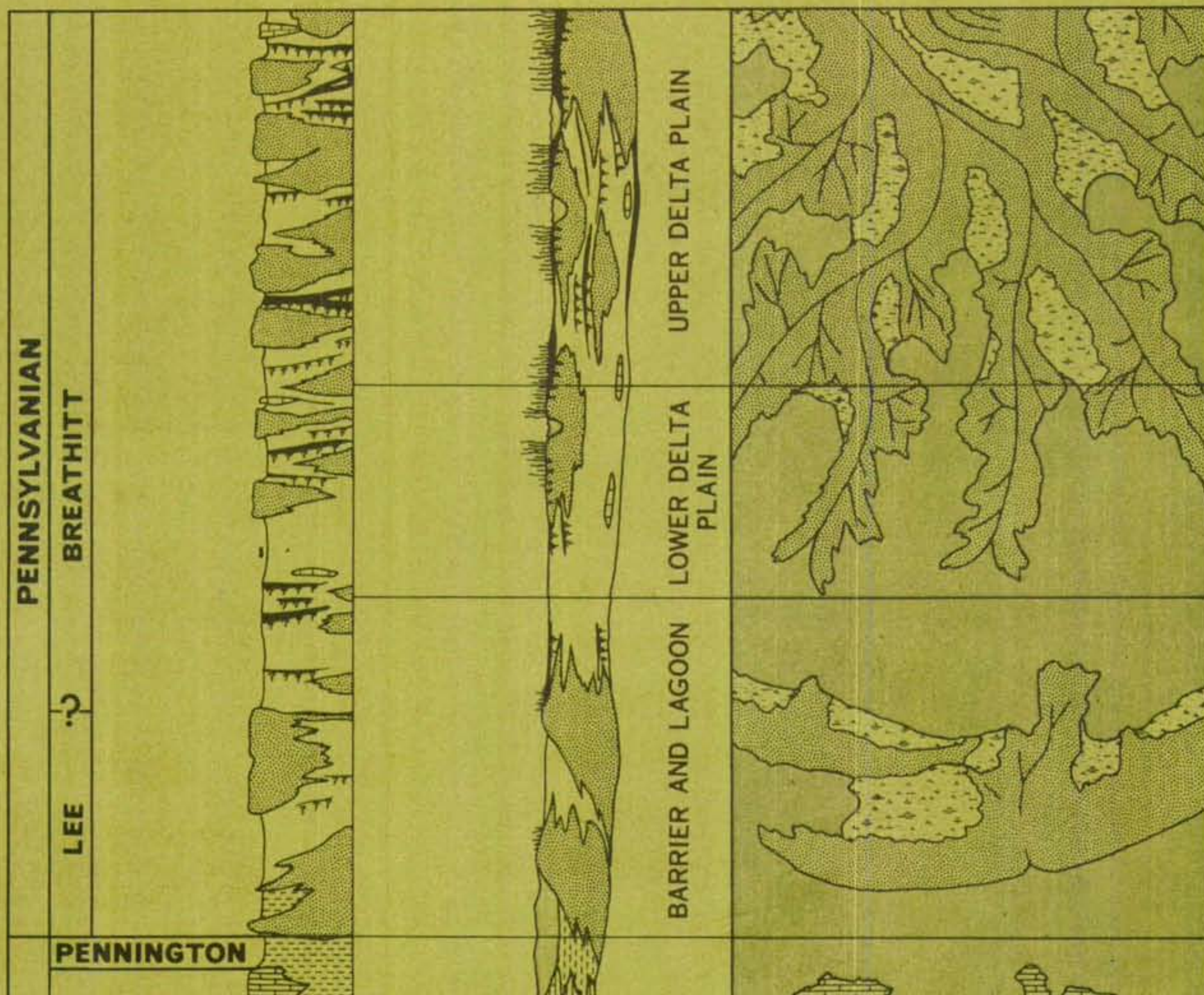

DEPOSITIONAL ENVIRONMENTS OF EASTERN KENTUCKY COALS

PREPARED BY
KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY
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ANNUAL FIELD CONFERENCE
COAL DIVISION
GEOLOGICAL SOCIETY OF AMERICA
October 29-30, 1971

DEPOSITIONAL ENVIRONMENTS OF EASTERN KENTUCKY COALS

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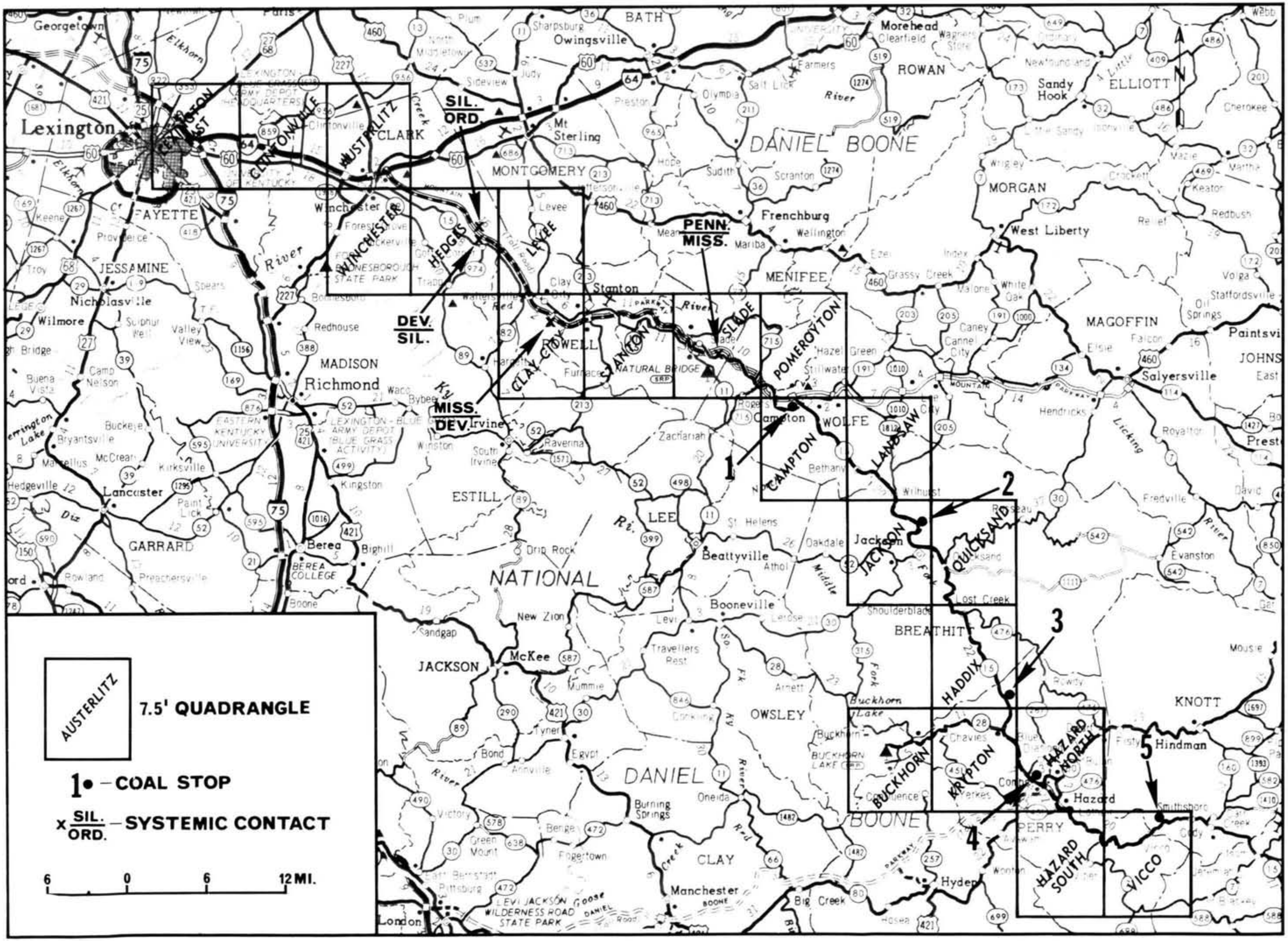


Map showing route of field trip.

DEPOSITIONAL ENVIRONMENTS OF EASTERN KENTUCKY COALS

INTRODUCTION

Gilbert E. Smith

In seeking to bring the Coal Division to the coal fields of Kentucky, a choice of a meeting that would be near enough was necessary. Washington, D.C., in 1971 seemed the best opportunity for many years.

During the past few years, highway building in Kentucky has left many exposures of the rocks that are a delight to the geologist. Those of us who were used to small exposures, or cores for that matter, now have the opportunity to look at sheer cuts several hundred feet high and in some places over a mile in length. The explanation of what we see requires a whole new concept, and much of it is being developed in Kentucky. A field trip held last April by the Geological Society of Kentucky introduced this new concept to many people, and the interest generated there led to the decision to show another area on this trip.

Since Lexington is located near the crest of the Cincinnati arch and we must travel across rocks much older than Pennsylvanian to reach our main area of interest, we have prepared a guide for these rocks which will show the major time breaks of the Ordovician-Silurian, Silurian-Devonian, Devonian-Mississippian, and the Mississippian-Pennsylvanian as we go. The mileage log has been broken at the start of the Mountain Parkway to permit usage of the mileposts by those who follow us in the area. The road log and descriptions of the rocks for this pre-Pennsylvanian part of the trip (Part 1) were prepared by Garland R. Dever, Jr. of the Kentucky Geological Survey and are presented in more detail since we will not be stopping to examine these rocks.

Many studies have been made of the Pennsylvanian rocks in Appalachia, primarily for economic reasons. The vast coal deposits are once again being sought after as the need for energy rises. Areas far from road or railroad, long thought to be too far from market, are now being evaluated. At this writing some 1800 mines have been licensed by the Kentucky Depatment of Mines and Minerals to operate in eastern Kentucky, and over 65 million tons will be produced from these mines this year.

The environmental descriptions of the Pennsylvanian rocks were prepared from the extensive notes of John Horne made from over 200 exposures along the 72 miles of the trip. John also prepared the detailed descriptions and drawings for Stops 1, 2, and 4. Peter Whaley gathered data, made detailed descriptions, and prepared the drawings for Stop 3. John Ferm spent time in the area with the other workers and served as advisor for their interpretations and descriptions of the stops.

The basal orthoquartzitic sandstones of the Lee are considered beach-barrier deposits which have become quartz enriched by reworking. These massive sandstones formed the barriers between the coal-forming areas on the landward (southeast) side and the open sea. Immediately behind the orthoquartzitic sandstones are the back-barrier lagoonal deposits of relatively thick dark shales and siltstones.

These bay fills contain scattered limonite nodules and beds, thin overwash sandstones from the barrier, and a few distributary-bar sandstones. The coal beds are thin and not persistent. Upward through the lower delta plain deposits toward the Whitesburg-Fire Clay coal zones, the sandstones are more numerous and the coals become thicker and more widespread. From the Whitesburg-Fire Clay coal zones upward through the section, sandstone becomes the major lithology, and the bay-fill sequences become thinner, with some containing marine fossils. These beds are characteristic of upper delta plain deposits.

Figure 1, prepared by Horne, shows the relationships of the Carboniferous rocks between Pine Ridge and Vicco. This cross section depicts the entire Carboniferous succession as representing a single environmental system consisting of offshore clays and carbonates, barrier sands, back-barrier sands and clays, and delta plain deposits. The progradational character of the system is in accord with results of Ferm and Cavaroc (1968) in West Virginia, Ferm, Ehrlich, and Neathery (1967) in Alabama, and Ferm and others (1971) in Kentucky. The role of growth faulting in basin subsidence is shown by the thick accumulation of sediments on the downthrown block of normal faults which have relatively little or no surface expression. Such structures both in the Gulf Coastal Plain and Appalachian Plateau are known to be sites of petroleum accumulation. The occurrence of economically important coal beds, likewise, seems to be partially controlled by these features as well as by depositional environment. The thickest, most widespread, beds are located within the upper delta plain environments of the more rapidly subsiding southeastern blocks.

What we present on this trip are not final results, but a framework in which a few detailed studies have been made by some dedicated men who came to eastern Kentucky and worked long hours. Time permits us to examine only a few of the roadcuts that let us work with so many of the Pennsylvanian rocks of the Appalachians in eastern Kentucky.

ACKNOWLEDGMENTS

Those primarily involved with this trip are grateful for the assistance provided by others. Bob Hulse, now of the University of South Carolina, and Richard Englehardt, now at Eastern Kentucky University, were involved in the field studies of the environmental settings. Douglas F. B. Black and Gordon W. Weir of the U. S. Geological Survey, Lexington, and Karen C. Dever assisted in the work on the pre-Pennsylvanian part of the trip.

Our thanks go to the University of South Carolina and Murray State University for supporting their people in work on this project.

Sam Settle assisted with the preparation of the road log while working for the Kentucky Geological Survey.

The committee thanks Dr. Wallace W. Hagan and his staff for their work in the editing and preparation of the guidebook.

ROAD LOG

PART 1: GUIDE TO THE GEOLOGY ALONG INTERSTATE HIGHWAY 64 AND THE MOUNTAIN PARKWAY, LEXINGTON TO WOLFE COUNTY, KENTUCKY

Garland R. Dever, Jr.

Milepost

79.0± Interstate 75-Interstate 64 interchange. Travel east on Interstate 64.

