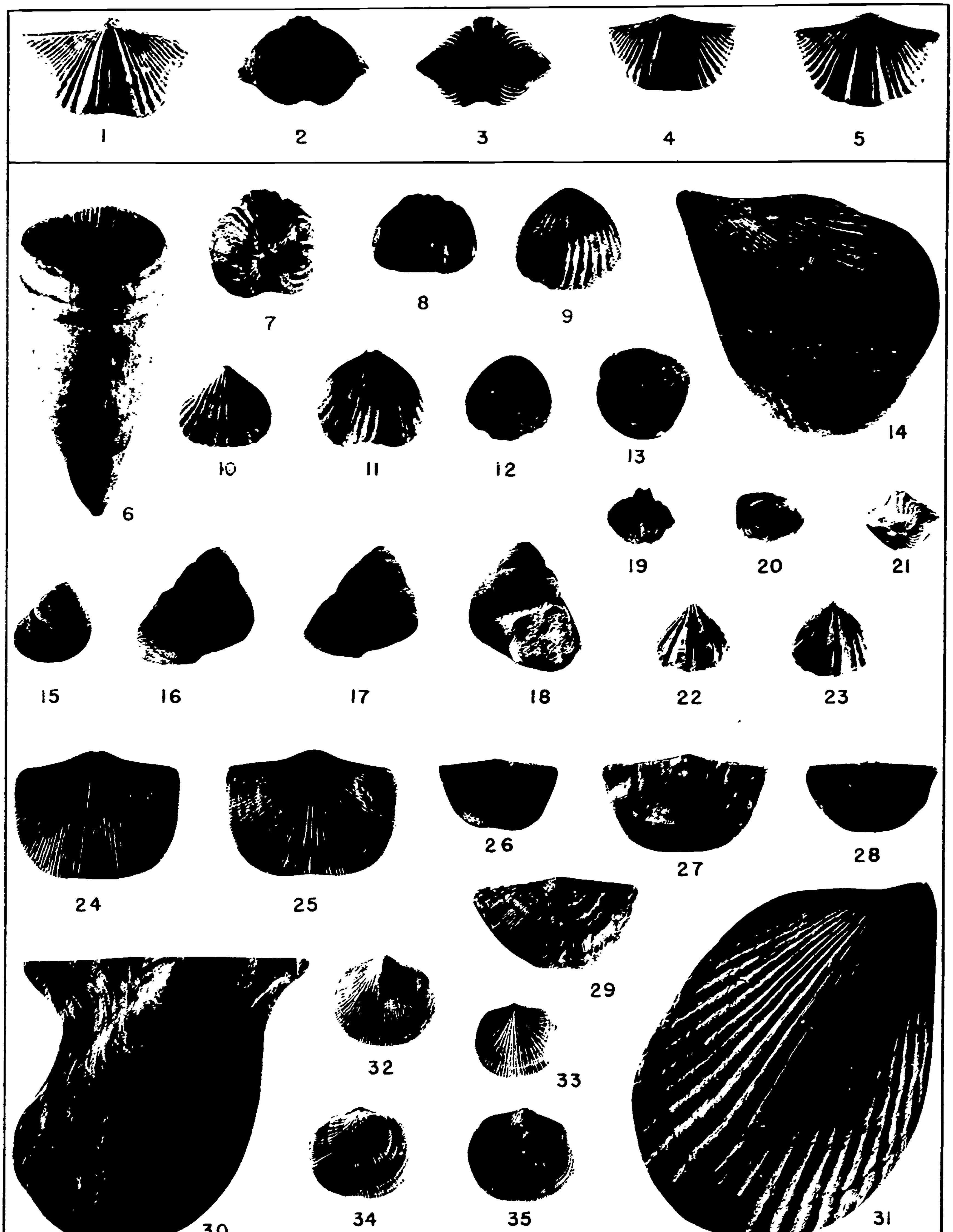
26-29 *Leptaena richmondensis.* Articulate brachiopod. Entire Richmond.

30 *Pterinea demissa.* Pelecypod. Entire Cincinnatian.

31 Anomalodonta gigantea. Pelecypod. Whole Richmond.

32-35 *Onniella meeki.* Articulate brachiopod. Entire Richmond.

(All figures natural size unless stated otherwise.)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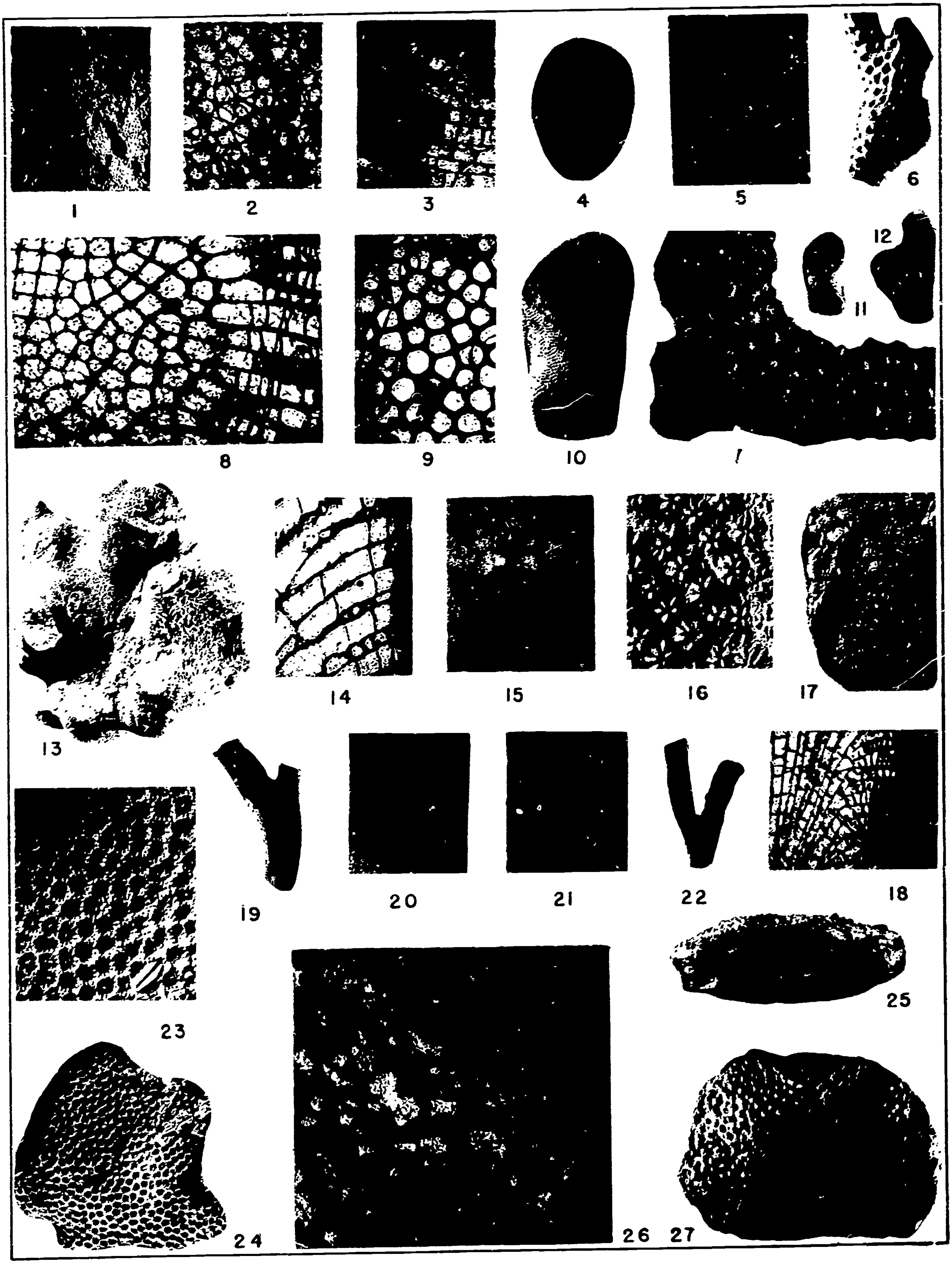

PLATE III

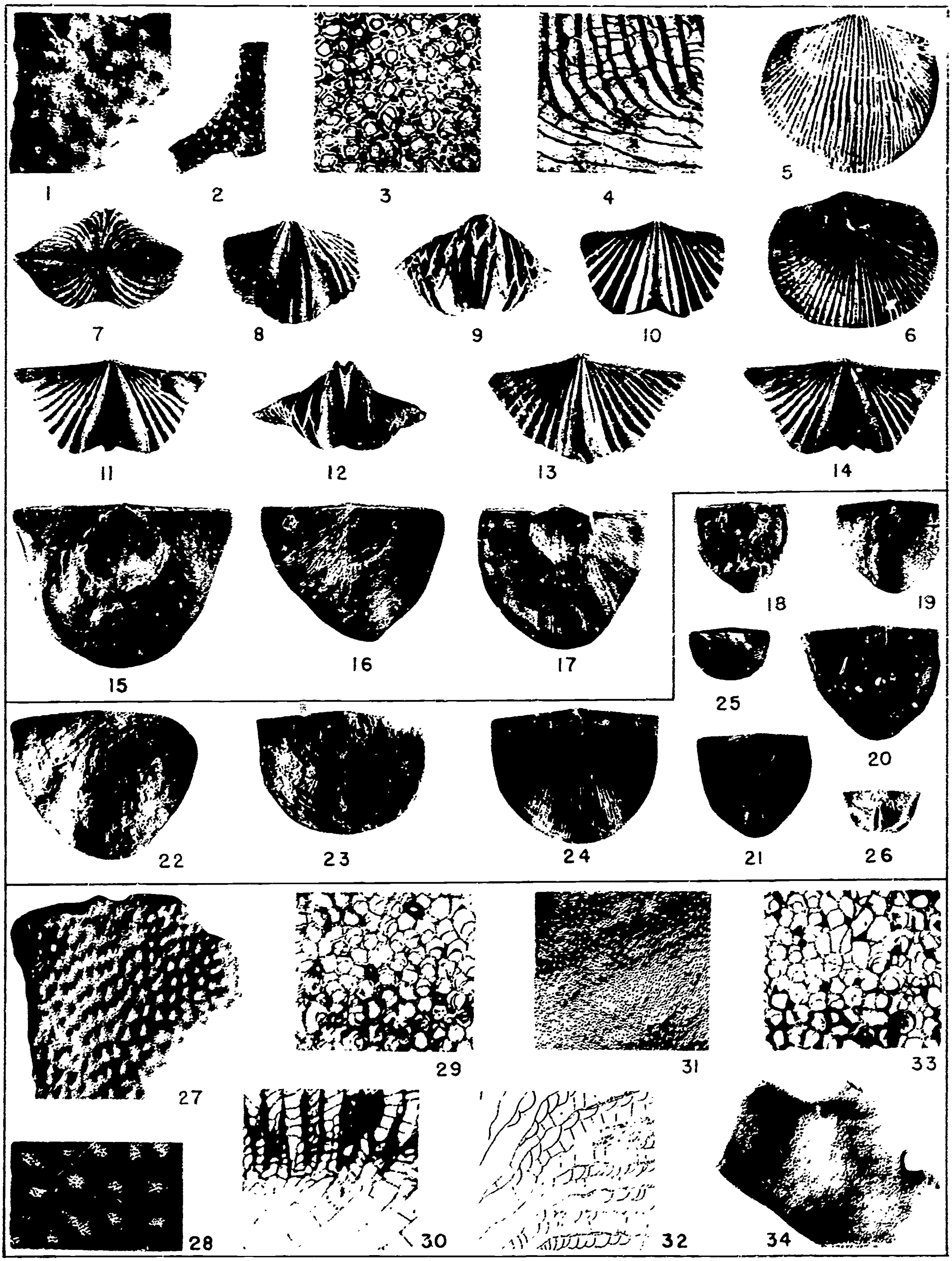
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PLATE IV

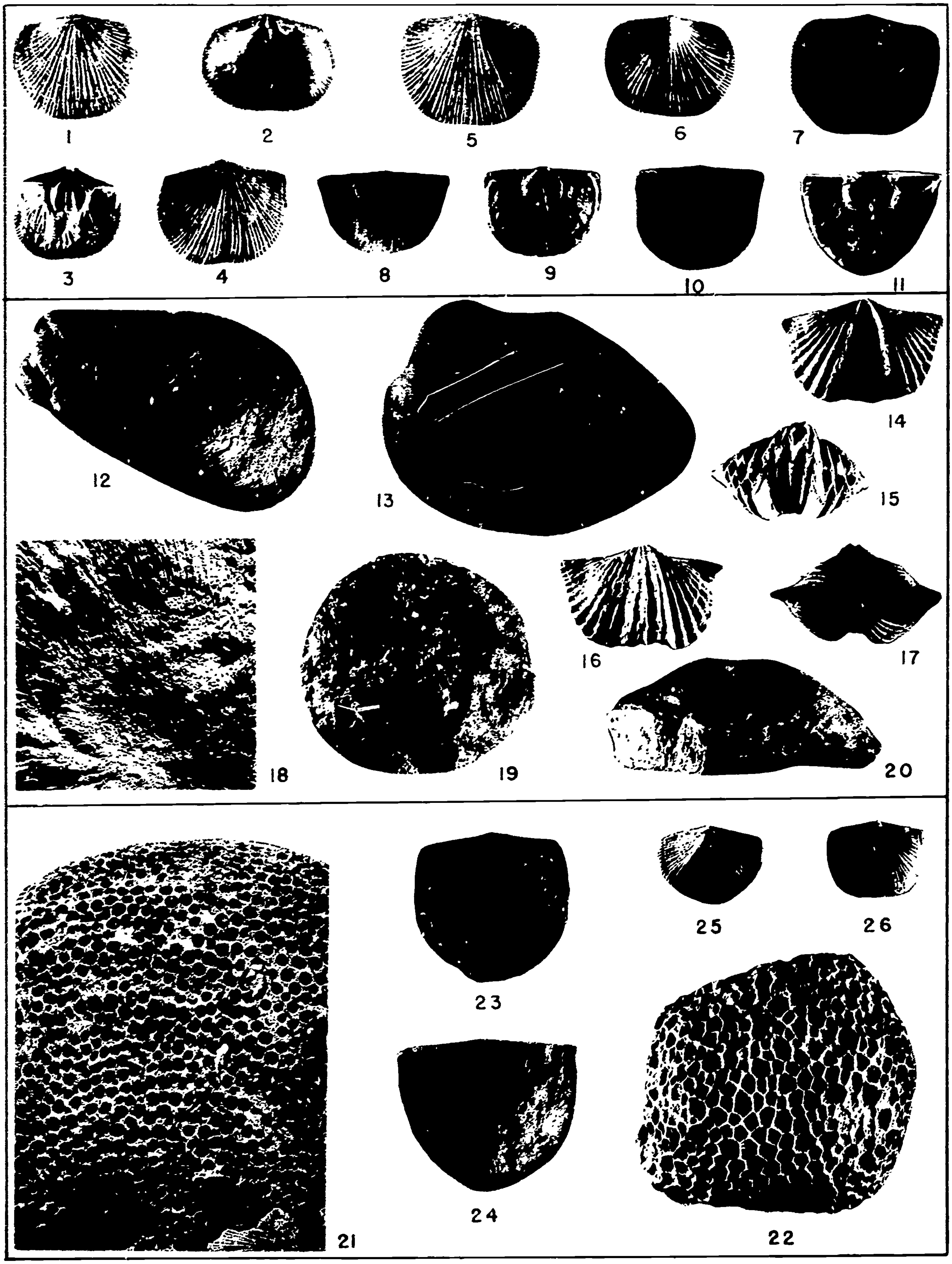


PLATE V

PLATE III

Some fossils found in the Richmond formations

Fig.

1-4 *Homotrypella hospitalis.* Bryozoan. More or less hemispherical masses. Fig. 1: Enlarged surface. Fig. 2: Tangential section. Fig. 3: Longitudinal section. Fig. 4: Hemispherical shape, natural size. Entire Richmond.

5-7 *Hallopora subnodosa.* Bryozoan. Fig. 5: Longitudinal section. Fig. 6: Natural size. Fig. 7: Enlarged. Entire Richmond except Elkhorn.

8-12 *Rhombotrypa quadrata.* Bryozoan. Figs. 8-9: Tangentiol section. Fig. 10: Enlarged. Figs. 11-12: Natural size. Richmond except Arnheim.

13-15 *Batostoma varians.* Bryozoan. Fig. 13: Natural size. Fig. 14: Longitudinal section. Fig. 15: Tangential section. Arnheim and Waynesville.

16-18 *Constellaria polystomella.* Bryozoan. Fig. 16: Englarged. Fig. 17: Natural size. Fig. 18: Longitudinal section. Richmond except Arnheim.

19-22 *Bythopora meeki.* Bryozoan. Figs. 19 & 22: Natural size. Fig. 20: Longitudinal section. Fig. 21: Tangential section. Waynesville and Liberty.

23-24 *Protarea richmondensis.* Encrusting coral. A compound coral which grew as crust over other objects. Fig. 23: Englarged. Entire Richmond.

25-27 *Stromatocerium huronense.* Hydroid coral. Fig. 26: Enlarged. This belongs to group called the Stromatoporoidea. Entire Richmond.

(All figures natural size unless stated otherwise.)

PLATE IV

Some fossils found in various Richmond formations

Fig.

1-4 *Homotrypa wortheni.* Bryozoan. Fig. 1. Enlarged. Fig. 3: Tangential section. Fig. 4: Longitudinal section. Whitewater.

5-6 *Retrorsirostra carleyi.* Articulate brachiopod. Limited to a thin zone in the Arnheim.

7-10 *Platystrophia clarksvillensis.* Articulate brachiopod. Waynesville and Liberty formations.

11-14 *Platystrophia cypha.* Articulate brachiopod. Ranges from McMillan to Liberty formations.

15-17 *Strophomena concordensis.* Articulate brachiopod. Arnheim and Waynesville formations.

18-21 *Strophomena nutans.* Articulate brachiopod. Waynesville formation.

22-24 *Tetraphalerella neglecta.* Articulate brachiopod. Waynesville formation.

25-26 *Thaerodenta rugosus clarksvillensis.* Articulate brachiopod. Waynesville and Liberty formations.

27-30 *Homotrypa dawsoni.* Bryozoan. Fig. 28: Enlarged. Fig. 29: Tangential section. Fig. 30: Longitudinal section. Waynesville formation.

31-34 *Homotrypa flabellaris.* Bryozoan. Fig. 31: Enlarged. Fig. 32: Longitudinal section. Fig. 33: Tangential section. Entire Richmond.

(All figures natural size unless stated otherwise.)

PLATE V

Some fossils found in various Richmond formations

Fig.	
1-4	*Glyptorthis insculpta.* Articulate brachiopod. Waynesville and basal Liberty formations.
5-7	*Plaesiomys subquadrata.* Articulate brachiopod. Liberty and Whitewater formations.
8-11	*Strophomena planumbona.* Articulate brachiopod. Arnheim through Liberty formations.
12	*Ischyrodonta elongata.* Pelecypod. Internal mold. Whitewater formation.
13	*Cycloconcha unbonata.* Pelecypod. Whitewater formation.
14-17	*Platystrophia moritura.* Articulate brachiopod. Elkhorn formation.
18-20	*Tetradium approximatum.* Compound coral. Forms hemispherical masses of large size. Figs. 19-20: Several times reduced. Entire Richmond, especially abundant in the Saluda, Upper Whitewater, and Elkhorn.
21	*Calapoecia cribiformis.* Compound coral. Entire Richmond, especially found in upper formations.
22	*Cyathophylloides alveolata.* Compound coral. Entier Richmond, especially found in upper formations.
23-24	*Strophomena vetusta.* Articulate brachiopod. Fig. 23: Interior. Fig. 24: Exterior. Liberty and Whitewater formations.
25-26	*Holtedahlina sulcata.* Articulate brachiopod. Waynesville to Whitewater formations.

(All figures natural size unless stated otherwise.)

The Tenth Field Guide is not included because it is identical to the Sixteenth Field Guide (see page 16-1).

ELEVENTH ANNUAL

OHIO Inter-collegiate FIELD TRIP

AUTUMN, 1960

BOWLING GREEN

- HOST UNIVERSITY -

TRIP LOG

Mileage Individual	Total		Description (Sketch Map, Page 11-16)
0.0	0.0	9:00	Leave assembly area. Turn left leaving parking lot and continue south to stop sign at Ridge St. Turn right to Thurstin Ave. Turn left to next stop sign (Wooster). Turn right with *caution*. Proceed two blocks — turn left on to S. Summit.
1.0	1.0		Turn right on Lehman to stop light (U.S. 25).
			Turn left on to U.S. 25 (Main St.)
0.2	1.2		Turn right (west) at blinker light on to Sand Ridge Road.
2.3	3.5		Note climb on to sand ridge. SLOW — sand in cut on left side of road. This is probably Lake Warren beach.
4.6	8.1		Weston, Ohio — continue straight ahead.
2.6	10.7		Turn left on to Custar Road — cross Beaver Creek.
0.9	11.6		Turn right on to Portage Road. (Sign to Pugh Quarry)
1.7	13.3	9:20	Pugh Quarry. STOP #1. Park on right side — out of truck road. ways. Please use care in the quarry!
		10:20	Leave. Return to cars and continue west on Portage Road.
7.2	20.5		Malinta, Ohio. Turn left at stop sign on to Route 109 and temporary 65.
1.1	21.6		Cross Turkeyfoot Creek

0.2	21.8		Cross Turkeyfoot Creek
0.5	22.3		Turn right on to County Road J. Cross Turkeyfoot Creek.
1.5	23.8	10:40	Elery, Ohio. Cross railroad tracks and turn right on gravel road toward tile kilns. Drive back to pit and stop. STOP #2.
		11:00	Leave. Return to County Road J turn right and continue west.
6.2	30.0		Cross Wade Creek. Note till in stream bank and road cut.
0.3	30.3		Stop sign. Turn left on to County Road 18.
0.9	31.2		Stop sign. Turn right on Ohio 281.
2.1	33.3		Note till in road cut.
0.9	34.2		Note till in road cut.
3.7	37.9	11:30	STOP #3 at Kingsbury Park on Maumee and Auglaize Rivers. Lunch.
		12:30	Leave. Return to cars, cross Auglaize River and turn right at first street to Fort Defiance.
0.3	38.2	12:35	STOP #4. Fort Defiance.
		1:00	Return to cars and continue on Washington Ave.
0.1	38.3		Turn left on Jefferson St. and proceed to Ohio 281. Turn right on Ohio 281.
0.3	38.6		Turn left at stop light on to Ohio 111.
1.1	39.7		Pass Riverside Cemetary.
0.9	40.6		Left on Powerdam Road.
0.5	41.1		Cross Auglaize River
0.9	42.0		Stop sign, turn right.
0.4	42.4	1:15	STOP #5. *Auglaize River.* Toledo-Edison Power Dam Follow guide car and park on right side of road past curve. Walk back to exposure on east side of river bank. 1. Glacial striations. 2. Ohio Shale (Conodonts) 3. Joint pattern.
		2:00	Leave. Continue south on Powerdam Road.
3.6	46.0		Stop sign, turn right onto 196 Paulding.
0.4	46.4		Cross Auglaize River.
0.1	46.5		Stop sign of merging Ohio 111. Continue straight ahead.
0.9	47.4	2:15	STOP #6. *Junction Quarry.* Park on left side of road in parking lot. Devonian-Traverse group.
		3:00	Leave. Retrace route to junction of Ohio 111 and 196 Paulding.
0.9	48.3		Junction of Ohio 111 and 196 Paulding. Bear right on to 196 Paulding.
3.1	51.4		Junction of Ohio 66 and 196 Paulding. Continue straight ahead.
0.9	52.3		Stop sign, Arthur, Ohio. Continue straight ahead.
0.9	53.2		Stop sign, turn left.
0.4	53.6		Turn right on to Holly Road 9.
0.2	53.8		Cross South Powell Creek.
0.2	54.0		Stop sign, turn right on to Ohio 15.

0.4	54.4	Cross North Powell Creek.
3.4	57.8	Rice, Ohio
3.1	60.9	Wisterman, Ohio
2.3	63.2	Kieferville, Ohio
0.5	63.7	Stop sign, turn left on to Ohio 113, with caution.
3.2	66.9	Stop sign. Cross Ohio 108.
4.5	71.4	Begin to come up on end of Defiance moraine. Junction of routes 109 and 113. Continue straight ahead.
2.2	73.6	Leipsic, Ohio, continue through town on 113.
1.4	75.0	Cemetary on beach ridge on right.
8.2	83.2	McComb, Ohio. Continue through town on 113.
5.8	89.0	To your right, up on beach ridge, is old McComb sand and gravel pit. Continue on 113.
2.6	91.6	Van Buren, Ohio continue through town on 113.
0.4	92.0	Turn right on to Allen Twp. Road 218.
0.3	92.3	STOP #7. *Van Bure Lake State Reserve.* Here particular attention will be given to glacial till.

* * * * * *

That is all. Have a safe trip home. For Route 25 south, return to 113, turn left and proceed west one mile past overpass then turn left.

Best route east is 113 to Fostoria.

THE GEOLOGICAL HISTORY OF NORTHWESTERN OHIO

Although there are no outcrops of Pre-Cambrian rock in Ohio, a few oil well rigs have drilled into the top of it and have struck what is believed to be an extension of the Canadian Shield. The rock layer contains schists, gneisses, and granite of the same type as found in the Canadian Shield.

The Cambrian is not exposed in Ohio and has only been reached through drill cores. The beds range from 600 to 700 feet in thickness and are composed of up to 50% sandstone. The common deposit of the Cambrian time was dolomite, laid down in comparatively quiet, shallow waters. During the beginning of the Cambrian, the area of Ohio along with a great part of the eastern section of the continent subsided to form a great geosyncline. As the sea intruded upon the land, animal life developed. The dominant type of life was the trilobite with a few minor phylums such as the brachiopods beginning to develop.

The mean thickness of the Ordovician rocks of Ohio is approximately 1,960 feet, varying considerably locally. The rock is composed mainly of dolomite, limestone, dolomitic shale or calciferous shale. There is no less than 3,262 square miles of Ordovician rock exposed in Ohio. Life under the sea was abundant in the Ordovician. Again trilobites were a dominant life form, with one (Genus Isotelus) attaining a length of 18 inches. The braciopods were also a dominant phylum in Ohio. Bryozoans became abundant during the Ordovician and horn corals began to appear. This rock is of economic importance as it has produced a large quantity of oil, maximum amount in 1896, 20,757,130 barrels.

The normal thickness of Silurian rock in Northwestern Ohio is 800 feet with some deposits up to 2,000 feet in some localities. These rocks contain the most economically valuable materials in Ohio, namely dolomite, limestone and gypsum; also oil, natural gas, salt and brine are found in this formation. The warm inland seas of Ohio favored life and it was very abundant. Coral reefs became plentiful during the Silurian: Eurypterids, Nautiloid Cephalods, and even a few primitive land plants began to appear. Only the scorpion, of which there are only four known specimens of Silurian age, were land creatures.

During the Devonian, the sea was teeming with marine life, all kinds of invertabrates and vertabrates of the phylum pisces. Some members of this group reached great length such as the placioderm *Dinichthys* which attained a length of 25 feet. The lungfishes began to appear giving rise to the amphibians, also true land plants began to appear.

Early Mississippian, black shales were accumulating in Northwestern Ohio which later gave way to silts and fine sands. Later, the sea began to clear and limestones were deposited. Rocks of the last part of the

Mississippian are not found in Ohio. Therefore, Ohio was probably out of water. A great many types of fossils were found during this period, and over 400 types of fish, gonoids, pelecypods, conodonts and other creatures were found.

Although not represented in Northwestern Ohio by outcrops, the Pennsylvanian period should be mentioned.

The area of Ohio was alternately invaded by the sea and then following the invasion, a retreat of the sea and deposits of non-marine sediments. When the lowlands were not covered by the sea, dense forest-swamps prevailed and in the recurring cyclothems coal beds were formed. The animal life of the Pennsylvanian period is represented by corals. Laphyllidium. Crionoids, brachiopods, pelecypods, gastropods, and few trilobites which is an indication of their eventual extinction. Amphibians, reptiles, spiders and many types of non-flowering plants existed at this time.

The Permian period is not represented in Northwestern Ohio either, but it is worth mentioning a few pertinent facts about it. The land now uplifted and the sea ended in Ohio. The area of interest now shifts to land animals which were present, or reptiles of which we have a very incomplete record as they were probably washed away by erosion during the following ages. Beds from the upper Permian to the Pleistocene were either not deposited or they have been eroded away as we have no record of the animal life in Ohio during these periods.

Approximately one million years ago the climate of North America cooled down. As the snow was deposited in the winter it would pile up. With the coming of the cool spring and summer not all the snow would melt completely and would be added to the next winter's snow. When sufficient amounts of snow had been deposited, the glaciers were formed and they eventually spread out over Ohio from the north to the south. As these glaciers moved over the land they carried sand, rocks, gravel and boulders moving them down across Ohio. These in turn scratched and scoured the rock surfaces over which they were dragged. When the glacier melted, the glacial debris, called drift, was deposited upon the land surface forming the rich Ohio overburden soils.

The fossils of the Pleistocene represent most of the forms of life today. Modern plants, Ostrocads, pelecypods, Gastropods, and a few bird skeletons are found. Many forms of Vertebrates now extinct, mammoths, mastodons, giant beavers, musk-ox and ground sloths are found. As of yet, however, no indication of ancient man has been found in Ohio.

PLEISTOCENE GEOLOGY OF NORTHWESTERN OHIO

Comparatively little work has been done on the glacial geology of Northwestern Ohio outside of the early work by Leverett and a little later by Carney. Recently the staff (now assisted by graduate students) at Bowling Green has been working — first in Seneca County, and this year work is beginning in Hancock and Wood counties.

Apparently only the Wisconsin glacier left very noticeable effects in Northwestern Ohio. It made many changes in the surface features, leveling certain areas to a smooth, even plain, piling up drift in others to knobby hills and billowy ridges, and filling certain valleys with great quantities of outwash materials from the finest silts to coarse boulders. That large part of the bedrock surface which is composed of limestone or dolomite was ground and polished, and in places small scratches and great furrows were carved into the soft rock. Where the bedrock was not smoothed it was covered with the debris from the melting ice. Even in this flat country, irregularities in the bedrock surface, slight though they might be, were responsible for determining, at least in part the positions of the moraines and of the beaches of the lakes which followed the glacier.

The chief moraine in Northwestern Ohio is the Defiance moraine. Others lie to the south, but will not be included in the area to be covered on this trip. The till plain north and south of the moraine is, in this area, mostly covered by lake plain or beach deposits. The till varies in thickness from 0 to 175 feet. The most conspicuous filled valley in this area lies in Auglaize and Mercer counties. The fill varies from 100 to 500 feet, and consists of more or less stratified material at the bottom and till at the top.

GLACIAL LAKES

The beach ridges left by the lakes formed during the retreat of the Wisconsin glacier are quite distinctive physiographic features in northern Ohio. Generally they are low, narrow ridges, embankment like in character, and are composed largely of sands and sandy silts with some gravel. Lake Maumee I, the first lake, came into existence when the ice had receded far enough to the north so that a basin became uncovered which was blocked to the north by the ice and to the south by the Ohio divide — in this area this

BEDROCK GEOLOGY OF NW OHIO

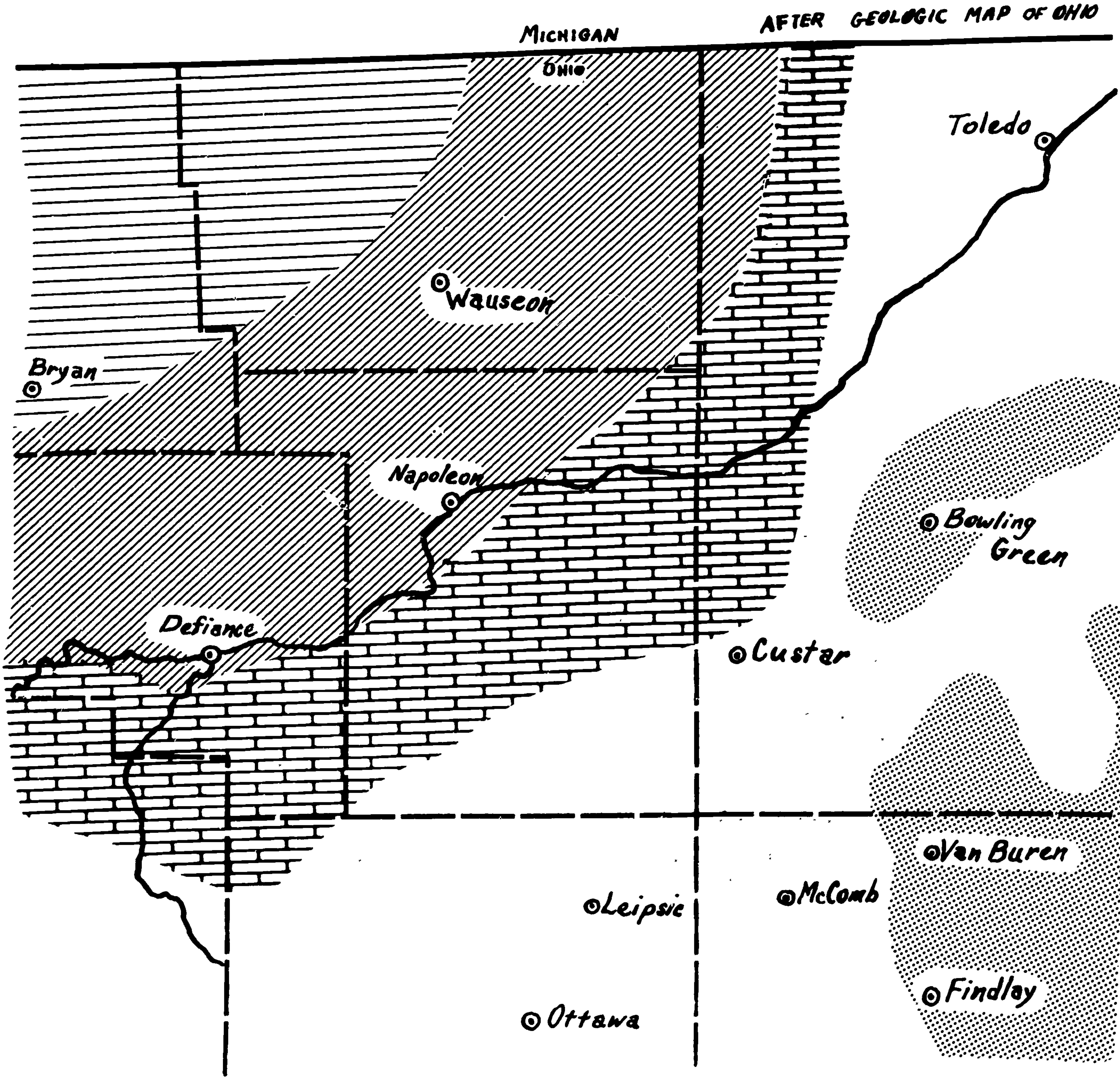
WAVERLY + MAXVILLE } MISSISSIPPIAN

OLENTANGY + OHIO } DEVONIAN

COLUMBUS + DELAWARE

MONROE } SILURIAN

NIAGARA



is the position of the Defiance moraine. This first lake is identified by beaches characteristically occuring at an elevation of 800 feet. Drainage from the lake was to the west by way of the Maumee and Wabash rivers, the Maumee river breaching the Defiance moraine (or finding a low place in the moraine) in the vicinity of Defiance. Maumee I beaches are present only in the western part of the state, implying ice present to the east still.

Lake Maumee II beaches are found at an elevation of 760 feet. A retreat of the ice front opened a lower outlet across Michigan. These beaches are not prominent because they were covered by the waters of Lake Maumee III. The ice readvance which caused Maumee III also covered the northern outlet causing a return to the old Maumee-Wabash outlet. Beaches of Maumee III are the best developed of any of the three stages. They stand at 780 feet. The trip will follow this beach much of the way from Leipsic to Van Buren on Route 113. These beaches are present all the way to the eastern end of Lake Erie.

A large bay was formed in connection with the Maumee lakes behind the Defiance moraine, lying west and south of Defiance, extending as far west as Ft. Wayne, Indiana (or nearly so), north across the Michigan line, and east to Findlay. A smaller version of this same bay existed during the next major lake stage, Lake Whittlesey. The Whittlesey beaches of northern Ohio are generally the best developed of any of the beach ridges, lying at an elevation of 735 feet. *The trip will cross the Whittlesey beach at a point which is not noted in the road log. Just before coming into Defiance, Route 281 joins Route 18 which has been traveling the Whittlesey beach. The beach is crossed at this point, somewhat obscured by the cutting of the Maumee River which lies off to the right.*

The third major lake stage in this area is the Lake Warren stage, which lies at an elevation of 680 feet. This is the ridge followed by the trip on Sand Ridge Road going out of Bowling Green.

Radiocarbon dates of the various lakes are approximately as follows:

Maumee I, II, and III —between 13,000 and 14,000 years
Whittlesey —slightly less than 13,000 years
Warren —about 10,000 years.

(after Forsyth, 1959)

GLACIATION IN NORTHWESTERN OHIO CITIES AND TOWNS

Defiance County —Defiance

The area was glaciated by both the Illinoian and Wisconsin ice sheets. Regionally drift is from 40-80 feet in thickness. The western boundary of the Defiance moraine, which is not prominantly defined here, lies just west of the town.

Hancock County —Findlay

Both ice sheets covered the area. The southern border of the Defiance moraine crosses the town just north of the Blanchard River. South of this river the drift is thin, averaging less than 25 feet, but north of the stream it increases, from 40 to 100 feet.

Lucas County —Toledo

Within the city limits the drift averages more than 100 feet.

Williams County —Bryan

Drift here varies from 100 to 175 feet in thickness.

Wood County —Bowling Green

Drift here is thin, from 5 to 25 feet.

(after Ohio Bulletin 44)

PUGH QUARRY

WATCH FOR THESE POINTS OF INTEREST

Rim glacial grooves and striations, stylolites, fossils (immediately under striations) carbonaceous deposition on tiny calcite crystals

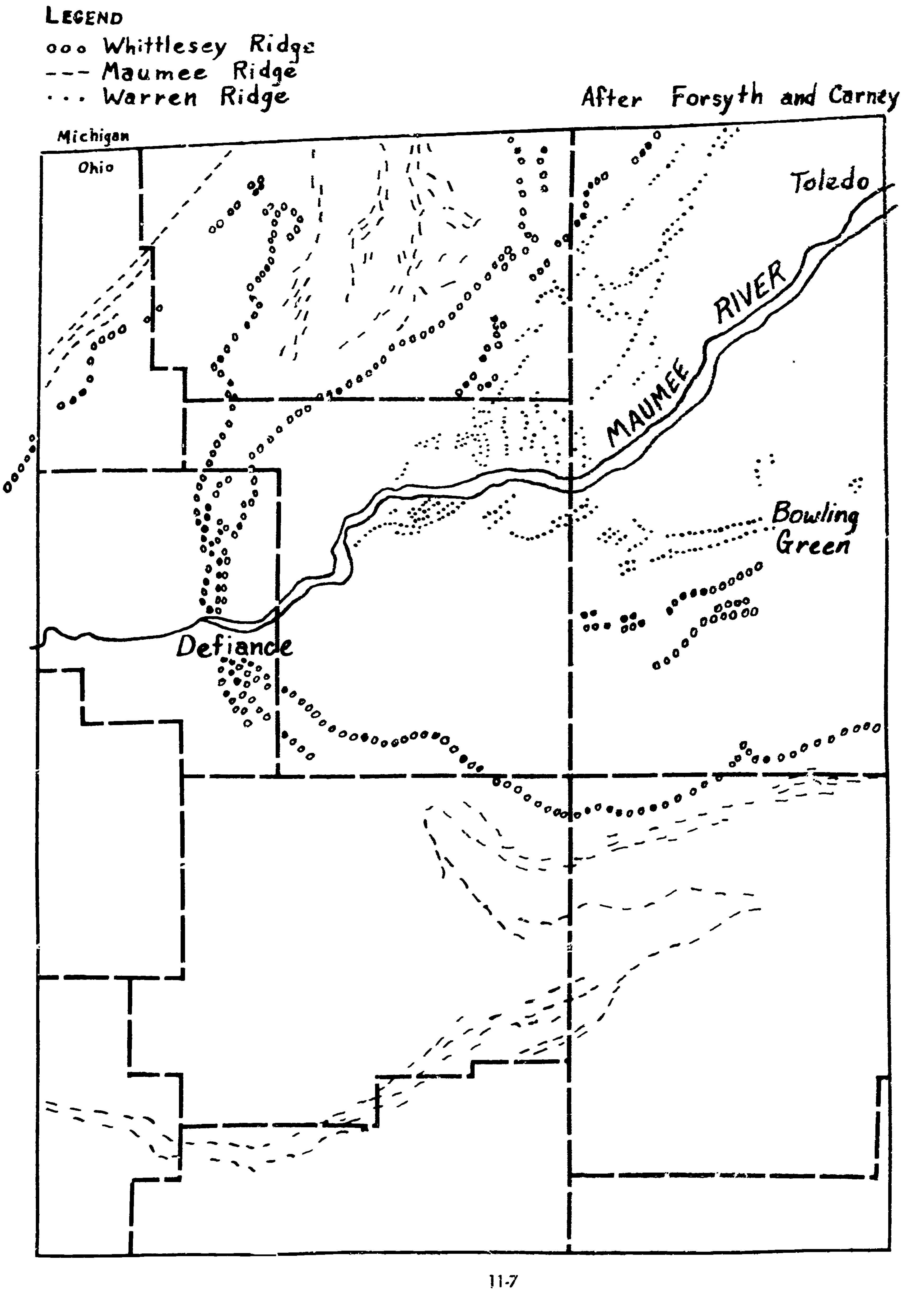
30 foot blasting level

vugs of calcite (depleted) unconformity between Columbus Formation and Detroit River group

to left of ramp breccia and some calcite and marcasite, 60 foot blasting level

to right of ramp possible collecting of calcite and marcasite bottom of quarry, 90 feet

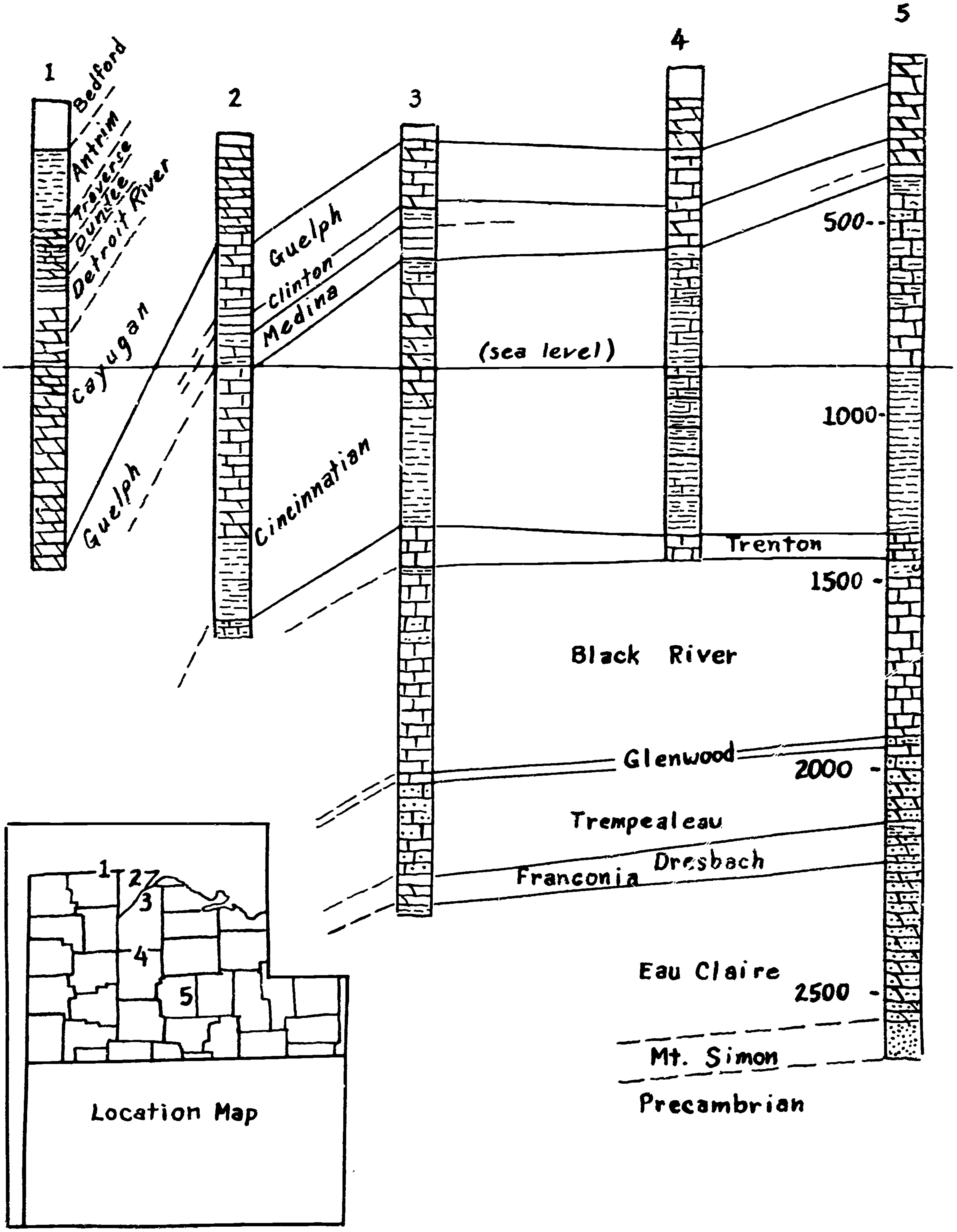
PLEISTOCENE BEACH RIDGES



GEOLOGIC CROSS SECTION OF THE PALEOZOIC ROCKS

OF NORTHWESTERN OHIO

(Modified after Shearrow, 1957)



INTRODUCTION

The Pugh Quarry Company is located three and one-fourth miles northwest of Milton Center, four and one-half miles southwest of Weston, in the southwest corner of section 6, Milton Township, Wood County.

The author wishes to thank Mr. Verne Miller of Pugh Quarry for verbal contributions concerning historical background material and present day plant procedures.

REGIONAL GEOLOGY

The Paleozoic era was a time of alternating elevations and subsidences with accompanying sea invasions and sedimentary deposition. During the Ordovician period a low, arching ridge, developed from northern Alabama to Lake Erie and on into Canada. This arch enters Ohio near Cincinnati, continues across the state to east of Toledo. This arch, known as the Cincinnati Arch, is too low a structure to be a noticeable feature of our landscape, therefore we know of its existence only because the sedimentary rocks dip away from its crest.

The consolidated rocks in Wood County are nearly all dolomitic. They lie on the west flank of the Cincinnati Arch, dip northwestward into the Michigan basin, and are broken by faults. One of the better developed and larger faults has a throw of 200 feet. It passes through Waterville on the Maumee River and near Bowling Green. Deducting for this Bowling Green fault, the dip of the consolidated rocks in Wood County is approximately 13 feet per mile.

The surrounding terrain is the result of glaciation and is a till plain of the Central Lowlands province. The dominating feature of this region is the old lake plain.

LOCAL GEOLOGY

The Pugh Quarry lies in the somewhat crescent-shaped area of Middle Devonian outcrop. It is impossible to determine the exact thickness of the Middle Devonian formation in the northwestern part of Ohio, since no single outcrop gives the entire section and the well records have not been satisfactory. At present there is oil drilling interest nearby. This new information obtained from cores may clear up some questions pertaining to this area.

PUGH QUARRY GEOLOGY

The lower portion of the Columbus limestone (Dundee) is seen in the upper part of the quarry walls. In general the strata are massive in bedding, somewhat earthy in appearance, and light gray to light brown in color. The uppermost layers are fossiliferous. The following brachiopods are found: *Stropheodonta, Atrypa, Rhipidomella.* The coral *Favosites* is also found, plus numerous others.

On the rim of the quarry, glacial striations and grooves are evident. The till here is only a few feet thick. Also on the rim small joints made more evident by blasting reveal styolites and small calcite crystals with a manganese covering.

Near the base of the Columbus there are numerous vugs. These pockets, now depleted by mineral collectors, did contain crystals of calcite. Just below the area of vugs the Columbus formation rests disconformably on beds of the Detroit River group.

The Anderson limestone and Lucas dolomite represent the Detroit River group just below the Columbus formation, and is exposed in the lower part of the quarry. The Lucas is characteristically a dolomite. The formation is well bedded; the layers are from two to twelve inches in thickness. The color varies from light blue to drab depending on the state of oxidation of the iron minerals.

ECONOMIC GEOLOGY

From 1875 to 1900 only flat rock was quarried for foundations. Many homes in Weston and Deshler nearby today still have foundations built from rock quarried during this period. In 1905 crushing equipment was set up and material was quarried and crushed for road construction. In 1910 all operations ceased and the quarry filled with water. In 1935 the Pugh Company moved in new crushing equipment and started to pump out the water.

Today the rock is quarried from the natural bed, crushed by jaw or roll crushers and screened into various sizes. The piles seen near the entrance of the quarry show different grade sizes.

Pugh Quarry is approximately 90 feet in depth and is worked in three steps, each a 30 foot level. The composition of the bedrock is generally dolomitic.

Pumping equipment for a 50 foot capacity is financially reasonable. For each additional foot over 50 feet more elaborate equipment is needed and the cost is unproportionally high. Pugh Quarry is pumping water half of the time at the rate of 750 gallons per minute. The nature of the dolomite and the hardness of the rock at lower levels warrants the high pumping cost.

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TILE QUARRY

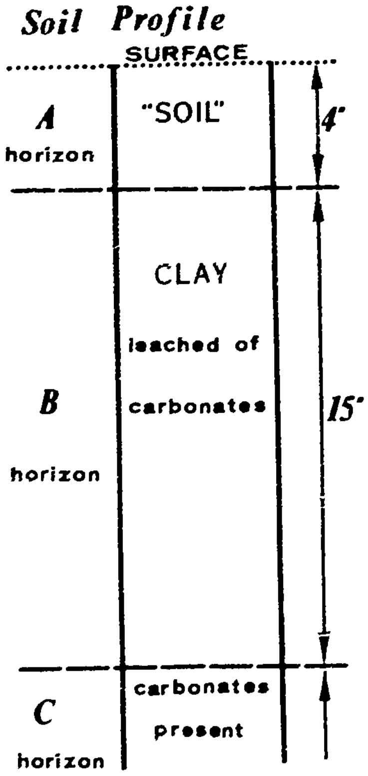
This quarry, located on the glacial lake plain at Elery, Ohio has been in operation since the late 1890's. During this time, approximately 56 acres have been quarried. However, the production in the last ten years has exceeded the production in all of the previous sixty years.

At the present rate, 2 acres are being quarried per year and six men produce 40,000 tile per week. The clay is more than 30 inches in thickness in some parts of the quarry. Rarely, however, does the quarry depth exceed 19 inches because below this depth, the carbonate content is too great to make high quality tile.

The first four inches constitute the "A" horizon and have been reworked by roots of plants, weathering and other means, and the clay minerals have, to a great extent, been leached out. The usable clay in the "B" horizon contains many pebbles.

This clay lens extends from the southwest to the northeast and thins out in all directions.

Soil Profile



FORT DEFIANCE

LOCATION

Fort Defiance lies on the glaciated, smooth, dissected lake plain of glacial Lake Whittlesey, at the apex of a V formed by the junction of the Auglaize River and the Maumee River. The elevation at this point is about 695 feet above sea level.

BED ROCK

The Ohio Shale, a dark carbonaceous shale of Late Devonian age, underlies the glacial drift and lake sediments in this area, but is rarely found outcropping except in a few places in the river beds. This is underlain by the massive blue-grey limestones of the Hamilton Group.

LAKE DEPOSITS AND DRIFT

The area was glaciated by both the Illinoian and the Wisconsin ice sheets, resulting in the deposition of from 40 to 80 feet of fine grained blue clay till interbedded with lenses of sandy till.

Numerous igneous and metamorphic boulders are found buried in the drift and scattered about the surface, carried down from the Canadian Shield area by the ice sheets and dropped when the ice retreated.

Fine, laminated clays are found overlying the drift in and around Defiance and indicated the deposition of lacustrine sediments on the bottom of Lake Whittlesey.

SUMMARY — DAM CUT

"An exposure in the east bank of the Auglaize River just downstream from the Toledo Edison Dam, three miles south of Defiance, Ohio, reveals two tills, separated by a cobble pavement and overlain by lacustrine and alluvial deposits. The upper till is clay-rich, with a mechanical analysis that fits within the ranges of both the late Cary till of Northeastern Ohio (Shepps, 1953) and the upper till of southern Ontario (Dreimanis and Reavely, 1953). The lower till is much sandier, with a mechanical composition that fits within the ranges of the sandier Tazewell till of northern Ohio and the lower till of southern Ontario.

Because the mechanical analyses of the tills and their relative stratigraphic positions are almost the same in Northeastern Ohio, southern Ontario, and in the Toledo Edison Dam cut, it is inferred that the glacial history of the three areas must have been almost the same, thus providing a basis of correlation between these areas.

Radiocarbon determinations give a date of 24-27,000 years ago for the advance of the glacier which deposited the lower sandy till. By about 12,000 years ago, both the sandy and clayey tills had been deposited and the ice had made its final retreat from the area. On the basis of comparison with radiocarbon dates in Illinois (Horbert, 1955), this ice advance and retreat appear to have occupied the entire classic Wisconsin interval."

(Forsyth, Jane L., 1960. Correlation of tills exposed in Toledo Edison Dam cut, Defiance, Ohio. Ohio Jour. Sci., 60(2):94)

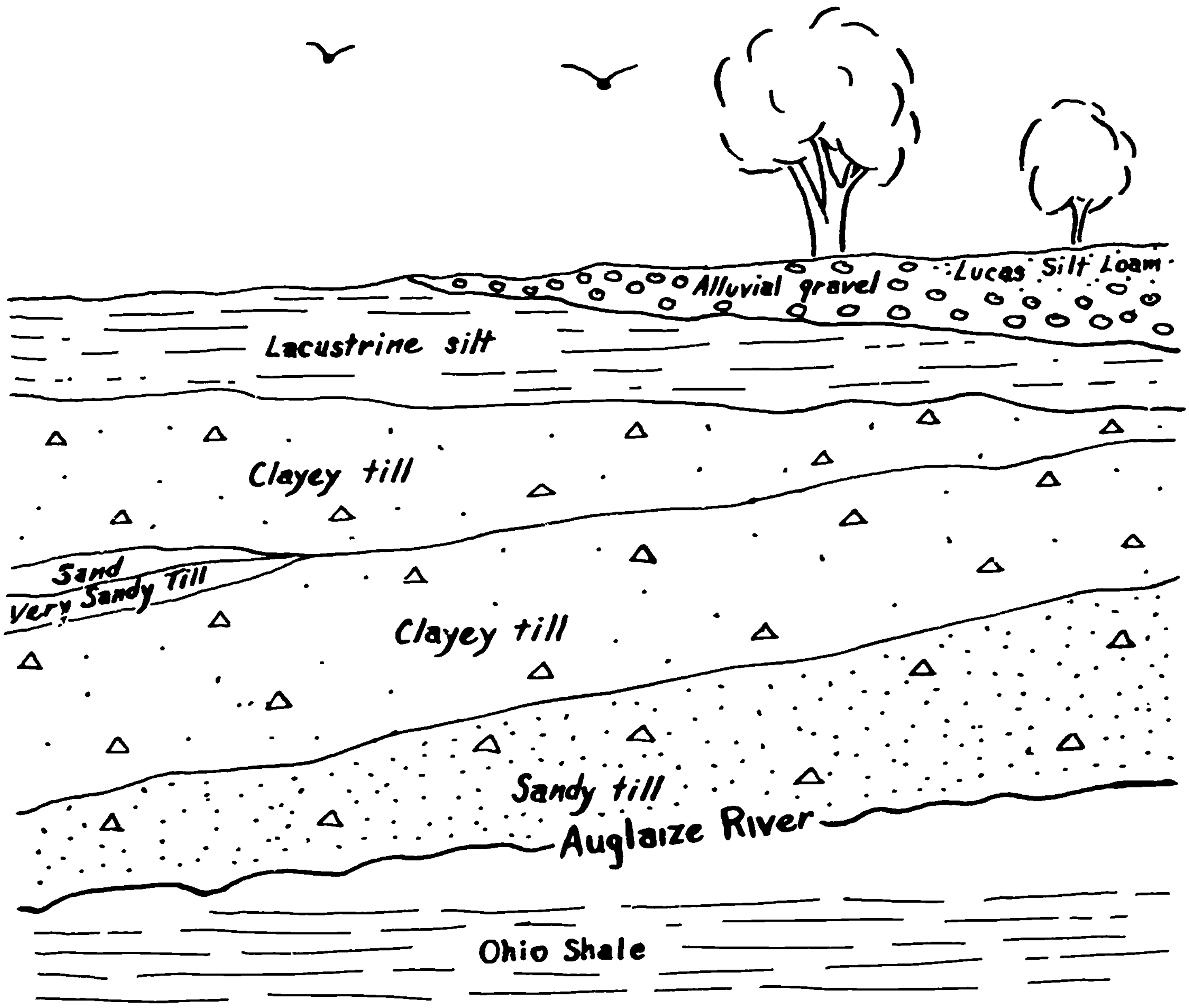
OHIO SHALE

The Ohio shale makes up a large fraction of the Devonian system. Throughout central and southern Ohio the Ohio shale formation is dominantly a black or dark brown carbonaceous and somewhat arenaceous shale.

In northern Ohio the Ohio shale formation has been divided into three members: Cleveland shale, Chagrin shale and the Huron shale.

The Cleveland shale member is exposed along the river bottom. There are two sets of joint patterns crossing the shale, which can be seen on the surface of the outcrop. These joint sets trend generally northwest and northeast. They intersect approximately at right angles and are nearly vertical. Minor sets also occur. This black shale contains many pyrite concretions. The percentage of organic material in the shale is sufficiently high to support combustion if the rock is once heated to the kindling temperature.

Because of the scarcity of other fossils, conodonts are of stratigraphic importance, as Wilbert Haas has demonstrated in his recent U.G. Professional Paper 286 (1956). In this publication he uses the sequence of conodont fossil zones to correlate the Chattanooga shale with the Ohio shale, which he believes to be entirely of Devonian age. Other fossils include a number of plants, carbonized and silicified, plant spores in local abundance, and plants and skeletal material of fish.



Stratigraphy exposed in Toledo Edison Dam Cut

STRATIGRAPHY OF THE SILICA SHALE

The Middle Devonian formation crops out in belts throughout central and Northwestern Ohio. In the central part a threefold division has been recognized, but in northwest Ohio Stauffer (1909) has made only two distinct divisions. The correlation of the northwest divisions with those in the central regions, and with the Middle Devonian formations in New York State are as follows:

NORTHWEST OHIO	CENTRAL OHIO	NEW YORK
Traverse	(Olentangy fm	Hamilton beds
	(Delaware 1s	Marcellus shale
Columbus 1s	Columbus 1s	Onondaga 1s

The name Silica shale of the Traverse group was proposed by Grace A. Stewart (1927) for shales and thin interbedded argillaceous limestones exposed in a quarry excavated 10 to 15 years previously by the Sandusky Cement Co. at Silica, Ohio approximately 8-miles northwest of Toledo, Ohio. Intermittent exposures of the formation along Ten Mile Creek had been previously called "Traverse" by Stauffer and other authors. The type locality for the formation is the previously mentioned quarry, now operated by the Medusa Portland Cement Co. The Silica shale is underlain by 8-feet of bluish-gray 1s, which is somewhat argillaceous in its upper part. This limestone, directly overlying the Dundee limestone was given the provisional name "Blue" limestone by F. E. Chorman in Bassett and in Stewart. Because the fauna of the "Blue" Limestone is similar to that of the overlying shales and interbedded limestone (F. E. Chorman and G. A. Stewart) after a field conference with Drs. Carman and Stewart, have dropped the name "Blue" limestone and have extended the name Silica formation to include the beds above the Dundee Limestone.

A thick-bedded, bluish-gray limestone overlies the Silica shale. The contact between the shale and this overlying limestone layer is well defined and is worked by mosses of branching sea weed wherever the contact is observed. The upper surface of the limestone reveals excellent glacial striae.

The Traverse formation of Northwest Ohio is dominantly Hamilton in its faunal content, and perhaps no one bed carries such a fine assemblage of Hamilton fossils as does the Silica shale bed. The shale is bluish-

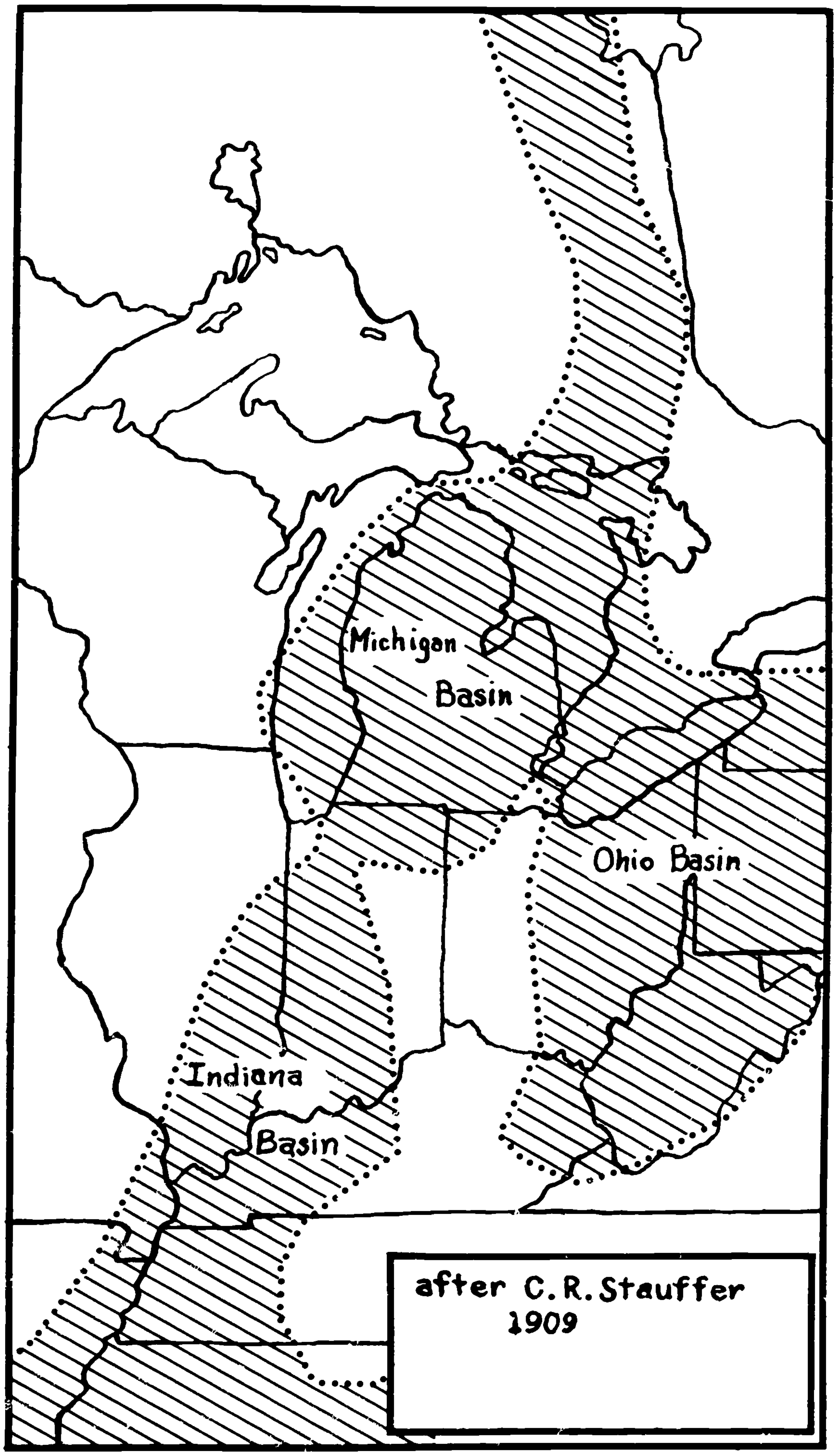
gray in color, soft and highly calcareous, and disintegrates very rapidly on exposure. It contains much iron pyrite, or more correctly speaking marcasite, which is in the form of concretions or as replacement of the shell material in the fossils. The line of separation between the "Blue" limestone and the shale is not clear cut lithologically, there being a transition through shaly limestone to the shale above. In the upper part of this transitional layer fossils occur in abundance. Some of the characteristic forms are *Spirifer mucronatus var. prolificum. Strophedonta demissa, Chonetes coronatus, Chonetes fragilis,* and *Rhipidomella vanupemi.*

Correlation of Devonian Rocks of New York, Northern Michigan and southern Michigan and northwestern Ohio.

Epoch	Stages	New York [Generalized]		Northern Michigan		SE Michigan and NW Ohio	
Upper Devonian	Conewango		Oswago fm		? ? Antrim shale		? ? Antrim shale SE Michigan Ohio shale [NW Ohio]
			Cattaraugus				
	Cassadaga		Conneaut gp.				
	Chemung		Chemung ss.				
	Finger Lakes		Enfield sh.				
			Ithaca sh.				
			Genudewa ls.	Traverse Group	Squaw Bay ls.		
Middle Devonian	Taghanic		Geneseo sh.				
			Tully fm.		Thunder Bay ls.		
					Potten Parm fm.		
	Tioughnioga	Hamilton Group	Moscow fm.				
			Ludlowville fm.		Norway Point fm.		
					Four Mile Dam fm.		Ten Mile Creek dol.
	Cazenovia		Skancateles fm.		Alpena ls.		
					Newton Ck. ls.		
					Genshaw fm.		
					Ferron Point fm.		Silica fm.
					Rockport Quarry ls.		
					Bell sh.		
			Marcellus fm.		Rogers City ls.		
					Dundee ls.		Dundee ls.
	Onesquethaw	Onondaga	Paraspirifer acuminatus zone				
					Detroit River group	Detroit River Group	Anderdon ls.
							Lucas dol.
							Amherstburg dol.
							Sylvania ss.
			Amphigenia zone		Bois Blanc fm.		Bois Blanc fm. SE Mich. only
Lower Dev.	Deerpark		Oriskany ss.		Garden Island fm.		
	Helderberg		Helderberg group				

Hypothetical Map of the Middle Devonian Sea

Delaware-Olentangy Time



BEACH RIDGE IN THE AREA OF McCOMB (HANCOCK COUNTY)

A beach ridge of Lake Maumee III, the third major Pleistocene lake of the Lake Erie basin in Ohio, with an elevation of 780 feet can be seen south and parallel to State Route 113. Lake Maumee III beaches are present along the entire length of the Erie basin in Ohio, as are all the younger beaches; this means that, by Lake Maumee III time (13,000 to 14,000 years ago), the glacial front had retreated out of the state to the north.

(Forsyth, 1959, p. 2, 4)

VAN BUREN LAKE AREA

Lake Maumee is the first and highest of a series of large, well defined glacial lakes which occupied the Huron-Erie Basin. Lake Maumee was limited on the south and west by a land barrier, but its limits on the north and east were determined by the retreating ice sheet. The Defiance moraine marks the position which the ice sheet held during a large part of the lake's existence. The Defiance moraine is composed of till, largely clay with a liberal mixture of small pebbles. Surface boulders and cobbles are rare. The water-laid part seems a little more compact than the land-laid part. The water-laid part carries little surface sand, much of its surface being a black, mucky clay. North of Findlay, the Defiance moraine rises nearly 50 feet above the level of Lake Maumee, but about 10 miles west it drops nearly to the highest lake level and continues at that level for about 10 miles farther, where it is crossed by a beach ridge of Lake Maumee. The course of the beach is south of east for several miles from the point where it crosses the Defiance Moraine. It then swings with the moraine to a course north of east and leads through McComb and Van Buren to Fostoria. There are essentially two beach ridges which run parallel and about 15 feet apart along the northern side of the moraine, although in some areas the two may not be differentiated. The two ridges are due to two different but almost coincident lake levels during retreat of the ice. At Van Buren there is a cut bank 12 to 15 feet high, the base of which seems to be near the level of the second beach and the top near the level of the upper beach. Van Buren then, and Highway 113 which goes through Van Buren, appear to be built on a beach ridge which represents the first and third levels of Lake Maumee. This ridge abuts the Defiance moraine on the north side of the moraine. Gravel pits in the area show clearly the beach relationship of this material to the moraine, which apparently stood as high ground against which the beaches were built.

