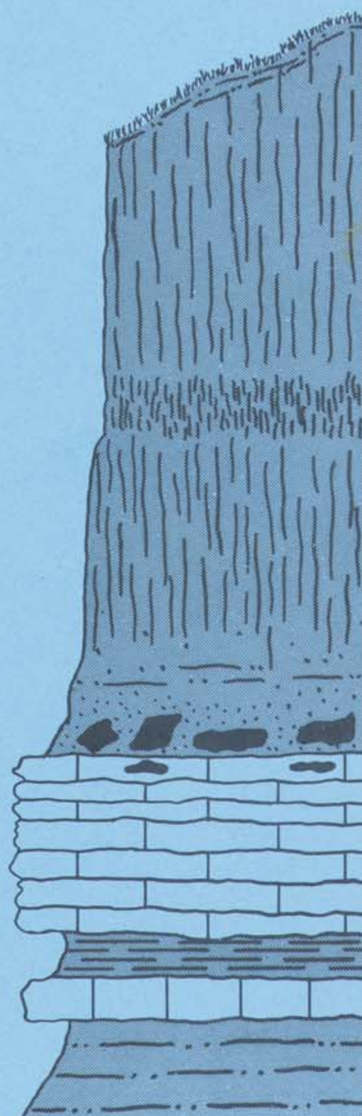
GUIDEBOOK

To Pleistocene and Pennsylvanian Formations In The St. Joseph Area, Missouri



PREPARED FOR ASSOCIATION OF MISSOURI GEOLOGISTS
15TH ANNUAL FIELD TRIP AND MEETING, OCT. 4-5, 1968
WALLACE B. HOWE, CHAIRMAN

Sponsored By Missouri Geological Survey & Water Resources, Rolla, Mo.
William C. Hayes · State Geologist & Director

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By Wallace B. Howe
ASSISTANT STATE GEOLOGIST

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DEDICATION

Garrett A Muilenburg

1889-1968

This guidebook is dedicated to Garrett A Muilenburg, who, through over 50 years of active work in Missouri with the Missouri School of Mines and Metallurgy and the Missouri Geological Survey, and in consulting work subsequent to his retirement in 1958, contributed enormously to the education and development of many of the members of our Association and to our increasing knowledge of Missouri geology.

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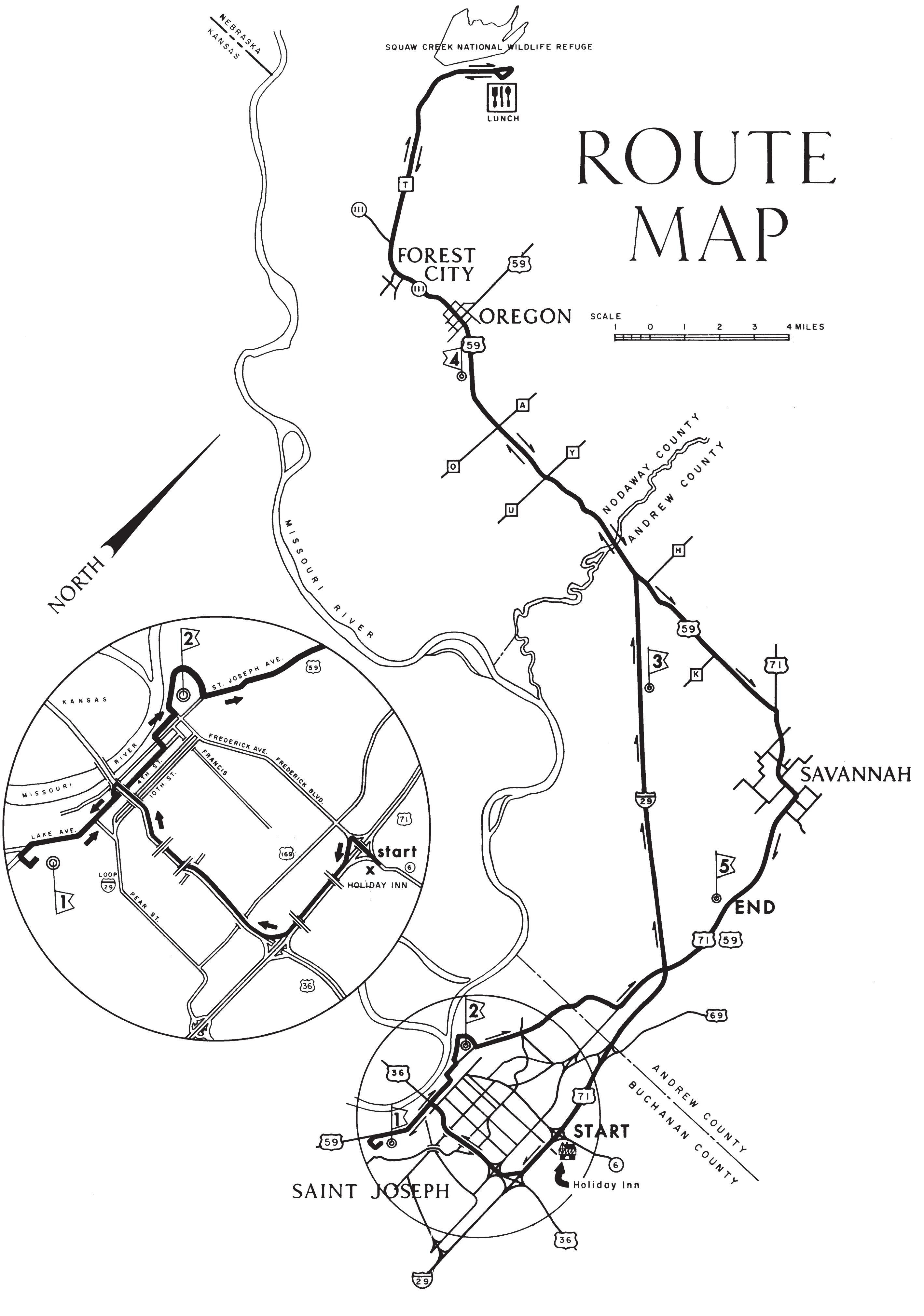
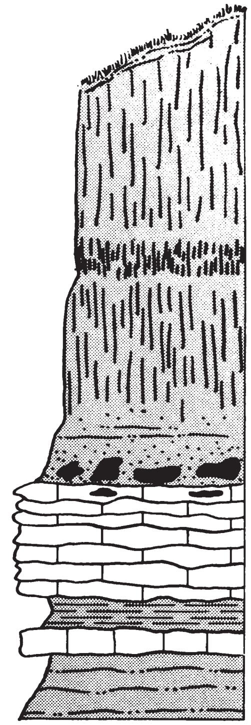
ROUTE MAP


NEBRASKA
KANSAS
SQUAW CREEK NATIONAL WILDLIFE REFUGE
LUNCH
FOREST CITY
OREGON
SCALE
1 0 1 2 3 4 MILES
NORTH
MISSOURI RIVER
NODAWAY COUNTY
ANDREW COUNTY
SAVANNAH
END
ANDREW COUNTY
BUCHANAN COUNTY
START
Holiday Inn
SAINT JOSEPH
KANSAS
MISSOURI
RIVER
LAKE AVE.
ST. JOSEPH AVE.
FREDERICK AVE.
FREDERICK BLVD.
FRANCIS
4TH ST.
10TH ST.
PEAR ST.
LOOP
start
HOLIDAY INN

By Wallace B. Howe
ASSISTANT STATE GEOLOGIST

Pleistocene Deposits And Pennsylvanian Bedrock Formations In The St. Joseph Area, Missouri



INTRODUCTION

At this, the 15th Annual Meeting of the Association of Missouri Geologists, field trip participants have an opportunity to see typical northwestern Missouri Pleistocene deposits as well as some of the economically important Pennsylvanian bedrock strata. Emphasis has been placed on the Pleistocene deposits because of their importance to geologists in determining geological history and the fact that many Association members are not acquainted with them. Excellent exposures of both Pleistocene and Pennsylvanian strata are found in highway cuts, quarries, and borrow pits in this area.

Geologists from the Kansas and Nebraska Geological Surveys met with members of the Field Trip Committee in July 1968 to discuss certain problems with the identification and correlation of some of the Pleistocene deposits. Comments by C. K. Bayne (Kansas) and Vincent Dreeszen (Nebraska) were of particular significance.

The cooperation of Mr. Albert E. Richardson, president, Gordon Brothers Quarries, Inc., Forest City; Mr. Eddy Ray, manager, Tes Trams Social Club, St. Joseph; and Mr. Harold H. Burgess, refuge manager, Squaw Creek National Wildlife Refuge, Mound City, is gratefully acknowledged.

PENNSYLVANIAN BEDROCK UNITS

Pennsylvanian strata (refer to Fig. 1) exposed in the St. Joseph area are of late Pennsylvanian (Virgilian) age, comprising rock types that were deposited in a variety of environments that range from non-marine swamp and deltaic to shallow-water marine. The amazing variety and cyclicity of these deposits is due chiefly to the shifting of environmental parameters as viewed at a given point in space and time. Many individual beds are traced with confidence for hundreds of miles along the outcrop and into the subsurface. Such beds represent deposits that are interpreted as having formed in slowly shifting environmental "belts" and so are of slightly different age at different localities unless such points are along the depositional strike. The uniformity of these beds and the almost mechanical repetition of lithologies in cyclic sequences are phenomena that have fascinated stratigraphers for decades. Foremost among these students of cyclic sedimentation in Pennsylvanian rocks is Raymond C. Moore, whose many papers on the subject are mostly available through the Kansas Geological Survey.

The Virgilian Series comprises the Douglas, Shawnee, and Wabaunsee Groups. The strike of these beds is NNE to NE in the northwestern Missouri area, and they dip gently to the northwest.

Youngest Wabaunsee strata (uppermost Pennsylvanian) are exposed in western Atchison County, in the northwestern corner of the state. The Douglas Group (consisting mostly of shale) is exposed along the river bluffs in St. Joseph and to the south for some distance. There are scattered exposures east and northeast of the city. Basal limestones of the Shawnee Group crop out above the Douglas in the hills at St. Joseph.

Pennsylvanian strata seen at the various stops on the field excursion are all assigned to the Shawnee Group and include: 1) the Plattsmouth, Heumader, and Kereford Members of the Oread Formation, 2) the lower part of the Kanwaka Formation, 3) the upper members of the Lecompton Formation, 4) the Tecumseh Formation, 5) the Ervine Creek Member of the Deer Creek Formation, 6) the Calhoun Formation, and 7) lower and middle parts of the Topeka Formation. Many other Shawnee units, as well as some of the lower beds of the Wabaunsee Group, will be noted in passing in the road log.

Pennsylvanian rocks offer many challenges to the student of geology. Perhaps of most interest to many is their profusely fossiliferous character. Further observation usually indicates that such rocks are not only extremely fossiliferous, but that nearly every bed in a given succession contains a distinctive faunal assemblage. Such assemblages are intimately related to the control of the local environment, as are the lithologic characteristics. The petrology of Pennsylvanian limestones is complex because of the variety of type and relatively large amount of organic material usually present, and because of the variety of limestone that may be present within a relatively thin succession. Field trip participants can collect several limestone types and associated fossils.