79.1 Overpass (Hume Road).

LEXINGTON LIMESTONE

Along Interstate 64 from Lexington to its junction with the Mountain Parkway, the roadcuts are predominantly in the Middle Ordovician Lexington Limestone, and mainly expose the Millersburg Member (Fig. 2). The Millersburg is composed of rubbly-weathering, nodular and irregularly bedded, fine- to medium-grained, fossiliferous limestone and shale (Fig. 3). Stromatoporoids occur in several zones in the upper 15 to 20 feet (MacQuown, 1968). Tongues of resistant, tabular and crossbedded, medium- to coarse-grained, bioclastic limestone of the Tanglewood Limestone Member overlie and occur within the Millersburg Member between Lexington and Winchester. The main body of the Tanglewood Limestone Member in this area underlies the Millersburg.

The geology of the next 10 miles is shown on the geologic maps of the Lexington East quadrangle (MacQuown and Dobrovolny, 1968) and the Clintonville quadrangle (MacQuown, 1968).

Milepost

79.4 Beds of Tanglewood calcarenite interbedded with rubbly-weathering limestone and shale of Millersburg Member.

80.0 Millersburg Member. Rubbly-weathering, nodular and irregularly bedded limestone and shale. Stromatoporoid zone in lower part of cut. Beds of Tanglewood limestone at west end and in top of cut.

80.5 Underpass (Royster Road).

82.0 Millersburg Member.

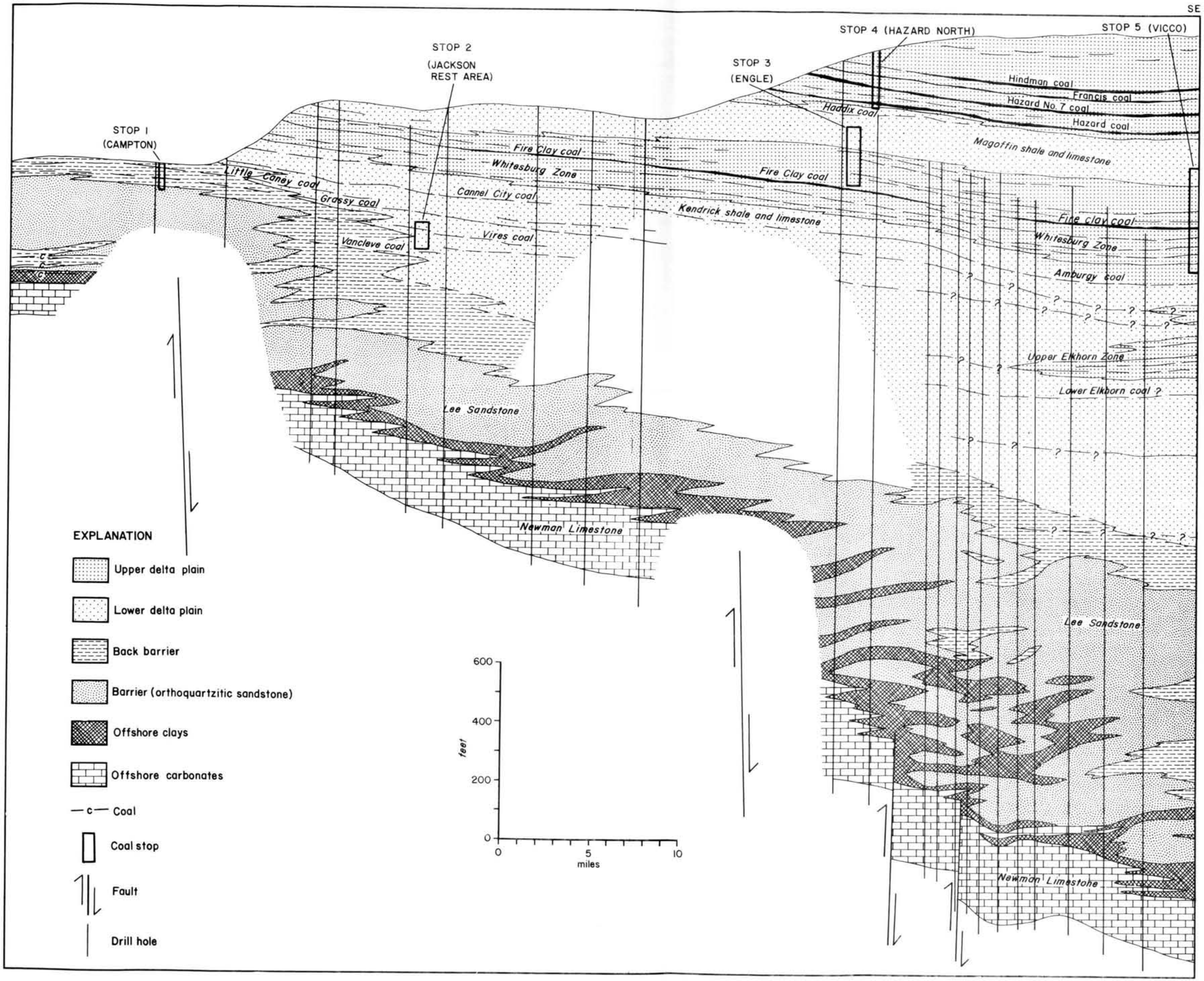


Figure 1. Cross section of Carboniferous rocks between Pine Ridge and Vicco showing locations of stops.

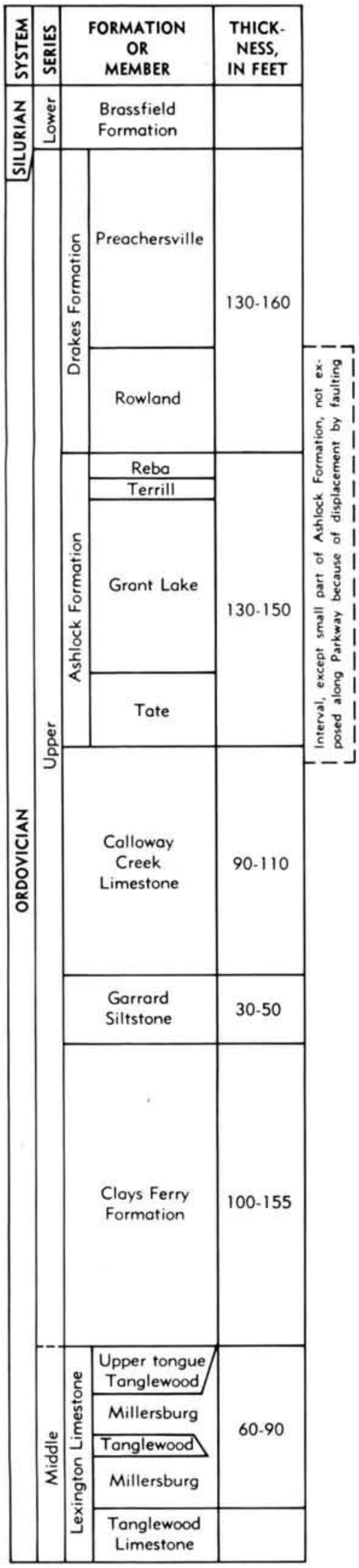


Figure 2. Generalized stratigraphic section showing Middle and Upper Ordovician and Lower Silurian rocks exposed along field trip route from Lexington to milepost 9.2 on the Mountain Parkway.

Figure 3. Millersburg Member of Lexington Limestone. Rubbly-weathering, nodular, and irregularly bedded limestone and shale. Stromatoporoid is present to the right of geologic pick (milepost 86.3).

83.3 Overpass (Cleveland Road). Millersburg Member.

83.9 Millersburg Member, with thin interbeds of Tanglewood limestone.

84.2 Millersburg Member.

84.7 Exit ramp to Lexington Army Depot. Millersburg Member.

85.0 Overpass (Ky. 859).

85.6 Millersburg Member. Beds of Tanglewood limestone exposed at road level along eastbound lanes.

86.3 Millersburg Member. Stromatoporoid zone in middle part of cut (Fig. 3).

86.9 Clark County line. Medium- to thick-bedded bioclastic limestone of the upper tongue of the Tanglewood Limestone Member, which overlies the Millersburg Member. Low hill north of the highway is capped by the Clays Ferry Formation (MacQuown, 1968).

87.8 Overpass (Paris-Clintonville Road).

88.0 Millersburg Member.

88.5 Tanglewood Limestone Member exposed in ditch along south side of highway.

88.6 Millersburg Member. Thin interbeds of Tanglewood limestone at east end of cut.

89.1 Millersburg Member.

89.6 Millersburg Member.

90.0 Millersburg Member.

90.5 Zone of Tanglewood limestone overlain and underlain by rubbly-weathering limestone of Millersburg Member.

90.8 Millersburg Member. Bed of Tanglewood limestone at top of cut.

91.3 Stromatoporoid zone exposed along eastbound lanes.

91.5 Exit ramp to Winchester via Van Meter Road.

91.7 Overpass (Van Meter Road).

91.9 Entrance ramp. Millersburg Member. Rubbly-weathering, nodular and irregularly bedded limestone and shale. Relatively thick zone of Tanglewood limestone, occurring within the Millersburg, is exposed in upper half of cut.

92.5 Millersburg Member, with thin interbeds of Tanglewood limestone.

92.8 Overpass (Louisville and Nashville Railroad).

93.0 Millersburg Member. Thin zone of Tanglewood limestone near middle of cut. Stromatoporoid zone near top of cut along westbound lanes.

93.1 Overpass (Louisville and Nashville Railroad).

93.5 Exit ramp to Winchester via U.S. 227.

93.7 Overpass (U.S. 227).

93.8 Entrance ramp into westbound lanes. Cuts along ramp show Millersburg faulted against Millersburg. Beds on south (downthrown) side have an apparent southeast dip. Limestone beds of the Clays Ferry Formation, also having an apparent southeast dip, are exposed along entrance ramp on south side of Interstate 64.

94.0 Exit ramp from westbound lanes. Millersburg Member. Stromatoporoid zone in lower half of cut.

94.6 Thin-bedded limestone of Clays Ferry Formation in cut along eastbound lanes. Beds at west end are essentially horizontal; beds at east end have an apparent southwest dip. Along the westbound lanes tabular, thin-bedded limestone and interbedded shale of Clays Ferry Formation overlie nodular and irregularly bedded limestone of Millersburg Member of Lexington Limestone. West end of cut exposes downfolded beds of Clays Ferry Formation which have an apparent southwest dip. Folding evidently is associated with a fault.

94.7 Overpass (U.S. 60).

94.8 Tabular, thin-bedded limestone of Clays Ferry Formation overlying irregularly bedded limestone of Millersburg Member. Beds are essentially horizontal.

94.9 Clays Ferry Formation.

95.0 Exit to Mountain Parkway.

Milepost (Mountain Parkway)

0.1 Millersburg Member. Stromatoporoid zone exposed in cuts.

0.3 Nodular and irregularly bedded limestone and shale of Millersburg Member.

0.5 Millersburg Member.

0.7 Millersburg Member. Tabular, thin-bedded limestone of Clays Ferry Formation is poorly exposed in the upper part of cut.

0.8 Tabular, thin-bedded limestone of Clays Ferry Formation.

1.0 Clays Ferry Formation.

1.2 Overpass (Ecton Road).

1.4 Clays Ferry Formation.

2.0 Clays Ferry Formation overlying Lexington Limestone. Nodular and irregularly bedded, fossiliferous and calcarenitic limestone of Millersburg Member exposed at west end of cut. Overlying Clays Ferry consists of tabular, thin-bedded limestone and siltstone with interbedded shale. Limestone is generally micrograined to fine grained. A few thin, contorted beds (flow-roll structure) of siltstone are exposed at east end.

2.4 Underpass (Morris Road).

CLAYS FERRY FORMATION

The Clays Ferry Formation consists of interbedded limestone and shale, and siltstone. Limestone is micrograined to very coarse grained, in part sheathed in limy silt, ranges from sparsely fossiliferous to beds of brachiopod-bryozoan hash, and generally occurs in thin, tabular beds (Fig. 4). Some siltstone is present throughout the formation, but it is abundant in the upper part. Locally, contorted beds (flow-roll structure) of siltstone, similar to those common in the overlying Garrard, are present in the Clays Ferry.

Milepost

2.6 Clays Ferry Formation. Tabular, thin-bedded limestone with thin interbeds of shale and silty shale (Fig. 4).

Figure 4. Clays Ferry Formation. Tabular, thin-bedded limestone interbedded with shale (milepost 2.6).

3.0 Clays Ferry Formation. Thick, resistant bed of brachiopod-bryozoan hash is present at top of cut.

3.2 Clays Ferry Formation. Thin-bedded limestone with thicker interbeds of silty shale. Some siltstone is present in upper part of cut.

3.3 Clays Ferry Formation. Shale with thin interbeds of siltstone and limestone. Thick contorted bed (flow-roll structure) of siltstone in lower half of cut.

3.5 Underpass (Chesapeake and Ohio Railroad).

3.6 Clays Ferry Formation. Thin-bedded siltstone and limestone with relatively thick interbeds of shale.

4.9 Clays Ferry Formation. Thin-bedded siltstone and limestone interbedded with shale.

5.2 Bridge over Stoner Creek and Stoner Ephesus Road.

5.5 Garrard Siltstone overlying Clays Ferry Formation. Three contorted beds (flow-roll structure) of siltstone in cut along westbound lanes (Fig. 5). Thick contorted beds are separated by intervals of thin-bedded siltstone interbedded with shale. The Garrard is transitional with the underlying Clays Ferry Formation; the contact is placed at the base of the lowest thick siltstone bed (Simmons, 1967a).

6.3 Overpass (Schollsville Road). Calloway Creek Limestone. Thin to medium beds of irregularly and planar-bedded limestone separated by partings and thin beds of shale and siltstone. Limestone is fine to coarse grained and very fossiliferous, containing abundant bryozoans and brachiopods. The genera **Strophomena** and **Constellaria** are common in the lower part of the Calloway Creek that is exposed along the Parkway.