(after Leverett and Forsyth)

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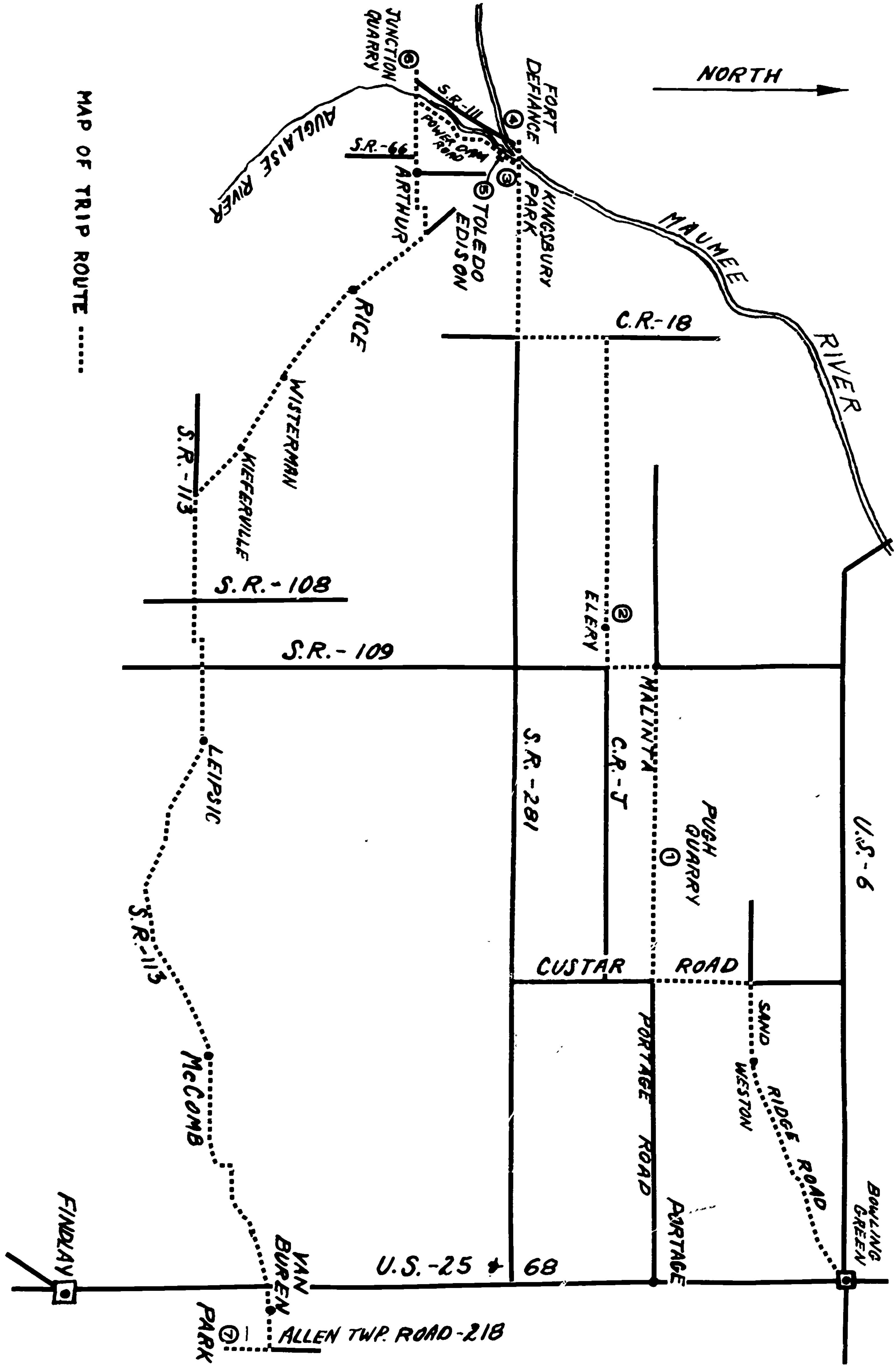
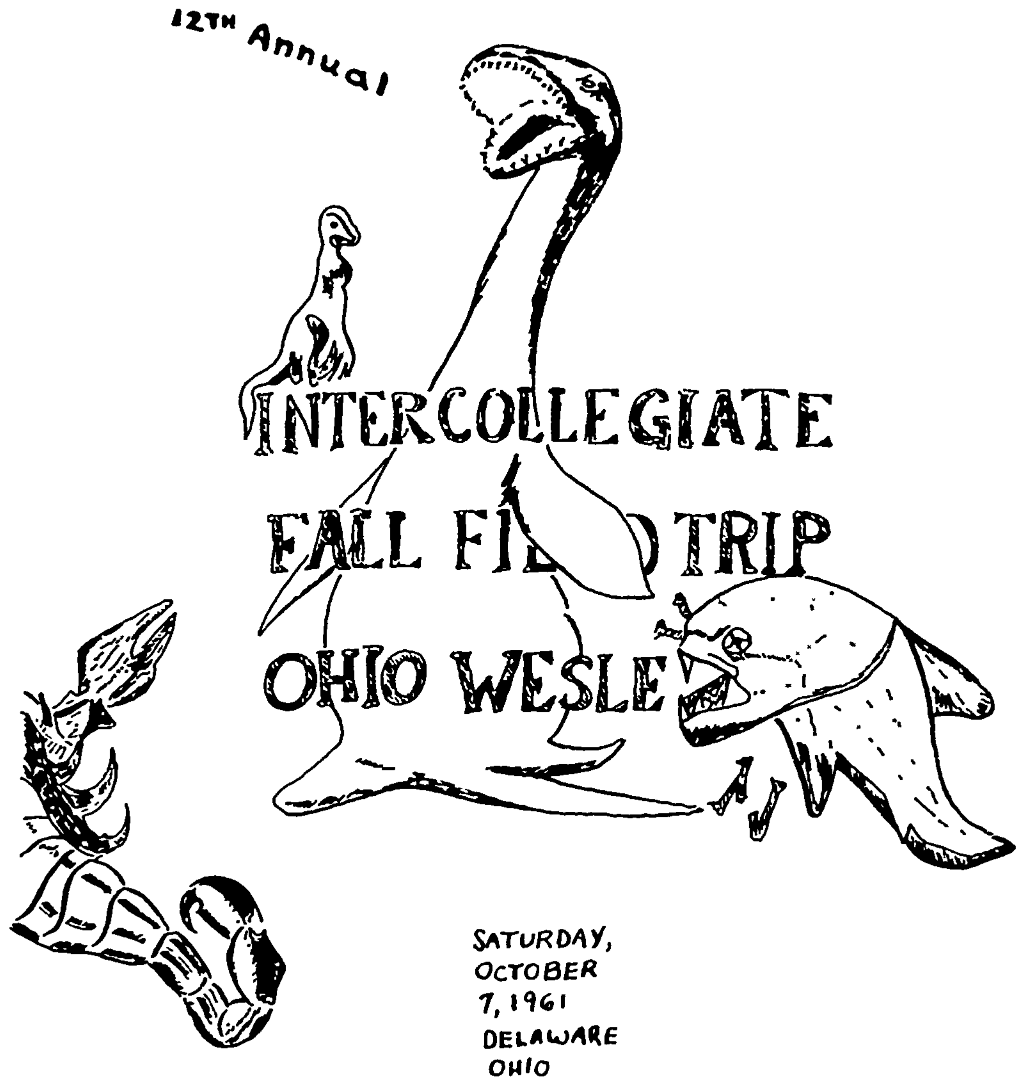

MAP OF TRIP ROUTE .....
NORTH
JUNCTION QUARRY
FORT DEFIANCE
S.R.-111
POWER DAM ROAD
S.R.-66
AUGLAISE RIVER
ARTHUR
KINGSBURY PARK
TOLEDO EDISON
MAUMEE RIVER
RICE
C.R.-18
WISTERMAN
KIEFERVILLE
S.R.-113
S.R.-108
ELERY
S.R.-109
MALINTA
C.R.-J
S.R.-281
PUGH QUARRY
U.S.-6
LEIPSIC
CUSTAR ROAD
SAND RIDGE ROAD
WESTON
PORTAGE ROAD
S.R.-113
McCOMB
BOWLING GREEN
PORTAGE
FINDLAY
VAN BUREN
U.S.-25 + 68
PARK
ALLEN TWP. ROAD-218



ROAD LOG

Assemble in Parking Lot — Ohio Wesleyan University

Miles	
0.0	Leave parking lot, turn right (south) on Henry Street. Go through R.R. underpass, turn right (west) on Harrison Street. Turn left (south), on U.S. 23 & 42 turn right (west) at next traffic light, (you can turn right on red light here) and follow U.S. 42 out of town.
6.0	Cross Scioto River Bridge
6.5	Turn right on Ohio 257 to Bellepoint.
6.9	Turn left on Delaware County Road 150 which follows Mill Creek.
8.2	STOP #1. Columbus limestone, and Lucas (?) dolomite, Detroit River Series.
	Retrace route to Ohio 257, turn left on 257 and immediately turn right beyone EUB Church, cross old bridge.
10.0	Turn left on township road.
10.4	STOP #2. Bioherm in Columbus limestone.
	Turn around, go south to U.S. 42 (1/4 mile south of school) continue south across U.S. 42 on to Ohio 257.
13.0	Delaware County 137, turn left on County 5, right on County 123.
18.8	Turn right (south) on U.S. 23.
20.4	Camp Lazarus entrance. Follow road into camp.
20.9	STOP #3. Delaware Limestone, Olentangy shale and Ohio shale.
	Return to U.S. 23, turn north, proceed to Ohio Wesleyan for lunch. Coffee in the geology labs. You can buy lunch at the Union or at restaurants about a block away. BE BACK ON TIME!
0.0	Leave Merrick, turn left, turn right (east) at traffic on to Ohio 37.
6.8	STOP #4. Ohio shale at Alum Creek.

Continue east on Ohio 37.

9.0	Berkshire, turn right (south) on County 34.
10.4	Rome (5 road intersection), bear left on County 34 to
13.4	Galena, turn left on County 30.
13.6	Turn left on County 19.
14.0	Road fork, straight ahead on to deadend road.
14.4	STOP #5. Bedford shale.
15.3	Retrace route to Galena, turn right on Harrison Street (County 24).
17.3	Sunbury
17.6	Turn right on Cherry Street.
17.9	Left on Otis.
18.0	Bear right on High.
18.2	Croton Street, turn right.
	STOP #6. Berea Sandstone.

END OF TRIP

Return to center of Sunbury to reach highways

GENERAL GEOLOGIC HISTORY OF DELAWARE COUNTY

Delaware County is mantled by a compact yellow weathering till, often attaining a thickness of 50 feet. The county is traversed by two Wisconsin end moraines, the Powell in the south and the Broadway in the north, along with several kames and eskers in the North West.

Bedrock formations are exposed in north-south belts, the younger occurring successively to the east due to a gentle eastward dip of 25 feet per mile.

The county's dolomites and limestones represent either deposition far from the Devonian shore or the existence of low land areas from which few detrital sediments were derived. Extensive sandstones indicate higher lands and swifter streams. Disconformities exist between the Delaware limestone and the Olentangy shale, and the Bedford shale and the Berea sandstone.

A. Hobbs

STOP #1

COLUMBUS LIMESTONE & LUCAS DOLOMITE (Detroit River Series)

The Columbus limestone and the Lucas dolomite are exposed here. The contact, marked by a poor conglomerate, is just above water level, and is difficult to find.

The Lucas dolomite crops out in a belt 4 to 5 miles wide in the western edge of the county, and varies from 400 to 600 feet in thickness.

It exhibits two facies: a thin-bedded, fine-grained, grey dolomite and a thicker bedded, buff or brown dolomite, more porous than the first and resembling the dolomitic lower Columbus limestone.

The Lucas Dolomite is nonfossiliferous and contains, at best, a few imperfect casts of brachiopods.

The Columbus limestone crops out in a wide belt in the western part of the county, and is about 80 feet thick. It is generally massive to thick bedded, gray to light brown, and dolomitic in the lower part.

A. Hobbs
S. Wagner

STOP #2

BELLPOINT BIOHERM — COLUMBUS LIMESTONE

The Bellpoint bioherm, in the lower part of the Columbus limestone, is a local fossil-rich mass built by sedentary organisms such as corals, crinoids, and bryozoa. It is a light brown, fine grained, well compacted, thick bedded dolomitic limestone containing the following fossils.1

BRACHIOPODA

Atrypa
Brachyspifer audaculus
Choretes
Megastrophia hemisphaerica
Mucrospirifer mucronatus
Strophiodonta

BRYOZOA

Salcoretepora

CORALS

Heliosphyllum halli
Siphorophsentis gigantea
Synaptophyllum simcoense
Zaphrentis corniculum

CRINOIDEA

stems

GASTROPODA

Palaeotrachus Kearnegi
Tentaculites Scalariformis

1. *Ohio Fossils:* Aurele La Rocque & Mildred Fisher Marple, Columbus 1956.

P. J. Fox

STOP #3

CAMP LAZARUS

A youthful stream cuts through the camp exposing the Delaware limestone, the Olentangy shale, and the Ohio shale before it runs into the Olentangy River two miles to the west.

DELAWARE LIMESTONE

The Delaware limestone is the uppermost formation of the limestone series of western Ohio. It is blue-grey, thin-bedded, and fine grained, with numerous thin bands of brown, shaly limestone as partings, and is also noted for numerous layers of chert nodules that occur throughout the formation.

OLENTANGY SHALE

This is a soft, grey-green, gritless shale 30 to 35 feet in thickness. It is not laminated, and when freshly dug it shows an indistinct bedding with layers three to six inches thick. The exposed surface crumbles to small, flat, angular debris that eventually weathers to a grey clay.

The Olentangy rests in apparent conformity on the Delaware Limestone. However, south of Delaware County the Olentangy rests in succession on the Delaware, the Columbus, the Lucas, and, in Ross County, on the Niagaran, proving an unconformity at the base of the Olentangy.

OHIO SHALE

When fresh it is a dense, fine-grained, deep chocolate-brown or brownish-black shale, slightly gritty and indistinctly but thinly laminated. When freshly broken it has an oily smell.

CONCRETIONS

Large rounded concretions of dark-brown dolomitic limestone are very abundant in all the exposures of the lower part of the Ohio Shale. They vary from a few inches to six or eight feet in diameter, the smaller ones being nearly round. whereas the larger are more elliptical. The shale beds are bent both above and below the concretions.

The smaller concretions are solid to the center, but in the larger ones the center is more or less broken and healed with coarsely crystallized calcite.

Fish bone fragments are occasionally found at the center of the concretions, and served as the nucleus about which the concretion grew.

Westgate (1926) argues that crystallization began following the compaction and consolidation of the shale as ground water circulated above the impervious Olentangy shale.

According to Clifton (1957) concretions were formed during some stage of compaction. The concretions are not subsequent forms because they contain undeformed and unoriented spore cases. Spore cases in the shale are flattened and orientated parallel to the bedding. It is unlikely that the concretions form at the same time and at about the same rate as the enclosing sediment, for it is doubtful that shale forming mud could support a concretion at the water-mud interface.

The arching of the shale above and below the concretion is due to the compaction and shrinkage of the mud around the solid object.

J. Clausz
J. Watts

STOP #4

ALUM CREEK: OHIO SHALE

The upper portion of the Ohio shale exposed at Alum Creek contains calcareous layers with cone-in-cone structure: concentric cones of varying heights composed of calcite, clays, and insoluble materials. According to Karhi (1948) these structure resulted from diagenesis of a calcareous ooze later affected by pressure and solution to form the cone-in-cone.

The depositional environment of the Ohio shale has long been a controversy between those who favor shallow water or "tidal flat" deposition, and those who favor a deep-water environment. (For an excellent summary see Hoover, 1960, pp. 32-33).

There are two outstanding sets of joints which meet at nearly 90° and have an almost vertical dip.

A fine example of differential weathering can be seen in the slope of the bank.

M. W. Finkin

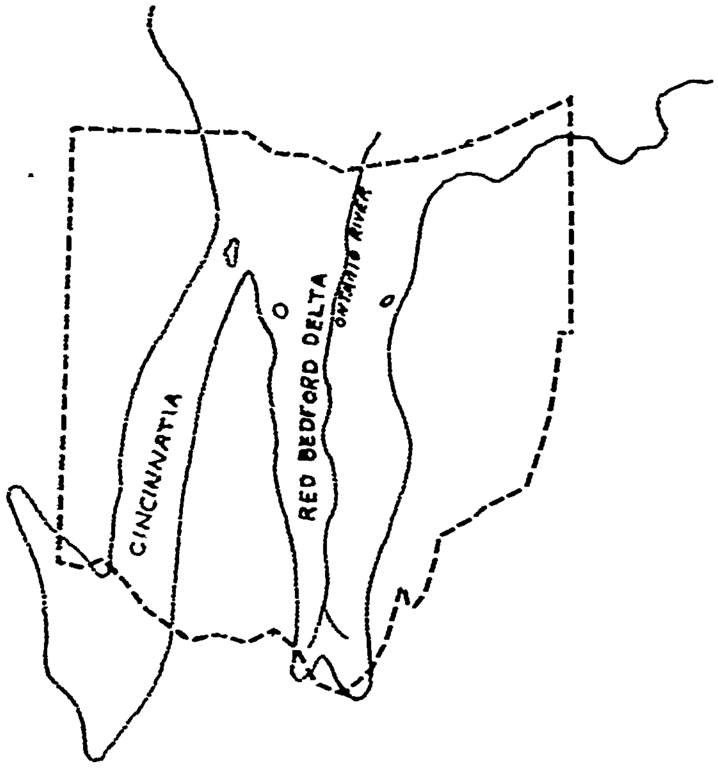
STOP #5

GALENA SHALE TILE & BRICK CO.
Bedford Shale

This exposure of the Bedford Shale is about 35 feet thick although the thickness of the entire formation here is about 100 feet. The red claystone is approximately 3 feet thick overlain by approximately 15 feet of gray soft claystone and underlain by approximately 15 feet of gray claystone with interbeds of thin gray silty mudstone. The red shale thickens toward the source area to the north. This exposure is near the base of the formation; the contact with the Ohio Shale is about 1/4 mile south of the pit. Except for the lower two feet the Bedford Shale is nonfossiliferous.

At the beginning of Bedford time an extensive Delta formed southward through the middle of the Ohio Bay, its sediments attaining a maximum thickness of 150 feet in the center and feathering out at the edges. Large quantities of red soil materials were transported from the Canadian Shield by the Ontario River and deposited in Central Ohio. Reduction of the red sediments in favorable local environments account for the drab sediments associated with the red beds. Subsidence following the maximum development of the delta led to the deposition of gray muds and silts on top of the red layers. Introduction of clastic sediments in the subsiding delta led to the formation of the overlying Berea sandstone.

The Bedford shale is valuable for the dry component in the manufacture of bricks.



PALEOGEOGRAPHIC MAP OF BEGINNING OF LATE BEDFORD TIME

Modified from Pepper, J. P.; W. DeWitt Jr.; D. F. Demarest. *Geology of the Bedford Shale and Berea Sandstone in The Appalachian Basin*, U. S. Geological Survey — Professional Paper 259, Washington D. C., 1954. Pl. 13C.

J. Campbell
R. Ross

STOP #6

BEREA SANDSTONE — SUNBURY

The Berea sandstone is a medium to fine-grained, ripple-marked and cross-bedded lower Mississippian sandstone which lies unconformably on the Bedford shale, mostly as channel fill.

The lower 2/3 of the formation is more massive and cross-bedded than the upper 1/3, which is noted for its ripple marks.

One should note the shale boils in the underlying Bedford shale, the Berea-Bedford contact, and the flow folds in the Berea.

The largest sandstone flow is 8 to 12 feet thick and 225 feet long (Cooper, 1943). It is obvious from the truncated tops of the flow structures that these were formed previous to the deposition of overlying beds.

K. Engler
B. Peck

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(GEOLOGIC MAP OF DELAWARE COUNTY CAN BE FOUND IN THE SIXTH FIELD GUIDE)

13th ANNUAL OHIO INTERCOLLEGIATE FIELD TRIP

KENT STATE UNIVERSITY
OCTOBER 6, 1962

Kent State Geological Society Professional Paper 2

ROAD LOG

Mileage

STOP #1. Assemble in the Morton Salt Company Parking Lot

Fairport Mine, Painesville, Ohio
(Morton Salt Company)

The salt deposits of Ohio consist of two types: (1) natural sodium chloride-bearing brines occurring within the pore spaces of sedimentary rocks of Cambrian through Pennsylvanian Age, and (2) solid rock salt or halite occurring in layers interbedded with sedimentary rocks of Silurian Age.

In the Painesville area, the salt of economic value is the rock salt variety. It is confined to three stratigraphic zones, each consisting of two to seven relatively pure salt layers interbedded with shale, dolomite, and anhydrite (See drill log.) The upper, middle, and lower zones are, respectively, 100, 35, and 110 feet in aggregate thickness. The salt, which is commonly colorless, white, or gray, occurs as coarsely crystalline masses showing no bedding, or as finer-grained layers with a distinct lamination.

In the extraction of the salt, the brine variety is recovered by drilling and subsequent pumping to the surface. The rock salt is obtained by artificial brining (drilling-introduction of water-solution of the salt-pumping to surface) or by conventional mining methods.

Until recently, most of the salt produced in Ohio was obtained by artificial brining and, to a limited extent, by pumping of natural brines. One of the first salt mines to open in Ohio since 1901, and the first in the United States in the last 25 years, is the Fairport Mine located roughly 1/2 mile south of Lake Erie at Painesville.

The Fairport Mine is the deepest salt mine in the nation, extending to a depth of over 2,000 feet. The mine is being developed in such a way that, eventually, a system of tunnels will provide a five-mile subterranean network extending under Lake Erie. The mining technique employed is the "room-and-pillar" method, providing for the excavation of large "rooms" and

the retention of blocks or "pillars" of salt (between the rooms) which serve as natural supports for the mine. By this technique, approximately 50 per cent of the salt will remain untouched in the mine.

Estimated reserves of salt at the Fairport Mine exceed 200 million tons, or the equivalent of 200 years of maximum production. When full production is attained, a mining capacity of 300 to 500 tons per hour is expected.

0.0 Leave Morton Parking Area.

0.2 Turn left (across R.R.)

0.9 Turn left.

0.1 Stop sign —turn right.

0.3 Stop sign —straight ahead —join Route 283.

1.1 Turn left on Route 535.

0.4 Cross Grand River.

0.2 Bear left on Route 535.

0.9 Leave Route 535 —Continue straight ahead on East Street.

0.4 Turn right on Second Street and enter Diamond Alkali Company Parking area.

STOP #2

The Diamond Alkali Company

The group will gather in the auditorium of the Industrial Relations Building at the extreme east-end of Second Street in Fairport. The company plans to guide us on a two hour tour through the Soda Ash, Chlorine, and Utilities operations.

A. *The Soda Ash Operation: Ammonia soda process*

1. Limestone ($CaCO_3$) and coke (C) are placed in kilns to produce carbon dioxide gas (CO_2) and lime (CaO)

   a). $CaCO_3 + C \longrightarrow CaO + CO_2$

2. Brine (NaCl) pumped from deep (2000 feet) wells is saturated with ammonia gas (NH_3) and run into carbonating towers where it reacts with the carbon dioxide from the kilns.

   b). $NaCl + NH_3 + H_2O + CO_2 \longrightarrow NH_4Cl + NaHCO_3$

   This yields a deposit of solid sodium bicarbonate ($NaHCO_3$) and ammonium chloride in solution. The bicarbonate is separated from the solution in rotary vacuum filters. It is then washed and calcined; this reaction yields soda ash (Na_2CO_3) and carbon dioxide gas.

   c). $2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$

3. The Soda Ash process is economically feasible only because the expensive ammonia is recovered and used over again. The ammonium chloride solution in (b) is pumped into lime stills where ammonia gas is recovered and re-cycled through the towers.

   d). $2NH_4Cl + CaO \longrightarrow CaCl_2 + 2NH_3 + H_2O$

B. *The Chlorine Operation: Electrolytic process*

1. Purified brine is placed in electrolytic cells through which an electric current is passed. Chlorine gas (Cl_2) and hydrogen (H_2) are liberated and caustic soda (sodium hydroxide, NaOH) remains in solution.

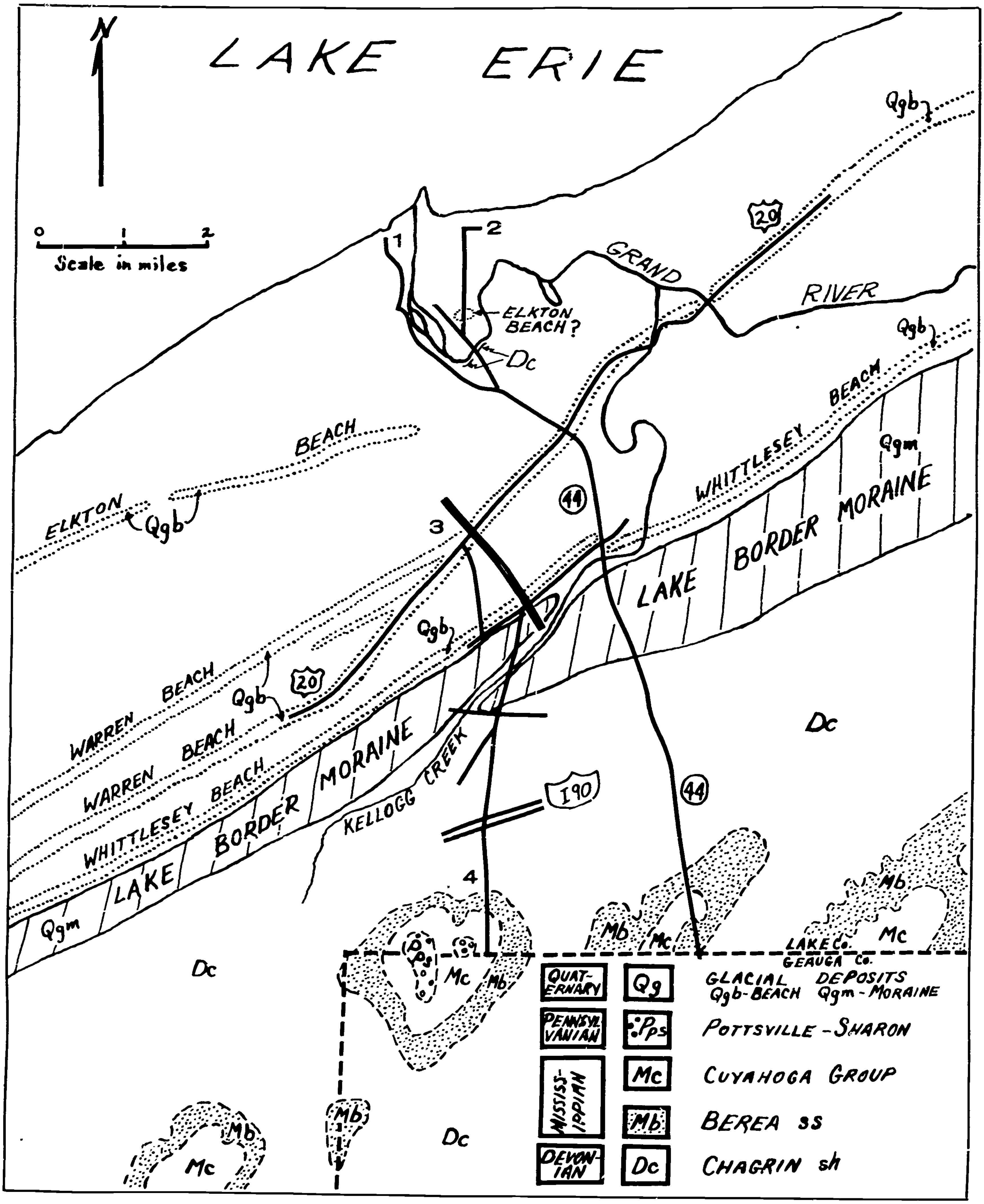
2. The chlorine gas is cooled, dried, and compressed. Some is piped into another part of the plant for use in chlorination processing operations. Some is further cooled and compressed into liquid chlorine.

3. The hydrogen gas is used as a fuel or combined with chlorine to make hydrochloric acid.

4. The caustic soda is concentrated, settled and filtered.

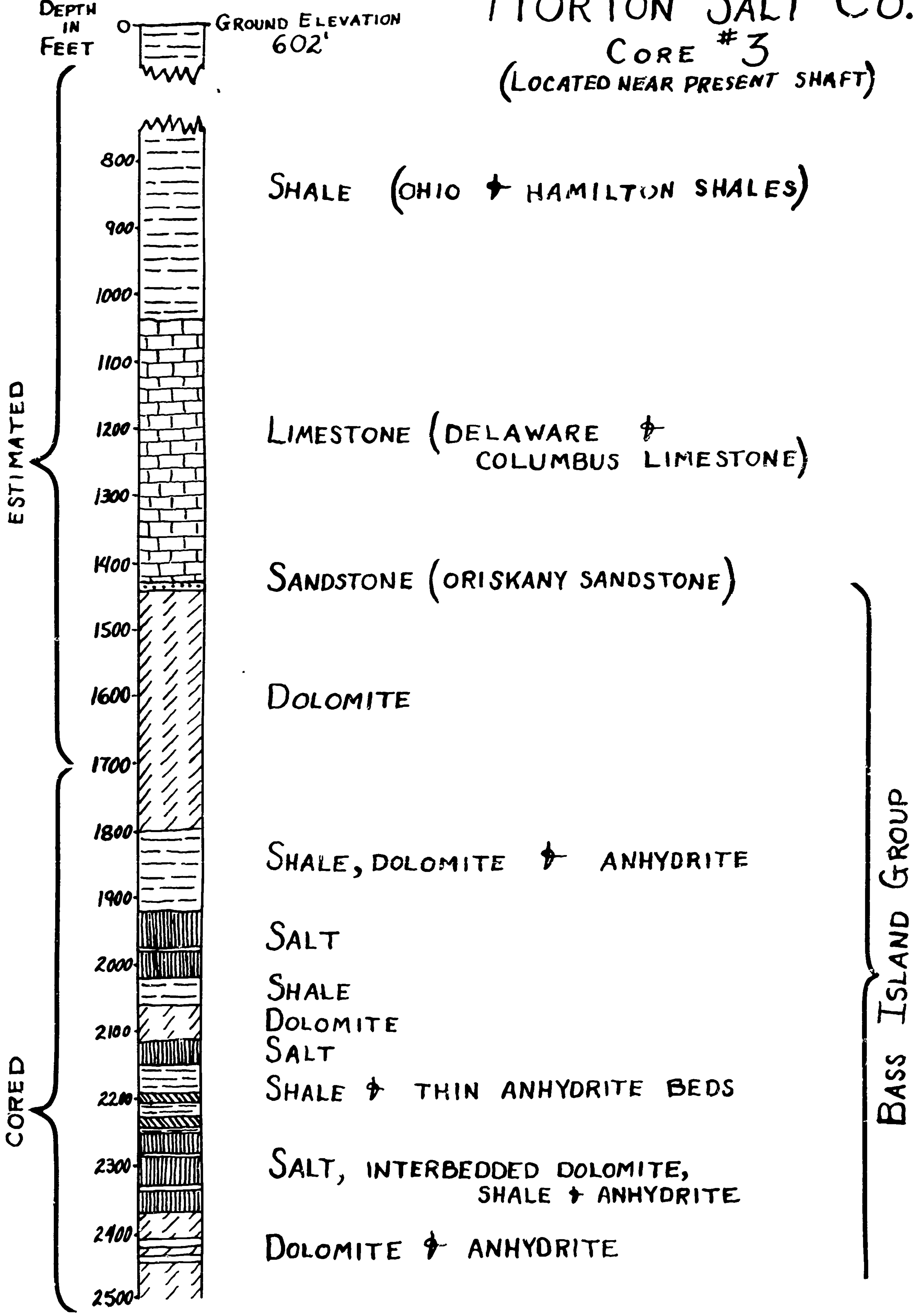
C. *The Utilities Department*

The department is Diamond Alkali's power plant. More than one thousand tons of coal per day are consumed here to furnish steam, generate electricity, pump millions of gallons of



N
LAKE ERIE
0 1 2
Scale in miles
1
2
3
4
GRAND RIVER
ELKTON BEACH?
Dc
ELKTON BEACH
Qgb
WARREN BEACH
WARREN BEACH
WHITTLESEY BEACH
WHITTLESEY BEACH
LAKE BORDER MORAINE
LAKE BORDER MORAINE
Qgm
KELLOGG CREEK
20
44
I90
Mb
Mc
Pps
LAKE Co.
GEAUGA Co.
QUATERNARY
Qg
GLACIAL DEPOSITS Qgb-BEACH Qgm-MORAINE
PENNSYLVANIAN
Pps
POTTSVILLE-SHARON
MISSISSIPPIAN
Mc
CUYAHOGA GROUP
Mb
BEREA SS
DEVONIAN
Dc
CHAGRIN sh

Morton Salt Co.
Core #3
(Located near present shaft)



water from Lake Erie, and produce the compressed air and vacuum necessary to operate the Diamond Alkali plant complex.

Leave Diamond Alkali Parking lot.

0.0 Turn left onto East Street.

0.4 Join Route 535 — Continue straight ahead. This level is Elkton Beach Level (elev. 610-615). Notice directly ahead Little Mountain (to the right) and the "Knob" (to the left).

0.9 Stop sign — Continue on Route 535.

0.3 Cross Grand River — Chagrin shale (Devonian) along river to the right.

0.4 Route 535 ends — Continue straight ahead on Route 283.

0.9 Turn right on to Route 20 — Warren Beach (Elev. 670-680).

1.7 Turn right on to Fern Drive (first road after Thruway Bridge Excavation).

STOP #3. Park in line along Fern Drive or in level areas adjacent to it. *If* there is any construction in progress, *do not* block drives or entrance ways! This road cut is through the Warren Beach, and shows interbedded sand and gravel and, at the base, a Wisconsin till.

0.0 Right turn on to Route 20.

0.3 *Caution* — Left turn on to Fairgrounds Road. (This is the first traffic light on Route 20. Get into center lane after leaving Stop #3).

0.7 Turn right on to Interstate 90, *but* take oblique right on to Morley Road. Road cut on left — Exposure of Ashtabula till at top (10 feet thick) overlying one foot of gravel (note spring and grass line) with an underlying unnamed till (10 feet exposed). This is the "Lake Border Moraine."

1.1 Cross Prouty Road.

0.3 Bear left *from* Morley to Hermitage Road (This is the Maumee III level — Elev. 780).

0.9 Thruway Underpass.

0.3 Concord test well, Diamond Alkali Company, on left in woods (Depth to salt, 2355 feet).

0.8 Contact of Berea Sandstone and underlying Bedford Shale (Elev. 1060 feet).

0.4 Entrance to the "Knob." (Special permission necessary).

STOP #4. This is private property, *PLEASE* do not touch or destroy anything (including rocks).

Permission was granted with the understanding that future ingress to the property will not be allowed without prior permission from the owner.

The "Knob" offers one of the best views of the beach ridges and the Lake Border Moraine in Northeastern Ohio. The Sharon sandstone and conglomerate caps the top of the knob.

Ohio Intercollegiate Field Trip

MUSKINGUM COLLEGE

October 12, 1963

PENNSYLVANIAN IN MUSKINGUM & COSHOCTON COUNTIES

Rocks of Pennsylvanian age outcrop in forty counties in eastern Ohio. Economically the Pennsylvanian is the most important system of rocks in eastern United States, consiting of recurring beds of coal, clay, shale, limestone, sandstone and iron ore. The consolidated rocks of Muskingum County, excluding those exposed in the extreme western part, are of Pennsylvanian age. Except for exposures of Mississippian age in the deep valleys of the northwestern and southwestern parts of the county, the rocks of Coshocton County belong to the Pennsylvanian system.

The average thickness of the Pennsylvanian outcrop in Ohio is over 1,000 feet. Forty-four coal beds occur and 27 limestone members are recognized together with considerable sandstone, shale, clay and iron ore. The system is divided into four series, the Pottsville, Allegheny, Conemaugh and Monogahela. Only the first three series outcrop in the area covered by this trip.

The contact between the Mississippian and Pennsylvanian rocks is unconformable. At the close of Mississippian time crustal disturbance uplifted the Mississippian rocks and severe erosion took place. The Maxville limestone, the topmost member of the Mississippian system was removed from large areas of Muskingum and all of Coshocton counties and erosion cut deeply into the Logan formation below. Wide basins and trough-like valleys were formed and the Pottsville rocks were deposited in these depressions. Thus the lower coal beds often appear to be stratigraphically below the Maxville limestone.

The Pottsville series is exposed in its full thickness in the western part of Muskingum County but the exposures in eastern part of the county are small. They outcrop in every township of Coshocton County but in the eastern part of the county are confined to the lower slopes of the large valleys. Many of the members of the series are poorly represented. This is especially true of the lower members.

The coal beds of the Pottsville series are usually too thin to be economically important. The limestones are thin but of great value in stratigraphic correlation. The series comprises all the rocks from the top of the Mississippian, upon which it rests unconformably, to the Brecksville coal, which is considered to be the base of the Allegheny series. The top of the Homewood sandstone is often taken as the uppermost member of the Pottsville but it is erratic in distribution and absent over a large area. Fossils in the upper Pottsville beds are very similar to those in the beds near the base of the Allegheny, so it is difficult to use fossils in making the separation. Under these conditions the division is largely arbitrary.

The *Allegheny series*, which Rogers called the Lower Coal Measures, contains some valuable coal beds and economically is the most important of the Pennsylvanian rocks exposed in Muskingum and Coshocton Counties. In addition to the coal beds there are clays and shales suitable for a variety of ceramic products. The series also contains sandstones, flints, ores and limestones. Quantitatively it consists mostly of sandstones and shales.

The most important members of the series are the Brookfield coal, Putnam Hill limestone, Clarion Coal, Vanport or Ferriferous limestone, Lower Kittanning or No. 5 coal, Hamden limestone, Middle Kittanning or No. 6 coal, Lower Freeport or No. 6a coal and the Upper Freeport or No. 7 coal.

The contact between the Upper Freeport or No. 7 coal, which is the last thick coal deposit until the Pittsburgh bed is reached, and Mahoning sandstone above is considered to be the plane of separation. This is, in a general way the surface above which fresh water limestones are abundant. The separation is based largely on lithologic evidence.

The *Conemaugh series* in Ohio consists of recurring beds of sandstone, shale, limestone, clay and coal. Of this series Stout says, "In the Allegheny formation thick coal beds, gray siliceous shales, soft micaceous sandstones, and light plastic clays are conspicuous; whereas the Conemaugh formation highly-colored argillaceous shales, shaly, ripple-marked sandstone, and nodular and marly limestones are especially prominent."

The lower part of the series consists of gray siliceous shales, shaly, ripple-marked sandstones and fossiliferous limestones. The rocks of the upper half are mostly non-marine while those of the lower half are marine.

Nine of the limestones have some stratigraphic importance. The marine limestones are thin but persistant while those of fresh water origin tend to be nodular and local.

The Conemaugh series is transitional between the predominantly marine Allegheny below and the fresh or brackish water Monogahela series above.

In Coshocton County only the lower part of the series outcrops. In Muskingum County it is present in its full thickness.

The rocks of the Conemaugh series and those of the Monogahela series above are closely allied except that the coal beds of the Monogahela are thicker and more valuable than those of the Conemaugh. In this area the separation is purely arbitrary and is considered as the base of the Pittsburgh or No. 8 coal.

The *Monogahela series*, extends from the base of the Pittsburgh coal to the roof of the Waynesburg coal. The most conspicuous rocks are clay shales and limestones. These are the type of rocks that are conspicuous in the Upper part of the Conemaugh series. Sandstones are usually more conspicuous in the Monogahela than in the Conemaugh series.

Monogahela rocks outcrop in Muskingum County but are absent in Coshocton County. In Muskingum County four well defined coal members are present but only one is important. The coals in this series are somewhat thicker than those of the Conemaugh.

MORNING TOUR

8:00—8:30 Registration at the Hydrological Station.

STOP #1. —8:30 Orientation and Tour of the Hydrological Station.

0.0	Leave for the strip mine—Follow Ohio 621 south to Ohio 16.
2.8	Outcrop of Lower Mercer 1s (Pottsville) on the right. This limestone is also called Blue or Zoar 1s
6.4	At the intersection of Ohio routes 16 and 36 turn right.
9.8	Take Ohio 76 south — go under bridge and turn right on ramp and go over bridge, note the width of the Tuscarawas River valley here.
10.4	Turn right on Ohio 76 at first light after bridge to Second St.
10.7	Turn left on Ohio 76 at Walnut St.
11.2	Turn right on Ohio 76 at S. Seventh St.
12.3	Turn left on Ohio 76S. Sohio station on the lefthand corner.
14.3	Strip mine (coal #6 or Middle Kittanning) on the right side of the road.
17.4	Turn left at the coal mine conveyer belt to
18.4	STOP #2. The Coal mine office.

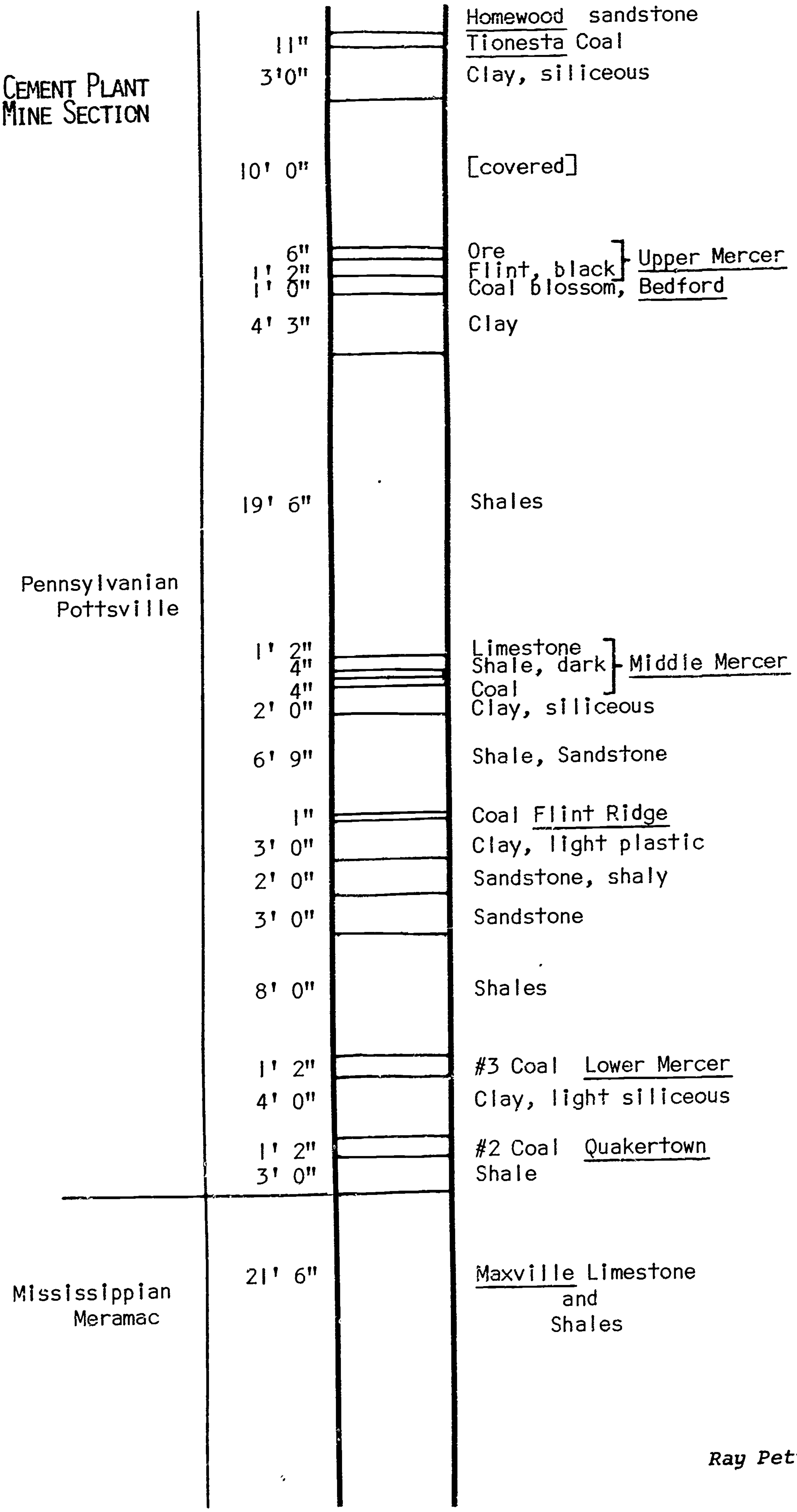
19.4	Exit from coal mine, turn left on Ohio 76.
21.0	High wall to the left, similar to that observed at the mine.
23.4	Cow Run ss (Conemaugh) outcrops on the left. The Cow Run ss was used for canal locks, bridge piers, foundations, flagstone, etc. The present use of Portland cement has replaced this stone for most of its former uses.
24.5	Mason Mines (coal #6 or Middle Kittanning) and Wills Creek bridge, note the width of the valley of Wills Creek.
26.6	Strip mine on the left side of the road (coal #6).
27.5	Otsego. The town is located on a sand and silt terrace. A well defined terrace system is present from the mouth of White Eyes Creek to about a mile south of here. *TURN* right staying on Ohio Route 76S.
28.0-28.6	Terraces on both sides of the road which extend a mile to the south. (Notice that the school house is situated on a comparatively large terrace).
29.3	Large slump blocks of Cow Run ss may be seen on both sides of the road.
29.5	Cow Run ss outcrops near the top of the ridge to the right. Large blocks have slumped down the hill.
30.5	Cow Run ss on the ridge at the left of the road. Large slip blocks.
32.6	Cow Run ss outcrops on the road banks near the top of the hill.
33.8	Bloomfield — stay on Ohio 76S. Turn right at the end of town. The high plain, the remnants of which form the concordant summits of this portion of Ohio, is known as the Allegheny Plateau. Here you will note the even skyline of the much dissected plateau.
38.9	STOP #3. New Concord, Ohio, turn left on U.S. 40 to the Muskingum College entrance. Lunch in the Hollow.

AFTERNOON TOUR

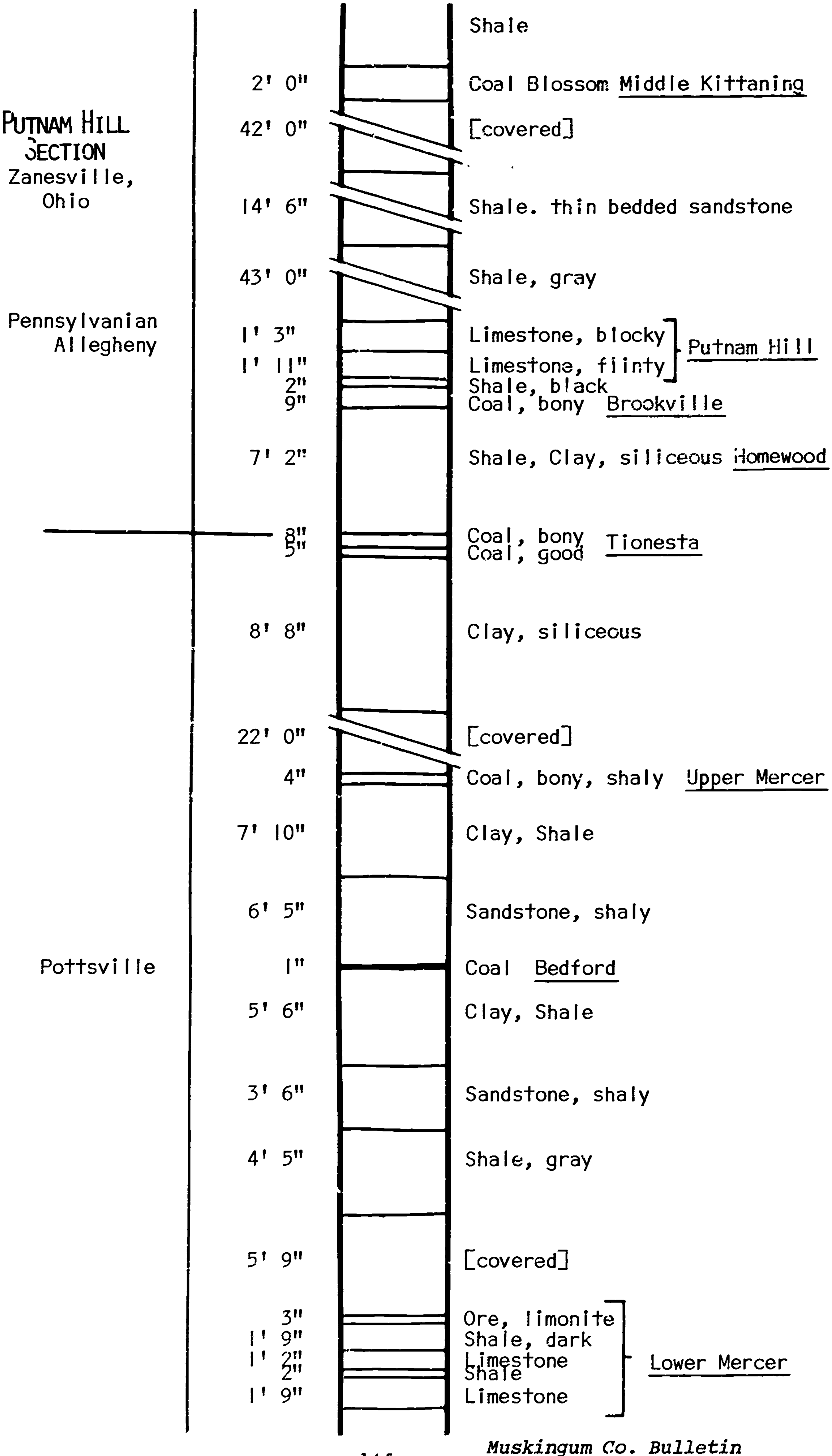
1:00 p.m. — Leave Muskingum College

0.0	Cambridge Hall (Geology-Geography Dept. is on the ground floor). Turn right on U.S. 40.
0.2	New Concord western boundary.
1.1	Cambridge ls (Lower Conemaugh) forms the floor of the railroad underpass (left of the road).
2.8	Abandoned mine dump, Harlem coal (Conemaugh), to the right.
4.2	Pottery sales rooms, Zanesville is a pottery center. The shales and clays beneath the Upper Freeport or #7 coal are the raw materials. From here to Zanesville the road crosses the Upper Freeport horizon many times. The valleys are in Allegheny strata and the hills are the Conemaugh rocks.
5.8	Mahoning ss (Lower Conemaugh) is massive on both sides of the road.
6.0	Cross the Salt Creek which flows south to join the Muskingum River south of Duncan Falls.
8.2	Cross Little Salt Creek flowing south to join Salt Creek.
8.4	Mahoning ss outcrops on the right.
8.9	Turn right at the traffic light to Interstate 70.
9.1	Turn left to Interstate 70 (Zanesville By-Pass).
10.1	Mahoning ss
11.0	To the right is an abandoned strip mine in the Upper Freeport or #7 coal. This coal marks the top of the Allegheny formation.
11.9	Far to the left is a strip mine (#7 coal) and a shaft mine (on old U.S. 40).
14.1	Eastern Zanesville boundary.
14.5	Arched bridge — shales of the Middle Allegheny are exposed.
15.5	Cross the Muskingum River.

CEMENT PLANT MINE SECTION



Ray Petty



Muskingum Co. Bulletin

15.6 Turn right on Maple Ave. exit.

15.9 Turn right to Ball Street.

16.0 Turn right to Linder Ave.

16.8 Cross the Licking River at the "Y" Bridge. The confluence of the Muskingum and Licking Rivers is on your left. Turn right at the traffic light. The first "Y" Bridge was built here in 1814. The present bridge dates to 1900.

16.9 Turn left on Pine Street (the first traffic light off the bridge). The Muskingum River cuts through the Allegheny series into the Pottsville rocks. The Brookville coal, under the Putnam Hill limestone, form the boundary between the two series.

17.0 STOP #4. Putnam Hill, this section is included on page 5.

17.7 Turn right on Dugway.

18.2 Turn right on U.S. 22.

20.2 Homewood ss, the top of the Pottsville, is exposed behind the shopping center on the right.

21.0 Homewood ss is exposed on the right. This sandstone is well developed only locally in Muskingum County. It lies below the Brookville coal and above the Tionesta coal and often replaces these coals and many feet of other rocks as well. It often coalesces with other sandstones so the exact limits of this member are often difficult, if not impossible, to determine.

21.3 Homewood ss is exposed behind Winsor's Steakhouse.

24.2 Homewood ss is exposed on both sides of the road.

24.4 Limestone quarry to the left. (Maxville 1s).

24.9 Homewood ss is exposed on both sides of the road.

26.1 Shales, coals, and limestones of the lower Pottsville are exposed with a slight unconformity toward the bottom.

26.9 Turn left at East Fultonham on Ohio 345.

28.2 Turn left at Dairy Queen.

28.3 Cross the railroad tracks and keep left (follow the tracks to the mine).

29.2 Cross the bridge. The Maxville 1s is exposed in the creek bed.

29.3 STOP #5. Mine Entrance. Mine tour.

Return to U.S. 22, you are now 10 miles south of Zanesville.

We would like to gratefully acknowledge the cooperation of Mr. Lloyd L. Harrold, of the Hydrologic Station; Mr. O. B. Dildine, of the Simco-Peabody mine; Mr. Harold Dillon, of the Zanesville Recreation Dept.; The Zanesville Police Dept.; Mr. Grant Orndorff and Mr. Ray Petty of the Columbia Cement Corp. who made this trip possible.

We are glad you could be with us and we hope you will come back to see us any time.

Drive carefully and have a good trip home.

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THE FIFTEENTH ANNUAL
OHIO INTERCOLLEGIATE
GEOLOGY FIELD TRIP

Sponsored by

THE GEOLOGY CLUB

OF

THE COLLEGE OF WOOSTER

WOOSTER, OHIO

OCTOBER 17, 1964

FIFTEENTH ANNUAL OHIO INTERCOLLEGIATE GEOLOGY FIELD TRIP
The College of Wooster, Wooster Ohio
October 17, 1964

Miles

0.0 The field trip starts at the parking area in Marshallville, Ohio.

STOP #1 —Walk northeast from Marshallville along the railroad track to study the Mississippian-Pennsylvanian unconformity exposed in the first large cut, about 0.8 mile from the parking area. Watch out for an occasional freight train. The tracks are greasy, so do not sit on them.

The following discussion has been condensed from the work of Conrey (1921), Multer (1955 and 1957), and VerSteeg (1948):

In the area that is presently eastern Ohio the end of the Mississippian was marked by a period of erosion while the seas were absent. This erosion continued long enough to produce a surface with considerable relief. Dendritic streams draining toward the southeast cut into the surface until the relief reached a maximum of 270 feet with differences in elevation of more than 150 feet within a short distance being common. In early Pennsylvanian, Pottsville, time this area was invaded by the ocean. The earliest sediments, eg., the Sharon conglomerate, are confined to the valleys and basins between the hills on the Mississippian surface.

The Pottsville sea apparently advanced rapidly over the surface with the water becoming deep fairly quickly. The fragments of Waverly sandstone contained within the Pottsville are for the most part angular though they show the effect of movement by waves and currents. That the hills on the Mississippian surface were buried and not eroded down also indicates rapid subsidence.

Here at Marshallville the Mississippian rocks underlying the unconformity are massive sandstones of the Black Hand member (?) of the Cuyahoga formation. The basal Pottsville consists of a thin basal conglomerate which here is not a conglomerate but actually a coarse-grained sandstone. Above this is a sequence of thin to medium-bedded silty shale interbedded with silty sandstone containing much organic material and $FeCO_3$ concretions.

As will be seen along the railroad cut, the Pottsville beds dip away in all directions from the Mississippian hills. In places the dip is quite high. Two explanations have been advanced to account for the dip of these beds. The presence of what appear to be stream valleys cut in the Mississippian hills have led some to postulate that the Pottsville beds were sub-aerial. They account for the dip of the beds as initial dip resulting from the deposition of sediments by streams flowing down the slopes.

The second theory accounts for the dip of the Pottsville rocks by differential compaction. It has been suggested that most water deposited clays contain at least 50% water. This water is forced out with consequent loss of volume when the clays are buried. Since the sediment over the valleys would be thicker than that over the hills, the mud in the valleys would be compacted more and the shale beds would attain the dip away from the hills that is seen in these exposures.

Following the Pennsylvanian, erosion has stripped the Pottsville rocks from the tops of the hills leaving them only in the depressions. Wisconsin glacial deposits presently cover the eroded surface.

Return to the parking area. Drive west on Euclid Ave. two blocks to Main Street.

0.3 Turn right (north) on Main Street (Ohio Route 548) and drive two blocks.

0.5 Turn left (west) on Church Street (County Road 27). For the next several miles observe the rolling plains of the Cary ground moraine.

2.0 Stop sign — at Ohio Route 94. Continue west on County Road 27. On the right are several storage tanks for the small local oil production from the "Clinton" sandstone (Silurian).

4.2 Turn left (south) Ohio Route 5 toward Wooster.

8.2 Smithville. Observe Smithville Inn on the right in the center of town, the home of good eating and Inn-maid noodles.

8.9 Turn right (west) on Smithville Western Road (County Road 86).

11.9 Blinking Stop light in Madisonburg. Turn left (south) on Ohio Route 3.

13.2 Note four terrace levels, characteristic of streams in this area, along Little Apple Creek to the left at the bottom of the hill.

14.0 First traffic light in Wooster. Turn right (west) on Highland Ave.

15.7 Stop sign — turn left (south) on Mechanicsburg Road (County Road 22). There are numerous outcrops of Waverly sandstone and shale in this braod valley, particularly along the creek to the south and west of here.

17.2 Turn left into shale pit of Medal Brick, Inc. and park as directed.

STOP #2 — WARNING!! Because of the instability of the face (a power shovel was buried a few weeks ago) the company does not permit visitors to climb the cliffs or walk near the present working face. Please cooperate.

As indicated in the Columnar Section (Figure 1) the rocks exposed in this pit represent the upper part of the Cuyahoga Formation and the lower part of the Logan Formation of the Waverly Group deposited in Mississippian time.

Over the years this has been a good locality for the collection of Waverly fossils. Student collectors have identified about 60 species representing 8 phyla from the rocks of this pit. Brachiopods (many genera and species), bryozoa (both branching and lacy), pelecypods (both scallop-like and clam-like), gastropods (both coiled and conical), and crinoids (stem and arm fragments) are fairly common. Conularids, crinoid heads, cephalopods (straight nautiloids), and trilobites (very small pygidia only) are rather rare.

The shale exposed along the sides of the trench and big hole at the southwestern side of the pit contains clay-ironstone concretions and concretionary layers. These hard layers, although difficult to work, provide a greater variety of fossils than any other rock in the pit. Fossil distribution in the sandstones and conglomerate is rather erratic but iron-stained impressions of many types can be found in the blocks that have fallen from the cliff or have been dumped from the bench above.

Oscillation ripple marks and cross-lamination are common in the sandstones. These may be seen in blocks near the foot of the cliff. Several generations of ripple marks each trending in a different direction may be seen in some of the blocks.

To obtain material for the manufacture of brick, a considerable thickness of sandstone and conglomerate is stripped from above the shale to prevent serious contamination. After blasting, a truck hauls the shale to the brick plant and dumps it into a hopper from which it passes through a jaw crusher on its way to a rotary grinder which reduces it to a fine

powder. The powder is poured into a mixer with water and a little barium carbonate and is stirred until it becomes a uniform plastic mass. This viscous material is extruded through a rectangular opening the size of the largest face of the brick and is cut (about 15 bricks at a time) by wires stretched on a frame which are forced automatically through the moving ribbon of clay. The soft, wet bricks are piled carefully on small flat cars and are pushed into long tunnels where they are dried for about a week by hot air from the kilns. After drying, the bricks are removed from the ovens and are piled in the long down-draft kilns. Spaces are left between the bricks to permit easy circulation and uniform burning. When the kiln is full, its doors (two at each end) are sealed with bricks and mortar. A fan is placed in the chimney to help the circulation and coal fires are built in the numerous furnaces which open outward on both sides of the kiln. The hot air rises from the open tops of the inside extensions of the furnaces, moves upward to the arched roof, descends through the bricks and the openings in the floor, and escapes through the chimney or is by-passed to the drying ovens. The bricks are burned at temperatures above 1500° F. for several days. After they have cooled, the kiln is opened and the bricks are removed and loaded for shipment.

Leave the pit and turn left (south) on County Road 22.

17.6 Turn left at the Shell Oil Station on to Oak Hill Avenue. Almost immediately turn right (east) on Western Ave. and continue east to the Stop sign.

17.9 Turn left (north) on Woodland Ave.

18.0 Stop sign at Bowman Street. Continue straight ahead.

18.1 Turn right down the hill into Christmas Run Park.

18.2 LUNCH STOP. Park cars near Pavilion number 1 as directed.

0.0 From the Pavilion drive back south and west across the bridge and up the hill.

0.3 At the top of the hill turn left (south) on Woodland Ave.

0.6 Turn left (east) on Saybolt Ave.

0.7 At the bottom of the hill, turn right (south) on Columbus Ave.

1.0 Traffic light at Liberty Street. Continue south on Columbus Ave. to the south end of the overpass.

1.5 Turn left (east) on ramp to Wooster By-pass, U.S. Routes 30 and 250 East.

2.6 Turn right on next exit ramp to Ohio Route 76.

2.9 Traffic light at end of ramp. Turn left and drive on Ohio Route 76 up Madison Hill past the Ohio Agricultural Experiment Station (on the left).

3.5 Junction of Ohio Route 76 and U.S. Route 250. Continue south on Ohio Route 76. This is a hilly winding road. Drive carefully.

8.4 Moreland.

9.2 Munson Knob, spelled Munser on the old maps, (ahead and to the left) is an erosional remnant that rises above the general upland to an elevation of almost 1300 feet. Notice the oil wells near the knob.

The knob itself is composed of sedimentary rocks of the upper part of the Pottsville Formation and the lower part of the Allegheny Formation (both Pennsylvanian). The Brookville coal, which is the basal member of the Allegheny Formation was once mined on the southwest side of the knob; the Putnam Hill limestone, which lies above the coal, is exploited north and east of the knob by the Holmes Limestone Company.

The wells which you see in this area are a few of the nearly 150 wells drilled to depths of 3000-3500 feet within the approximately 6 square mile area of the Moreland Oil Pool. The oil and gas in this pool are found in two different Silurian reservoir rocks, each representing a distinctive ancient environment. At a depth of approximately 3000 feet, gas and some oil are obtained from cavities and fractures in the "Newburg" dolomite, probably a former reef-type limestone. At approximately 3500 feet the drill bit encounters the oil and gas bearing "Clinton" sandstone. These lenticular, well sorted fine-grained sandstone beds contain marine fossils and plant fragments and appear to be ancient off-shore bars.

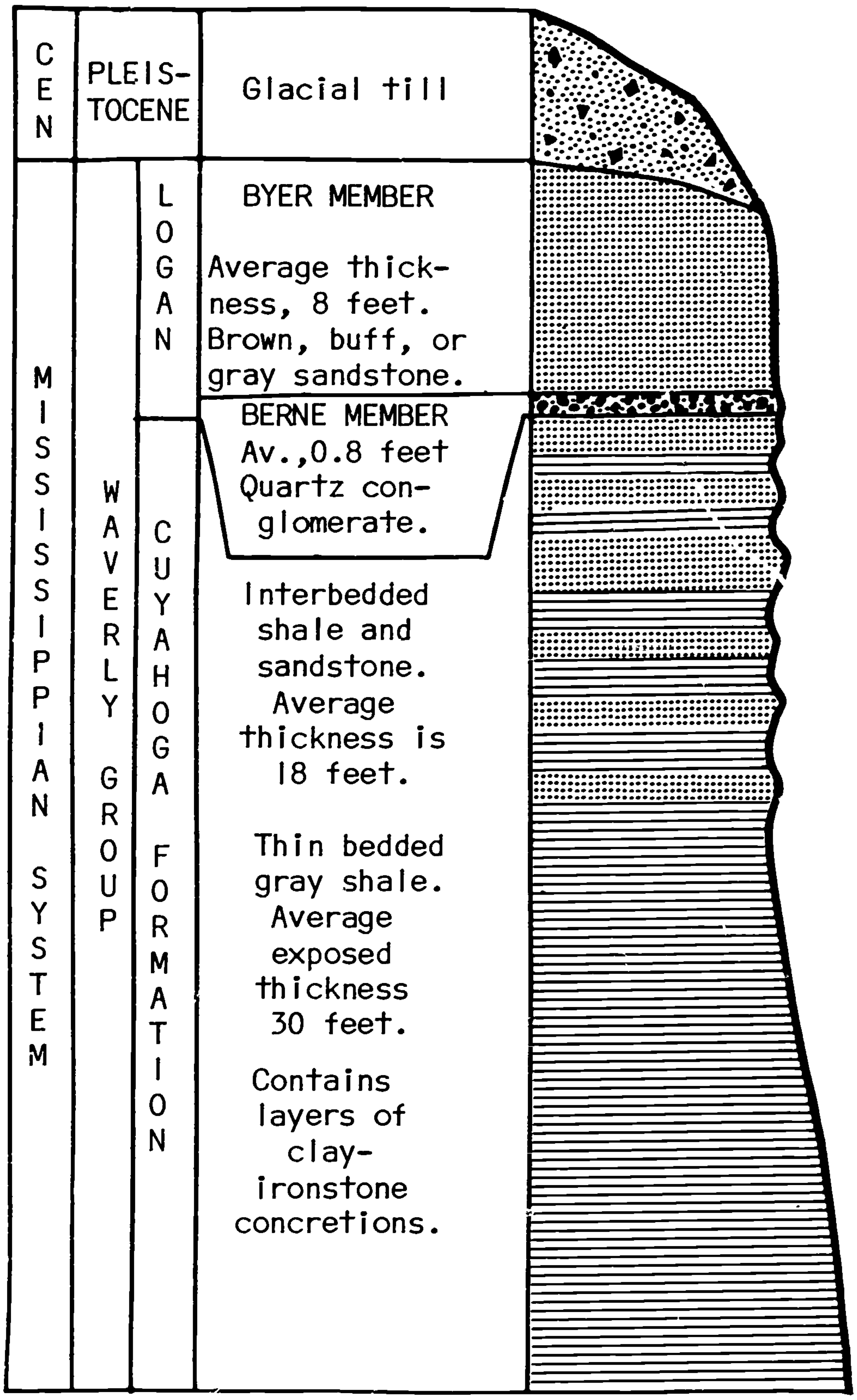

Figure 1

Columnar Section

showing rocks exposed at the shale pit of the Medal Brick, Inc., Wooster, Ohio

Most of the wells in the Moreland Pool were drilled with cable tools but a few have been drilled by rotary outfits. The rotary drilling method is more expensive than the cable tool method but takes only one-third as long (about 17 days) to drill down to the "Clinton". This rotary method also makes it possible to recover cores of the producing beds for further study.

Post-drilling to the "Newburg" dolomite, hydrochloric acid is pumped down to dissolve larger openings in the dolomite. To increase the permeability of the "Clinton" sandstone, oil and loose sand are pumped under tremendous pressure into the rock to open and maintain passageways for additional oil and gas flow. Initial production after such fracturing ranges from 75 to 1000 barrels per day with varying amounts of gas up to 1,600,000 cubic feet per day. Initial production figures, however, are not an indication of what the

well will produce over the years. Most wells soon decline to a rate considerably lower than their initial production. According to Multer (1963, p. 4) "the discovery well of the Moreland Pool, Smith Petroleum Co. No. 1 Baker Community, — Which was drilled into the "Clinton" — yielded 16 barrels of oil and a show of gas before fracture. The initial rock pressure was 1100 pounds per square inch. After hydraulic fracturing with 2000 pounds of sand and 650 barrels of oil, the well yielded 700 barrels of oil and 1,555,000 cubic feet of gas in the first 24 hours. Production soon settled to a rate of 100 barrels per day."

11.9 Wayne-Holmes County line.

12.9 Stratified deposits in the sand and gravel pit on the left.

White (1949, p. 37, 38) points out that this deposit is part of a kame terrace that "extends from one-half mile north of the Wayne-Holmes County line to the point where Salt Creek enters Killbuck Creek. From the county line to Tea Run the terrace is about one-eighth mile wide. It is almost absent from Tea Run to a point about one-half mile south. It thence becomes gradually wider, being one-half mile wide at its southern end a little less than one mile north of Holmesville. —The material of these terraces ranges from dirty, bouldery, poorly sorted gravel with obscure bedding, to well sorted, medium-grained gravel in horizontal strata."

White (1949, p. 33) expresses the opinion that "in Holmes County the ice sheet in the waning stage of glaciation lost all forward motion. The ice sheet melted down as well as back. The hilltops appeared first above the ice and the final stage of ice disappearance was that of blocks, in most places elongate, in the major valleys. Meltwater from the ice blocks flowed between the blocks and the valley sides. Stratified deposits, generally gravel were laid down. Upon the final melting of the ice masses in the valleys, gravel deposits were left in terrace-like forms along the valley sides. The place of the former ice blocks remained as kettle holes."

The gravel removed from this bank may be used as it is (bank run gravel) for some purposes such as gravel roads but must be sized (screened) and washed for other purposes such as concrete aggregate. Clay ironstone concretions which are rather abundant in the gravel cause some trouble. After concrete has been poured and has hardened, oxidation continues in the concretions. Commonly those near the surface swell and "pop out" forming conical, iron-stained pits.

One feature that is rather common in deposits of this type occurs near the north end of the cut. It is a resistant "monument" which has been by-passed by the shovels because of its hardness. This gravel that has been thoroughly cemented by calcium carbonate deposited from percolating ground water.

14.8 This low area is subject to spring flooding. Gauges have been installed to show motorists the depth of water over the road.

15.1 Stop sign — Holmesville. Continue on Ohio Route 76 by turning left at this intersection and then right at the traffic light.

As you continue south from Holmesville, look ahead, to the right, and to the left. You will see what White (1949, p. 27-28) describes as "a morainic ridge of peculiar form that extends almost across the Killbuck Valley in Prairie Township south of Holmesville. This ridge (stippled in Figure 2) lies east of Killbuck Creek. The eastern end of the moraine is located in S Sec. 2 where it emerges from the kame terrace area on the north side of Martins Creek. The ridge extends for 1 mile southwest into central Sec. 10 where it bends northwest to its termination at the southwest corner of Holmesville. The ridge is one-eighth of a mile wide at its eastern end, increases to a width of three-eighths of a mile in its central portion, and decreases to one-quarter mile at its western end. It ranges from 60 to 80 feet in height.

The surface of the moraine is composed of low knolls and a few shallow kettle holes. The material of which it is built is mainly sandy to gravelly till. Some masses of dirty gravel are included in the till, but no large masses are known, although local contractors have prospected the ridge carefully in their search for road gravel.

This morainic ridge does not now extend entirely across the Killbuck valley nor does it give evidence of ever having done so. There is no tall ridge on the west side of Killbuck Creek which would match with the west end of the Moraine. Three possible modes of

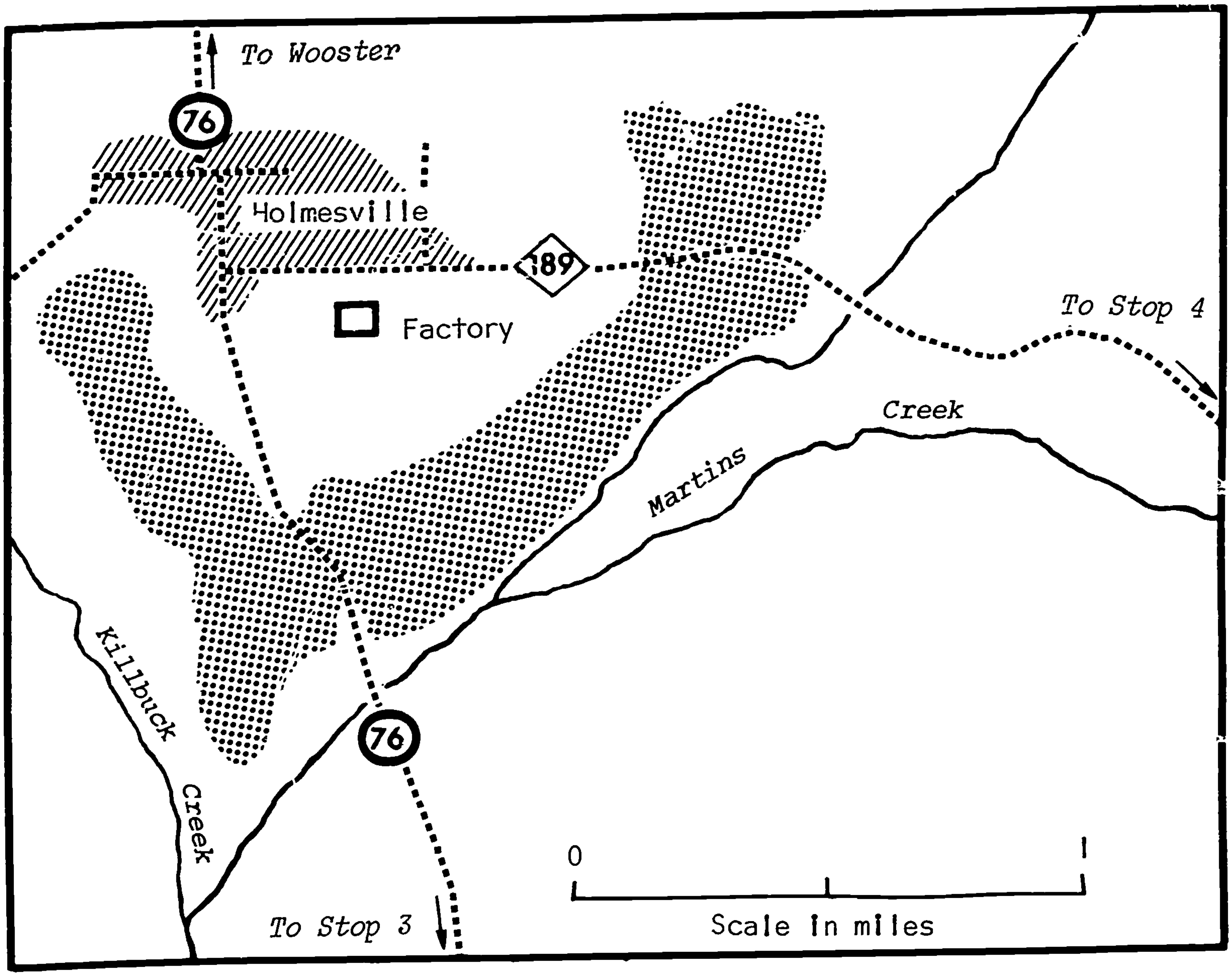

Figure 2
Moranic Ridge at Holmesville

origin for the ridge are here considered:

(1) The morainic ridge may have been deposited in a crevasse or open space between dead ice blocks in the valleys of Martins and Killbuck Creeks and in the lowlands at Holmesville ———. However, crevasse fillings consist mainly of water-sorted material, and this ridge is mainly till. It is therefore not the usual crevasse-filling type.