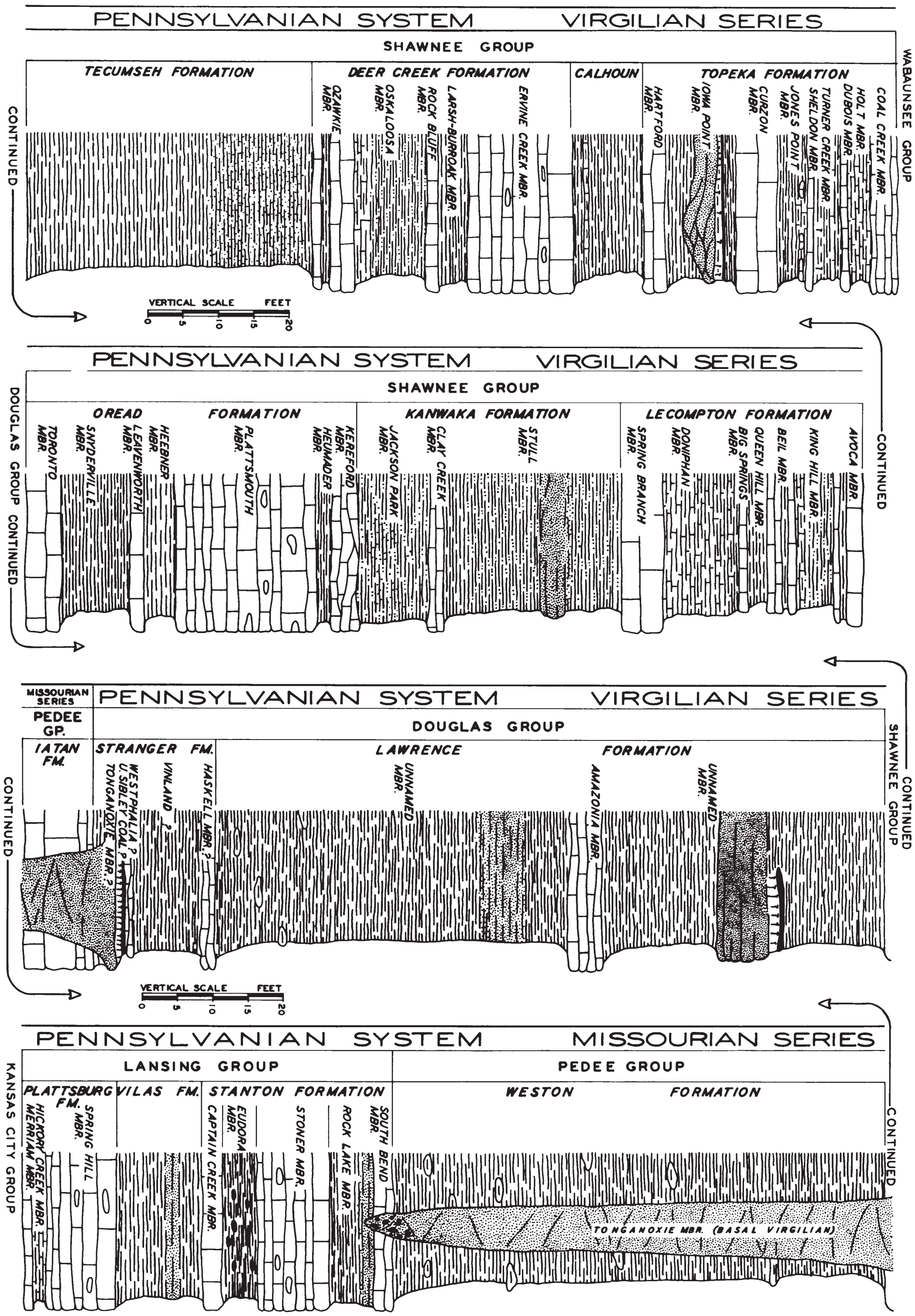


Fig. 1. Generalized column illustrating succession of Pennsylvanian strata in the St. Joseph, Missouri area. The thick channel-fill expression of the Tonganoxie Sandstone is seen only to the south of St. Joseph, in Platte and Clay Counties. Adapted from Figs. 21 and 22, Vol. 40, Missouri Geological Survey and Water Resources.

The Plattsmouth and Ervine Creek limestones, seen at two of the scheduled localities, are the most important limestone units of the northwestern Missouri area because they are thick enough to be quarried profitably for the production of crushed rock and agricultural limestone. Crushed stone acceptable for portland cement concrete paving by the Missouri State Highway Department is not produced from either of these limestones. Aggregate for that purpose is shipped into the area. The Ervine Creek and Plattsmouth, like other similar limestones, vary slightly in character form place to place. Other thinner upper Pennsylvanian limestones have been quarried at various points in northwest Missouri, generally for local and less demanding use.

Economic utilization or potential utilization of other types of Pennsylvanian rock in the area is limited to shale for brick and tile (formerly manufactured at St. Joseph from shales of the Douglas Group) and lightweight aggregate (produced at New Market from the Weston shale). Many upper Pennsylvanian shales are amenable to the production of either of these commodities, market and other factors being the limiting determinants. Coal beds occur in Douglas and Wabaunsee strata in Missouri with considerable tonnages having been mined from beds (principally the Nodaway coal) within the Wabaunsee Group. Coal beds in the Douglas Group do not appear to have ever been mined.

PLEISTOCENE STRATIGRAPHY

Introduction

Pleistocene deposits and Pleistocene history are of considerable importance to Missourians. The widespread and generally favorable influence of Pleistocene deposits upon the character of agricultural soils of northern Missouri and the plentiful supply of potable groundwater generally associated with the deposits that occupy the preglacial valleys are of enormous importance to the general economy of the State. The northern Missouri area was glaciated during early Pleistocene (Nebraskan and Kansan) time, but escaped glaciation during middle and latter Pleistocene time. Pleistocene till and associated deposits covered most of the area north of the Missouri River and extended south at a number of localities. Extensive alluvial and eolian deposits of middle and late Pleistocene age were formed in the northern part of the state and in much of southern Missouri as well. Even though southern Missouri was not glaciated, the Pleistocene Epoch is represented in that region, a fact that is all too often overlooked. Southern Missouri was a periglacial region during early and middle Pleistocene time and to some extent, perhaps, in the latter part of the Pleistocene. An important Pleistocene vertebrate fauna is gradually being brought to light from discoveries in the numerous caves of that region. In Missouri, Pleistocene deposits include glacial, fluvio-glacial, and eolian deposits that range in age from early Nebraskan to Recent (see Fig. 2). Extensively developed and widely recognized paleosols are, in

Time-Stratigraphy		West	N-Central	East
Recent Stage*		Modern soils, valley alluvium		
Wisconsinan Stage	Valderan Substage	Bignell Loess	Not differentiated	
	Twocreekan Substage	Brady Soil	Not differentiated	
	Woodfordian Substage	Peoria Loess	Peoria Loess	Peoria Loess
	Farmdalian Substage	Farmdale silt (?)	Farmdale (?)	?
	Altonian Substage	Absent (?)	Absent (?)	Represented by Roxanna silt at St. Louis
Sangamonian Stage		Statewide distribution Sangamon Soil plus associated deposits		
Illinoian Stage		Loveland Loess valley alluvium (terraces)		Loveland Loess Till deposits in St. Louis County
Yarmouthian Stage		Assumed statewide distribution Yarmouth Soil plus associated deposits commonly compounded with Sangamon Soil		
Kansan Stage		Late Kansan silt and clay as local deposits Extensive deposits of glacial till throughout northern part of state Early Kansan periglacial silt? Proglacial sand and gravel		
Aftonian Stage		Afton Soil plus associated deposits; differentiation possible only locally		
Nebraskan Stage		Glacial till of unknown but possibly considerable original extent Nebraskan periglacial silt Proglacial sand and gravel		

*The adoption of the term Holocene, as a division of Series rank, in substitution for the term Recent in its current usage, is under consideration by the Missouri Geological Survey's Stratigraphic Committee.

Fig. 2. Classification of Pleistocene deposits and paleosols in Missouri.

many localities, the principal basis for division of the Pleistocene sucession. Compared with surrounding states, Missouri is one in which relatively little modern detailed Pleistocene stratigraphy has been done.

The preglacial topography of Missouri is important in the interpretation of Pleistocene history. Because of the considerable information available through water well and test drilling work in northwestern Missouri, it has been possible to delineate the principal preglacial drainageways. Most of the buried valley systems were inherited from topography that presumably developed during the late Tertiary. The present drainage system in northwestern Missouri is a composite of exhumed ancient valleys and superposed valleys associated with streams that developed upon Pleistocene till plains. Floors of the lower reaches of the principal buried valleys lie as much as 100 feet below the beds of present-day streams. This represents down-cutting that took place during one or more of the principal periods of glaciation, when sea level was appreciably lower worldwide.

As shown on Fig. 3, major drainageways in northwestern Missouri included one that extended from northwest to southeast and occupied the locus of the present Grand River valley from a point near Gallatin to its mouth. A major tributary to this stream extended from St. Joseph eastward to a point near Gallatin. The segment of modern Missouri River between Kansas City and the Malta Bend and Marshall areas (in Saline County) was occupied by what has been termed the lower Kansas River valley. The ancient Kansas River and the ancient Grand River joined in the Malta Bend area and formed the ancient Missouri, which flowed essentially along its present course eastward to St. Louis.

The modern Missouri River valley bounding northeastern Saline County is probably a post-Kansan feature as is the upper Missouri River between Kansas City and St. Joseph and segments farther north. Lower Kansas River and the ancient Missouri River below its confluence with the ancient Grand were mostly Kansan ice-marginal streams. Several of the tributary valleys to the ancient Grand River may have been ice-marginal also, although these relationships are far from definitely established. Recent reports by Heim and Howe (1963a; 1963b) summarize much of the information on bedrock topography and Pleistocene drainage history.

Much of the interest in the bedrock or preglacial topography in northwestern Missouri has been associated with the search for increased ground water supply for that entire region. Test drilling work has shown that in some localities the buried valleys are completely filled or are blocked at points by glacial till, while other valleys contain sand and gravel deposits capable of producing large quantities of potable water. In some northernmost counties, interpretation of cross sections prepared from well records indicates that the bedrock surface was generally covered with outwash sand and gravel deposits that were later buried and/or scoured by glacial till. Knowledge of the distribution of the various types of glacial deposits and their relationship to the bedrock topography is limited. The wide variety of types of deposits that may be encountered is recognized; however, sufficient information about their distribution is not available. The

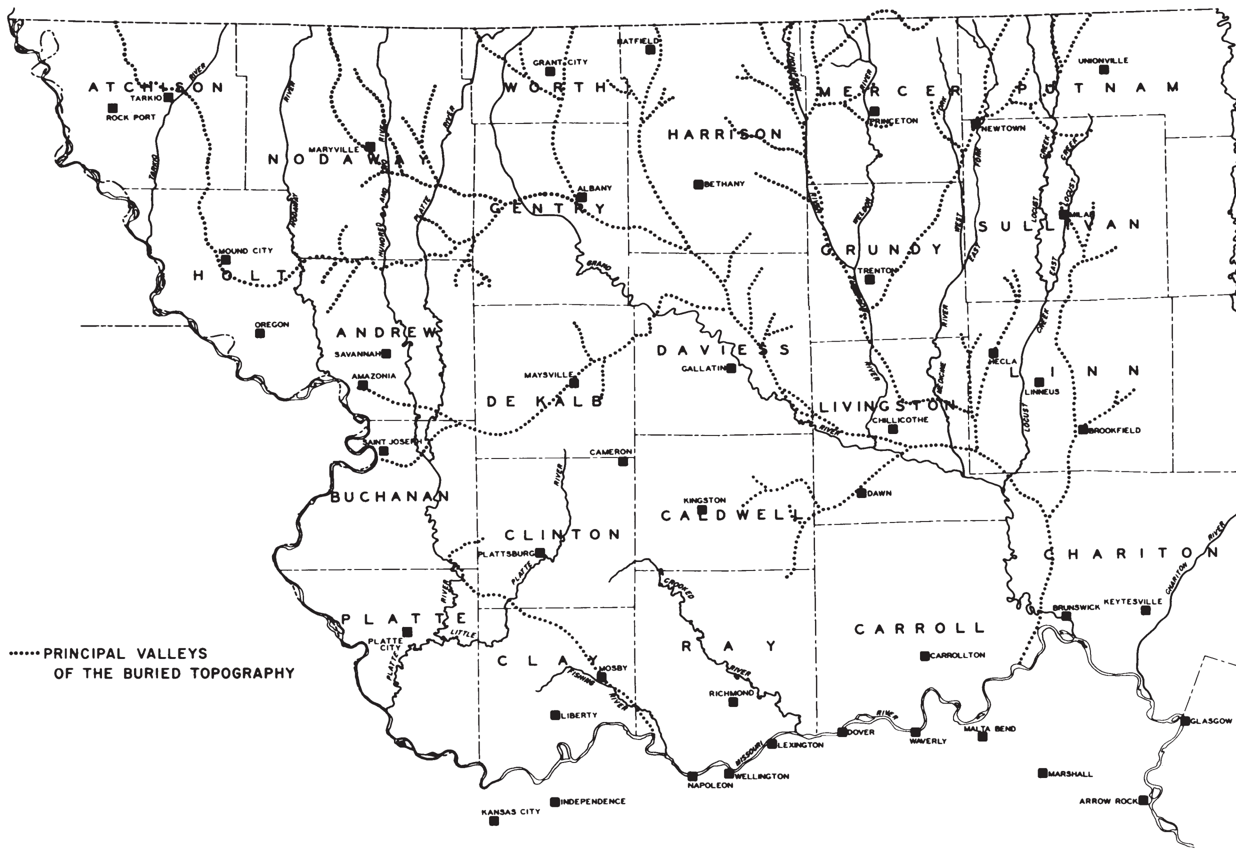


Fig. 3. Buried (shown by dotted lines) and modern drainage pattern in northwestern Missouri (from Fig. 1, Heim and Howe, 1963a).

delineation of the buried and exhumed topography on the bedrock surface is fairly well defined, but these data are only a part of the answer to the problems that exist with water supply. Moreover, many details of the stratigraphic succession have yet to be determined. The general succession of deposits and their inter-relationships is fairly well defined and can be demonstrated in the area.