Figure 5. Contorted bed (flow-roll structure) of siltstone in the Garrard (milepost 5.5).

6.6 Calloway Creek Limestone. View of the Knobs rising above the Blue Grass. The ridges and isolated hills of the Knobs region are a belt of erosional remnants along the front of the Pottsville Escarpment. The higher hills and ridges are variously capped by Lower Pennsylvanian Lee sandstone and conglomerate, Upper Mississippian Newman limestone, and Lower Mississippian Borden siltstone.

6.8 Calloway Creek Limestone.

7.1 Garrard Siltstone.

7.3 Blocks of Garrard siltstone are exposed at the southeast end of cut along eastbound lanes, overlying the thin-bedded limestone and interbedded shale of the Clays Ferry Formation.

7.5± Approximate position of fault in the Agawam fault zone of the Kentucky River fault system.

7.6 Grant Lake(?) limestone, Ashlock Formation (Fig. 2). Along westbound lanes, poor exposures of rubbly-weathering, irregularly bedded limestone containing many fragments of the brachiopod **Platystrophia ponderosa.**

7.8± Approximate position of fault in the Agawam fault zone of the Kentucky River fault system.

7.9 Preachersville Member of Drakes Formation. Dolomitic mudstone. Massive bed of grayish-green dolomite overlies dolomitic mudstone at southeast end of cut along westbound lanes. The grayish-green dolomite is more commonly found in the underlying Rowland Member of the Drakes Formation, but the lithologies of the two units locally interfinger through a thickness of a few feet (Simmons, 1967b).

8.2 Preachersville Member. Dolomitic mudstone, with interbeds of resistant dolomite.

8.7 Preachersville Member. Dolomitic mudstone with very thin beds of dolomite. A resistant dolomite bed occurs at the bench in the cut. Shale, with thin beds of argillaceous dolomite, is present in the slope above the bench.

9.2 Brassfield Formation (Lower Silurian) overlying Preachersville Member of Drakes Formation (Upper Ordovician) at northwest end of cut along westbound lanes (Fig. 6). Plum Creek Clay Member of Noland Formation overlies Brassfield at the southeast end.

Figure 6. Brassfield dolomite (Lower Silurian) overlying mudstone of Preachersville Member of Drakes Formation (Upper Ordovician) at milepost 9.2.

SILURIAN FORMATIONS

The Brassfield Formation consists of fine- to medium-grained dolomitic limestone and dolomite with partings and thin beds of shale. A thin basal zone contains phosphatic nodules and abundant grains and rarer small pebbles of quartz. Crinoid columnals, brachiopods, small horn corals, and bryozoans are common fossils. A bed of abundant crenulate ("scalloped") crinoid columnals is present immediately above the prominent shale bed in the upper part of the formation along the Parkway. This "bead bed" characteristically occurs in the upper few feet of the Brassfield along the eastern outcrop belt (Rexroad and others, 1965, p. 10).

The Noland Formation consists of four members (Fig. 7), in ascending order, the Plum Creek Clay, Oldham Limestone, Lulbegrud Shale, and Waco (Rexroad and others, 1965). The Plum Creek Clay Member is composed of clay shale with thin, discontinuous beds of dolomitic limestone. The Oldham Limestone Member consists of thin- to medium-bedded dolomitic limestone and dolomite with partings and thin interbeds of shale. The Lulbegrud Shale Member is predominantly shale, with a few thin, discontinuous beds of dolomitic limestone. The Waco Member consists of a basal "massive" dolomite bed, overlain by shale with interbeds of fossiliferous dolomite and dolomitic limestone.

The Estill Shale is predominantly shale, with a few thin discontinuous beds of dolomite and dolomitic limestone.

Milepost

9.5 Thin-bedded dolomitic limestone and shale of Oldham Member and Plum Creek clay shale overlying Brassfield Formation.

9.7 Bridge over Upper Howard Creek. Duffin Member of Ohio Shale and Kiddville layer

SYSTEM	SERIES	GROUP		FORMATION OR MEMBER	THICKNESS, IN FEET
MISS.	Lower			Nancy Mbr. of Borden Fm.	
				Sunbury Shale	
DEVONIAN	Middle and Upper			Ohio Shale	130-150
				Duffin Mbr.	
				Boyle Dolomite	½-22
				Kiddville layer	
SILURIAN	Lower and Middle	Crab Orchard Group		Estill Shale	0-50
			Noland Fm.	Waco	20-50
				Lulbegrud Shale	
				Oldham Limestone	
				Plum Creek Clay	
				Brassfield Formation	8-20

Figure 7. Generalized stratigraphic section showing Silurian, Devonian, and Lower Mississippian rocks exposed along the Mountain Parkway from milepost 9.2 to milepost 18.8.

(Middle Devonian) overlying Lulbegrud Shale Member of Noland Formation (Silurian) in cuts immediately south of bridge (Fig. 8).

Figure 8. Duffin Member of Ohio Shale and Kiddville layer (Middle Devonian) overlying Lulbegrud Shale Member of Noland Formation (Silurian) at milepost 9.7. Basal part of the predominantly massive Duffin is thin bedded and interlayered with carbonaceous shale. Thin bed immediately overlying the Lulbegrud shale is the Kiddville layer.

OHIO SHALE AND KIDDVILLE LAYER

The Ohio Shale predominantly consists of black, fissile, carbonaceous shale. The Duffin Member, which occurs in the basal part of the formation in this area, is finely crystalline, calcareous dolomite, containing clasts and some quartz sand and silt. At Upper Howard Creek, the unit is predominantly massive; the basal part is thin bedded and sandy, and interlayered with thin seams of black fissile shale (Fig. 8). Along the Parkway to the southeast, the Duffin Member consists of dolomite interbedded with carbonaceous shale and mudstone (Fig. 10).

The Kiddville layer is argillaceous, calcareous to dolomitic, and contains abundant phosphatic nodules and quartz silt and sand. The Kiddville has been found to be present at the base of the Devonian section in this area, regardless of the thickness or nature of the overlying Devonian unit (Holbrook, 1964, p. 24).

As a result of a regional unconformity, the basal Middle Devonian formations rest on progressively older formations (in this area, progressively older Silurian units) toward the axis of the Cincinnati arch (Fig. 9) (Holbrook, 1964; McFarlan and White, 1952).

Milepost

10.0 Old Indian Fields. View of Pilot Knob to the southeast. Knob is capped by Lower Pennsylvanian conglomerate and sandstone, which is resting on Lower Mississippian Borden siltstone (Cowbell Member). Nada and Renfro Members of the Borden Formation and the Upper Mississippian Newman Limestone and Pennington Formation are absent.

10.4 Overpass.

10.7 Ohio Shale. Carbonaceous shale overlying dolomite of Duffin Member.

11.0 Ohio Shale.

11.6 Ohio Shale overlying Boyle Dolomite. Carbonaceous shale overlies and is interbedded with dolomite of the Duffin Member. Small-scale folding in Duffin is believed to have

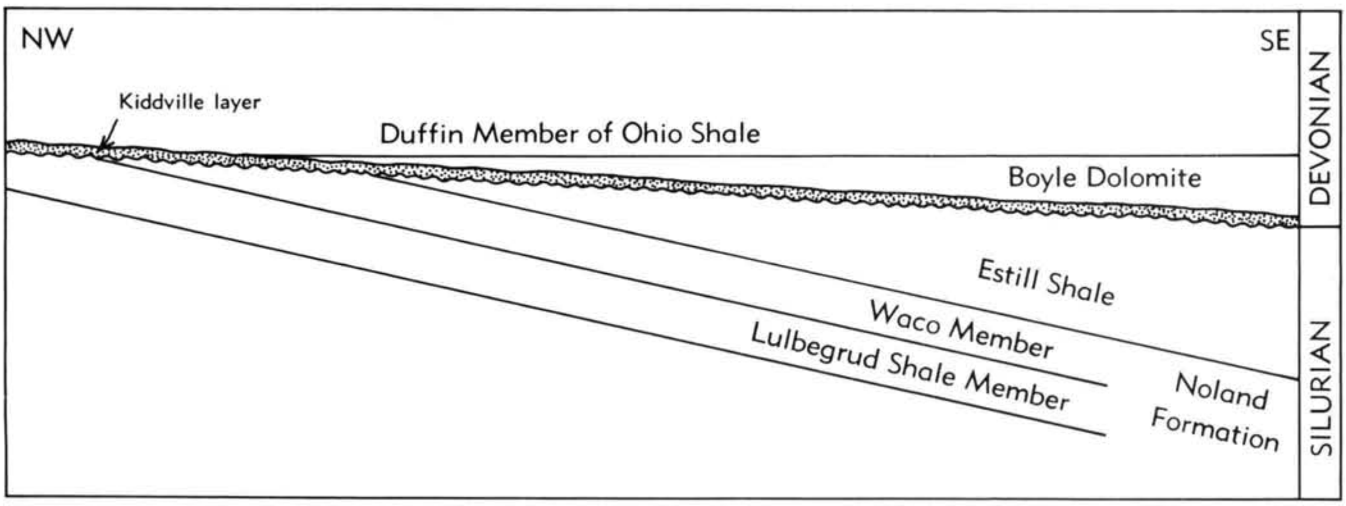


Figure 9. Diagrammatic section showing Silurian and Devonian stratigraphic relationships along the Mountain Parkway.

Figure 10. Fissile, carbonaceous Ohio Shale and Duffin Member overlying cherty Boyle Dolomite (milepost 16.0). Duffin Member consists of interbedded dolomite and carbonaceous shale, and mudstone.

been formed by penecontemporaneous submarine slumping (McFarlan and White, 1952; Wigley and Sergeant, 1970). Pyrite, marcasite, and sphalerite occur locally in the dolomite. A thin argillaceous, calcareous, and sandy Kiddville-type zone and a 1-foot interval of silty and sandy shale underlie the Duffin. Boyle dolomite, exposed at the base of the cut, is finely crystalline, petroliferous, slightly vuggy, and locally crinoidal. A similar dolomite is poorly exposed beneath the Duffin at milepost 10.7. Overlying shale and Kiddville-type lithology are probably the "upper Kiddville bed," which occurs within the Boyle (Holbrook, 1964, p. 24).

BOYLE DOLOMITE

The Boyle Dolomite is composed of finely to medium crystalline dolomite and dolomitic limestone, which is, in part, petroliferous. Chert, in nodules and discontinuous layers, is abundant in the upper part of the unit. Crinoid columnals, corals, and brachiopods are common fossils. A thin interval of sandy shale, referred to as the "upper Kiddville bed" (Holbrook, 1964, p. 24), commonly occurs between the upper cherty dolomite and the lower, and generally noncherty, part of the unit.

Milepost

11.7 Bridge over Lulbegrud Creek. Powell County line.

11.8 Ohio Shale. Carbonaceous shale overlying dolomite of Duffin Member.

12.3 Ohio Shale.

13.1 Ohio Shale.

13.2 Overpass (Brush Road).

13.6 Ohio Shale.

14.7 Waltersville toll plaza.

15.1 Ohio Shale.

15.3 Ohio Shale overlying Boyle Dolomite. Carbonaceous shale overlying and interbedded with dolomite; underlain by dolomitic mudstone. Interval of interbedded dolomite and carbonaceous shale, and underlying dolomitic mudstone are assigned to the Duffin Member. Cherty dolomite of the Boyle is exposed at southeast end of cut.

15.5 Ohio Shale and Boyle Dolomite (Middle Devonian) overlying Estill Shale (Middle Silurian). Upper part of Boyle is very cherty. Kiddville layer is present at the base of the Boyle. Greenish-gray shale of the Estill is poorly exposed in lower part of cuts.

15.7 Ohio Shale overlying Boyle Dolomite. The geology of the next 5 miles is shown on the geologic map of the Clay City quadrangle (Simmons, 1967c).

15.8 Ohio Shale overlying Boyle Dolomite.

16.0 Exit ramp to Clay City. Ohio Shale overlying Boyle Dolomite (Fig. 10).

16.2 Overpass (Ky. 15). Ohio Shale (Duffin Member) and Boyle Dolomite overlying Estill Shale. Kiddville layer is present at the base of the Boyle.

16.9 Light-gray clayey sand exposed along westbound lanes is part of a Pleistocene or Holocene alluvial terrace deposit (Simmons, 1967c) that lies above the younger alluvium in the valley of the Red River.

17.1 Ohio Shale exposed along westbound lanes.

18.1 Bridge over Red River.

18.3 Overpass (Ky. 1057). Ohio Shale in cuts along Parkway. Exposure in hillside on south side of Parkway shows grayish clay shale of Nancy Member of the Borden Formation (Lower Mississippian) overlying black carbonaceous Ohio-Sunbury shale. The conodont fauna shows the age of the uppermost part of the interval of carbonaceous shale in this area is Early Mississippian (J. W. Huddle, oral communication, 1971). North of this area, the Devonian Ohio Shale is separated from the Mississippian Sunbury Shale by a thick interval of Bedford Shale and Berea Sandstone.

18.6 Ohio-Sunbury shale.

18.7 Ohio-Sunbury shale.

18.8 Nancy Member of Borden Formation. Greenish-gray and reddish-brown shale.

BORDEN FORMATION

The Borden Formation consists of four members (Fig. 11), in ascending order: Nancy, Cowbell, Nada, and Renfro (Weir and others, 1966). The Nancy Member is composed mainly of shale, from clayey and slightly silty in the lower part to silty in the upper part. Shaly siltstone occurs in the upper part of the unit. Sideritic ironstone concretions are common. The Nancy is mined in Powell County for use in the manufacture of heavy clay products such as building brick. The Cowbell Member consists of thick-bedded, resistant siltstone interbedded with silty shale and shaly siltstone. It is transitional with the underlying Nancy Member; the contact is picked at the base of the lowest relatively resistant siltstone (Fig. 12) (Simmons, 1967c). The Nada Member is composed of variegated, clayey and silty shale with some interbedded siltstone. The Renfro Member consists of yellow- to orange-weathering, aphanitic to finely crystalline, argillaceous dolomitic limestone and dolomite, with partings and thin beds of shale.

