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CAMBRIAN SEDIMENTATION AND STRUCTURAL EVOLUTION OF THE ROME TROUGH IN KENTUCKY

University of Cincinnati PH.D. 1980

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CAMBRIAN SEDIMENTATION AND STRUCTURAL EVOLUTION
OF THE ROME TROUGH IN KENTUCKY

A dissertation submitted to the

Division of Graduate Studies
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

DOCTOR OF PHILOSOPHY

in the Department of Geology of the
Graduate School of Arts and Sciences

1980

by

E. J. Webb
B.S. Drury College, 1950

UNIVERSITY OF CINCINNATI

May 8 19 80

I hereby recommend that the thesis prepared under my supervision by Elmer J. Webb

entitled Cambrian Sedimentation and Strucutral Evolution of the Rome Trough in Kentucky

be accepted as fulfilling this part of the requirements for the degree of Doctor of Philosophy

Approved by:

Paul Edwin Potter

Kees A De Jong

J Barry Maynard

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ABSTRACT

Cambrian sedimentation of the Rome trough in eastern Kentucky was studied using 85 wells supplemented by available cuttings and cores. Most conclusions are based on cross sections, isopach and structure maps, and the environmental interpretation of geophysical logs. Thin section petrology played a supplementary role.

The Rome trough contains a wide variety of sedimentary rocks, many of which are restricted to the trough itself. The trough is both bounded by and has within it synsedimentary faults. These faults were active during the Middle Cambrian. Facies and their thickness within the trough are closely related to the activity of these synsedimentary faults. A notable element of the Middle Cambrian fill of the trough is the Garrard County delta system, which covers an area of about 200 square miles. Identification of this delta system proved to be a major step in understanding the Middle Cambrian fill of the trough. This delta was supplied by a river that flowed from the northeast.

The Rome trough in Kentucky is part of a rift system that extends from Pennsylvania into Missouri. Precambrian faults may have determined the position of the trough.

INTRODUCTION

This is a subsurface study of Cambrian rocks centered on the Rome trough of eastern Kentucky, first named by McQuire and Howell (1963). The study area includes southern Indiana, southern Ohio, western West Virginia, northeastern Tennessee and all of eastern Kentucky (Fig. 1).

My objectives are four-fold:

(1) to compare and contrast Cambrian sedimentation, facies, depositional environments, sandstone petrology, and provenance, in and adjacent to the Rome trough;

(2) to determine the relation between faulting and facies of the Cambrian sediments within the Rome trough;