The Pleistocene Succession

Essential features of the stratigraphic succession of the Pleistocene Series in northwestern Missouri are discussed in the following paragraphs under subheadings identified by stage (age) terms. Order of the units in this discussion is from oldest to youngest.

Nebraskan Stage.-- Nebraskan deposits are generally identified only tentatively or provisionally in Missouri. A portion of the sand and gravel fill in the buried valleys is assumed to represent coarse Nebraskan outwash. There are no known exposures where a sequence within the buried valleys can be established and thus far it has not been feasible to do so from drilling information. The assumption that the buried valley fill includes both Nebraskan and Kansan outwash material is, however, almost certainly valid because the buried valleys or segments thereof served as drainageways during Nebraskan and Kansan time. Proof of the existence of Nebraskan outwash will be feasible when it is possible to delineate significant areas in which Nebraskan till occurs above outwash deposits.

The principal basis for recognition of Nebraskan till is its association in sequence with an overlying till (Kansan) and an intervening soil profile (Afton). Till of Nebraskan age is recognized in outcrop in the Moberly and Macon areas in north-central Missouri: in southern Iowa, near Hopkins, Missouri; and in outcrops in Kansas along the Missouri River bluffs. Nebraskan till also appears to be present at many widely scattered points in the north-central and northwestern Missouri areas, where carefully logged test drilling records are available. No evidence of Nebraskan till has been found south of the buried valley of the ancient St. Joseph River between St. Joseph and Gallatin, Missouri. This valley may have been ice-marginal to the Nebraskan glacier.

Basal till containing few or no northern erratics such as that seen at Stop 5 is not an uncommon type in the northwestern Missouri and northeastern Kansas area. Davis (1955) described similar material from Platte County, Missouri where he identified it as a "local" facies of the Kansan till of that area. Northeastern Kansas exposures that include such a basal till were shown the writer in June 1966 by Howard O'Connor and Charles Bayne. Dort (1966) discusses some of the problems in age assignment of these tills. Bayne and O'Connor (1967) refer them to the Kansan Stage. Such "basal" till facies presumably might be associated with till of either Nebraskan or Kansan age.

A thin silt bed present beneath paleosol tentatively identified as the Afton Soil is exposed at Stop 3. This material is probably a periglacial deposit, possibly equivalent to the Seward or Fullerton of Nebraska. The alternative interpretation offered in the discussion of Stop 3 would suggest the inclusion of two silt units and an intervening paleosol in a periglacial deposit of Nebraskan age. As indicated in the discussion related to Stop 2, there is a possiblity that silt exposed at that locality is also of Nebraskan age. Further studies in northwest Missouri may show that periglacial silt of Nebraskan age is more widespread than present knowledge would suggest.

Till-like material with large amounts of Pliocene chert gravel has been examined in southwestern Clay County exposures. This material, which is deeply weathered, may represent Nebraskan glaciation in the area and force an alternative interpretation of the southern limit of Nebraskan glaciation in the state. Similar relationships exist in the St. Louis region where they have been described by Goodfield (1965). Some of the characteristics of this material, including its intimately mixed associated clay, may have resulted from periglacial processes acting upon older gravel and associated soils, such as the Aftonian soil.

Aftonian Stage.-- New exposures along Interstate 29 (seen at Stop 3) include one of the few exposures of a well-defined paleosol known in northwestern Missouri that can be even provisionally referred to the Aftonian. At the Interstate 29 locality, the paleosol in question is not associated with glacial till, but is underlain and overlain by silt tentatively regarded as periglacial deposits of Early Nebraskan and Early Kansan age, respectively.

Afton Soil was well exposed a few years ago in the overburden of a limestone quarry in southern Iowa just north of Hopkins, Missouri and has been identified in exposures in adjacent northeastern Kansas. Gray leached material above glacial till and below calcareous till referred to the Kansan is recorded in test-drilling logs at scattered points over northern and northwestern Missouri. This probably represents the Aftonian paleosol.

Kansan Stage.-- Most glacial till present in northern Missouri is classed as Kansan. At present there is no basis for division of the Kansan tills in Missouri as has been accomplished in Nebraska by Reed and Dreeszen (1965) who identify two distinct till deposits. Two Kansan tills are also recognized in northeastern Kansas, as reported by Bayne and O'Connor (1967). According to current interpretation, Kansan glaciers overrode the area affected by Nebraskan glaciers in Missouri and extended far to the south where they locally blocked the ancient Kansas River forcing it to develop alternate routes generally marginal to the glacial front. The provisional identification of early Kansan periglacial silt at Stop 3 (along Interstate 29) adds another type of material to be considered and, if correct, suggests that the Kansan till of this part of Missouri may be of Medial rather than Early Kansan age.

Kansan glaciation tended to obliterate most of the pre-existing topography. The early stages of the post-Kansan drainage systems, which presumably were the precursors of those currently in existence, are not clear. Part of the buried sand and gravel fill in some of the old valleys in northwestern Missouri is undoubtedly pre-Kansan material. The fine sand exposed at Stop 2 has been referred to the Atchison Formation of early Kansan age; however, Davis (personal communication) suggests that it may represent Illinoian terrace deposits.

Outwash-derived alluvium developed during recessive stages of Kansan glaciation undoubtedly is associated with valley fill in the ancient Kansas River valley below Kansas City which, for the most part, is the locus of the modern Missouri River. Lacustrine and accretion-gley deposits that are provisionally identified as very late Kansan and early Yarmouthian in age, are widespread in upland regions in Platte, Clay, Clinton, and Caldwell Counties in Missouri, and in certain counties in eastern Kansas. These deposits may have incorporated considerable quantites of late Kansan loess, as well as volcanic ash, and are a composite of lacustrine and accretion-gley types. They have been named the Ferrelview Formation (Howe and Heim, 1968).

Yarmouthian Stage.-- The Yarmouthian Stage is represented in Missouri by a soil profile, the Yarmouth Soil, and by parts of the composite lacustrine and accretion-gley deposits identified as Ferrelview which were deposited at the same time that the Yarmouth Soil was being developed. Well-defined and clearly-differentiated Yarmouth Soil is known in only a few localities in northwestern Missouri. The reason for this is that the next younger deposit, the Loveland Loess (although of widespread distribution) is generally thin and completely incorporated in the profile of the next younger soil (Sangamon). Development of the Sangamon Soil was so intense that, in most areas where the intervening Loveland Loess was deposited, its influence extended all the way through the Loveland and into the underlying Yarmouth. Where the Loveland is absent through non-deposition, the Sangamon is superimposed upon the Yarmouth and may represent a continuation of soil-forming processes (Wright and Ruhe, 1965, p. 31; Howe and Heim, 1968, p. 18). In the absence of the Loveland Loess, the Yarmouth Soil is not commonly distinguishable in Missouri, although its presence is inferred at many points. New exposures seen in July 1968 at Kansas City International Airport (under construction) indicate that considerable weathering of the till and some accumulation of resistant erratics took place prior to deposition of the Ferrelview Formation. The till in that area is assumed to be Kansan and, thus, the pre-Ferrelview weathering probably is Yarmouthian.

Illinoian Stage.-- No Illinoian glaciers reached northwestern Missouri, although Illinoian till is present at St. Louis. Alluvial deposits preserved as terraces have been recognized at a number of points, and as indicated in a preceding section, extensive loess deposits (the Loveland Loess) are recognized. The valley of the modern Missouri River between Kansas City and St. Joseph, Missouri was evidently cut principally during Illinoian time.

Sangamonian Stage.-- The Sangamonian Stage is represented by one of the most intensely developed and most widespread of the Pleistocene paleosols. The Sangamon is recognized over large areas in northern Missouri, and may ultimately be identified even in the Ozark region. It is well defined and widely exposed in the northwestern part of the state. As already indicated, the Sangamon profile may be intimately associated with older profiles so that the identification of the older one may be in doubt. The paleotopography during Sangamon time was such that the Sangamon Soil developed on an erosional surface that in places transected an older one associated with the Yarmouth. The general relationship in the northwestern Missouri area is the development of the Sangamon profile over a wide variety of indurated and nonindurated rock types with the profile itself being overlain by Wisconsinan loess, principally the Peoria Loess.

Generally, in the north-central Missouri area, slope-site exposures of till with the Sangamon profile developed on it include a prominent "lag" or "stone-line" accumulation of resistant erratics, which occur within the Sangamon paleosol or possibly within a composite Sangamon-Yarmouth paleosol.

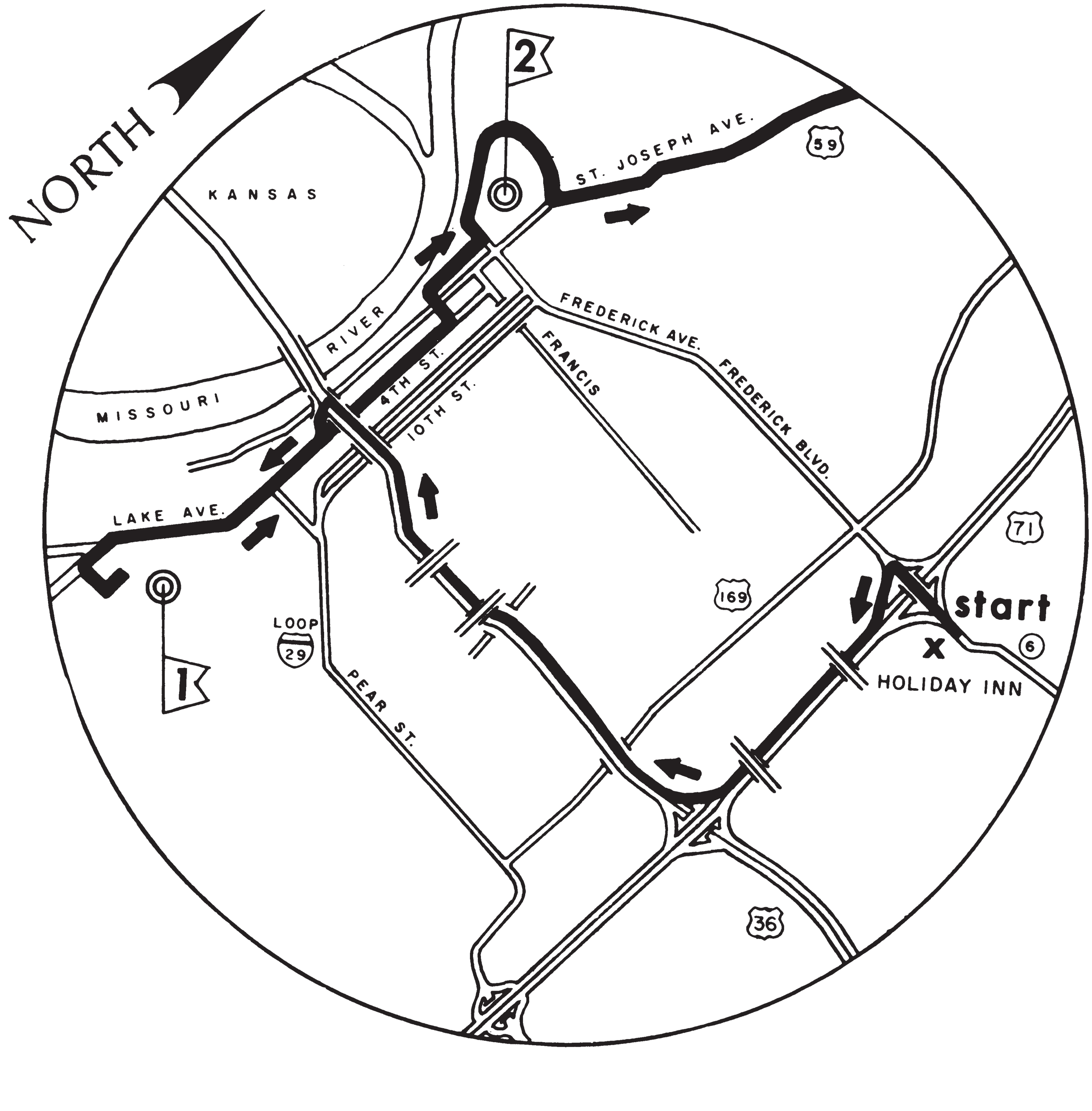
Wisconsinan Stage.-- Wisconsinan deposits in northwestern Missouri include loess tentatively referred to the Farmdale but possibly in part or wholly older than Farmdale, and younger loesses identified as Peoria and Bignell.