Milepost

20.0 Nancy Member. Sideritic ironstone concretions and layers.
20.2 Nancy Member. Ironstone concretions and layers; sphalerite is present in some of the concretions.
21.1 Overpass.
21.7 Nancy Member. Ironstone concretions.
21.9 Exit ramp to Stanton.
22.0 Underpass (Ky. 213). Newman Limestone (Upper Mississippian) is capping or near the top of the higher ridges.
22.6 Nancy Member.
23.0 Abandoned quarry in Newman Limestone on ridgetop south of Parkway. The Newman is quarried in Powell County for use as concrete aggregate, roadstone, and agricultural limestone.
23.5 Nancy Member. Scattered ironstone concretions.
24.5 Overpass (Ky. 15-Ky. 11).
24.7 Bridge over Red River.
25.0 Overpass. Nancy Member exposed on slope north of Parkway.
26.0 Bridge over Cane Creek. To the east, view of ridgetop capped by Lower Pennsylvanian sandstone.

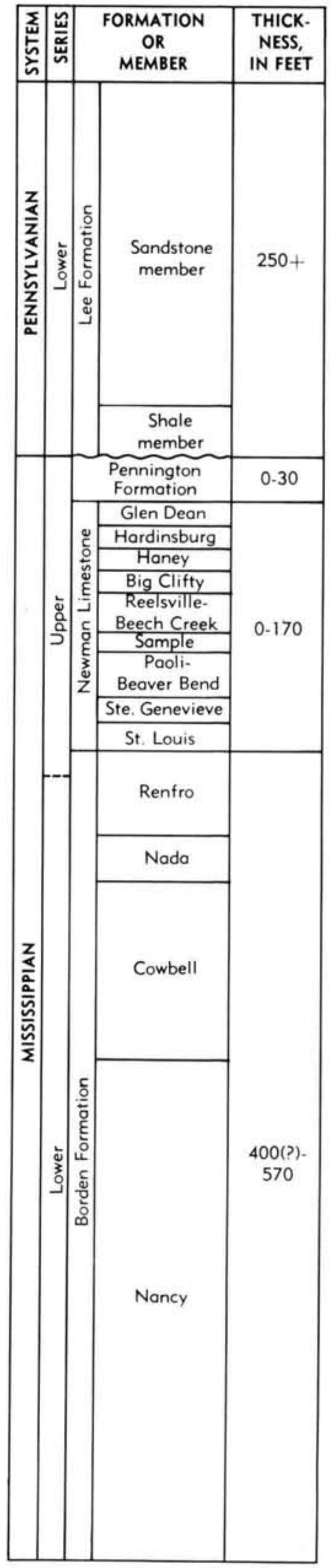


Figure 11. Generalized stratigraphic section showing Mississippian and Lower Pennsylvanian rocks exposed along the Mountain Parkway from milepost 18.8 to the Wolfe County line.

Figure 12. Resistant siltstone with interbedded shale of Cowbell Member overlying shale and shaly siltstone of Nancy Member of Borden Formation (milepost 30.8). Contact between the members is placed at the base of the lowest resistant siltstone bed.

26.9 Shale and shaly siltstone with ironstone concretions in upper part of Nancy Member.
27.3 Underpass (Ky. 613).
27.9 Bridge over Red River.
28.1 Nancy Member. Shale with ironstone layers. Shaly siltstone at south end of cut.
28.5 Talus from quarry in Newman Limestone on slope south of Parkway.
29.2 Overpass. Upper part of Nancy Member. Shaly siltstone with ironstone concretions.
29.6 Nancy Member at road level. Resistant beds of siltstone with interbedded shale on slope above road are in the basal part of the Cowbell Member.
30.3 Nancy Member at road level. Basal part of Cowbell Member exposed on slope above road.
30.8 Basal part of Newman Limestone overlying Borden Formation. Shaly siltstone and shale at base of cut is the uppermost part of the Nancy Member. Contact with overlying Cowbell Member is at base of lowest ledge-forming siltstone bed (Fig. 12). Cowbell Member consists of thick-bedded, resistant siltstone interbedded with silty shale; the upper part is predominantly siltstone. Variegated shale with thin siltstones of the Nada Member overlies the Cowbell. This cut is the type locality of the Nada (Weir and others, 1966, p. 31-32). Yellow- to orange-weathering, dolomitic limestone and dolomite near top of cut are in the Renfro Member. Overlying resistant ledge of gray limestone is the basal part of the Newman Limestone.
31.1 Underpass (Ky. 77). Community of Nada.
31.3 Cowbell Member overlying Nancy Member. Shaly siltstone and shale in basal part of cut are in the uppermost part of the Nancy. Cowbell Member consists of thick, resistant siltstones interbedded with silty shale.
31.7 Cowbell Member.
31.8 Bridge over Middle Fork of Red River.
32.1 Underpass (Ky. 15-Ky. 11).
32.2 Cowbell Member.
32.6 Bridge over Middle Fork of Red River.
32.7 Slade toll plaza. Exit ramp to Ky. 11.
32.8 Cowbell Member.
33.0 Cowbell Member.
33.2 Overpass (Ky. 15). Cowbell Member.
33.9 Variegated shale with thin siltstones of Nada Member overlying uppermost siltstone bed of Cowbell Member.
34.0 To the east, view of gray limestones of the Newman overlying yellow- to orange-weathering dolomitic limestone and dolomite of Renfro Member and shale and siltstone of Nada Member of the Borden Formation.

NEWMAN LIMESTONE AND PENNINGTON FORMATION

The Newman Limestone has been divided into a number of members. The lower members are the St. Louis and Ste. Genevieve (Butts, 1922). McFarlan and Walker (1956) correlated limestones and shales in the middle and upper parts of the Newman with formations of the Chester Series in the Illinois basin. Along the Parkway, the recognizable units of McFarlan and Walker (1956) are the Paoli-Beaver Bend limestone, Sample sandstone (shale), Reelsville-Beech Creek limestone, Big Clifty sandstone (shale), Haney limestone, Hardinsburg sandstone (shale), and Glen Dean limestone (Fig. 11).

The basal member, the St. Louis, consists of micrograined to fine-grained limestone generally containing abundant comminuted fossil material. Chert, in the form of nodules, balls, and thin beds, is abundant. The St. Louis is very fossiliferous, containing the colonial coral **"Lithostrotion" proliferum,** brachiopods, bryozoans, crinoids, and echinoids. The uppermost part is dark-colored, brecciated and disturbed limestone with algal mats and, possibly, subaerial crusts.

The Ste. Genevieve is composed of oolitic, bioclastic, and micrograined limestones. A thin basal zone contains clasts of limestone and chert from the underlying St. Louis. The uppermost part of the Ste. Genevieve also is a dark-colored interval of brecciated and disturbed limestone with algal mats and subaerial crusts. McFarlan and Walker (1956) correlated this interval with the Bryantsville Breccia.

The lower and middle parts of the Paoli-Beaver Bend consist of oolitic and bioclastic limestone with shale partings. The upper part is thin-bedded, micrograined to very fine-grained limestone containing algal mats and thin discontinuous beds of chert, with partings and thin interbeds of shale. A shale bed occurs between the Paoli-Beaver Bend and the underlying Ste. Genevieve.

The Reelsville-Beech Creek is composed of oolitic and bioclastic limestone. The unit is massive, except for the basal part, which is commonly thin bedded. Crinoid and blastoid material is very common and includes **Agassizocrinus, Pentremites godoni,** and **P. pyriformis**. A large unidentified crinoid stem, ½ to ¾ inch in diameter, is present in this member, and its occurrence along the eastern outcrop belt is restricted to this unit (McFarlan and Walker, 1956, p. 8-9). A shale bed, correlated with the Sample Sandstone, occurs between the Reelsville-Beech Creek and the underlying Paoli-Beaver Bend. A thin shale bed overlying the Reelsville-Beech Creek has been correlated with the Big Clifty Sandstone.

The Haney is composed of oolitic and bioclastic limestone. The member is very fossiliferous, containing crinoids, brachiopods, and bryozoans, including **Archimedes.** Chert is common, in the form of nodules and thin discontinuous beds. The Haney is thin to medium bedded with partings and interbeds of shale. Overlying the Haney is a relatively thick interval of shale, which has been correlated with the Hardinsburg Sandstone.

The Glen Dean is composed of bioclastic limestone and is very fossiliferous. Crinoids, brachiopods, and bryozoans are common. Along the Parkway, the unit is thin bedded and shaly in the lower part, massive in the upper part, and thin bedded at the top.

The Pennington Formation is not present in much of the area adjacent to the Parkway. At milepost 34.8, it is represented by a few feet of green and red shale overlying the Glen Dean limestone.

Milepost

34.1 Ste. Genevieve and St. Louis members of the Newman Limestone overlying Renfro and Nada Members of the Borden Formation in cut along westbound lanes.

34.4 At top of cut along westbound lanes, carbonaceous shale and sandstone of the Lee Formation (Lower Pennsylvanian) resting on greenish-gray shale of Hardinsburg member of the Newman (Upper Mississippian). The Glen Dean member of the Newman and the Pennington Formation are absent. Section exposed below the Hardinsburg shale extends from the Haney downward through the upper part of the St. Louis (Fig. 13).

34.5 Newman Limestone in cut along westbound lanes. Paoli-Beaver Bend, thin-bedded at the top, is exposed in lower part of cut. Overlying shale has been correlated with the Sample. Massive-appearing limestone in middle of cut is Reelsville-Beech Creek. Thin- to medium-bedded limestone of Haney is exposed at top of cut.

34.6 Lower Pennsylvanian fill of sandstone and shale in the Newman Limestone in cut along eastbound lanes. Sandstone and shale are resting on limestone of the Reelsville-Beech Creek member and, at the extreme east end of the cut, on limestone of the Haney member (Figs. 14 and 15). Localized fill and slump structures may be associated with the presence of paleosolution features in the Newman limestone. One thin coal is exposed in the upper part of the cut.

34.75 Greenish-gray shale of Hardinsburg member overlying Haney and Reelsville-Beech Creek limestone in cuts along eastbound lanes.

34.8 Shale member of Lee Formation (Lower Pennsylvanian) overlying the Pennington Formation and Newman Limestone (Upper Mississippian). This member of the Lee,

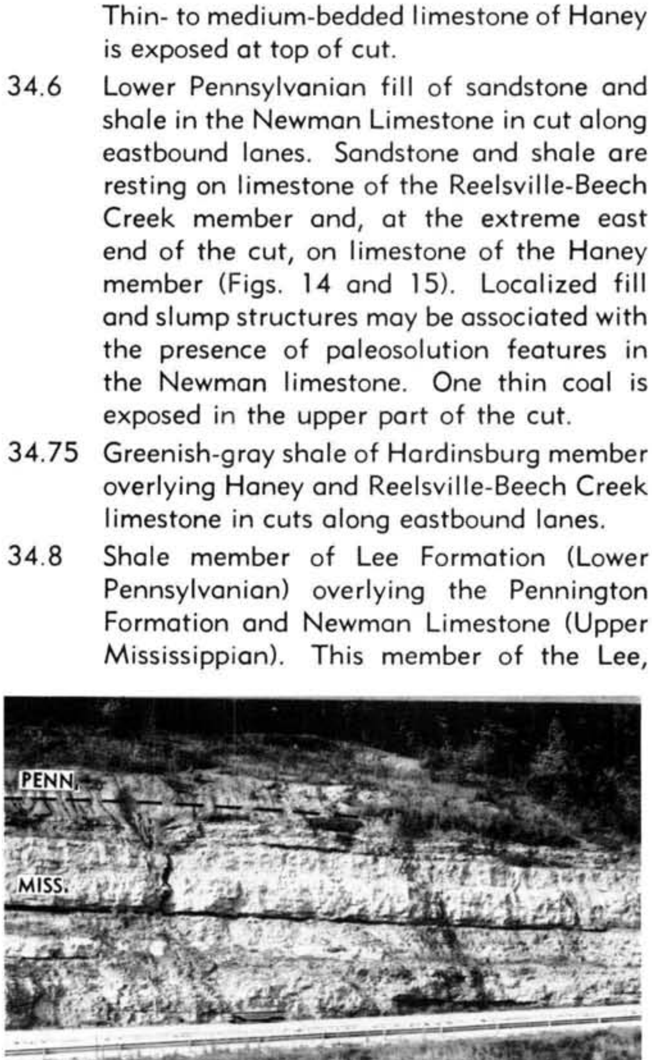


Figure 13. Upper Mississippian Newman Limestone (milepost 34.4). Interval exposed in the Newman extends from Hardinsburg shale downward through the upper part of the St. Louis. Lower Pennsylvanian shale and sandstone overlie the Hardinsburg member.

Figure 14. Lower Pennsylvanian fill of sandstone and shale resting on Reelsville-Beech Creek member of the Newman Limestone (Upper Mississippian) in west end of cut at milepost 34.6.