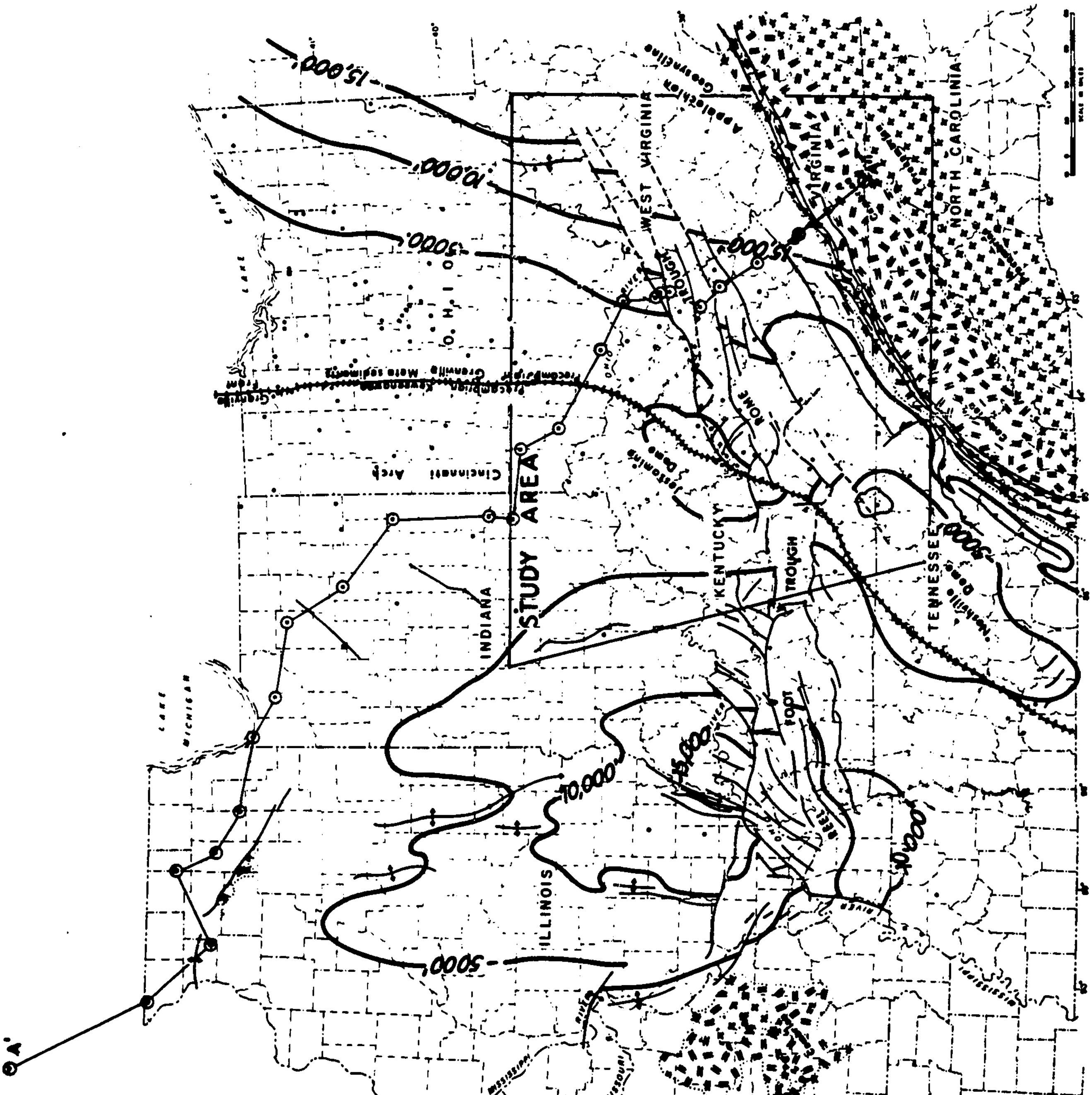
(3) to determine the age of rifting that produced the Rome trough; and

(4) to correlate the fill of the Rome trough with the classic Cambrian section of southern Wisconsin and that of the Cambrian outcrop in Virginia and northeastern Tennessee.

To solve these problems I primarily used geophysical logs from eighty-five deep test wells in conjunction with available drill cuttings and cores (please see Appendix). These data were supplemented by petrographic study of the major rock types, especially the sandstones.

Figure 1

Index Map of east-central United States showing study area, major structural featues and contoured on the Precambrian with a 5000 foot interval.



A'
STUDY AREA
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
O H I O
Cincinnati Arch
ROME
TROUGH
-5000-
10,000
15,000

CONCLUSIONS

1. The Rome trough in Kentucky (hereafter called trough) is a part of the Rome rift system which extends from Missouri to Pennsylvania.

2. The location of the trough was probably determined by Precambrian faults. Subsidence began in early Middle Cambrian time, and the trough became dormant as a distinct depositional entity by late Middle Cambrian time.

3. All major faults of the trough are synsedimentary faults. Stratigraphic evidence indicates the average rate of faulting was never more than the average rate of sedimentation: thus there was little topographic expression of the trough in Middle Cambrian time and the sides of the trough were generally not subaerially exposed.

4. Within the trough are five well defined fault blocks which subsided with different rates at different times.

5. The trough is filled with a variety of Middle Cambrian sedimentary rocks, many of which do not occur outside the trough. These include black carbonaceous shales, shallow marine and deltaic sandstones and shales, cratonic turbidites, algal biostromes, shelf and possibly some deeper water carbonates, and minor, shallow water evaporites associated with the shelf carbonates. However, thick

evaporite sequences common in troughs and rifts in other parts of the world are lacking in the Rome trough.

6. Facies distribution within the trough suggests a paleoslope parallel to its long axis so that paleocurrents flowed from northeast to southwest.