Much of the record of early Wisconsinan time appears to be lost in northwestern Missouri. The most reliable estimate as to the age of the Sangamon Soil is 70,000 years, as indicated by a series of summary charts prepared by Frye and associates, including Frye and Willman (1963, p. 6-7). The next youngest deposits in northwestern Missouri are thin clay and silt deposits that are provisionally assigned to the Farmdalian Substage. The Farmdale (?) deposits in northwestern Missouri have produced mastodon remains (Mehl, 1966); fossil ground squirrels collected near Forest City may also have come from deposits of the same age. A single Carbon 14 dating on material collected at the top of silt referred to the Farmdale in northwestern Missouri indicated that the age of these deposits is 25,100 + 2200 years BP (Martin and Williams, 1966, p. 26). Ruhe, Rubin, and Scholtes (1957) have reported a Farmdale radiocarbon date of 24,500 + 800 years BP from western Iowa. Thus, there is a period of about 45,000 years duration in the northwestern Missouri area for which there is seemingly no record. In western Illinois and in the St. Louis, Missouri region, deposits of intermediate age assigned to the Altonian Substage occur above the Sangamon Soil and below the Farmdale deposits. An alternative interpretation is that the 5 to 15 feet of silt referred to the Farmdale in northwestern Missouri (as at Stops 2 and 4) is of Altonian age and the overlying paleosol is the only record of the Farmdalian Stage. This would follow observations made by Frye, Willman, and Glass (1968). The Gilman Canyon Formation (Reed and Dreeszen 1965, p. 42) is a pre-Farmdale unit of early Wisconsinan age. The possibility that a part or all of the silt referred to the Farmdale in northwestern Missouri is directly correlative with the Gilman Canyon should be investigated.

The Wisconsinan Peoria and Bignell Loesses are present in maximum aggregate thickness of at least 100 feet along the Missouri River valley bluffs and are widely distributed in northwestern Missouri. The Peoria Loess is also present in eastern Missouri, where along with thick, slightly older Wisconsinan loess it forms part of a thick loessial succession along the Mississippi River bluffs. The youngest Wisconsinan loess, the Bignell, is not recognized in eastern Missouri and its distribution down the Missouri River valley is unknown. The Bignell is profusely fossiliferous at most localities, containing abundant gastropods belonging to a number of genera. The Peoria is also fossiliferous at many points, where complete leaching has not taken place. These loess deposits are separated by a poorly defined soil horizon called the Brady Soil.

Wisconsinan alluvial deposits appear to compose most of the sand and gravel fill in the valley of modern streams such as the Missouri and Grand rivers. In areas where the modern stream occupies a valley that existed during or even before early Pleistocene time, the alluvial fill is undoubtedly a composite complex.

FIELD TRIP ROAD LOG



FIELD TRIP ROAD LOG

BEGIN ROAD LOG: Starting point is at entrance (exit) to Holiday Inn Motel, on State Route 6, just east of Interstate 29 interchange.

Mileage Cum.	Diff.	
0.00		Leave entrance to Holiday Inn, turning left (west) on Route 6. Cross overpass and turn left to travel south on I-29.
	1.30	Continue south.
1.30		Site of Missouri Western College on the left. This will be a new institution within the University of Missouri system. Plans call for development of a 4-year curriculum by the early 1970's.
	0.50	
1.80		Turn right (west) on U. S. Highway 36.
	0.90	Continue west.
2.70		Overpass Belt Highway (U. S. 71-169).
	1.80	Municipal Golf Course on left.
4.50		22nd Street exit.
	0.95	Move to left lane.
5.45		Turn left (south) on 6th Street, exit ramp. Turn right on 6th Street.
	0.25	
5.70		Stop light: 6th & Hickory. Continue south.
	0.30	
6.00		Stop light: 6th & Atchison. Pick up U. S. 59 at this point. Continue south. St. Joseph's railroad marshalling yards, most of its grain elevators, and its stockyard district are seen to the right.
	0.80	
6.80		Important intersection ahead. Caravan will continue straight ahead -- keep to the left!

0.35

7.15 Stop light: U. S. 59 to right. Caravan continue straight ahead along King Hill Avenue for 1 block to Clayton Street.

0.50

7.20 Turn left (east) up Clayton Street.

0.05

7.25 Turn left (north), and proceed to Russell Street and entrance to Tes Tram Club parking lot.

0.05.

7.30 Enter parking lot and park in rear for STOP 1. Pleistocene exposures.

STOP 1

Note: For description and discussion of the exposures seen at Stop 1 please turn to page 29. Approximately 30 minutes has been allowed for this stop.

0.25 Leave Stop 1, retracing route down to King Hill Avenue.

7.55 Stop sign: Clayton Street and King Hill Avenue. Turn right (north).

0.05

7.60 Stop Sign: U. S. 59 and King Hill. Follow U. S. 59 north.

0.80

8.40 Quaker Oats Products, St. Joseph Structural Steel, and Dugdale Packing Company plants on the right to the east. One of the preglacial valleys (St. Joseph Valley) extends to the east below the Quaker Oats Plant area. The modern Missouri's channel is cut below that of the preglacial valley by 50 to 75 feet.

0.35

8.75 Stop light: Route 59 turns to right. Caravan continue north on 6th.

0.30

9.05		Stop light: 6th & Hickory. Continue north.
	0.25	
9.30		Underpass U. S. 36; continue north on 6th -- watch for trains.
	0.45	
9.75		New Orleans and Ponderosa Clubs on left. Dancing nitely. Go-Go Girls, etc. These organizations are subject to temporary shut-down. Continue north in any event. Watch for trains.
	0.05	
9.80		Stop sign: 6th & Messanie. Turn left (west) on Messanie.
	0.10	
9.90		Stop light: 4th Street. Continue west on Messanie.
	0.05	
9.95		Warehousing complex area; enter on Messanie and turn right on 3rd Street. Continue north on 3rd.
	0.15	
10.0		Charles Street. Continue north on 3rd.
	0.15	
10.25		Felix Street. Continue north on 3rd.
	0.15	
10.40		Stop sign: Jule Street. Continue north on 3rd.
	0.05	
10.45		Faraon Street (one-way); turn left (west) on Faraon. Continue west on Faraon.
	0.15	
10.60		Main Street. Turn left (south) on Main, go 1 block to --
	0.05	

10.65		Jule Street: Turn right (west) and continue past RR tracks and pick up MacArthur Drive which is a river road paralleling the bluff. Continue north for a short distance to STOP 2. Pioneer Sand Company and Holliday Sand and Gravel Company have dredging operations based in the vicinity. Both produce sand for Portland Cement and asphaltic cement concrete mixes; no gravel is produced.
	0.40	
11.05		Stop 2 area Pleistocene exposures (Wyeth Park locality). Park along right side of road and/or in the parking area at the foot of the bluff.

STOP 2

Note: For description and discussion of the exposures seen at Stop 2 please turn to pages 30 and 31.

Approximately 1 hour has been allowed for this stop.

	0.50	Resume trip. Continue north on MacArthur Drive.
11.55		Iatan limestone exposures just above road level on the right. The Iatan is somewhat thinner here than in the type area a few miles to the south.
	0.20	
11.75		Turn right (east) on Paris Avenue.
	0.15	
11.90		Proposed I-229 will overpass Paris Avenue at approximately this point. Continue east.
	0.40	
12.30		Intersection Paris Avenue and Chestnut Street. Continue east on Chestnut. The old cut to the right is known locally as "Dug Cut." The work was done by hand labor and was made to receive the main water lines from St. Joseph's Municipal Water treatment plant located about 1 mile north. Water supply is by direct intake from Missouri River.
	0.55	
12.85		Stop sign: 3rd Street. Turn right on 3rd.
	0.05	

12.90 Turn left onto Middleton Street.

0.05

12.95 Stop sign: 4th and Middleton. Continue on Middleton.

0.10

13.05 Stop light: St. Joseph Avenue (U. S. 59) and Middleton. Pearl Brewery (Nee Goetz) straight ahead. Turn left on St. Joseph Avenue.

0.30

13.35 Stop light: Grand Street. Continue north on St. Joseph Avenue.

0.40

13.75 Stop light: 5th Avenue. Continue north.

0.80

14.55 Entrance to Krug Park on left. Municipal concerts and other civic activities, Krug Bowl, children's playgrounds, etc. Krug Swimming Pool across highway to east. Continue north.

1.10

15.65 Intersection U. S. 59 (St. Joseph Avenue) and State Route K. Continue north-northeast on U. S. 59

0.60

16.25 Upper part of Plattsmouth Limestone exposed in low cuts to right and left. Complete Plattsmouth succession will be seen at Stop 6.

0.20

16.45 Barnes Auto Salvage Yard on right. Attention is called to this in support of Mrs. Johnson's program. Continue north-east on U. S. 59.

0.30

16.75 Junction with Route DD to left, continue straight ahead on U. S. 59.

0.30

17.05 St. Joseph County Club grounds on left. Continue northeast on U. S. 59.

0.75

17.80 Stop sign: Junction of U. S. 59 and U. S. 71. Cross with caution to north-bound lane and continue north on U. S. 59-71. A buried preglacial valley similar to that noted at mile 8.40 is now being crossed. The Pleistocene fill of this valley (Amazonia valley) is exposed along the Missouri River bluffs south of Amazonia on State Route K.

1.80

19.60 U. S. 59-71 & I-29 interchange. Take northbound lane on I-29. Cuts along this segment are all in Pleistocene till with thin loess cover.

1.50

21.10 Overpass State route DD and Chicago & Great Western Railway.

1.60

22.70 Overpass proposed I-229. This will be a major interchange linking the proposed relocation of U. S. 71.

0.80

23.50 Overpass county road.

0.90

24.40 Overpass CB & Q RR and Hopkins Creek.

0.25

24.65 Overpass State Route T. Quarry and stockpile on right. Plattsmouth and Kereford limestones were crushed for 14 miles of I-29 base at this quarry by J. A. Tobin Construction Company. Lower beds of Oread Formation exposed on backslope to right, Plattsmouth Limestone Member exposed

0.50 on the left.

25.15 Lecompton Formation strata exposed on both sides of highway. Black fissile shale is lower part of Queen Hill Member. Upper bed is the Avoca Limestone Member. Most of this succession will be seen at Stop 3.

0.90

26.05 Deer Creek Formation strata exposed on both sides of road. All members are represented in this exposure. Dark gray to black fissile shale is Larsh-Burroak Member. To the north, Upper Deer Creek strata exposed in cuts on both sides of road.

1.45

27.50 Stop 3, Pleistocene and Pennsylvanian exposures. Park with care along right shoulder.

STOP 3

Note: Refer to pages 32-35 for description and discussion.

Approximately 45 minutes have been allowed for this stop.

0.60 Resume trip. Continue north on I-29.

28.10 Ervine Creek Limestone Member, Deer Creek Formation on right. Higher backslope cuts here are in glacial till. Deer Creek, Tecumseh, and Lecompton Formations exposed along route.

2.60

30.70 Junction (with interchange) of I-29 and U. S. 59. Continue west on I-29 - U. S. 59.

1.15

31.85 Cross Nodaway River into Holt County.

0.65

32.50 I-29 (under construction) to right. Continue west on U. S. 59. Exposures on the left from Deer Creek at base through Kanwaka and middle part of overlying Topeka Formation. Upper part of Topeka poorly exposed to the right in 0.4 mile upland area with loess cover above thin till. Sharp S-curve ahead!

2.25

34.75 Junction State Route U (left) and Y (right). Continue west on U. S. 59.

1.95

36.70 Junction State Route O (left) and A (right). Continue west on U. S. 59.

1.75

38.45 Gordon Brothers, Inc. Oregon Quarry on left. This operation will be visited after lunch. Continue west on U. S. 59. Note vertical cuts in thick loess along road. This is a time-tested design for cut stability in loess.

1.25

39.70 City limits of Oregon, Missouri, county seat of Holt County.

0.50

40.20 Junction U. S. 59 and State Route 111. Continue west on 111. Note new Courthouse Building on the left. This replaces one destroyed by fire a few years ago.