(2) It may have been deposited at an active ice front which stood in this location after the territory to the south had been freed of ice. A definite ice front never existed to the east or west of this moraine on the upland, but a small lobe of ice in the lowland north of the moraine may have maintained its continuity with the main ice sheet, while to the east and west the ice sheet had become disintegrated into separated masses and blocks. The absence of an outwash plain south of the moraine indicates that sufficient open space did not exist for its deposition, probably because masses of dead ice were present there.

(3) The ridge may have been deposited by live ice while dead ice remained in front. Kame terrace gravel across Martins Creek immediately south of the moraine shows that dead ice existed just south of the position of the moraine at some time. The kame terrace and the moraine are distinctly separated from each other, and it seems most logical that the agent which kept them separated was dead ice which was present south of the moraine while it was being deposited."

15.7 Begin climb toward the top of the morainic ridge.

16.4 County Home on the left.

17.5 STOP #3 — Park as directed on right shoulder where the shoulder is wide enough. BE SURE THAT ALL FOUR WHEELS ARE OFF THE PAVEMENT. Be careful not to slide into the swamp on the right. Watch out for traffic on the highway when crossing to the outcrops.

The Mississippian-Pennsylvanian contact at this location is stratigraphically higher than it was at the Marshallville exposure. Here the basal Pennsylvanian Pottsville Formation rests unconformably on the Logan Formation of Mississippian age (see the stratigraphic column, Figure 3, on p. 8). White (1949, p. 55) describes the basal conglomerate of the Pottsville, the Harrison member, as follows:

> The Harrison member is composed of pebbles and cobbles of quartz, chert, and silicified limestone, and of coarse sand, cemented by clay material, silica, or iron compounds. The pebbles and cobbles are well rounded. The silicified limestone fragments range from a fraction of an inch to 6 inches or more in diameter. Casts of fossils are present, and from a study of these ——— Conrey (1921, p. 89) concluded that they are derived from the Maxville Limestone ———. It is regarded as likely that before the Harrison member was deposited the surface was discontinuously covered with resistant fragments of residual Maxville material from which all carbonate had been leached. The surface had been eroded below the Maxville horizon. The residual fragments were transported by streams and currents, indicated by the rounded character of the pieces ———. The average thickness of the member is 1 foot, 1 inch.

The Quakertown coal, which normally lies 10 to 20 feet above the unconformity is in this outcrop replaced by the Massillon member of the Pottsville. This is a massive, coarse-grained sandstone containing 1 to 2 foot layers of rounded quartz pebbles near the base and scattered bands of these pebbles as high as feet above its base. It is generally tightly cemented but occasional lenses of cross-bedded, friable sandstone are present in outcrops higher on the ridge. This unit also contains casts and impressions of what appear to be *Calamites* (?).

There is some question as to the actual location of the unconformity itself. At this outcrop, we find *two distinct* conglomerates overlying the buff, fine-grained sandstone the weathered surface of which breaks into irregular and roughly rectangular blocks from a few inches to several feet on a side.

White (1949, p. 59) believes this to be the Vinton member of the Logan Formation. He puts the contact at the base of the lower of the two conglomerates, calling it Harrison and apparently assuming that the upper conglomerate is a basal layer in the Massillon sandstone. However, on close examination of what White calls Harrison, one notes the conspicuous absence of both the chert nodules and the quartz cobbles that were previously described as being characteristic of this basal conglomerate. Also, about 150 feet south of this outcrop is an exposure of an almost identical conglomerate which is both underlain *and* overlain by similar sandstone beds. Here the unconformity is *above* the conglomerate and separated from it by 5 feet of sandstone.

These observations indicate the possibility that this conglomerate is not the Harrison of Pennsylvanian age, but rather the Allensville conglomerate which lies between the Byer and Vinton members of the Logan Formation (see Figure 3). Conrey (1921, p. 81) describes the Allensville as:

> ———a marine conglomerate which varies in thickness from 8 to 24 inches. ——— were it not for this conglomerate, there would be little basis for dividing the beds above the Berne horizon (i.e., the Byer and Vinton members), as it forms the only marked break in a long succession of fine-grained sandstones and shales ———. It consists of a rather firmly cemented matrix of medium to coarse-grained sandstone with quartz pebbles ranging from one-eighth to one-half inch in diameter.

Lamborn (1954, p. 30) states that "the similarities in lithologic characteristics of the Vinton and Byer members in many areas are such that their separation is difficult in the absence of the intervening Allensville."

This evidence, then, introduces the possibility that the unconformity lies *between* the two conglomerates, especially since the upper bed has many of the features that White ascribed to the Harrison, including an iron-rich matrix, quartz cobbles and pebbles, and chert nodules some as large as 3 inches in diameter.

AVERAGE STRATIGRAPHIC SECTION
(after White, 1949)

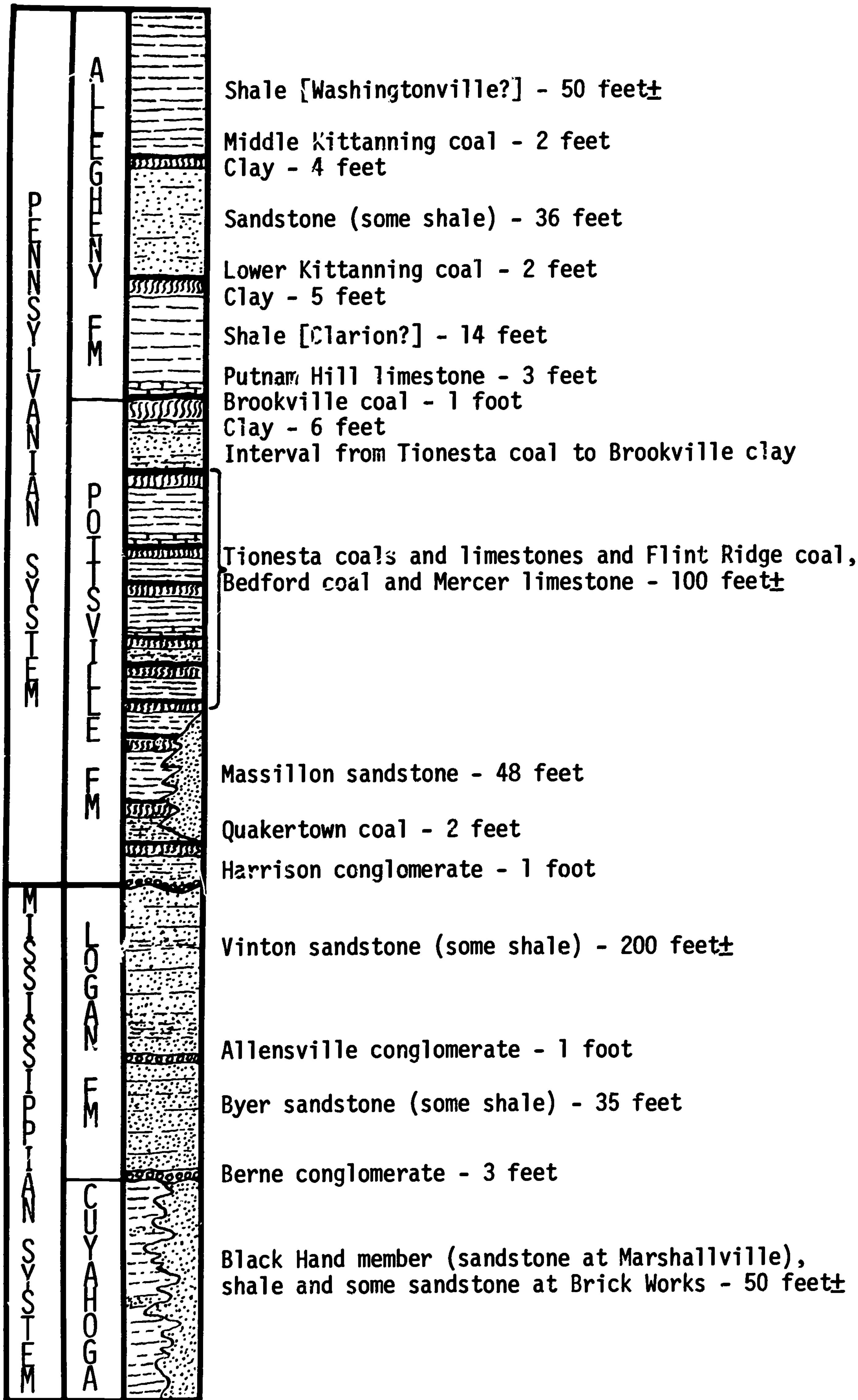

FIGURE 3

Continue south on Ohio Route 76.

19.7 Turn around by turning left through black-topped driveway of the Sunset View Nursing Home and head back toward Holmesville.

23.0 At southern edge of Holmesville, turn right at Sohio station on to County Road 189 and drive east. Notice that the conspicuous morainic ridge extends across the road ahead.

23.4 Junction with County Road 192. Addressograph-Multigraph plant on the right. Continue east on County Road 189.

24.0 The road climbs the northwest side of the morainic ridge, passes through a shallow cut, and then descends on the southeast side. As you cross the moraine, notice the hummocky topography with the closed depressions (kettle holes). On the southeast side of the ridge, an abandoned pit that once revealed well stratified sand and gravel lies to the left beyond the sawmill.

For the next 4.7 miles we will be driving up the valley of Martins Creek. White (1949, p. 39) has the following to say about the Martins Creek valley:

> Kames and kame terrace deposits exist in the valley of Martins Creek from Benton, in southwestern Salt Creek Township, to its mouth in southeastern Prairie Township. On the northeastern side of the valley a narrow terrace one-quarter to one-half mile in width extends from Benton to a point 1 mile east of Holmesville. It descends in this interval from an altitude of 1,020 to 920 feet. At its northwestern end it is associated with a group of kames at the northeastern end of the Holmesville moraine, having an altitude of about 1,000 feet. The northeastern boundary of the terrace is formed by the till-covered hillsides which rise sharply above the terrace. The surface of the terrace is extremely rugged and there is a relief of as much as 60 feet from the bottoms of the kettle holes to the tops of the conical kames. The inner border of the terrace is very irregular and forms one side of an elongate kettle hole through which Martins Creek flows. The material of this terrace is cobbly, bouldery gravel, in fairly horizontal beds ——.
>
> The kame deposits on the southwest side of the valley are only rudely terrace-like.

25.5 We are driving on top of the kame terrace. Notice large sand and gravel pit cut into the side of the terrace below the road level to the right.

27.2 Notice the well-bedded sand in the bank to the left. The many holes are the nests of bank swallows.

27.7 Stop sign — Turn right on Ohio Route 241 into Benton.

27.9 Turn left at the Sohio station on to County Road 206.

28.7 Turn right on Private Road (gravel).

29.3 Cross road. Continue straight ahead on Private Road.

29.9 STOP #4 — Limestone, coal, and clay pits of the Holmes Limestone Company. Park as directed off the road and out of the way of trucks.

An examination of the average Pennsylvanian section of Holmes County (Figure 3) reveals that only the Pottsville Formation and the lower part of the Allegheny Formation are present. Along the eastern wall of this pit (Figure 4) the deepest excavation exposes the Brookville Clay (the uppermost member of the Pottsville Formation). This is turn is overlain by the Brookville Coal (the basal member of the Allegheny formation), the Putnam Hill Limestone, and patches of shale some of which are badly weathered. Brachiopods and crinoid stems over one-half inches in diameter found in the limestone reveal its marine origin.

Above the limestone and shale we can see a 3 to 5 foot layer of gray clay till derived in part from the shale. This till is covered by a 15 to 20 foot layer of yellow gravel outwash which shows some horizontal bedding and cross-bedding. Within the outwash are lenses of clay which accumulated in water-filled kettle holes in the outwash gravels. The uppermost deposit is a discontinuous layer of yellow silty till derived in part from sandy or silty bedrock. The gray clay till may be early Wisconsin (Tazewell); the yellow silty till is probably Late Wisconsin (Cary).

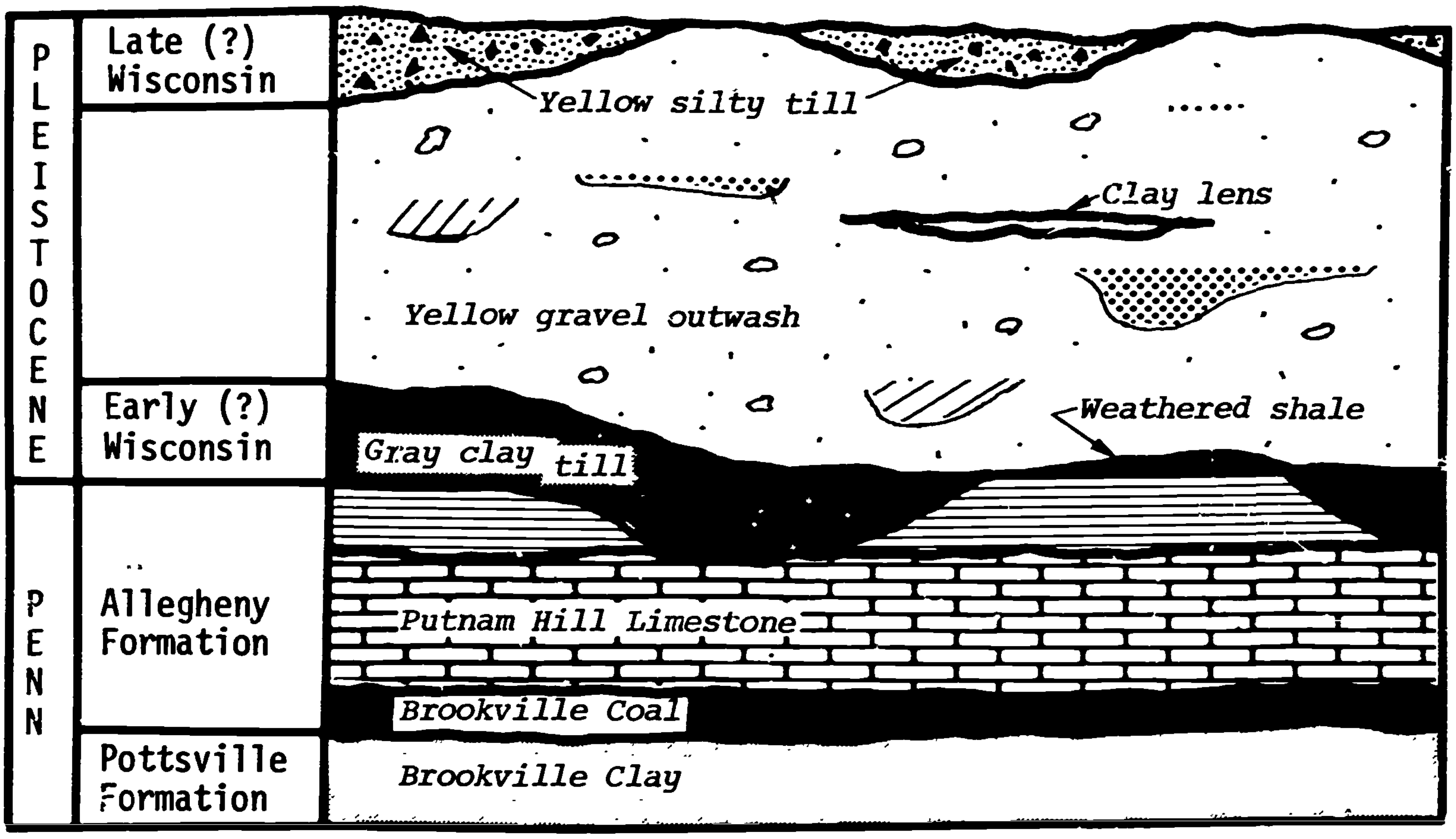

Figure 4
Diagrammatic Section of Holmes Limestone Co. Pit (not to scale)

High on the wall at the north end of the pit you can see patches of the Lower Kittanning coal that had been left as pillars during underground mining at some time in the past. Although overlying material has filled the mine openings some timbers are still visible.

To the west of the parking area just below road level is an exposure of the Middle Kittanning coal.

Limestone, especially agricultural lime, is the principal product of this company. The limestone must first be stripped of its overburden. It is then drilled and blasted, loaded into trucks, and hauled to the processing plant which lies about 2 miles east-northeast of here on County Road 201. After removal of the limestone, the coal is easily recovered for use as fuel, and the underclay can be sold as fireclay for the manufacture of fire brick and furnace linings.

Producing pits may be examined nearby.

Return along the same road to County Road 206.

30.7 Turn right on County Road 206 and continue east. Notice well developed stream terraces along Martins Creek to the right.

32.0 Stop sign — Drive straight ahead on Township Road 159.

32.3 STOP #5 — The Plains. Park on the right side just beyond the side road so that traffic can pass.

According to White (1949, p. 39), "A rudely circular area of kame deposits about 2.5 miles across exists in northwestern Berlin Township and southern Salt Creek Township, at an elevation of about 1,100 feet ——. To the northwest, at Benton, the tract passes into kame terraces which extend down Martins Creek. This area has a well-developed kame and and kettle topography. The kames are 40 to 60 feet high and swampy kettle holes are common. The largest kettle hole is an irregularly shaped, flat bottomed, swampy depression about a mile in diameter, known as The Plains. Kames rise around its borders, except on the east, where morainic knolls of till form the border. The gravel is, in general, cobbly and contains boulders and till masses."

This swampy area has been converted to agricultural uses by the development of a series of drainage ditches. During the excavation of the ditch which parallels the road on the north side, the skeleton of a giant ground sloth was found buried in the clay and peat

that have filled this large kettle hole lake. The skeleton is mounted and is on display in the Geological Museum in Orton Hall on the campus of Ohio State University. The shells of fresh water molluscs have also been found in great abundance. A student collecting samples for a pollen study found that the lake deposits are at least 23 feet deep.

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The Geological Society of Marietta College

presents

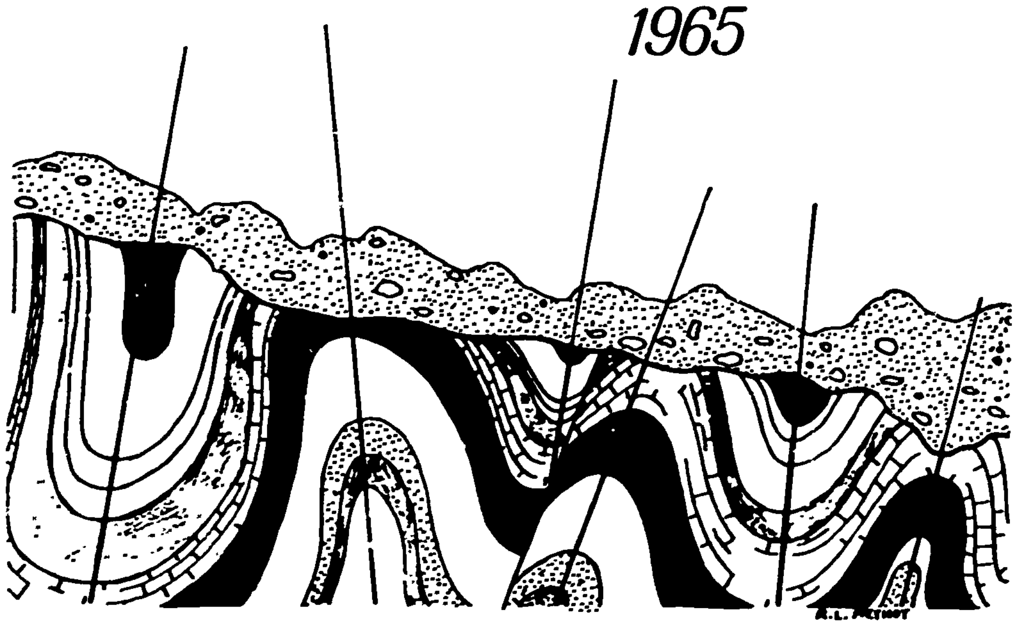
the 16th annual OHIO INTERCOLLEGIATE FIELD CONFERENCE

THE R. W. WHIPPLE NATURAL SCIENCE FIELD STATION

BARTOW, WEST VIRGINIA

OCTOBER 8, 9, 10

1965



ROAD LOG FOR JUDY GAP TRIP

Use this log in connection with the geologic map.

Mileage

0.0	Junction of road to Field Station and W. Va. 28. Turn left (north) on W. Va. 28. Dev. Chemung Fm., marine sandstones and shales, from the Field Station to mile 7.5.
6.7	Summit of Allegheny Mountain, 3950 feet.
6.9	Leave Pocahontas County and enter Pendleton County at the birthplace of rivers.
7.5	Transitional contact of the Dev. Chemung and Hampshire fms. (Catskill Delta deposits) exposed on the left side of the highway. The contact is based on fossils and lithology. The Chemung Fm. is composed of marine brown sandstones and the overlying Hampshire Fm. is composed of nonmarine reddish brown sandstones. The beds dip eastward and form the western limb of the Stony River Syncline. The Hampshire Fm. is exposed along the highway from mile 7.5 to 14.1.
9.0	Dev. Hampshire Fm. on the left side of the highway showing exfoliation and stream cross-bedding in the ferruginous siltstones and sandstones.
9.6	Dev. Hampshire Fm. on the left side of the highway. Load casts are present on the base of the sandstone above the one inch coal seam.
10.1	The beds of the Hampshire Fm. are essentially horizontal. The axial trace of the Stony River Syncline trends north and south (at right angles to the highway).
11.1	Cross Big Run.
12.4	Stream cross-bedding in the Hampshire Fm. on the left side of the highway.
14.1	Transitional contact of the Dev. Hampshire and Chemung fms. (Catskill Delta deposits) on the left side of the highway. The reddish brown sandstones of the Hampshire Fm. have primary sedimentary structures of flute casts, groove casts, graded bedding, and load casts, indicating turbulent current deposition. The prominent road cut at Cherry Grove consists of brown marine sandstones and shales of the Chemung Fm. These beds dip westward and form a part of the eastern limb of the Stony River Syncline.

16.5 Dev. Harrell Shale with a N-S strike essentially parallel to W. Va. 28. The black and gray shales are vertical. Fucoids are exposed on some of the bedding surfaces. The transitional contact of the Harrell and Brallier fms. is exposed near the picnic tables on the left (south) side of the Harrell exposure. A Pleistocene stream channel deposit of gravels lies unconformably on top of the Harrell Fm. at this locality.

17.3 Dev. Hamilton Fm. on the left side of the highway is concealed by vegetation.

17.4 Vertical beds of the black Dev. Marcellus Shale are exposed on the left side of the highway adjacent to the Circleville sign.

17.8 North Fork River.

18.5 Sil. Tonoloway Ls. exposed in the quarry on the right side of the highway. *Hindella* brachiopod locality.

19.5 Sandstone blocks from the Dev. Ridgeley Sandstone are exposed on the right side of the highway.

20.7 Turn right on U.S. 33. Judy Gap section. Sil. Tonoloway Ls. exposed in the quarry. The flat wall of the quarry is a limestone bedding surface. (See the cross section of Judy Gap and mile 29.5).

21.2 Ord. Martinsburg Fm. (marine fossiliferous shales, limestones, and sandstones) exposed from mile 21.2 to 25.1.

21.7 *Crytolithus tesselatus* trilobites in the road cut on the left side of the highway.

23.6 Om with fossils.

24.9 Germany Valley overlook.

25.4 STOP #1 — Turn cars around. Nonmarine Ord. Juniata redbeds with hematite. The nonmarine Sil. Tuscarora Fm. of orthoquartzite forms the high ridge. Both formations are a part of the Queenston Delta deposited west of "Appalachia" in a subsiding basin.

25.7 STOP #2 — Contact between the marine Ord. Martinsburg and the nonmarine Ord. Oswego fms. The contact is based on paleontology and mineralogy. The upper Martinsburg sandstones contain large *Lingula nicklesi* and *Orthorhynchula linneyi* brachiopods (*Orthorhynchula linneyi* Assemblage Zone). The overlying Oswego sandstones are stream deposits and contain no fossils. The upper Martinsburg sandstones contain no hematite or limonite flakes but these are present in the Oswego sandstones. The formational contact represents the vertical facies change between marine and nonmarine environments of the Queenston Delta.

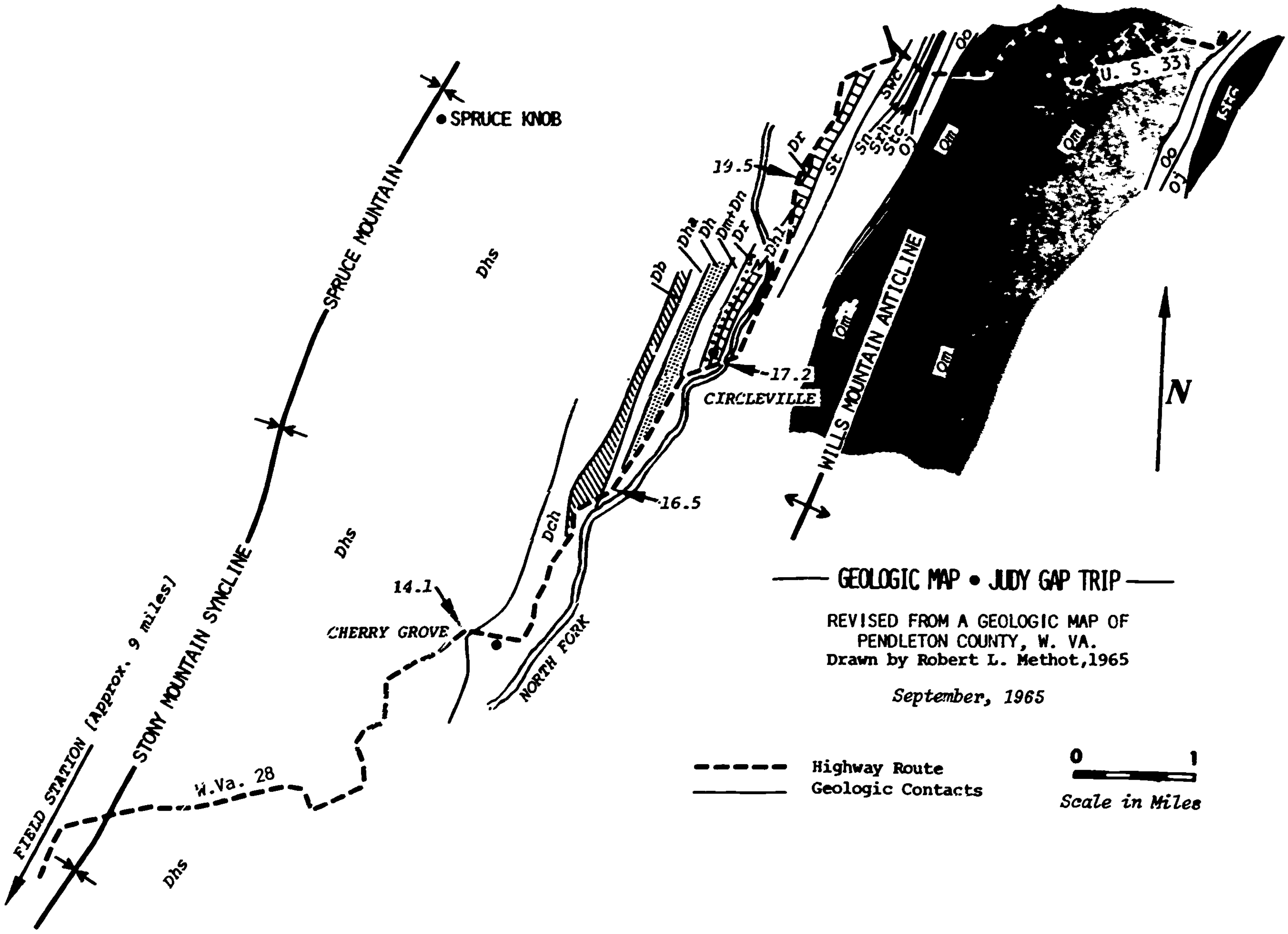
25.9 STOP #3 — Germany Valley Overlook. View of the breached asymmetrical Wills Mountain Anticline. The Ord. and Sil. formations include the Martinsburg, Oswego, Juniata, and Tuscarora. The resistant Sil. Tuscarora Fm. forms the hogback and ridge on both sides of the anticline. The synclinal mountain to the west has Pennsylvanian rocks along the axial trace. The Martinsburg Fm. in the highway cut contains the following fossils: crinoid stem plates, straight nautiloid cephalopods, brachiopods (*Rafinesquina*, Orthids), pelecypods (*Byssonychia*, *Allonychia*), bryozoans, and graptolites. The Martinsburg Fm. is exposed from mile 25.9 to 29.5.

26.2 STOP #4 — Lunch adjacent to the fossiliferous Martinsburg Fm.

29.5 STOP #5 — Judy Farm. Cars stop on the left side of the highway adjacent to the gate. Passengers unload. The driver of each vehicle will proceed to the quarry and will be returned to the gate in a Marietta College vehicle. Upper part of the Ord. Martinsburg Fm. with the *Orthorhynchula linneyi* and *Lingula nicklesi* brachiopods. The contact between the Martinsburg Fm. and the overlying Oswego Fm. is well exposed. (See Stop #2) From the gate westward along the highway the following formations are exposed: Martinsburg, Oswego, Juniata, Tuscarora, Rose Hill, McKenzie, Williamsport, Wills Creek, Tonoloway. Refer to the cross section of Judy Gap and the descriptions of each formation.

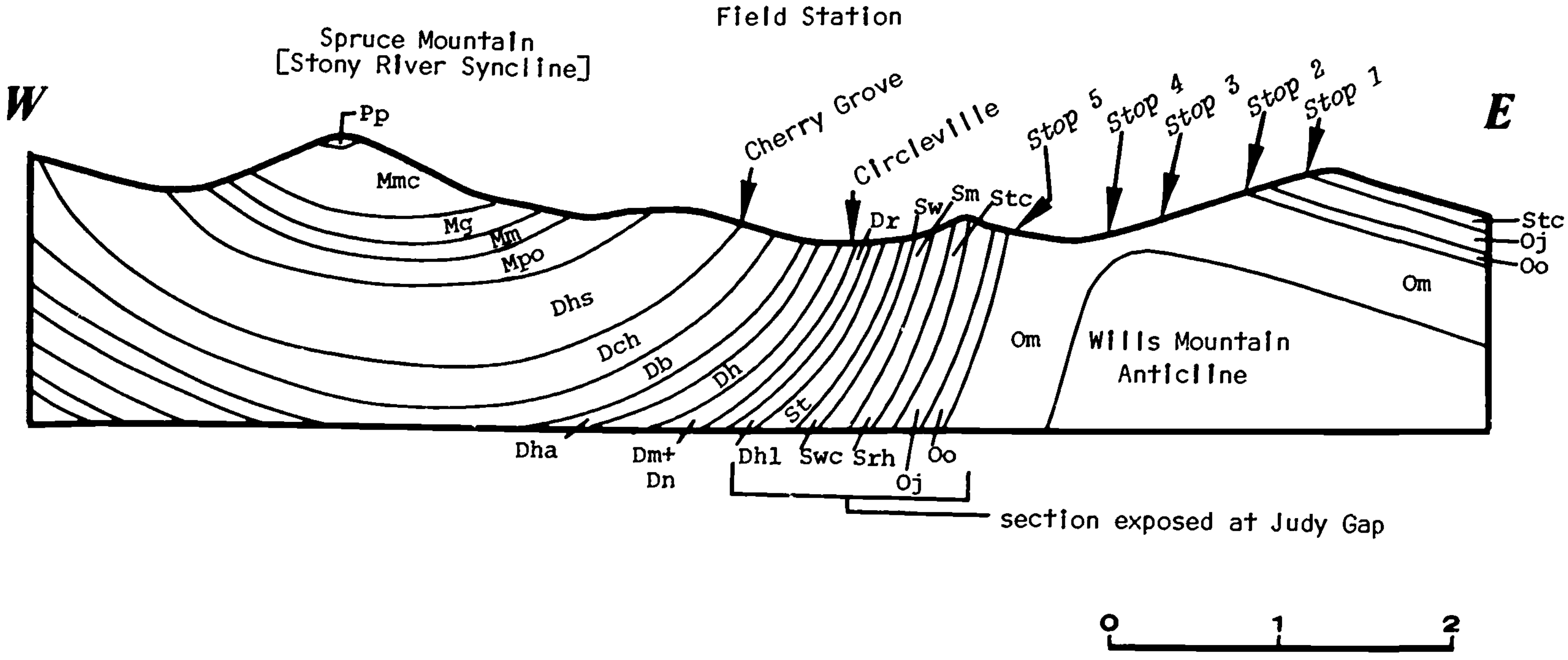
STOP #6 — (Tentative) See mile 14.1. Dev. Hampshire Fm. with flute casts.

STOP #7 — (Tentative) See mile 7.5. Transitional contact between the Dev. Chemung and Hampshire fms.



JUDY GAP TRIP

E - W cross section 15 miles north-east of the R. W. Whipple Natural Science Field Station



"SOUNDING KNOB TRIP" ROAD LOG

Mileage	
0.0	Ralph W. Whipple Natural Science Field Station.
0.1	Turn right on W. Va. 28. All cuts Dev. Chemung Fm. (Dch) until mile 8.
1.9	Dch on left with fossils.
2.0	Stop sign. Make sharp left on U.S. 250.
2.4	Dch with fossils (brachiopods, pelecypods, etc.) on right.
4.0	Cross Little River
4.6	Cross Old House Run at picnic ground.
6.5	STOP #1 — Park on right, use caution! Chemung Fm showing crest of Horton Anticline & fault (?). Alternating beds ranging from thin-bedded shale through coarse garywacke. Fossils (plants, pelecypods, fish parts(?), etc.). Trend of U.S. 250 in downhill direction is N30W.
7.8	Dch on left and right.
8.1	Dev. Hampshire Fm. (Dhs) on left and right.
8.8	Dhs on left, outcrop approximately 75 feet high. Ferruginous shale, siltstone, sub-garywacke, and graywacke. Roadcuts Dhs until mile 12.
9.0	Leave Pocahontas Co., W. Va., enter Highland Co., Va.
12.4	Dch on left with fossils and ripple marks.
12.9	Dch with ripple marks. Steeply dipping shale, siltstone, and ss.
13.2	Dev. Brallier Fm.(Db) with fossils.
13.7	Dev. Brallier Fm and Harrell Sh.(Dha). Cut approximately 50 feet high, 200 feet long. "Dirty" sandstone, fissile shale, and very minor amounts of limestone. Depauperate(?) fauna (pelecypods, etc.). Beds nearly vertical, dip varies between 85NW and 85SE, strike N35E. Dev. Marcellus Sh. (Dm) probably forms low weathered cuts 50 feet up road.
14.1	Dev. Helderberg Group (Dhl) on left and right. Mainly fossiliferous limestone (hash of brachiopods, crinoid stems, corals, bryozoans, etc.). Structure uncertain, some overturning and possibly some faulting.
14.9	Sil. Rose Hill Fm. on left, ferruginous quartzite.
15.1	Crest of Lantz Mtn., elev. 3670 feet. Sil. Tuscarora Fm. (Stc), an orthoquartzite, is ridge-former. Beds are overtorned to west.
15.2	Ord. Juniata Fm. (Oj) on left.
16.4	STOP #2 — Park on left. Ord. Martinsburg Fm.(Om) on right. Complex. tight, minor folding and faulting in thin-bedded shale interbedded with thin beds of limestone.
16.8	Hightown, Va., crossroads. Traversing anticlinal valley on limestone with some shale. Ls. outcrop in field behind P.O. —gas station — store.
17.4	View to left (NE) and right (SW) shows ends of plunging Hightown Anticline (Wills Mtn. Anticline in W. Va.). W limb forms Lantz Mtns., E limb forms Monterey Mtn. ahead. From here, as the elev. increases the rocks become younger, some squence as coming down Lantz Mtn. but in reverse.
18.3	Om on right with fossils.
18.8	Om on left, sandstone, siltstone, shale, and limestone. Fossils.
19.2	Oj on right.
19.5	Crest of Monterey Mtn., elev. 3895 feet.
19.8	Stc on right, white orthoquartzite.
20.4	STOP #3 — Back into parking area on right, just beyond cut. Sil. Rose Hill Fm. Mainly ferruginous shale and siltstone with ripple marks and mud cracks on dip slope. Strike N45E, dip 60SE. *Note:* Proceed slowly when leaving this stop, see next notation.

20.5 Continuation of same outcrop. Much larger ripple marks.

20.6 Sil. McKenzie Fm.(Sm) with ostracods.

21.6 Dhl on left. Fossils (brachiopods, corals, bryozoans, etc.).

22.1 Leached Dev. Ridgeley Ss. along road to left. Fossils.

22.2 Monterey, Va., city limits.

22.4 Dev. Ridgeley Ss. on right.

22.5 Intersection of U.S. 250 with U.S. 220. About in center of Monterey Syncline.

23.1 Quarry in Dhl on left. Fossiliferous (brachiopods, etc.) limestone cut by basic igneous dike.

23.3 Dhl on right, limestone.

24.3 Stc on right. Spring on right.

24.4 *Caution.* Make sharp right turn onto Va. Forest Fire Trail.

27.6 Sil. Rose Hill Fm. scree. Some patches of outcrop, but difficult to find with certainty. Fine to coarse grained ferruginous quartzite. Contains fossils (tracks, trails, etc.) and limonite bands and nodules.

27.7 Stc scree.

27.9 Open field with view of Middle section of the Ridge and Valley (or Folded Appalachians or Newer Appalachians) Province.

28.4 View of Middle section of the Ridge and Valley Province.

29.7 Take right fork of road.

30.1 STOP #4 — Park in field with caution, grass covered boulders. Base of Sounding Knob. This structure, elev. 4,390 feet, is a neck-like, igneous mass that cuts through the Tuscarora Fm. The summit is a hard, dense, dark basalt that weathers to rusty rounded masses. Its chief mineral constituents are plagioclase, augite, and magnetite, with a small percent of olivine. Evidence of igneous activity is not common in the central Appalachians, and exists only in a few isolated areas. It is generally thought that the igneous structures of this region are Triassic, associated with volcanic activity evidenced in the Newark Group in the eastern U. S. Toward the SW from the summit of Sounding Knob is a breached anticline of "textbook" quality. This is the Jack Mtn. Anticline. The western prong is formed by Little Mtn. and the eastern by Jack Mtn. The central section has been eroded down through the Martinsburg Fm. into the limestones which floor the present valley. The enclosing ridges are formed of the Tuscarora Fm. Sounding Knob lies on the western prong of the Jack Mtn. Anticline. (JMW)

30.1 Retrace route to U.S. 250, after regrouping at mile 32.5.

32.4 Stc scree.

32.5 STOP #5 —Informal stop to allow caravan to regroup. See mile 27.6 for description.

35.8 Turn left (west) on U.S. 250. (Approx. 1 mile on right, view of quarry described at mile 23.1) (Approx. 1.4 miles on left, view of Trimble Knob 0.7 mile S of Monterey).

37.4 Turn left (south) on U.S. 220.

38.7 Turn right (west) on Va. 636.

39.4 STOP #6 — Trimble Knob (Pyramid Hill) is a prominent feature in Monterey Valley. It rises 324 feet above the valley floor as a "pyramidal" plug intruded through the Needmore Shale (Dn). Although within sight of Sounding Knob, it is not directly associated with it. Upon fresh fracture the rock at Trimble Knob is a vesicular and amygdaloidal basalt (many vesicles are filled with various forms of silica). (JMW)

40.0 Turn right (east) on U.S. 250.

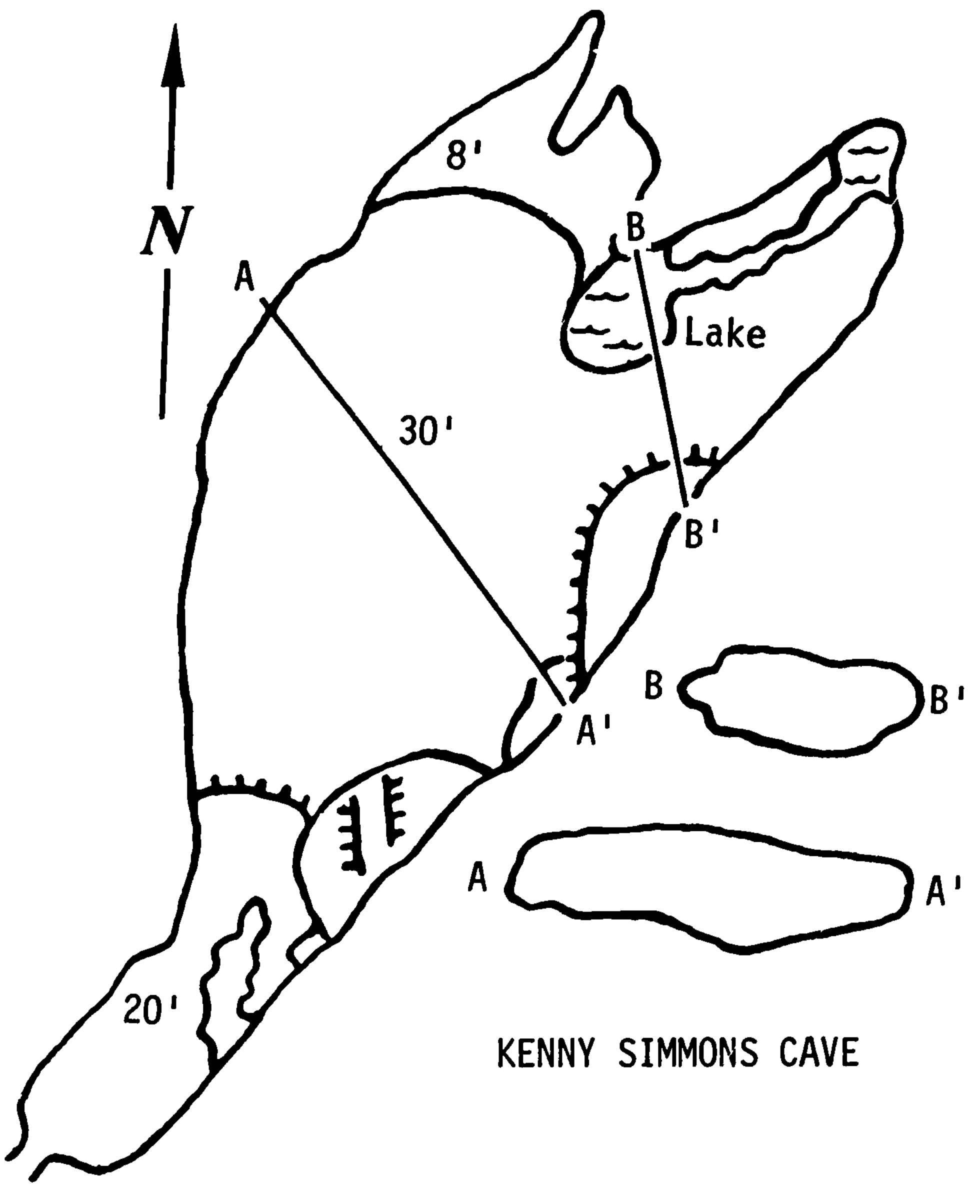
40.2 & 0.0 Turn left (north) on U.S. 220. (Miles for rest of trip start from 0.0 at this intersection).

2.8 Basic igneous intrusive in Dev. Ridgeley Ss. on left.

3.6 Cross East Branch of Strait Creek.

4.4 Concentration of hematite in Ridgeley Ss. on left.

5.6	Cross Strait Creek.
6.5	Cross East Branch Potomac River.
7.6	Leave Highland Co., Va., enter Pendleton Co., W. Va.
12.6	STOP #7 — *Caution.* Make sharp left turn into driveway. Kenny Simmons Cave (Keyser Ls.). *Please* be careful and courteous, this is private property and we are here through the kindness of Mr. Simmons. *Please* DO NOT REMOVE any cave formations. Observe them and leave them for others to see, cave formations do not grow over night. See pg. 16-7 for description.
16.8	Large quarry, limestone of Dev. Helderberg Group. Includes Quarry Cave (Keyser Ls.). Fossils.
18.7	Hamilton (New Scotland Ls.), Trout, and New Trout (both in New Scotland-Coeymans Ls.) Caves in hill to left. Entrance to Trout Cave can be seen in prominent face several hundred feet above road as we approach the hill.
20.9	STOP #8 — Marcellus Sh., carbonaceous shale showing intense deformation.
22.4	Franklin, W. Va., city limits.
23.1	Jct. of U.S. 220 and U.S. 33. Remain on U.S. 220, do not turn.
23.6	Turn left (west) on U.S. 33.
32.1	Crest of North Fork Mtn., elev. 3592 feet. Juniata Fm. (Note: See Stop #1 at mile 25.4 of Judy Gap Log which we will pass just ahead at the picnic ground).
	STOP #9 — See Stop #3 at mile 25.9 on Judy Gap Log.



KENNY SIMMONS CAVE

KENNY SIMMONS CAVE

Kenny Simmons cave is fairly well known and at the turn of the century it was used for annual Fourth of July dances and parties.

Kenny Simmons cave is in a low round hill at an elevation of 2175 feet. It is about 100 yards west of U.S. Highway 220. The coordinates of the cave in the Circleville quadrangle are 38° 32' 54" N; 79° 26' 53" W.

The main room is 450 ft. long and is 150 ft. wide at the maximum toward the back. This room divides into two sections. On the east side breakdown is piled to the ceiling. Beneath this breakdown are a series of passages and crawlways. An extension of these passageways lead to an opening about 20 ft. below the main entrance and it was through this opening that the cave was first entered. Later, in 1895 the main opening was dug out and enlarged.

Stalactites and columns have formed near the entrcnce, along the east wall of the main room and in the crawl passages, the floor is composed of deep clay which is very smooth. Where the room divides, there is a chasm that leads to a pond. The pond can be entered in a boat through a twisting channel with a low ceiling continuing for 30 ft. There the pond is 25 ft. across with a 20 ft. ceiling and a white silt bottom. The water is 10 ft. deep and very clear.

GEOLOGIC SECTION FOR THE ROCKS IN THE VICINITY OF THE R.W. WHIPPLE

NATURAL SCIENCE FIELD STATION

Pennsylvanian	Pottsville Fm (Pp)	160 ft. Nonmarine and marine, white orthoquartzite, shale, and conglomerate. Sharon Conglomerate at the base.
Mississippian	Mauch Chunk Gp. (Mmc)	1700 ft. Nonmarine and marine, red-brown to gray sandstone and shale, with coal beds in the upper half of the group. Fossiliferous.
	Greenbrier Fm. (Mg)	300 ft. Marine, limestone and shale. Limestone forms the Sinks of Gandy.
	Maccardy Fm. (Mm)	30 ft. Marine and nonmarine, shale, sandstone, and yellow limestone. Fossils are not common.
	Pocono Group (Mpo)	300 ft. Marine, nonmarine deltaic deposits of sandstone, conglomerate, and shale. Plant fossils occur near the base.
Devonian	Hampshire Fm. (Dhs)	(Catskill Fm. of old reports) 2,000 ft. Nonmarine, reddish brown shales and massive sandstones. Primary sedimentary structures includes cross bedding, ripple marks, flute casts and groove casts. The Hampshire Fm. is the nonmarine facies of the Catskill Delta and was deposited by westward flowing streams. Fossils are rare and include broken plant parts and fish teeth.
	Chemung Fm. (Dch)	1,000 ft. Marine, green and brown interbedded shale and sandstone with cross bedding and ripple marks. The formation forms the exposures within a radius of several miles from the Field Station. The fm. is the marine facies of the Catskill Delta. The Chemung-Hampshire contact is indistinct and is one of inter-fingering facies between the marine Chemung below and the nonmarine Hampshire above. The contact may be drawn above the highest bed containing marine fossils or at the base of the lowest red sandstone or shale. The basal contact is not distinct and is placed above the thin bedded Brallier shales

and below the thick bedded Chemung sandstones. Fossils are common and include the brachiopods *Cyrtospirifer disjunctus, Atrypa, Cupularostrum, Camarotoechia*, and the pelecypods *Leptodesma* and *Modiola*. Crinoid stem plates and bryozoa are locally abundant.

Brallier Fm. (Db) — (Portage of old reports) 1,000 ft. Marine, green to brown micaceous shale with interbedded thin green sandstone. There is a transitional contact between the underlying Harrell black shales and the overlying Brallier brown shales and sandstones. Fossils are very abundant and well preserved in the road cuts near Monterey. The fossils include the brachiopods *Leiorhynchus, Mucrospirifer, Tylothyris, Spinatrypa*, and *Tropidoleptus*; crinoid stems, pelecypods, and bryozoa.

Harrell Shale (Dha) — (Genesee of old reports) 100 ft. Marine, black and gray, fissile shale that weathers gray or green. Fossils are not abundant but include fucoids, *Styliolina*, and the pelecypods *Buchiola* and *Paracardium*.

Hamilton Fm. (Dh) — 50 ft. Marine shales and sandstones that rapidly disintegrate when exposed to the atmosphere. Not present in the vicinity of Monterey and poorly exposed near Circleville.

Marcellus Shale (Dm) — 400 ft. Marine, black fissile carbonaceous shale with few fossils. Several thin lenticular limestones at the base of the formation are coquinas of the small brachiopod *Ambocoelia virginiana*.

Needmore Shale (Dn) — 50 ft. Marine, green to black, fossiliferous shale. Fossils include trilobites *(Phacops cristata)* and *Orbiculoidea* brachiopods. The lower contact is distinct.

Ridgeley Sandstone (Dr) — (Oriskany Sandstone of old reports) 50 ft. Marine, coarse grained massive calcareous brown sandstone. The contact between the Ridgeley and the underlying Port Jervis is transitional. Fossils are abundant and occur as internal and external molds. *Costispirifer arenosus* and *Acrospirifer murchisoni* have been collected.

Helderberg Group (Dh1)
Port Jervis Fm — 80 ft. Marine, sandy limestone with numerous black chert nodules. The basal contact is indistinct.

Port Ewen Fm. — 50 ft. Marine, siliceous limestone with black chert nodules. The upper contact is based on fossils. The basal contact is usually covered and is placed on the top of a shale member of the New Scotland Fm. The fm. has few fossils.

New Scotland Limestone — 30 ft. Marine, gray limestone with interbedded gray and black chert that weathers white. The fm. is exposed in Trout Cave near Franklin. The limestones are very fossiliferous and contain the large brachiopod *Macropleura macropleura* and *Platyceras* gastropods. The bedded chert and the large brachiopods easily separate the New Scotland Fm. from the other fms. in the Helderberg Gp.

Coeymans Limestone — 20 ft. Marine, coarsely crystalline gray crinoidal limestone that is difficult to distinguish from the Upper Keyser Limestone. The brachiopod *Gypidula coeymansis* is the guide fossil for the formation and is absent in the overlying New Scotland Fm. and the underlying Upper Keyser Limestone.

	Keyser Fm.	200 ft. Marine, gray massive coarsely crystalline limestone. In Pendleton Co. the fm. is divided into three members: Upper Keyser Ls., Big Mountain Shale, Lower Keyser Ls. The basal contact of the fm. is distinct. The ls. of the Keyser are coarsely crystalline and have abundant fossils while the fine groned ls. of the Tonoloway have few fossils. The Silurian-Devonian contact occurs within the Keyser Fm. Common fossils include the coral *Favosites* and the brachiopods *Howellella, Eccentricosta,* and *Meristella.*
Silurian	Tonoloway Limestone (St)	(Bossardville of old reports) 400 ft. Marine, thin bedded to massive, light gray limestones, with ripple marks and mud cracks. Fossils include *Hindella* brachiopods, high spired *Hormotoma* gastropods, and abundant large *Leperditia* ostracods.
	Wills Creek Fm. (Swc)	(Roundout of old reports) 260 ft. Marine, thin bedded gray limestones and shales mainly in two inch layers. The contact between the Wills Creek and overlying Tonoloway Ls. is indistinct and is placed at the top of the shaly ls. of the Wills Creek. Large black ostracods *(Leperditia elongata)* are abundant.
	Williamsport Ss. (Sw)	3 ft. Nonmarine, greenish-brown thick bedded sandstone. The lower and upper contacts of the fm. are distinct and are conformable.
	McKenzie Fm. (Sm)	250 ft. Marine, brown shales and thin bedded fossiliferous limestones. Many of the ls. are essentially composed of small black ostracods. The following genera are represented: *Kloedenia, Kloedenella, Eukoedinella,* and *Beyrichia. Camarotoechia andrewsi* brachiopods are abundant in the ls. near the top of the fm., with coquinas of *Whitfieldella marylandica* near the base. The high spired gastropod *Hormotoma* is common throughout the fm.
	Rochester Shale (Sr)	25 ft. Marine, gray shale with interbedded gray limestone. The upper contact is indistinct lithologically and is based on the presence of abundant *Schellwinella elegans* brachiopods. The ostracods *Drepanellina clarki* are found near the base. Not well exposed at most localities.
	Keefer Sandstone (Sk)	10 ft. Marine, brown sandstone with hematite. Unfossiliferous, not exposed at most localities.
	Rose Hill Fm. (Srh)	(Clinton of old reports) 250 ft. Marine, green and brown shale and sandstone. Red hematitic sandstones are abundant near the base of the fm. Ripple marks and ichnofossils (fucoids and trails) are excellently exposed near Monterey. Fossils are chiefly ostracods and include the following genera: *Zygobolba, Zygosella,* and *Mastigobolbina.*
	Tuscarora Fm. (Stc)	(White Medina of old reports) 150 ft. Nonmarine, white orthoquartzite with silica cement. The fm. is the youngest deposit of the Queenston Delta, having been deposited by westward flowing streams. The resistant fm. forms prominent hogbacks. The Ordovician-Silurian contact is for convenience placed at the base of the Tuscarora Fm. Fossils are rare, but *Arthrophycus alleghaniensis* is locally abundant.
Ordovician	Juniata Fm. (Oj)	(Red Medina of old reports) 700 ft. Nonmarine, reddish brown sandstone and shales of approximately

equal amounts. The environment of deposition is similar to that of the Tuscarora and Oswego fms. Fossils are rare.

Oswego Fm. (Oo) — (Gray Medina of old reports) 150 ft. Nonmarine, gray and brown sandstone with limonite flakes near the base. The Oswego sandstones were deposited by westward flowing streams and represents the oldest nonmarine facies of the Queenston Delta. Fossils are rare.

Martinsburg Fm. (Om) — 2,000 ft. Marine, thin bedded fossiliferous limestones and gray-green shales. The fm. is the basal part of the Queenston Delta with an eastern source for the sediments. The delta sediments of the Martinsburg are chiefly turbidites in Virginia but none have been found near the Field Station. The brown sandstones near the top of the fm. are in the *Orthorhynchula linneyi* Assemblage Zone. The zone contains abundant *O. linneyi* and very large *Lingula nicklesi*. Fossils are common throughout the fm. and include the brachiopods *Rafinesquina* and *Dalmanella*, as well as the pelecypods *Byssonychia* and *Allonychia*. Excellently preserved *Cryptolithus* trilobites are locally abundant. Crinoid stems and bryozoa can be found at most outcrops.

ROAD LOG TO SINKS OF GANDY AND SPRUCE KNOB

Mileage	
0.0	From Field Station follow 28 north.
7.0	Pocahontas - Pendleton County Line. Turn left on Forest Service Road to Spruce Knob Lake (11 miles).
18.0	Spruce Knob Lake Camp Site.
19.0	Spruce Knob Lake.
21.0	Junction Forest Roads 41 and 1 —Take sharp left turn.
23.0	Sinks of Gandy —STOP #1 —Drive through gate and park.
	Drive back down road 1/2 mile; park —Outlet of underground stream (opposite side of sinks) STOP #2.
29.0	Junction —8 miles to Spruce Knob —(same as mileage point 19.0).
36.0	Base of Spruce Knob —STOP #3.

SINKS OF GANDY CREEK

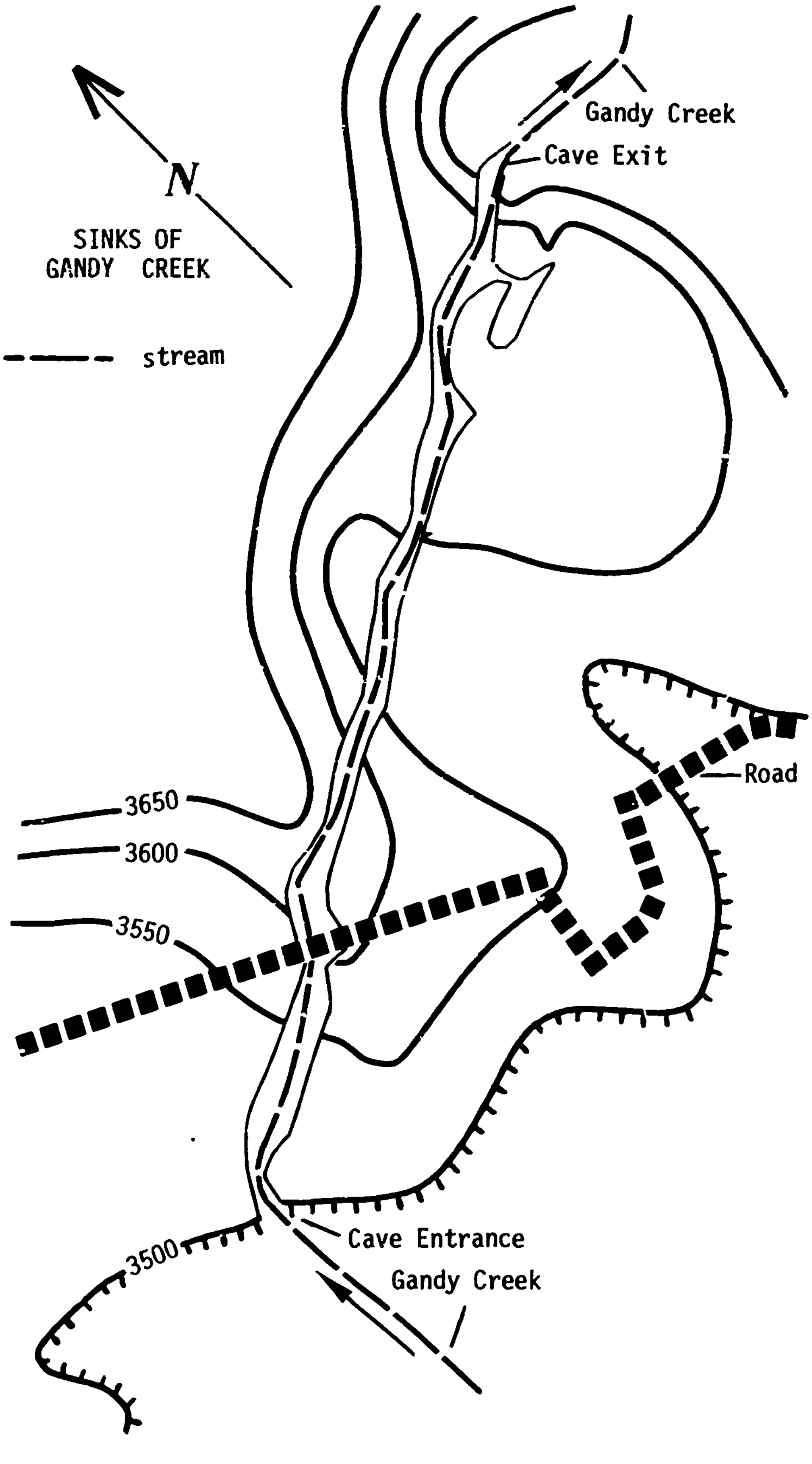
The south entrance of the Sinks of Gandy Creek is located about 1/2 mile west of Osceola on the southern side of Yokum Knob. The entrance is in a low ledge of horizontal limestone (the base of the Greenbrier Ls.) at an elevation of 3500 ft. It is 30 ft. wide and 15 ft. high. The passage heads N for 100 ft. and then turns N.E. for 2725 ft. to its northern exit. The main passage has an average width of from 30 ft. to 60 ft. However, portions of it exceed 100 ft. in width. The ceiling is 6 ft. to 30 ft. in height. Side passages are small and short.

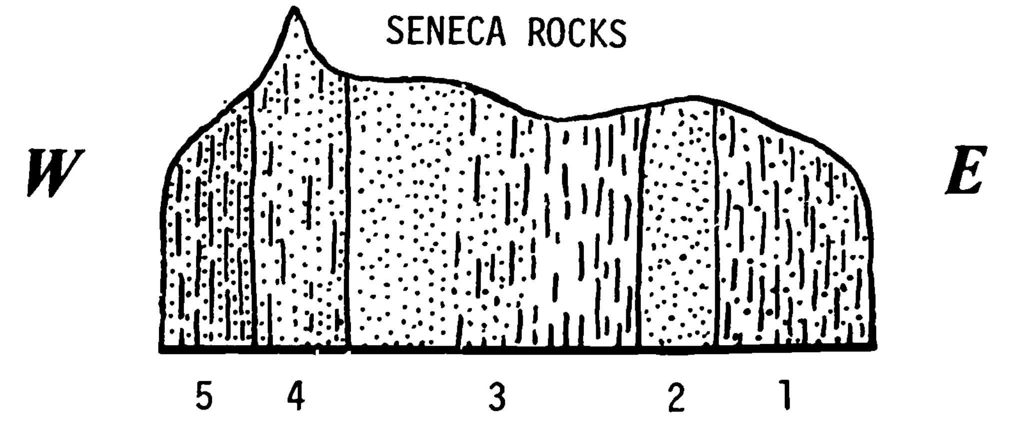
In some sections the stream flows only in narrow trenches, while the remainder of the passage is a gravel bank or ledge. In several places, however, the stream occupies the entire floor, almost blocking the passage. Because of this, visitors should expect to have wet clothing.

SENECA ROCKS

Seneca Rocks are located about 1/2 mile east of the mouth of Seneca Creek and are formed by the Tuscarora Formation, which is a dense, white, resistant conglomeratic sandstone and orthoquartzite.

These rocks are part of the west limb of the Wills Mountain Anticline and are nearly vertical. Seneca Rocks is actually just a part of the feature known as the Devil's Backbone, which goes the whole length of the county forming the rest of the River Knobs. This can be seen very clearly from the summit of Spruce Knob.





5. Rose Hill Fm.

4. Tuscarora Fm.

3. Juniata Fm.

2. Oswego Fm.

1. Martinsburg Fm.

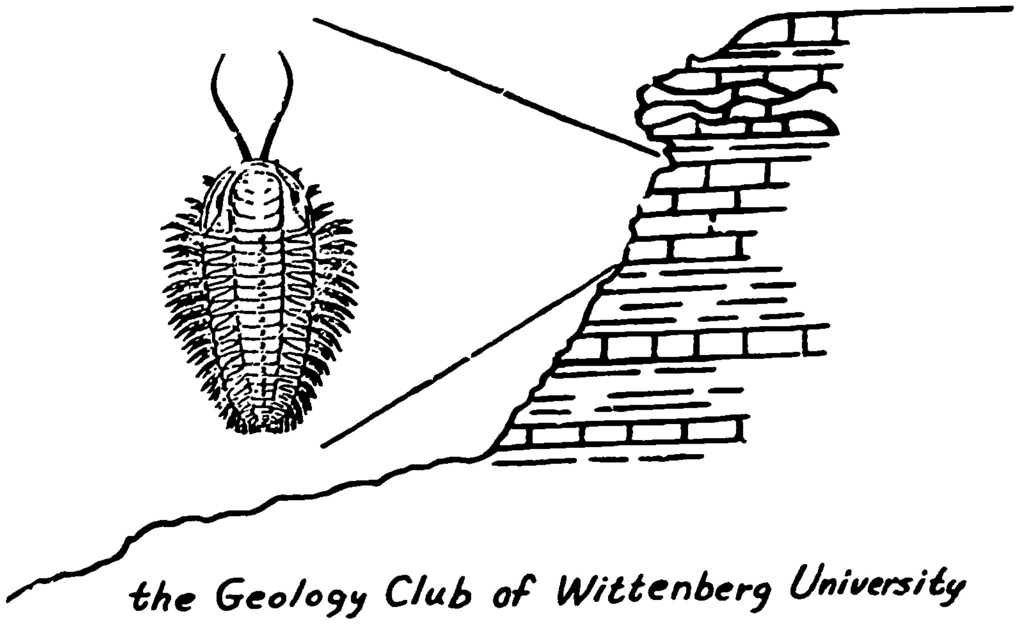
SPRUCE KNOB

Spruce Knob is the highest point in W. Va. with an elevation of 4860 feet. Some believe it is a monadnock rising above the Schooley Peneplane and its general relief is due to stream disection. Its cap rock consists of the Sharon Conglomerate of the Pottsville Formation. This Pennsylvanian rock is the youngest member of and lies along the axial trace of the Stony River Syncline. Parallel to Spruce Knob on the west is the Allegheny Front. The average elevation of Spruce Mt., the long ridge of which Spruce Knob is a part, is 4600 feet.