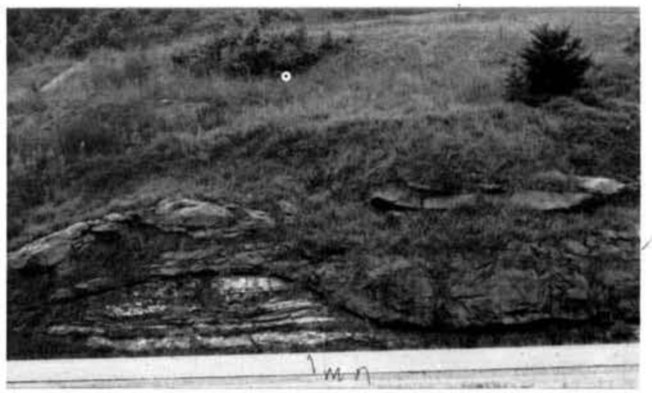


Figure 15. Lower Pennsylvanian sandstone fill resting on Reelsville-Beech Creek and Haney members of the Newman Limestone (Upper Mississippian) in east end of the cut that starts at milepost 34.6.

which is considered to be approximately equivalent to the Beattyville Shale (Huddle, 1963, p. 57), consists of shale, commonly carbonaceous, interbedded with sandstones and siltstones that are predominantly thin to medium bedded. This is a back-barrier sequence representing dark lagoonal mud interbedded with orthoquartzitic sand that was swept into the lagoon from the barrier as overwash and through inlets. One thin coal is exposed in the upper part of the cut. The Pennington Formation consists of a few feet of green and red shale overlying massive to thin-bedded limestone of the Glen Dean member of the Newman. The lower part of the Glen Dean is thin bedded and shaly. Hardinsburg shale and top of the Haney limestone are exposed in lower part of cut.

34.85 Shale member of the Lee Formation. Shale with interbedded sandstones and siltstones of back-barrier sequence. Two thin coal beds are exposed in the cut.

34.9 Shale member of the Lee Formation. Three thin coal beds are exposed in the cut. The lower two coals appear to be the beds exposed in the cut at milepost 34.85. The coals in this member are discontinuous, and satisfactory correlations between them have not been established (Huddle, 1963, p. 63).

35.1 Lee Formation in cut along westbound lanes. Thick, cliff-forming, orthoquartzitic barrier sandstone, in part conglomeratic, overlying back-barrier sequence of the shale member. Two thin coals exposed in the shale member appear to be equivalent to the two upper coals in the cut at milepost 34.9.

35.2 Thick, cliff-forming orthoquartzitic barrier sandstone of the Lee Formation. Parkway is climbing upward through the Pottsville Escarpment.

35.5 Orthoquartzitic barrier sandstone of the Lee Formation.

35.7 Overpass (Tunnel Ridge Road). Sandstone in upper part of cuts is thin to medium bedded with interbedded shale, and grades westward into the barrier and eastward into back-barrier lagoonal deposits.

35.9 Wolfe County line.

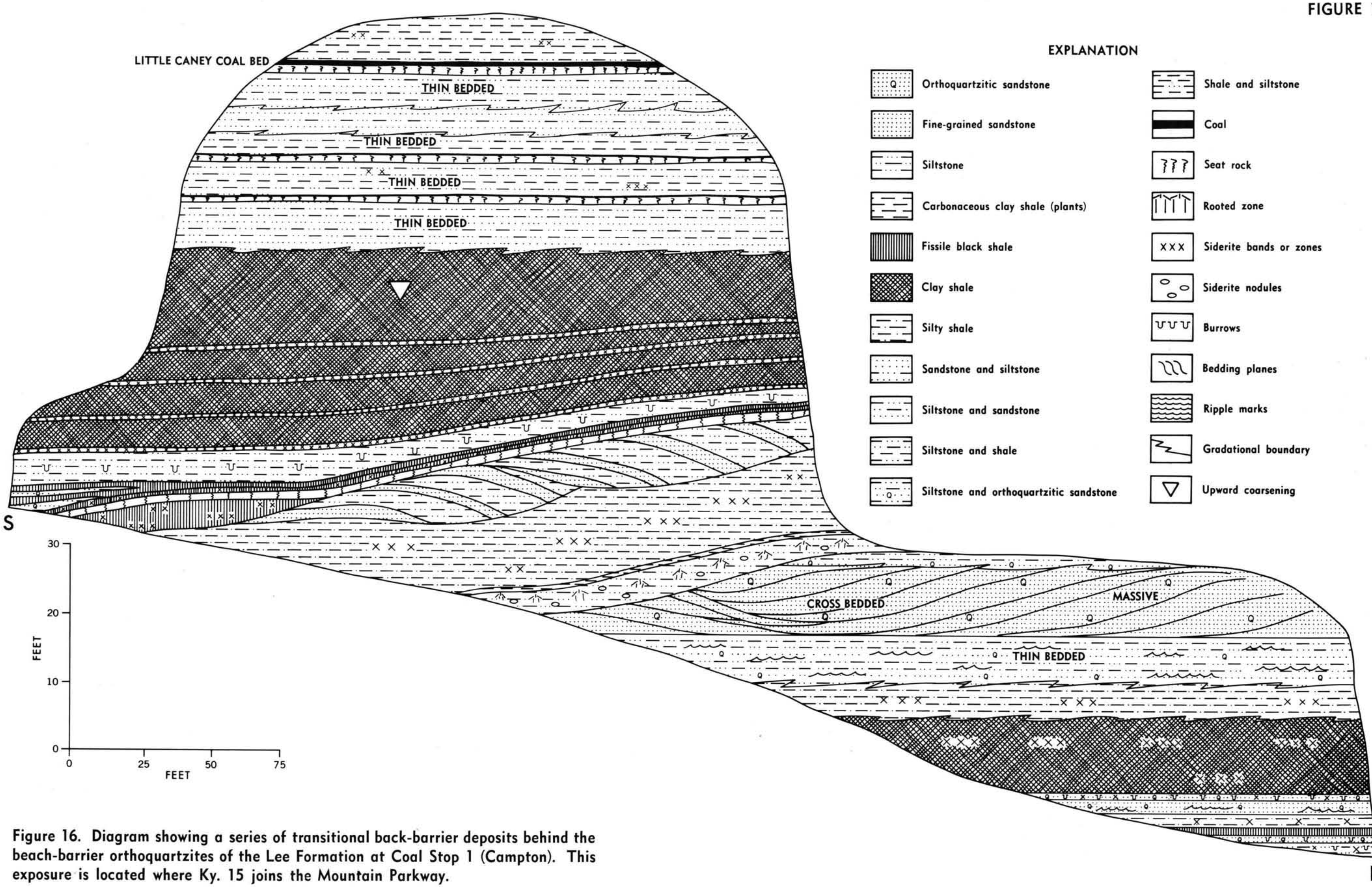


Figure 16. Diagram showing a series of transitional back-barrier deposits behind the beach-barrier orthoquartzites of the Lee Formation at Coal Stop 1 (Campton). This exposure is located where Ky. 15 joins the Mountain Parkway.

PART 2: DEPOSITIONAL ENVIRONMENTS OF PENNSYLVANIAN ROCKS ALONG THE MOUNTAIN PARKWAY AND KENTUCKY HIGHWAY 15, WOLFE COUNTY TO KNOTT COUNTY, KENTUCKY

John C. Horne, Peter W. Whaley, and Gilbert E. Smith

Milepost

36.0 Thin-bedded sandstones and siltstones on right.

36.2 Next four or five exposures are dark carbonaceous shales of a bay fill overlying some of the orthoquartzitic sandstones of the Lee Formation.

37.9 Overpass. Next several exposures show relationship of dark bay-fill shales and thin sandstone and siltstone beds of a back-barrier sequence.

39.4 Overpass.

39.5 On the right is a bay-fill sequence showing small slump blocks in the bottom of a channel, all overlying orthoquartzitic sandstone.

39.8 Exposure of a barrier orthoquartzitic sandstone overlain by a bay-fill sequence and capped by a distributary sandstone. A fault cuts the exposure on the east end.

40.0 The exposures along both sides of the road for the next 2 miles show the relationship of bay fill, thin siltstones, and orthoquartzitic sandstones of the back-barrier sequence.

42.7 Leave Mountain Parkway and continue right on Ky. 15 toward Hazard.

43.0 COAL STOP 1.

COAL STOP 1 (CAMPTON)

Rocks at the base of this cut (Fig. 16) occupy a stratigraphic position about 25 feet above the top of the Lee Formation as it is mapped in this area; the Little Caney coal bed is at the top of the cut. Exposures of the Lee Formation can be seen along the Mountain Parkway just north of this location.

This exposure illustrates a series of transitional back-barrier deposits between the beach-barrier orthoquartzites of the Lee Formation and the lower delta plain typical of the lower part of the Breathitt Formation. The sandstones in the lower third of the cut are orthoquartzites formed as washovers and tidal channels from barriers lying to the west. The dark zone exposed in the lower third of the cut grades from fine to coarse upward and is an excellent example of a small back-barrier lagoon filled partially by dark clays and silts and capped by sandy overwash or tidal-flat sediments. Flaser bedding, common in recent tidal zones, is common in the dark siltstones. Dark shales overlying the thick orthoquartzitic sandstone also represent back-barrier bays. They contain abundant burrowed sideritic ironstone and siltstone. Slumps, common on the flanks of the channel, can be observed midway up through the cut. The upper part of the exposure shows small shallow bay or lake deposits in which "dirty" (micaceous and feldspathic) sandstones provide the first indication of delta-plain deposition.

Coal beds are generally thin in the back-barrier facies, but in some cases such as the Vancleve and Zachariah, these deposits assume local economic importance.

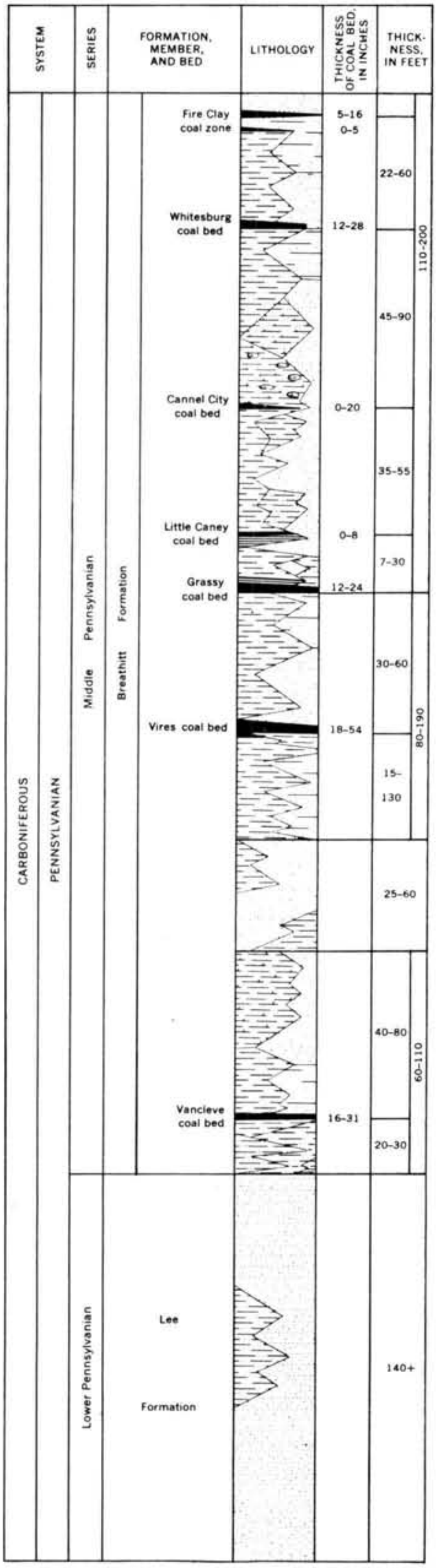
Lateral changes of units exposed in this cut provide an excellent example of the northwest (seaward) and southeast (landward) transitions observable in Carboniferous strata in eastern Kentucky (Fig. 17). The Grassy coal bed, here represented by the black shale in the middle part of the cut, within 10 miles to the southeast passes into distributary-mouth-bar sandstones and bay shales of the lower delta plain. On the other hand, the Little Caney coal bed passes northwestward into dark shale similar to the Grassy here. Perhaps the most remarkable lateral change is in the orthoquartzites of the Lee Formation which, within 20 miles to the east, drop stratigraphically nearly 200 feet. The rocks into which it grades laterally are back-barrier sediments of the type shown at this stop and lower delta plain deposits which will be examined at Coal Stop 2.

Mileage

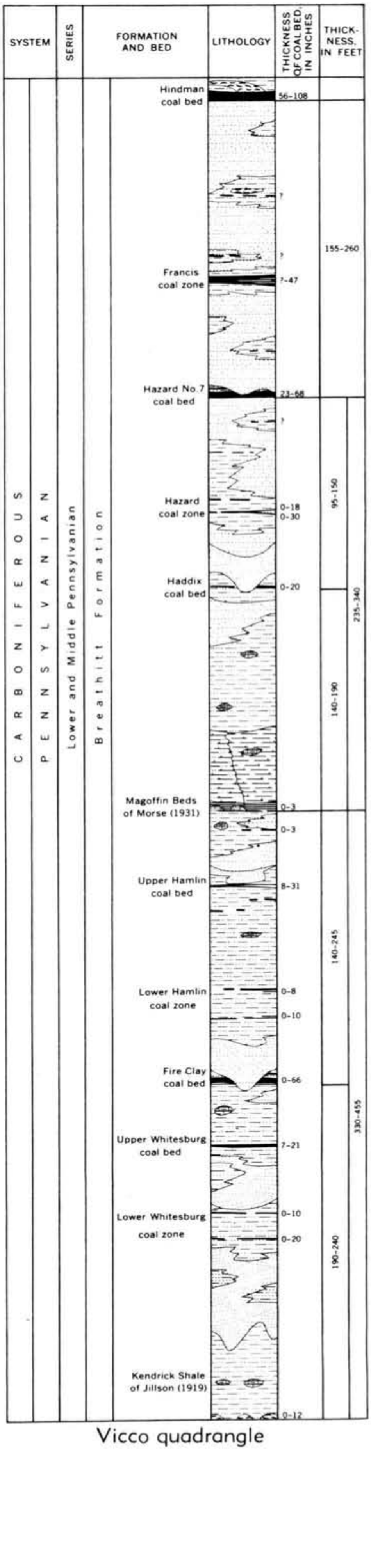
43.1 From Stop 1 to Campton we pass through several small cuts showing the dark shales of the bay-fill sequence with rippled and burrowed siltstones.