0.45

40.65 Leave Oregon. Continue west on 111.

2.00

42.65 Enter Forest City. Junction 111 and route T. Gordon Brothers, Inc., office on left in business district. Follow 111 through town and to the right (north). One of the important reference wells in northwestern Missouri was drilled less than 2 miles SE of Forest City (SE NW Sec. 4, T. 59 N., R. 38 W.) in 1901. This well, State of Missouri No. 1-W. F. Davis, is generally referred to as the Forest City diamond drill hole. It penetrated to a depth of 2500 feet, where it was terminated in the Silurian. The core drilling (actually one of several put down in the very early 1900's) was made possible by a special appropriation by the 40th General Assembly of the Missouri Legislature, during the tenure of State Geologist John A. Gallaher. The appropriated money was used at the discretion of the State Geologist in counties where matching funds were available through local subsription.

0.80

43.45 Leave Forest City. Junction 111 and Route T north. Follow Route T. Shale along road is the Severy (basal Wabaunsee). Thin, slabby limestone seen at grass roots is the Church Limestone Member, Howard Formation.

1.55

45.00 Bridge (one lane) over Kimsey Creek. Continue north. Now entering an area of picturesque loess bluff topography, typical of that present at many other points such as Council Bluffs.

3.15

48.15 Proposed Highway 159 will extend to this point from the west and parallel T to a point north of Sqaw Creek Game Refuge. From there it will extend east to intersect with I-29.

0.40

48.55 Enter Game Refuge Area. Loess bluffs are particularly well defined here. Note abundance of small-scale landslide scars.

1.80

50.35 Enter Squaw Creek National Wildlife Refuge Headquarters area for Lunch Stop.

LUNCH STOP

Approximately 1 hour has been allowed for lunch stop. Rest room facilities are available.

Squaw Creek National Wildlife Refuge serves as an important resting and feeding area for migratory waterfowl as they move between their nesting grounds in the north and the wintering marshes along the Gulf of Mexico. Eatablished in 1963, this 6,809-acrea refuge is administrated by the Bureau of Sport Fisheries and Wildlife. U. S. Fish and Wildlife Service.

As interpreted by Heim and Howe (1962) the principal preglacial drainageway in northwest Missouri extended across Holt County between this point and Mound City four miles to the north. Refer also to Fig. 3. Unlike the buried valleys in the St. Joseph area, this valley (Grand River Valley) is cut somewhat deeper than the floor of the modern Missouri.

0.15

Resume trip.

50.50 Leave Squaw Creek Refuge Headquarters area, retracing route to Junction Highway 111 and 59 at Oregon, Missouri.

10.15

60.65 Junction Missouri State Highway 111 and U. S. 59. Continue east on U. S. 59. Slow for next stop.

1.75

62.40 Stop 4, Gordon Brothers, Inc., Oregon Quarry. Enter and park (Pleistocene and Pennsylvanian exposures).

STOP 4

Note: Refer to pages 36–39 for description and discussion.

Approximately one hour has been allowed for this stop.

Resume trip.

0.55

62.95 Leave parking area, turn east on U. S. 59, and retrace route to Junction U. S. 59 and I-29 east of Nodaway River.

7.60

70.55 Junction U. S. 59 and I-29. Continue east on U. S. 59. Basal Deer Creek exposures at the left.

0.60

71.15 Junction U. S. 59 and Star Route H (north). Continue east on U. S. 59.

1.10

72.25 Davis Roadside Park on the right.

1.90

74.15 Junction U. S. 59 and State Route K (south). Continue east on U. S. 59.

2.25

76.40 Junction U. S. 59 and U. S. 71. Turn right on combined U. S. 59 and U. S. 71.

1.75

78.15 Savannah City limits. Continue on 59-71 through Savannah. Savannah is the county seat of Andrew County, Missouri. Continue south from Savannah on 59-71.

4.90

83.05 Cumberland Ridge Presbyterian Church on right. Slow for next stop.

0.60

83.65 Stop 5, Gordon Brothers, Inc., Savannah Quarry. Enter and park with caravan (Pleistocene and Pennsylvanian exposures).

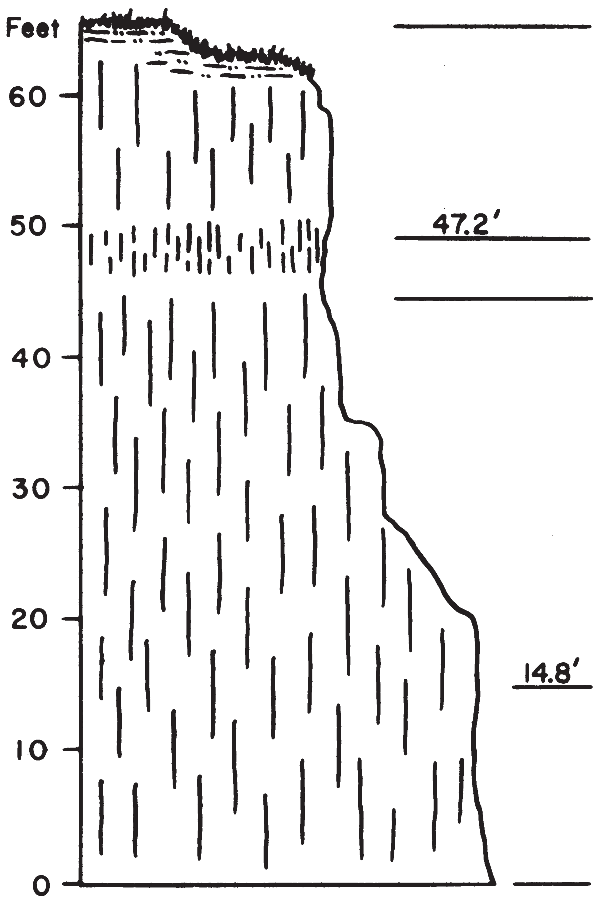
STOP 5

Note: Refer to pages 40-43 for description and discussion.

Approximately one hour has been allowed for this stop.

END OF TRIP.

STOP 1. **South St. Joseph Loess Section in Missouri River bluffs north of Russell Street on the Tes Trams Club property.**



Silt (Bignell); light brownish-gray; poorly compacted, calcareous, profusely fossiliferous with abundant snails.

Silt; clayey; a paleosol identified as the <u>Brady Soil</u>.

Silt; (Peoria); light grayish-brown; slightly calcareous with snails present at many points.

Silt; as above; calcareous, light brownish-gray.

DISCUSSION

Davis and Pauken

The Tes Trams locality has the best available exposure of both the Peoria and Bignell loesses with an intervening Brady Soil. Both of the loesses are fossiliferous at this locality. The paleosol development is distinguished as a band of grayish-brown, non-calcareous loess. Mr. Robert Pauken, University of Missouri, Columbia, located this exposure during a search for suitable sites for Pleistocene snail collection and provided the information on thickness and lithology. Pauken is engaged in a regional study of snails from Pleistocene loesses in Missouri.

NOTES:

STOP 2. Pleistocene deposits (Wyeth Park locality) above MacArthur Drive, north of the foot of Jule Street in St. Joseph, Missouri.

DISCUSSION

Davis and Howe

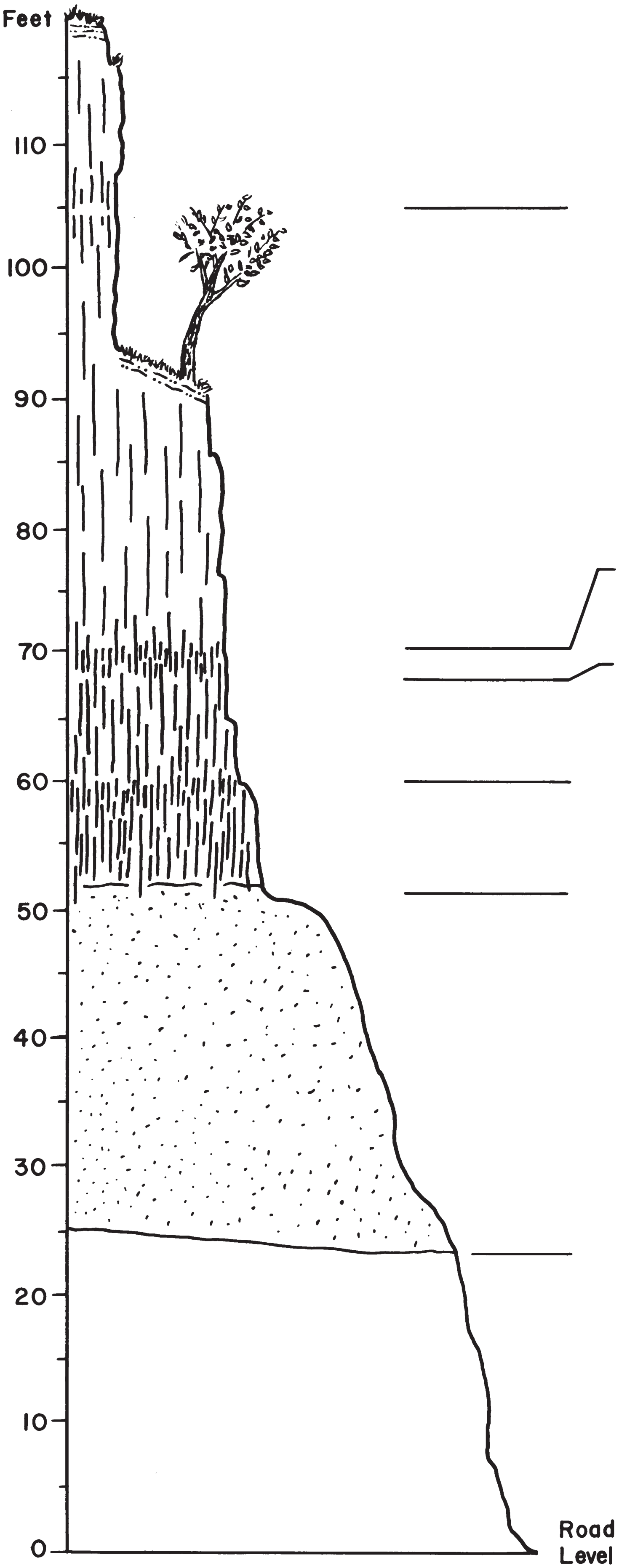
The Wyeth park locality is important to students of the Pleistocene in Missouri because of the exceptional thickness of the Pleistocene succession that is exposed and the large number of depositional and paleosol units that are represented. Many of the inter-related factors involved in the interpretation of such a succession are illustrated at this stop. One of these is the importance of information about the topography prior to deposition of the various units. An early Pleistocene valley is assumed to have occupied a position within the area of the modern Missouri River valley at this point, and probably represented part of an upstream segment of a prominent east-trending buried valley (St. Joseph Valley of Heim and Howe, 1963a) extending to the east from the southern part of St. Joseph. Basal silt seen at this locality may represent ponded sediment deposited during a period of drainage blockage during Nebraskan or Kansan time. The silt closely resembles Nebraskan silt present at approximately the same elevation at a point almost directly across the Missouri River in Doniphan County, Kansas. The silt at the Kansas exposure, shown to the authors by C. K. Bayne (Kansas Geological Survey) includes in its upper part, a well-defined paleosol identified as Afton. The overlying sand probably represents a remnant of Illinoian terrace deposits that occur along an essentially modern course of Missouri River above Kansas City. The loess sequence and associated paleosol above the Illinoian (?) terrace material were deposited or developed upon increasingly precipitous bluffs at the edge of the Missouri River valley. The lateral variations along the bluff are typical. Among the interesting features are the evidence of slump and landslide structures, part of which developed prior to Late Wisconsinan time.

The unit tentatively referred to the Farmdale is the only depositional record of the relatively long period following the development of the Sangamon Soil and preceding the beginning of Peoria Loess deposition. It is provisionally referred to the Farmdale, although it may be an older Wisconsinan unit comparable to the Gilman Canyon (Reed and Dreeszen, 1965, p. 42) of Nebraska, or to a part of the early Wisconsinan Roxanna sequence (Frye and Willman, 1960) of western Illinois. Refer also to discussion of Pleistocene -- STOP 4 and to pages 15 and 16.

In addition to the ancient colluvial deposits, loess mixed with modern rubble can be seen at various localities in the exposure.

NOTES:

STOP 2. Wyeth Park Locality.