17th Annual

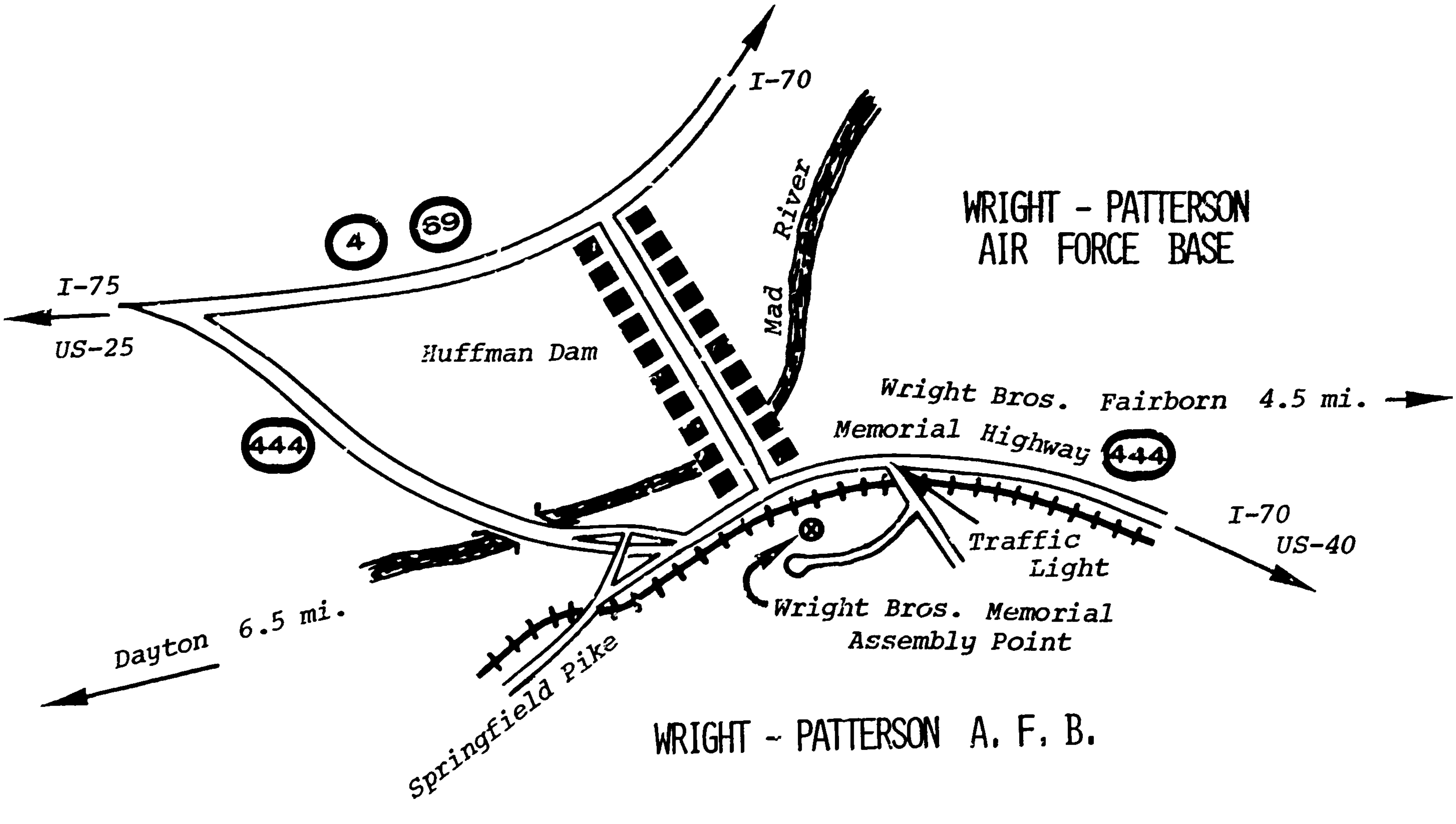
Ohio Intercollegiate Geology Field Conference

15 October 1966

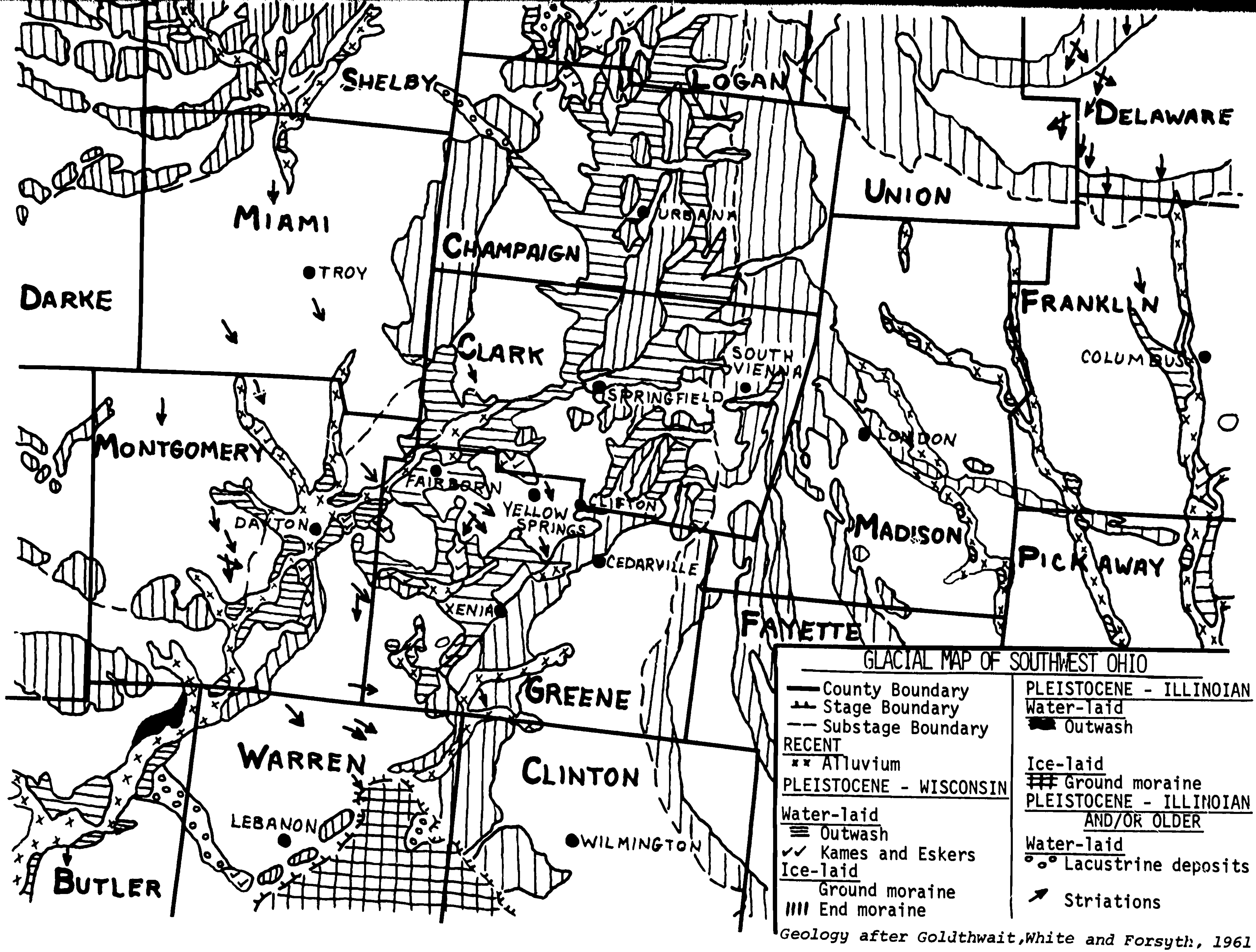


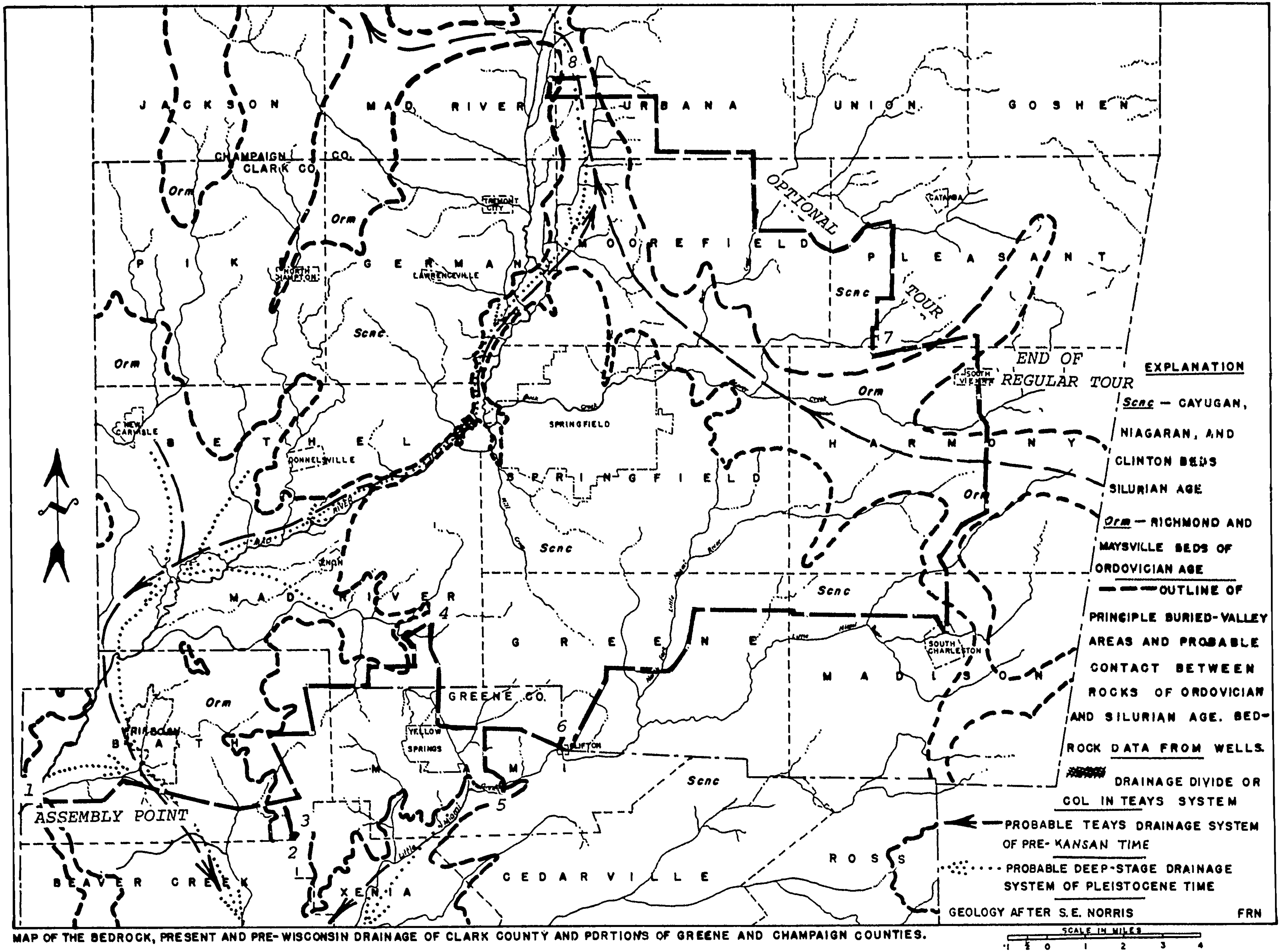
the Geology Club of Wittenberg University
Springfield, Ohio

ASSEMBLY: 8:00 A.M. in the parking area at the Wright Brothers Memorial in Bath Township. The memorial is located just east of State Highway 444 opposite Huffman Dam on the Mad River in westernmost Greene County and is surrounded by Wright-Patterson Air Force Base.



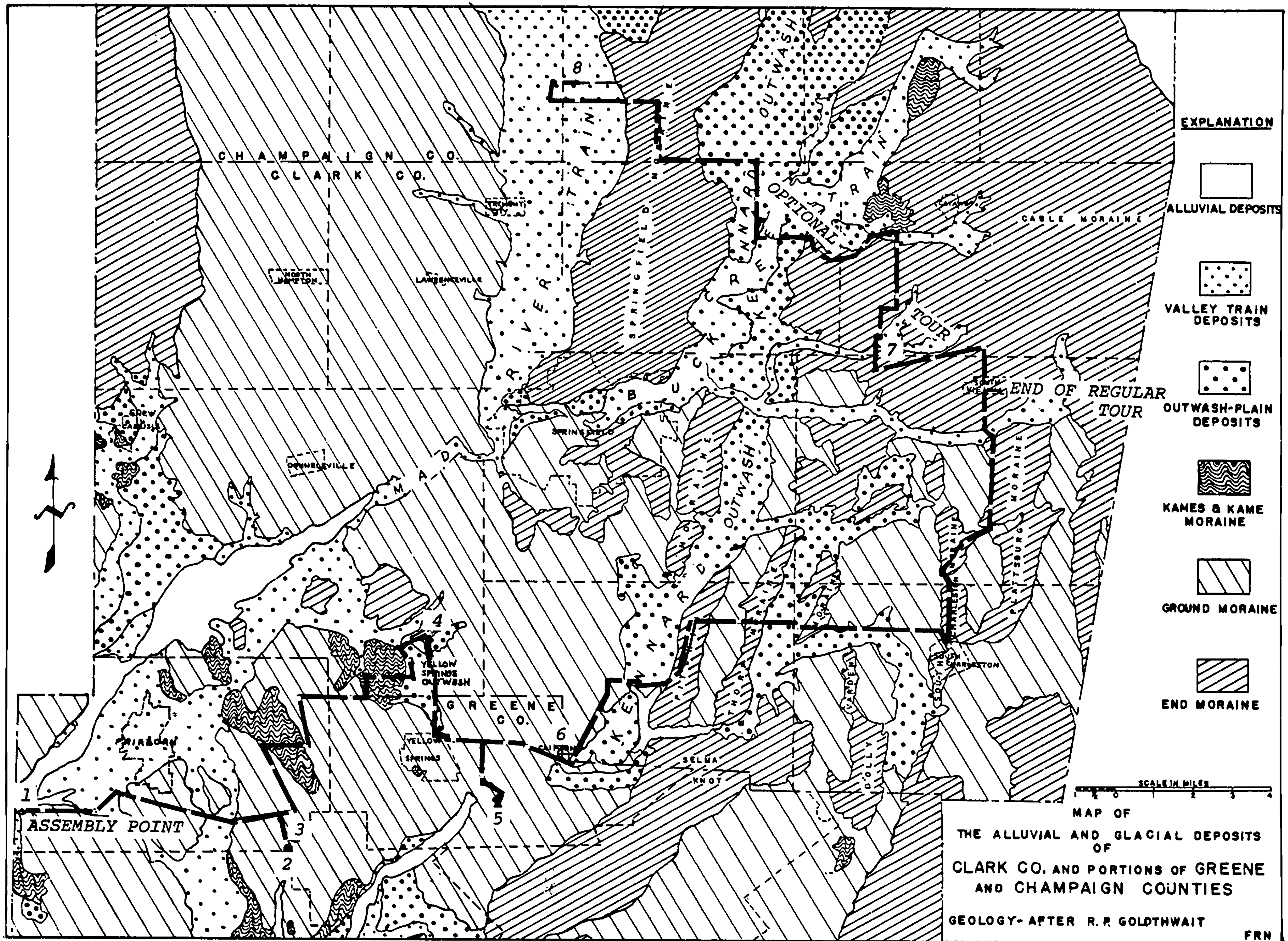
INDEX


GLACIAL MAP OF SOUTHWEST OHIO
County Boundary
Stage Boundary
Substage Boundary
RECENT
Alluvium
PLEISTOCENE - WISCONSIN
Water-laid
Outwash
Kames and Eskers
Ice-laid
Ground moraine
End moraine
PLEISTOCENE - ILLINOIAN
Water-laid
Outwash
Ice-laid
Ground moraine
PLEISTOCENE - ILLINOIAN AND/OR OLDER
Water-laid
Lacustrine deposits
Striations
SHELBY
LOGAN
DELAWARE
UNION
MIAMI
CHAMPAIGN
URBANA
TROY
DARKE
CLARK
FRANKLIN
COLUMBUS
SOUTH VIENNA
SPRINGFIELD
LONDON
MONTGOMERY
FAIRBORN
YELLOW SPRINGS
CLIFTON
DAYTON
MADISON
PICKAWAY
CEDARVILLE
XENIA
FAYETTE
GREENE
WARREN
CLINTON
LEBANON
WILMINGTON
BUTLER
Geology after Goldthwait, White and Forsyth, 1961



MAP OF THE BEDROCK, PRESENT AND PRE-WISCONSIN DRAINAGE OF CLARK COUNTY AND PORTIONS OF GREENE AND CHAMPAIGN COUNTIES.

Figure 3.


EXPLANATION
ALLUVIAL DEPOSITS
VALLEY TRAIN DEPOSITS
OUTWASH-PLAIN DEPOSITS
KAMES & KAME MORAINE
GROUND MORAINE
END MORAINE
SCALE IN MILES
MAP OF
THE ALLUVIAL AND GLACIAL DEPOSITS
OF
CLARK CO. AND PORTIONS OF GREENE
AND CHAMPAIGN COUNTIES
GEOLOGY- AFTER R. P. GOLDTHWAIT
FRN
CHAMPAIGN CO.
CLARK CO.
GREENE CO.
MAD RIVER
BUCK CREEK
OPTIONAL
TOUR
END OF REGULAR TOUR
ASSEMBLY POINT
YELLOW SPRINGS OUTWASH
CABLE MORAINE
SPRINGFIELD
PLATTSBURG
SELMA
KNOT
YELLOW SPRINGS
CLIFTON
DONNELSVILLE
LAWRENCEVILLE
NORTH HAMPTON
SOUTH CHARLESTON
1
2
3
4
5
6
7
8
Figure 4.

HUFFMAN DAM ROADCUT

CROSS SECTION

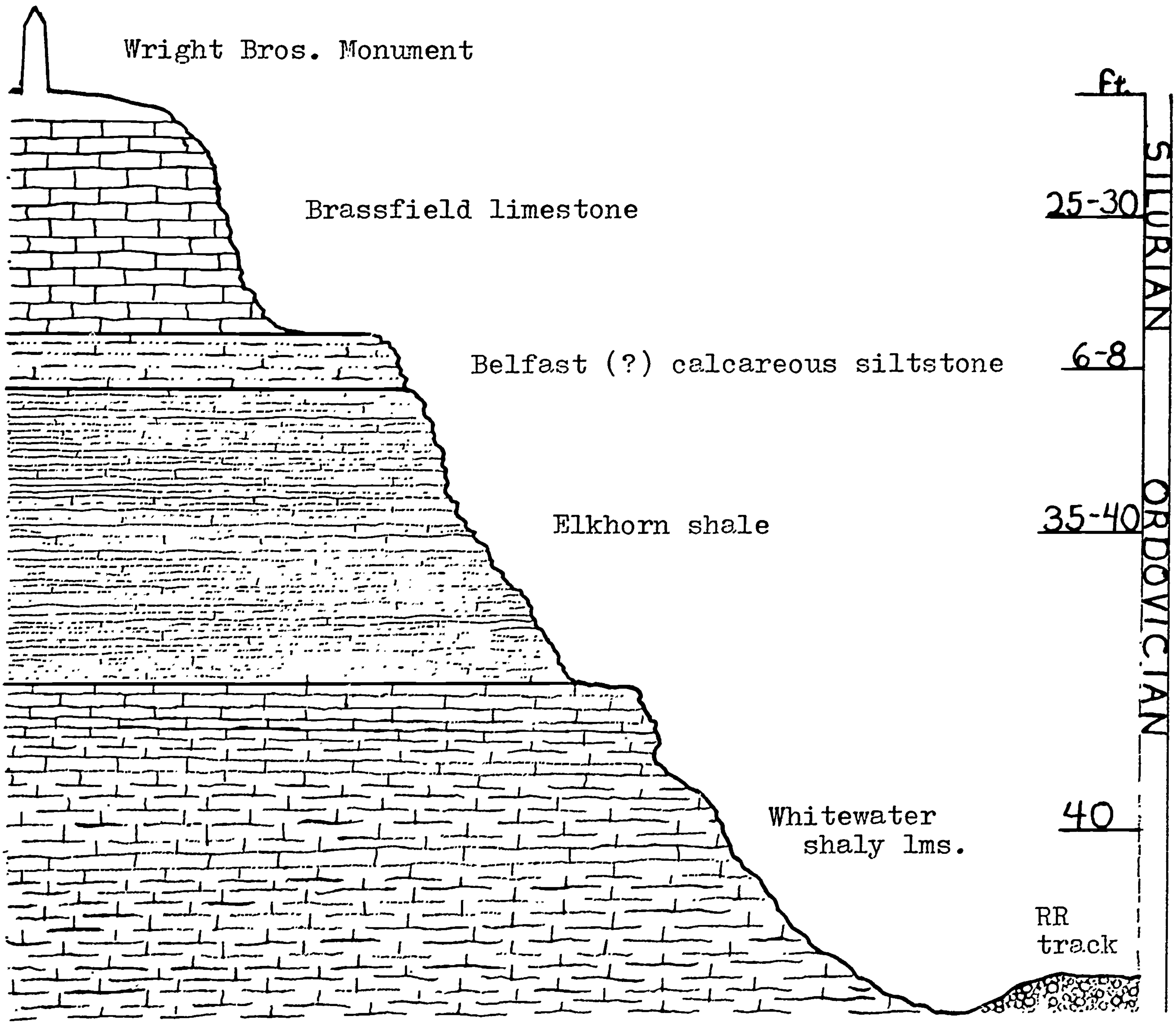


Figure 5.

ROAD LOG

Mileage

Increments	Total	
	0.0	STOP #1 —*Huffman Dam railroad cut.*

From the parking area at the Wright Brothers Memorial, proceed directly to the Huffman Dam railroad cut. The sides of the cut are steep and very slippery (especially when wet) and caution must be exercised at all times.

This exposure is a typical example of the fossiliferous upper Richmond. The approximately 115 feet of sedimentary rock, including the Whitewater, Elkhorn, Belfast, and Brassfield strata (p. 25), are mostly shaly limestone and siltstone, capped by the Silurian Brassfield Limestone. The Richmond here is representative of shallow water deposition in epeiric seas. Sediment from the Queenston Delta was deposited on the Cincinnati Arch during a time of maximal inundation.

The fossils in the exposure are quite abundant and are readily collected. The two most commonly found fossils are brachipods and bryozoans. Brachiopods, both articulate and inarticulate, have been found in large numbers and much use of them has been made as index fossils. The bryozoans come in many shapes, from large and small twig-like forms to masses and crusts. Several genera of gastropods are common and can be found with ease. The coelenterates are best represented by the anthozoans, especially by the horn corals and by some colonial forms; scyphozoans and stromatoporoids, although represented, are rare. Echinoderms are found in the strata mostly as doughnut-shaped or pentagonal columnal fragments of crinoids. The nautiloid type of cephalopod, mostly those with straight conical shells, is well preserved and good specimens may be located. Good specimens of pelecypods are rare, but the fragments are common, and trilobites, too, are found mostly in fragmentary form. Conodonts can be found in most of the beds, but an effort is required to locate them. Although the first fish were appearing in Ordovician time, there is no fossil evidence for them from this region. In order to facilitate the identification of the fossils found, illustrations of the more common fossils in the upper Richmond have been included (pp. 26-29). (See also general articles on p. 22 and p. 23).

Return to cars.

Increments	Total	
	0.0	Leave Wright Brothers Memorial. Turn right (south) on to Old Route 4. Traveling over ground moraine overlying generally thick and extensive outwash deposits of sand and gravel. This sequence indicates a readvance of the ice sheet after the deposition of the outwash materials.
1.5	1.5	Crossing Mad River valley train.
.4	1.9	Re-enter ground morain overlying outwash deposits.
.3	2.2	Cross Col. Glenn Highway. Old Route 4 becomes Kauffman Ave.
.5	2.7	Turn right (east) on to Dayton Yellow Springs Road. Continuing on ground moraine overlying outwash deposits.
2.3	5.0	Descend to valley train deposits along Beaver Creek.
.1	5.1	Cross Beaver Creek.
.5	5.6	Ascending thick ground moraine. Till is generally more than 20 feet thick and contains buried sand or gravel beds in some places.
.4	6.0	Village of Byron. Traveling over thin (less than 20 ft. deep) ground moraine.
.5	6.5	Turn right (south) on to Linebaugh Road.

.3

6.8 Turn left (east) through gate onto the property of the Southwestern Portland Cement Company. Drive carefully and follow the lead car over company roads. The railroad which we parallel is company-run and is used in daily shuttle service to haul limestone from the quarry (Railroad cars are loaded directly from rock-hauling trucks at the platform just east of the tracks) to the kilns, which are about 4 miles to the northwest in the city of Fairborn.

STOP #2 — *Quarry "E", Southwestern Portland Cement Co.*

Exposed here is the upper Brassfield Limestone. The quarry floor is at the base of the upper Brassfield formation, since only the upper Brassfield is being actively quarried because of its low magnesium content. The Brassfield Limestone, typically an irregularly bedded, coarsely crystalline, well-cemented, pink limestone, is, in places, made up chiefly of crinoid fragments. However, the character of the formation is highly irregular, as can be seen in the quarry faces. The color locally ranges from hematite-red to green depending on the relative amounts of ferric and ferrous iron present. The bedding is highly irregular in thickness and in lateral continuity, and the beds frequently lens out within a short distance. Lenses of blue clay are irregularly distributed. Throughout this formation the most important characteristics are the corals *Halysites* and *Favosites*, crinoidal hash, stylolites, and pyritized materials.

The lower Brassfield grades into the upper Brassfield, but is physically and chemically distinct. It is a light brown, friable, sandy textured, porous and permeable, dolomitic limestone. The high porosity and permeability of the lower Brassfield, which are thought to be chiefly a result of solution, plus the fact that it is underlain by the impervious Elkhorn shale, make it an important aquifer and one of the chief sources of domestic water. Because the lower Brassfield is magnesia-rich (9-18%), it cannot be used in cement and, consequently, this quarry does not penetrate into it.

The upper part of the formation is relatively pure calcium limestone and is the only local source suitable for making Portland cement. The magnesium content is quite variable but is generally less than 5%. The higher magnesium content of the lower Brassfield is attributed to preferential leaching in the aquifer zone of the more soluble calcite, thus producing enrichment of dolomite in the lower beds. The quarry floor is at the base of the upper Brassfield formation.

At this time, no complete list of the Brassfield fauna has been compiled. (The only list available is the one in Schuchert's *Stratigraphy of Eastern and Central United States.)* However, the fossil record is abundant and numerous types of organisms are present. Within the present quarry, several forms are abundant:

- crinoids
- brachiopods, especially *Stegerhynchus*
- bryozoans, especially the twig-like *Hallopora* and the fenestrate *Fenestrellina*
- gastropods
- stromatoporoids
- orthoceroid cephalopods
- corals, especially the chain coral Halysites, the honeycomb coral *Favosites*, and the horn corals *Streptelasma* (less than 50 septa) and *Cyathophyllum* (more than 50 septa)

(See also general articles on p. 25 and p. 33)

DRILL LOG

Footage	Description
0-10	Till 3 inches Dayton limestone
(upper Brassfield)	
10-11	Pink, highly fossiliferous, coarsely crystalline limestone; yellow clay seams common; material becomes dense, gray-green, silty lower 6 inches.

11-13 Pink limestone; highly pyritized (crystals to 1/2 inch); highly fossiliferous; green clay seams common; badly shattered in lower half of section, gray tint.

13-15 As above, upper two feet grades into firm fossiliferous pink encrinite.

15-17 Pyritized (crystals to 3/8 inch) material changing to gray-green tint; clay seams interbedded throughout lower 2/3 of core, highly fossiliferous (crinoid fragments predominate).

17-19 Upper foot as above; lower foot is pink, crystalline encrinite, stylolites common, firm, dense.

19-21 Becoming porous in texture; silty in appearance; light brown in color; stylolites common; very fine clay seams.

21-27 Silty in appearance; many fine clay seams to 2 inches thick throughout; gray-green in color, turning pink in lower portion with brown-green cast.

27-29 Pink-gray encrinite; stylolites common; occastional solution cavities near base.

(lower Brassfield)

29-31 Pink to brown material; becoming porous; rare oxidized solution passages; coarse crystalline fossiliferous materials, with shell fragments common; clay seams.

31-35 Porous encrinite; firmly compacted; intermediate cementation; brown to pink cast.

35-37 As above; upper foot appears sandy brown, oxidized color throughout upper two-thirds of section. At 36 ft. dense, well-cemented, crystaline rock with stylolites common, blue-green, silty appearance.

(base of the Brassfield)

Return to cars. Follow lead car to next stop.

STOP #3 — *Glacially striated pavement.*

Approximately 20 acres has been stripped of overlying glacial material (chiefly till) as much as 80 feet thick. This surface represents an old erosion surface polished, abraded, and striated by ice movement. Fossil forms and rock textures show well on the polished surfaces. The direction of the ice movement is toward the southeast, which indicates that it was made by the advancing margin of the Miami lobe ice. Criss-crossing striations, representing ice advance from two different directions, i.e., from both lobes, have been observed on these surfaces.

From the point of view of glacial geology, the region covered by this field trip is one of the most interesting and challenging in Ohio. It lies within an "interlobate" area, between the major deposits of the Scioto (eastern) and Miami (western) glacial lobes, and is further complicated by the presence of the Silurian bedrock escarpment (held up mainly by the Brassfield Limestone and Cedarville Dolomite). This escarpment was over a hundred feet high when the glaciers advanced into the region, so it greatly influenced the arrangement and nature of the deposits left by the ice. Instead of a respectable series of parallel end moraines, the marginal glacial deposits occur as small irregular areas of end moraine and kames in a scattered disorganized distribution that makes correlation of deposits extremely difficult. A strikingly high area may be end moraine, kame, or the escarpment itself thinly covered by drift; bedrock exposures or well records may help to identify it, in some places, but such data are not available everywhere.

The region should not really be called "interlobate", because the two ice lobes, to the east and to the west, did not reach their maximum position in this area at the same time. Evidence for this view comes partly from the overall relationships of the various deposits, both geographic and stratigraphic, from stone counts, and from the occurrence of criss-crossing glacial striations on some of the rock surfaces exposed in the Southwestern Portland Cement Company quarries. (The rock containing these

criss-crossing striations has long since been blasted away; presently, only markings indicating the southeasterly direction of movement of the Miami lobe are visible).

Moraines marking the receding margin of the Miami ice lobe are the Pitchin, the Springfield, a series of isolated spots of end moraine and kame moraine west, northwest, and north of Yellow Springs (probably equivalent to the Springfield moraine to the north and the Camden moraine to the southwest), and the Farmersville moraine. Also associated with this Miami lobe advance are the well-developed striations at the Southwestern Portland Cement Company's quarries.

The major end moraines of the Scioto ice lobe in this area are the Reesville and Xenia moraines, but a sequence of other, younger moraines are present to the east (the Glendon, Esboro. Bloomingburg and London moraines), all of which unite to the north, together with the Reesville, to form the Cable moraine. The Xenia moraine seems to line up with the Scioto lobe Cuba moraine to the south. However, the Pitchin moraine, which pebble counts indicate to be a Miami lobe deposit, also seems to line up with the Xenia moraine, and the exact explanation remains uncertain.

This region is also characterized by a number of striking bedrock gorges, whose presence is probably due to the Silurian bedrock escarpment here. Each gorge ties into a distinct outwash system whose source was to the north in Champaign and Logan Counties. The highest terrace system, called the Kennard outwash, is also the most easterly. It can be traced from its source in southern Logan County to the gorge at Clifton. At one stage, it also appears to have occupied a more eastern route in southeastern Clark County, so as to feed into the gorge at Cedarville. In order for this to have happened, the more westerly route must have been blocked, presumably by ice. The glacial front must have advanced as far east as the Pitchin moraine at this time. This must have been before the major deposition of the Kennard outwash to the west, because there is no evidence (such as till over outwash) to suggest readvance of the ice from the west after its deposition. Farther to the north, in both Champaign and Logan Counties, the Kennard outwash is capped by till which was deposited by Miami lobe ice. Actually, the presence of ice was necessary in many areas to form a west wall for the meltwater stream that deposited this outwash, for in these areas, there was no high land to otherwise prevent the water from flowing westward into the Mad River valley.

The gorge at Yellow Springs was formed by the water which flowed from the northwest, depositing the Yellow Springs outwash just north of town. Because of the water funneling down into the upper end of the gorge, the Yellow Springs outwash has a triangular outline, being narrowest at the lower end next to the entrance to the gorge. At its other, northern end, about two miles north of Yellow Springs, the outwash seems partly to head in an area of kames and partly to end in mid-air above the valley of Mud Run; here, again, ice must have been present in order to deposit the kames, to serve as a source for the stream of water and the outwash gravel, and to maintain a continuation of the gradient back upstream. The gravel pit at Stop #4 exposes some gravel which is probably the same as the Yellow Springs outwash. At this pit, a "paleosol" is visible in the top of the gravel, just below several feet of calcareous till cap. Forsyth (1965) has identified a similar paleosol that is developed in till at Sidney to be of middle Wisconsin age. If the soil at Stop #4 is the same as the one at Sidney, this would indicate that both the Kennard and Yellow Springs outwash are of early Wisconsin age.

The gorge west of Springfield (just south of the Ohio Masonic Home) was cut by the same water which deposited the Mad River valley train. (This gravel is properly called a valley train, rather than outwash, because it is restricted within true valley walls). This is the deposit which fills most of the Mad River valley north of Springfield and southwest toward Dayton. The great width of this deposit southwest of Springfield appears to be a result of the stream having cut below the Silurian escarpment there. For a time, the ice which deposited the Farmersville moraine apparently extended southeastward across the valley of the Miami River at Dayton, because this valley train can be traced southeastward from the Mad River valley at Fairborn to the Little Miami River valley at a small town called Alpha.

(See also general article on p. 33)

Return to cars.

6.8 Turn right (north) back on to Linebaugh Road and retrace route.

.3

7.1 Turn right (east) on to Dayton Yellow Springs Road. Traveling over thin ground moraine.

.6

7.7 Turn left (north) on to Highway 235.

1.6

9.3 Turn right (east) on to Herr Road. Note hummocky topography of kames to either side of road. Hill ahead to right had small abandoned gravel pit in it. Depth of leaching in gravel at first house on left directly beside road was measured at 35 inches. Mapping of the glacial features in both of these counties (Clark and Greene) was by Dr. R. P. Godthwait (published in reports by the Ohio Department of Natural Resources, Division of Water, in 1950 and 1952) of the Ohio State University. It is his interpretation which is presented here.

1.0

10.3 Note black soil drainage ditch along left side of road. In many areas of central and western Ohio, black soils are the only remaining indication of once-existent prairie vegetation, which invaded Ohio about 5,000 years ago during the "climatic optimum" of time when the climate was somewhat warmer and dryer than today. Prairie vegetation, mainly grasses, creates such black soils. But black soils also develop in poorly-drained topographic situations under forest vegetation. The best way for anyone who is not a soils specialist to recognize the difference is to see whether the black soil persists up onto the better-drained locations, something that only the prairie-produced black soil would do. This has not been checked here.

.2

10.5 It is likely that this low area is also underlain by gravel. The rise ahead is presumably a bedrock excarpment, probably the escarpment of the Cedarville Dolomite. Plastered up against it, at its foot and on its top, are kames. Note the small abandoned gravel pit in the kame to the right.

.3

10.8 STOP. Turn left (north) on to West Enon Road. We have just left the area of kames and are now in an area mapped as thin ground moraine, as we are still on top of the escarpment noted above.

.5

11.3 Re-enter eastern margin of kame area. Most of the kames lie to our left (west), on the top and off the edge of the escarpment. For this reason, very little kamic topography can be seen from here.

.5

11.8 Cross Yellow Springs-Fairfield Road and continue straight ahead. The route here passes back on to thin ground moraine. The boundary of the area of low kames continues on diagonally to the northwest.

.5

12.3 Turn right (east) on to East Enon Road, which crosses an area of thin ground moraine.

1.5

13.8 Note exposure of Brassfield Limestone in valley of shallow run (Clear Creek) to left. This is why the ground moraine is called "thin".

.2

14.0 As road rises from valley of shallow run (tributary to Clear Creek), we enter another kame field; some higher kames are visible ahead to the left.

.1

14.1 Turn left (north) on to Lower Snyderville Road, which is located in kame field. Enter Clark County.

.5

14.6 STOP. Turn right (east) on to Jackson Road, which passes over some of the highest kames. Note abandoned gravel pits far to left and in high hill to right.

.9

15.5 Route drops down off kames on to outwash. This outwash, which on this map has been called the Yellow Springs outwash, forms a triangular shaped area representing a deposit by meltwater which was being funneled down south to the Yellow Springs

gorge. To the north from here, the outwash can be traced into the kames we have just crossed and to the present valley of Mud Run.

.4

15.9 STOP. Turn left (north) on to Old Enon Road, which is still on the outwash.

.2

16.1 Yellow Springs outwash surface can be seen extending to the south to where the towers of the Main Building on the Antioch College campus in Yellow Springs mark the narrow southern end of the outwash and the Yellow Springs gorge. Across the valley, the outwash can be seen in direct contact with the kames we have just crossed. Are these deposits the same age? If the outwash is of the same age as the kames marking the apron of gravel washed out beyond the kames, the ice must have been very close, since kames mark ice-contact positions. Outwash deposited in ice-contact positions, however, is usually marked by kettles, but none have been reported from here. To the northwest (ahead to the left), the outwash ends abruptly in mid-air; where is the upper end of this deposit? Was the presence of ice necessary to provide the continuation of the gradient; To the northeast (ahead to the right) across the valley of a small creek, a small area of flat land seems to be at the same elevation as this outwash. Gravel is also present there; it may be the same gravel deposit. However, it has a cap of till, meaning that the glacier readvanced over that outwash after gravel deposition ceased, covering it with a layer of till.

.3

16.4 Notice houses ahead across valley of unnamed tributary to Mud Run. This is the level of gravel capped by till which was discussed above. The route ahead takes us up on to this level.

Notice that, ahead after a turn left and right, our road goes into the dissected part of the outwash and approaches the position the ice edge must have had.

.5

16.9 STOP. Turn right (east) on to Fairfield Pike.

.1

17.0 Note good exposure of Euphemia and Springfield Dolomites in bluffs of creek back to left.

.2

17.2 Note Euphemia Dolomite exposed in bottom of creek to right.

.1

17.3 Gravel pit to left. More pits are present ahead on the left and on the right. The thick well-bedded gravel which is exposed here and which may be observed best after we turn right ahead, is capped by 3 to 9 feet of till.

.5

17.8 Turn right (south) on to Tecumseh Road around gravel pit.

STOP #4 — *Keiffer Gravel Pit.*

This spot is in the discontinuous line of the Springfield Moraine. The moraine consists of a series of hummocky areas and sharp kame groups, which seems to tie into the Camden Moraine at Dayton. In any case, the stone counts in this area accord with those for Miami lobe advance. Such drift is round for 8 miles east of here where it butts against the till of the Scioto lobe and the eastward curving Thorp-Xenia inner Cuba Moraine.

The section here is typical of the region:

3 to 9 feet of till covering a rolling surface of the underlying sand-gravel topography. Contains chunks of the "soil" buried beneath it. Till is calcareous (not leached) where more than 5 feet thick and carries an extra-red, 36-inch-deep soil profile due to the good underdrainage.

0 to 2 feet of dark reddish brown "paleosol" developed in the underlying sand and gravel. This "buried soil" is similar to the very irregular Fox soils today, but only the deep pendants of clay-rich, leached B-2 material escaped removal by the glacier. In many parts of this quarry it is wholly absent (scraped off?).

60 feet or more of bedded sands and gravels similar to those found under more than 200 square miles of till-covered area from 5 miles east of Springfield to the west edge of Dayton, and from Xenia to Bellefontaine. In some places, as in high

kames one mile southwest, the overlying till is thin or absent, and foreset structure indicates shifting currents in several directions and ice-contact relations. This gravel is probably the Yellow Springs outwash.

Bedrock (Niagaran limestone) is 20 to 30 feet below the pit as indicated by test diggings and a well at this level north of Fairfield Pike.

It has long been questioned as to whether this is truly a buried soil only partly removed by overriding ice. If it is so, the long warm soil-forming period that it denotes (mid-Wisconsin?, pre-Wisconsin but post-Sangamon?, Sangamon?) is uncertain.

In seeking answers to these questions at this typical section, it should be noted that:

(1) the horizontal nature of the paleosol and the inclusions of it in the overlying till suggest it is a soil. It has been reported (Goldthwait, 1959) that in other areas this clay-enriched zone extends horizontally for 100 to 200 feet at depths of 4 to 5 feet:

(2) the lack of A-zone top soil and the presence of clay-filled joints in the thin till above in some places suggest that it may be post-glacially developed by the groundwater transportation of clay (Gooding, Thorp, and Gamble, 1959). However, it has also been pointed out (Goldthwait, 1959) that in some places no vertical cracks are present over the clay-enriched zone, or if they are present, they have no clay skin;

(3) the deepest portions of the paleosol indicate well-developed clays that are not similar to the very old Sangamon soils exposed south of the Wisconsin border;

(4) radio-carbon dates in the upper till nearby (e.g. Wright-Patterson Air Force Base) indicate that the cover dates from fairly early in the traditional Wisconsin (21,600 - 400 years ago);

(5) the gravels are not as deeply silted nor as heavily indurated as many of the known Illinoian gravels further south; and

(6) a similar soil that is developed on a buried *till* near Sidney, Ohio has recently been analyzed as "mid-Wisconsin" (Forsyth, 1965)-

Return to cars.

.4

18.2 Descend onto lower level of outwash. This gravel is not thick, for Cedarville Dolomite is exposed in the bottom of the creek (notice especially to the left (east). Road leaves outwash just beyond house on the left and climbs up onto thin ground moraine.

.9

19.1 View to right (west) to Yellow Springs outwash and to kames we crossed a little while ago. Road is still located on thin ground moraine.

.4

19.5 Cross county line from Clark to Greene County. Tecumseh Road becomes Polecat Road.

.1

19.6 Another view ahead to the right (west) to the outwash, which is now much more narrow. Back to the northwest, the wider outwash and the kame field are still visible.

This is the site of the old Yellow Springs water works. They used to get their water here from trenches cut in the outwash. As the town grew, this became inadequate and they drilled wells into the bedrock in town. Eventually, even this supply was insufficient, so they now have wells in the valley of the Little Miami to the south of both the town and the gorges. Here they get their water from the thick glacial gravels which fill this valley.

.4

20.0 Road goes down northeast bank of outwash channel on to outwash. Digging operations to right expose gravel. Note how deposit is much more narrow than it was to the north and how it narrows still more ahead to the left, as it approaches the upper end of Yellow Springs gorge.

.3

20.3 Rise up on to southwest bank of outwash channel.

.3

20.6 Sign saying "Yellow Springs." Turn left (east) on to Fairfield Pike.

Here road drops down at railroad underpass into outwash channel, now only about 200 feet wide. Bedrock gorge in Cedarville Dolomite begins only a few hundred feet to our right (south).

.1

20.7 Cross Yellow Springs Creek and turn right (south) on to Cemetery Street.

.2

20.9 STOP. Cross *heavily-travelled* U.S. Highway 68 WITH CAUTION. Continue straight ahead (east) on Highway 343 over thin ground moraine.

.1

21.9 Turn right (south) onto Meredith Road (Highway 370).

1.1

23.0 Turn left (east) through the main gate of John Bryan State Park. Follow lec car to parking area.

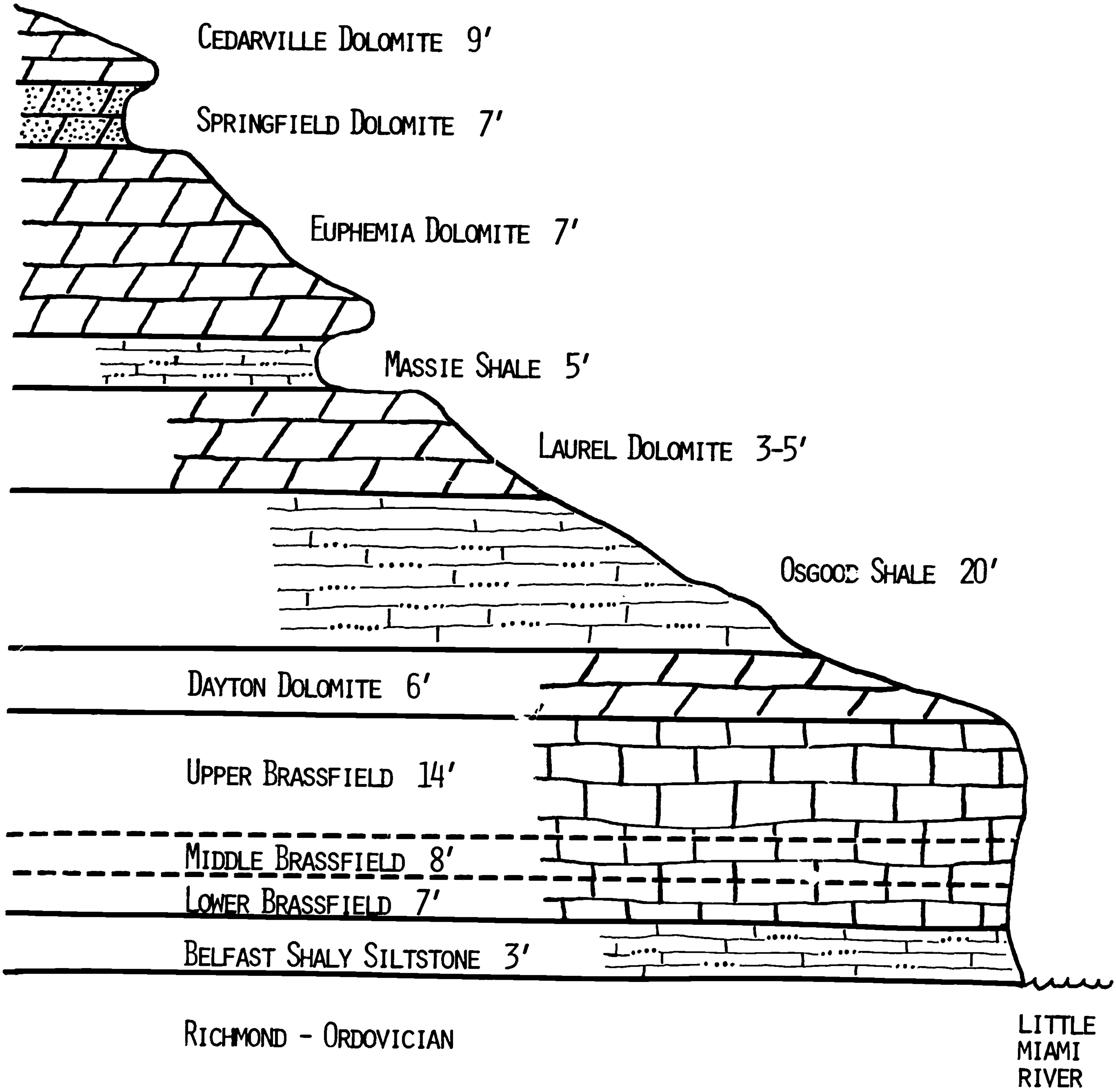
STOP #5 — *Lunch break and Silurian stratigraphy, John Bryan State Park.*

This lower picnic area is a large terrace formed at the top of the resistant Brassfield Limestone. Walk across the terrace toward the Little Miami River and follow the trail down to the river. Beginning here there is exposed about 60 feet of Silurian strata ranging from the Belfast Bed to the Cedarville Dolomite:

FORMATION	THICKNESS	DESCRIPTION
Cedarville Dolomite	up to 50 ft.	white to blue-grey, holocrystalline, porous; very small, irregularly-outlined pockets or open spaces; usually coated with a thin layer of travertine; cliff-former
Springfield Dolomite	10 ft.	grey, thin-bedded
Euphemia Dolomite	7 to 15 ft.	medium grey mottled with blue, medium-grained, porous; irregularly-bedded; massive
Massie Shale	6 ft.	grey, soft, fossiliferous, clay-rich; several 1-3 inch layers of limestone in the upper half
Laurel Dolomite	5 to 7 ft.	buff, hard
Osgood Shale	25 ft.	blue-grey but weathering light brown, calcareous
Dayton Dolomite	5 to 8 ft.	grey to greenish grey, fine-grained; very dense and hard
Brassfield Limestone	up to 50 ft.	white to pink or red; cliff former; upper: thin lens-like beds of encrinite; middle: massive; lower: thin regular beds
Belfast Bed	2 ft.	greenish-grey, silty shale interbedded with medium grey, impure limestones

Silica and Magnesia Content of Limestones and Dolomites*

FORMATION	SiO_2 (wt. %)	MgO (wt. %)
Cedarville	0.06	21.42
Springfield	4.14	20.41
Euphemia	0.95	21.16
Laurel	5.45	17.50
Dayton	5.90	15.38
Brassfield	1.18	4.35



PROFILE OF JOHN BRYAN STATE PARK

Figure 6

*Analyses after Stout(1942), *Dolomites and Limestones of Western Ohio*, Bulletin 42, Geological Survey of Ohio.

Some features which may be noted at the John Bryan exposure are:

1. The sharp contact between the Brassfield and Dayton formations.
2. The regular bedding of the Dayton Dolomite.
3. The blue-grey Osgood Shale with limestone beds. Although fossils are rare, well-preserved cephalopods and gastropods are occasionally found. Some beds are marked by wormlike trails.
4. Clumps of pyrite or where oxidized, limonite at places in the Laurel Dolomite.
5. The Massie Shale, which is usually marked by a spring zone, and which is conspicuous by its lack of resistance to erosion compared to the overlying dolomite. Notice the "cave" it forms at the head of the gulley. Occasional cup corals, brachiopods, trilobites, and crinoid stem plates may be found in the Massie.
6. The spectacular cliff at the head of the gully formed by the Euphemia, Springfield, and Cedarville Dolomites. Notice the brick-like structure of the Springfield Dolomite and the solution pits in the Cedarville Dolomite. Abundant molds of *Pentamerus laevis* occur in the thin horizon near the base of the Cedarville.
7. Jointing, which is quite regular in the Cedarville and Springfield Dolomites. The six sets of joints are approximately vertical and are consistent throughout the Yellow Springs region. The trends are predominately N20°E and N60°E.

Return to cars and retrace route, following lead car.

23.0 Leave John Bryan State Park. Turn right (north) on to Meredith Road (Highway 370). Continue traveling over thin ground moraine.

1.1

24.1 Turn right (east) on to Highway 343.

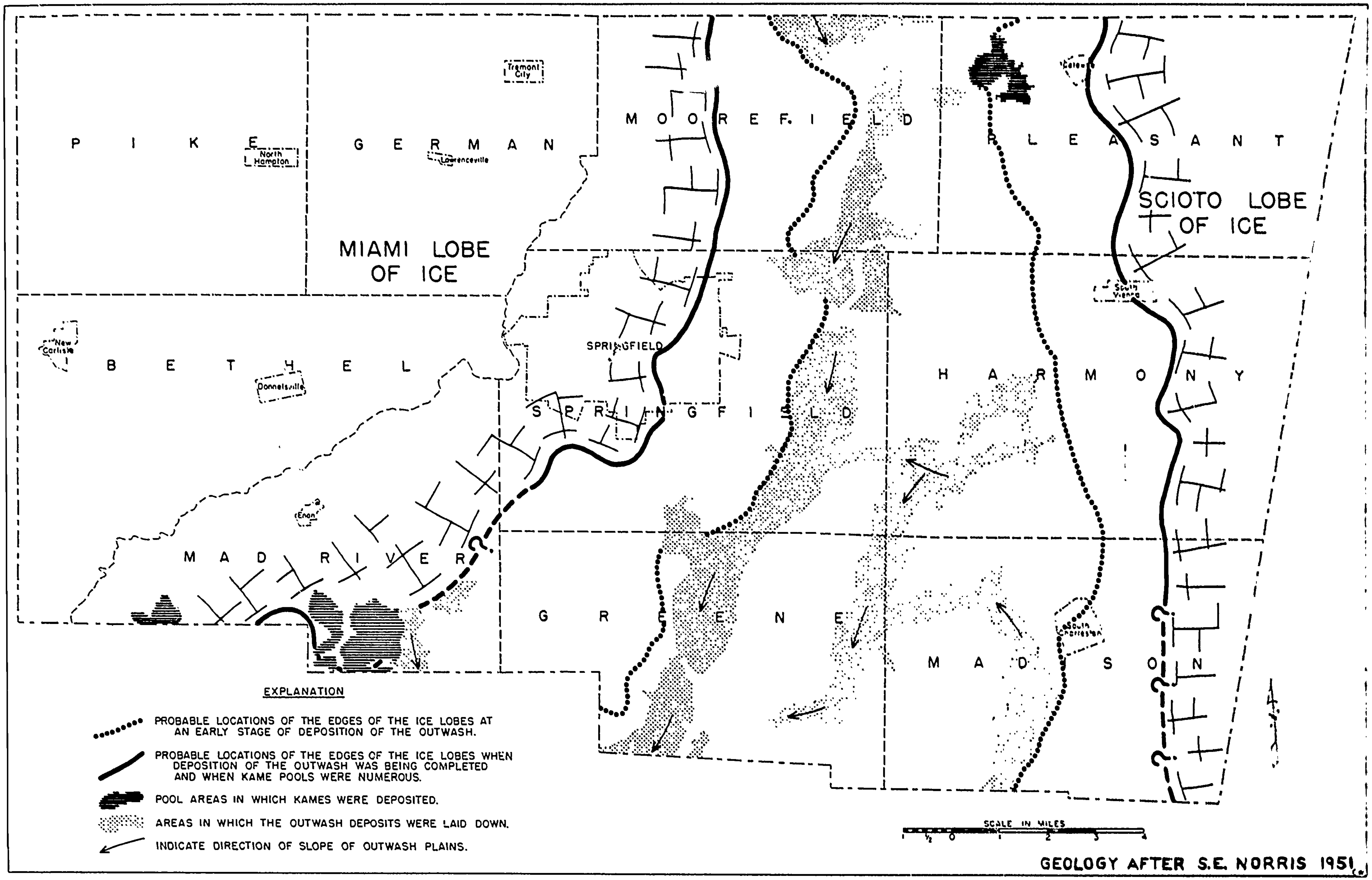
1.9

26.0 Follow lead car into parking area on the right.

STOP #6 — *Clifton Gorge.*
NOTE: The gorge is a dangerous area and over-confidence can lead to disastrous results: *Please Be Very Careful!!!* *Carelessness can result in serious injury!!!!!!!!!*

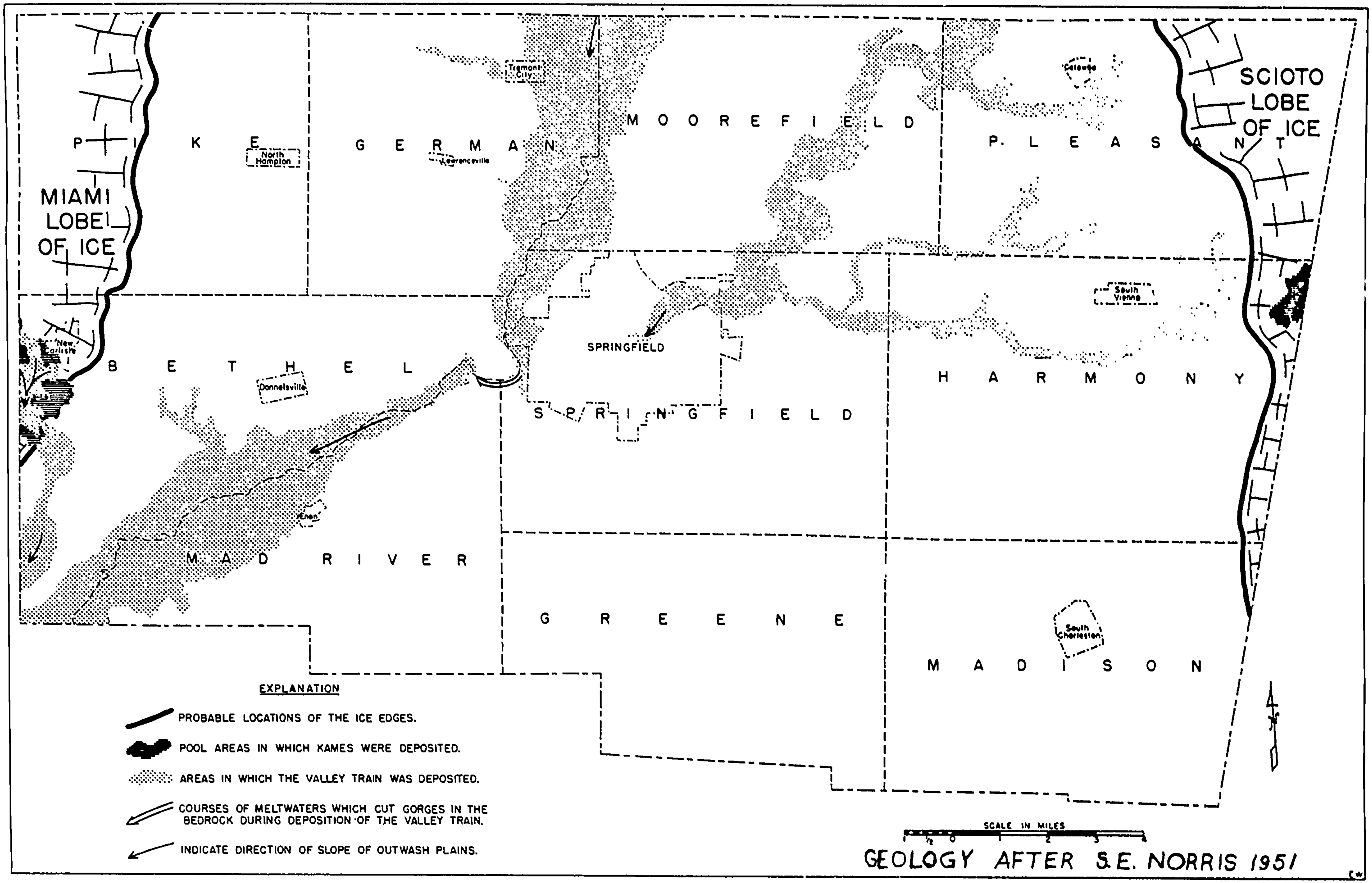
The bedrock exposed in this area is derived from sediment that was deposited on the bottom of the inland seas that covered central North America during the Silurian Period. The formations visible in this part of the gorge are the thin-bedded Springfield Dolomite and the younger, massive Cedarville Dolomite. Farther downstream the Little Miami River has cut below these two into older formations, but exposures are few because of rubble, soil, and vegetation cover. The rocks in this area have a slight regional dip of a few degrees to the northeast because of their location on the east flank of the Cincinnati Arch. This broad north-south trending anticline is the major structural feature of western Ohio.

Whereas the form of the gorge is controlled by the rock stratigraphy, the length and the great potholes are due to glacial conditions. At some state during the Pleistocene glaciation of the area, the meltwater from the ice over the Miami River, Mad River, and tributary basins had to pour south through this gorge. The Mad and Miami River valleys must have been filled by ice, for the Kennard Outwash, which was deposited by this surge of meltwater, is 33 miles long and 1 to 4 miles wide, extending all the way from Logan County south to Clifton Gorge. (See map, p. 5) Parts of the outwash have been eroded away or buried under a thin till veneer, but its slope is still a regular, 8 ft./mi. at the northern end to 4 ft./mi. at the Clifton end. The amount of drainage, which was concentrated in summer floods, must have been tremendous. Evidence for this consists of the great depth of the narrow gorge and the giant potholes (2 ft. to 8 ft. across) high on the ledge and wall surfaces on either side and also south of the gorge in the woods. Because of their elevation above the present stream level, these potholes do not seem to be related to existent stream.



AREAS COVERED BY ICE DURING DEPOSITION OF KENNARD OUTWASH

Figure 7.



AREAS COVERED BY ICE DURING DEPOSITION OF MAD RIVER AND BUCK CREEK VALLEY TRAINS

Figure 8.

They are not forming under present conditions, but are attributed to the torrential quantities of meltwater accompanied by the availability of cobble or boulder tools. The potholes occur only in the Cedarville Dolomite, although a few extend down into the Springfield.

(See also discussion under Stop #2, p. 8)

Return to cars.

26.0 Continue east on Highway 343.

.4

26.4 Village of Clifton. Turn left (north) on to Highway 72 and enter Clark County. Traveling over thick ground moraine.

.7

27.1 Turn right (north) on to Old Clifton Road.

.6

27.7 The flat expanse to the right in the valley of the North Fork of the Little Miami is an outwash plain deposited by the stream from the north that was responsible for cutting the major portion of Clifton Gorge. Recent alluvium lines the present stream. A high water table (reducing conditions) forms characteristic dark soil on these outwash deposits. .

1.2

28.9 Turn right (east) on to Jackson Road. Descend from higher ground moraine to Kennard outwash plain.

1.5

30.4 Bridge crossing the North Fork of the Little Miami. This is a State Division of Water gaging station.

The marked topographic change ahead is due to the Pitchin moraine. Stone counts indicate that this is the first end moraine of the western Miami lobe of the glacier. Route continues to north on crest of moraine.

1.5

31.9 Pitchin Village.

.4

32.3 Turn right (east) on to Old Springfield Road.

.2

32.5 Descend to thinner ground moraine.

1.3

33.8 Ascend on to the Thorp moraine, which is the first end moraine of the eastern Scioto lobe.

.4

34.2 Topographic change marks descent on to outwash plain deposits.

2.0

36.2 The Dolly Varden moraine —the second Scioto lobe end moraine.

.7

36.9 Slight topographic drop to thick ground moraine. At 38.1 miles continuity of ground moraine is broken by small arm of outwash which continues for one half mile.

2.3

39.2 Turn sharp left (north) on to Buena Vista Road (Highway 70) and continue north on crest of the South Charleston moraine, which is the third end moraine of the Scioto lobe.

2.1

41.3 Turn right (north) on to Highway 54.

1.1

42.4 Topographic sag of ground moraine between end moraine. End moraine ahead is the Plattsburg moraine —the fourth Scioto lobe moraine.

.7

43.1 For the next 1.2 miles, route continues along western margin of the Plattsburg moraine. To the right is the crest of the Plattsburg moraine and to the left is the lower ground moraine. In the distance to the left is the northern extension of the South Charleston moraine. For approximately the next 1.2 miles the route traverses the pre-Kansan Teays river channel. Here the bottom of the channel is approximately 500 feet below the surface.

(See article on the Pleistocene drainage changes, p. 36).

1.2

44.3 Enter the village of Plattsburg.

.8

45.1 Descent to valley train deposits along Beaver Creek.

.4

45.5 Beaver Creek. The higher topography to the north (ahead) is end moraine. This moraine, called the Cable moraine, is a very broad, continuous moraine formed by the coalescing of the various definite topographic ridges to the south.

.9

46.4 U.S. Highway 40 at South Vienna.

END OF REGULAR TOUR. For those interested in continuing on the optional tour, pull up on the right behind the lead car until the others have turned on to U.S. 40 and then continue north on Highway 70. For those leaving us now, thanks for your attendance; we enjoyed being your hosts! Drive carefully, and we'll see you at the field conference next year!

Begin optional tour.

46.4 Village of South Vienna.

1.3

47.7 Turn left on to the Old Columbus Road. The valley to the right is that of the south branch of Sinking Creek, which is part of the watershed for Clark Lake.

2.8

50.5 Turn right (north) onto the Vernon Asbury Road.

.4

50.9 STOP #7 — *Clark Lake.*

The glacial drift here is 200 ft. deep on the edge of the buried main Mahomet-Teays valley. Presumably, at Harmony, 2 mi. south (on U.S. Highway 40), it is over 550 ft. to bed rock! This sharp valley extends northwest under our next and last stop. Thus far our knowledge of glacial history is unravelled from a few tens of feet of surface drift, and we do not know whether the fine sands filling the deep valley result from the Kansan glacier, the Illinoisan glacier, Lake Tight, or some other cause.

This is near the western edge of the 8-mile broad Cable moraine. Stone counts indicate it was put down by the Scioto lobe rather than the Miami lobe. This means that the Cable moraine is not an interlobate moraine, truly, but the compound lateral moraine of the Scioto lobe all the while that the formation of the Reeseville, Glendon, Esboro, Bloomington, and London moraines and the intervening recessions took place. Although individual moraine lines are broken by the valley of this creek and Beaver Creek to the south, this spot is about the extension of the crest of Reesville moraine into the mass of ridges which make up Cable moraine; a 3-mile long gravel till ridge just north and west may mark the ice edge in Reesville time.

Work to the south indicates that this is the outermost end moraine of the late readvance of Scioto ice which overran logs now 20,000 to 23,000 years old in the till near Columbus. Apparently this Scioto lobe advance met the Miami lobe just west of here, for thin sheets of till extend from the Springfield moraine out over the 2-mile broad Kennard outwash. This simultaneous advance of Miami lobe put down the till covering the soil at Stop #4 and pushed down logs dated at 23,600 years in Sidney or 21,000 years near Dayton. If the stratigraphy has been properly related (till over soil on gravel on earlier till, all the same in central Ohio), this means that much of the bulk of the underlying Cable moraine was put down by earlier Wisconsin ice.

Return to cars.

50.9 Resume travel to north on Vernon Asbury Road.

Topographic rise ahead due to change from the valley train deposits to end moraine.

1.1

52.0 Turn left at Asbury Church and continue north on Vernon Asbury Road. Watershed of north branch of Sinking Creek to right (east).

.8

52.8 Descend on to valley train deposits of the south branch of Buck Creek.

.2

53.0 Turn left (west) on to Neer Road. We are now traveling along valley train deposits. Hills to right are gravelly kame deposits formed by meltwater at the edge of the ice.

.8

53.8 Turn left (south) on to Mahar Road.

.5

54.3 Small gravel pit to left on curve in road. Stratification and structure would indicate a kame. Broad flat valley of Buck Creek to right (north). Valley is lined with valley train deposits with higher outwash terraces on each side.

.2

54.5 Rise on to moraine.

.4

54.9 Continue to left on Moorefield-Catawba Road.

1.0

55.9 Descend from moraine to Kennard outwash.

.8

56.7 Descend rather sharply into Buck Creek valley train deposits from outwash. An intermediate plain is visible downstream on left side.

.6

57.3 Rise out of valley on to outwash terrace. Old gravel workings to right.

.1

57.4 Village of New Moorefield. Turn north (right) on to Mumper Road for one half mile and turn left (west) on to Prairie Road. Slow for sharp right turn.

.9

58.3 Cross Highway 4. *USE CAUTION.*

.2

58.5 Exposure of gravels in cut on hill to right.

.4

58.9 Gravelly soil of pasture.

.2

59.1 Turn left (west) on to County Line Road.

2.0

61.1 Rise on to the Springfield moraine. Moraine is a complex of interbedded till and gravels and exhibits the typical hummocky topography of a moraine.

1.4

62.5 Notice eroded pasture area to right (north) with some portions "healed". Meandering stream exhibits good undercut and slip-off slopes.

.2

62.7 DANGEROUS INTERSECTION: USE CAUTION. Turn right (north) on to Middle Urbana Road. Enter Champaign County.

1.1

63.8 For the next .2 of a mile the road cut on the right exhibits typical interbedded gravels and till of the Springfield moraine. The dark line represents a buried soil profile which is probably the same as the paleosol seen at Stop #4.

.6

64.4 Turn left (west) on to the Dallas Road.

.6

65.0 Descend the rather sharp ridge of the Springfield moraine. Note the broad expanse (3 miles wide) of the Mad River Valley train. The very small Mad River is most certainly a misfit stream. Notice the levees built up along the tributaries coming off the high moraine. The rather gentle slope leading up to the ridge is probably a bajada caused by the coalescing of alluvial fans.

.5

65.5 Cross heavily-travelled U.S. Highway 68. *USE CAUTION.* Continue on Dallas Road.

.9

66.4 Southern end of Cedar Swamp.

.7

67.1 Turn right (north).

.2

67.3 Keep right (east) on Woodburn Road.

1.3 68.6 STOP *8 — *Cedar Swamp.*

Cedar Swamp is the remnant of a post-glacial lake that is now reduced to a strip adjacent to Cedar Run. The swamp is unique for its unusual flora. Formerly more extensive, most of it has been cleared away for agricultural purposes.

The Springfield water supply comes from a new water system located on the Mad River at Eagle City. Geologically, the Mad River Valley offers excellent ground water sources. The valley is lined with 200 to 300 feet of valley-train gravels. The highest sustained flow per square mile of drainage area in the state during dry seasons, because of the vast storage of ground water in the gravels of the valley, makes the Mad River one of the state's best water producers.

68.6 Return to cars. *End of optional tour.* Continue east on Woodburn Road to U.S. Highway 68.

DRIVE CAREFULLY AND ARRIVE HOME SAFELY!!

GENERAL ARTICLES

Ordovician History of Southwestern Ohio

During Ordovician time, the land was generally flat, except for slight local warpings, which, due to the shallowness of the spreading epeiric seas, were responsible for the many and frequent shifts in shoreline location. At the time of greatest inundation, fully half the present continent was submerged under an arm of the ocean stretching from the Gulf of St. Lawrence through the area of the Middle West, and, joined by inland seas, extending west to the location of the present Cordilleran mountain system.

The early Ordovician seas were mostly confined to the Cordilleran, Appalachian, and Ouachita geosynclines. Only the Canadian shield remained fully emergent. The middle Ordovician seas spread across the Canadian shield into the Appalachian geosyncline. At this time, the northeast portion of Appalachia began to rise. The late Orodovician advance was greatest of the three, and, indeed, this part of the Ordovician marks the greatest of all recorded inundations.

Paralleling the western margin of the Appalachian geosyncline was the Cincinnati Arch, a gentle structural dome that ran northward from the vicinity of Nashville, through Cincinnati and Lake Erie, and into Ontario. It had begun to form during the middle Ordovician and influenced the nature of the Ordovician deposition by becoming an area of shifting shorelines in the active seas. As a consequence of the arch, the seas were shallower in western Ohio than in the eastern part of the state.

Toward the beginning of Cincinnatian time, the northern part of the Appalachian geosyncline experienced the beginning of the Taconian Orogeny, an uplift which gradually spread until the southern half of Appalachia had also risen to create a submarine barrier from the Atlantic. The Taconics, which were probably a chain of islands, provided the debris which became the extensive Queenston Delta to the west of the range.

The beginning of the Cincinnatian was marked by a striking change in the nature of the sediments, as a great deposit of mud spread southward in southwestern Ohio, while sands accumulated farther east. These sandy formations, which attained a great thickness in central New York and Pennsylvania, increasing in coarseness upward and eventually passing into gravel beds and non-marine red beds, were part of the Queenston Delta. As erosion increased in the rising Appalachia, the shoreline was gradually crowded westward until a low deltal plain stretched from the foothills to beyond the region of the Niagara.

During this time, warm shallow seas stood over the Cincinnati Arch. These waters were normally clear and deposited a thick layer of calcite ooze. From time to time, pronounced renewal of the erosion in the Taconics would cause considerable volumes of clay to enter the seas, which would then muddle and produce a layer of argillaceous sediment. It is this sequence of thoroughly interbedded limestones and calcareous shales that typifies the Richmond strata.

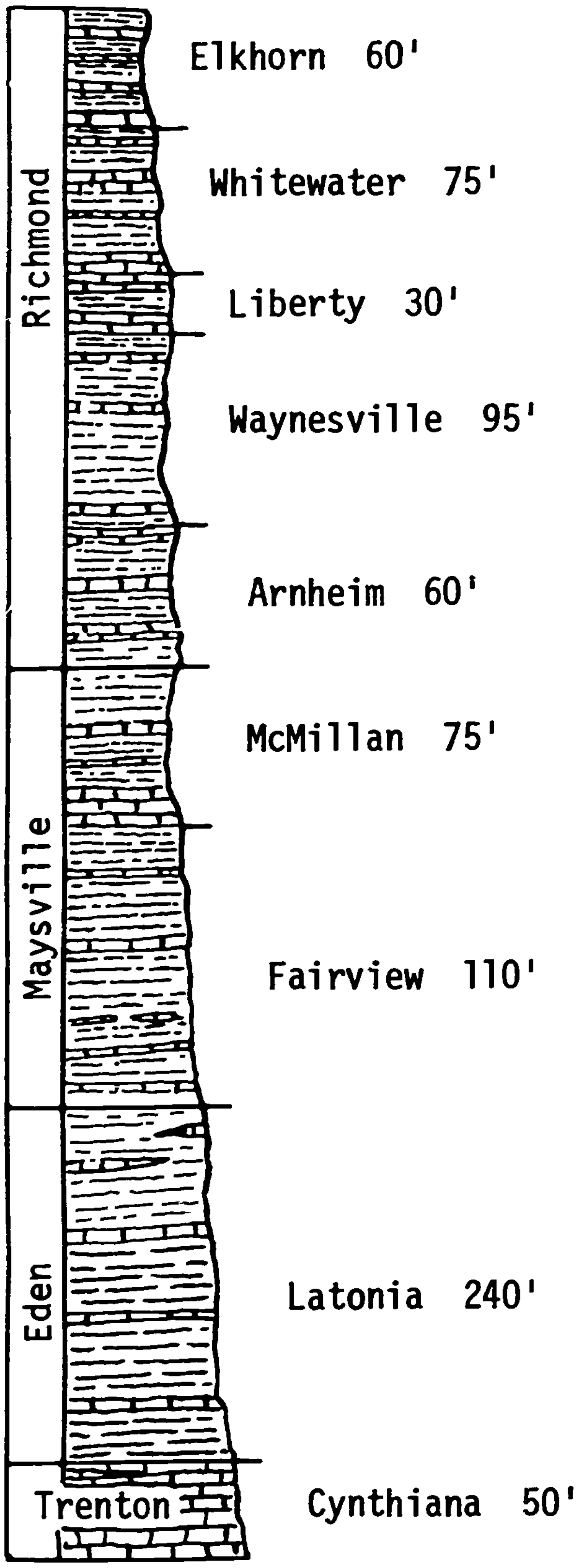


Figure 9.
ORDOVICIAN ROCKS OF OHIO

RICHMOND STRATIGRAPHY AND LITHOLOGY

The typical column of Richmond strata shows a rather uniform sequence of interbedded limestone and calcareous shale. Lithologically, the beds are very uneven and irregular, and the individual units tend to disappear laterally over short distances. Consequently, the various formations do not have characteristic lithologies, and their differentiation is almost solely by paleontological studies (see accompanying figure). The entire Cincinnatian Series was first described from the tri-state region surrounding Cincinnati, and the type sections of all the formations in the Richmond Group are in this area as well.

The limestone of this area is rather pure (90% average) calcium carbonate. The carbonate present is essentially pure clacite; any original aragonite would have altered to the more stable calcite since deposition. The chief impurities are probably clay minerals and detrital quartz, the latter occurring in the silt size range.