7. There is a well defined delta system centered in Garrard County in the western portion of the trough.

8. The Garrard County delta system was the only major source of sand and mud that entered the trough from its sides. The source was possibly as far as 200 to 500 miles (320 to 805 km) away.

9. Sandstones in the upper part of the Rome Formation appear to be more mature than those in the lower part.

10. The Mount Simon Sandstone was derived from the craton to the north and northwest whereas the sandstones of the Rome trough probably come from the northeast.

11. The Mount Simon Sandstone is of Late Cambrian age and the term should be used only north of the Rome trough.

12. The basal arkose, which is easily recognized on geophysical logs, varies from 0 to 300 ft. (91 m) thick, and is informally named the Kirby arkose from subsurface sections in Garrard County, Kentucky.

REGIONAL SETTING

The Rome trough lies in eastern Kentucky and West Virginia and can only be studied by subsurface geology. The trough was filled with Cambrian sediments, which cover a large area in the Southern Appalachians and the eastern Midwest (Fig. 1). These Cambrian sedimentary rocks have been sparsely described and interpreted in the literature, the major publications being summarized in Table 1.

I began my investigation of Cambrian sedimentation by making a regional cross section that extends from Wisconsin to North Carolina (Fig. 2). The 800 mile (1290 km) long cross section, with 24 key wells (Table 2), was constructed after first considering every pre-Knox test well between the Wisconsin and Ozark domes and the outcrops in North Carolina and adjacent parts of Virginia and Tennessee. Sample studies were carefully correlated with geophysical logs and additional core and sample studies were undertaken in Ohio, West Virginia and Kentucky.

The Cambrian is about 500 feet (152 m) thick at the outcrop in Wisconsin, thickens to 2900 feet (883 m) in the pre-Ordovician Eastern Interior basin (wells 4 through 9) and then thins to an average of 800 feet (243 m) upon a regional uplift near Cincinnati, Ohio (wells 11 through 18). This broad uplift may represent the ancestral Kankakee and Cincinnati arches.

The Precambrian surface upon which Cambrian sediments were depos-

TABLE 1

SELECTED ANNOTATED REFERENCES
TO PRE-KNOX SEDIMENTS

Freeman, 1953: Initial comprehensive tabulation and interpretation of Cambro-Ordovician rocks in Kentucky. No deep wells had as yet been drilled in eastern Kentucky and hence Rome trough was not recognized.

McGuire and Howell, 1963: A tabulation of all Cambro-Ordovician tests drilled in Kentucky with cross-sections and maps of Cambrian and Ordovician units. Authors show an abrupt thickening into basin to the southeast at present northern limit of Rome trough. As a result of this study, the petroleum industry became aware of the deeper oil and gas potential in Kentucky.

Calvert, 1964: A tabulation of all the wells of the Sauk sequence (Knox to Precambrian) in Ohio with formation tops and lithologic data. Pioneer in Cambrian stratigraphy because construction of cross sections that extend from Kentucky to Ontario (1962) and from West Virginia to Illinois (1964). Demonstrated uniformity of depositional environments and shelf stratigraphy over a broad Cambrian shelf and shows their truncation northward toward the Canadian shield.

Harris, 1964: Through the use of cross sections and maps Harris depicts facies relationships between exposures of Conasauga Group and Rome Formation of Tennessee with equivalent subsurface rocks in central Kentucky and the significance of particular facies to oil and gas exploration.

Buschback, 1964 and 1970: Discussion of Cambrian and Ordovician strata of northern Illinois based on cross-sections and maps. Careful lithologic description based on cores and binocular examination of cuttings and good maps of areal distribution. Notable because subsurface of Illinois is related to outcrop in Wisconsin and Missouri.

Janssens, 1973: Subsurface study of Cambrian formations utilizes 111 test wells in Ohio. Updates previous data and maps, particularly pre-Knox units. Isopach maps suggest Cambrian delta system with progradation to the south. Careful lithologic descriptions of Cambrian sediments based on core and binocular examination of drill cuttings.