Silt (Bignell?); poorly compacted; calcareous and fossiliferous below modern soil horizon; contact with underlying unit poorly exposed.

Silt (Peoria); compact; prominently jointed; several distinct light and dark zones, but entire thickness is referred to single unit.

Silt, clayey; darker than above or below; apparently a well-developed buried soil; horizontal.

Silt (Farmdale?); mottled light pink or tan, with brown and reddish-brown spots; grades into unit below.

Silt, sandy (Sangamon Soil); compact with varying clay content which increases in southern end of exposure; grades into unit below; relict concretions.

Sand; mostly fine but including some medium; loose, friable, well-sorted; unweathered; sharply gradational above; well-defined contact below; Illinoian terrace (?); older material (?).

Silt, possibly Nebraskan, with some clay and very little fine sand; brown color and clay content suggest post-depositional weathering; 3-foot medium to dark brown zone occurs about 6 feet above road level; sand-filled burrows are present locally at the top of this unit.

STOP 3. Pleistocene exposures along Interstate Route I-29. In NE¼ NW¼ sec. 15, T. 59 N., R. 36 W., Andrew County, Missouri.

DISCUSSION

Davis and Howe

New highway construction at this locality has exposed Pleistocene materials not previously reported in Missouri. These deposits are provisionally identified in this Guidebook.

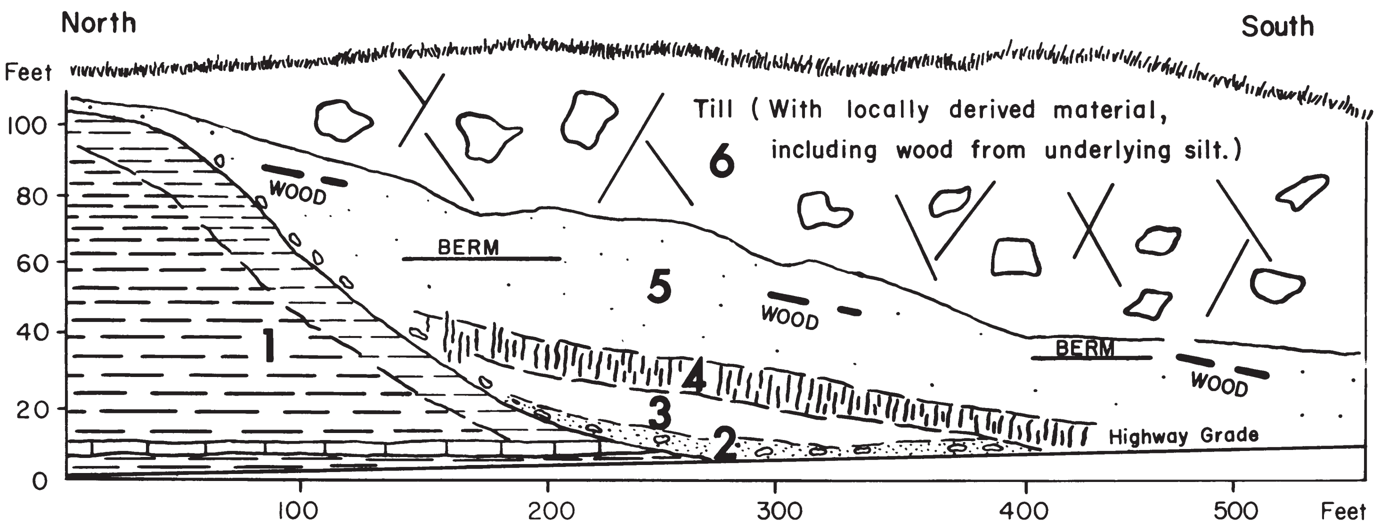
Two (possibly three) weathering horizons are recorded here. The oldest, on the shale bedrock surface and with associated coarse colluvium (Unit 2), may have developed during Pliocene time. A well-defined paleosol (Unit 4) appears to represent soil developed in sandy silt possibly to be referred to the Seward or Fullerton (early and late Nebraskan periglacial silts). The paleosol is provisionally identified as the Afton Soil. Silt (Unit 5) above the Afton (?) Soil is tentatively identified as Kansas periglacial material and referred to the Atchison or Red Cloud. Glacial till rests on the glacially-eroded surface of the upper silt. C. K. Bayne (Kansas Geological Survey) visited this locality with the authors and suggested, on the basis of his experience in nearby areas in Kansas, that Units 2, 4, and 5 are Nebraskan. He considered the upper part of Unit 5 to be the truncated remnant of an Afton Soil.

Regardless of the age assignments suggested, the origin and characterization of the two silt units pose problems. Unit 3 may represent loess-rich colluvium, or periglacial material deposited in a pond or lake. Development of the richly humic soil (4) would have required a peroid of stability, followed by the introduction of more silt (5), with the episode ending in the development of forest cover. Mineralogic studies of the silts would help to establish their essential similarity and probable relationship to glacial materials with respect to provenance.

The tilted attitude of the silt and associated soil is not readily explained. It may represent the effect of compaction.

NOTES:

STOP 3. Interstate 29 exposures.



DESCRIPTION OF UNITS

1. Pensylvanian bedrock -- shale, with limestone at base; well-defined oxidized and/or weathered zone at contact with younger deposits.

2. Limestone and chert cobbles and gravel; silt and clay matrix; no northern erratics observed; less than 1 foot to maxium of about 2 feet.

3. Silt, sandy; dark gray; in sharp well-defined contact with (3) below; maximum thickness about 2 feet.

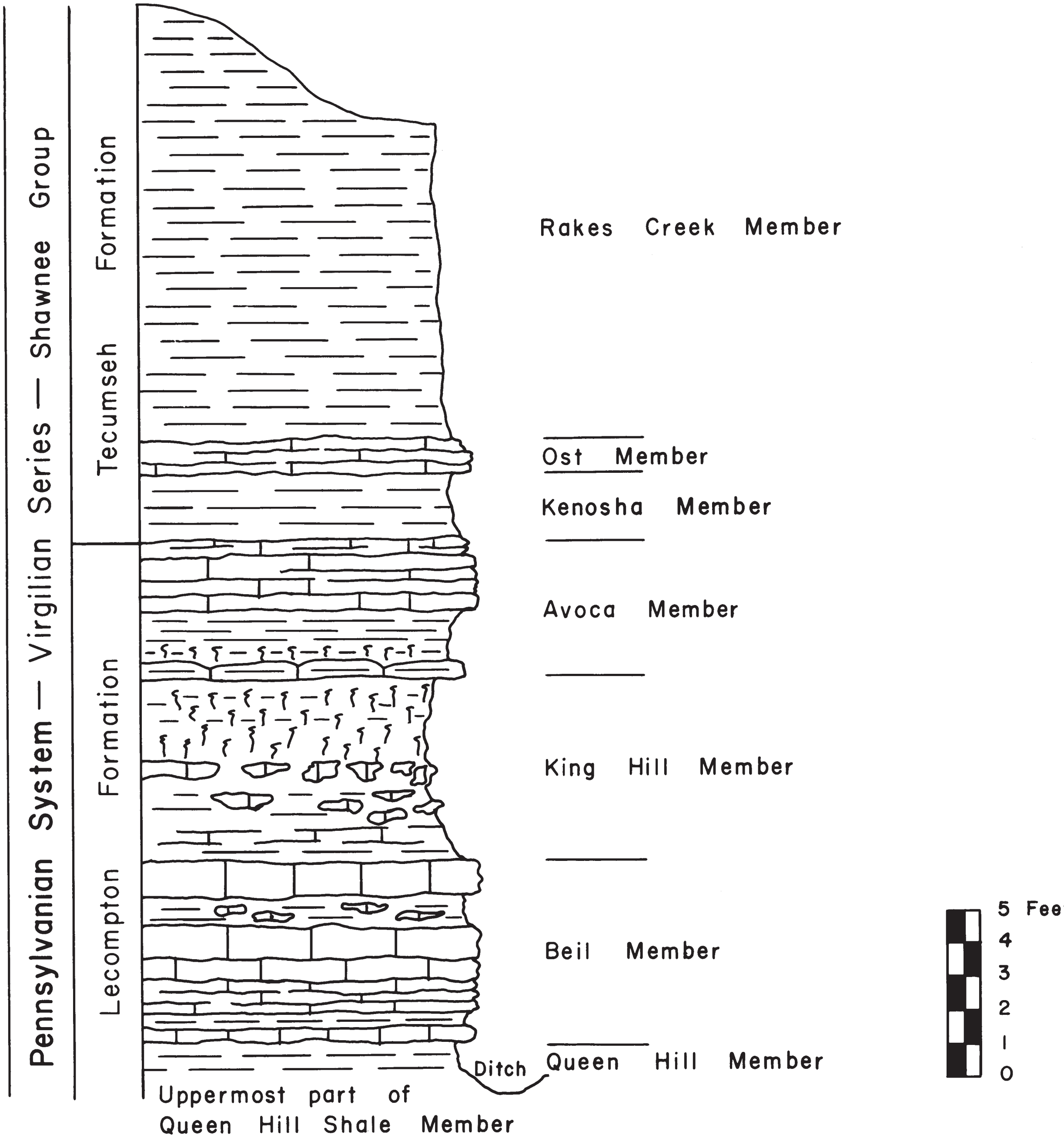
4. Soil; dark brownish-gray; silty; appears to represent period of soil development on unit (3) below; maximum thickness about 3½ feet.

5. Silt, with some fine sand; dark gray, resembling (3) below; coarse wood debris (including pine -- identified by Professor Joseph Wood, University of Missouri, Columbia -- and possibly spruce) common in upper part; upper 2 feet are darker than below and contain secondary calcium carbonate nodules; a few limestone pebbles and granules are found 2 to 3 feet below the top, maximum thickness about 7 feet.

6. Till; unoxidized below -- oxidized and partly leached above, basal part bouldery with dominantly local material; sand pockets in southern part of exposure.

NOTES:

STOP 3. Pennsylvanian exposures along Interstate Route I-29, in NE¼ NW¼ sec. 15, T. 59 N., R. 36 W., Andrew County, Missouri.



DISCUSSION

Howe

Pennsylvanian strata seen here include upper members of the Lecompton Formation and the overlying Tecumseh Formation. The Lecompton comprises seven members, only the upper four being well exposed at this locality. Units of the Lecompton generally appear to be more variable and more argillaceous than analogous units in other formations of the Shawnee Group, although there is no difficulty in tracing the succession over wide areas. Most, if not all of the Tecumseh is exposed here, as rubble derived from the Ozawkie Limestone Member of the Deer Creek Formation occurs at the top of the exposed shale. The three members of the Tecumseh have not been differentiated in former reports owing to difficulty in identifying the Ost Limestone.

STOP 3. Pennsylvanian

PENNSYLVANIAN SYSTEM
VIRGILIAN SERIES–SHAWNEE GROUP

TECUMSEH FORMATION

14. Shale (Rakes Creek Member); medium gray, weathering tan to grayish brown; approximate thickness exposed . . . . 40′
13. Limestone (Ost Member); medium gray; extremely argillaceous, tough, crinoidal . . . . 10″-12″
12. Shale (Kenosha Member); dark to medium gray; includes one and perhaps two carbonaceous zones near base . . . . 2′

LECOMPTON FORMATION

11. Limestone (Avoca Member); coquinoidal, argillaceous; occurs as single massive ledge, although thin and irregularly-bedded; composed almost entirely of fusulines, pelecypods, "Osagia" and other fossil material . . . . 1½′-2′
10. Clay and shale (Avoca Member); gray; lower part is claystone containing fossil wood and coaly material, and is analogous to underclays; upper part is dark gray shale . . . . 1′-2′
9. Limestone (Avoca Member); light brownish-gray weathering to light gray; mostly dense; prevailing laminar character and irregularity suggest unit is essentially stromatolitic . . . . 4″-8″
8. Claystone (King Hill Member); olive- to greenish-gray, with local maroon coloration in lower part; structure of basal part is crumbly compared to more massive material above . . . . 2′-2½′
7. Shale (King Hill Member); calcareous, blocky; grading upward to irregularly-bedded to nodular impure limestone; unit shows considerable lateral variation as do most of the divisions of the Lecompton 2′-6″
6. Limestone (Beil Member); generally resembles unit (4) below; abundant fossils along with large quantities of coated shell debris . . . . 1′
5. Shale (Beil Member); calcareous including some rubbly argillaceous limestone; abundant fossils; seemingly a persistent zone . . . . 8″-10″
4. Limestone (Beil Member); argillaceous; gray, weathering to grayish-brown; irregular to wavy bedding; shaly in lower part with some shaly to nodular limestone, becoming more massive above with a persistent uppermost massive unit; abundant fossils include fusulines, echinoderm debris, fenestrate bryozoa; syringoporid corals, and a variety of brachiopod genera; average thickness . . . . 2′-6″
3. Shale (Beil Member); calcareous . . . . 2″-3″
2. Limestone (Beil Member); argillaceous, a single uneven layer; fossils include gastropods and brachiopods . . . . 3″-6″
1. Shale (Queen Hill); olive-gray; calcareous, with shell debris; exposed . . . . 1″

NOTE: Lower members of the Lecompton are exposed in nearby ravines and road cuts. The three members of the Tecumseh Formation have not been differentiated in previous reports. Unit 10 thins to a few inches in area exposures so that units 9 and 11 may appear to be in contact. Most of the Lecompton units are quite variable in thickness and character, although the general succession is traced over wide areas.