43.9 Crossroads at Campton; continue straight ahead.

44.1 The next series of exposures on the right shows bay-fill sequences with interbedded



Jackson quadrangle



Vicco quadrangle

Figure 17. Generalized stratigraphic columns for the Jackson (Prichard and Johnston, 1963) and Vicco (Puffett, 1964) quadrangles showing relationship of named coal zones seen along field trip route.

FIGURE 18A
(FIGURE 18B on reverse side)

Figure 18A. Diagram showing series of exposures along Ky. 15, 3 miles north of Jackson at Coal Stop 2 (Jackson rest area, north part). Rocks are typical lower delta plain deposits of the lower part of the Breathitt Formation.

FIGURE 18B

Figure 18B. Diagram of exposures at Coal Stop 2 (Jackson rest area, south part).

sandstones and siltstones of a back-barrier environment. These beds are in the stratigraphic interval from the Little Caney coal up to the Grassy coal; some are burrowed.

45.4 For the next 3 miles we pass through a series of bay fills and distributary sandstones and go up section to just under the Vires coal bed.

48.4 Distributary sandstone between Vancleve coal and Grassy coal.

48.7 Series of bay fills and distributary sandstones.

48.9 Abandoned channel in a distributary sandstone on the left.

49.0 Distributary sandstone over Vires coal.

49.3 Bay fills and distributary sandstones associated with Vires coal and Grassy coal zones for next 2 miles.

51.0 On the right is Vancleve coal with splay sandstone overlain by thick bay-fill sequence.

51.4 Road junction; Ky. 1261 to Bethany.

51.5 Thick bay-fill sequence which overlies a black fissile shale with **Lingula** and **Orbiculoidea.** Interval between Grassy coal and Vancleve coal.

52.2 Several exposures of bay-fill and distributary sandstones near Grassy coal and Vires coal zones are seen for the next mile.

53.1 Wolfe-Breathitt County line. This exposure shows several distributary sandstones with channel fills. The Fire Clay-Hazard No. 4 coal is near the top.

53.2 For the next 1.5 miles there are a series of exposures of bay-fill sequences with channel sandstones and distributary sandstones. The Vancleve coal is present in some of the exposures.

54.7 Channel sandstones and siltstones where the Vancleve coal has been cut out. Distributary-bar sandstones are at the top.

54.8 Bay-fill sequences over the Vancleve coal and distributary sandstones and bay fill below the coal.

55.5 Vancleve. Road junction, Ky. 205.

55.8 Along the right are exposures of several bay fills with fine-grained channel sandstones and thin coals associated with the Vancleve coal zone.

57.4 Bar-channel sandstone scouring through bay fill and cutting out Vancleve coal. Another channel sandstone is below the coal horizon.

57.8 Bar-channel sandstone above Vancleve coal zone shown in two exposures.

59.6 COAL STOP 2.

COAL STOP 2 (REST AREA NORTH OF JACKSON)

Strata in this exposure extend from the Vires coal bed at the top of the cut downward to a position about 15 or 20 feet above the Vancleve coal bed (Figs. 18A, B). These rocks form the lower part of the Breathitt Formation and are typical lower delta plain deposits. The most characteristic elements of such deposits are thick, coarsening-upward, shale-siltstone sequences and distributary-mouth-bar sandstones. The shale-siltstone units are believed to represent deep and relatively widespread interdistributary bays or minor delta fronts. An excellent example occurs below the Vires in the upper third of this cut. This unit, except the lenticular sandstone in the lower part, grades, with some interruption, from fine to coarse upward through an interval of nearly 80 feet. Zones of calcareous concretions are abundant; calcareous brachiopods and gastropods are present, and the entire interval is intensely burrowed. Thinner and more lenticular sequences similar to this, and probably representing minor bays and lakes, are present in the lower half of the exposed interval.

Distributary-mouth-bar sandstones form the second conspicuous element in lower delta plain deposits. These rocks are generally thin bedded and rippled, and grade laterally into bay shales and siltstones. Very good examples can be observed in the lowest part of the northwest portion of the cut, in the lower portion of the thick bay sequence in the top of the cut, and at the southeastern edge of the exposure just below the coal bed at the base of the marine bay sequence.

Distributary-mouth-bar sands, formed as they are at distributary mouths without laterally confining channel walls, lack sharp lateral contacts. However, as sediment accumulation reaches sea level and levees form, channels develop within the previously deposited sand body. Such a channel, filled with sand, can be observed in the lowest distributary-mouth-bar sandstone at the northwest extremity of the exposure. The lower part of the channel here is filled with medium-grained sandstone and contains wood chips and shale fragments at the base. Prominent accretion beds show that channel filling proceeded from southeast to northwest, and slump beds from the channel wall are apparent. This particular channel did not fill entirely with sand, as the upper part is a coarsening-upward bay-fill siltstone and clay capped by a thin seat rock and coal.

The remaining sequence above this latter thin coal seems to represent bays and minor channel-distributary units which are probably satelllite splay units from some nearby large channel. Marine fossils are not present in this interval but some beds are intensely burrowed.

This cut is particularly important in the regional sense as it represents the lateral equivalent of the Lee orthoquartzites in the Campton-Pine Ridge area. At this latter locality, the Grassy coal bed, which is above the top of this cut, was passing laterally into a lagoonal bay environment and was underlain by dark lagoonal shales and back-barrier orthoquartzites. Thus, the entire lower delta plain shown here grades laterally, first into a back-barrier facies and then into barrier orthoquartzites within a distance of 15 miles (Fig. 1).

Mileage

For the next 3 miles, exposures show bay fills with distributary-bar sandstones associated with the Vires coal zone.

62.9 Road junction, Ky. 15 and Ky. 30 in Jackson. Continue straight ahead.

63.8 Large cut on the left side shows the interval from the Vires coal at the base up to the Cannel City coal near the top. A series of bay fills and distributary-bar sandstones with small channel sandstones are exposed. The road goes uphill; the Cannel City coal zone is near road level, and the Lower Whitesburg coal zone is near the top of the ridges.

64.6 For the next mile the road drops back down through the section, and the bay-fill shales and distributary sandstones are associated with the Grassy coal to Cannel City coal zones.

65.5 On the right, the Grassy coal at the base of a bay fill is overlain by bar-channel sandstones. Near the top is the Kendrick shale zone. The upper coal is unnamed.

65.7 Junction with Ky. 1111. Continue ahead on Ky. 15.

65.8 For almost a mile along the left there is a continuous exposure through a large bar-channel sandstone resting on dark bay-fill shales. On top of the sandstone is the Grassy coal zone, and the Kendrick shale is near the top of the exposure.

66.7 The next two exposures show the distributary sandstones under the Cannel City coal zone.

67.9 Cannel City coal zone over sandstones and siltstones on the flank of a distributary sandstone.

68.1 Along the left for the next mile, Cannel City coal zone at the base, channel sandstone cut into bay fill, and Lower Whitesburg coal zone beneath the sandstone at the top.

69.1 Three thin coals make up Cannel City coal zone.

70.4 Kendrick at the base overlain by bay fills with bar-channel sandstones and thin irregular coal zones. Whitesburg coal zone is near the top.

71.0 Junction Ky. 1110; continue on Ky. 15. For the next mile, the section from the dark nodular Kendrick shale up to the Whitesburg coal zone is exposed.

72.4 Junction Ky. 476; continue on Ky. 15.

73.2 In the next 1.5 miles there are several exposures of the nodular Kendrick shale. The box cut at mile 73.4 has the Fire Clay coal zone at the top.

75.1 On the right is the Kendrick shale with large sideritic nodules indicating a distal bar with a distributary bar above. The coal in the section is the Whitesburg which was mined here.

75.3 The exposures for the next 1.5 miles show the sequence of bay fill, distal-bar material, distributary-bar sandstone, and thin coals. This section is stratigraphically between the Cannel City and overlying Whitesburg coal zones.

76.6 This box cut shows a distributary-bar sandstone and overbank deposits. A channel cut into the bar sandstone is filled with steeply inclined siltstone beds.

76.9 Box cut showing sequence of bay fill and sandstones in interval from Whitesburg coal zone at bottom to Haddix coal zone at top.

77.0 On the left is the Whitesburg coal zone showing a split Lower Whitesburg with the Upper Whitesburg coal above the bay fill.

77.3 Lower Whitesburg coal at base with Fire Clay-Hazard No. 4 coal zone at top of exposure.

77.8 Small slump structure on north side of road; distributary bars and bay fills from Whitesburg to Hamlin coal zones.

78.2 Bar-channel sandstone merging with distributary-bar sandstone below Fire Clay coal zone.

- 78.6 On the left, exposures of Fire Clay coal zone with Magoffin beds at top. Abandoned mine workings are present.
- 79.3 Distributary bar with small slot (channel) cutting below Fire Clay coal zone. Thick bar-channel sandstone of Hamlin coal zone at top.
- 79.5 Series of three exposures showing bar-channel sandstone below Fire Clay coal zone.
- 79.9 Breathitt-Perry County line. Sandstone below Fire Clay coal zone in next exposures.
- 80.6 Distributary sandstone below Upper Whitesburg coal zone at base with bay fills and bar-channel sandstones up to Hamlin coal zone near top.
- 80.7 Exposures of Fire Clay coal zone to Whitesburg coal zone.
- 81.1 At Engle, distributary sandstone with coal, overlain by bay fill and sandstone with burrowed zones. Fire Clay coal zone at top.
- 81.4 COAL STOP 3.

COAL STOP 3 (ENGLE)

This series of three cuts (Figs. 19A, B, C) shows the interval from the Hamlin coal beds (just above the Fire Clay coal) through the top of the Magoffin marine zone. The Hamlin coals occur in the lower part of the exposure, and the Magoffin limestone is exposed at the top of the northern cut, about 50 feet below the top of the middle cut, and about 25 feet above the base of the southern cut.

The lower part of this exposure, up to the first dark shale containing marine fossils, represents an upper delta plain, whereas the upper part is probably transitional between an upper and lower delta plain facies.

The upper delta plain facies here consists of thin, bay-like, coarsening-upward sequences between closely spaced coals and seat rocks and prominent channels filled with sandstone and siltstone. The "bay" units (probably lakes here) are intercalated with thin sandstones which probably represent overbank flood deposits from adjoining channels. The channels are clearly marked with prominent scour surfaces and present a distinct pattern of lateral fill toward the southeast. Recurrence of scours within the channel provide evidence of temporary reversal of lateral migration.

The lower delta plain portion of the exposure, which extends from the lowest unit of dark shale with marine fossils to the top of the cut, is one continuous delta-front sequence similar to that at Stop 2 but interrupted in the middle by an enormous distributary-mouth-bar sandstone with subsidiary thin coals and seat rocks. The coal and seat rock above the lower marine shale in the middle cut show a localized filling of the marine bay and development of a platform over which the distributary-mouth bar formed. The middle cut also clearly shows that a very large channel developed within this bar producing a slump on the northwest channel wall. Initial deposits of channel fill were sand shown at the lower part of the southeast end of the middle cut, but at least half of the fill exposed here is dark shale containing marine fossils. Such phenomena are common in the lower delta plain of the Mississippi River where abandonment of distributaries has led to encroachment of marine or brackish water into the old channel. The upper portion of the exposure, above the distributary sandstone and channel, is a more conventional coarsening-upward, bay-type unit including the Magoffin limestone in the lower part and siltstone and sandstone in the upper portion, with all units containing abundant marine fauna and invertebrate burrows.

This exposure is very important in the sense that it shows the mechanism of transition between the thick bay fills of the lower delta plain and similar, but thinner, deposits of the upper delta plain. Thus, in a seaward direction, the thick sandstone at the base of the Magoffin zone may be expected to wedge out, yielding a single bay succession, whereas in a landward direction, sequences similar to the Hamlin zone in the lower part of the exposure may be expected to replace the fossil-bearing Magoffin shales. In the Natural Bridge-Hazard area, this pattern is complicated by southeastern regional subsidence which thickens both upper and lower delta plain elements and also yields a setting for more favorable development of thick minable coal beds in the Hazard area (Fig. 17).

Mileage

- 81.9 Magoffin marine limestone at road level; mostly bay fills and bar-channel sandstones.
- 82.2 Next exposures show Haddix to Hazard coal interval.
- 83.0 Box cut exposes interval from Haddix coal zone at bottom to Francis coal at top. Hazard coal has been mined here.