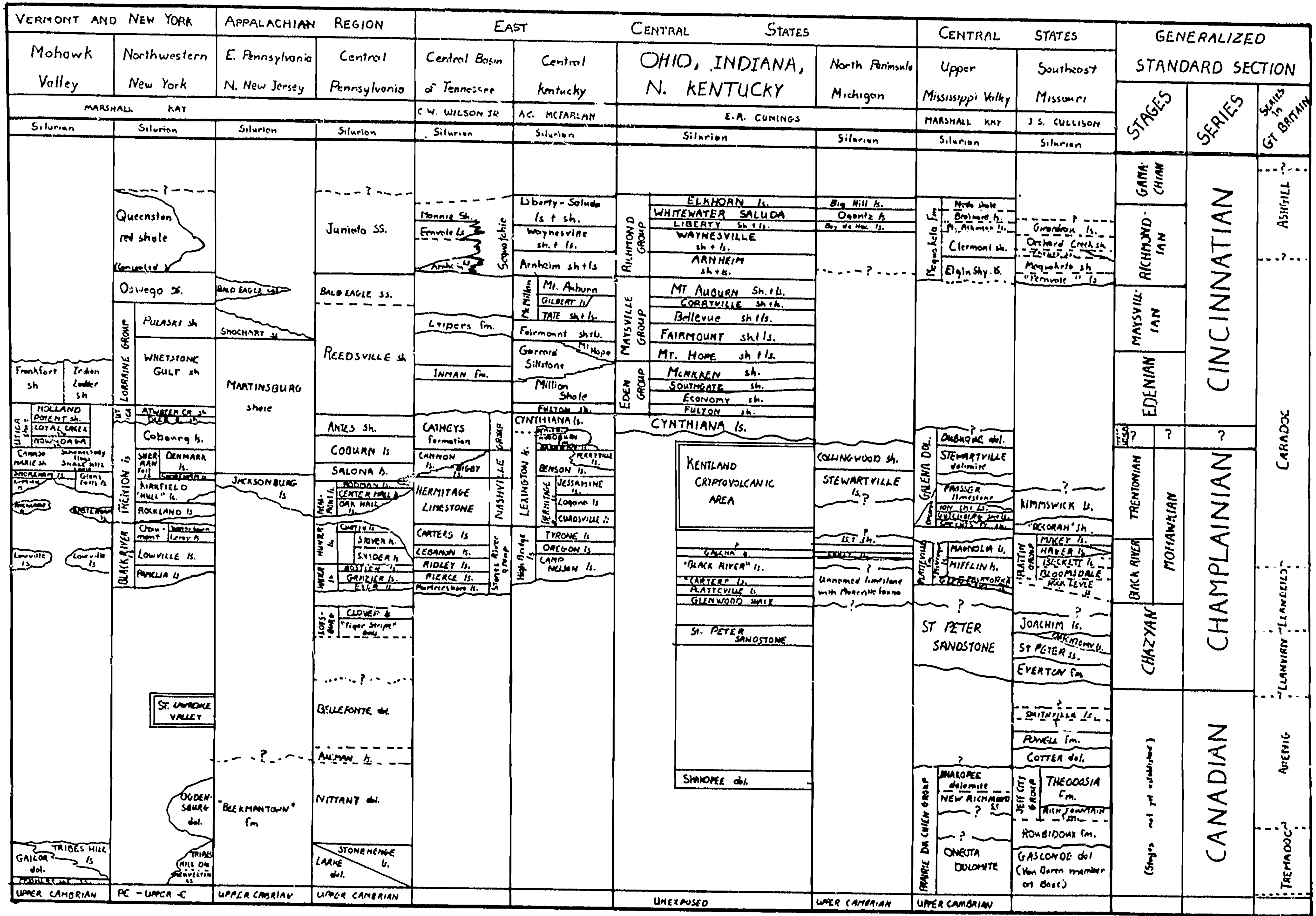
The limestone is appropriately classified as a biosparrudite (Folk, 1959). That is to say, it has a sparry calcite matrix, 25% interclasts, 25% oolites, and a fossil/pellet ratio of greater than 3:1. Most of the limestone beds in this section have numerous, well-preserved microscopic and megascopic fossils. In many beds, however, the fossils are severely fractured, abraded, and otherwise mechanically weathered, as if by wave action or by strong currents. The limestone is typically hard and compact, often forming ledges on steep banks and falls in streams. It weathers to a medium or pale gray. Small, thin lenses of the limestone are frequently interspersed throughout the shale beds.

The term "shale" is actually a misnomer when applied to some of the rocks in the section. The so-called "shale" often shows little fissility: moreover, it is often massive and friable. When exposed to moisture, it readily reverts to a soft clay. Removal of this clay results in the formation of limestone ledges on banks. The shale is medium gray. Fossils may be common or absent, but in all cases, the shale is less fossiliferous than the limestone.

The limestones of the Cincinnatian Series contain a rich assemblage of sedimentary structures, including cross-bedding, sole markings, ripple marks, convoluted beddings, and penecontemporaneous slides of appreciable magnitude. Also present are conglomerates and minor erosional channels. Both the types and abundances of sedimentary structures in the limestones are very uniform over a wide area on the east side of the Cincinnati Arch, differing little, if at all, from those of many quartz sandstone and shale sequences. Study of these sedimentary structures leads to the conclusion that during intervals of limestone accumulation in the Cincinnatian Series, the interface was commonly subject to active currents that produced a related series of primary sedimentary structures: small channels, local conglomerates, flutings, crossbedding and megaripples. These currents had a preferred west to west-northwest orientation that prevailed throughout the series on the east side of the Cincinnati Arch. The directional homogeneity of the Cincinnatian series compares favorably with that which has been demonstrated for quartz sandstone-shale sequences of both continental and marine origin. Penecontemporaneous load casts, convolute bedding, and slides locally and briefly interrupted normal accumulation of sediments on a stable, shallow, marine shelf.

RICHMOND PALEOECOLOGY

The Richmond Group consists of interbedded fossiliferous limestone and shale. During periods of shale deposition, mass mortality appears to have occurred over large scattered areas. This is evidenced by the relative paucity of fossils in the shale. The abundant life which subsequently formed limestone was apparently an outgrowth of forms which survived in marginal areas during periods of turbidity. This may have



CORRELATION OF ORDOVICIAN FORMATIONS Figure 10.
(After W. H. Twenhofel, et al., G S A Bulletin, vol. 65, March, 1954, pp. 247-298)

been the means by which most fauna were preserved during clay deposition. The presence of some brachiopods and bryozoans in the shale has suggested that these forms may have been able to withstand the adverse environment and to continue living in the same place until clearer water returned. Although the possibility of their transportation from less turbid areas also exists, this is improbable, for the good preservation of delicate specimens in the shale suggest growth in place.

The fossil fauna and petrology of the Cincinnatian Limestone leads to the following conclusions about the environment of deposition:

1. The limestone was marine in origin. This is evident from the presence of fauna that is exclusively marine today, eg., brachiopods.
2. The depth of the water was less than 100 fathoms and probably less than 15 fathoms in many cases. Present-day biostromes occur in water of this depth, and the "fossil hash" abundant in some beds suggests that much of the limestone may have been deposited in water shallow enough to permit vigorous wave action to pulverize the fossil material.
3. The paleoenvironment was probably rather warm. Warm water is necessary for flourishing biostromes and substantial limestone deposition.
4. Since abundant life would require a suitable oxygen supply, it is indicated that the water was probably well oxygenated. However, the small pyrite crystals found in some strata indicate that sulfate-reducing bacteria were able to exist in an anerobic environment immediately below the veneer of fresh sediments.
5. There was apparently strong current action during deposition. The sparry matrix that cements fossil fragments could have formed only in an environment that had enough energy to remove the fine micro-crystalline calcite ooze.

GENERALIZED SECTION OF THE SILURIAN IN OHIO

BELFAST BED

The Belfast Bed, which was first named by Foerste (1896), consists of 4-6 feet of interbedded greenish-gray, silty shale and medium gray, impure limestones. Fossils are rare and not usually diagnostic. Foerste (1931, 1935) has reported tracing Belfast strata into layers containing Brassfield fossils and also finding Brassfield species in Belfast beds. The contacts above and below are difficult to identify; they have been said to be both transitional and disconformable. Accordingly, the Belfast Bed is quite controversial, and the interpretation remains in doubt. It is placed by some in the Richmond (Ordovician) and by others in the Alexandrian (Silurian). The Belfast has been identified nearly continuously from Adams County west to the Lewisburg area.

BRASSFIELD LIMESTONE

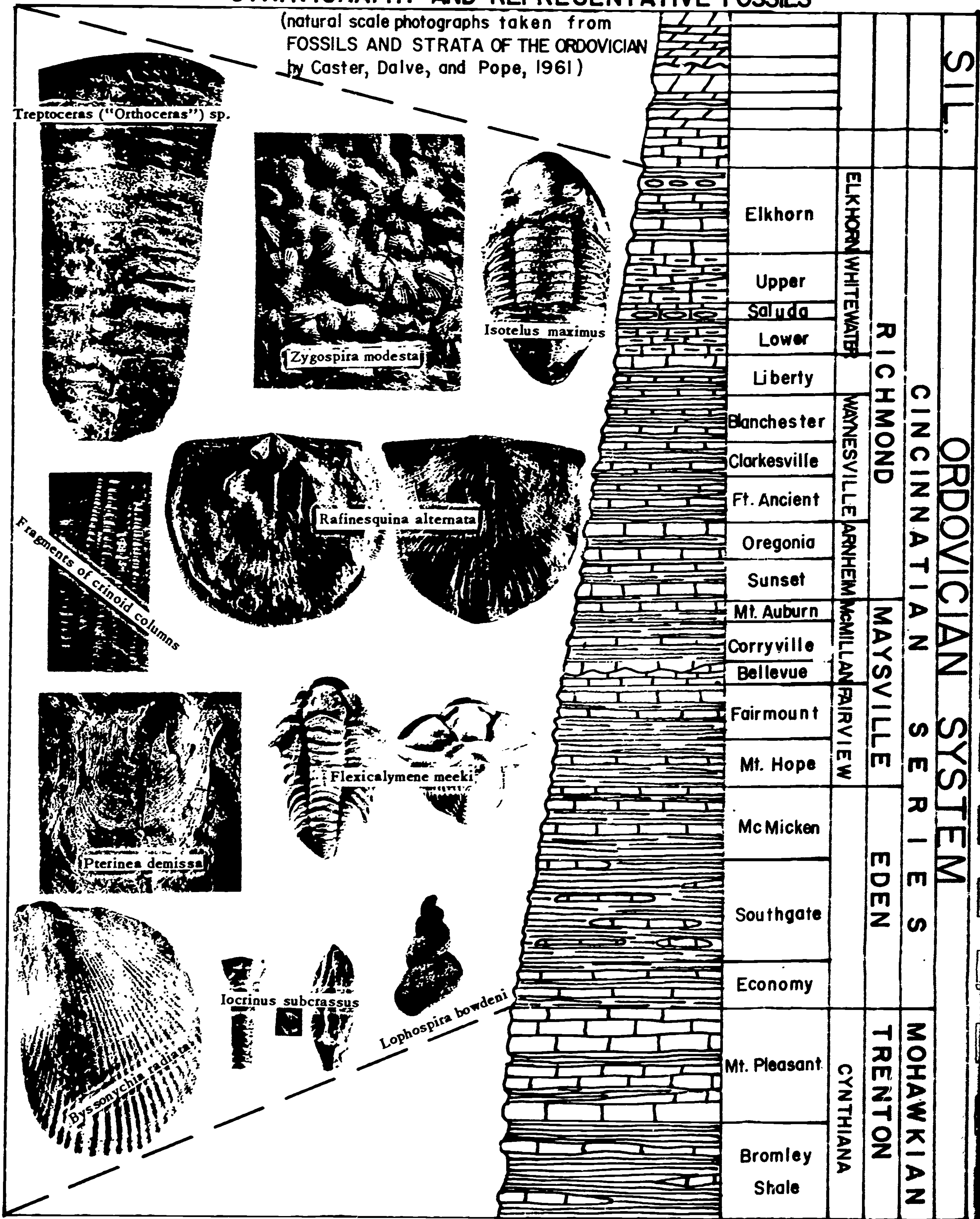
One of the most persistent of the Silurian formations in Ohio, the Brassfield Limestone can be traced in nearly continuous outcrops from the Indiana boundary to the Ohio River. South of that river, it can be traced to the type locality in Madison County, Kentucky. Foerste (1906) named the exposures there along a now abandoned railroad grade between the towns of Panola and Brassfield. In Ohio, the Brassfield was first called the "Flinty Limestone," in the report of Locke (1838); later it was referred to as the "Clinton Limestone" by Orton (1871), who had erroneously correlated these beds with the Clinton of New York. Still later studies of the faunas demonstrated the Medinian Age of the Brassfield, but in subsurface usage the misnomer "Clinton" has continued up to the present in referring to the sandstone facies of the Brassfield to the east.

The Brassfield Limestone has several typical lithologies. In the lower part, it is interbedded with greenish-gray shale and gray-buff argillaceous limestone, somewhat dolomitic; it is usually only a few feet thick, but it increases southward. The middle portion is a limestone, white to pinkish, coarse-grained and massively bedded, with the thickest development toward the central and western outcrop areas. Toward the top, the formation is bioclastic and contains abundant corals, brachiopods, and crinoid fragments. The whole Brassfield typically weathers a strong buff to reddish brown.

Although green shale fragments are found here and there throughout the formation, they usually occur in the lower beds. Residues of the lower part contain quartz, silt, and some sand grains. Crossbedding and ripple marks are common. From a 20 foot section in the type locality, the Brassfield thickens northward to about 50 feet in Adams County, Ohio, and gradually thins again to 30 feet in Greene County and about 22 feet in Preble County.

CINCINNATIAN SERIES

STRATIGRAPHY AND REPRESENTATIVE FOSSILS

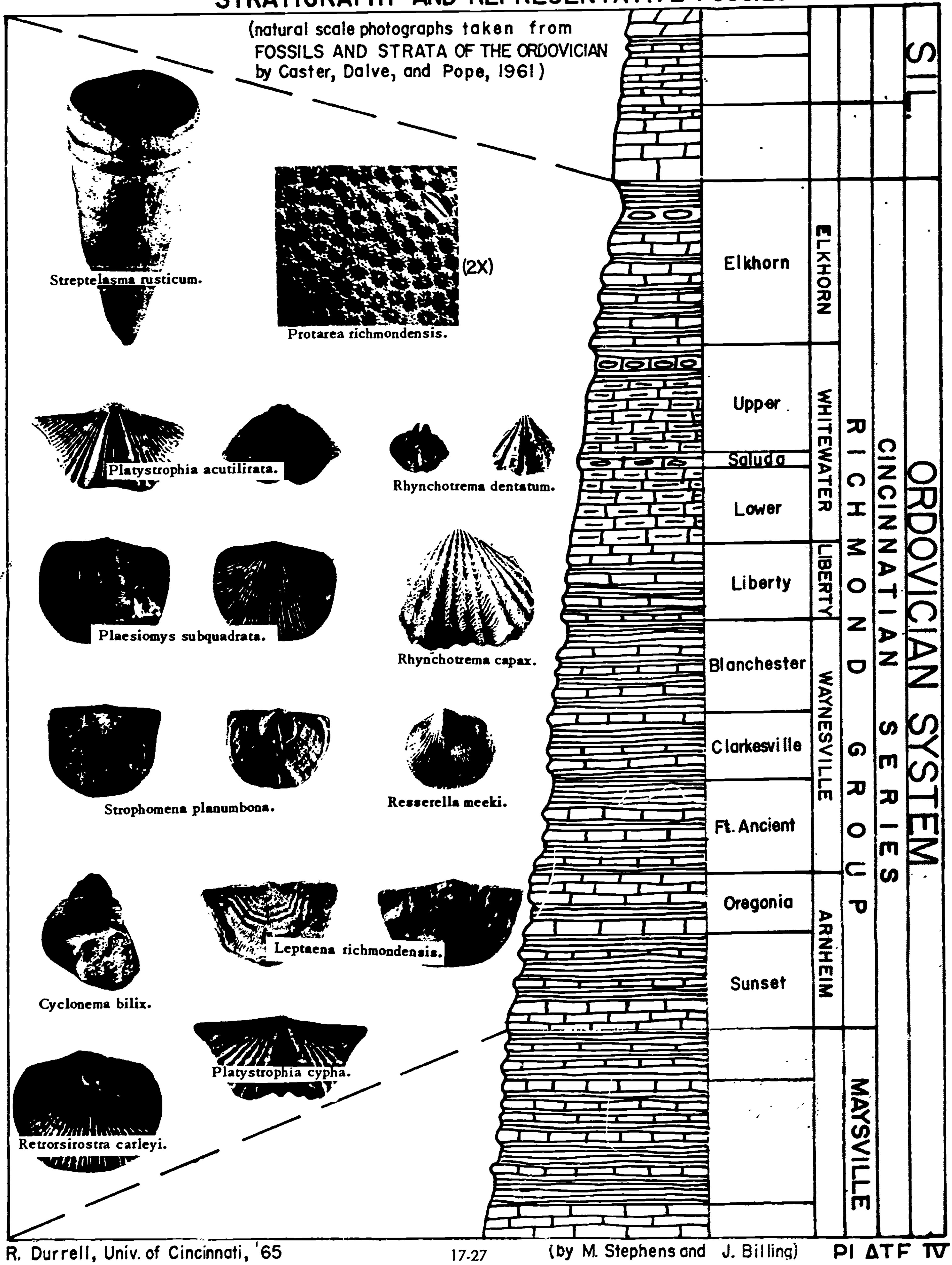


R. Durrell, Univ. of Cincinnati, '65 (by M. Stephens and J. Billing)

PLATE I

RICHMOND GROUP

STRATIGRAPHY AND REPRESENTATIVE FOSSILS

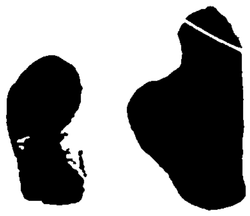


R. Durrell, Univ. of Cincinnati, '65 (by M. Stephens and J. Billing) PLATE IV

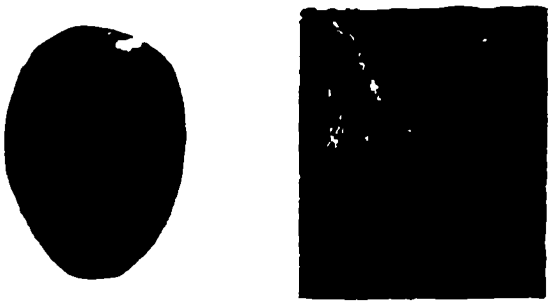
UPPER RICHMOND GROUP
REPRESENTATIVE FOSSILS

enlarged
Peronopora vera

Constellaria polystomella



Rhombotrypa quadrata



enlarged
Homotrypella hospitalis

enlarged
Homotrypa wortheni

Bythopora meeki

enlarged
Homotrypa flabellaris

enlarged
Hallopora subnodosa

Glyptocrinus sp.

Conularia formosa

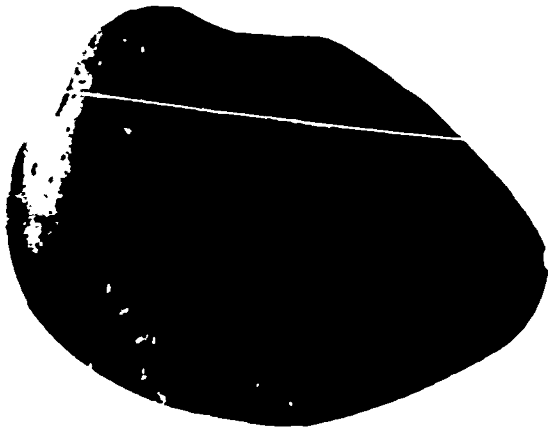
Reteocrinus nealli

Lichenocrinus sp.

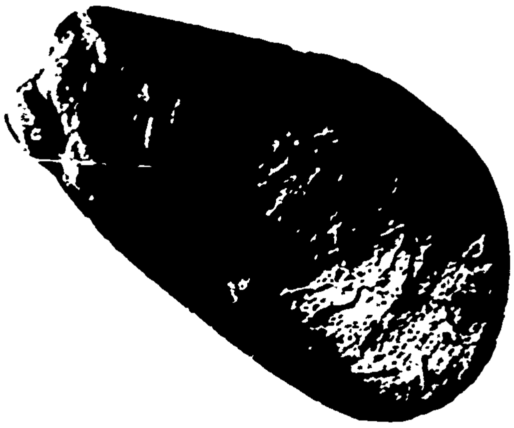
Lichenocrinus tuberculatus

Tentaculites richmondensis

UPPER RICHMOND GROUP
REPRESENTATIVE FOSSILS



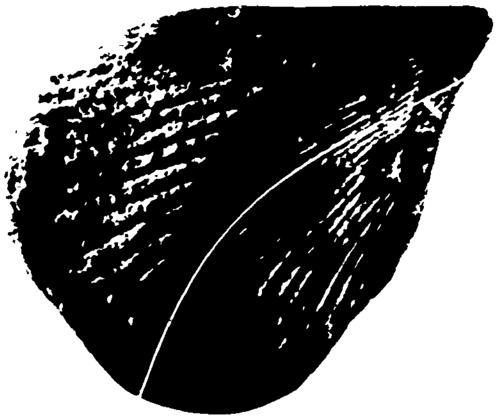
Whitella umbonata



Ischyrodonta elongata

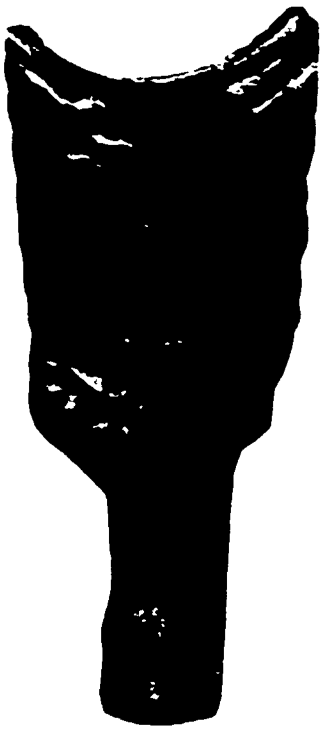
Anomalodonta gigantea

Modiolopsis modiolaris



Byssonychia grandis

Hebertella occidentalis



Endoceras proteiforme

Petrocrania scabiosa

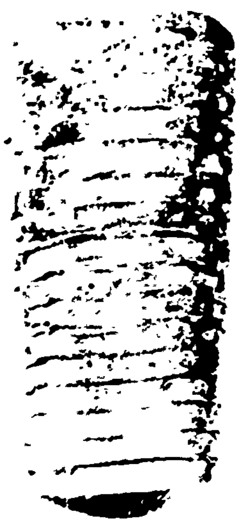
Platystrophia moritura

Strophomena sulcata

Lingula sp. X4

Strophomena vetusta

Nereidavus varians X3



Treptoceras duseri

Sinuites cancellatus

(natural scale photographs taken from FOSSILS AND STRATA OF THE ORDOVICIAN by Caster, Dalve, and Pope, 1961)

Identification of the lower contact is a problem, but it is usually described as being gradational on the Belfast Bed in most areas. Locally the Brassfield may be in disconformable contact with green shales of the Elkhorn formation. The upper contact is a disconformity which, because of the difference in the lithology of the overlying Dayton formation, is easily identified.

DAYTON DOLOMITE

Named the "Dayton Stone" by Orton (1871) for exposures in Montgomery County, the Dayton formation, like the Brassfield, runs nearly continuously across the state from east to west and south to Lewis County, Kentucky.

This, the oldest formation in the Niagaran series, is represented by 2-7 feet of gray to greenish-gray, fine-grained limestones that are nearly always very dense and hard. The plane of contact between the Dayton and Brassfield is sharp and is regarded as disconformable in Adams, Clinton, and Highland Counties, but is is conformable elsewhere. The thicker and more solid layers of dolomite in the lower half of the Dayton give way to thinner beds, which are frequently separated by thin partings of shale. This somewhat argillaceous upper portion thus preceded the Osgood Shale and there is every indication that deposition was continuous from Dayton on into Osgood time. The difference in lithology is due to a gradual change in the characters of the sediments. From central Greene County northward and westward around the escarpment, the Dayton is overlain conformably by the Osgood Shale. At many locations in southern Ohio, the Dayton is apparently missing in the Niagaran section.

Foerste and Busch have done most of the faunal work in the Dayton. The characteristic fauna include stromatoporoids, anthozoans, bryozoans, brachiopods, gastropods, cephalopods, and trilobites.

OSGOOD SHALE
(Alger)

The term Osgood Shale was first used by Foerste in 1896 in referring to exposures near Osgood, Indiana, but it is also common practice to combine the Osgood Shale, Laurel Dolomite, and Massie Shale into the Alger Formation. The unit is one of alternating beds of gray, shaly limestone and indurated shale. It outcrops in Preble, Miami and Greene Counties in west-central Ohio, and undoubtedly exists, though not exposed, in Darke, Clark, and Clinton Counties.

The Osgood rests conformably on the Dayton Dolomite and is overlain conformably by the Laurel Dolomite. The lower contact is usually fairly definite, even though the upper layers of the Dayton tend to be shaly or thin-bedded. The upper contact is also fairly sharp, for, although the Osgood contains thin carbonate layers at the top, the Laurel formation is easily recognized by its massive character.

The only fossils ever recorded from the Osgood of west-central Ohio were collected by Foerste at Rocky Point, 3 miles northeast of Dayton, but the types found were diagnostic of the Niagaran and not characteristic of the Osgood. It would appear that the Osgood sea in this area offered very unfavorable conditions for marine life.

The Osgood and Laurel formations have generally been differentiated on a lithological, rather than a faunal, basis. The thick Osgood Shale of Clark and Greene counties is commonly regarded as the northward extension of the Alger Clay of Highland and Adams Counties, Ohio, and the adjacent parts of Lewis County, Kentucky.

LAUREL DOLOMITE
(Alger)

Foerste (1896) named the Laurel Dolomite from exposures near the town of Laurel, Franklin County, Indiana. In Ohio, the Laurel consists of a gray to dark gray, mottled, dense, medium-grained, even-layered dolomite with some shale partings. The residue of the Laurel contains silty clays in fairly large quantities and also minor amounts of chert, glauconite, and pyrite. In Greene and Clark Counties, Ohio, the Laurel is overlain by a conformable shale referred to as the Massie, described by Foerste (1935) and containing a Waldron fauna. Elsewhere, the Laurel is overlain by the Euphemia Dolomite with an abrupt, although conformable, contact. The Laurel rests conformably on the Osgood Shale.

Although the Laurel Dolomite of west-central Ohio has always been considered to be practically unfossiliferous, Foerste and Busch have described a few species of anthozoans, crinoids, and brachiopods.

MASSIE SHALE
(Alger)

Foerste first referred to this shale unit from an exposure along Massie Creek near Cedarville, Ohio (1922) without giving it a name, but he eventually named it in 1935.

In Clark and Greene Counties, the thickness varies from 3 ft. 11 inches to 6 ft. 3 inches. It is conformably underlain by the Laurel Dolomite. The upper contact of this formation with the Euphemia Dolomite is conformable and the change is not quite as abrupt as at the lower contact. The limestone layers in the upper portion of the Massie foreshadow the long interval of quiet deposition that followed, but they are readily distinguished from the porous, massive dolomite of the overlying Euphemia.

Foerste collected 11 species of fossils at the type locality, and Busch has since increased this number to 54. Some of these fossil species correlate with the Waldron fauna of Indiana and include anthozoans, annelids, crinoids, bryozoans, brachiopods, gastropods, and trilobites.

Foerste believed that the Osgood, Laurel, and Waldron seas of Indiana extended to the east across Preble, Montgomery, Greene, and other northern counties of Ohio. The absence of the Waldron-Massie unit (The Waldron of Indiana is equal to the Massie of Ohio) between the Laurel and the Euphemia in Preble, Miami, and Darke Counties and of the easternmost portion of the Niagaran of northern Indiana makes it unlikely that the Waldron sea of Indiana ever extended to Clark and Greene Counties in Ohio. It is thus more probable that this embayment from the south split into two arms, the westernmost covering portions of Tennessee, Kentucky, and southern Indiana, while the easternmost extended as far north as Greene and Clark Counties in Ohio.

EUPHEMIA DOLOMITE
(Bisher)

The Euphemia was first named by Foerste (1917) from a section in a quarry just north of Euphemia (now Lewisburg) in Preble County, Ohio. Along with the Springfield Dolomite, the Euphemia constitutes the Bisher Formation referred to by some workers.

It thickens eastward from 3 feet at New Paris to 11 feet at Springfield, Clark County, and then thins again to 7.5 feet at Cedarville, Greene County. The Euphemia has never been identified along the escarpment west of the Indiana-Ohio border or south of Cedarville, Greene County.

The Euphemia is a medium-gray mottled with blue, medium-grained, porous, irregularly-bedded dolomite. The residues contain fine quartz silt, clay, sand-sized grains of chert, and also some glauconite and pyrite. The Euphemia rests conformably on the Massie Shale in Greene and Clark Counties and on the Laurel Dolomite in Miami, Montgomery, and Preble Counties. The contact with the Springfield above is conformable.

Most of the fossils of the Euphemia also occur in the overlying Springfield and Cedarville Dolomites, and, therefore, have very little correlative value. The Euphemia fossils are very unevenly distributed, with the brachiopods being the dominant forms, from the standpoint of both number of individuals and number of species. Among other forms found are anthozoans, crinoids, bryozoans, gastropods, cephalopods, and trilobites.

SPRINGFIELD DOLOMITE
(Bisher)

Orton in 1871 used the term "Springfield Stone" to refer to the middle unit of Locke's former Cliff Limestone, now known as Cedarville (Lilley). In 1873 Orton again used "Springfield Stone" for local building stone from quarries near Springfield, Clark County, but when it turned out that these quarries were in a unit basal to the Cedarville, the use of the name was dropped in southern Ohio, although it was retained in the Springfield area for the building stone. The Springfield is a light tan to gray, fine-grained, dense, regular-bedded, fossiliferous dolomite that is separated by thin partings of brown shale. It weathers to a light brown color. In the Springfield region, the upper six feet contain many thin, nodular layers of chert ranging up to 1.5 inches in thickness.

The thickness of the Springfield increases from west to east. It is 6 feet 4 inches thick at New Paris (the western most exposure), 12 feet at Covington, and it averages 14 feet thick. The thickest exposure in west-central Ohio follows the Niagaran escarpment, which is exposed in Preble, Montgomery, Miami, Clark, and Greene Counties. It is not exposed west of the Ohio-Indiana border or south of Cedarville. The contacts with the underlying Euphemia and the overlying Cedarville are conformable.

The majority of the fossils of the Springfield Dolomite are long-range forms and have little correlative value. Among the species found are stromatoporoids, anthozoans, cystoids, bryozoans, brachiopods, pelecypods, gastropods, conularids, cephalopods, and trilobites. The Springfield fossils are unevenly distributed with the brachiopods being by far the dominant forms both with regard to number of species and number of individuals.

CEDARVILLE DOLOMITE
(Lilley)

In 1871 Orton first used the term Cedarville Dolomite to apply to the local "Pentamerus Limestone." In his 1873 report, he designated the quarries in the vicinity of Cedarville as the type locality.

The fresh Cedarville rock is a white to blue-gray, holo-crystalline, porous dolomite with very small, irregularly outlined pockets or open spaces. In contrast to the stromatoporid cavities in the underlying Springfield, these cavities are largely the result of the solution of cystoids and crinoids, which are always preserved as casts of the interior and are thus loose in a cavity before exposure. The color of the Cedarville is not uniform, but includes occasional local mottling of blue; purple weathering soon gives the formation a buff or dark appearance.

The Cedarville is massive, but it breaks down on weathering into thin, irregular beds. The massive character of the Cedarville causes it to weather more slowly than the thinner-bedded Springfield; and so the Cedarville characteristically forms over-hanging ledges where the two formations are exposed in the same section. It constitutes the resistant cap rock of the several formations making up the Niagaran escarpment in west-central Ohio.

Solution along the contacts of crystals create a grainy rock of loosely cemented crystals resembling a friable sandstone. At a few places, cliff faces are coated with a thin layer of travertine.

A complete section of Cedarville is not exposed anywhere, so the thickness can only be estimated. In the Moore's quarry near Springfield, a thickness of the Cedarville approximating 110 feet is now exposed. This same formation is thought to directly underlie the glacial drift from the western-most portion of Fayette and northwestern Montgomery Counties to southwestern Wells County in Indiana.

The Cedarville is moderately fossiliferous with *Pentamerous laevis* being the dominant species. Other groups of fossils found in west-central Ohio include porifera, stromatoporoids, anthozoans, cystoids, crinoids, bryozoans, brachiopods, pelecypods, gastropods, cephalopods, and trilobites.

An attempt to establish definite fuanal horizons in the Cedarville has met with only moderate success. This is to be expected, however, when the quiet and uniform conditions that undoubtedly existed during the Cedarville stage are considered. There are very few characteristic species and the number of individual specimens is commonly too few to make these species of use.

The basal contact of the Cedarville Dolomite with the Springfield Dolomite is conformable and is exposed in numerous localities in west-central Ohio.

GUELF DOLOMITE
(Peebles)

The Guelf refers to 100-150 feet of light-gray to buff, saccharoidal, massive, reefoid dolomite restricted to norhtern Ohio. The upper contact, which is a disconformity with low relief, is overlain by the Greenfield Dolomite.

GREENFIELD DOLOMITE
(Salina Group)

The Greenfield is 30-100 feet of gray to tan, fine to medium-grained, even-bedded dolomite. Cross-bedding, stromatolitic nodules, and fine brown laminations are characteristic features. It is limited to northern Ohio.

TYMOCHTEE DOLOMITE
(Salina Group)

The Tymochtee is a medium to dark-gray, thin-bedded dolomite that contains some black, carbonaceous shale beds. The true thickness of the formation is not known, but it is estimated to be 100-150 feet. The

base of the formation, which was first discovered recently, grades into the Greenfield; the top, as yet, is not known. The Tymochtee is limited to northern Ohio.

PUT-IN-BAY FORMATION
(Bass Island Group)

Put-in-Bay is a massive 60 foot breccia occurring in two layers separated by bedded strata. The lack of persistance of the brecciated layers strongly suggests a local facies; perhaps it should be included as a member of the Raisin River Dolomite. Put-in-Bay is also limited to northern Ohio.

RAISIN RIVER DOLOMITE
(Bass Island Group)

The Raisin River, which is about 50 feet thick, is a light to medium-gray (sometimes yellowish), argillaceous, sparingly fossiliferous, thin to massive bedded dolomite. It is generally found in northern Ohio, where it is capped by the Devonian.

SILURIAN PALEOECOLOGY AND GEOLOGIC HISTORY

In the very early Silurian times, seas did not cover southwestern Ohio. Not long after the start of the period, however, marine waters from the South advanced to cover the area. These were fairly shallow, mid-continental seas that probably ranged up to 600 feet in depth. These seas produced the mid-Silurian accumulation of shale, limestone, and dolomite. The variation of lithologies is a result of the periodic muddy nature of the seas in early Silurian time, when clay minerals predominated in the sediments. This cyclic nature could have been caused by the periodic presence of low islands to the north during these times and also by the Taconic disturbance to the east.

The fauna represented in the section includes corals, brachiopods, bryozoans, crinoids, and cephalopods. Since these are all essentially benthonic forms, they give good indication of the depth of the seas. This fauna prefers warm, marine water below wave base, but less than 600 feet deep. Excellent examples of biostromes are furnished by the abundant fauna in the encrinites of the Brassfield formation.

The preservation of abundant calcium carbonate in the marine fossils indicates that the chemical environment must have been nearly neutral. And the evident fragmentation of fossils implies that the seas were quite agitated. As long as the water was clear, life flourished, but when the clastic content increased, the marine life apparently diminished. This is suggested by the lack of fossils in the shaly portions of the stratigraphic section and by the abundant faunas present in the more pure limestones.

GENERAL GLACIAL HISTORY OF SOUTHWESTERN OHIO

Pleistocene glaciers, advancing from the north and northwest, extended completely across the plains in the west and, in the east, pushed southward up on the Appalachian Plateau for a distance of about 70 miles.

Three of the four Pleistocene glaciers are known to have invaded Ohio. Most of glaciated Ohio is covered by deposits of the last, the Wisconsin glacier. Deposits of the next preceeding glacier, the Illinoisan, occur at the surface south of the Wisconsin boundary across most of the state, but in the northeast these deposits are restricted to a narrow belt, and in one area are completely overlapped by the younger Wisconsin drift. Illinoisan deposits are presumed to underlie most of the Wisconsin drift, but only in a very few places has a buried soil or other diagnostic feature been observed that would identify the lower material as Illinoisan. Pre-Illinoisan deposits have been recognized in three areas: (1) the Cincinnati region, where the deposit is generally till; (2) terraces along the Hocking River valley in central Ohio; and (3) two terraces along the valley of Little Beaver Creek in northeastern Ohio.

Identification of deposits as pre-Illinoisan is mainly on the basis of the depth and intensity of weathering of the soil developed in the deposit. In the Cincinnati area, the soil in the pre-Illinoisan till is characterized by brighter colors and a deeper profile than that developed in the younger Illinoisan till, though both soils are so deep and so strongly weathered that distinction is difficult where the till is less than 15 feet thick over the bedrock. The pre-Illinoisan till appears to be limited in occurrence to upland positions, whereas Illinoisan drift is present both on the uplands and in the valleys, thus providing both another means of differentiation between the two tills and additional substantiation for the difference in ages.

Illinoisan till, wherever it lies at the surface in Ohio, is always associated with characteristic soils which are consistently deeper and more weathered than those in Wisconsin deposits, but not so strongly weather-

CORRELATION OF THE SILURIAN FORMATIONS OF SOUTHWESTERN OHIO

After Chart No. 3 G. S. A. Bull. Vol. 53, pp.533-538. 1942

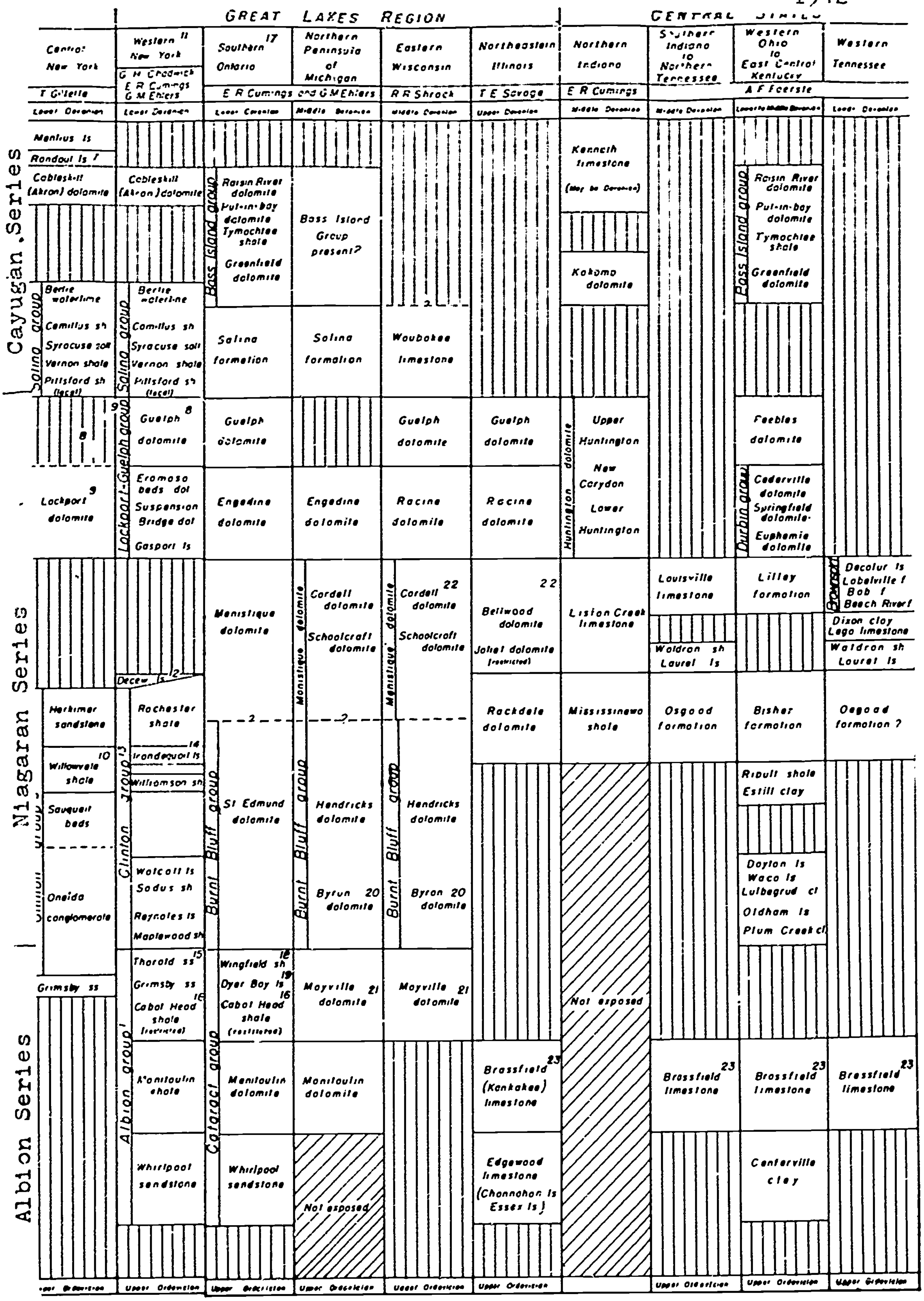


Figure 11.

Thicknesses taken from "Stratigraphy of the Silurian Rocks in Western Ohio" 1963
C. H. Summerson

GENERALIZED SECTION OF THE SILURIAN ROCKS OF WESTERN OHIO

system	series	group	formation
			glacial deposits (ground moraine) 0-400'
Silurian	Cayugan	Bass Island	Raisin River Dolomite 50'
			Put-In-Bay Dolomite 50'
		Salina	Tymochtee Dolomite 100-150'
			Greenfield Dolomite 30-100'
	Niagaran	Lockport	Guelph Dolomite 100-150'
		Clinton	Cedarville Dolomite 110'
			Springfield Dolomite 6-14'
			Euphemia Dolomite 4-8'
	Alexandrian	Albion	Massie Shale 4-6'
			Laurel Limestone 10-50'
			Osgood Shale 35-40'
			Dayton Dolomite 2-12'
			Brassfield Limestone 22-50'
Ordovician	Cincinnatian	Richmond	Belfast Shaly Siltstone 4-6'
			Elkhorn Shale
			Whitewater Shale

section

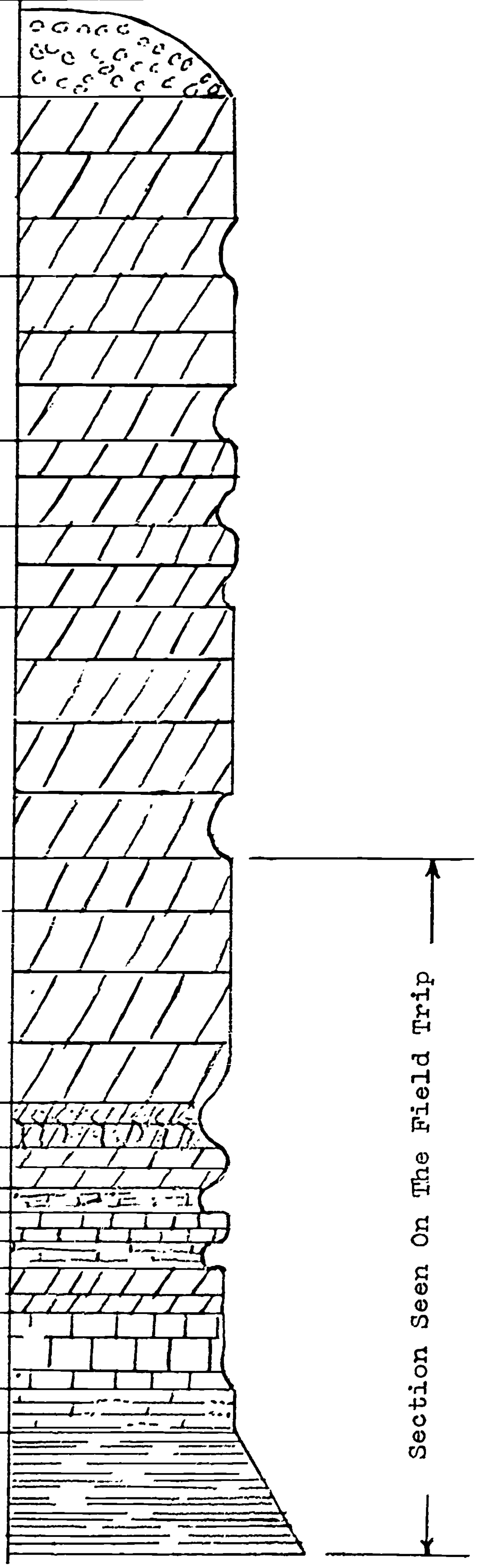


Figure 12.

ed as the soils in the pre-Illinoisan materials. In most places, no true morainal topography is present, and the topography on the Illinoisan drift is simply a somewhat smoother version of that on the underlying bedrock surface. Except for local spots and places where recent dissection has taken place, all areas of Illinoisan till are so broad and flat that the term "till plain" is more appropriate. The till of these plains is generally covered by several feet of loess, believed by many to be of Wisconsin age.

Wisconsin drift mantles most of the glaciated Ohio and, because of the recency of its deposition, it still retains, almost without modification, its original topographic form. As a result, a great deal more is known about its history than is known about that of any of the pre-Wisconsin deposits. Soils have been a particularly valuable tool in the identification and mapping of the different Wisconsin drifts of western Ohio; the amount of weathering is a measure of their age, and other differences in the soils are clues to subtle but important differences in the nature of the parent tills.

Five tills are recognized in southwestern Ohio. Four occur at the surface and are identified on the basis of soils; a fifth, older till lies below the surface and is recognized in southwestern Ohio in a number of exposures which have the same characteristic topography. All of these units are of "late Wisconsin," or classical Wisconsin age. The four soils which define the four areas of Wisconsin-age surface tills are distinguished from each other on the basis of: (1) the presence or absence of a silt (loess) cap; (2) the depth of soil development; (3) the amount of clay in the B horizon; and (4) the amount of clay in the parent till. These four areas occur in irregular east-west bands parallel to end moraines and so are considered to be significant in the interpretation of the glacial history of the region. The southernmost of the bands, which lies between the Wisconsin boundary to the south and the distal margin of the Camden moraine to the north, is that of the Russell 67 soils. The Miami 60 soils occur between the Camden moraine and the outer edge of the Farmersville moraine to the north. The Farmersville and the Union City moraines bound the area of the Miami 6A soil, while to the north of the Union City moraine, soils of the Morley (or Miami 6B) catena are mapped.

The "early Wisconsin" is believed by Goldthwait and Forsyth to be represented in Ohio by: (1) a terrace along the Hocking River whose height and soil are intermediate in characteristics between those which are unquestioned Illinoisan and those which are of typical Wisconsin age; (2) an area in Highland County where the surface soils, which belong to the Deep Russell group, are much deeper and appear somewhat more weathered than the true Russell soils mentioned earlier; and (3) buried gravels, in which paleosols capped by calcareous till of traditional Wisconsin age are found at a number of locations (near Springhills in Champaign County, Springfield in Clark County (Stop #4 of the present trip), Carroll in Fairfield County, Columbus and Groveport in Franklin County, and Sidney in Shelby County). But the best evidence for the "early Wisconsin" comes from the famous buried soil developed in till that is exposed in a railroad cut and in a stream bank two miles and four miles, respectively, south of Sidney. The soil profile unquestionably represents a fairly long ice-free interval, an interpretation supported by the nonglacial aspect of a pollen profile present and by radiocarbon dates. According to the latter, the soil-forming interval ended 22-23,000 years ago and began at least 30,000 years earlier. Forsyth (1965) has come to the conclusion that the underlying till is "early Wisconsin" in age and has tentatively correlated the till with Gooding's Whitewater and/or Fayette drifts in Indiana and with Frye and Willman's earliest Altonian glaciation in Illinois. It appears that all these correlated units date from the same interval, the earliest part (50,000 to 70,000 years ago) of the Wisconsin Stage (early Altonian). Most other areas had deposits of subsequent pre"late Wisconsin" (later Altonian) glacial advances; it was the lack of such deposition that allowed the Sidney soil to develop without interruption into a significant paleosol.

Several layers of Wisconsin-age terraces are present in southwestern Ohio, but detailed work has not been done on them there. Mapping by Goldthwait and Forsyth along the valleys of the Miami River and its tributary, the Mad River, has shown the presence of two major constructional terrace systems which drain to the south from the interlobate area in Logan County. The higher one, called Kennard, is capped by till to the north and has been interpreted to be of "early Wisconsin" age; the lower one, the Mad River valley train, which is related to the "late Wisconsin" Farmersville moraine and therefore to the Marcy-Farmersville terrace system, is very extensive and can be traced from Logan County south to the southern edge of Montgomery County, where it represents the major level of constructional terrace, and, possibly, on into central Butler County.

PLEISTOCENE DRAINAGE CHANGES

The Pleistocene was a time of pronounced drainage change. The pre-glacial drainage in Ohio consisted of a series of northward flowing streams, separated from each other by divides, that were developed on an old-age surface called the Lexington Peneplain (Fig. 1, p. 37). The primary stream in the state was the Teays River, whose buried valley between Chillicothe and Lake Erie now constitutes the upper reaches of

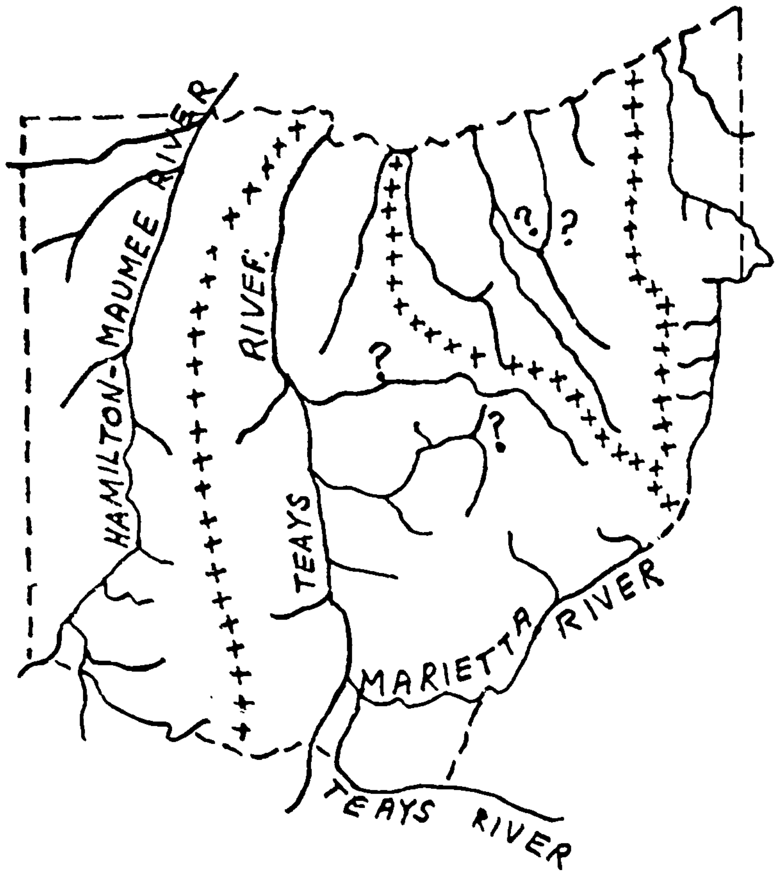


Fig. 1

Preglacial drainage

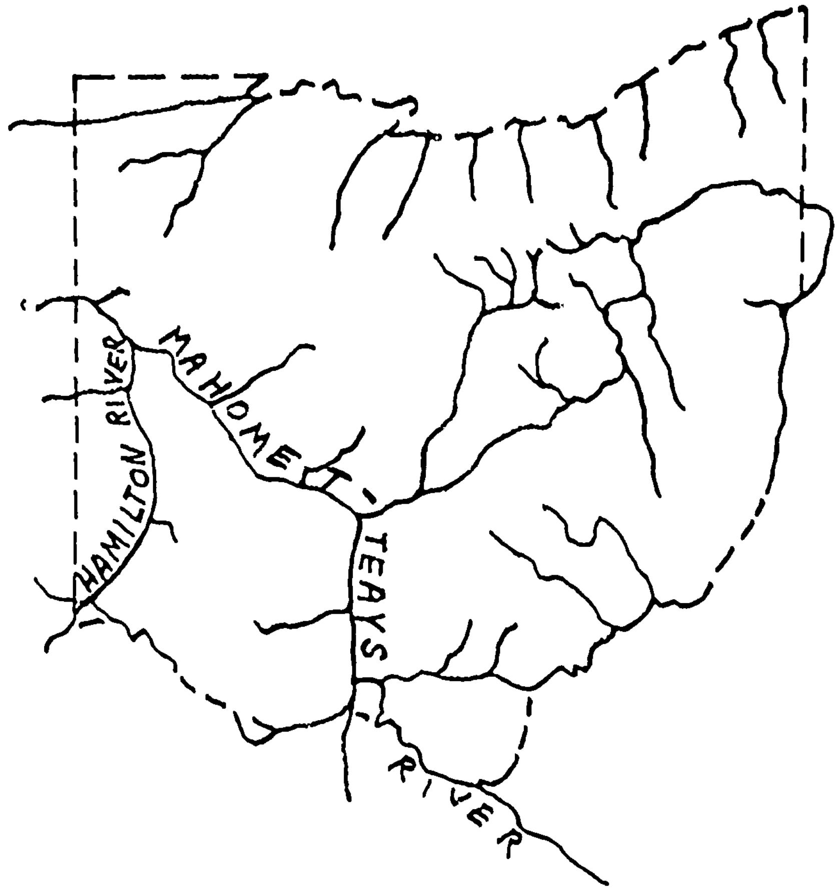


Fig. 2

Aftonian drainage

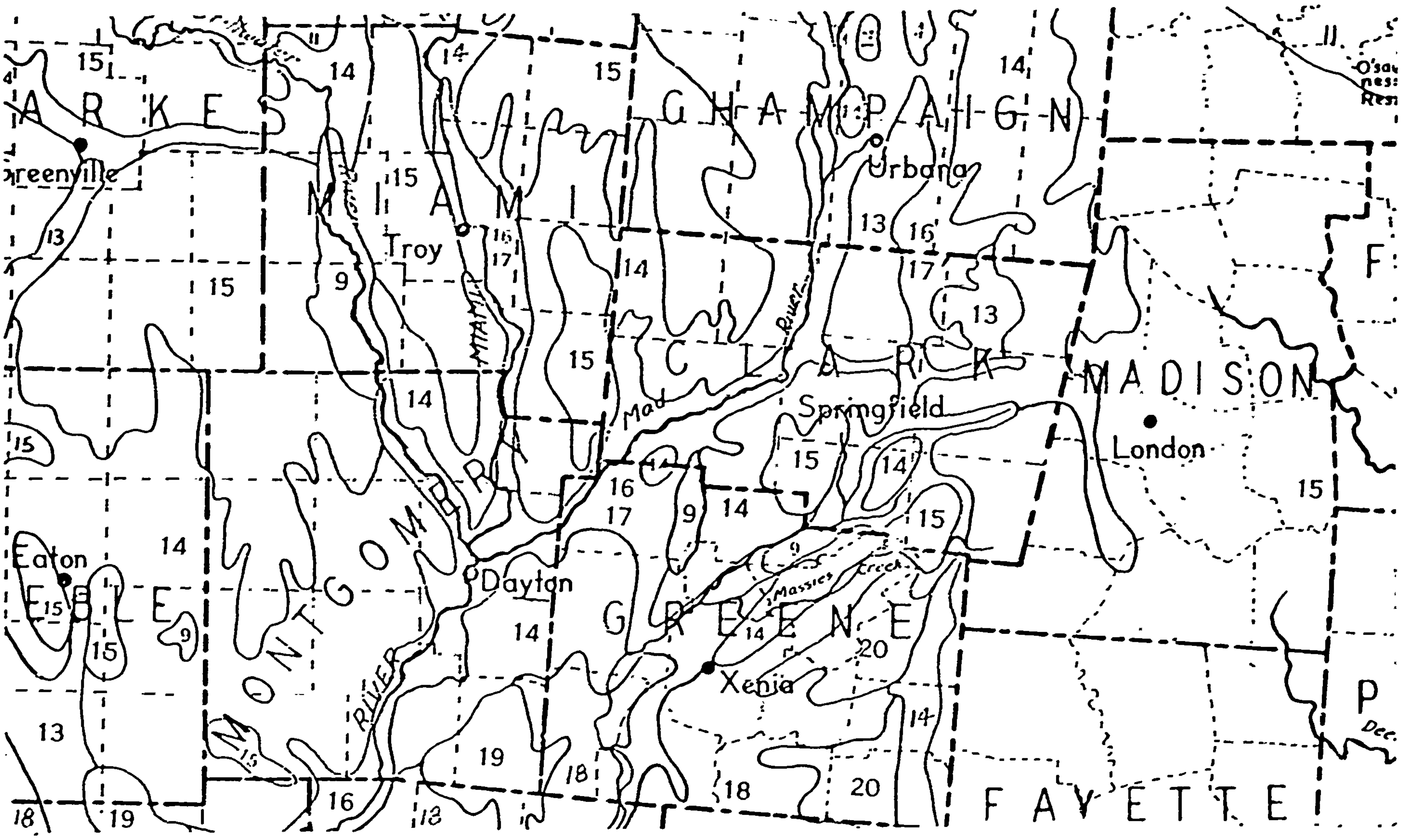
Fig. 3

Yarmouth drainage

DRAINAGE CHANGES IN OHIO DURING THE PLEISTOCENE

Figure 13. Geology after Coffey (1961)

WISCONSIN TILL SOIL REGIONS



Most of Ohio's soils developed in a humid temperate climate and under deciduous forest vegetation. Principally light colored, they are partially leached of some soluable minerals. As a result of differences in relief and natural drainage, color and texture of topsoil, character of subsoil, and character of and depth to parent material, about 400 types have been recognized.

I. HIGH-LIME WISCONSIN TILL SOIL REGION

Most soils in this region formed from medium and moderately fine textured, limey till. They are relatively young, so their natural fertility status is moderate to high.

A. SOILS DEVELOPED FROM MODERATELY FINE TEXTURED (CLAY LOAM) TILL

11. Blount-Pewamo-Morley: Deep, mainly poorly drained, nearly level to gently undulating. The grayish brown Blount occurs on slight knolls or slopes in close association with the very dark Pewamo, which occupies the depressions.

B. SOILS DEVELOPED FROM MEDIUM TEXTURED (LOAM) TILL

13. Miami-Kendallville-Fox: Grayish brown, well drained, moderately deep soils on rolling relief, some underlain with gravel and sand.

14. Miami-Celina: Grayish brown, deep, well drained soils on undulating to hilly relief.

15. Crosby-Brookston: The grayish brown, imperfectly drained Crosby soils occupy gentle slopes. Very dark colored, very poorly drained Brookston occurs in slight depressions.

C. SOILS DEVELOPED IN MEDIUM TEXTURED MATERIAL OVER LIMEY GRAVEL AND SAND ON TERRACES OR OUTWASH PLAINS

16. Fox-Ockley-Westland: The moderately deep Fox and deep Ockley are grayish brown, well drained soils on level to steep slopes. The very dark colored, very poorly drained Westland occurs in depressions or on low flats where a high water table existed during soil formation.

D. ALLUVIAL SOILS ASSOCIATED WITH THE HIGH-LIME TILL REGION

17. Genesee-Eel-Sloan: Deep, neutral, fertile, brown to black, medium textured soils of the flood plains that are differentiated from each other by extent of drainage.

E. LOESS-MANTLED HIGH-LIME TILL SOILS

18. Russel-Xenia-Wynn: Generally well drained, grayish brown, silty soils on long undulating to steep slopes.

19. Fincastle-Brookston: The light colored, imperfectly drained, medium acid Fincastle and the dark colored, poorly drained, neutral Brookston soils occur closely associated on nearly level ground. Fincastle occupies the slightly higher land and Brookston, the lower areas.

20. Birkbeck-Reesdale-Ragsdale: The moderately well drained, light colored Birkbeck, the imperfectly drained, light colored Reesville, and the very dark colored, very poorly drained Ragsdale are medium acid to neutral, deep, silty soils on nearly level to undulating relief.

II. THE OLD LAKE-BED REGION

Most of the soils of this region developed in fine textured, calcareous lake sediment or glacial till.

A. SOILS DEVELOPED IN SHALLOW TO MODERATELY DEEP TILL OVER LIMESTONE

9. Milton-Millsdale: These soils range from neutral to medium acid and from level to steep. The poorly drained, dark colored Millsdale, imperfectly drained, grayish brown Randolph, light colored, well drained Milton, and brown, well drained Catawba soils vary according to the depth to limestone.

Figure 14.

the Scioto River. The origin of the Teays appears to be in the Piedmont region of North Carolina, and the present valleys of the New River and the Kanawha River in West Virginia have been interpreted as remnants of the main valley of this ancestral Teays. From northern Ohio, its lower course is not known; it may have followed the course of the present St. Lawrence River, or it may have emptied into the Mississippi Embayment in southern Illinois.

The advance of the Nebraskan ice sheet from the northeast disrupted this drainage and forced the Teays to cut its way down through its westward divide (Fig. 2, p. 37). From there, the Teays followed the bed of the Mahomet River northwestward to the vicinity of Fort Wayne, and then westward through Indiana and Illinois to the Mississippi Embayment, an extension of the Gulf of Mexico, which was located in southern Illinois at that time. The great size of this Mahomet-Teays system may be readily grasped when it is considered that the Mississippi River was a tributary to the Mahomet-Teays, into which it flowed in central Illinois. Extensive testing of the area to the immediate north of the city of Springfield shows that the westward-trending abandoned channel is very narrow and over five hundred feet deep to bedrock. The fine sands at the base of the channel are thought to be from a Kansan backup of flow.

The Kansan glaciation, in turn, disrupted the Mahomet-Teays system and initiated the Deep Stage drainage, which bore only slight resemblance to the previous system, as the Mahomet-Teays, Hamilton, and other northward-flowing streams were blocked off, and their flows were frequently reversed (Fig. 3, p. 37). With the advent of the Illinoisan glaciation, the present course of the Ohio River was determined as an ice-front stream. The new Ohio River drainage system was greatly enlarged toward the end of the Pleistocene due to the large amounts of meltwater runoff.

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18TH ANNUAL INTERCOLLEGIATE GEOLOGY FIELD CONFERENCE

Mount Union College Geology Students
Alliance, Ohio
October 28, 1967

Traditionally, and properly, this conference is student managed. The three students who accepted the invitation a year ago are not now in school at Mount Union. Of those who have picked up the job this fall only two were aware of the trip last spring. These are willing workers, and we are proud of them. However, they are simply not old hands at local geology. Honestly, had I foreseen the past year I would have urged all concerned to try Mount Union for '68, not '67.

WELCOME

Your hosts are

Bob Bennett
Hugh Nile
Kim Roessner
June Fursey
Dave Snyder

Some help from Wiese and Rice

Thanks to Keler Mines and Ohio Stone for pit access.

Thanks to Mr. Dan Bull, Pennsylvania RR. Trainmaster

The geology is here, you are here, the weather is what it is, and if you follow it with an eye open and perhaps some doubts about mileages the guide will get you to places to look and argue.

Go to it!

A word about Pennsylvanian stratigraphy

There will be differences of opinion about correlations. However, the general nature of the beds can be seen in the field.

Something like this succession of beds surrounds each coal, and is repeated, with variations, and with members missing from most sequences. From top down:

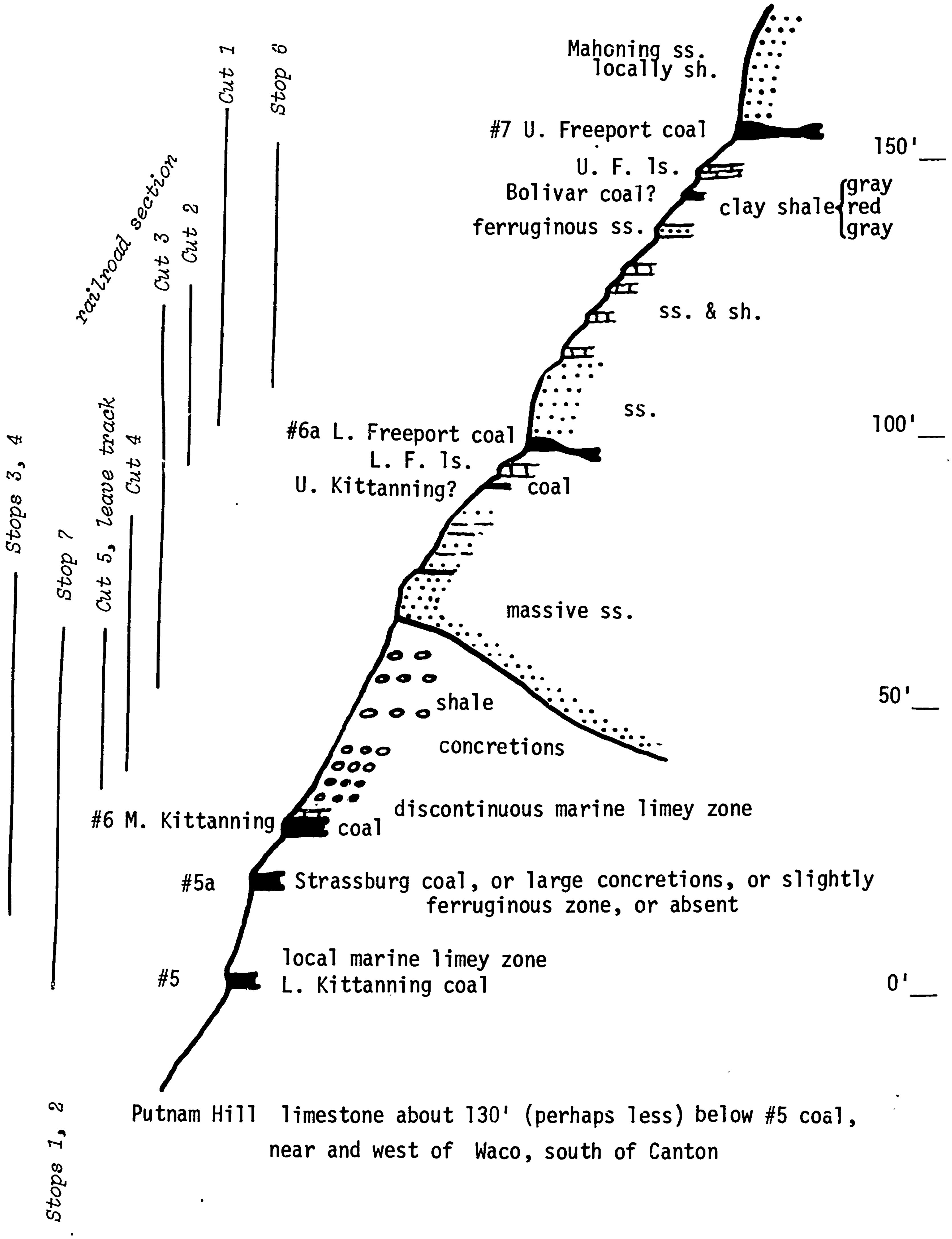
Erosion surface
Terrestrial shale, or siltstone or sandstone
Marine shale, sometimes carbonaceous — may contain distinctive concretions
Marine limestone — may be sideritic
Coal
Underclay, or sand or siltstone — low iron content
Clayey shales, freshwater limestone
Terrestrial sandstone, or shale
Erosion surface

Coal beds, in addition to having stratigraphic names, with some dubious correlations, have miner's numbers, counting upward. Only those commonly mined get numbered. Locally mined coals get subscript numbers referring them to the next lower coal, e.g. the 5a is above the 5 and below the 6, less widely mined than either the 5 or the 6.

The number is likely to be locally applied to a bed which is obviously not, in any reasonable stratigraphy, the correlative of the bed carrying that number elsewhere. This is done because of similarity of the coals, or even for market reasons.

The following sketch section, worked up from notes in Ohio Survey files and a few personal notes by Rice is for the local area. Those of you familiar with Stout's standard section will note wide differences of dimensions, absence of some standard units.

FOR SOUTHEASTERN STARK COUNTY
AND BAYARD CUTOFF OF PENNSYLVANIAN RR.



LOCATION MAP — Ohio Intercollegiate Field Trip, October 28, 1967

The first stop, Keler Mines, can be reached from Ohio 225 by way of either Greenbower-Middletown Road or Armour St. Neither of these roads is conspicuous. Note land marks indicated.

This stop presents excellent collecting in black shales and in two limestones, all abundant in chunks on the spoil pile. If there are as many as two geologists present, there will be a stratigraphic argument in the range #4 to #5 coal.

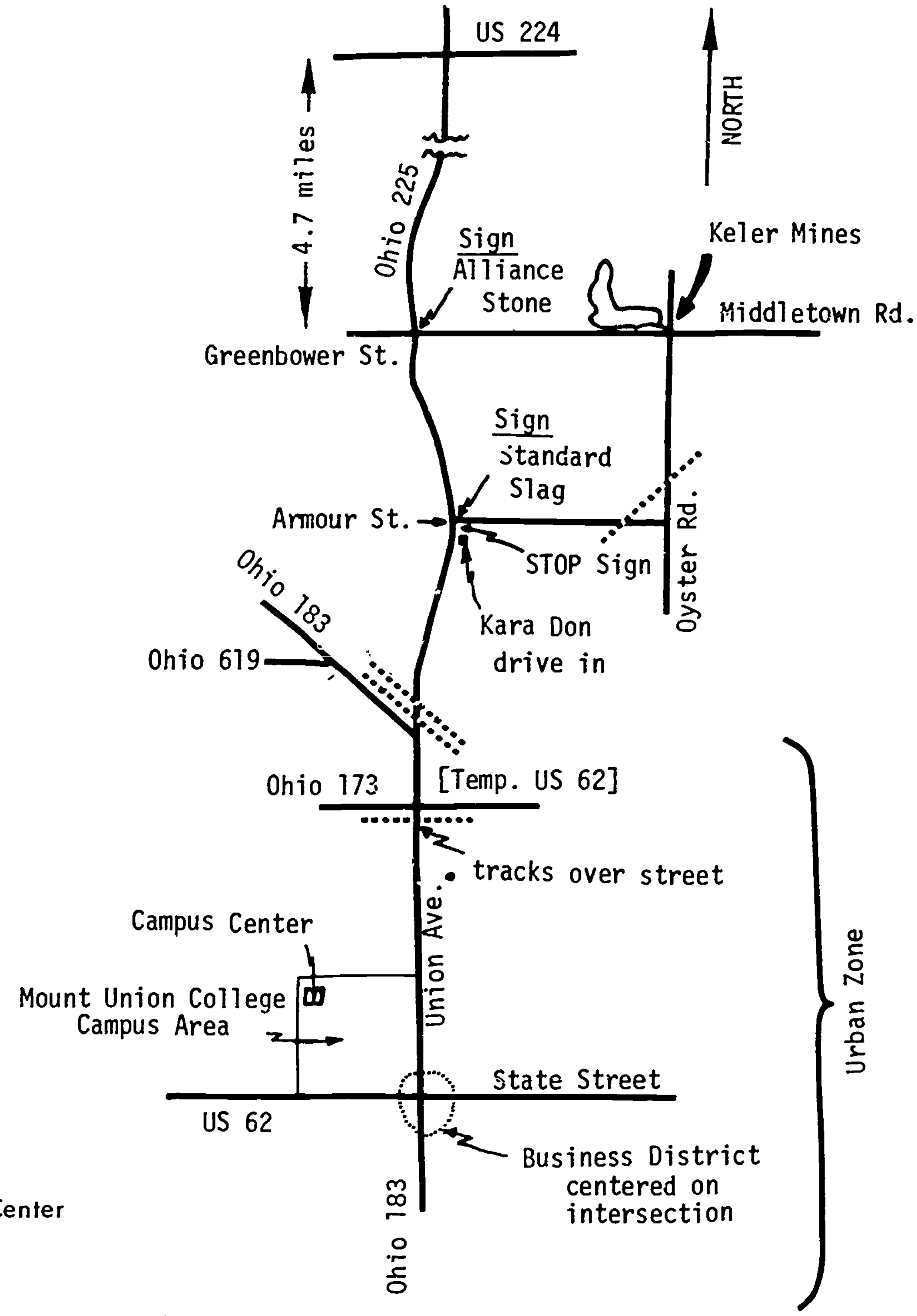
The Mount Union College campus is visible from either U.S. 62 or Ohio 183, but not from their intersection in a business district. The Hoover-Price Campus Center occupies the northwest corner of the campus, north of stadium, serves breakfast from 7 to 8, with some leeway for late geologists, and has a snack bar for still later geologists.

We will pull caravan out of the campus center area at 8:30, but suggest that you go directly to the first stop at your own convenience. There will be a man there for parking cars and directing guests to the pit.