STOP 4. Pleistocene Exposures in Gordon Brothers Oregon Quarry. On Rock Creek, in NE¼ SW¼ sec. 36, T. 60 N., R. 38 W., Holt County, Missouri.

DISCUSSION

Howe and Davis

Pleistocene deposits seen here above the Pennsylvanian bedrock are somewhat different than those of other localities visited at the scheduled stops.

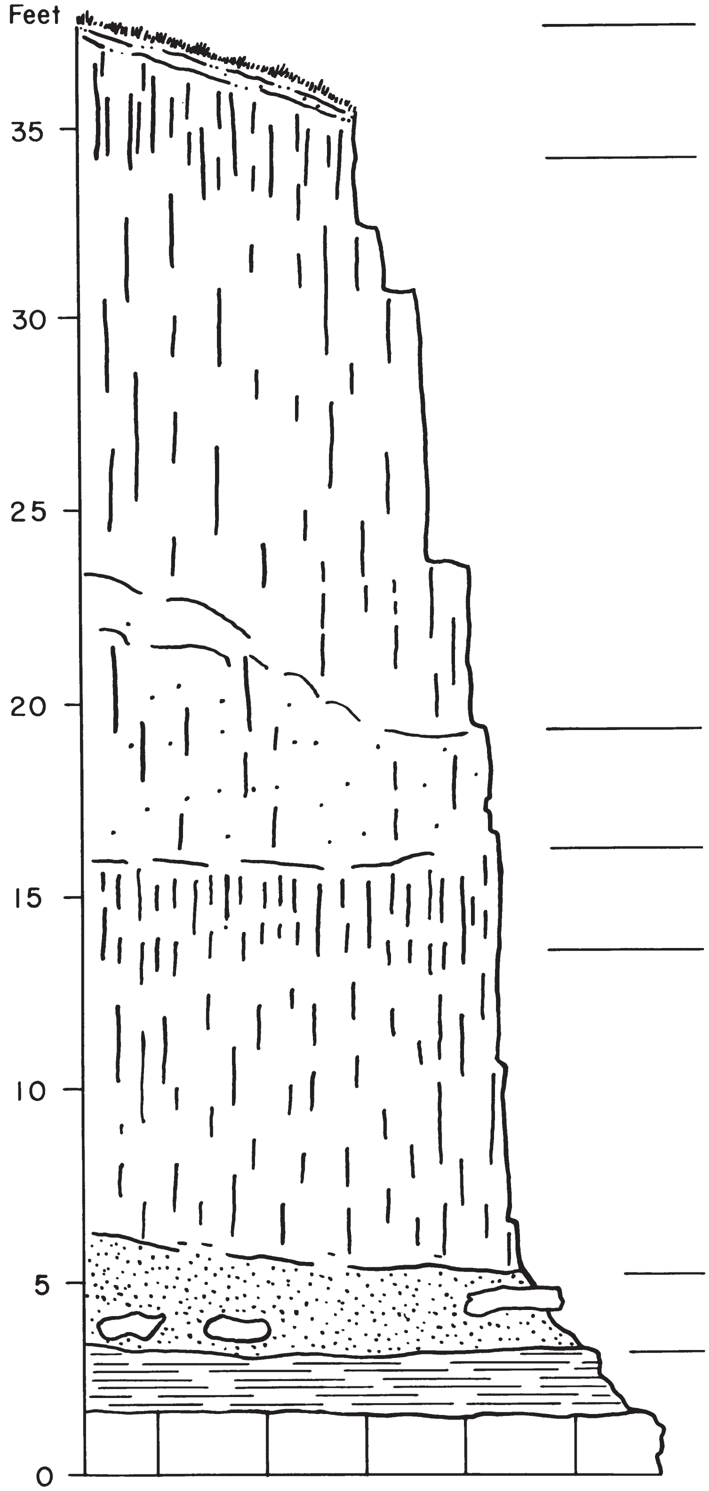
The basal sand and gravel, with cobble- and boulder-sized erratics, are overlain by 10 feet or more of loess referred to the Loveland. The age of the basal material is not known, although the introduced and/or in situ clay development suggests that it may represent Kansan material with a record of Yarmouthian weathering prior to burial by the Illinoian Loveland Loess. Alternatively, detailed investigation may indicate that the clay present in the sand was derived during development of the Sangamon Soil.

The silt (tentatively referred to the Farmdale) appears to be distinct from the overlying Peoria Loess, and rests upon the Sangamon Soil. Silt with similar character and stratigraphic relationships was seen at Stop 2 (Wyeth Park), and has been described (Martin and Williams, in Mehl et al, 1966) at the Grundel Mastodon site in northern Holt County (SE¼ NW¼ sec. 27, T. 63 N., R. 40 W.) where charcoal dated as 25,000 + 2200 years BP was associated with Mastodon remains in the uppermost part of a silt unit. The identification of this unit is in part based upon that radiocarbon date and its comparison with information published by Frye and Willman (1960).

An alternative interpretation is that the Grundel Mastodon date is irrelevant to the underlying material, and that the deposits identified as Farmdale in northern Holt County and those in question at this locality are actually older than Farmdale. The Gilman Canyon Formation (Reed and Dreeszen, 1965, p. 42) of Nebraska is somewhat older than the Farmdale and further study may indicate that post-Sangamon, pre-Peoria deposits such as these should be referred to the Gilman Canyon. Refer also to discussion of Stop 2 and to pages 18 and 19.

NOTES:

STOP 4. Pleistocene at Gordon Brothers Oregon Quarry.



Silt; modern A and B horizons of surface soil.

Silt (Peoria); compact, light tan; well-developed jointing; few scattered concretions -- most of $CaCO_3$ leached.

Silt (Farmdale?); compact; brownish-tan to tan mottled with pink; reddish-brown limonite stains; thickness variable.

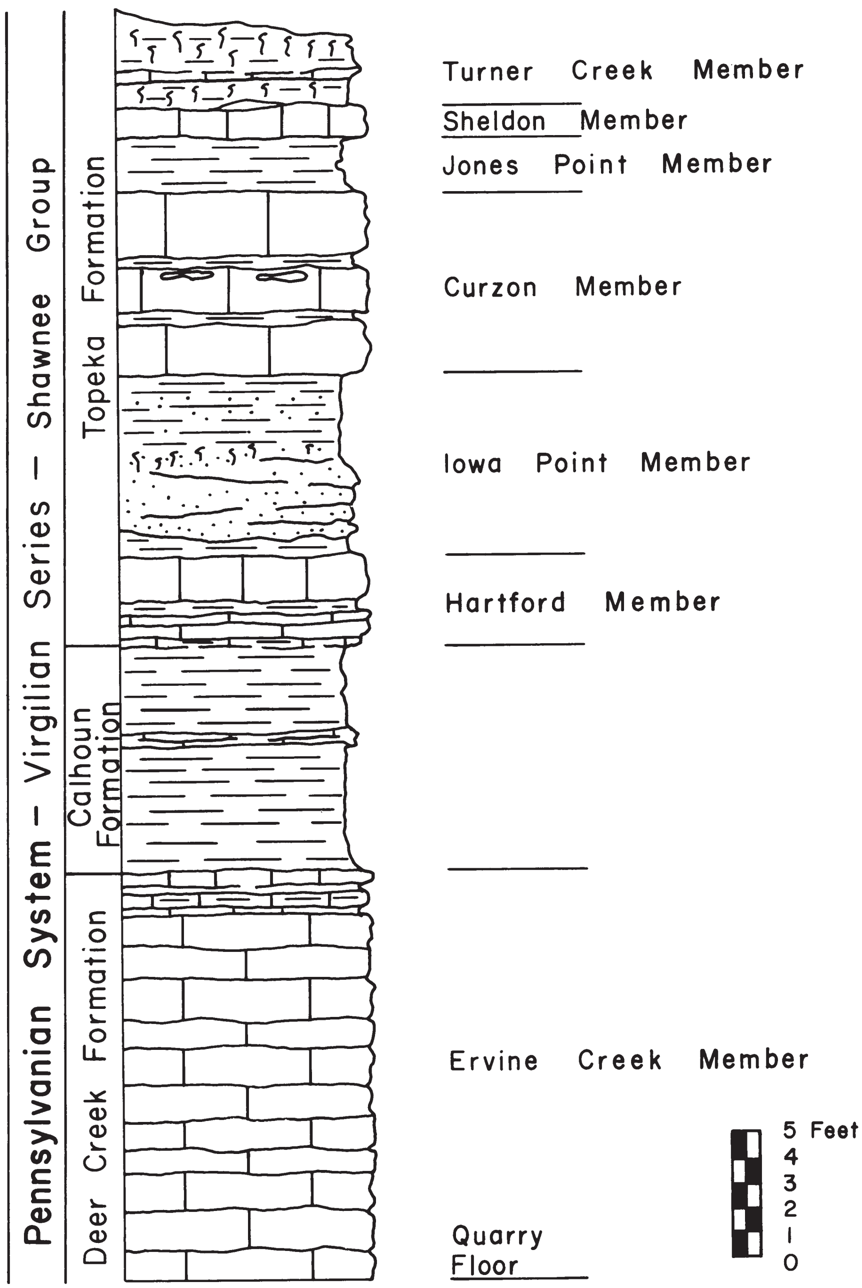
Silt (with Sangamon Soil); reddish-brown; compact.

Silt (Loveland); compact; brownish-tan; upper boundary indistinct or gradational; variable clay enrichment associated with Sangamon Soil development.

Sand and gravel, with associated erratic boulders and cobbles; Kansan?; Illinoian?

Pennsylvanian bedrock.

STOP 4. Pennsylvanian exposures in Gordon Brothers Oregon Quarry. On Rock Creek, in NE¼ SW¼ sec. 36, T. 60 N., R. 30 W., Holt County, Missouri.



DISCUSSION

Howe and Herndon

Pennsylvanian strata exposed here in June 1968 included the Ervine Creek Member of the Deer Creek Formation, the Calhoun Formation, and lower and middle parts of the Topeka Formation. The Ervine Creek limestone is extensively quarried in this part of Missouri, as it is one of two units that can be worked. The stone is not as good as the Plattsmouth. Where it is all represented, the Topeka Formation comprises nine members which can be distinguished readily in most exposures. Topeka units not seen here are exposed elsewhere in southern Holt County, as in cuts along U. S. 59 west of Nodaway River.

NOTE: The description of Pennsylvanian units at this stop was made along the working face during quarry operation and is presented as a field description rather than as a detailed description.

STOP 4. Pennsylvanian.