83.5 Exposures of Haddix coal zone; the long cut shows a bar-channel sandstone.
84.1 Magoffin beds, mostly bay fill with nodules and prominent beds of limestone. Dark shales capped by bar-channel sandstone.
84.2 Road junction, Ky. 28. Buckhorn Lake to the right.
84.4 Several exposures show bay fill with nodules and beds of limestone in the Magoffin marine zone. A bar-channel sandstone overlies the Magoffin beds.
85.5 Haddix coal zone; bay fills and bar-channel sandstones.
86.0 Roadside tables; bar-channel sandstone over Haddix coal zone.
86.5 Large box cut; series of bar-channel sandstones and bay fills. Hazard coal zone at base; Francis coal zone at top.
87.3 Magoffin beds; bay fill with large nodules.
87.9 Magoffin bay fill with Haddix coal zone above, exposed along old road.
88.2 Large box cut in the Hazard coal zone to Francis coal interval; shows bay fills and bar-channel sandstones.
88.7 Bar-channel sandstone with Magoffin beds at top of cut.
88.8 Road junction, Ky. 267.
88.9 Long exposure of bar-channel sandstone under Hamlin coal zone.
89.3 On the right, Magoffin bay fill with large nodules. Bar-channel sandstone with channel cut into it; fill is fine grained. Hazard coal at top.
89.8 COAL STOP 4.

COAL STOP 4 (HAZARD NORTH)

The stratigraphic interval exposed in this cut (Fig. 20) extends from the Haddix coal bed near the base of the cut to sandstones above the Hindman coal bed at the top (Fig. 21). The Hazard No. 7 coal bed (not visible from the road) is exposed in the prominent bench about halfway up the cut (Fig. 22).

The depositional environments are those of an upper delta plain with nearly all aspects of this sedimentary system represented in various parts of the cut. The beds in the lower fourth of the exposure (downward from the thin split coal bed 25 feet above the Hazard) reflect numerous channel-fill and overbank deposits, sediments laid down in adjoining shallow and laterally restricted lakes, and the coals and seat rocks formed in the ancient swamp. Strata downward from the Hazard bed seem to represent essentially swamp deposits with thick seat rocks, thin coals, root fragments (Fig. 23), and upright stumps (Fig. 24); minor channel (probably over-bank) sandstones are associated with these units. Directly above the Hazard is an excellent example of overbank deposits from two distinct channels. The overbank units grade laterally into one another near the center of the cut. Fill deposits are mostly sandstone with festoon bedding and lag siderite gravel in the lower portion and lateral accretion beds in the upper portion. These accretion point-bar deposits indicate that channel migration was from east to west. Some channel-fill deposits spill over into adjoining interchannel areas which are intensely root penetrated.

Figure 21. View of Coal Stop 4, looking south.

Figure 22. View of abandoned mine workings in the Hazard No. 7 coal. Note roof collapse over mined-out areas.

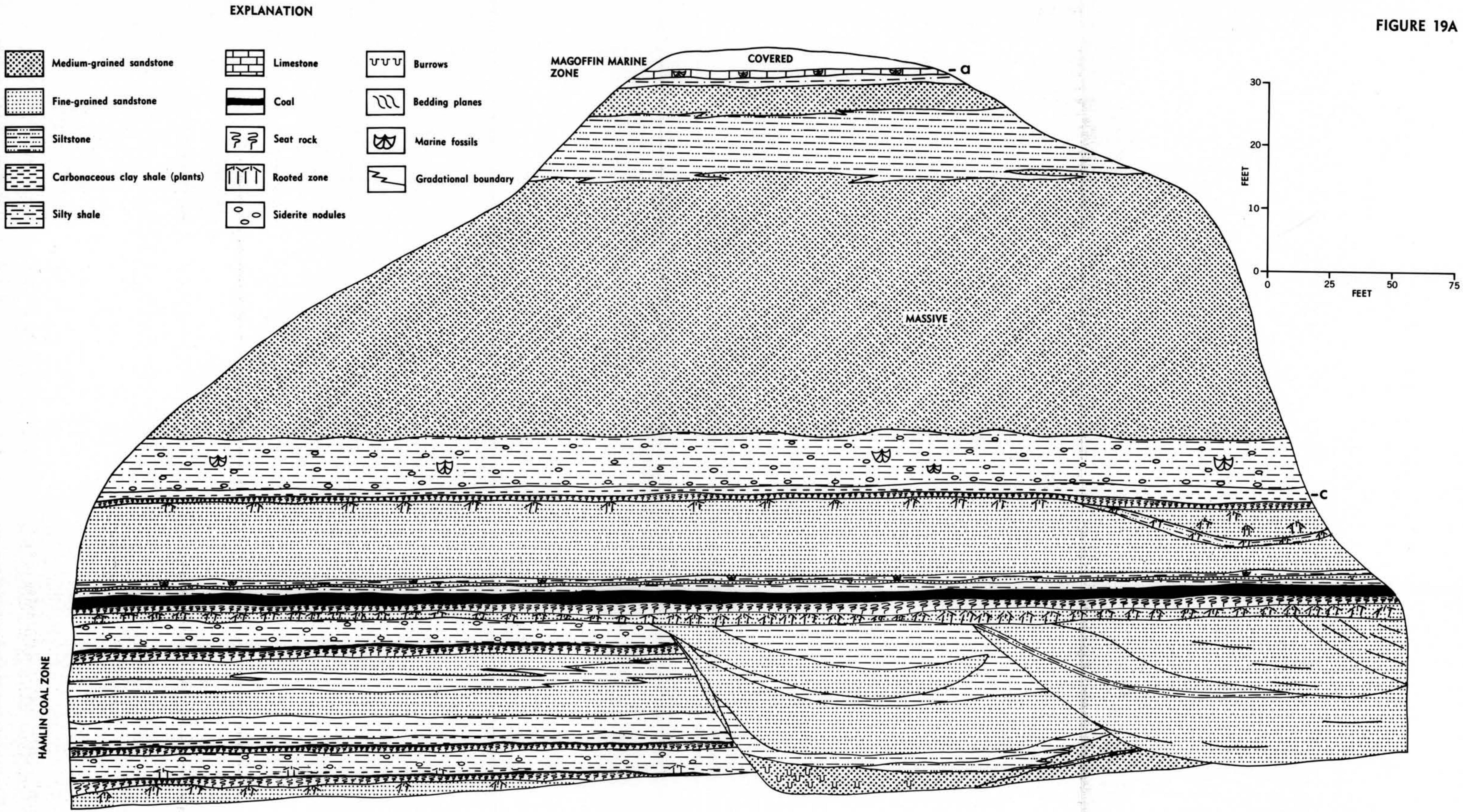


Figure 19A. Diagram showing the transitional zone between lower and upper delta plain environments at Coal Stop 3 (Engle, north cut). Several features related to channel development may be seen.

FIGURE 19B
(FIGURE 19C on reverse side)

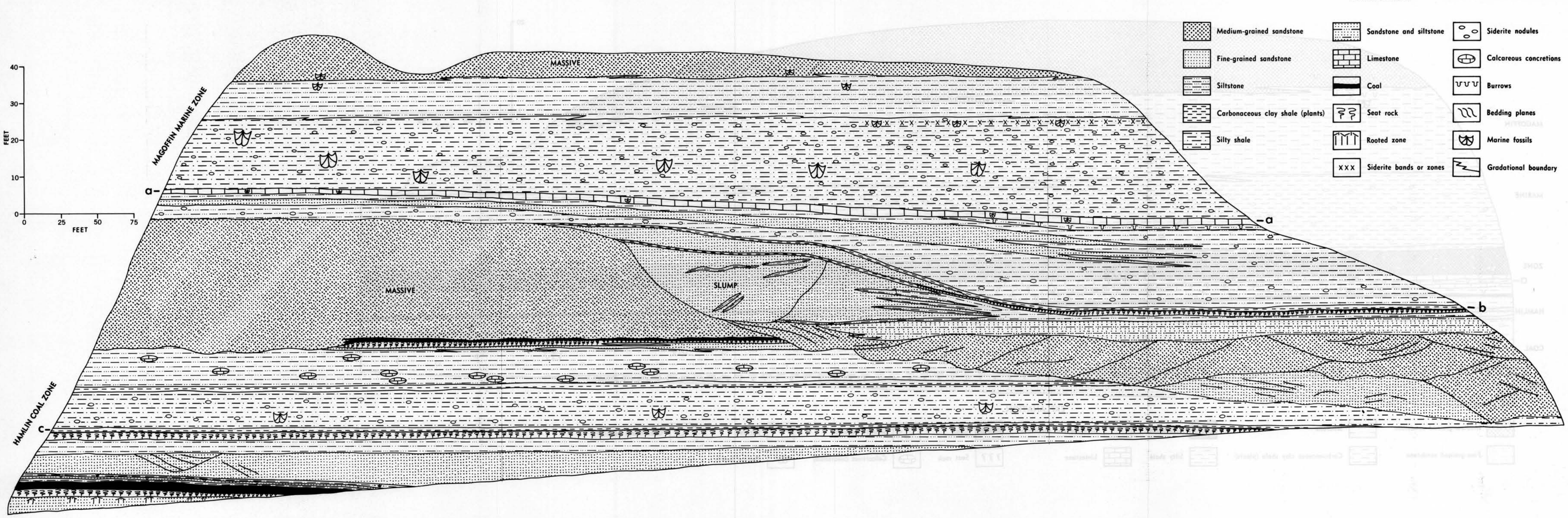


Figure 19B. Diagram of exposures at Coal Stop 3 (Engle, middle cut).

FIGURE 19C

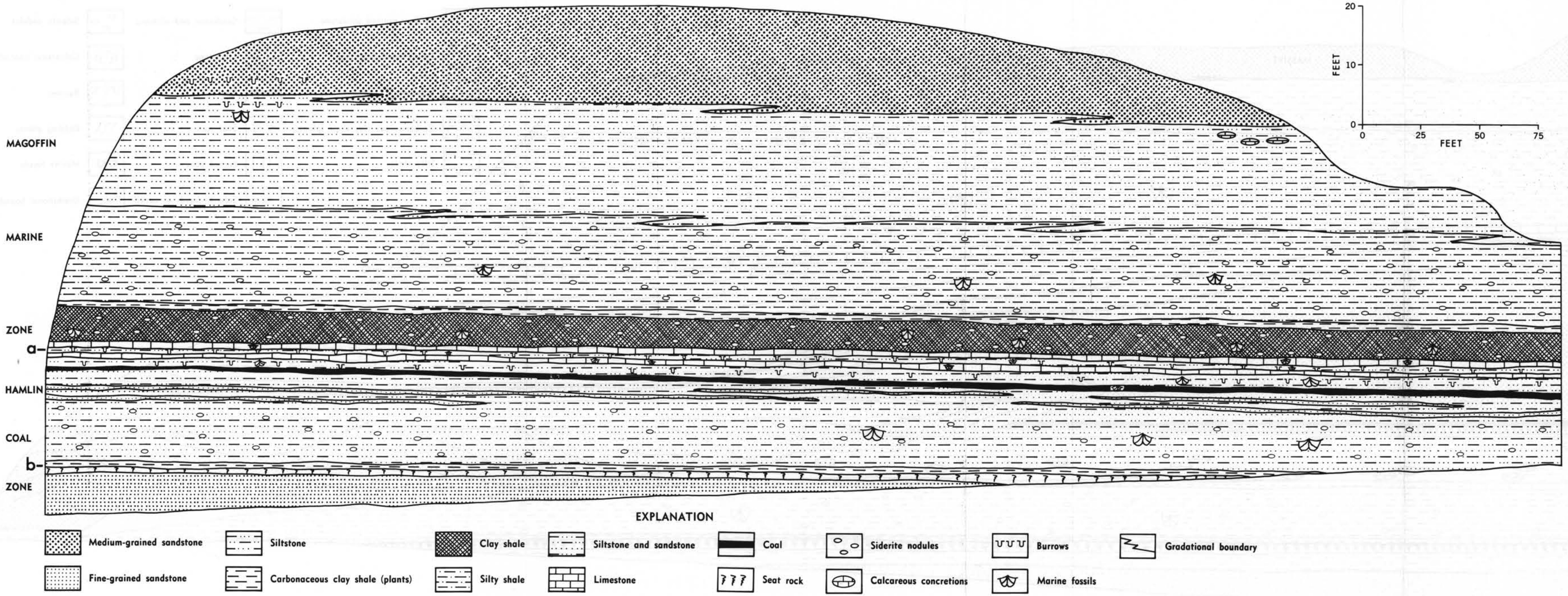
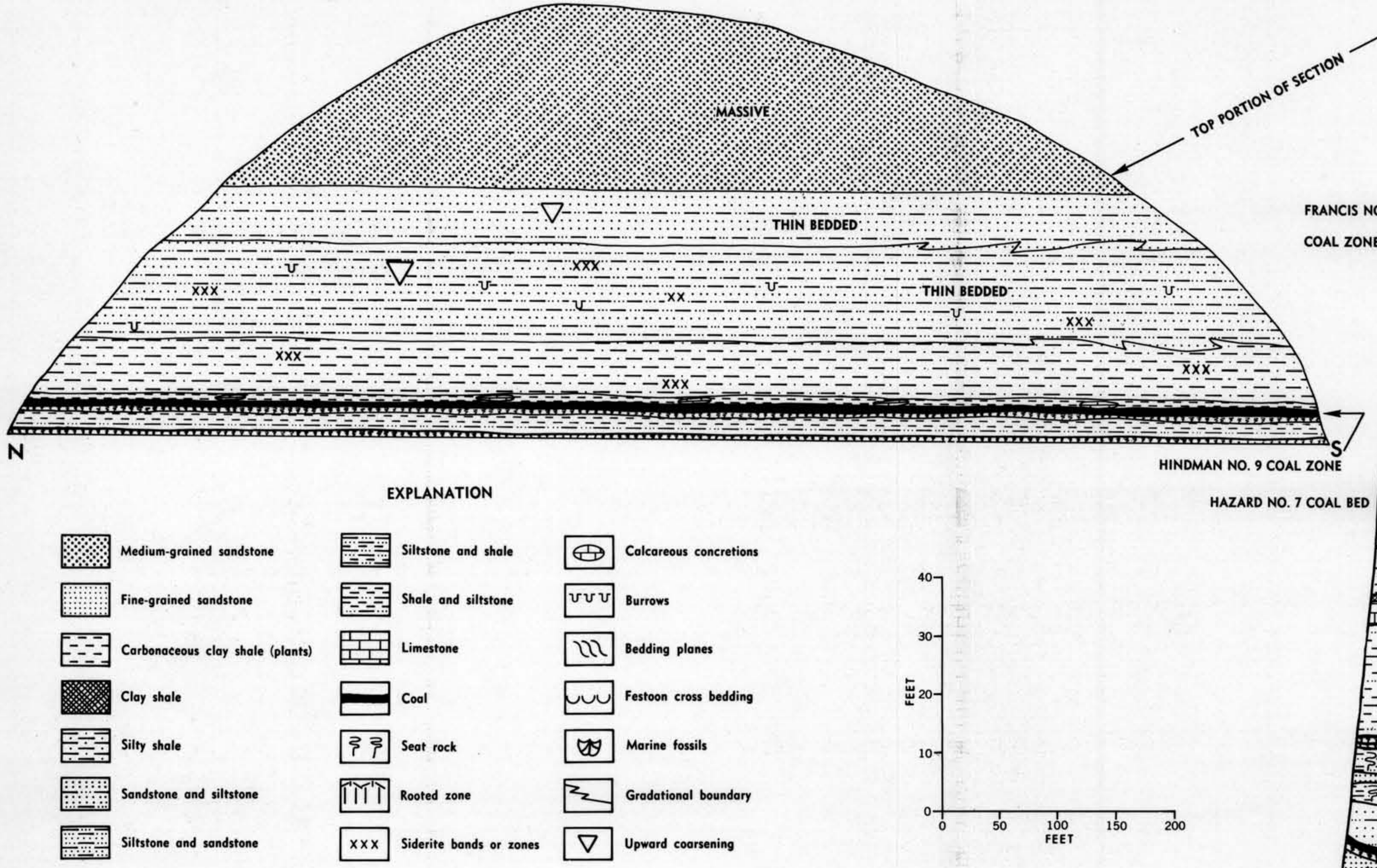