NOTE:
U.S. 62 is under construction a few miles west of Alliance, and is being carried comfortably on Ohio 173. The town routing gets changed from time to time, is shown as of 10/16/67.

Not even a jeep can get through the bridge construction on 62. Take the detour.

Railroad crossings shown are *bumps*, with exception of the RR overpass.



Headquarters

Look for signs at the Campus Center

Parking

In street south of Campus Center, immediately adjacent to stadium. This is northbound parking.

ROAD LOG

Mileage is logged from Stop #1, six miles from Mount Union College campus, because many participants will go to that stop directly, at their own convenience. See location map for details of approach.

Assembly point is Stop #1, 8:30 A.M. or earlier or later at your convenience. Move on to Stop #2 at your convenience, or plan to drive by it if you prefer to glance at the Van Port ls. from the road.

We should leave Stop #1, Stop #2 area promptly at 10:00 A.M. because we will be involved in train schedules from Stop #6 on.

Time: 8:30
STOP #1 — Keler Mines pit northwest corner of Oyster Road and Greenbowner St. — Middletown Rd.
0.0 mi.

First or upper pit floor interpreted as being at #4 coal with Putnam hill limestone tongues in pit wall. Note small structures near ramp to lower coal in western lower part of pit, also lateral facies change in sandstone between the two coals. There is room for difference of opinion on stratigraphy in this area. Stop #2, four tenths of a mile south, shows a limestone quite different from what is here called Putnam Hill. Pits within a mile east have shown that limestone above the section in the south wall of this pit, but are not now in good condition for demonstration. That upper, thicker, limestone is interpreted as Van Port.

Fossil collecting —east-west pit —walk along terrace half way up spoil pile, for limestone and black shale blocks.

South on Oyser Road

Stop #2 — Alliance stone pit, west of road. Take second entry. Brief examination of Van Port. Your mileage in pit is not logged.

Time: 10:00
South on Oyster Road

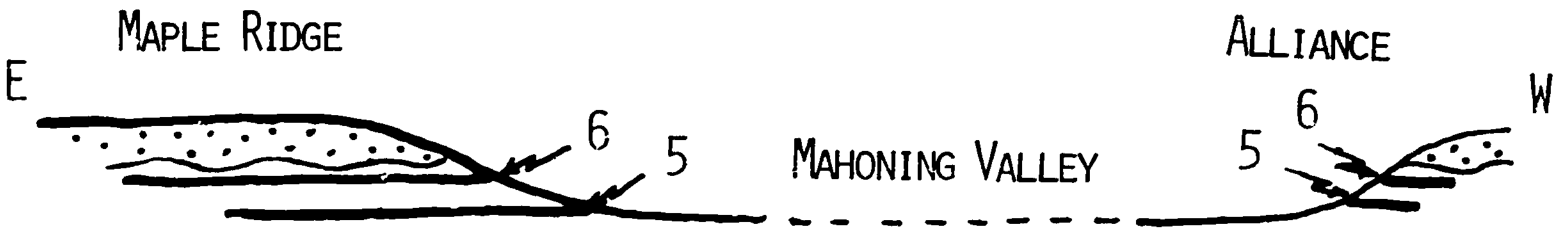
1.3 and following. Long slope southwest to downtown Alliance is approximately a dip slope. Van Port is exposed in low country near the visible business district.

1.7 Left turn east, Courtney Road

3.2 Cross Bandy Road cautiously

4.3 Right turn, south, Johnson Road, look both ways at this turn. Southward slope of Johnson Road is essentially a dip slope underlain at least in part by #5 coal. This is the south slope of a local half dome of which you have seen the southwest slope. There is also an east slope.

Low part of Johnson Road is glacial and alluvial continuous with Mahoning River lowland to west. High country directly south of you, Maple Ridge, which we will cross, projects into Mahoning lowland from general upland to east. Upper portion of this ridge is a locally massive sandstone over the #6 coal. #5 coal near drainage level at base of hill.



5.4 Cross route 173

6.0 Stop light, continue down south slope of Maple Ridge.

Spoil piles ahead on left are shale, those on right are shale and sandstone — both piles from over #6 coal.

6.3 Turn right, west, lane between fireplug and gray and white house.

Pits on right (sandstone and shale piles) were for #6 coal, lower pits on left for #5 coal.

6.7 Exposure at right, #6 coal obvious. Breaks in coal are collapsed underground workings sectioned by more recent open pit. Equus caballus bones recovered from coal level in this open pit operation.

Note sandstone increasing westward in this cut.

STOP #3 — Actually a slow drive-by

As you round corner, note channeling at base of sandstone, and cross bedding in sandstone. Sandstone contains, as pebbles, fragments of underlying shale and its concretions. This sandstone is similarly developed on the whole west nose of Maple Ridge. Elsewhere the corresponding section is more shaly.

Look also west northwest across river bottoms. Hill above downtown Alliance (distant chimneys) is unusually steep, shows a similar sandstone in street excavation.

Interpretation — An east-west fluvial channel sandstone, more resistant than the adjacent shales, makes a narrows in the Mahoning valley.

Minor detail —#5 coal is below water, 5a coal may be represented by the rusty streak a yard above water.

7.1 Left turn, west, Lake Park Road

Flat before you contains at least 100 ft. of glacial fill, much of it till, very limited aquifers, lake beds making the finished flat upper surface.

7.7 Pits on right similar to what you have seen

8.2 Mahoning River

9.6 Left turn, south, traffic light, city limits, Mahoning Ave.

STOP #4 — 10.2 Moderate speed drive by. College Plaza Bowling on right.

Behind bowling, a sand and gravel cut with till tongues. Typical local ice-margin deposit against bedrock hill.

Bedrock cuts show #6 coal near road level, much less sandy section above it than you saw in Maple Ridge. Eroded from above visible section is an estimated 20 feet, mostly shale and clay, up to 6a coal which has been found (?) in a basement near campus, less than a mile farther west. You will see this section in a series of railroad cuts.

You are on brick street. It and miles like it came out of pit which faces and practically includes shopping center ahead, right. Alliance Clay Products, and Alliance Brick plants left, across street. Recent fashions of pale brick have shifted emphasis to the low-iron clays below coals, rather than the shales which give various red bricks.

10.6 Traffic light, U.S. 62, continue south one mile.

11.8 Right turn, west, Beech Street.

12.7 Left turn, south, Rt. 183 FAST CROSS TRAFFIC.

Several miles of typical rolling upland on Wisconsin drift. Here and for several miles west the pre-glacial topography is much obscured by drift from a few feet to over 200 feet thick. Good unsolved problems.

16.0 S-curve, left offset, Whitaker mammoth site, R.I.P.

18.6 Second S-curve, left offset, leave Wisconsin drift near bottom of hill. Patches of Illinoian for a few more miles south of the Wisconsin border.

19.3 Left turn, east, Rt. 173, in New Franklin. FAST TRAFFIC.

The following side trip east is to see a pair of temporary spillways from the west headwater of the Mahoning into Sandy Creek drainage. They isolate, *sharply,* a triangular remnant of the pre-glacial divide which they cut.

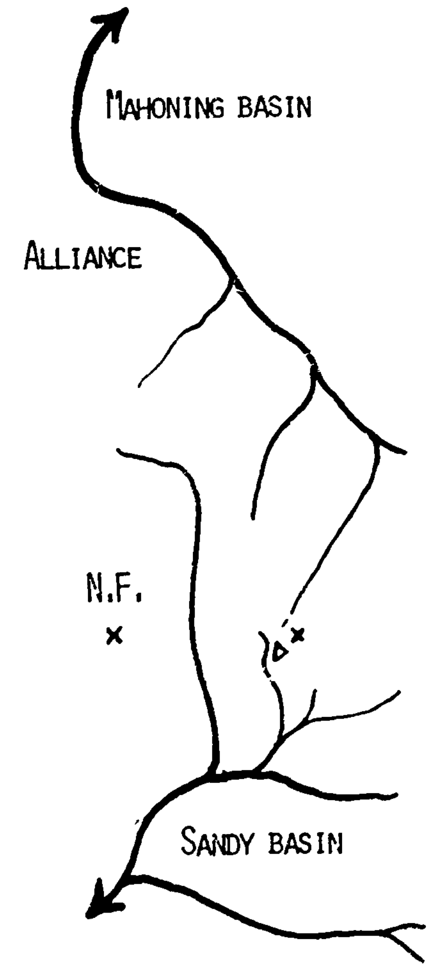
Down, east, from New Franklin into large valley of south-flowing Sandy Creek. Irregular kame terraces and outwash low in valley.

21.9 Lowmiller Road crossing, on the topographic divide between basins. Sandy Creek lowland behind and south. Mahoning valley ahead, left. Small drain line in field, left foreground, flows toward headwater swamp of west headwater of Mahoning, but has been artificially deflected to Sandy Creek through west spillway. Follow it.

22.7 West spillway, to right. Mahoning headwater swamp, left.

22.9 East spillway, right. High part of spillway floor is at bend. Thence, without steep divide, the slope is south.

23.5 Turn right, south, County Rd. 403.



23.7
STOP #5 — Park at right, step to field at left, for view over territory which you have just passed.

Problem: Two outlets of same body of water can not cut down rapidly, without one almost immediately robbing the other. Consider two streams along margins of a tongue of ice which filled Mahoning valley and abutted against hill isolated by the spillways.

As the ice melts back, the surviving spillway is functional until the Mahoning northeast of Alliance can take its present course.

Other geology at Stop #5.
- Sandy Creek low country obvious to south
- Strip mine, to southeast, #7 coal, 2 to 7 feet thick
  - Underground mine almost under you, 6 feet of coal
  - Tipple visible in woods at right as you return
- #6 coal (?) in Mahoning bottoms, you may have noticed from valley floor. That mine uncovered a mammoth (?) skull, and ribs, below peat.

From Stop #5, turn around at next drive south, and return to Route 183 at New Franklin.

Note: as you approach west spillway, that its head is partly filled by an alluvial fan, on which a small creek is reported to have been deflected artificially from Mahoning headwater swamp into the spillway. A well a short distance south of road went through about 35 or 40 feet of fill, which brings the rock floor of the spillway to reasonable agreement with the lacustrine beds east of Alliance. More detailed work needed on this problem.

28.7 Left turn, south, Route 183, New Franklin, FAST TRAFFIC. Better check your mileage.

PLEASE KEEP WIDELY SPACED ON NEXT FEW MILES OF HIGHWAY and prepare for a left turn.

32.2 Railroad overpass

32.4 *LEFT TURN.* Bayard Road and *steep* dirt lane up hill to left.

Time: 11:30, we hope.
STOP #6 — Hilltop above Pennsylvania railroad cut.

Meet Mr. Dan Bull, Trainmaster, our host.

Our road log is written to enter the railroad right of way at the end of the land north of tracks and west of Rt. 183, for a run of two and a half miles. This is by courtesy of the Pennsylvania Railroad. Our sequence of events may be rearranged to fit train schedules.

Gravel pit, southeast, across outwash floor of Sandy Creek valley, in Illinoian kame terrace (G. White)

Thin patch of Illinoian till, west slope of north rim of cut. Redder soil for about 50 feet along rim. Very rotten granite boulder has weathered out of this patch. Two firm wind polished cobbles in Mount Union Geology Collection from base of this till. Southwest wind.

Stratigraphy in cut:
- #7 Upper Freeport coal remnants in grassroots
- Upper Freeport fresh water limestone high in bank, and a higher split of limestone in grassroots.
- Bolivar coal may be present in the clay shale section.
- Red clayey shale in upper bank (good local marker bed) (local stratigraphy of this part of section not well worked out).
- Upper Freeport sandstone (lower part of cut).
- #6a Lower Freeport coal probably about 15 ft. below rail.

DON'T BUNCH ON HIGHWAY!! — Wait, as you re-enter highway, until not more than two caravan cars are between you and railroad. Traffic from north is nearly blind (and frequently stupid) where you enter lane. Run on past lane and return at leisure if it seems safer.

Railroad track section from cut east of Route 183 through five cuts that we will see from tracks and a farther cut that we will approach by road takes us down through about 150 feet of section. We should stop something like five minutes in each cut to get out and look, but not take time to collect extensively or to climb. Those who want Upper Freeport limestone can

find chunks in south ditch of first cut west of 183. Lower Freeport limestone shows near west end of second cut west of 183, and there are chunks in ditch of third cut. You may find spirorbis type irregularly coiled worm tubules about the size of lower case letter O of this typewriter in either limestone. They are darker than the rock (usually), look like small bread rolls.

33.7 First Penn. RR. cut west of 183

High south wall of this cut contains full section of non-resistant beds seen at top of cut east of 183 but at higher elevation.

Full section of upper Freeport sandstone. Note channeling of base of this sandstone into underlying shales at west end of this cut. 6a coal either cut, or below rail.

34.0 Second cut west of 183

6a lower Freeport coal and lower Freeport limestone obvious a few feet above track level.

34.9 Third cut west of 183

6a coal and lower Freeport limestone about half way up the 90 foot wall. There is about as much clay between the limestone and the coal as there is below the limestone, but perspective foreshortens the slope above the limestone. See south wall for better perspective. Note that limestone is absent in east part of north wall.

Much of lower half of this cut corresponds to much of the section seen above the 6 coal in Alliance. Note scarcity of sandstone here.

35.5 Fourth cut west of 183

6a coal and limestone have been found a few feet above north rim of this cut.

We are almost down to the #6, middle Kittanning coal.

35.7 Strip mine on right is for #6 coal, not far from rail level.

You may wonder about the upper Kittanning coal. Three miles northwest of here it may be present as a gray streak near the base of the clayey shale a few feet below the lower Freeport limestone.

36.3 Leave tracks (or enter a dead end)

Look ahead just before you leave. Typical weathered shale slope for section above 6 coal.

Turn right, west, or road at end of lane.

36.7 Turn right, north, Baird Ave.

37.0 Park tight, east shoulder. We'll put a flagman out to pass traffic around parked cars.

STOP #7 — Lunch and Geology in any order

Time 12:30 to 1:30 if on schedule, or longer if you find you want to stay here longer. This schedule should put us at our last stop before 3:30, and that would be good.

Railroad cut under bridge shows #6 middle Kittanning coal, and a typical shaley section above it. The siderite concretions in this shale are sufficiently characteristic and frequent to make an auxiliary stratigraphic index for location on incomplete and weathered exposures. Some of these concretions contain veinlets of dark sphalerite.

A few brachiopods have been found in north wall of RR. cut, near projecting sandy ledges.

Strip mine north of tracks reaches down to #5 lower Kittanning coal.

Pit south across pasture and west-bound Pleasant Valley Road has yielded a few brachiopods a few feet above the #6 coal.

For a year or more, Alliance Clay Products blended a truckload of shale from this southern pit with about four truckloads of shale from the corresponding section in their large pit in Alliance. They wished to blend their somewhat sandy short-haul shale with a clayier shale, to control manufacturing characteristics, and got the modulating material from the same stratigraphic position but a different location.

Pasture west of parked cars has been test drilled for coal. It's mostly glacial drift, hence remains pasture.

Turn around, just north of bridge or elsewhere with caution.

37.4 Turn west, right, on Freed Road, *second* westbound road south of tracks, *NOT* Pleasant Valley Road seen from tracks.

38.3 *Cautiously* cross Paris Ave. on hill. Freed Road bends southwest beyond this crossing, then south, becomes Freedmont.

39.4 U.S. 30, turn right, west.
6a lower Freeport coal and limestone low in first cut west.

40.2 Robertsville east limit
#5 coal near creek level in north edge of Robertsville. Continue through Robertsville.

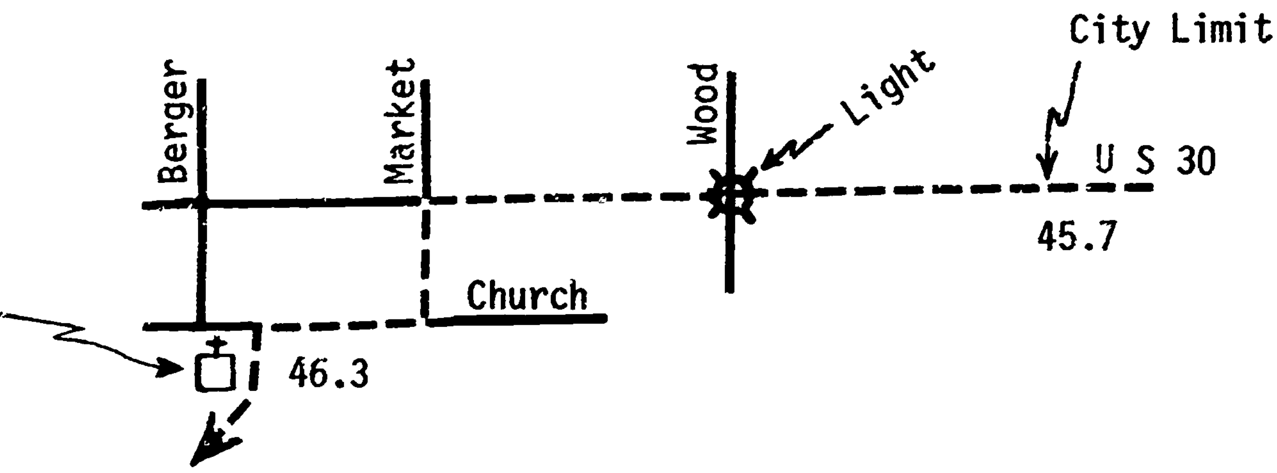
Approaching East Canton (Osnaburg before World War I) Numerous large pits for clays under #5 and #6 coals. Distribution of pits is confusing because the section dips eastward irregularly and locally just east of East Canton, almost as steeply as the grade on U.S. 30 as you climb to the city limits.

Prepare for a left, south, offset of one block, followed by a left turn on an obscure road; all in about six blocks from East Canton city limits. *Do not turn right, north, with either U.S. 30 or Ohio 44. Go straight.*

Left on Market
Right on Church
Left on Berger
before

White frame
church building

St. Paul's
Church of Christ



Southwest on narrow, winding Berger Road

47.3 Stop. End Berger at east-west Orchard View Drive. Cross Orchard View into pit road, follow leader. Routing in this pit depends on condition of burning dump, and wind. Estimated one mile round trip in pit.

STOP #8 — #6 coal m. Kittanning—upper bench
5a coal Strassburg—dark streak in wall
5 coal l. Kittanning—lower bench

Strassburg coal ranges from zero thickness to a little over a foot in this cluster of pits, and from poor to good quality. In a few places its horizon is represented by scattered sideritic concretions too big to lift. It has not been satisfactorily identified more than a few miles to the east, but a slightly ferruginous zone in the Alliance area might correspond to it. (dubious correlation)

Thick underclay and clayey shale section below #6 and down through clay under #5 is basis of glazed tile industry.

A rather similar ceramic base is obtained north of here, near Akron-Canton airport, from lower clays associated with the Mercer coals.

West from here the section which you see rises from low in the hills to the hilltops southwest of Canton, and the Putnam Hill limestone can actually be found near the foot of the hill in Waco, three miles west of here, about 130 feet below the #5 coal.

48.3 Leave Stop #8. Mileage from pit entrance at Berger and Orchard View. Stay on blacktop, right at first fork and left at second fork going west on Orchard View.

48.3 Leaving Stop #8, west on Orchard View Drive (repeated direction) (for page turning)

Flat lowlands are Nimishillen Creek drainage (s. from Canton).

50.8 Enter Waco
You are close to level of Putnam Hill Limestone. 5 and 6 coals and clays in excavations a hundred feet or more up the hills.

51.2 Traffic light, Waynesburg Drive. *Turn left, south.*

51.6 . Curve half left, southeast. Watch for right turn in 0.3 mile.

51.9 *Millerton Street — Sharp Right Turn* — we'll try to flag this one.

West on Millerton, 1.5 miles, to its end at Central Ave.

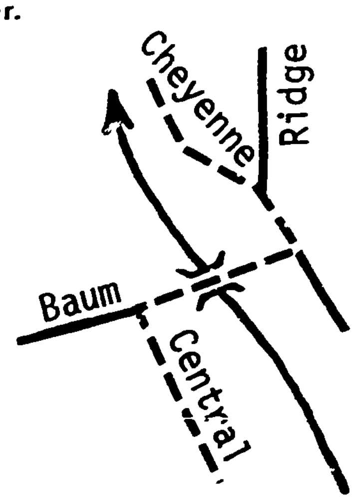
To your right, north, lowland of downtown Canton is obvious. Much of the landscape you are on is shaped to drain into that basin, i.e. northward. In that lowland the three branches of Nimishillen Creek join, making the main stream which flows south from Canton through the large valley which becomes obvious ahead as you approach the end of Millerton.

This is glacially reversed drainage, from older northword drainage. There is a large body of glacial and fluvio-glacial material involved here, including much outwash in the Canton lowland and south along Nimishillen Creek, for miles.

53.5 End Millerton at Central Avenue (and Hebrew Cemetery)
Turn left, south, obliquely down east slope Nimishillen Creek valley.

You are looking down stream, but up the pre-glacial valley form which narrows from here to the cut through the old divide between North Industry and Howenstine.

As you approach North Industry you will see various pits, which are for the most part below the Putnam Hill limestone. We are coming down section toward the Mercer limestones (and Lamb's Howenstine limestone) which are not far from stream level in the narrows ahead, but involve a lot of bushwhacking to find and decipher.



55.2 Stop sign, crossroad, continue

55.9 Stop, end Central, *Turn Right* maneuver as sketched through North Industry.

56.8 Bridge back to east side of creek.

57.4 Type Howenstine in woods at left (Lamb) Almost impossible to find.

58.5 Howenstine Drive. Cross it, enter Route 8 ahead, *with care*, and continue south on Route 8.

We have come out of the North Industry - Howenstine narrows through the pre-glacial divide, entered the broad outwash plain of Sandy Creek which you looked over before lunch. It drains westward to the Tuscarawas.

62 approx. East Sparta, continue on Route 8

67 approx. Mineral City, north limits. SHARP TURN RIGHT.

Traffic flow may sweep you on into town. OK. Double back at leisure. It's obvious.

Right turn, northwest, up hill, on older narrow highway replaced by the broad highway on which you have come. Stop where old road crosses deep rail cut, enter cut with caution (steep slopes, poison ivy), and look around.

STOP #8 — Mineral City Railroad cut

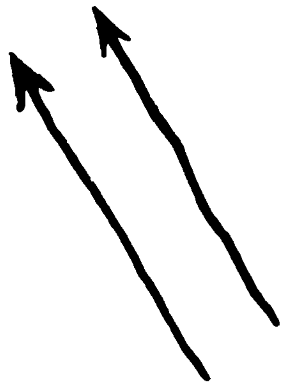
Top of cut is probably Mahoning ss, low Conemaugh. Below it, most of the section from #7 coal, high Allegheny, down through #6 coal (perhaps 5 in sod at east end, north side).

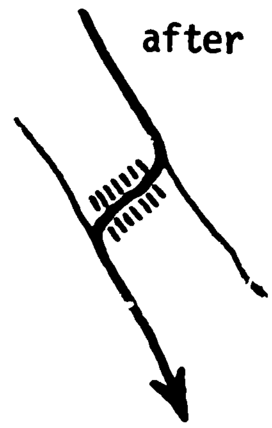
We find this cut interesting, will be happy to hear discussion.

This is probably a local phenomenon rather than regional? Section is relatively conventional not far away.

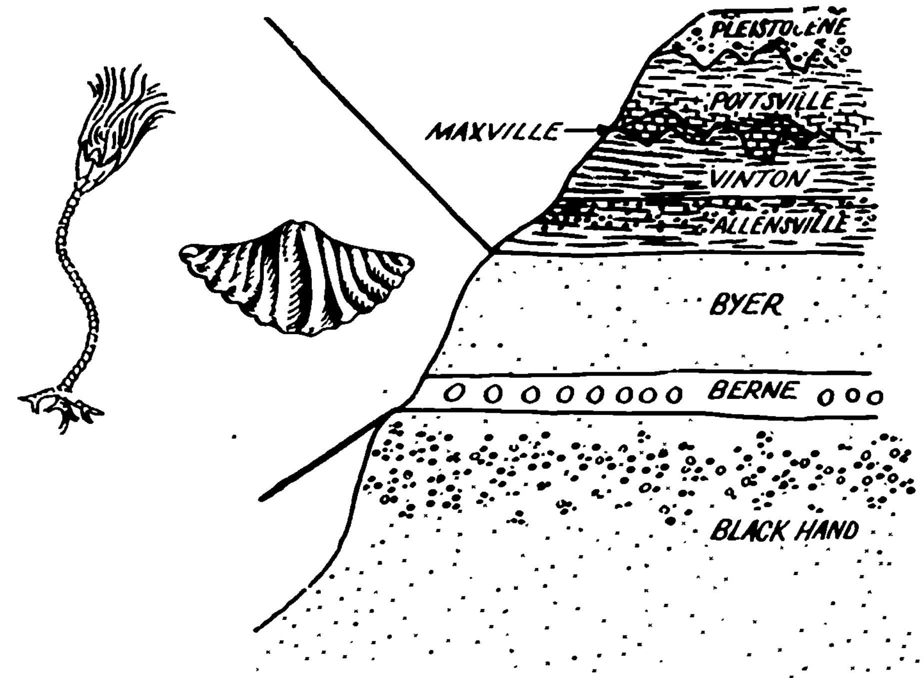
GOOD LUCK! THANKS FOR COMING!

For those headed south through Dover, or south to Dover to pick up U.S. 250 northwest toward Wooster. Near Zoarville, about two miles beyond Mineral City, you meet the Tuscarawas coming from the northwest, in a broad open valley which widens up stream. From Zoarville to Dover it cuts southwest in a narrow gorge through the pre-glacial ridge between the broad valley which it leaves, into another similar, nearly parallel broad valley which also widens northwest.





19th ANNUAL OHIO INTERCOLLEGIATE GEOLOGY FIELD CONFERENCE



OCTOBER 12, 1968

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C. L. Herrick Geology Society
Denison University
Granville, Ohio

The C. L. Herrick Geological Society of Denison University takes great pleasure in welcoming you to the Nineteenth Annual Ohio Intercollegiate Geology Field Conference. We hope that you enjoy your day as much as we have enjoyed arranging today's activities.

Your hosts include:

L. Edward Silcox, Jr. —President —Editor
F. Herbert Swan, III —Vice President —Editor
Beth Ann Wilson —Secretary

Peter Allen
Larry Behrens
Jeff Carskadden
Bob Hand
Tom Hartzell
Doug Johnston
Joan Kuechle
Bob Lyon

George Ramsayer
Bob Rice
Linda Slater
Tom Starr
Dave Trull
Gordon Whitney
Jim Wilson

Special thanks go to our professors who have devoted a great deal of time and energy in helping us arrange this field conference.

Dr. Charles Graham —Chairman

Dr. Kennard Bork

Mr. Michael Katzman

Dr. Richard Mahard (on leave)

Mrs. Marion Poules —Secretary

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GEOLOGIC SETTING

James Wilson ('69) and George Ramsayer ('69)

Granville, located in the south-central portion of Ohio, is situated approximately ten miles east of the western border of the Appalachian Plateau. A conspicuous escarpment or cuesta marks the Appalachian Plateau boundary. The till plain topography of the Central Lowlands to the west and the hilly terrain of the plateau to the east are easily recognizable.

The rocks of this general area are a part of the eastern limb of the Cincinnati Arch, a large, gentle upwarping structural feature which passes through Cincinnati and extends northward into Ontario and southward into Kentucky and Tennessee.

The gentle uparching of the beds and the extensive subsequent erosion have removed much of the younger deposits, so that older Paleozoic deposits are exposed along the axis of the arch while progressively younger beds are exposed both to the east and west of the arch. In the general Granville-Newark area, north-south bands of Mississippian and Pennsylvanian age rocks are exposed, while Permian age rocks crop out in southeastern Ohio and older Devonian, Silurian, and Ordovician rocks crop out westward.

The Granville-Newark area is underlain by Mississippian and Pennsylvanian age sandstones interbedded with some less resistant shales and siltstones. The major formations which will be observed on the field trip include the Cuyahoga Formation and the Logan Formation, both of Mississippian age. In general, the upper part of the Cuyahoga Formation consists primarily of sandstones and conglomerates, while the lower portion is dominantly composed of siltstones and shales. An important part of the field trip will be to recognize the facies change of the Black Hand Member of the Cuyahoga Formation. West of Granville the Black Hand is chiefly shale but contains thin siltstone layers. At the Dugway, siltstones predominate, and at Black Hand Gorge (east of Newark) the rocks are chiefly sandstone and conglomerate. This succession of deposits of the Black Hand Member indicates that the source was probably a series of deltas or lobes to the southeast.

The Loç Formation, which lies above the Cuyahoga, is divided into four members. The basal Berne Member is a marine conglomerate, and is distinguished from the underlying Black Hand Member of the Cuyahoga by a greater abundance of pebbles, increasing coarseness, darker color, and poorer cementation. Above the Berne lies the Byer Member, which is a fine-grained sandstone and siltstone. The younger Allensville Member lies above the Byer and is dominantly composed of yellow and reddish-yellow coarse-grained sandstones, along with some siltstones and shales. The uppermost member of the Logan Formation is the Vinton Member, which is composed primarily of siltstone and shale with some fine-grained sandstone. A channeled erosion surface marks the contact of the Vinton and the Pottsville series of the Pennsylvanian system.

The regional dip of the area is very gentle (approximately 30 feet per mile) and in a southeast direction. A succession of less resistant rocks (the siltstones and shales of the Lower Cuyahoga) are exposed to the west because of the slight southeastward dip. Extensive weathering, mass wasting, and erosion had reduced this belt of less resistant rocks to a broad lowland during pre-glacial time. West of Granville the escarpment boundary of the Appalachian Plateau Province rises up above the lowland, and is generally composed of sandstone hills.

During the glacial periods, ice sheets moved down from the north and sometimes covered the high resistant sandstone. When the ice melted, a thin layer of till was present on top of the sandstone escarpment, but thick till deposits covered the lowland to the west. Running water from the melting ice sheets formed streams in some of the larger valleys of the area and laid down large amounts of silt, sand, and gravel in the valleys. To the west of the Appalachian Plateau escarpment topography is controlled chiefly by glaciation, but to the east the topography is primarily controlled by bedrock.

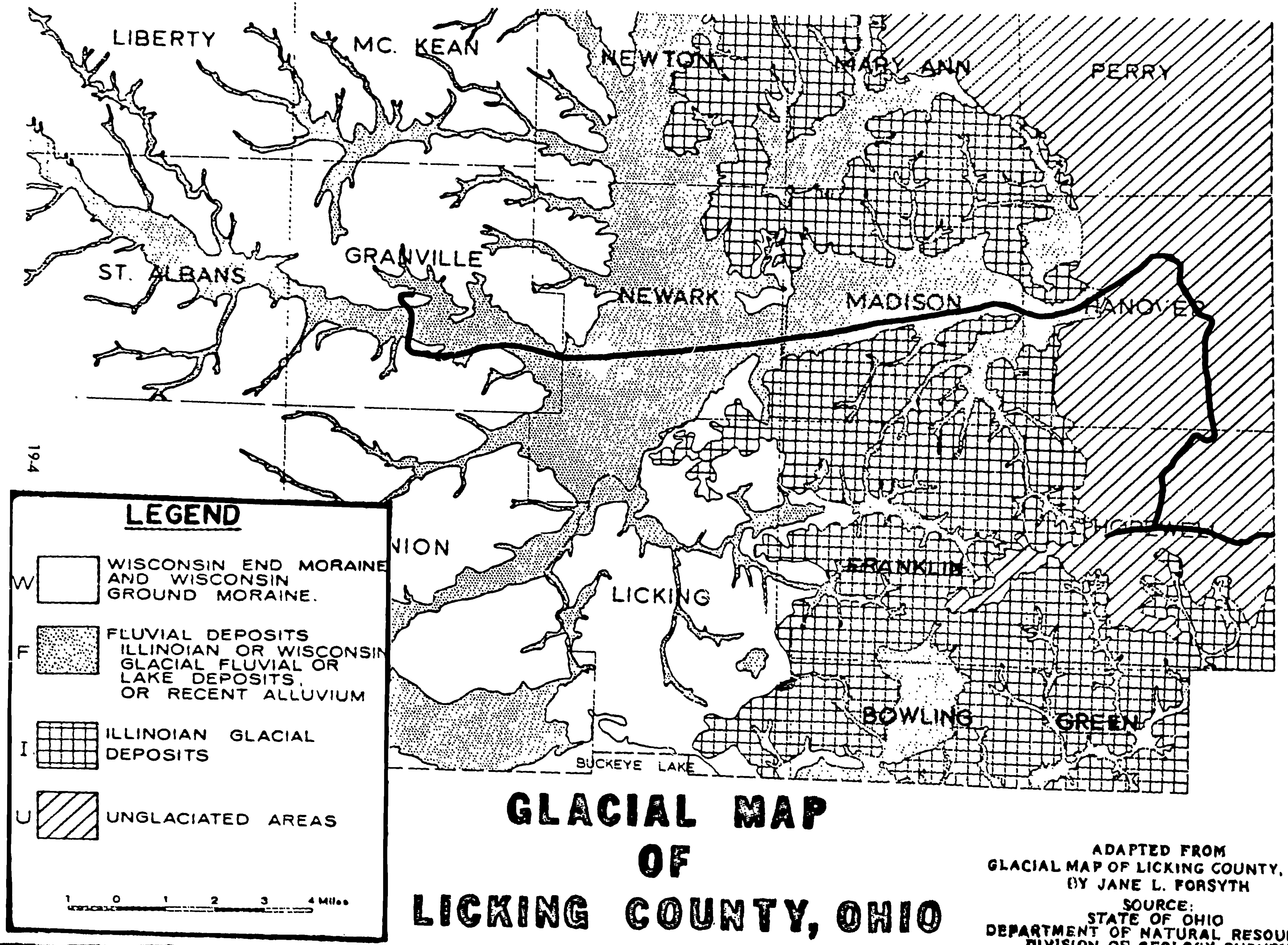
Since the Granville area lies within the eastern margin of the glaciated area, the stream systems follow patterns which were greatly affected by the deposits of the successive ice sheets, and as a result, many streams follow extremely winding courses through valleys. Maturely dissected plateau areas and also flat-lying valleys underlain by glacial deposits are present in the Granville-Newark area.

ROAD LOG

Denison University to Poverty Run

Mileage

Increments	Cumulative	
	0.0	Start from Physical Education Center at Denison University. TURN left up the hill on to Washington Drive.
0.5		College Hill is composed of the Cuyahoga and Logan Formations. Many of the early buildings on the campus were built of Byer Sandstone Member of the Logan Formation from quarries on and near the campus.
	0.5	Stop sign. TURN left on North Road.
0.1		
	0.6	Stop sign. TURN right under tunnel and proceed down President's Drive.
0.3		
	0.9	Stop street at entrance to college. Continue south on North Main Street.
0.05		
	0.95	Stop light at West Broadway. Continue straight ahead.
0.25		We are now descending a series of gravel terraces cut into the gravel fill of the Raccoon Creek. Wells drilled in the flat valley floor have penetrated more than 200 feet of valley train deposits of silt, sand, and gravel with isolated lenses of till before bedrock is reached.
	1.2	R.R. tracks.
0.2		
	1.4	Bridge over Raccoon Creek. Prepare to turn left to go east on State Route 16 bypass.
0.25		The large road cut at 1 o'clock on the bypass is composed of Cuyahoga sand and siltstone with the Berne Conglomerate Member of the Logan Formation discernible near the top.
	1.65	TURN left (east) on State Route 16.



GLACIAL MAP OF LICKING COUNTY, OHIO

ADAPTED FROM
GLACIAL MAP OF LICKING COUNTY, OHIO
BY JANE L. FORSYTH
SOURCE:
STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY SURVEY

The topography between Granville and Newark is characterized by a sharp contrast between a maturely dissected plateau of considerable scenic beauty but of dubious agricultural potential, and striking valley flats underlain by deep glacial drift deposits. The valley flats have been the site of excellent farms and at present Newark's industrial growth is aided by suitable terrain for industry and low cost housing. Ground water occurs in relatively abundant amounts in the gravels filling the deep buried valleys. The level of the water table is reflected by the level of Lake Hudson (an abandoned gravel pit) to the left.

1.15

2.8 Bridge over Raccoon Creek.

1.1

3.9 Traffic signal. Continue straight ahead.

0.4

4.3 Prepare to stop at road cut ahead.

0.4

4.7 STOP #1: Road cut in the Cuyahoga and Logan Formations on State Route 16 west of Newark. Student leader: Gordon Whitney ('69). Approximate time at stop for discussion and fossil collecting 30 minutes. See app. I in guidebook (p. 8).

The next stop will be at Black Hand Narrows (approximately 15 miles) where there are no rest room facilities. We suggest that people stop enroute at service stations, etc., within the next 2.5 miles. The caravan will move independently through Newark following the route indicated by the road log. We will reassemble at STOP #2 forty-five minutes from the last stop. Should you become confused pick up State Route 16 east out of Newark.

0.4

5.1 The road cut on the left is the location of "The Dugway." This was an old quarry and was frequently referred to in early literature on the Cuyahoga and Logan.

0.25

5.35 Continue east on Route 16 under "Granville Road" sign.

0.45

5.8 "Manor House" on left. Continue straight.

0.1

5.9 Highway Department Building on left. Continue straight.

0.05

5.95 Cross bridge over Raccoon Creek.

0.25

6.2 Traffic light at North 30th Street. Continue east on 16 (Church Street). Several hundred yards to the left obscured by houses are the famous "Octagon" and "Great Circle" Indian mounds. These mounds are believed to date back to 300 B.C.—400 A.D. and were part of the Hopewell Culture.

0.45

6.65 Traffic light at Newark Catholic High School and Wilson Junior High.

0.15

6.8 Traffic light at intersection with N. 21st Street, continue straight ahead.

0.3

7.1 Cross another bridge over Raccoon Creek.

0.4

7.5 Traffic light at N. 11th Street, continue straight on 16. (Church St.)

0.45

7.95 Traffic light at N. 6th Street, continue straight on 16. (Church St.)

0.15

8.1 Traffic light at N. 5th Street, continue straight on 16. (Church St.)

0.2

8.3 Stop light. Continue straight ahead. Prepare to turn left on North 2nd Street. (Follow the signs to State Route 16)

0.1

More than 300 feet of gravel lies beneath this portion of Newark.

8.4 TURN left on North 2nd Street. Follow the bypass on Route 16.

0.45

8.85 Buena Vista exit.

0.4

9.25 North Cedar Street exit.

0.9

10.15 O'Bannon Avenue exit.

0.9

We are now traveling eastward down the gravel filled valley of the Licking River towards Black Hand Narrows. The valley is extra wide because the pre-glacial Cambridge River occupied this portion of the present valley. This westward flowing river joined the Groveport River and was a major tributary of the Teays River system. (See app. VI, p. 18)

11.05 Dayton Road exit.

1.2

12.25 Blinker light at intersection of Route 16 and Licking County 585. Continue straight ahead on Route 16

2.1

14.35 Low divide off at 11 o'clock is location of the valley of the pre-glacial Cambridge River.

0.1

14.45 Intersection of Licking County 668.

0.9

15.35 Exposure of Black Hand sandstone on left.

0.2

15.55 Bypass ends and additional exposures of Black Hand sandstone on left. There were formerly primitive pictographs of bird tracks and a hand at this exposure. These pictures dated from 1200-1700 A.D. but were vandalized and largely destroyed last summer. The name of the "Black Hand" Member is derived from similar pictographs found along the Licking River.

0.3

15.85 Low notch in the skyline at 2 o'clock is where the Licking River flows through Black Hand Gorge.

0.3

16.15 The oil wells in this vicinity with the drilling framework still standing are mostly shallow Berea (Mississippian-Kinderhookian) wells of low production. The wells with the modern pumping jacks are usually "Clinton" wells and are approximately 3000 feet deep. "Clinton" is the driller's term for what we recognize as Albion Group of the Silurian-Alexandrian Series.

1.1

17.25 Bowerston Shale Company on left. The old quarry is on the right where sandy shales of the Vinton and some glacial drift formed the raw material for their tile and bricks. In the past decade they have been trucking shales and sandstones of Pennsylvanian age from an area north of Frazeysburg to the east. The bridge to the left crosses over a massive section of Black Hand exposed in the railroad cut.

0.3

WATCH FOR RIGHT TURN!

17.55 TURN right on to State Route 146.

1.0

18.55 TURN right towards Toboso on Licking County 273.

0.8

The upland to the right lies beyond the boundary of the Illinoian ice sheet and is unglaciated. There are remnants of outwash lying in the valleys.

19.35 Cut where new oil pipeline crosses the highway and valley. Lacustrine deposits were exposed in the cut.

0.25

19.60 Oil well with walking beam pump on left. Probably a Berea well.

0.25

19.85 Intersection of Hanover Twp. 275 on the right. Continue to bear left.

0.05

19.90 Black Hand sandstone outcrops on the left.

0.15

20.05 One-way iron bridge. TURN right immediately after the bridge.

0.15		
	20.20	STOP #2: Black Hand Gorge and lunch stop. Follow lead car and instructions of flagmen for parking. Those who have brought their own lunches take them with you. Student leader: Bert Swan ('69). Approximate time at stop 2 hours. See app. II in guidebook (p. 10).
		Leave Black Hand Gorge. Take sharp right TURN on Licking County 278 to the right of Toboso Elementary School.
0.3		
	20.50	R.R. tracks.
0.7		
	21.20	Intersection of Hanover Twp. 280 on the right. Continue straight ahead.
0.6		Traveling south on Licking Co. 278. We are now traveling on unglaciated terrain chiefly of Mississippian age with a few of the higher hills capped by Pennsylvanian Pottsville.
	21.80	Intersection of Hanover Twp. 281 on the left. Continue straight ahead.
1.0		
	22.80	We are dropping down into the valley of the Brusy Fork Creek which contains a few Wisconsin lacustrine deposits as well as the usual alluvium.
0.3		
	23.10	Stop sign. TURN right on to Licking Co. 277.
		Traveling on alluvial valley.
0.2		
		WATCH FOR LEFT TURN!
	23.30	TURN sharp left on to Hopewell Twp. 291.
0.15		
	23.45	One-way bridge over Brushy Fork Creek.
1.45		We are again on unglaciated terrain of Mississippian age. The Mississippian-Pennsylvanian boundary is crossed several times between here and our next stop but is difficult to discern because it is chiefly a contact between shales and sandstones of the Lower Pennsylvanian Group and rocks of similar lithologies of the Logan Formation. The Maxville Limestone is missing over most of this area.
	24.90	Bridge.
0.15		
	25.05	Cable crossing. This is the main telephone cable between New York and San Francisco. Its path approximates the 40th parallel.
0.05		
	25.10	TURN right on to Licking Co. 312.
0.25		Now on Pennsylvanian sediments.
	25.35	Pennsylvanian fossils can be found in the shales and siltstones of the low road cut on both sides of the road.
0.8		
	26.15	STOP #3: Flint Ridge State Memorial Prehistoric Indian Quarry. Follow the lead car and the instructions of the flagmen for parking. Student leader: Jeff Carskadden ('69). Approximate time at the stop 45 minutes. See app. III in guidebook.
0.2 (parking)		
	26.35	Leave Flint Ridge State Memorial via Licking Co. 312.
1.15		Traveling east over unglaciated terrain.
	27.50	Intersection of Licking Co. 312 and Hopewell Twp. 291. Continue straight ahead (east).
1.25		
	28.75	"Y" intersection. Take left fork (i.e. straight ahead). Continue on Licking Co. 312.
0.3		
	29.05	Intersection of Licking Co. 278 and Hopewell Twp. 312. Proceed straight ahead on Hopewell 312. The road bears right after the intersection.
0.4		
	29.45	TURN left onto Hopewell Twp. 278.

0.3		
	29.75	Sharp left hand TURN.
0.2		
	29.95	Sharp right hand TURN.
0.75		
	30.70	Mt. Olive E.U.B. Church on the right.
0.45		
	31.15	Intersection of Hopewell Twp. 122, Muskingum Co. 412 and Muskingum Co. 8. Continue straight ahead on Muskingum Co. 8.
1.0		
	32.15	Intersection. Continue straight ahead.
0.3		
	32.45	TURN left at sign "Macedonia Evangelican United Bretheran Church."
1.0		
	33.45	Bear right at "Y" intersection.
0.4		
	33.85	Cross small iron bridge.
0.3		
	34.15	Intersection. Continue straight ahead.
0.45		
	34.60	Blocks of limestone on the hill to the right.
0.1		
	34.70	TURN right on paved road.
0.2		
	34.90	Intersection. Continue straight ahead.
0.6		
	35.50	Entrance to STOP #4: Quarry in the Maxville Limestone at Poverty Run. Follow the lead car and the instructions of the flagmen for parking. Student leader: Beth Wilson. See app. IV in guidebook, (p. 14).
END		

GOOD-BY! THANKS FOR COMING! COME AGAIN SOON!

DRIVE CAREFULLY!

To reach I-70 continue south up the hill for approximately 2.4 miles to Mount Sterling (Hopewell P.O.). Turn right to go west, or left to go east, on this access road to U.S. Route 40 (I-70).

Appendix I

NEWARK ROAD CUT

Gordon Whitney ('69)

At this location Ohio Route 16 cuts through a well-exposed section of the Waverly Group. The first exposed section from the top is the Byer Member of the Logan Formation. This massive, yellowish-tan, fossiliferous sandstone of rather uniform appearance forms a resistant ledge over the more friable Berne Member. The exposed section of the underlying Berne is composed of a corase to medium grained, orange-tan, fossiliferous conglomeratic sandstone. The thin (approximately 9 inch) conglomeratic zone of pebbles embedded in a sandy matrix at the base of the member is the identifying lithologic characteristic of the Berne.

While it may not be an entirely valid conclusion, there is some evidence which indicates that the sharply defined contact between the Berne Conglomerate and the underlying Cuyahoga Formation represents a disconformity (Swick, 1956, p. 31). Although the remainder of the section, composed of the Cuyahoga Formation, could be characterized as the Black Hand Member because of sand content, the dominant lithology of the exposed strata is in marked contrast to that of the type section of the Black Hand. Hyde (1915, p. 23) has referred to these alternating beds of gray shales and brown siltstones and sandstones as the Granville Shale Facies of the Cuyahoga Formation as opposed to the more conglomeratic facies occurring in the Black Hand Narrows farther east.

Fossils are confined almost entirely to the Berne and Byer Members and good specimens are readily available in the talus debris. The community can generally be characterized by an abundance of brachio-

pods (especially rhipidomellids and productids), crinoids, and pelecypods. Cephalopods, fenestrate ectoprocts (bryozoans), gastropods, and trilobites also occur, although in rather reduced numbers. The disaggregated nature of the fossil assemblage, more commonly classified as a "fossil hash," possibly is the result of a high energy environment acting upon a thanatocoenosic community (i.e. a fossil assemblage brought together after death). In addition, the rare occurrence of fossil plants lends support to the idea of a near shore environment of deposition.

The following list of species may be of assistance to those interested in more detailed information:

Brachiopods:
- *Rhynchopora persinuata*
- *Avonia concentrica*
- *Spirifera striatiformis*
- *Syringothyris carteri*
- *Syringothyris bedfordensis*
- *Schellweinella* sp.
- *Buxtonia scabricula*
- *Schuchertella sciotoensis*
- *Athyris* sp.
- *Terebratula* sp.
- *Lingula meeki*
- Rhynchonellids
- Camaroteochids
- Productids
- Rhipidomellids

Pelecypods:
- *Aviculopecten winchelli*
- *Aviculopectin* sp.
- *Allorisma subcylinricum*
- *Allorisma winchelli*
- *Grammysia* sp.
- *Palaeoneilo* sp.
- *Prothyris tenuiradiata*
- *Prothyris* sp.

Gastropods:
- *Hormotoma* sp.

Cephalopods:
- *Michelinoceras* sp.
- *Prolecanites* sp.

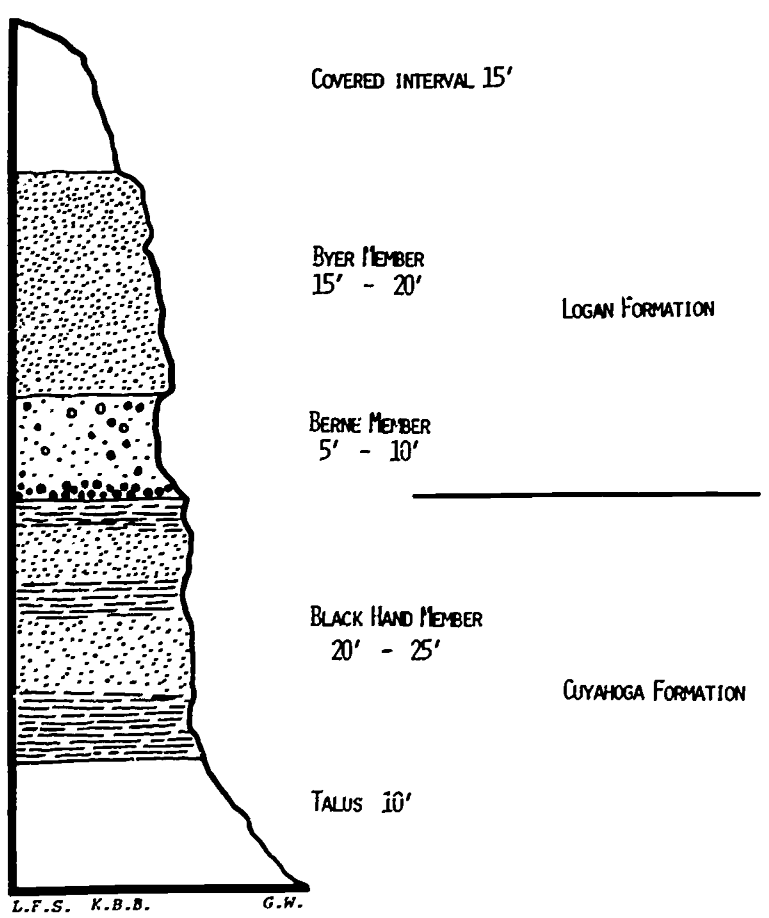
fenestrate ectoprocts

crinoids

trilobites

appendix I

Newark Road Cut



BLACK HAND NARROWS

(Adapted from Franklin, 1961, pp. 104-117)

Bert Swan ('69)

The Licking River has cut a narrow east-west gorge, Black Hand Narrows, about three miles long across Hanover Township between Hanover and Toboso. The Black Hand is exposed in this gorge better than anywhere else in the county. Excavations for the old Everett glass-sand quarry at the east end, an abandoned canal, the abandoned Ohio Electric Railroad, and the Baltimore and Ohio Railroad have improved the exposures in the Narrows area. A recent relocation of the Baltimore and Ohio has provided a series of new cuts between Toboso and Hanover. The black hand, from which the Narrows takes its name, was a pictograph once observed at the east end of the gorge, but long since has been destroyed.

The Black Hand in the Narrows is characteristically a tan and yellow, medium- to coarse-grained, cross-bedded, pebbly sandstone. In some places beds of conglomerate and lenses of clay and shale occur. Conglomerate beds and shale lenses are particularly well exposed in the new railroad cuts near the west end of the Narrows.

Areal Extent

The beds of the Black Hand Member can be traced westward intermittently along the Licking River and Raccoon Creek as far as Granville. At the Dugway (near Stop #1) and at the bypass roadcut south of Granville, the beds are composed of interbedded shale, siltstone, and fine-grained sandstone. Some beds are still coarse enough to be classed as part of the Black Hand Member. Between Black Hand Narrows and Granville the distinctive Berne Member of the Logan Formation serves as a key bed, and the Black Hand beneath the Berne can be observed to become finer to the westward in the intervening distance. A mile or so west of Granville the change of grain size within the Member continues but outcrops of layers immediately beneath the Berne are not observable. In southwestern McKean Township along Cat Run about four and one-half miles north-northwest of Granville, the beds immediately beneath the Berne member are so fine that they can no longer be classed as Black Hand.

South of Newark the lower 30 feet or so of exposure is too fine to be called Black Hand, as is the lowermost part of the Dugway exposure. Beyond Granville to the west, older fine-grained beds of the Cuyahoga formation come to the surface.

Going northward from Black Hand Narrows, the Black Hand becomes finer but is still a sandstone in the vicinity of the northern boundary of Licking County.

Composition

At the type locality the predominant constituent of the Black Hand is clear white quartz grains, one-half to one millimeter in diameter. These are rounded to angular and some of them show prismatic faces indicating secondary crystallization. An occasional flake of white mica may be observed. Within the sand matrix quartz pebbles, usually one-half inch in longest dimension, are grouped in layers often one pebble thick. Crombie (1952, p. 21) reports pebbles up to one and one-half inches in diameter and adds rose and gray quartzite and minor amounts of small gray and black chert pebbles to the pebble lithology.

The Black Hand is so nearly pure quartz in places that it was formerly quarried, for glass-making, south of the Licking River about three-quarters of a mile southwest of Toboso.

The washed sand showed the following minerals in the order of their abundance: quartz, orthoclase, plagioclase, microcline, tourmaline, limonite, sericite, kaolinite, magnetite, chlorite, rutile, zircon, monazite.

Color

Generally the color of the Black Hand at the surface is yellow, tan, or buff which is probably produced by weathering. Limonite gives the rock its characteristic color. In places exposed surfaces become dirty gray or black. Locally the color varies from almost pure white to brilliant reds and purples with marked changes of color occurring within distances of a few feet. The color changes have no regular pattern, bear no relationship to bedding, and cut across bedding surfaces and disconformities indiscriminately. Gray is probably the unweathered color. This color is commonly indicated in well logs but some logs record yellow, white, and brown colors suggesting that weathering may have occurred to depths of a few hundred feet.

Bedding

Bedding appears to be of three types: true or original bedding which is taken as a reflection of the attitude of the beds with respect to a horizontal plane at the time of their deposition, surfaces expressing disconformities, and cross beds. Beds vary from thin to thick. In some parts of the member the sandstone is quite massive with beds from one to several feet thick.

Original or true bedding planes are shown by occasional ripples on the surface or by thin partings of clay shale. Within the top six to 15 feet of the member these planes are horizontal or nearly horizontal but below this they dip at angles generally varying from ten to 15 degrees.

Within the mass are irregular surfaces which appear to have resulted from subaqueous erosion by currents which removed some of the sand before depositing other sand. Some of these surfaces may be traced for several tens of yards. On a particular surface cross beds appear to dip in all directions, an opinion concurred in by Hyde (1915, p. 19) but dissented from by Crombie (1952, p. 19) who states that cross beds generally strike northeast and dip from almost horizontal to 30 degrees to the northwest.

Some surfaces show well-developed honeycomb pitting and fluting which appear to be related to bedding.

Fossils

No evidence of fossils has been found in the coarser-grained Black Hand of the Narrows, but fossils have been reported in finer-grained facies elsewhere.

Environment of Deposition (Ver Steeg, 1947, pp. 726-727)

The Black Hand Member varies so much in composition within short distances that it is difficult to trace. When traced horizontally from the conglomerate masses, the beds thin abruptly, contain more shale, and the sandstones are finer-grained and do not exhibit strong cross-bedding and evidence of scouring action. The conditions under which the Black Hand Member accumulated were variable; such as those that prevail along a shore line where finer muds and sands are deposited in lagoons or quiet deeper waters offshore, or in beaches, bars, or deltas where stronger currents prevail.

The facies are so distributed as to indicate that thick elongate masses of sandstone and conglomerate extend in a slightly west of north direction. They are marine, and the dip of the true bedding planes (3-15°) suggests deposition in shallow water by rather strong currents with scouring action. All the evidence indicates that the currents come from the south.

It is probable that the Black Hand Member was laid down in a shallow interior sea, in which beaches, bars, and deltas were developed. The presence of quartz pebbles from half an inch to as much as 2 inches in length in the conglomeratic facies, although not fatal to the delta theory, is not in harmony with observations which appear to indicate that finer sediments usually prevail in deltas.

The quartz pebbles are well-rounded suggesting that they have been reworked several times. They were probably carried by waves and currents from their original site which was to the north or northeast and later reworked and shifted westward to produce bars, spits, beaches, and deltas. What appears to be a bar or offshore beach was built on the west side of the area.

The variable thickness and irregular contour of the top of the Black Hand Member suggest an unconformity with the Berne conglomerate Member at the base of the Logan Formation.

The Black Hand Member originally covered a larger area; a great part of the Waverly series was removed by erosion at the close of the Mississippian period.

The Origin of Black Hand Narrows — Jeff Carskadden ('69)

An early theory concerning the origin of the Narrows was proposed by Leverett (Mather, 1908, pp. 175-176). His theory stated that as the ice retreated westward from the Hanover area a lake was formed between the ice front and the Hanover dam. The rising waters of this lake breached a low divide in the hills south of the dam and carved Black Hand Gorge.

In a later work, however, Mather has shown that a lobe of ice was located in the valley east of Claylick, just west of the present Narrows, and that ice front channels, having elevations of as low as 775 feet, were draining through the Narrows to the east (Mather, 1908, p. 177). At the present time the Licking River is flowing on bedrock at an altitude of about 760 feet through the Narrows. The Narrows obviously represent a divide that has been cut down, but Mather argues that much of this cutting was prior to the arrival of the ice sheet in the area. His evidence is the valley of a small tributary stream entering the Licking from the south, between the ice front and the Narrows, which shows no accumulation of outwash or lacustrine deposits, which would have existed had the Licking, and hence the tributary, been ponded between the ice front and a divide at Black Hand. Other tributary streams, entering Licking valley from the south, but west of the maximum extent of the ice, show evidence of ponding (Mather, 1908, pp. 175-187). At least a partial deepening of the Narrows by the overflow of the ponded waters would seem logical, though pre-Illinoian stream capture may have been responsible for much of the down cutting in the area of the gorge.

FLINT RIDGE

Stratigraphy

Vanport Limestone is an important member of the Allegheny series, outcropping in numerous southeastern Ohio counties. The Vanport consists of two phases: a lower phase of marine limestones and shales, ranging from 5 to 20 feet in thickness, and an upper phase directly above the first consisting primarily of marine limestone and flint and averaging from 1 to 10 feet in thickness (Stout, 1918, p. 154).

Often only one phase is present. However, in the Flint Ridge area, both phases are present, and the flint facies of the upper phase reaches its greatest thickness and areal extent. The flint outcrops along the top of Flint Ridge and numerous outlying spurs and ridges in Fairfield and Hopewell townships, Licking County, and Hopewell Township, Muskingum County. The average thickness of the flint in this area is about 6 feet.

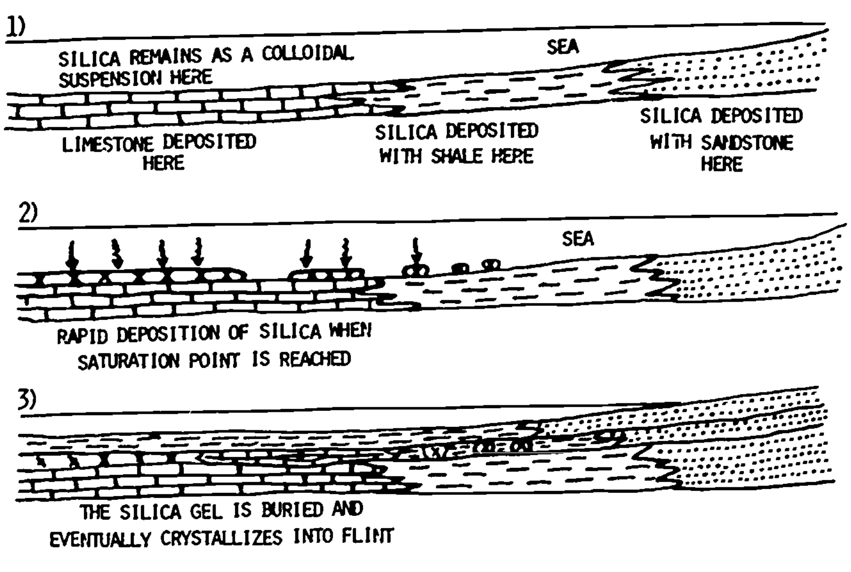
Origin of the Flint

Of the many theories concerning the origin of flint, replacement and direct deposition theories appear most often in geological literature.

a.) Replacement of limestone by silica occurs most commonly in diastrophic areas where silica-rich hydrothermal solutions are active. Hence it is unlikely that Vanport flint, or any of the Pennsylvanial flint in the Ohio area formed by replacement, with the exception of some minor lenses or nodules in which ordinary ground waters may have been responsible.

b.) Most of the recent writers on the subject see as plausable the direct deposition of silica on the sea floor. As calcium is being deposited on the floors of warm shallow seas, the silica carried to the sea by rivers, or derived from silica carried to the sea by rivers, or derived from silica secreting organisms, remains as a colloidal suspension in the sea water until a saturation point is reached. At this time the silica colloid rapidly coagulates on the sea floor as spherical masses or layers of gel. The deposit is buried and the gel eventually hardens into flint nodules or beds. (Tarr, 1926, p. 24, quoted in Stout and Schoenlaub, 1945, p. 12). Vanport flint reaches 98.9% silica in the Flint Ridge area (Stout and Schoenlaub, 1945, p. 82).

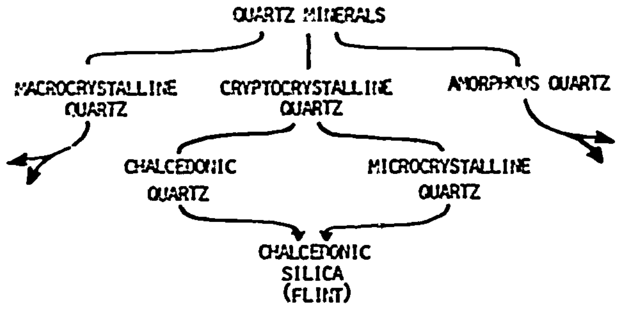
DIRECT DEPOSITION OF SILICA



Crystalline Structure of the Flint

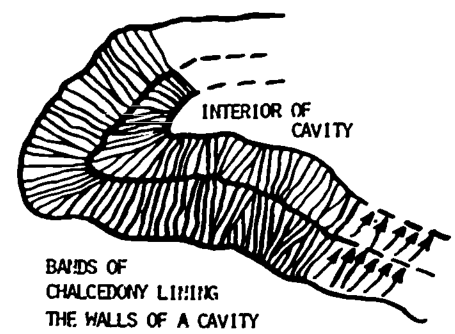
Before discussing the Vanport specifically, a brief explanation is in order concerning the classification of all quartz minerals according to crystalline structure.

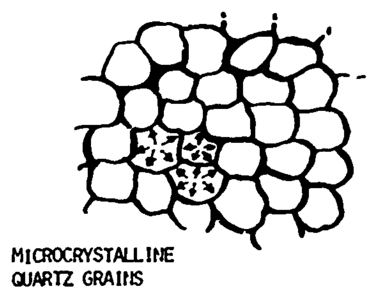
Quartz minerals can be divided into three broad categories: I) "Macrocrystalline" quartz, crystals visible without aid of a microscope; II) Cryptocrystalline quartz, composed of microscopic crystal forms; and III) Amorphous quartz such as glass. In dealing with flint the primary concern is with II) cryptocrystalline quartz. Cryptocrystalline quartz can be subdivided into 1) chalcedonic quartz, or chalcedony, composed of fibrous microstructures; and 2) microcrystalline, or granular quartz, composed of minute quartz grains (Folk and Weaver, 1952, pp. 498-510) (Pelto, 1956, p. 32). The relationships described above are best explained by the following chart.



The fibers of chalcedonic quartz average 1 or 2 microns in diameter and are often 100 to 200 microns in length. They form when crystallization begins at centers scattered along a surface, such as the lining of a cavity or gas bubble. Lateral growth is impeded by the growth of neighboring crystals, but growth outward from the cavity wall (i.e. inward toward the center of the cavity) is unhampered, and relatively long narrow fibers are formed (Folk and Weaver, 1952, p. 500, 507). Pure chalcedony occurs most commonly as cavity fillings in lavas, particularly in the western states (agates being the best example).

Microcrystalline quartz usually results from the crystalization of a silica gel. Crystallization begins at numerous centers spaced three-dimensionally throughout the gel. Crystal growth is impeded on all sides by the growth of neighboring cyrstals, resulting in a mass of interlocking polyhedral grains, often averaging about 4 microns in diameter (Folk and Weaver, 1952, p. 498, 500).





Varieties of quartz which are entirely microcrystalline are rare, and most microcrystalline quartz occurs together with some chalcedonic quartz. Cryptocrystalline quartz composed of both varieties is classified as 3) chalcedonic silica (Frondel, 1962, p. 195), of which flint is perhaps the best example.

From a limited study of Vanport flint using this section it can be tentatively concluded, as expected, that chalcedony occurs chiefly as vein and cavity fillings. Isolated bundles occur and may represent replaced fossils. However, the chief component of Vanport flint is granular microcrystalline quartz.

Archaeology of Flint Ridge

As early as 9,000 or 10,000 B.C. Indians of the Ohio Valley were utilizing the flint from the Flint Ridge area for their projectile points. However, the use of Vanport flint at this time was minor compared with that of the grey and black Upper Mercer flints of Coshocton County, Ohio. From the Paleo period through the Archaic the use of Vanport flint increased. However, it was probably not until the beginning of the moundbuilding era (1,000 B.C.) that fairly extensive quarrying operations were begun on the ridge. The vast majority of flint artifacts from Adena and Hopewell burial mounds and village sites are made from Flint Ridge Flint. Exotic raw materials played an extremely significant role in the religious aspects of the Moundbuilders' cultures, especially Late Adena and Hopewell, and the Indians were greatly attracted to the colorful flint from Flint Ridge. Not only religious items, but also many utilitarian tools were made from this material. Most of the pits on the Ridge, including those in the park area, probably date from Late Adena and Hopewell times (500 B.C. —A.D. 500).

By the beginning of the Late Woodland period the Hopewell culture had declined, and the use of exotic raw materials with it. During the Late Woodland and subsequent periods the vast majority of flint tools in Ohio were made from local flints, gathered from outwash deposits or local outcrops. Though some use of flint from Flint Ridge continued, it was never again to be exploited by the aborigines to the extent that it had been during the Early and Middle Woodland periods.

ARCHAEOLOGICAL PERIODS FOR THE OHIO VALLEY

PERIODS	CULTURES	
		10,000B.C.
PALEO		
		5,000B.C.
ARCHAIC		
		1,000B.C.
EARLY WOODLAND	ADENA	
		300B.C.
MIDDLE WOODLAND	HOPEWELL	
		600A.D.
LATE WOODLAND		
		1,100A.D.
LATE PREHISTORIC		

Economic Resources of Flint Ridge

To early settlers in the Ridge area the porous quality of the flint on the eastern and western ends of Flint Ridge provided excellent material for buhr-stones used in flour mills. In the early part of the nineteenth century flint from Flint Ridge was quarried and the buhr stones were used in mills in many parts of the Ohio Valley (Mills, 1921, p. 176). Early residents of the Ridge area also made gunflints from Vanport flint. However, the flints were evidently of poor quality for this purpose, since the gunflints were only used locally. (Europe was the main supplier of gunflints for the North American settlers.) The flint as well as the limestone from the lower phase of the Vanport member in the Ridge area were used in the past for local road construction and in cement (Stout, 1918, p. 160).

A PALEO-INDIAN FLUTED POINT (8,000B.C.) FROM OHIO, A MINORITY OF THESE WERE MADE OF FLINT RIDGE FLINT

A LATE ADENA POINT, THE VAST MAJORITY OF THESE ARE MADE OF FLINT FROM FLINT RIDGE

Appendix IV

GENERAL DISCUSSION OF MAXVILLE

Beth Ann Wilson ('69)

The Maxville Formation lies between the Waverly Group and the basal Pennsylvanian, but its distribution is patchy. A large time gap between the youngest Waverly and the Maxville, together with the presence of many small limestone pebbles of unknown source in the Maxville would indicate some pre-Maxvillian erosion of the Waverly. The patchy distribution of the Maxville is due to both deposition in topographic lows in the erosional surface of the Waverly and to post-depositional erosion of the Maxville. Proof is offered by the occurrence of the limestone on several hilltops of the pre-Pennsylvanian erosional surface and its absence in adjoining pre-Pennsylvanian valleys. Also the presence of fossiliferous limestone fragments in the basal beds of the Coal Measures shows evidence of erosion. (Hyde, 1953, p. 59).

However, it can be shown that the Maxville was not continuous over the entire southern Licking and northwestern Perry counties by the absence of the Maxville in areas of minimal pre-Pennsylvanian erosion and its occurrence for miles eastward along Jonathan Creek (including Poverty Run) where erosion would have been more intense. (Hyde, 1953, p. 59).

In various areas there are evidences that the Maxville was subject to erosion from time to time during its deposition. At Limeville, Kentucky, beds of limestone conglomerate appear in otherwise compact and irregularly bedded non-fossiliferous limestone. These conglomerates and occasional bedding planes characterized by jagged cracks extending into the body of the bed indicate that the water of the depositional environment was dried or drained from the area at varying intervals. (Hyde, 1953, p. 59).

Also present in the limestone are considerable amounts of coarse quartz sand as isolated grains in the body of the rock. These grains are white, rounded, and etched, and are up to one mm. in diameter suggesting wind blown dune sands in the vicinity of the limestone deposition. However, the sand's presence is not conclusively indicative of a semi-arid climate. (Hyde, 1953, p. 59).

Work done on the Maxville by James Scatterday at Ohio State University suggests that the Maxville be classified as a group covering a much greater period of time than was previously thought. The section (see page 16) includes several layers of dolomite, limestone, shaly limestone and shaly sandstone. These layers are proposed to be correlative with Chester, Ste. Genevieve, and St. Louis rocks of the Midwestern Mississippian System. However, Scatterday postulates that there is a sizeable unconformity within the group and that the Ste. Genevieve is missing entirely. Much of Scatterday's hypothesis is based on conodont evidence. (Dr. Graham, oral communications with Scatterday)

The Maxville has been economically important in the past for road construction, iron smelting, cement production, agricultural and chemical uses, and as a distinctive horizon, "Jingle Rock," in oil drilling.

The Maxville has been and still remains a problem in Ohio geology. Hopefully, work being done at the present by Dr. Alan Horowitz of Indiana University will help to solve the Maxville correlation problem.