PENNSYLVANIAN SYSTEM
VIRGILIAN SERIES—SHAWNEE GROUP

TOPEKA FORMATION

24. Claystone (Turner Creek Member?); calcareous; maximum exposed below Pleistocene deposits . 2'-6"
23. Limestone (Turner Creek Member?); argillaceous; lenticular .... 2"-6"
22. Claystone (Turner Creek Member); calcareous; with rough limestone nodules .... 9'-12"
21. Limestone (refer to Turner Creek?); argillaceous; lenticular .... 0-6"
20. Limestone (Sheldon Member); light brownish-gray, weathering light gray with extremely rough surface; interpreted as an exceptionally compact coquinoidal osagite .... 12"-16"
19. Shale (Jones Point Member); olive-gray; calcareous .... 2'
18. Limestone (Curzon Member); a single massive layer of argillaceous possibly dolomitic limestone that weathers easily and to a reddish-brown color; rock is mostly medium textured .... 2'-6"
17. Shale (Curzon Member); calcareous with abundant fossils .... 4"-6"
16. Limestone (Curzon Member); argillaceous; generally like unit (18) above; abundant bryozoa; thin chert band near top of single massive bed .... 18"-20"
15. Shale (Curzon Member); calcareous with abundant fossils .... 4"-6"
14. Limestone (Curzon Member); single massive ledge like unit (18) above; coarse conchoidal fracture . 2'
13. Shale (Iowa Point Member); silty to sandy; micaceous; contains abundant carbonized plant debris 2'-3'
12. Sandstone (Iowa Point Member); in part strongly calcareous, but contains plant debris throughout and a stigmarian zone at the top; rests with irregular contact with underlying shale .... 3'-4'
11. Shale (referred to Iowa Point); gray; argillaceous .... 6"-12"
10. Limestone (Hartford Member); medium gray; mostly medium-textured with some crinoidal debris; apparently consists mostly of comminuted shell material some of which is coated with Osagia . 1'-10"
9. Shale (Hartford Member); dark and carbonaceous at base, gray and calcareous above .... 4"-6"
8. Limestone (Hartford Member); dark, dense and extremely argillaceous at base, grading up to medium- to brownish-gray, medium-textured limestone above; contact with underlying shale is sharply transitional; upper part of this bed contains prominent masses of material probably algal in orgin . 12"-14"

CALHOUN FORMATION

7. Shale, medium- to dark-gray; sub-fissile; pectinid clams and lingulids throughout; probably sharp transition with bed below .... 4'
6. Limestone, shaly; and calcareous shale; a distinct unit; fossiliferous; average .... 6"
5. Shale; dark gray, soft; contains clams and lingulids much like (7) above; vague impressions suggest coarse plant debris; silty laminae in upper part .... 5'

DEER CREEK FORMATION

4. Limestone (Ervine Creek Member); an upper bed that consists mostly of Osagia-coated debris with scattered productid and Composita shells; average .... 6"
3. Shale; varying from a parting to as much as .... 2"
2. Limestone (Ervine Creek Member); argillaceous laminated, and probably silty in upper part; includes a generally but not always distinct lower part that is a massive dark calcareous shale packed with molluscan debris including a predominance of gastropods, unit persistant in occurence but variable in thickness .... 4"-10"
1. Limestone (Ervine Creek Member); light brownish-gray; mostly medium textured in relatively thick (1'+) slightly irregular beds; argillaceous to shale limestone associated with most of the bedding planes; fusulines are abundant throughout and probably are most common fossil; some silicification along porous coquinoid zones, but no well-defined chert observed; probably all but a few inches of the Ervine Creek included in indicated thickness .... 14'-6"

Quarry floor ....

STOP 5. Pleistocene exposures in Gordon Brothers Savannah Quarry, in N½ sec. 34, T. 59 N., R. 35 W., Andrew County, Missouri.

DISCUSSION

Davis and Howe

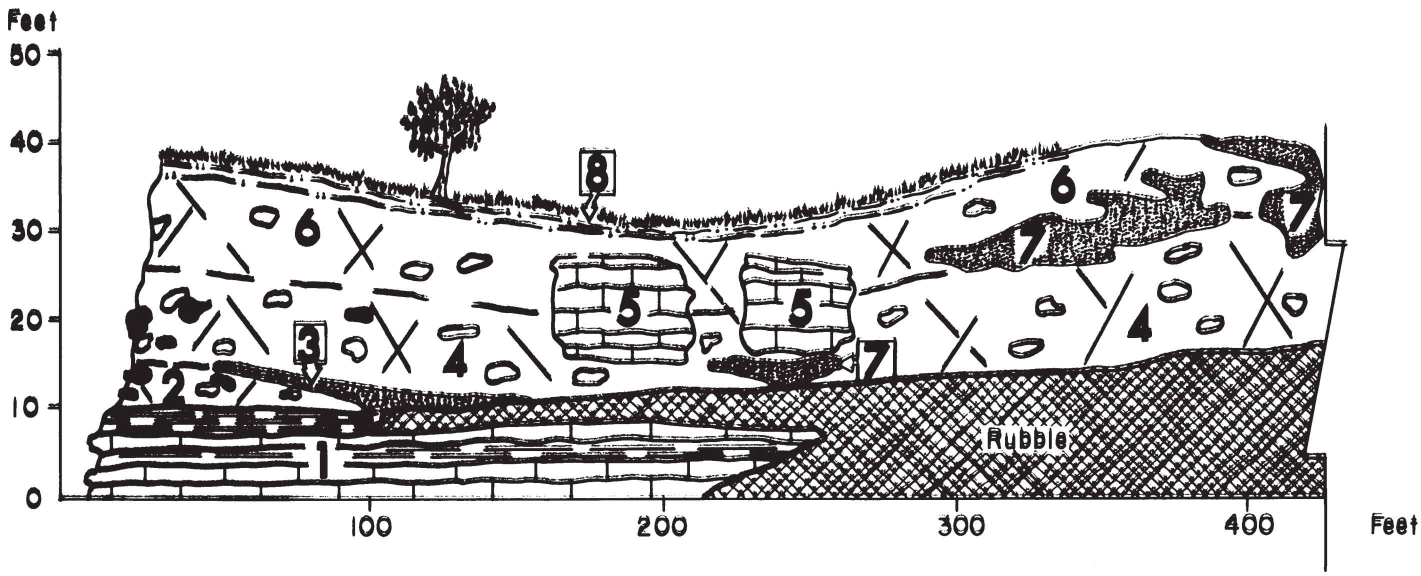
The description and sketch of the Pleistocene deposits seen at this locality were prepared in May 1968 and, understandably, some of the features seen at that time may not be available now. Subsequent minor slumping and further quarrying activity notwithstanding, this exposure is an extremely instructive one. Not only are many features typical of glacial deposits illustrated by exceptional exposures, but some atypical relationships are seen as well.

Perhaps the most important unit seen at this locality is a basal, erratic-free, till. This material, while it may be interpreted as solifluction debris, appears to be a bona fide till, either, 1) distinctly older than the overlying till seen above at this same locality or 2) a basal debris "facies" of the principal till seen here. No intervening paleosol which might resolve the problem is present at this locality. The possibility that one existed but was eroded prior to or concurrently with the advent of the later glaciation requires consideration. Dort (1966) and Bayne and O'Connor (Personal Communications; 1966; 1968) have indicated that similar till in an adjacent area in Kansas is separated from younger, overlying till by a soil profile. At this locality, the "basal" till is overlain by a thin and irregular layer of pebbly sand, and there is no evidence to suggest, 1) whether one or two tills are represented or 2) whether it (they) are Nebraskan or Kansan.

Other noteworthy features at this locality are, 1) the "upper" till, including much of the medium gray, unleached and unoxidized material not commonly seen in natural exposures, 2) the large limestone block erratics which were derived form the Ervine Creek Member, and 3) prominent distorted sand inclusions which represent incorporated masses of sand.

NOTES:

STOP 5. Gordon Brothers Savannah Quarry.



DESCRIPTION OF PLEISTOCENE UNITS

1. Pennsylvania bedrock -- shale and limestone.

2. Till (?); a boulder and cobble zone with silt-clay matrix; essentially unleached; all large clasts are limestone and make up about 20 percent of volume; erratics are present but constitute less than 1 percent of clasts over 4 mm in diameter; color light greenish-gray; mass includes some shale-rich streaks; some oxidation of sandy portions; contains scattered small twigs; basal contact nearly horizontal; jointing distinctly less pronounced than in overlying till.

3. Sand; mostly coarse, with pebbles of foreign rock types; maximum thickness about 1 foot.

4. Till; medium to dark gray except along prominent joints; unleached and unoxidized except along joints; clay-rich; erratics constitute 10 to 40 percent of coarser clasts.

5. Limestone blocks; exposed part of largest measured 15 x 36 feet; completely surrounded by till.

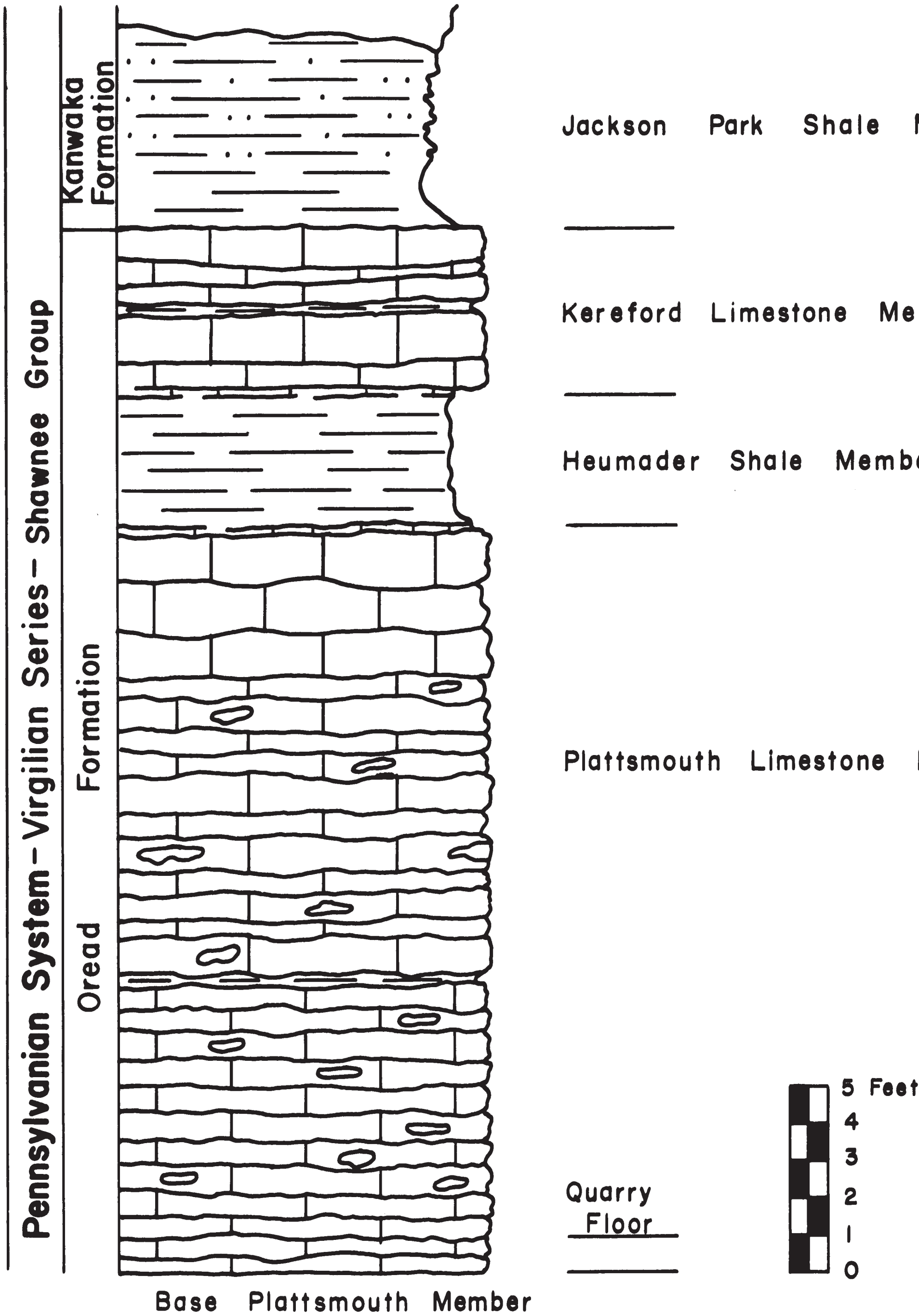
6. Till; oxidized and in large part leached; maximum thickness about 11 feet.

7. Sand; loose and friable; as large masses with contorted margins; medium to coarse.

8. Modern soil zone; A and B horizons together are about 3 feet thick.

NOTES:

STOP 5. Pennsylvanian exposures in Gordon Brothers, Inc., at Savannah, in N½ sec. 34, T. 59 N., R. 35W., Andrew County, Missouri.



DISCUSSION

Howe, Herndon, and Wortham

Pennsylvanian strata exposed in this quarry include the Plattsmouth, and the lower part of the overlying Jackson Park Shale Member of the Kanwaka Formation. The Plattsmouth has been the source of much of the commercially produced crushed stone in the area, being one of the two limestone units that are generally suitable for that purpose in this part of Missouri. The Kereford is also utilized for stone when it is feasible. Locally, it thickens and rests directly on the Plattsmouth so that quarrying of both units is possible without an additional stripping operation to remove the Heumader shale.

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