Figure 19C. Diagram of exposures at Coal Stop 3 (Engle, south cut).



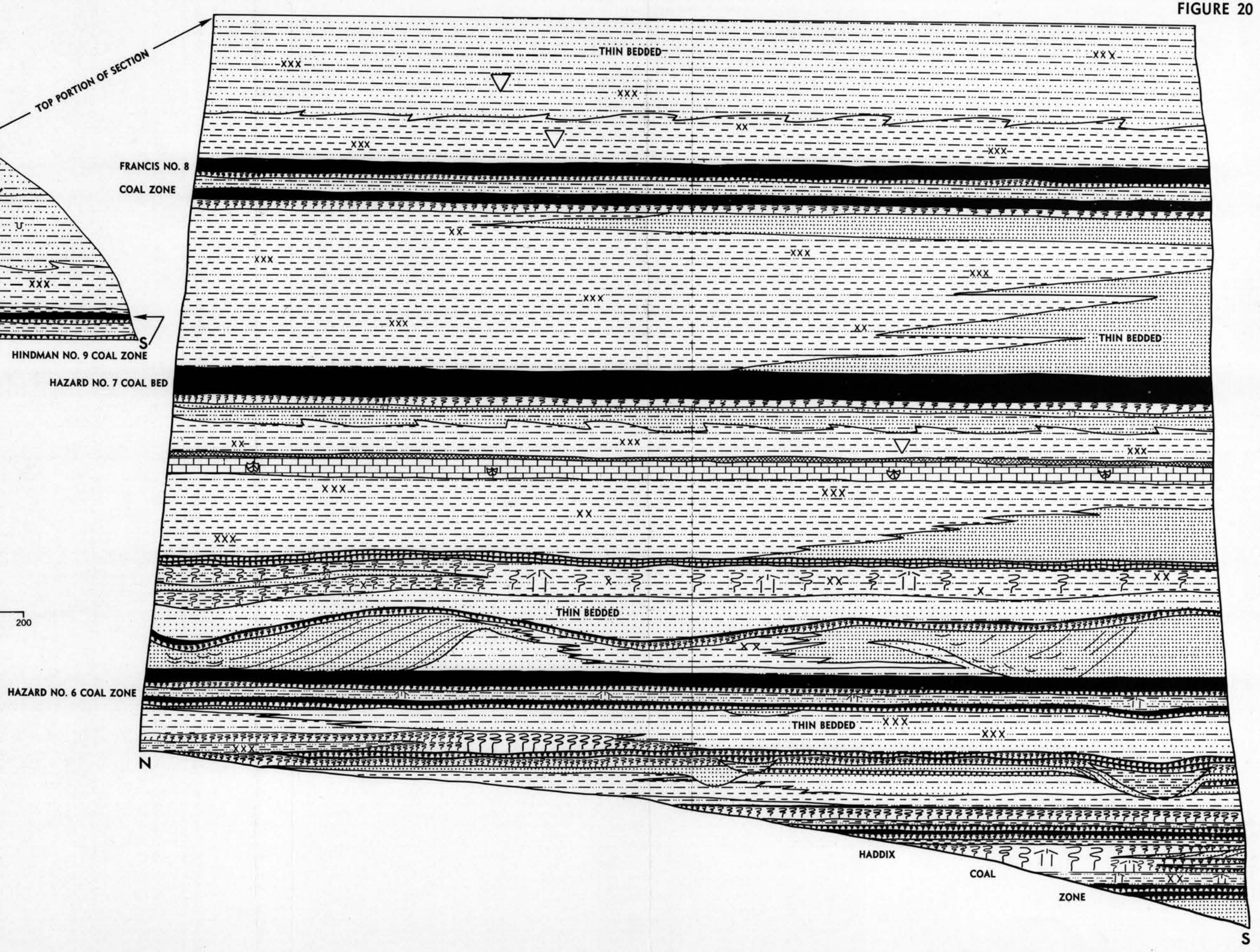


Figure 20. Diagram showing the major coal zones of the area in an upper delta plain environment at Coal Stop 4 (Hazard North). Roof collapse due to previous underground mining of Hazard No. 6 and No. 7 coals may be observed.

Figure 23. Stigmarian root fragment zone below the Hazard coal at Coal Stop 4. Easily recognizable fragments are present to the right of hammer and above the pencil.

The middle half of the cut (including strata up to the Hindman coal zone) represents somewhat more extensive and deeper interchannel bays or lakes with well-defined distributary-mouth-bar sandstones. The interchannel bays in this sequence seem to reflect progressive shallowing upward. The lowest bay deposit (below the Hazard No. 7 coal bed) contains marine faunas; the next (directly above the Hazard No. 7) is almost equally thick but lacks marine or brackish-water fossils and contains upright stumps. The top bay unit (above the Francis bed), like the one below it, lacks marine fossils. The distributary-mouth-bar sandstones which are intercalated with the lower two bay deposits are shown in typical development with flat-bottomed, broad-based sandstone lying directly upon the coal and with the diminished lateral extent upward through the sequence. The uppermost sandstones which cap both of these bay units are probably overbank splays from adjoining channels. Distributary-mouth-bar elements are not exposed in the uppermost bay (above the Francis).

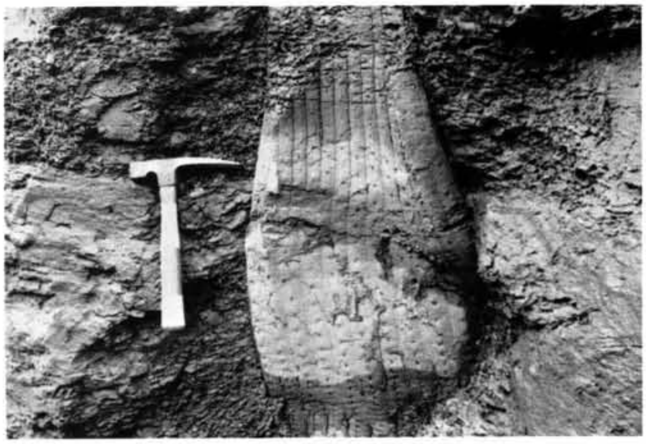


Figure 24. Upright tree stump in dark bay-fill shale near Coal Stop 4.

Deposits above the Hindman, which constitute the upper fourth of the cut, are similar to those directly underlying it. They include a prominent bay fill and a coarsening-upward sequence of shale and siltstone capped by a very thick channel-bar sandstone. Like bay deposits directly below the Hazard No. 7, those above the Hindman contain marine fossils.

Lateral changes in rock characteristics in this area provide some clue to regional paleogeography. Northwestward (Fig. 1), the entire Hazard-Haddix upper delta plain deposits shown here merge with the underlying lower delta plain strata of the Magoffin zone, whereas to the southeast, the Hazard-Hindman interval expands, including more coal beds and containing a greater proportion of thick sandstone.

Mileage

- 90.9 Fire Clay coal at base; distributary bar with sandstone-filled channel. Cut bank at east end; mine workings at east end. Hamlin coal zone at top.
- 91.0 Road junction, Ky. 80. Continue on Ky. 15 toward Hazard.
- 91.2 The series of exposures leading into Hazard includes the stratigraphic interval from the Upper Whitesburg coal zone up to the Hamlin coal zone. The box cut has the Fire Clay coal at the base, and the lower two-thirds of the section consists mostly of shallow-water bay fill. Above the limestone bed in the Magoffin, there is a thick bay fill with distributary sandstones.
- 92.1 Traffic light in Hazard; turn left on Ky. 15 and continue through the city.
- 92.3 Along the left is a large distributary sandstone over the Lower Whitesburg coal.
- 92.8 Turn left; follow Ky. 15.
- 93.1 Traffic light; continue ahead.
- 93.2 Underpass, traffic light; turn left.
- 93.6 Shrine Memorial Bridge; begin new Ky. 15. Lower Whitesburg coal zone up to Hamlin coal. Note collapse of roof over mined-out areas in Fire Clay-Hazard No. 4 coal. Distributary sandstones are becoming much thicker; bay fills are mostly marine. Several large exposures which have not been studied in detail at this time are present along almost 3 miles of continuous outcrop.

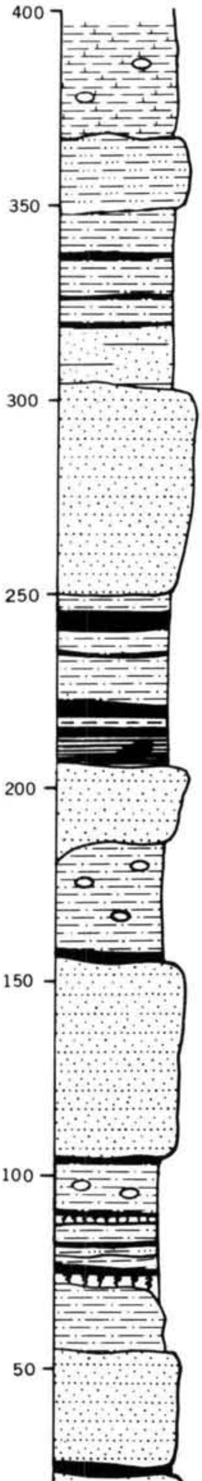


Figure 25. Generalized section of rocks seen at road level going uphill along Ky. 15 at Coal Stop 5 (Vicco). Many lateral variations in lithology between the coals can be observed.

Figure 26. Large sandstone body exposed above the Fire Clay coal at Coal Stop 5.

96.8 Several more exposures of distributary sandstone and marine bay fill with splays developed. Lower Whitesburg to Hamlin coal zone interval.

98.6 Detour Ky. 15 to Ky. 7. Continue straight ahead on new Ky. 15.

98.7 Kendrick marine shale at base; distributary sandstones and bay fill up to the Fire Clay coal horizon.

101.5 Distributary sandstone with splays in the Kendrick shale.

102.5 Short detour left.

102.9 Shales and siltstones of marine bay fill of Kendrick shale zone. Coals at top are Whitesburg zone.

104.3 Vicco. To the left, note church steeple at bridge level.

104.6 Perry-Knott County line. Sections on right show distributary sandstone splays and marine bay fills of Kendrick to Fire Clay coal zone.

Figure 27. Fire Clay, or Hazard No. 4, coal with characteristic flint clay parting in the lower part.

105.4 Road junction to Carrs Fork Reservoir. COAL STOP 5.

COAL STOP 5 (VICCO)—DO YOUR OWN THING

This stop (Fig. 25) allows you to walk up-section and observe the lateral changes (Fig. 26) that occur in the interval between the Kendrick shale at the road intersection at the bottom of the hill and the Magoffin marine zone, which is exposed high in the cut across from the rest stop at the top of the hill. Over 400 feet of vertical section is completely exposed at this location, and the coals can be observed and traced eastward in cuts along the new road for almost 3 miles. The Lower Hamlin coal zone has a 4-inch as well as a 4-foot coal, and the Upper Hamlin coal zone is made up of several very thin coals. The Fire Clay coal (Fig. 27) has the characteristic flint clay parting. At the rest stop, three levels of surface mining can be observed on the mountainside across the valley to the north. The Fire Clay coal is being mined at the lowest level, the Hazard No. 7 at the middle level, and the Hazard No. 9, or Hindman, at the top. The Carr Fork Reservoir will soon fill the valley.

Mileage

106.5 Rest stop at top of hill. This is the turn-around point and end of the trip.

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