Fauna of the Maxville
- *Productus cestriensis*
- *Seminula subquadrata*
- *Bellerophon sublaevis*
- *Zaphrentis cliffordana*
- *Nautilus pauper*
- *Dielasma turgida*
- *Allorisma maxvillensis*
- *Straporollus similis*
- *Spirifer keokuk*
- *Eumetria marcyi*
- *Fenestellids*
- *Rhombopora*
- *Trilobite* fragments

Morse, W. C., 1910, p. 107

Maxville formation
- Mississippian system
- 2 layers
  - Upper — buff dense, non-crystalline limestone, nearly non-fossiliferous, of unmeasured thickness
  - Lower — 5 feet of coarse, quartz sandstone with many small limestone pebbles from a source removed entirely by pre-Maxvillian erosion, irregular base ranging through 2 feet. At base stringers of sandstone one to three inches wide and at least one foot long penetrate downward into cracks in the underlying shales (Hyde, 1953, p. 132)

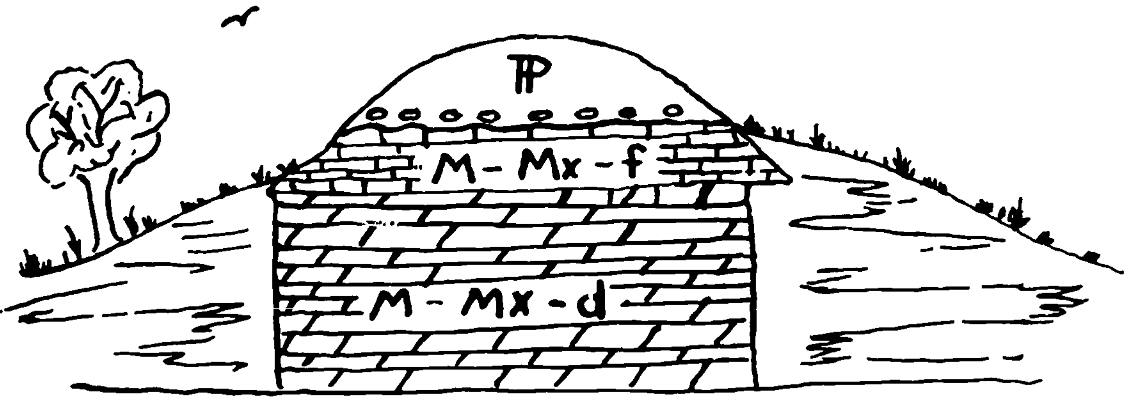
THE MAXVILLE AT THE POVERTY RUN QUARRY

Here the upper ten to fifteen feet of the Maxville are seen outcropping just below the Pennsylvanian beds. The main body of the quarry is dug into a layer of dolomitic limestone which weathers brown due to its high iron content. The contents of the quarry were probably used in road construction. One should

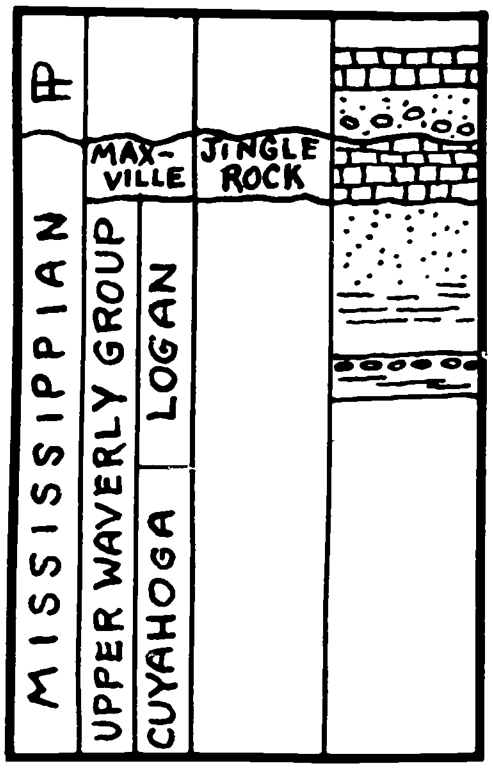
notice the travertine covering the joint surfaces of the large blocks of rock around the rim of the quarry. Carbonates readily available in the rock have been solutioned out and re-crystallized on these surfaces. (M-Mx-d)

Above the quarry are four feet of very fossiliferous limestone. On close examination the pebbly rubble becomes a mass of tiny brachiopods and gastropods which have weathered whole out of the rock. (M-Mx-f)

The brownish sandy rock topping off the section is six feet of basal Pennsylvanian rock.



DIAGRAMATIC CROSS-SECTION AT QUARRY

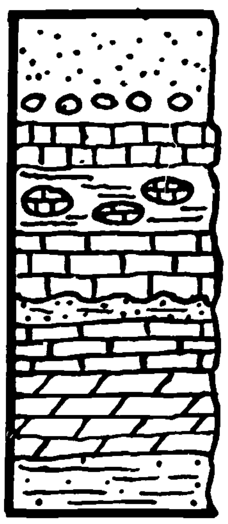


Conglomeratic Sandstone

Limestone

Vinton-Sandstone, grey, shaly

POSITION OF MAXVILLE IN THE REGIONAL GEOLOGIC COLUMN
(Geologic Map of Ohio)



COLUMN OF THE MAXVILLE* — James Scatterday (Personal communication with Dr. Graham)

Overlier: Pottsville — P

6 - Upper Jonathan Creek — Limestone, dense, grey 1 ft. 6 inches

5 - Middle Jonathan Creek — Shale, limestone nodules 4 ft.

4 - Lower Jonathan Creek — Limestone, grey, dense, weathers brown 4 ft.

3 - Sandstone, Shaly, green 6 inches

2 - Limestone 3 ft.

Dillon Falls

1 - Dolomite, shaly, grey 6 ft.

Base: Rushville — Blue grey soft clay shale with quartz sandgrains

GENERAL SECTION*

Chester	Blue Rock Formation Jonathan Creek
Ste. Genevieve	Missing - note disconformity between 3 and 4 above

St. Louis	Dillon Dam Formation
Burlington	Russville

*Not all of the following are formally recognized nomenclature.

Appendix V

MISSISSIPPIAN PALEOENVIRONMENT OF CENTRAL OHIO

Gordon Whitney ('69)

Ohio occupied a position on the stable craton during Mississippian times, but was influenced to a large degree by earlier tectonic developments to the east. Its shallow epeiric seas received clastics from the uplifted areas on the eastern border of the continent. Present day deposits in central Ohio indicate a near shore origin for the alternating layers of shale, sandstone, and conglomerate. Probably minor diastrophic changes during this time resulted in relatively rapid shifts of the shoreline, followed by variations in the nature of the sediment deposited.

Relationship to Stratigraphy

By the middle of the Mississippian Period, shales had given way to silts and fine sands which graded into conglomerates locally. In central Ohio these associated clastics formed near-shore submarine deltaic depsoits. Trending from the southwest to the northeast across Ohio, a series of deltas emptied into the Waverly Sea, depositing bands of coarse clastics interrupted by accumulations of mud and silt in basinal interlobate areas. Regionally this contrast is illustrated by the conglomeratic nature of the Toboso Conglomerate Facies (represented by the Black Hand Member) of the Cuyahoga Formation as compared to the finer nature of the Granville Shale Facies of the Cuyahoga Formation. (Hyde, 1953, p. 65 and Swick, 1956, p. 63). Thus the environment of deposition was largely influenced by an uplifted area directly to the southeast which constituted a source area of coarse clastic sediments. (Swick, 1956, p. 63)

"At the close of Cuyahoga time a recession of the sea locally exposed much of the unconsolidated Black Hand to erosion, as is indicated by a disconformity at the Black Hand-Berne contact at some sections in Licking County..." (Swick, 1956, p. 64). For those areas which were not exposed, a rather abrupt change in the depositional environment occurred. (Swick, 1956, p. 64). In any case the recession probably took place "at different times at different localities" (Swick, 1956, p. 64).

The beginning of Logan time was marked by an advance of the sea, which continued throughout Berne and probably most of Byer time. Much of the conglomerate of the Black Hand was either continuously or intermittently exposed. Streams and strong currents removed pebbles from the higher areas and deposited them in deeper water. (Swick, 1956, pp. 64-65). Again the Newark area formed a small inlet between two lobes of a delta. (Swick, 1956, p. 65). Generally the Berne was characterized by alternating quiet and troubled waters. During periods of relative inactivity, the finer clastics predominated; while during periods of storms, a slight recession of the sea, or the introduction of a new source, the percentage of conglomeratic material increased. (Swick, 1956, pp. 65-67).

By the time the Byer was deposited the source area had shifted considerably to the east. The small grain size of the Byer indicates the existence of a relatively quiet sea accompanying a low energy environment of deposition.

Pelecypods, crinoids, and brachiopods (including the productids) dominated the disturbed seas of the time. Not to be overlooked is the increased occurrence of plant fragments in near-shore marine deposits, indicative of the relative abundance of terrestrial plants during Mississippian times.

Unfortunately, Upper Mississippian rocks are not present in central Ohio. Thus while the sea may have covered Ohio during this time, erosion subsequently wiped out any changes recorded in the rock record.

EARLY DRAINAGE PATTERNS OF NEWARK AREA

Jeff Carskadden ('69)

In late Tertiary time, after several erosion cycles, the eastern Ohio area was finally reduced to the Lexington Peneplain. Prior to the first ice advance, the area was uplifted and the streams rejuvenated again, causing the dissection of the Lexington Peneplain and the formation of the Teays drainage system (Stout, 1938. pp. 10-11).

The chief river draining the eastern Ohio area after this rejuvenation was the Teays, which, after rising in the piedmont area of Virginia and North Carolina, entered Ohio near Portsmouth, and flowed north to Chillicothe and Circleville, then northwestward across the remaining portion of the state (Stout, 1938, p.14).

One of the tributaries to the Teays River, having its headwaters in the Muskingum County area, was the Cambridge River. Stout, Ver Steeg, and Lamb (1943, p. 65) suggest that the Cambridge River flowed south and southwest from Coshocton along a course later followed by the Deep-Stage Newark River through Trinway, Frazeysburg, Hanover, and Newark, where it entered the Groveport River, a major tributary to the Teays.

The Teays River was dammed in western Ohio by the Kansan or pre-Kansan ice sheet (Stout, et. al., 1943, p. 78) "with the result of flooding in the main valley and in those of all the larger tributaries. This was especially true of the streams in southern Ohio. Such valleys became long finger lakes. Eventually, through continued ponding, the waters broke over low divides or cols and established a new system of drainage...Soon after the new system of drainage was outlined regional uplift took place with consequent active cutting of stream beds..." (Stout, et. al., 1938, pp. 21-22). Concerning this new drainage cycle, or "Deep-Stage," Stout, Ver Steeg, and Lamb state: "Its main features are the development of many new streams, especially in the old Teays basin, the deepening of most channels below the preceding stream beds, the steep slope of the valley walls, the lack of reduction of the side streams, and the general immaturity of the basins." (Stout, et. al., 1943, p. 79).

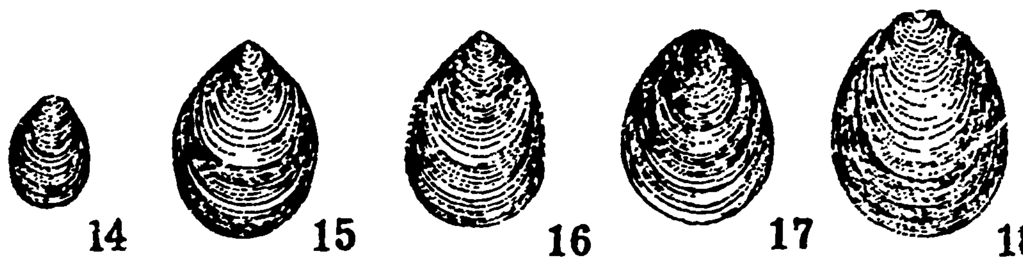
The chief stream draining the Ohio area during the Deep-Stage was the Cincinnati River, which cut the valley now occupied by the Ohio River from the area of the Pennsylvania-Ohio.boundary to as far west as Cincinnati, Ohio (Stout, et. al., 1943, map opposite p. 86).

One of the major tributaries to the Cincinnati River was the Newark River, which flowed in the valley of the older Teays Stage Cambridge River from West Lafayette, through Coshocton, Conesville, Frazeysburg, Newark, to Fairfield County. Here the Newark River left the old channel and flowed south along a course now followed by the Scioto River to Portsmouth where it joined the Cincinnati River. (Stout, et. al., 1943, map opposite p. 78).

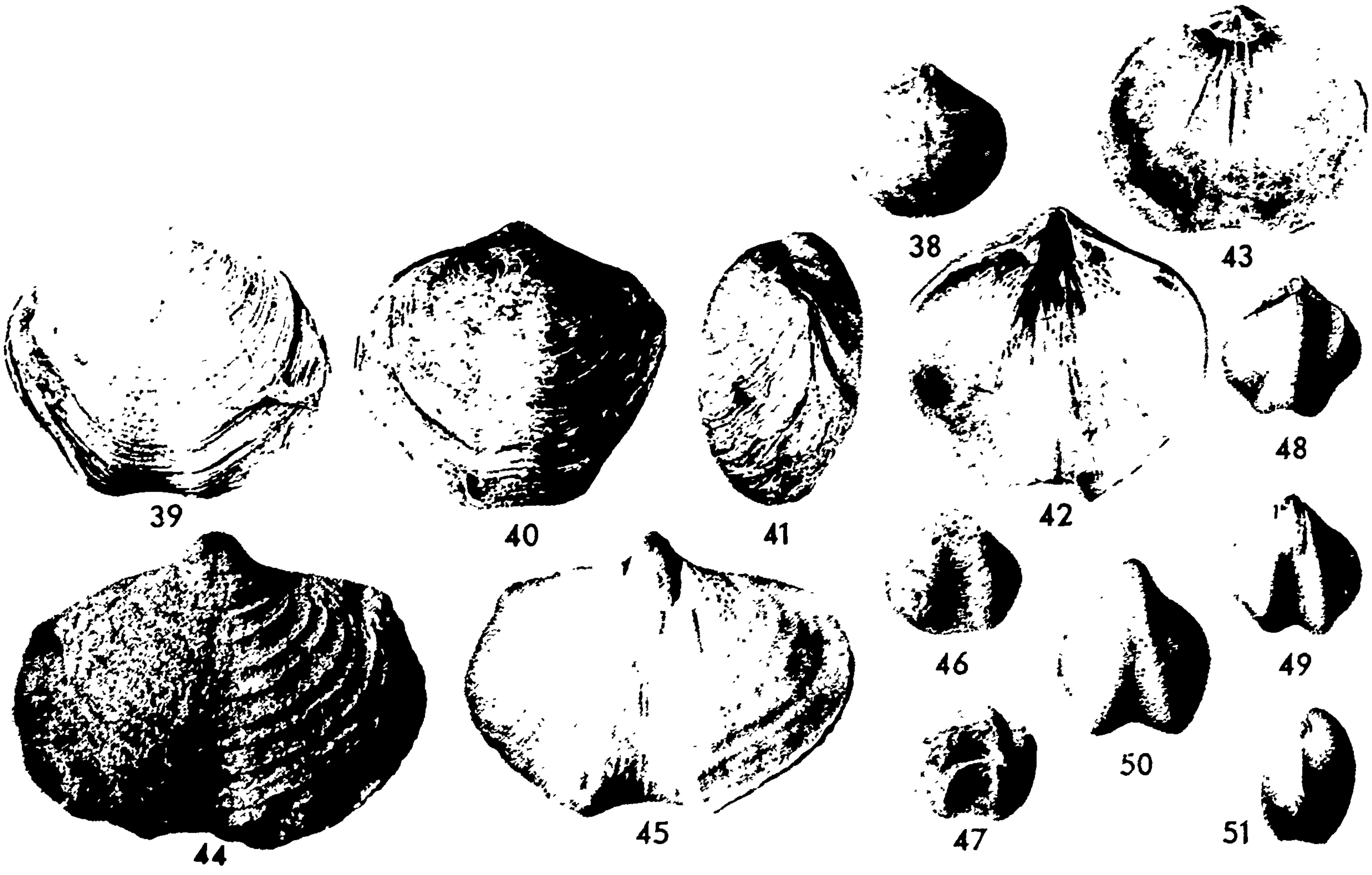
As the Illinoian ice sheet moved south, it dammed the Newark River in the vicinity of Hanover. Carney states that an ice tongue extended eastward from the main sheet up the old river valley (Cambridge-Deep State Newark) for about six miles (Carney, 1907, pp. 135 & 137). He adds that "the maximum position of this valley dependency is marked by typical morainic topography...with a contemporaneous deposition of drift against the side walls of the valley..." (Carney, 1907, p. 135).

To the east of the Hanover dam the Newark River and its tributaries were ponded. As the waters rose a col was breached near the Mudkingum-Morgan County line, resulting in the formation of the Muskingum River in its present course. (Stout and Lamb, 1938, p. 28).

PLATE I
Mississippian Brachiopods



Lingula meeki

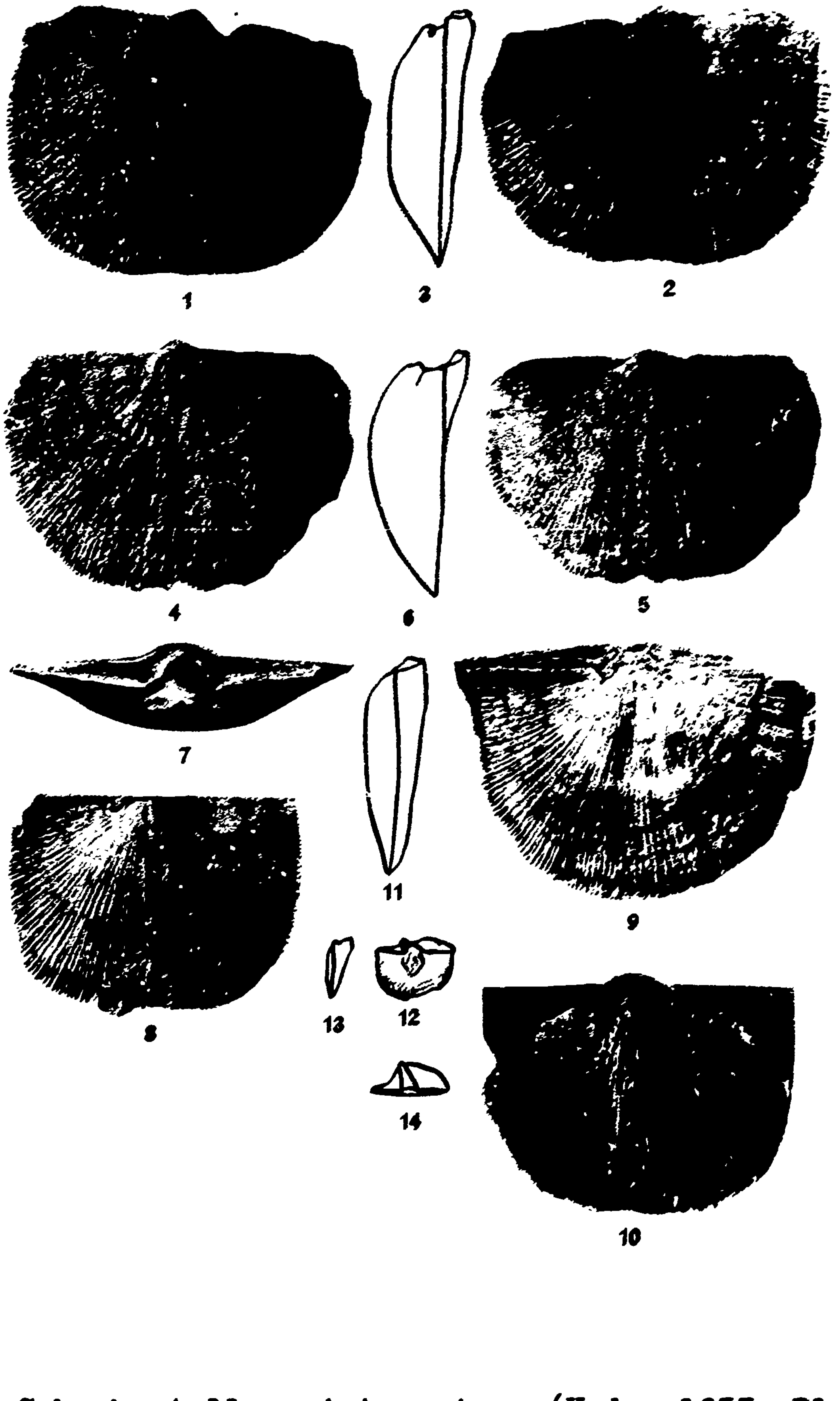


Athyris spp.

appendix VII

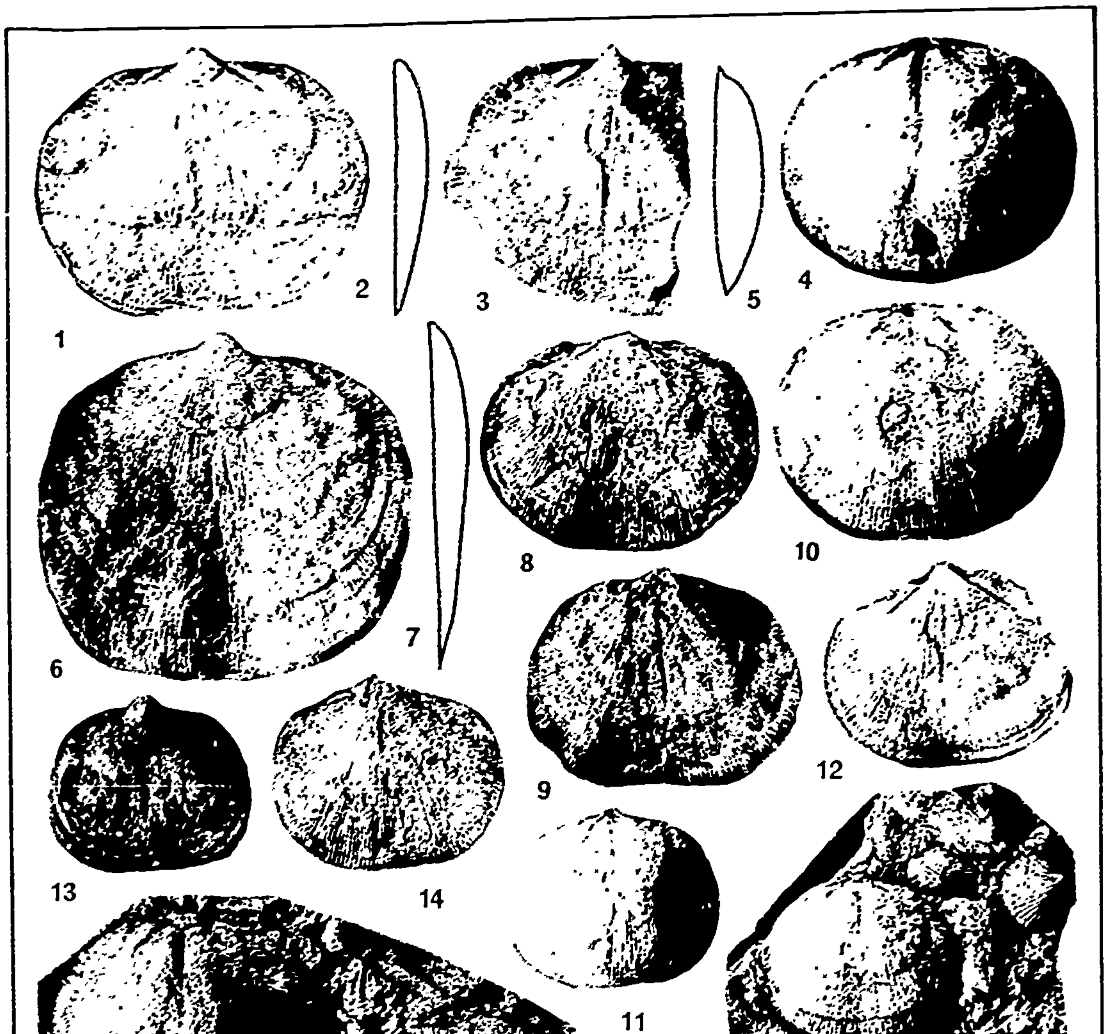
PLATE II

Mississippian Brachiopods Continued



<u>Schuchertella sciotpensis</u> (Hyde, 1953, Pl. 7)

PLATE III
Mississippian Brachiopods
Continued

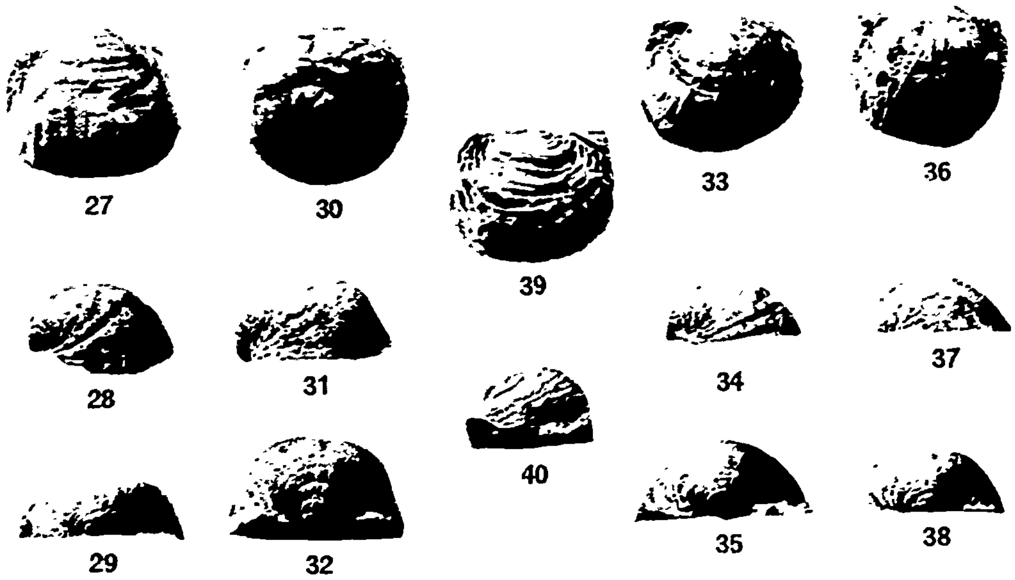


Rhipidomellids (Hyde, 1953, Pl. 6)

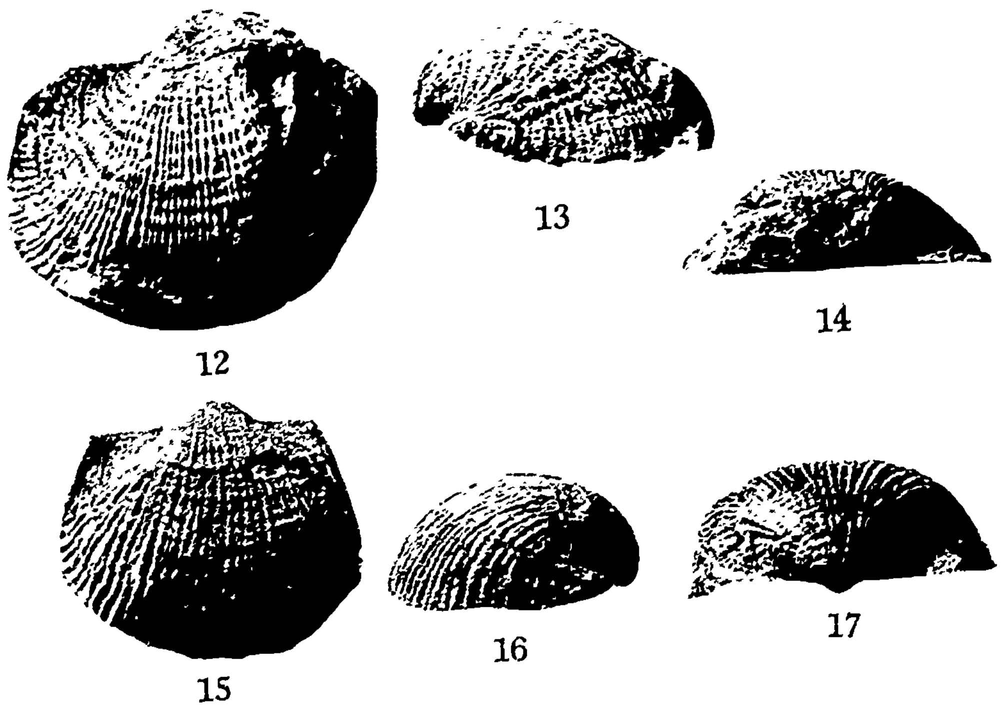
appendix VII

PLATE IV

Mississippian Brachiopods Continued

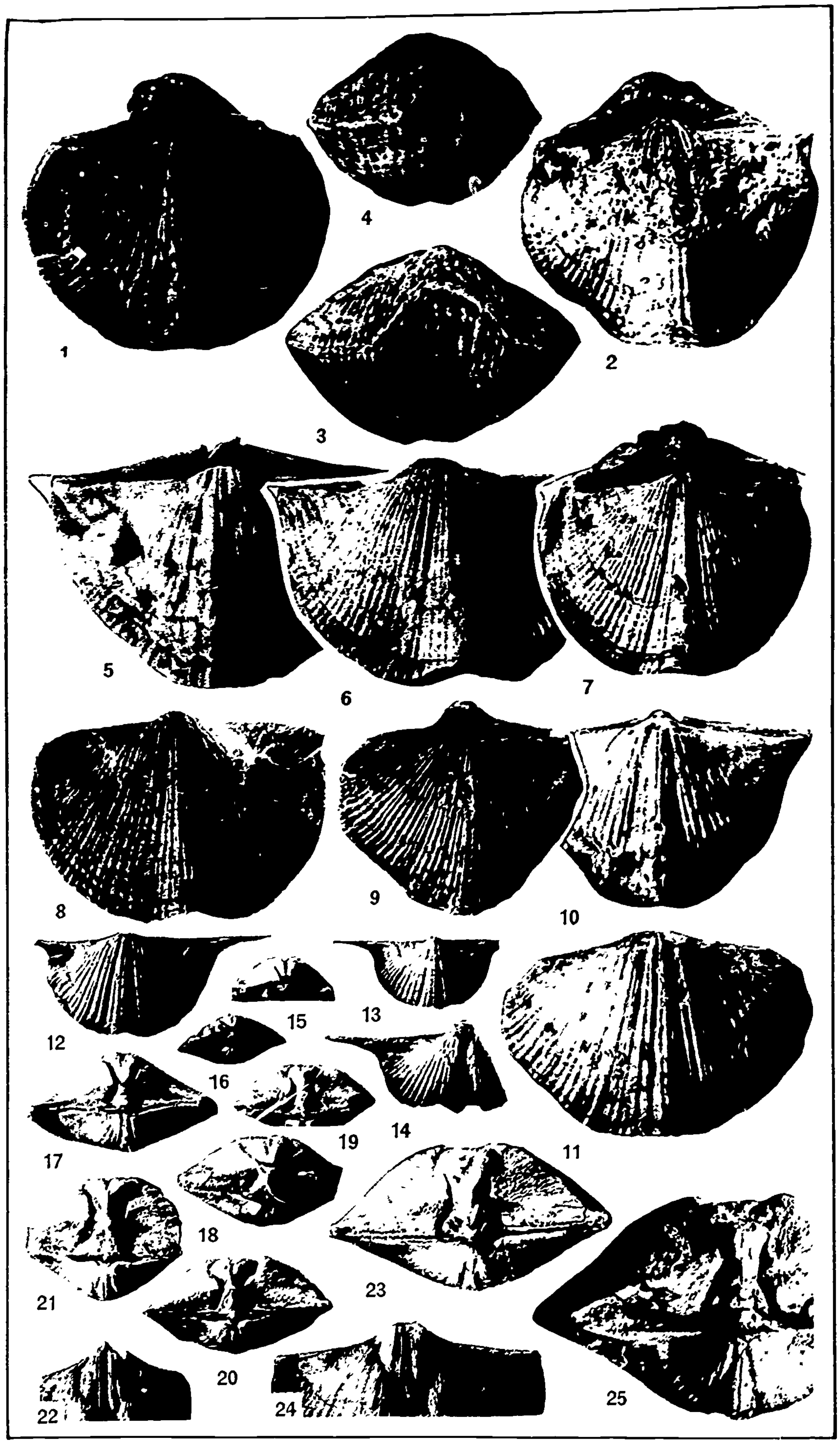


Avonia concentrica (Hyde, 1953, Pl. 9)



Buxtonia scabricula (Hyde, 1953, Pl. 15)

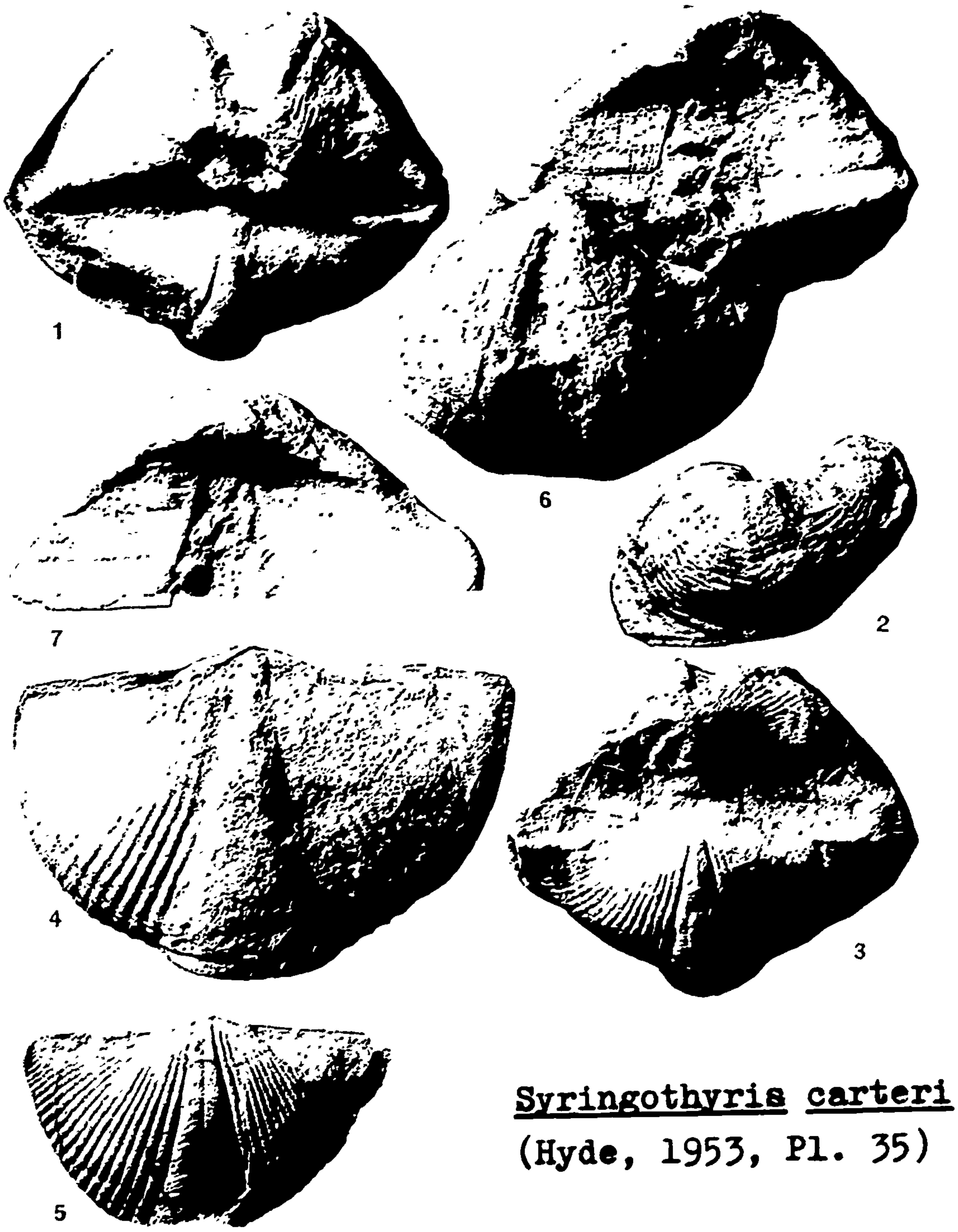
PLATE V
Mississippian Brachiopods Continued



Spirifer striatiformis (Hyde, 1953, Pl. 26)

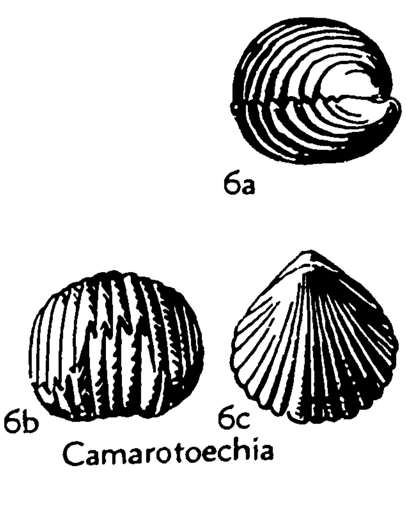
appendix VII

PLATE VI
Mississippian Brachiopods
Continued



<u>Syringothyris carteri</u>

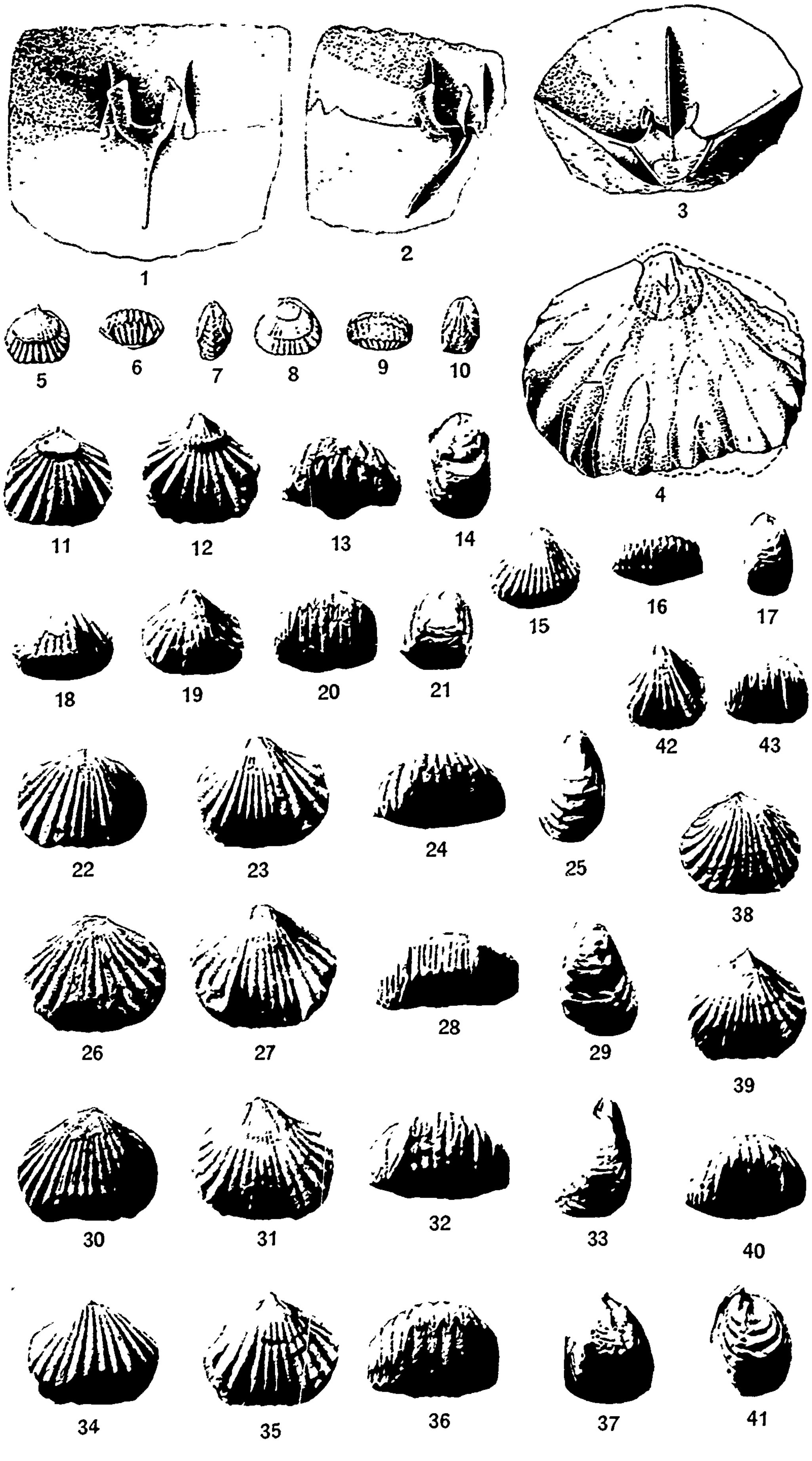
(Hyde, 1953, Pl. 35)



<u>Camarotoechids</u>

(Moore, et.al., 1952, p. 240)

PLATE VII
Mississippian Brachiopods Continued



Rhynchopora persinuata (Hyde, 1953, Pl. 18)

appendix VII

PLATE VIII
Mississippian Mollusca

Figures 1-3	*Prothyris tenuiraiata* (Hyde, 1953, Pl. 43)	Pelecypod
Figures 4- 6	*Allorisma subcylindricum* (Hyde, 1953, Pl. 44)	Pelecypod
Figures 7- 8	*Aviculopecten* spp. (schimmer & Shrock, 1944, Pl. 159)	Pelecypod
Figures 9-11	*Michelinoceras* sp. (Hyde, 1953, Pl. 49)	Cephalopod
Figure 12	*Hormotoma* (Moore, Laliker & Fischer, 1952, p. 295)	Gastropod
Figures 18-19	*Prolencanites* (Schimer & Shrock, 1944, Pl. 231)	Cephalopod

PLATE VIII

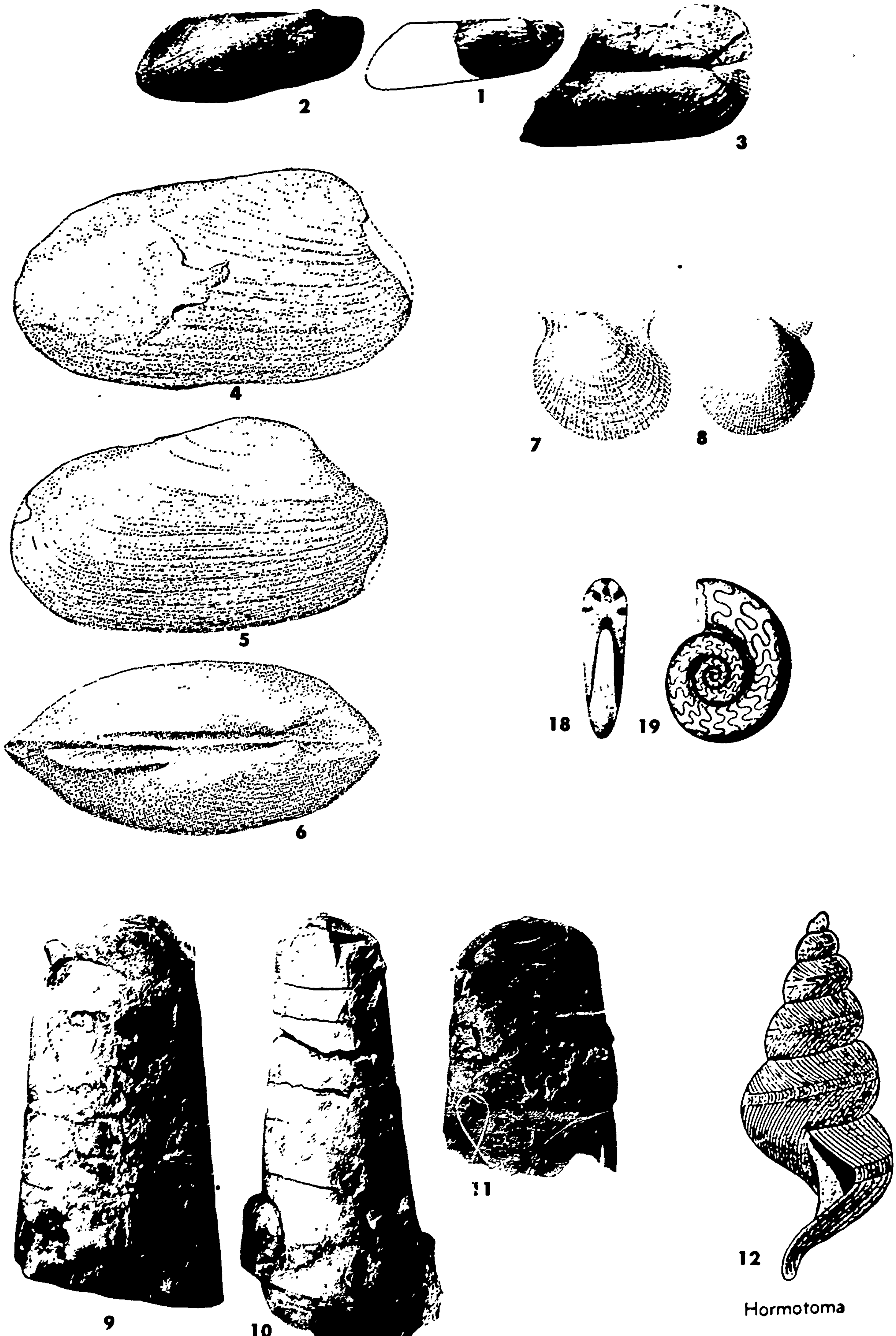


PLATE IX

Mississippian Mollusca
Continued

IX —a: *Palaeoneilo* spp. Pelecypod

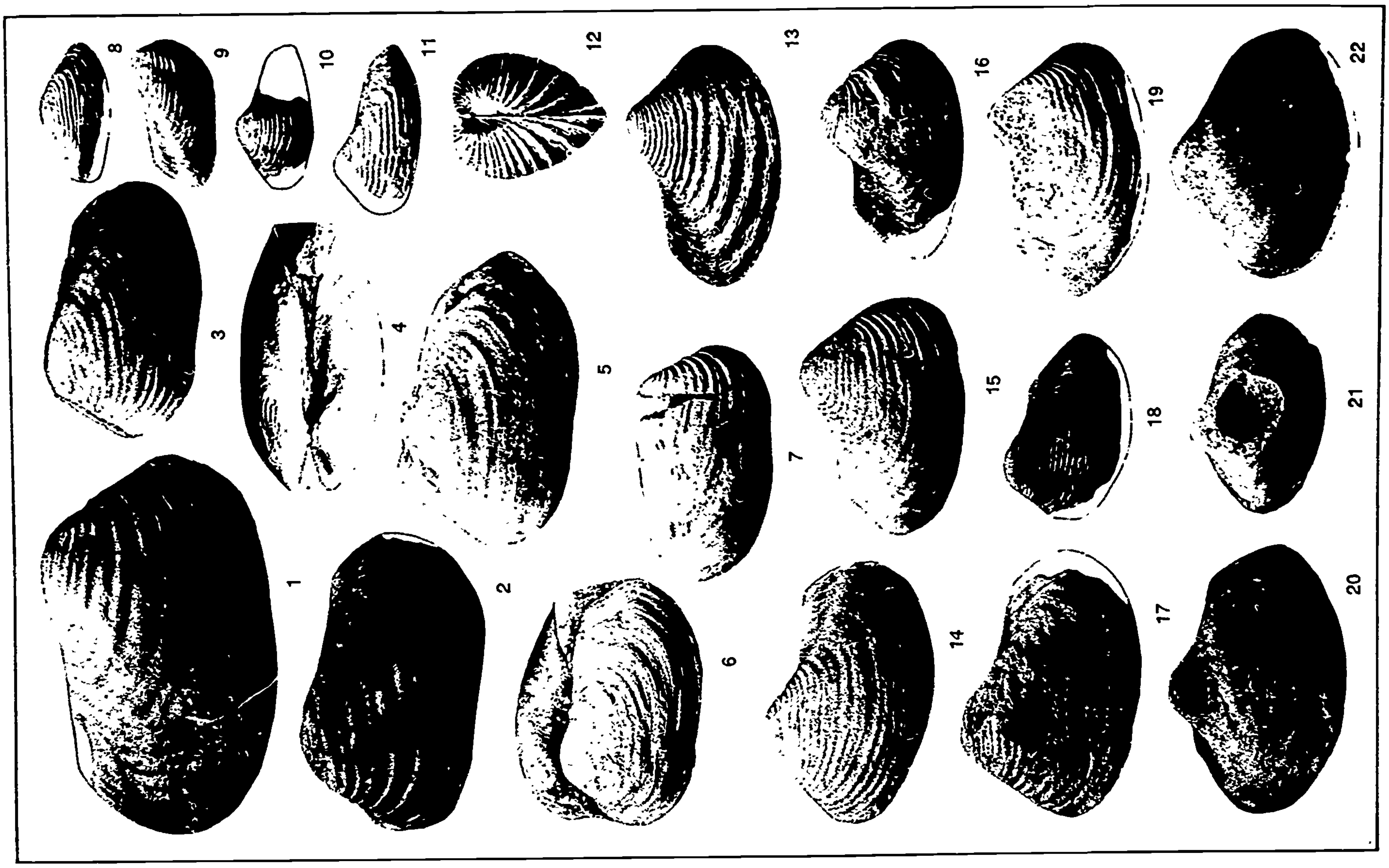
Figures 1-10	*P. bedfordensis*
Figures 11.20	*P. triaria*
Figures 21-25	*P. vintonensis*
Figure 26	*P. sulcatina*
Figure 27	*P. hubbardi*
Figures 28-32	*P. truncata*

(Hyde, 1953, Pl. 40)

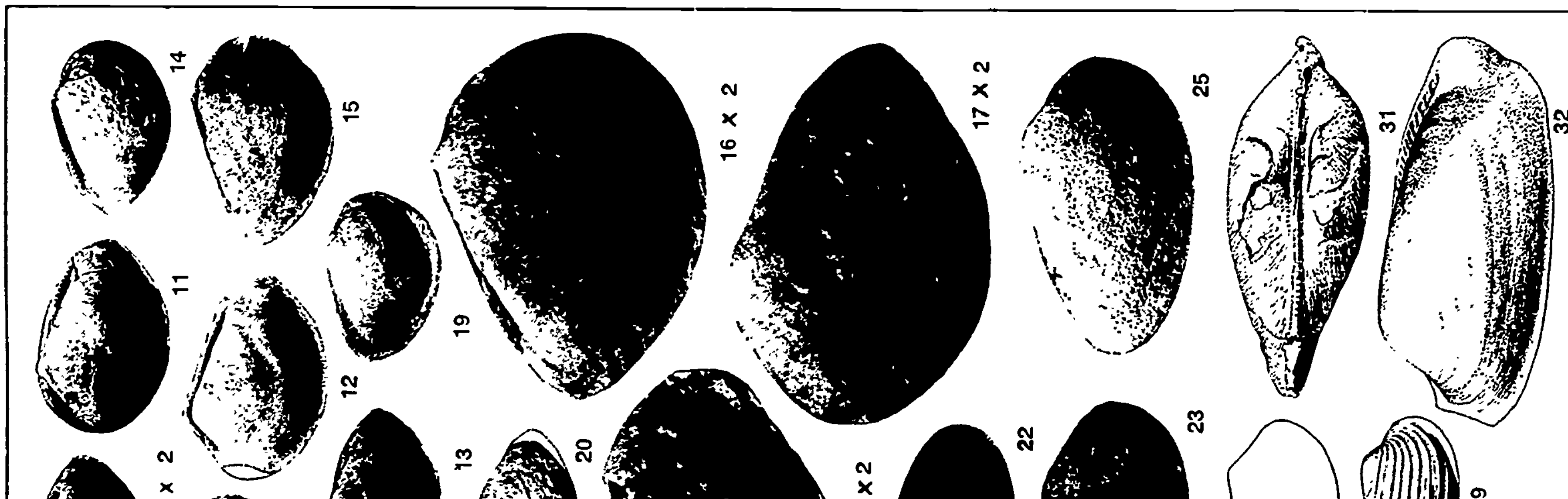
IX —b: *Grammysia* spp. Pelecypod

Figures 1- 2	*G. hannibalensis*
Figures 3- 7	*G. cuyahoga*
Figures 8-11	*G. juvenalis*
Figures 12-13	*G. plena*
Figures 14-19	*G. rostrata*
Figures 20-22	*G. famelica*

(Hyde, 1953, Pl. 38)



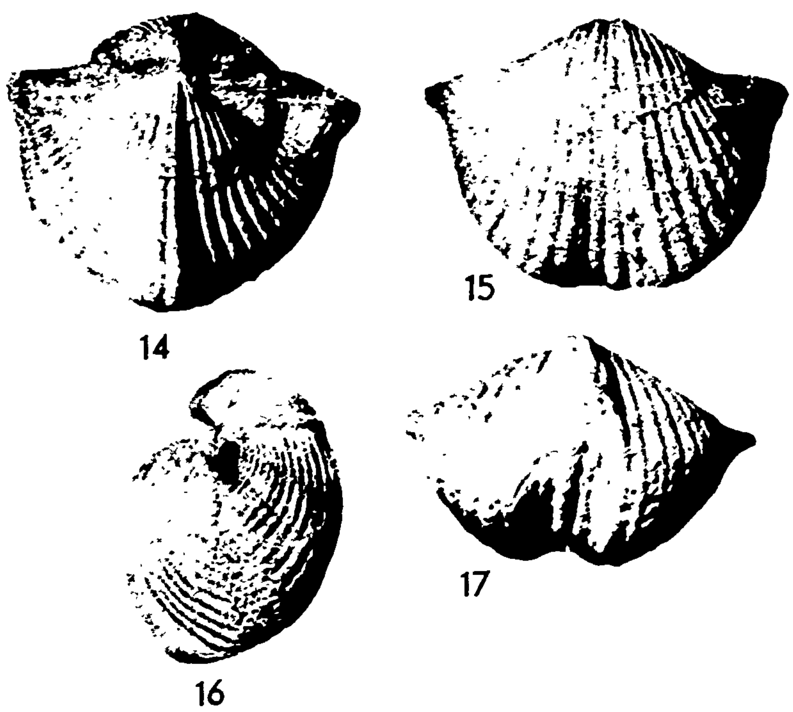
IX b.



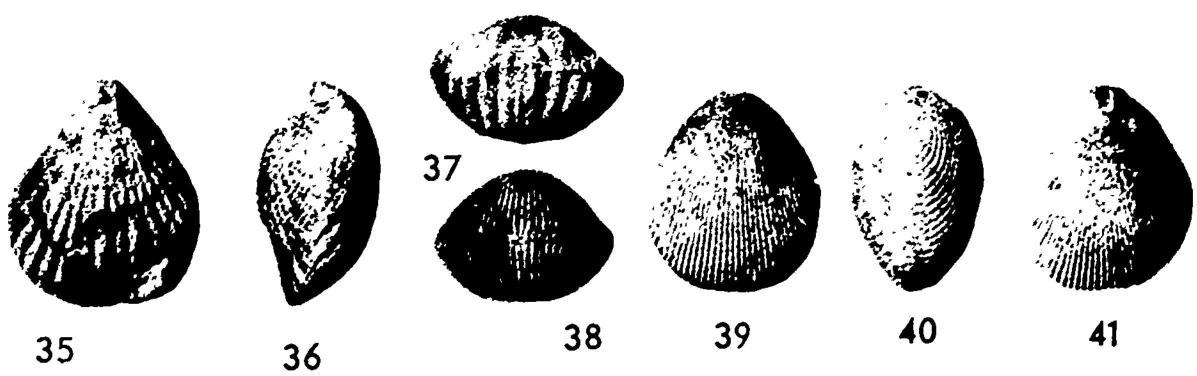
IX a.

PLATE X
Maxville Fauna

<u>Productus</u> sp. (Hyde, 1953, Pl. 10)



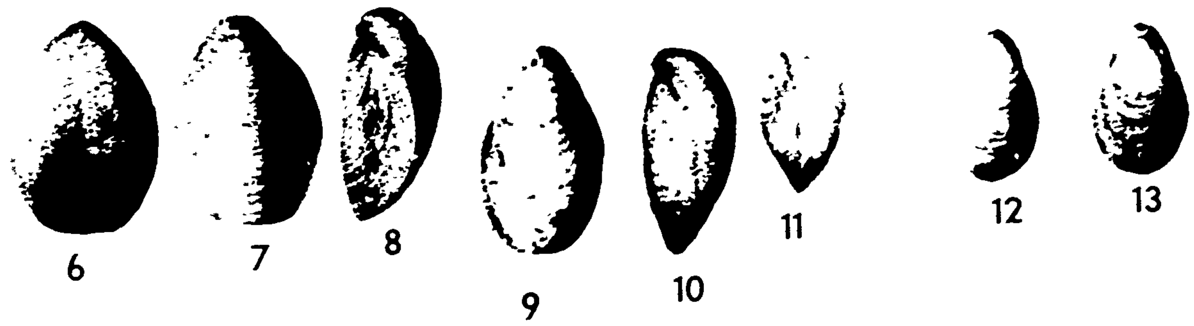
<u>Spirifer</u> <u>keokuk</u> (Shimer and Shrock, 1944, Pl. 124)



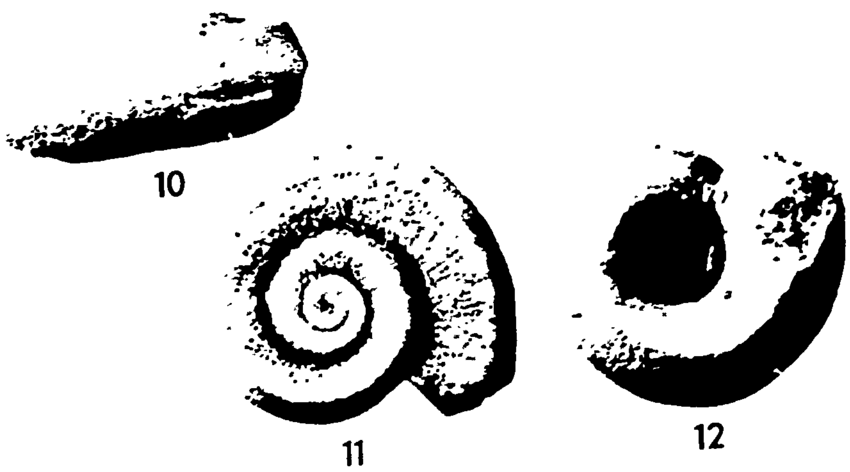
<u>Eumetria</u> spp. (Shimer and Shrock, 1944, Pl. 141)

PLATE XI

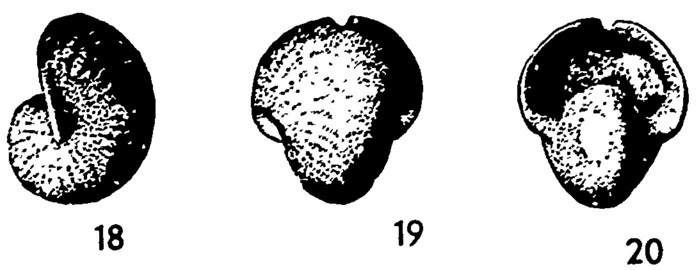
Maxville Fauna Continued



Dielasma spp. (Shimer and Shrock, 1944, Pl. 143)



Straparolus similus (Shimer and Shrock, 1944, Pl. 188)



Bellerophon sublaevis (Shimer and Shrock, 1944, Pl. 178)

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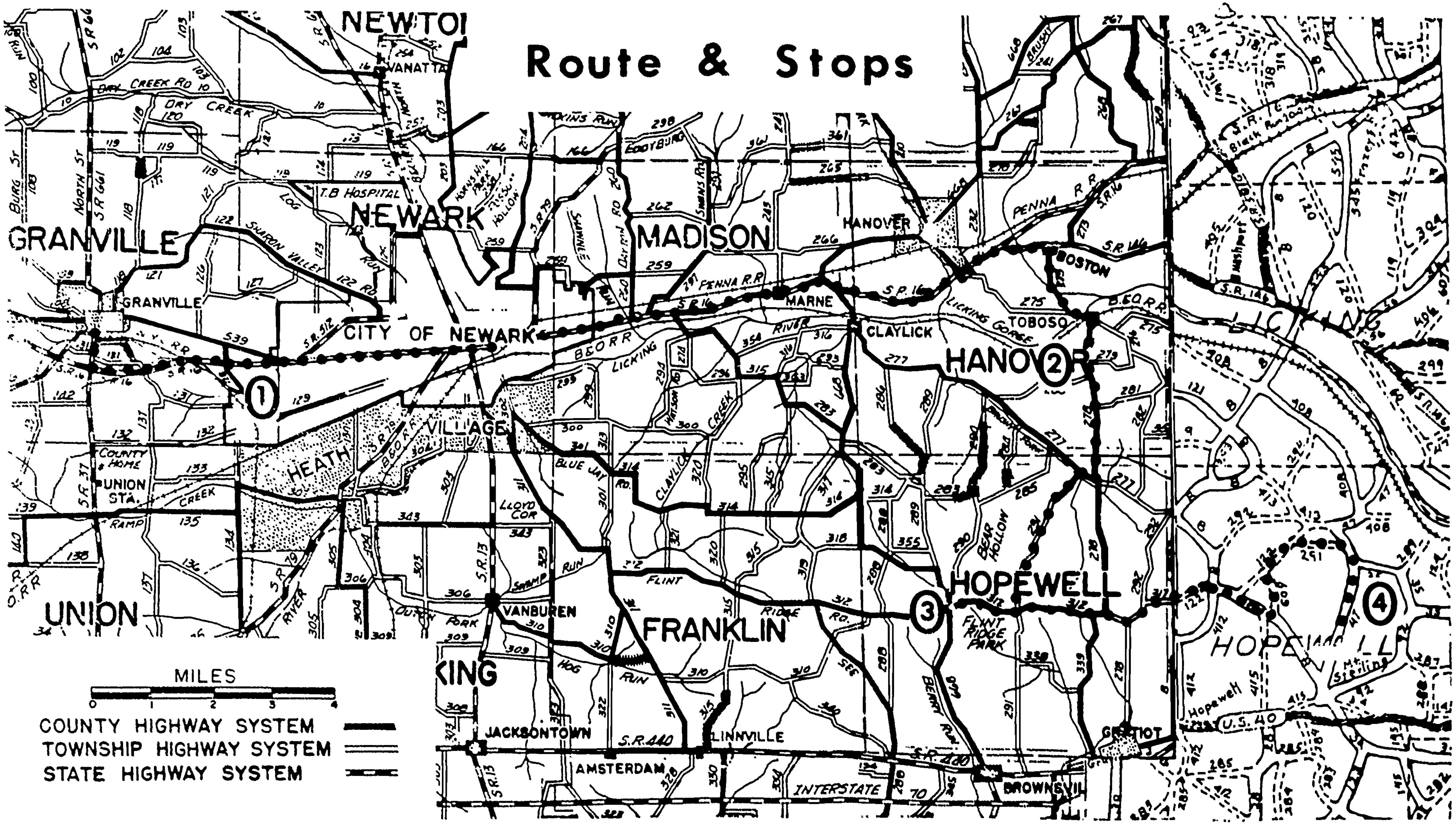
Route & Stops


NEWTO
GRANVILLE
NEWARK
MADISON
HANOVER
CITY OF NEWARK
CLAYLICK
TOBOSO
BOSTON
MARNE
HANOVER
HOPEWELL
FRANKLIN
UNION
VILLAGE
HEATH
VANBUREN
KING
JACKSONTOWN
AMSTERDAM
LINNVILLE
BROWNSVIL
GRATIOT
FLINT RIDGE PARK
BEAR HOLLOW
LICKING GORGE
T.B HOSPITAL
COUNTY HOME
UNION STA.
1
2
3
4
MILES
COUNTY HIGHWAY SYSTEM
TOWNSHIP HIGHWAY SYSTEM
STATE HIGHWAY SYSTEM

THE 20th ANNUAL

OHIO INTERCOLLEGIATE

FIELD TRIP

K S G S

APRIL 28 1949

Kent State University

PRESENTED BY

KENT STATE GEOLOGICAL SOCIETY

OCTOBER 25, 1969

20TH ANNUAL
OHIO INTERCOLLEGIATE
FIELD TRIP

TYPE LOCALITIES
OF
SELECTED MISSISSIPPIAN AND PENNSYLVANIAN
STRATA
IN NORTHWESTERN PENNSYLVANIA AND NORTHEASTERN OHIO

OCTOBER 25, 1969

TABLE OF CONTENTS

ACKNOWLEDGMENT

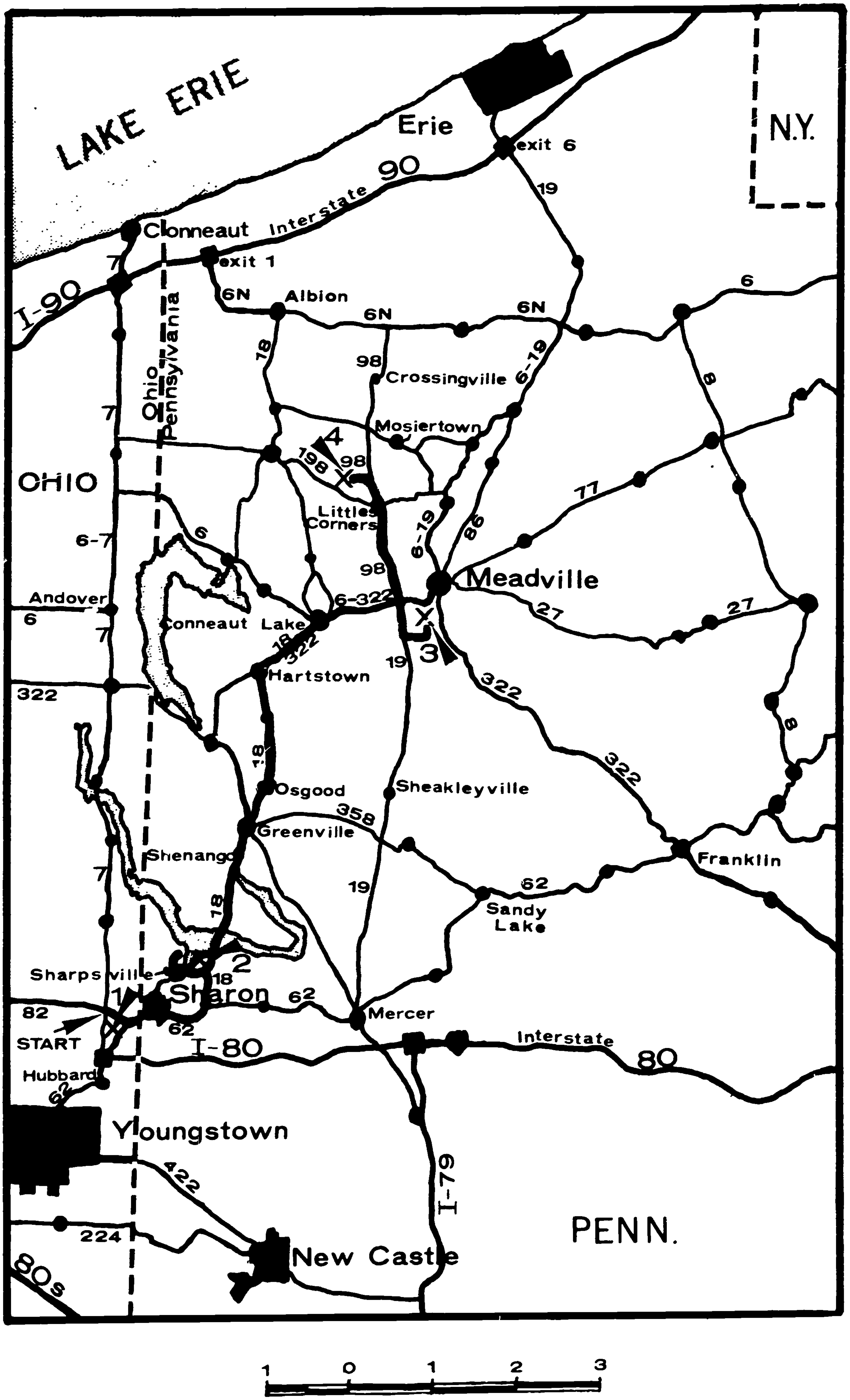
On behalf of the Kent State Geological Society and the Department of Geology, Kent State University, we would like to welcome you to the Twentieth Annual Ohio Intercollegiate Field Trip. We hope the day will prove to be a rewarding and educational experience for all.

This field trip could not have been possible if not for the continuous help and encouragement of Mr. Glenn W. Frank, Dr. Eugene J. Szmuc, and the faculty and staff of the Department of Geology.

Intercollegiate Field Trip Committee.

INTRODUCTION

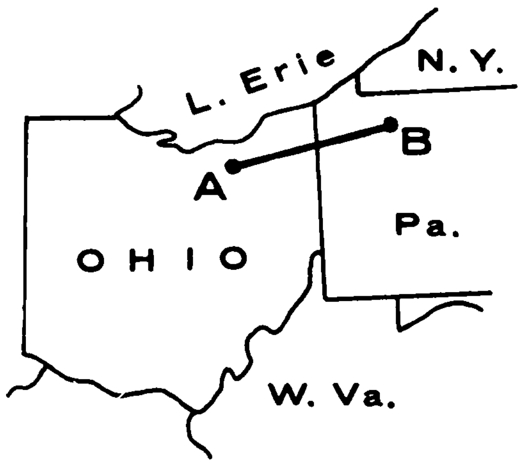
The Twentieth Annual Intercollegiate Field Trip is a general survey of the (approximate) "type sections" of the more outstanding formations present in northeastern Ohio and northwestern Pennsylvania. The purpose of this trip is to familiarize the observer with the stratigraphy of the area. The geology of this region has been extensively studied over the years; therefore, much information has been compiled and is available for use. The first detailed study was accomplished in the latter part of the nineteenth century by geologists who spent many hours on horseback and undertook numerous hikes through unfamiliar terrain. They were able to bring back a fairly accurate account of the geology of the region. Thanks to this initial research and work done since then, the geologist of today has at his disposal a precise compilation of facts and information to aid in further research of the area.


LAKE ERIE
Erie
N.Y.
exit 6
Interstate 90
19
Conneaut
exit 1
I-90
7
6N
Albion
6N
6N
6
18
98
Crossingville
6-19
8
Ohio
Pennsylvania
Mosiertown
4
198
98
OHIO
77
Little Corners
6
6-19
86
6-7
98
Meadville
Andover
6
6-322
27
27
Conneaut Lake
7
18
322
Hartstown
19
3
322
322
8
18
Osgood
Sheakleyville
358
Greenville
322
Shenango
Franklin
7
19
62
Sandy Lake
18
2
Sharpsville
18
1
Sharon
62
82
START
62
Mercer
I-80
Interstate 80
Hubbard
62
Youngstown
422
I-79
224
PENN.
New Castle
80s
1 0 1 2 3
miles

ROAD LOG

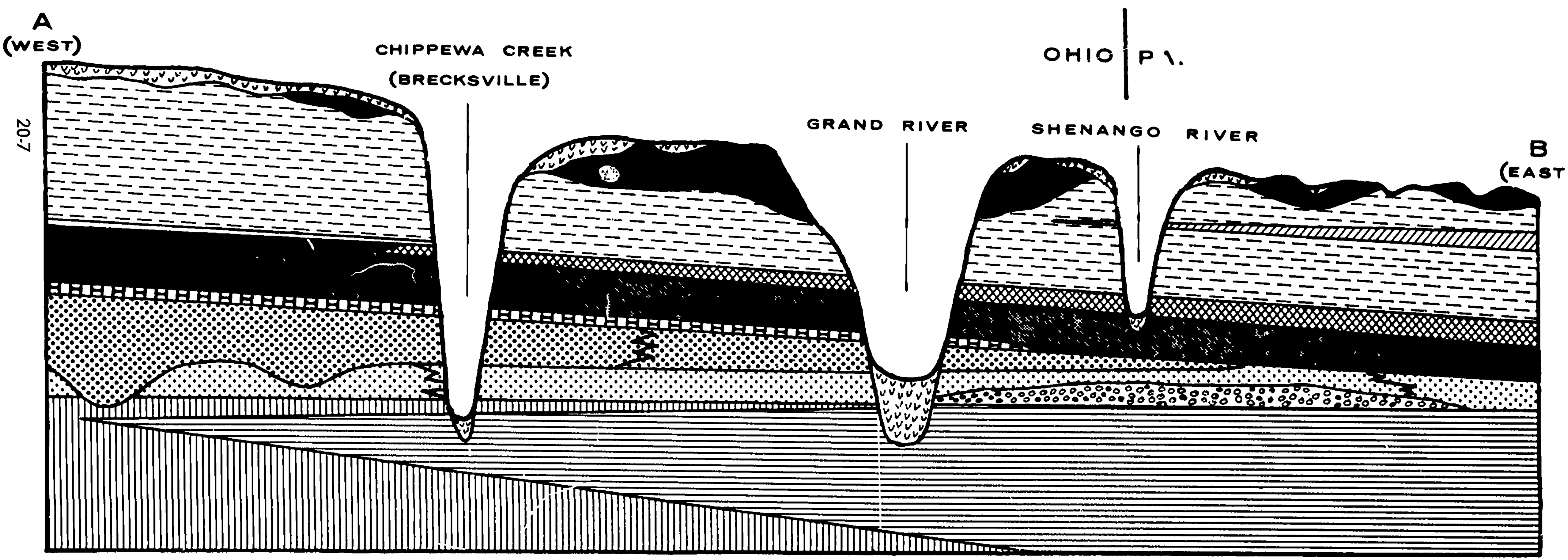
Reversible Total Mileage in Parentheses

Mileage Total	Mileage Increments	
0.0 (88.2)	0.0	STARTING POINT. Roadside rest area 4-27 on Ohio 82 Eastbound 5 miles west of Sharon, Pa.
		Proceed eastbound on Ohio 82
2.2 (86.0)	2.2	Hart-Sharon Road turn RIGHT proceed 200 ft. south to parking area
		SHARON OUTCROP
		Proceed eastbound on Ohio 82 to cloverleaf, take route marked Sharon, Pa. U.S. 62
		Proceed northeast on U.S. 62
4.0 (84.2)	1.8	Bear right at sign marked U.S. 62 North Mercer (avoid Business 62)
		Proceed on U.S. 62 North to junction with Pa. 18 North
8.2 (80.0)	4.2	Turn LEFT on Pa. 18 North
		Proceed on Pa. 18 North to junction with Pa. 518 South at Lamonts Corners
10.2 (78.0)	2.0	Turn LEFT on Pa. 518 South
		Proceed on Pa. 518 South to secondary road (paved, unnamed) by Hickory Upholstering sign, before curve in road
10.4 (77.8)	0.2	Turn RIGHT onto secondary road
		Proceed along secondary road (parallels railroad tracks, begins to curve away to right) to intersection with dirt road on left at end of curve
11.8 (76.4)	1.4	Turn LEFT onto dirt road (caution! very rough road, 5 mph)
		Proceed on dirt road, cross railroad tracks to junction with gravel road
12.1 (76.1)	0.3	Turn LEFT onto gravel road
13.2 (75.0)	1.1	Proceed straight on gravel road to parking area
		SHARPSVILLE OUTCROP
16.0 (72.2)	2.8	Retrace route back to Pa. 518 South
		Turn RIGHT onto Pa. 518 South
		Proceed on Pa. 518 South to junction with Mercer Ave. by Shenango River Reservoir Sign
17.0	1.0	Turn RIGHT onto Mercer Ave.



Generalized Geologic and Topographic Cross-Section of Upper Devonian, Mississippian, and Lower Pennsylvanian Systems in Northeastern Ohio and Northwestern Pennsylvania

(modified from Szmuc, E. J., 1969, Personal Communication)



VERTICAL EXAGGERATION ≈ "X 50"

QUATERNARY

Glacial Till

PENN.

Sharon Sandstone Formation

MISSISSIPPIAN

Shenango Sandstone member of the Cuyahoga Formation

Meadville Shale and Hempfield Shale members of the Cuyahoga Formation

Strongsville Sandstone member of the Cuyahoga Formation

Sharpsville Siltstone member of the Cuyahoga Formation

Orangeville Shale member of the Cuyahoga Formation

Sunbury Shale member of the Cuyahoga Formation

Berea Formation (deltaic and marine facies)

Bedford Formation (deltaic and marine facies), Shellhammer Hollow Formation, Corry Shale Formation

Cussewego Sandstone Formation (deltaic)

U. DEVONIAN

Chagrin Shale Formation

Ohio Shale Formation (Huron member, Cleveland member)

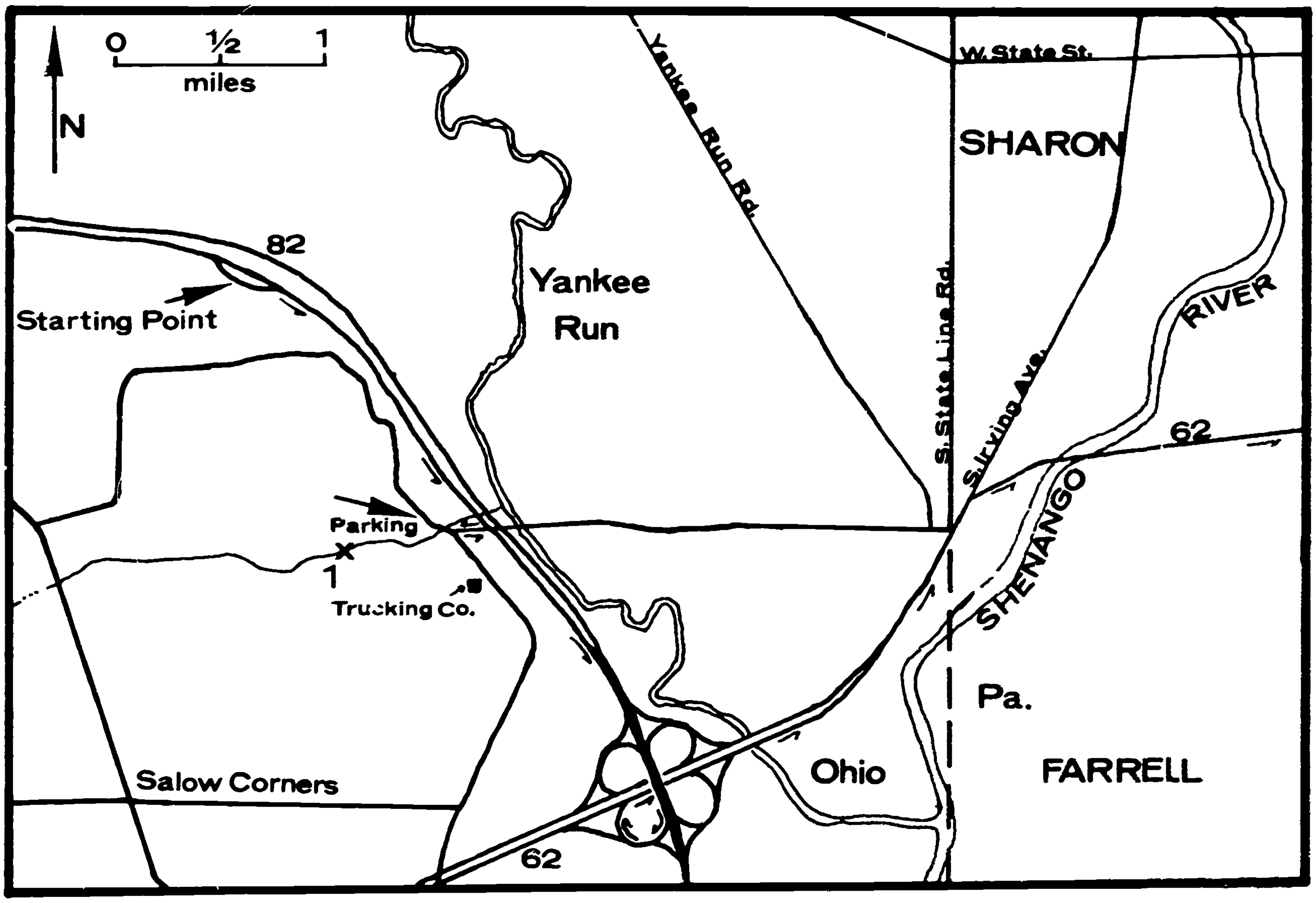
(71.2)		Proceed along Mercer Ave. following Reservoir signs to junction with High St. at MAHANEY RECREATION AREA sign
17.6 (70.6)	0.6	Turn RIGHT onto High St.
		Proceed on High St. to recreation area entrance
18.7 (69.5)	1.1	Turn RIGHT and proceed to Picnic Ground
		LUNCH STOP
		Retrace route back to the junction of Pa. 518 and Pa. 18 at Lamonts Corners
21.6 (66.6)	2.9	Turn LEFT onto Pa. 18 North
		Proceed on Pa. 18 North *through* Greenville to Hartstown and junction with U.S. 322, Pa. 18 North, and U.S. 6
44.3 (43.9)	22.7	Turn RIGHT onto U.S. 322
		Proceed on U.S. 322 to junction with U.S. 19
55.4 (32.8)	11.1	Turn RIGHT on U.S. 19
		Proceed south on U.S. 19 to the junction of a paved road (unnamed) by the Highlander Tavern and a motel
62.8 (25.4)	7.4	Turn LEFT onto the paved road
		Proceed on paved road, cross over stream and interstate highway to dirt road on the left on S curve past bridge
63.9 (24.3)	1.1	Turn LEFT onto dirt road
		Proceed to parking area
		MEADVILLE OUTCROP
		Retrace route back to U.S. 19
65.0 (23.2)	1.1	Turn RIGHT onto U.S. 19
		Proceed on U.S. 19 North back to the intersection with U.S. 322
72.4 (15.8)	7.4	Proceed straight through intersection (route becomes Pa. 98 North)
86.6 (1.6)	14.2	Proceed on Pa. 98 North to LITTLES CORNERS
		Proceed on Pa. 98 North to the intersection of FOSTER ROAD (dirt road)
87.3 (0.9)	0.7	Turn LEFT onto FOSTER ROAD
88.2 (0.0)	0.9	Proceed on Foster Road to parking area
		CUSSEWAGO OUTCROP

End of Road Log

SHARON SANDSTONE

INTRODUCTION

The Sharon Formation, which directly overlies the Mississippian Rocks in Ohio and western Pennsylvania, is the basal unit of the Pottsville Group. The Sharon is composed of indurated sand and gravel. Nowhere in the area is the entire unit exposed since the Sharon is the summit formation of this area and it occurs at altitudes in excess of 1100 feet. The Formation was named by the geologists of the Second Geological Survey of Pennsylvania from exposures at Sharon, Mercer County, Pennsylvania (J. P. Lesley, 1879). It is found in disconnected patches or outcrops that cap the highest hills in the area. The unit is non-fossiliferous except for a few plant fragments. The base of the Sharon represents a conspicuous unconformity in the area.



SHARON LOCATION MAP

Location: 0.9 miles north of Brookfield-Hubbard Line and 1 mile west of Ohio-Pennsylvania line.

Section: Sharon West Quadrangle; 1.1 mile south of Warren-Sharon Road, base of section 0.3 mile above junction with Yankee Creek.

ORIGINAL DESCRIPTION

The original reference to the Sharon group was made by J. P. Lesley in 1879 and occurred in the Pennsylvania 2d Geological Survey Report 02 pp. 319-333. It was named for the town of Sharon, Mercer County, Pennsylvania.

The Sharon described for this report contains the contact between the Sharon and underlying Hemfield and Shenango Formation. The Sharon consists primarily of cross-bedded units which are moderately well indurated with the unit being buff when fresh and weathering to a buff or light gray color. This outcrop shows ripple marks at the top with a trend of NW to SE. The conglomerate layers which occur near the base of the section are composed of subrounded to rounded quartz pebbles with an average size of 1/4". The pebbles are surrounded by sand and cemented by silica. The conglomerate beds have a sharp contact with the remainder of the unit both above and below. One such unit has a thickness of one foot and is poorly consolidated. The apparent dip of the unit at this locality is to the N-NE with many of the larger blocks possibly being displaced by slump.

The base of the Sharon shows a sharp contact with the lower unit (Meadville Shale) and this contact is exposed in the northern part of the outcrop area and represents the unconformity between the two formations. The only fossils reported from the area are plant fragments of Lepidodendron and Sigillaria.

Environmental Interpretation

The Sharon Formation exhibits crossbedding in which the dip direction of the secondary bedding varies from E-SE to SW with the greatest percentage of readings being SE. The Sharon Formation was deposited in the old channels that were present on the slightly warped Mississippian below, and (as mentioned in the introduction) this is a conspicuous unconformity. The base of this unit also contains many conglomeratic layers with the top being primarily absent of such layers. A sequence of overlapping crossbedded units occurs in most outcrops; abundant troughed units, indicating "cut and fill" phenomena, may be locally abundant.

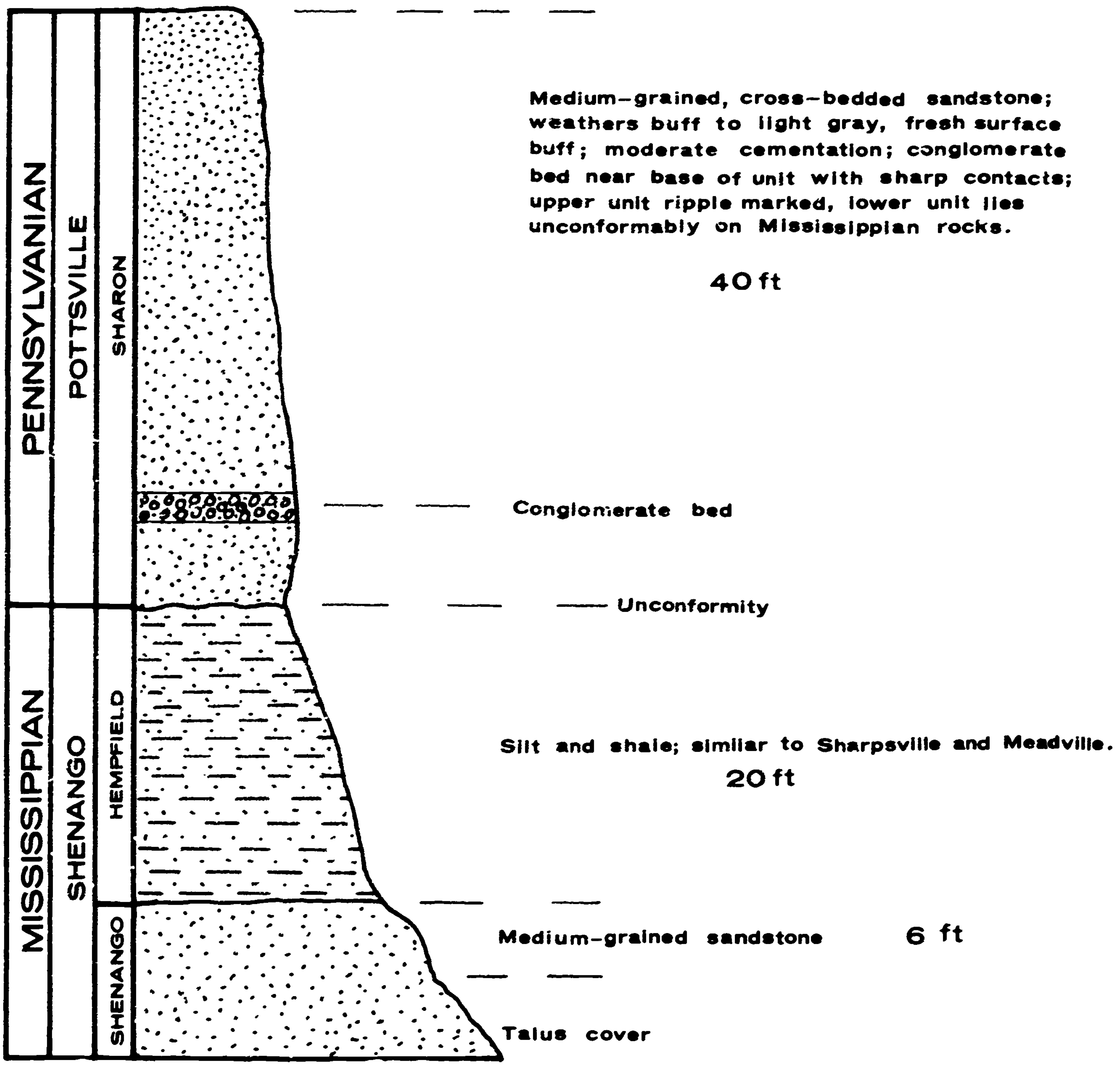
The presence of shale layers dispersed throughout the formation indicates temporary changes in depositional patterns; the re-occurrence of sandstone and conglomerate indicates resumption of medium — and coarse-grained sedimentation.

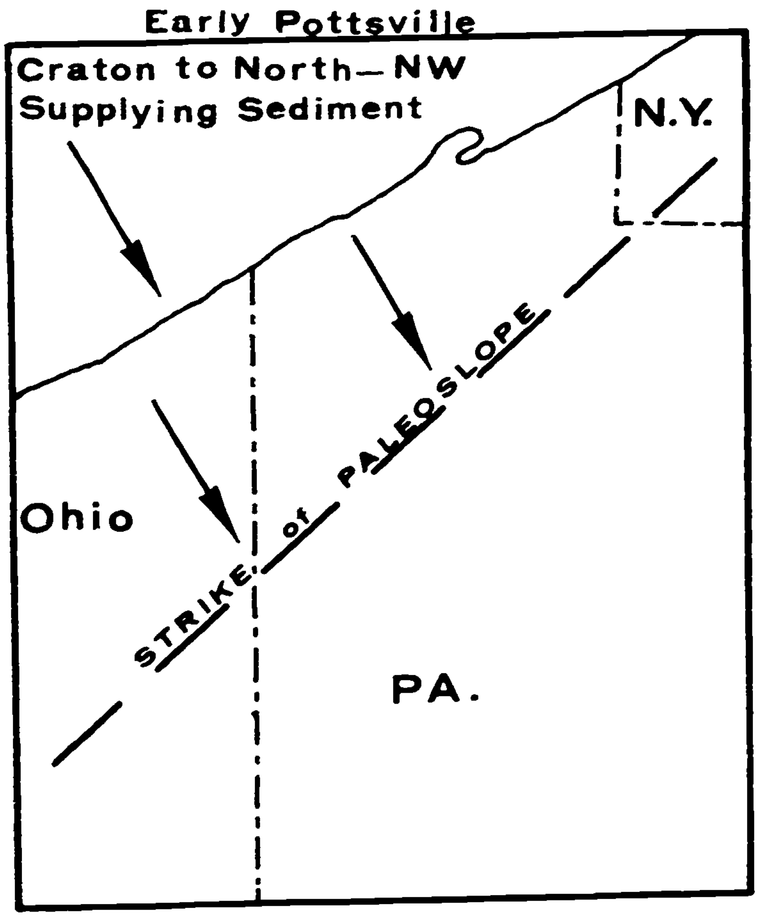
Present indications point to a unit that was deposited upon the rough or rolling surface which developed upon the Mississippian by the preceeding erosional cycle. Also, since there are quartz pebbles and conglomeratic layers present throughout the unit, rapid currents, able to remove the sand and finer particles from around them, are suggested.

The quartz pebbles could have been derived from a local source or transported from an area much more distant. The source area, primarily to the north, was probably a sedimentary or meta-sedimentary sequence (at least in part), as shown by the high purity of sand (96%-Si02), pebbles of sandstone, conglomerate, weathered limestone, and other features of the Formation.

Fossils found in the unit include broken and water-worn plant fragments of *Lepidodendron* and *Sigillaria.*

In Ohio the Sharon exhibits planar bedding (which is fairly common there), while in Pennsylvania it is rare.

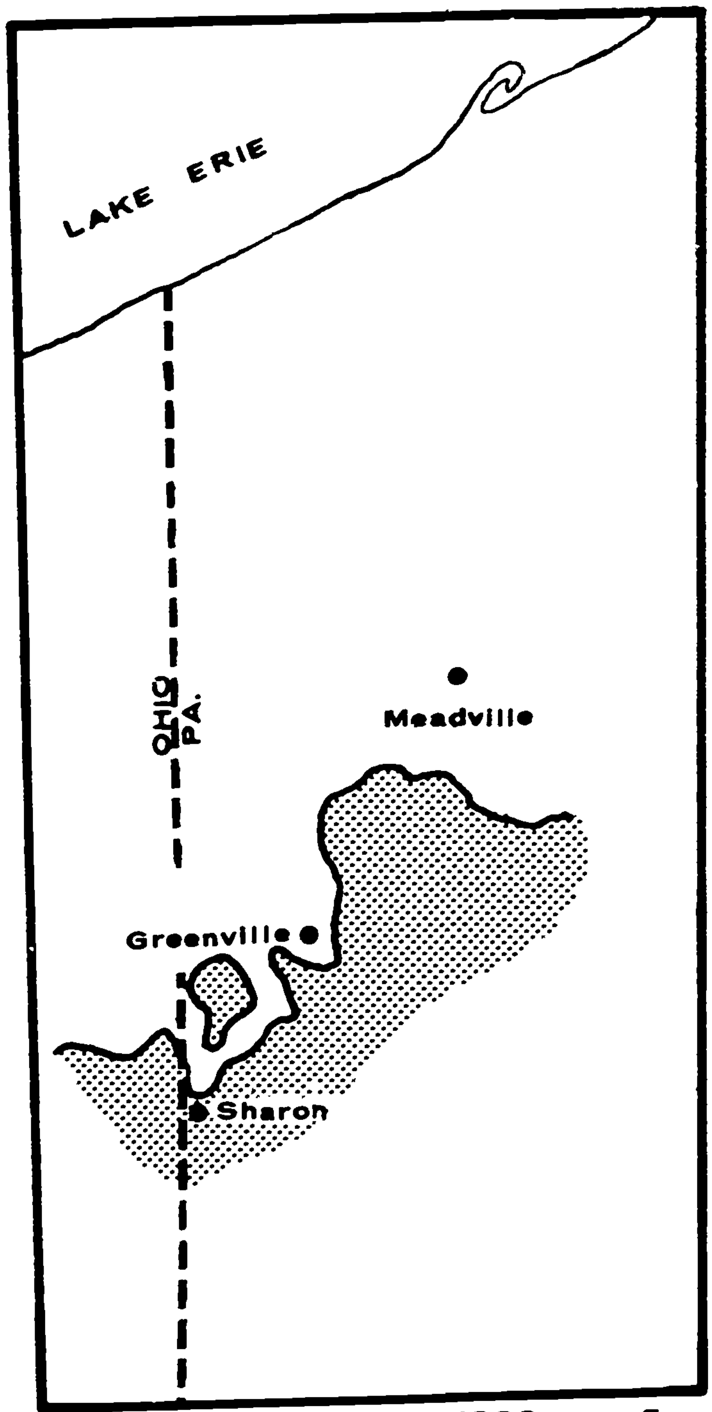

PENNSYLVANIAN
POTTSVILLE
SHARON
MISSISSIPPIAN
SHENANGO
HEMPFIELD
SHENANGO
Medium-grained, cross-bedded sandstone; weathers buff to light gray, fresh surface buff; moderate cementation; conglomerate bed near base of unit with sharp contacts; upper unit ripple marked, lower unit lies unconformably on Mississippian rocks.
40 ft
Conglomerate bed
Unconformity
Silt and shale; similar to Sharpsville and Meadville.
20 ft
Medium-grained sandstone
6 ft
Talus cover



PALEOSLOPE in the SHARON DISPERSAL SYSTEM

Adapted from Evans, 1968, pg. 23

OUTCROP MAP of SHARON FM. in WESTERN PA. and N.E. OHIO



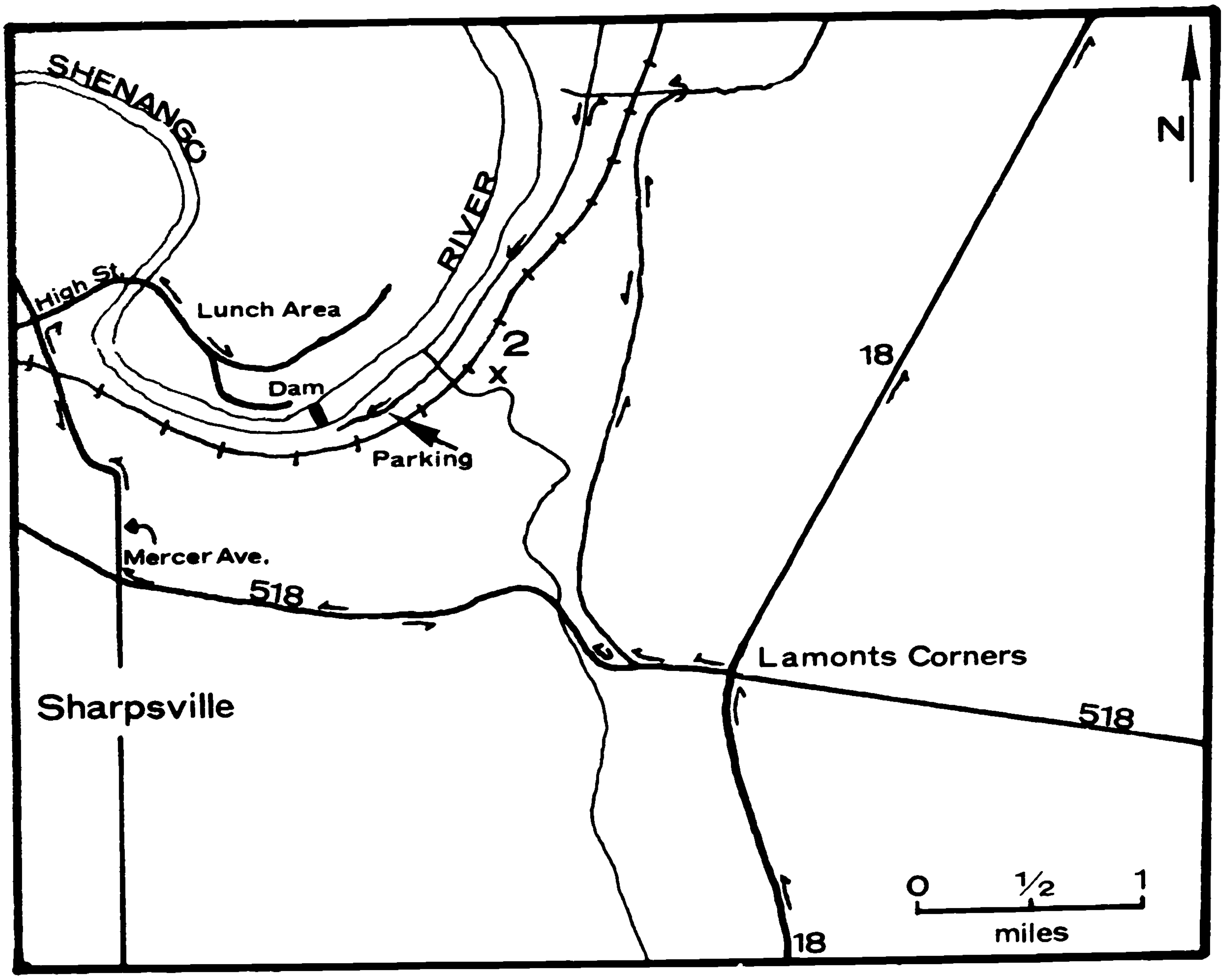
Adapted from Evans, 1968, pg. 5

With the above information taken into account the environment of deposition for the Sharon points to a deltaic origin. However, it has also been pointed out (Mrakovich, 1969) that the characteristics exhibited may be similar to those produced by an abraided river.

SHARPSVILLE SILTSTONE

INTRODUCTION

The Sharpsville member of the Cuyahoga Formation is the middle member of the formation, being underlain by the Orangeville and lying under the Meadville. It was first described in the latter half of the nineteenth century by I.C. White near Sharpsville, Pennsylvania. The Sharpsville ranges in thickness from 0 to 60 feet and wedges out to the west. It is a shallow marine deposit of sandy siltstone and silty shales.



SHARPSVILLE LOCATION MAP

Location: West of Sharpsville in a tributary of the Shenango River.

Section: Sharpsville Quadrangle, Mercer County, Hickory Township, Pennsylvania.

ORIGINAL DESCRIPTION

The Sharpsville member of the Cuyahoga Formation (lower to middle Mississippian) was originally described by Israel C. White in 1880, after he examined outcrops just east of the town of Sharpsville, Pennsylvania. Contacts with the underlying Orangeville member and the overlying Meadville member are gradational. White recognized three prominent sub-units. The "Sharpsville Lower Sandstone" consists of a series of non-fossiliferous siltstone layers which vary from one-half-to two feet in thickness; this lower bed has a total thickness of about twelve feet. The "Meadville Lower Limestone," approximately two feet thick, lies stratigraphically above the "Lower Sharpsville Sandstone" bed. This limestone's remarkable persistancy makes it useful as a geologic horizon in northwestern Pennsylvania and northeastern Ohio. White (1881-p. 84) described geomorphic evidence for its presence: "The hardness of these limestone beds compared with that of the measures enclosing them cause little water-falls in the beds of the streamlets, descending the hill slopes; and in some places the water flows over the limestone stratum for a considerable distance above such a cascade." The bed may be described as an arenaceous dolomitic limestone which weathers to form a brown siliceous crust. The rock is very hard and "flinty" in hand sample and is non-fossiliferous.

By far the thickest bed and the highest stratigraphic sub-unit of the Sharpsville member is the "Sharpsville Upper Sandstone." Total thickness of the bed is about fifty feet. It consists of "...Layers of fine bluish gray or greyish-brown flagstone, from 1 to 2 feet thick...(which)...alternate with thin layers of greyish shale. Rarely the shale amounts to one third of the mass; often to so little that the flags are almost a solid series" (White, 1881, p. 86). The upper half of the bed is fossiliferous, but the shells are usually poorly preserved; White (1881) reports one pe... *(Allorisma)* and three brachiopods *(Rynconella, Spirifer,* and *Productus).*

SHARPSVILLE MEMBER OF NORTHEASTERN OHIO

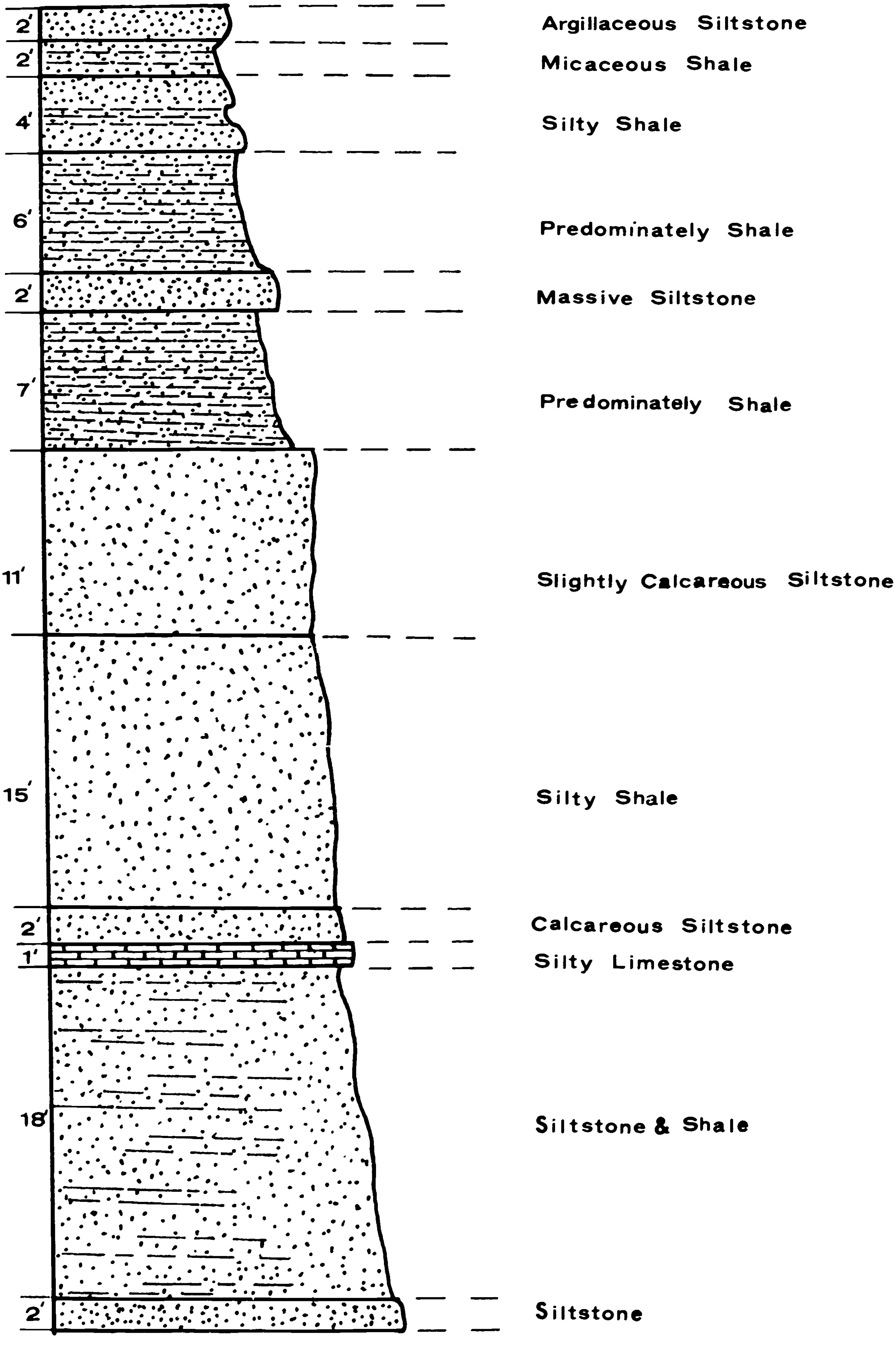
The Sharpsville in Ohio is a flaggy succession of cross-laminated sandy siltstones and silty shales containing a few calcareous beds. Its lower contact with the Orangeville member is a transitional zone which in some places constitutes more than fifteen feet of interbedded shale and siltstone. The top of the Sharpsville is difficult to identify in some areas, especially in the region east of Cuyahoga County, Ohio, where the overlying Meadville beds are essentially the same lithology. West of the Cuyahoga Valley where the lower Meadville is largely shale, the upper contact is more readily discerned. From Cuyahoga Falls, Ohio, to Central Cuyahoga County the Sharpsville is overlain by the Strongsville member. This contact can be recognized by the striking *Zoophycos* bed in the Strongsville.

Long groove casts can be found in the Sharpsville at the gorge of the Cuyahoga in Cuyahoga Falls and at Brandywine Creek below the old State Highway 8 bridge (north of Cuyahoga Falls). Flute casts near the top of the Sharpsville at the gorge indicate that the mean direction of paleocurrents was S78W. The flaggy sequence shows low angle cross-laminations which give evidence of deposition in a high energy environment. Stratigraphic relationships and dip of cross-beds reveal that during Cuyahoga time the marine basin was receiving most of its detritus from landmasses to the east, northeast, and southeast. The Sharpsville sedimentation was coarser and was probably derived from deltaic and other near-shore sediments to the east.

The average thickness of the Sharpsville Member is 55 to 60 feet in eastern Geauga County but further west it thins considerably and feathers out a few miles west of Parma, Ohio, and North Royalton, Ohio. The Sharpsville flags pass laterally into the blue-grey shales of the Orangeville Member.

Fossils are locally abundant in Geauga and Summit Counties, Ohio. They include many species of Brachiopod genera such as *Lingula, Orbiculoidea, Rhipodomella, Chonetes,* and *Quadratia.*

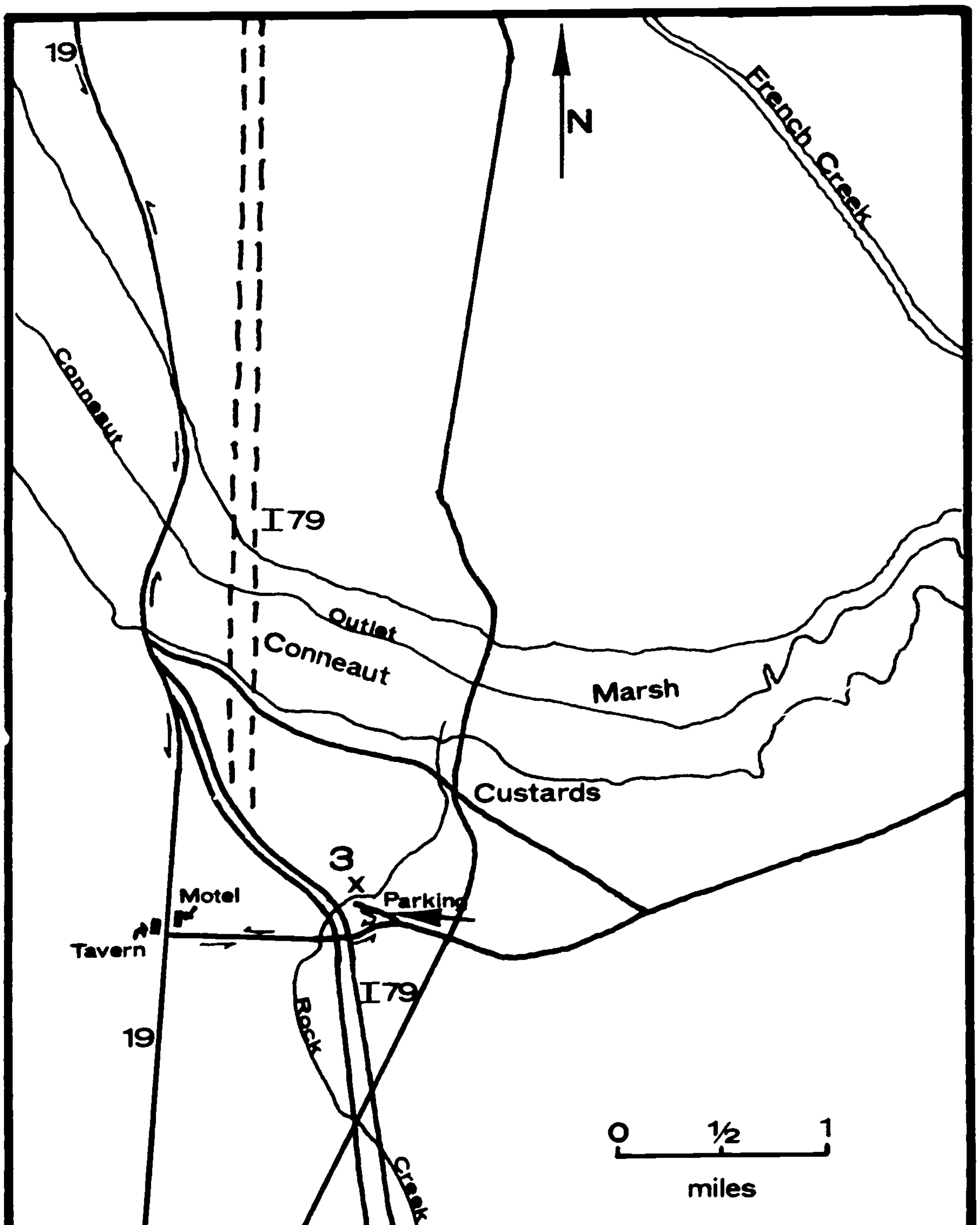
SHARPSVILLE MEMBER



MEADVILLE SHALE

INTRODUCTION

The Meadville Member of the Cuyahoga Formation (L.Miss.) is composed of three prominent beds: the Meadville Upper Shales, the Meadville Upper Limestone, and the Meadville Lower Shales. The Meadville Member was first described by I. C. White in 1881 for the Pennsylvania Geologic Survey. It is typically composed of ashen-grey or bluish-grey shales alternating with sandy flags. The formation was named for its occurrence at the town of Meadville, Crawford County, Pennsylvania.



MEADVILLE LOCATION MAP

Location: 12.5 miles south of Meadville, Pennsylvania, 1/2 mile south of Custards in Greenwood Township.

Section: Meadville, Pennsylvania, Quadrangle 1.1 miles east of U.S. 19 off dirt road east of I-79.

ORIGINAL DESCRIPTION

I. C. White first described the Meadville Member in 1881. The Meadville Upper Shales were described as "bluish grey or ashen-grey in color, argillaceous at the top, sandy lower down, sometimes flaggy but never massive." A number of locations are cited with the thickness of exposed outcrop ranging from fifteen to forty feet. Fucoids or seaweeds are the only fossil remains mentioned.

The Meadville Upper Limestone served as a key horizon for White in determining the geology of the region. "Its thickness seldom exceeds one foot often not six inches, never more than one foot six inches." In certain locations the unit was called a "Fish Bone Conglomerate" due to the large amount of fish scales, teeth, bones, plates, and spines crowded within. Scales of *Palaeoniscus* are the most abundant. *Cladodus, Orodus, Lambdodus, Mesodmodus, Stemmatodus,* and others are of frequent occurrence. Spines of *Ctenacanthus, Drepanocanthus,* and *Batacanthus* also occur. Numerous other species were reported for the unit. In correlation of this fossiliferous layer with other known faunal groups White felt that, "From all the evidence, I am inclined to an equivalency with the Lower Keokuk or Upper Burlington fish beds in preference to the Kinderhook." Aside from the presence of many fossils the unit also is composed of, "Rounded pebbles of shale and fine shandstone...usually of a dark color and derived from some older strata of the series. They are usually flat or lenticular, sometimes worn oval and tapering to a blunt point. The limestone matrix is not a pure carbonate of lime; but contains much silica, etc., and often resembles a sandstone weathered. The rock has the peculiar sub-carboniferous limestone fracture of this region, the broken surface being covered with many small elliptical, glassy, sparkling spots (which look like small shells until they are closely examined) due to a semi-crystalization of the carbonate of lime."

The Meadville Lower Shales are similar to the upper shales with, "alternating sandy flags increasing in numbers towards the bottom." The thickness of this formation averages forty feet, although sixty feet has been reported from some areas. "The outcrop extends little beyond that of the Shenango Sandstone, because the latter was its only protection from erosion." Fucoids are present as in the upper shale but also present are "badly preserved shells, evidently *Spirifers, Producti, Allorismae,* etc."

OUTCROP DESCRIPTION

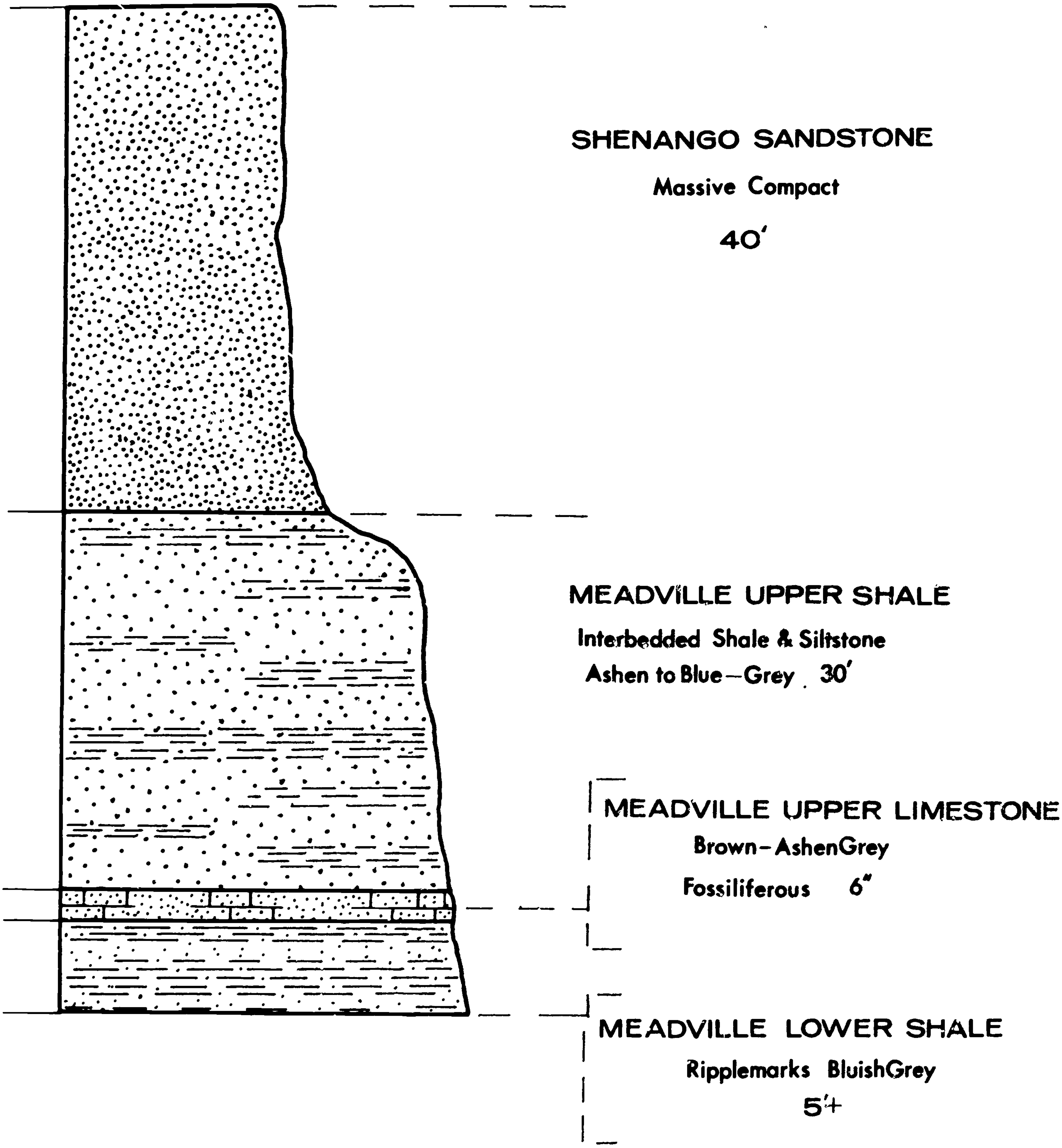
Exposed at the top of the outcrop is forty feet of Shenango Sandstone forming the cap rock on the hill. It is a resistant unit with smooth nearly vertical walls giving a small cliff-like appearance.

Below the Shenango lies thirty feet of the Meadville Upper Shales. This unit is less resistant and is covered (for the most part) by talus and vegetation. Near the stream it is well exposed. It consists of interbedded siltstone and shale layers. The shale layers are weathered, broken, and easily crumbled, while the siltstone layers are more resistant. The shale is bluish-grey when wet and ashen-grey when dry. It is thinly laminated and appears to be more of a siltstone than a shale. Fossil remains are not readily noticeable.

The Meadville Upper Limestone is also present. It is between 4 and 6 inches thick and approximately 5 feet above the level of the creek at the outcrop location. It is brownish-grey to grey in color and appears to be thinly laminated. Fish scales are abundant. A hand specimen, when viewed from the side, appears to have black banding due to the fish scales. Poorly preserved brachiopods can also be seen. The layers adjacent to the fossiliferous unit, both above and below, appear to be very micaceous or composed of fossil fragments. These specks are actually semi-crystalized $CaCO_3$ crystals, as described by White. The unit has little resemblance to a limestone but appears to be a sandy siltstone with a carbonate matrix. It weathers to a dull brownish-grey color.

The Meadville Lower Shales are exposed at the base of the section and form the bed of the creek. They are bluish grey shales, lacking the more pronounced interbedded siltstone-shale layers of the Upper Shales. Approximately 300 feet down stream excellent oscillation ripple marks are exposed, along with a very strong joint system ranging from 2 to 10 feet in width. Both of these features are exposed in the creek bottom. These shales appear to be of a more regular, silty nature and are very strong and resistant as compared with "normal" shales.

From the evidence stated the Meadville Member suggests a shallow marine environment. Brachiopods, Fucoids, ripple marks, fish scales, and the alternating silt-shale relationship indicate this depositional environment for the three beds composing the Meadville member.



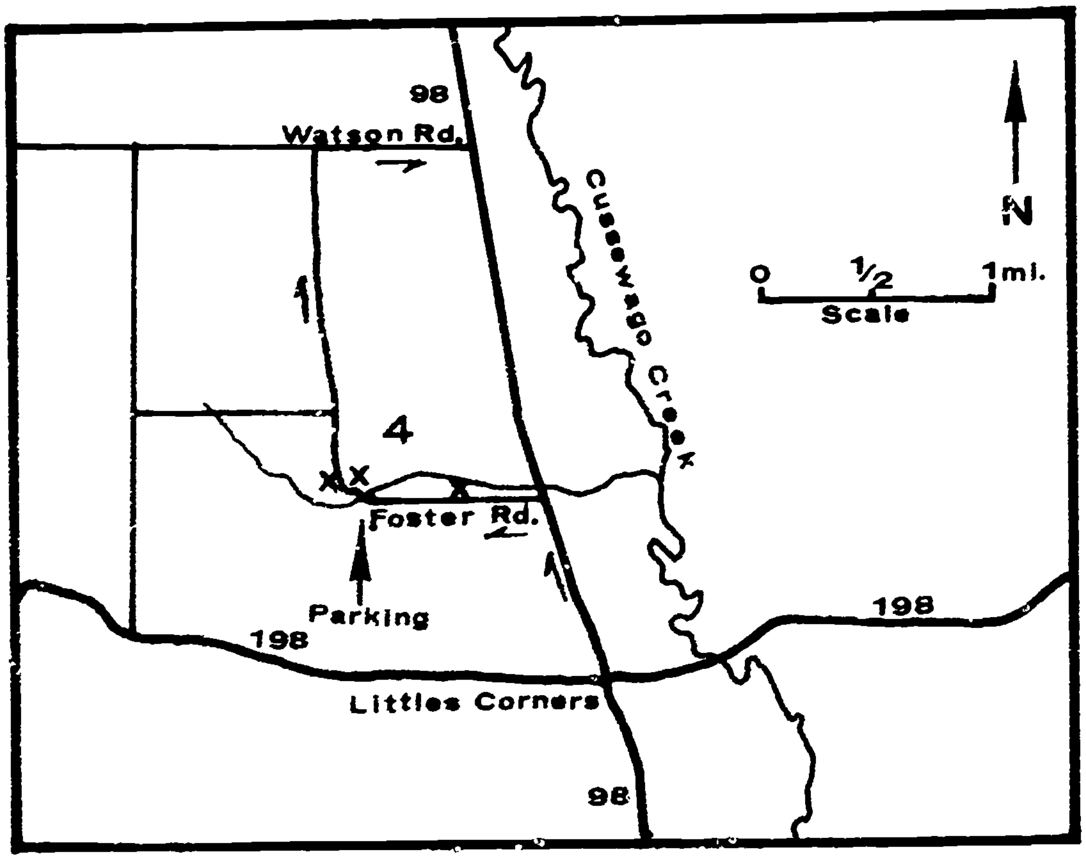
OHIO-PENNSYLVANIA RELATIONSHIP

In comparing the Meadville in Ohio and Pennsylvania, the Meadville is treated as a member of the Cuyahoga Formation in northeastern Ohio. The Cuyahoga Formation is Lower Mississippian in age and includes the Sharpsville siltstone and Orangeville shale members along with the Meadville. In Pennsylvania, however, the Meadville, as White described it, is considered a group. The lower portion of the Meadville in Ohio is composed of blue-black argillaceous, fissile shales and blue-grey, thin, laminated, arenaceous shales. Fine-grained sandstones are interbedded with the shale, increasing in occurrence until they compose as much of the deposit as do the shales in the upper portion, as seen in the examined outcrop in Pennsylvania. In general the Meadville is more fossiliferous and of more variable thickness in northeastern Ohio than in Pennsylvania.

CUSSEWAGO FORMATION

INTRODUCTION

Much of the original work in this area was done by I. C. White and J. S. Newberry late in the 19th century. At this stop are the units which represent the middle and lower extent of Mississippian time: the Orangeville Shale, the Bartholomew Siltstone (type section, deWitt, 1954), the Berea Sandstone, the Bedford Shale, and the Cussewago Sandstone (type section from I. C. White, 1881). The uppermost part of the Devonian will be represented by the Riceville Formation of the Venango Group.



CUSSEWAGO LOCATION MAP

Location: .3 miles north of Littles Corner, 12.7 miles west of Pennsylvania-Ohio line.

Section: Northeast section of the Linesville Quadrangle about .3 miles north of the intersection of route 98 and 198.

PALEOGEOGRAPHIC HISTORIES

The Riceville Shale's paleogeographic history is directly related to that of the Chagrin Shale, which is located west of the Riceville and grades laterally into it. Basically, both units were involved in the same general depositional environment in Upper Devonian time. The deposition of the Riceville and Chagrin involved the encroachment of a sea from the east depositing black muds which differed little from the shoreline to the center of the basin. The Riceville is lithologically similar to the Chagrin, except for the occurrence of more fossils and ripple marks, which tend to reinforce the picture of its shallow water, near-shore depositional environment.

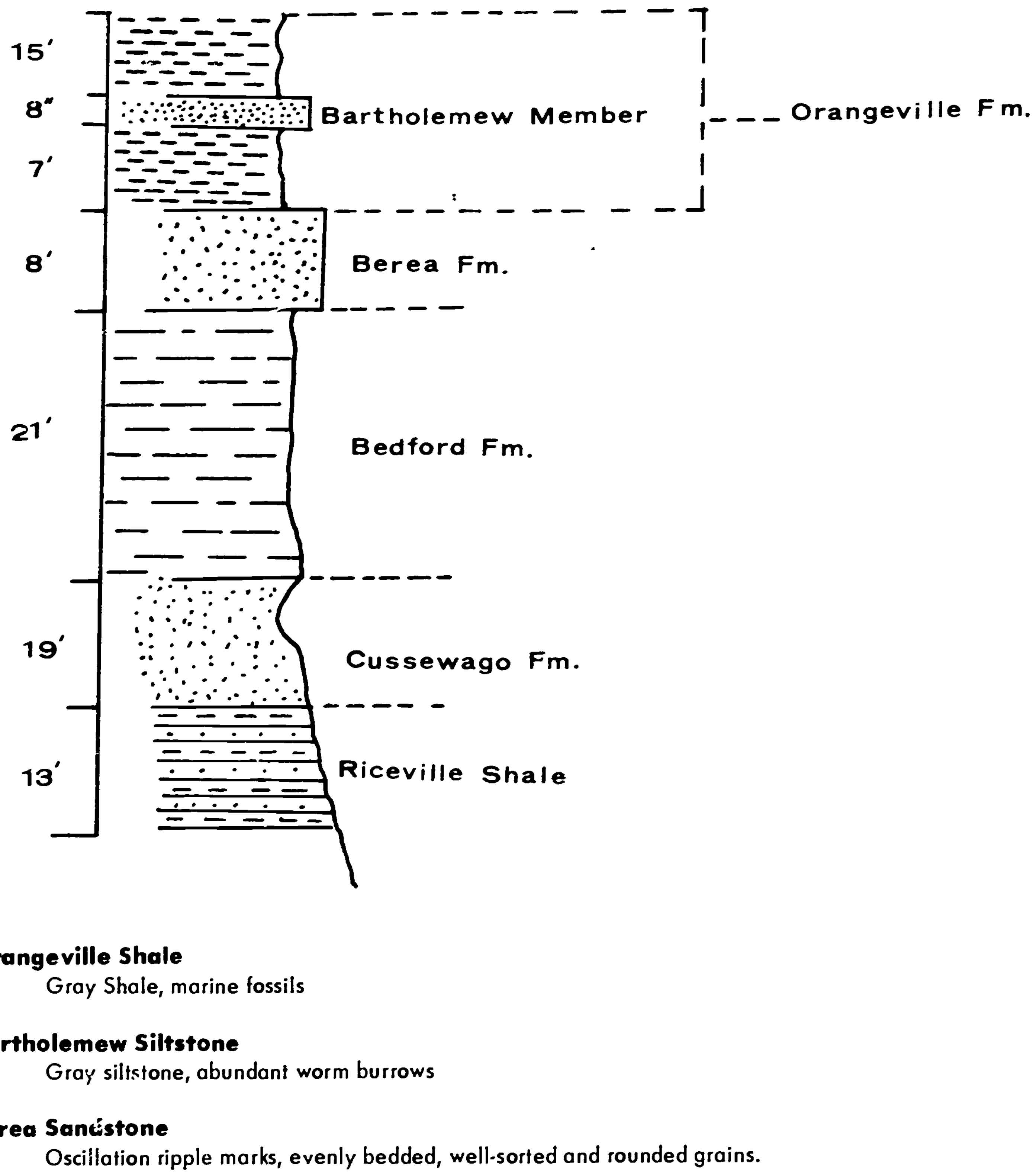
After the deposition of the Riceville Shale, a series of gradual transgressions and fluctuations of the sea began, marking the beginning of Mississippian time and the deposition of the Bedford, Cussewago, Berea, and Orangeville Formations.

As the first of these seas was gradually encroaching from the south, the Red Bedford and Cussewago deltas were being contemporaneously deposited from the north and southeast, respectively (see Fig. 1 — Bedford Time). With the continued transgression of the sea, the Cussewago delta was breached, since the accumulation of clastics was less than the rate of basin subsidence. The Gray Bedford, being deposited in the sea surrounding the Red Bedford delta, continued to be deposited over the Cussewago delta.

A regression of the sea resulted in a low-lying northern coast and shallow sea; this marked the first deposition of the Berea sands, first as channel deposits, later as the Berea deltaic deposit.

With another transgression of the sea, the position of the Be·ea delta receded. The reworking of the submerged Berea sediments, under stable conditions, resulted ir the Berea blanket sand (shoal deposit) as found in Pennsylvania (See Fig. 2 —Berea Time).

The Orangeville shale is the result of the continued transgression of the Berea sea, with a change in source material and less active conditions.



Orangeville Shale
Gray Shale, marine fossils

Bartholemew Siltstone
Gray siltstone, abundant worm burrows

Berea Sandstone
Oscillation ripple marks, evenly bedded, well-sorted and rounded grains.

Gray Bedford Shale
Gray shale, ripple marks, *Lingulids*

Cussewago Sandstone
Friable Ss, steeply dipping cross-beds, plant fragments, marine fossils rare.

Riceville Shale
Alternating shale and siltstone, ossilation ripple marks in an east-west orientation, shallow water fossils, cross-laminations.

Orangeville Shale

The Orangeville Shale was first described by I. C. White, 1881.

It is the lowest member of the Cuyahoga Formation in this area and is the highest unit in this sequence of which 23 ft. is exposed. It is a homogeneous gray silty shale, stained by the disintegration of iron minerals. Locally it has been weathered to a gray clay indicating the presence of aluminum. It is locally fossiliferous, containing specimens of *Orbiculoidea* and *Lingula*. It is interpreted to be a shallow marine deposit with evidence of a muddy and poorly oxygenated bottom.

Bartholemew Siltstone

This outcrop is the "type section" of deWitt when he first described this member in 1951.

Seven feet from the contact of the Orangeville Formation and the Berea Formation is the Bartholemew bed of the Orangeville member. This resistant bed consists of a gray to brownish-gray siltstone which averages less than a foot in thickness. It is characterized by abundant worm burrowings which appear as numerous short curved markings averaging 1/6" in diameter, and 1/4 - 1/2" in length, and are darker than the matrix of the siltstone. These markings, in conjunction with stratigraphic control, make it an excellent key bed.

Berea Sandstone

The Berea Sandstone was first described by J. S. Newberry in 1870.

The Berea is a medium to light gray sandstone-siltstone consisting of very fine to medium-sized quartz grains, which are very well cemented with a siliceous cement. The Berea is considered to be a shoal or blanket sand deposit, which corresponds to the uppermost phase of Berea deposition in Ohio (See Paleogeographic Map, Fig. 1).

Gray Bedford Shale

The Gray Bedford was also described by J. S. Newberry in 1870.

It is a gray thinly-bedded unit, fissile in nature, containing numerous symetrical ripple marks. The Gray Bedford has been interpreted as the interval between the Cussewago Sandstone and the Berea Sandstone (See Paleogeographic Map, Fig. 2). It is considered to be a shallow, low energy marine deposit surrounding the Red Bedford Delta and later covering the Cussewago Delta.

Cussewago Sandstone

This outcrop is the "type section" of I. C. White when he first described this unit in 1881.

In general, the Cussewago is a buff gray to yellow-green medium-grained sandstone, composed of subangular to subrounded, poorly cemented quartz grains which have an extreme tendency towards friability. The sandstone is essentially non-fossiliferous, except for the presence of plant fragments.

Within the formation there is a zonal variance between even bedding as opposed to high- and low-angle cross-bedding. In Crawford County, Pennsylvania, and parts of Ashtabula and Trumbull Counties, Ohio, the surface outcrops of this deltaic deposit are known as the Cussewago Sandstone, but in the subsurface they are generally referred to by well drillers as the Murrysville sand. The Cussewago is considered to be a deltaic deposit with its source area to the southeast. The Cussewago and Red Bedford are contemporaneous (See Paleogeographic Map, Fig. 1).

Riceville Shale

The Riceville Shale was also described by I. C. White in 1881.

Lithologically, the Riceville varies from a gray, tabular siltstone to a fine-grained sandstone, interbedded with gray silty shale and having limonite alteration. Individual cross-laminated beds range in thickness from 1" to 4". The Riceville represents the upper, eastward facies of the Chagrin Shale. It is interpreted to be a near-shore, shallow, marine deposit with its source area lying to the east.

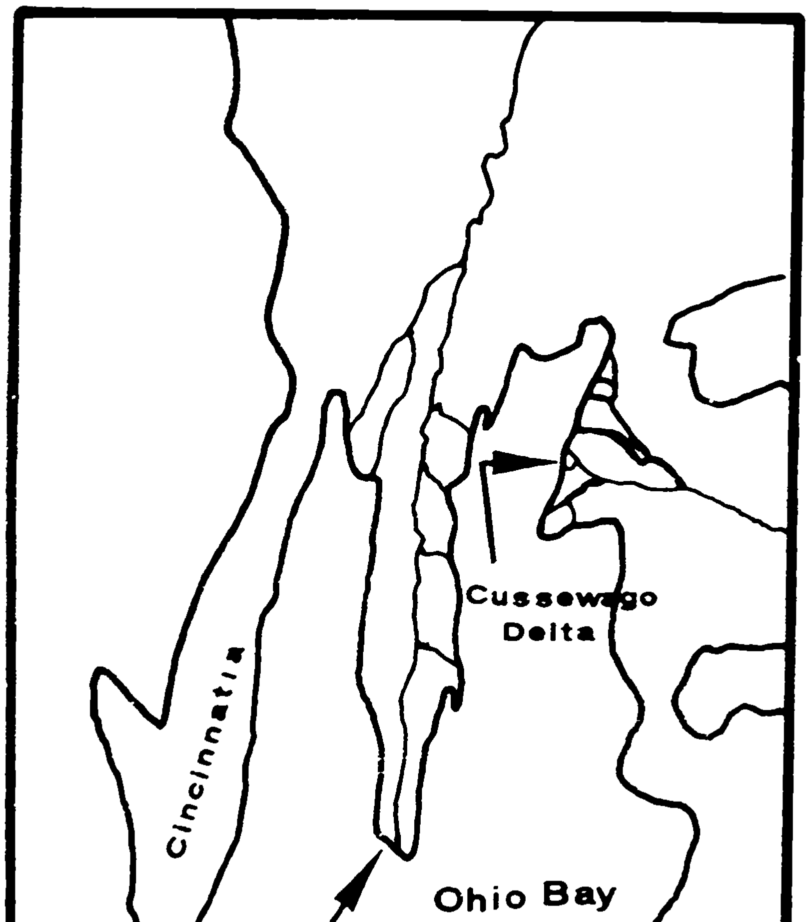


Fig. 1: Paleogeography of
Early Bedford Time.

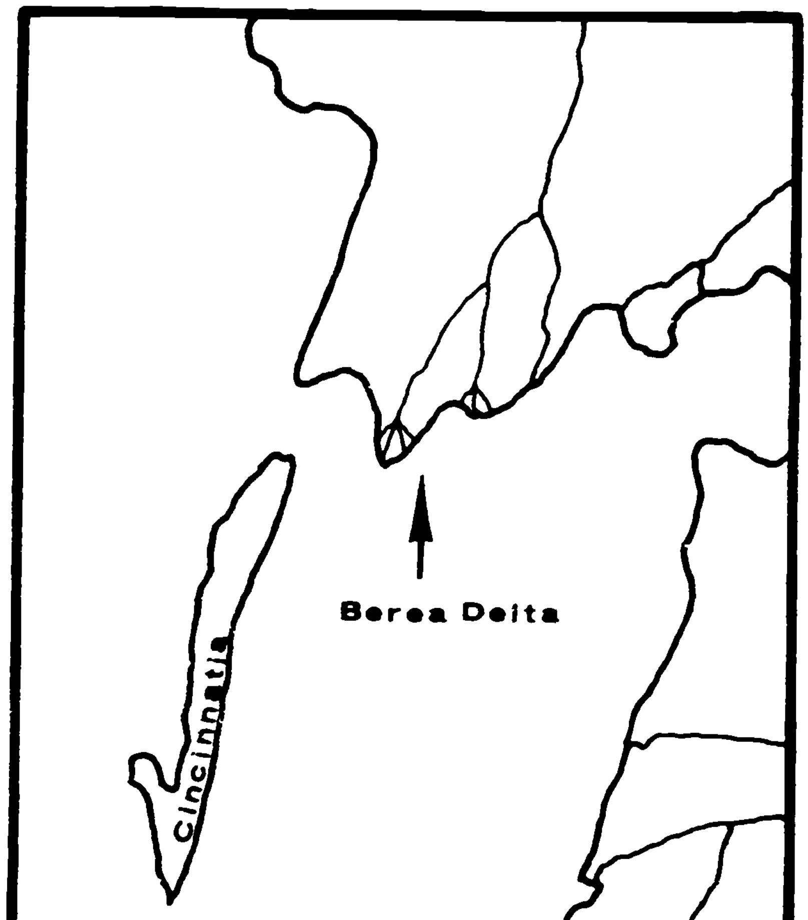


Fig. 2: Paleogeography of
Late Berea Time.

(Adapted from Pepper, deWitt, and Demarest)

Fossils appearing on the fossil plate are representative fossils of the Cuyahoga Formation and related units.

Pictures used in making the fossil plate are from: Szmuc, E. J. (1957), *Stratigraphy and Paleontology of the Cuyahoga Formation of Northern Ohio;* Ohio State Univ., unpublished dissertation, p. 584-623.

EXPLANATION OF FOSSIL PLATE

Fig. 1. *Punctospirifer* sp., brachial valve

Fig. 2. *Punctospirifer* sp., pedicle valve

Fig. 3. *Camarotoechia*(?) sp., pedicle valve

Fig. 4. *Syringothyris* sp., brachial valve

Fig. 5. *Orbiculoidea newberryi*, dorsal valve

Fig. 6. *Rhipidomella missouriensis*, pedicle valve

Fig. 7. *Chonetes pulchellus*, pedicle valve

Fig. 8. *Trigonoglossa flabellula*

Fig. 9. *Rhytiophora blairi*, pedicle valve

Fig. 10. *Rhytiophora blairi*, brachial valve

Fig. 11. *Paraconularia newberryi*

Fig. 12. *Cypricardella* sp., right valve

Fig. 13. *Schellwienella desiderata*, brachial valve

Fig. 14. *Lingula cuyahcga*, ventral valve

Fig. 15. *Lingula melie*, ventral valve

Fig. 16. *Palaeoneilo bedfordensis*, left valve

Fig. 17. *Nucula horightoni*, right valve

Fig. 18. *Paleoneilo truncata*, left valve

Fig. 19. *Modiomorpha* c.f. *lamellosa*, right valve

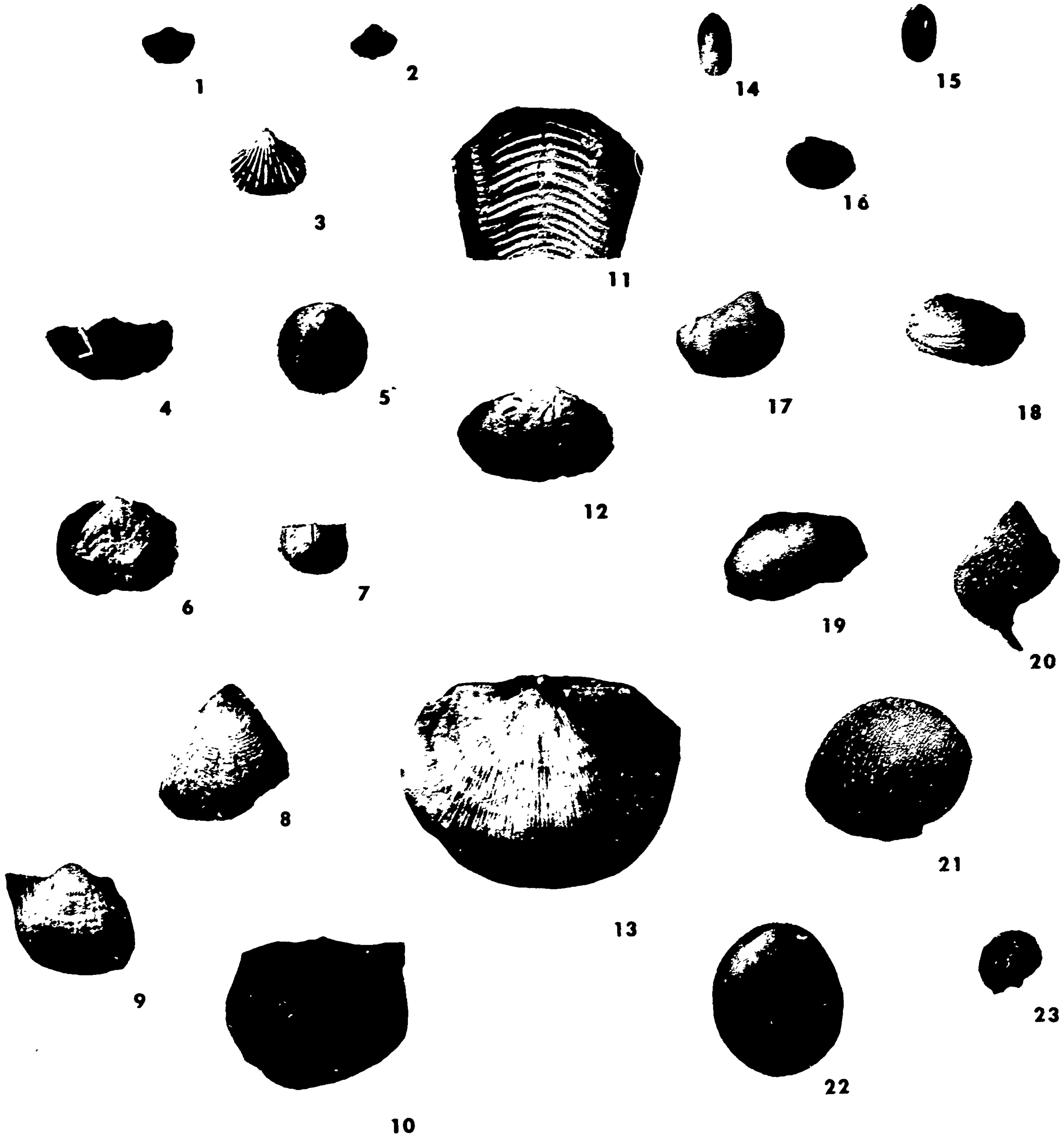
Fig. 20. *Mourlonia* c.f. *textiligera*, side view

Fig. 21. *Imitoceras discoidale*, side view

Fig. 22. *Oelertella pleurites*, dorsal valve

Fig. 23. *Tropidodiscus*(?) *cyrtolites*

Fossil Plate



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