Table 1 - Continued

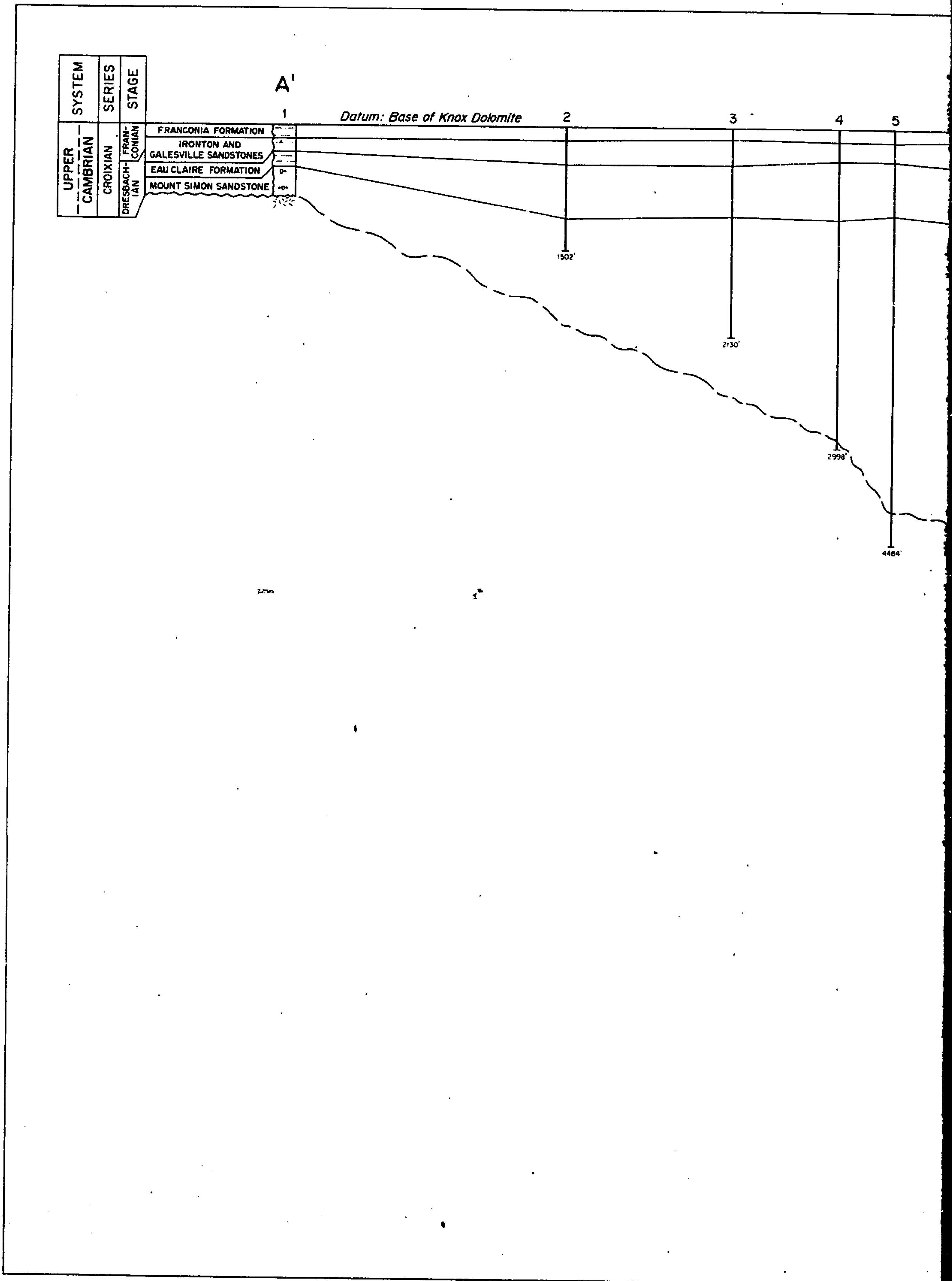
Catacosimos, 1973: Cambrian lithostratigraphy in the Michigan basin and relation to Wisconsin, Indiana and Ontario. Primarily concerned with the subdivisions of the Mt. Simon.

Ping-fan Chen, 1977: Mapped lower Paleozoic stratigraphy, tectonics, paleogeography and oil and gas possibilities in the central Appalachians (West Virginia and adjacent states) from outcrops and four deep tests. Recognizes a trough present in Cambrian time extending from the Kentucky-West Virginia border into western Maryland.

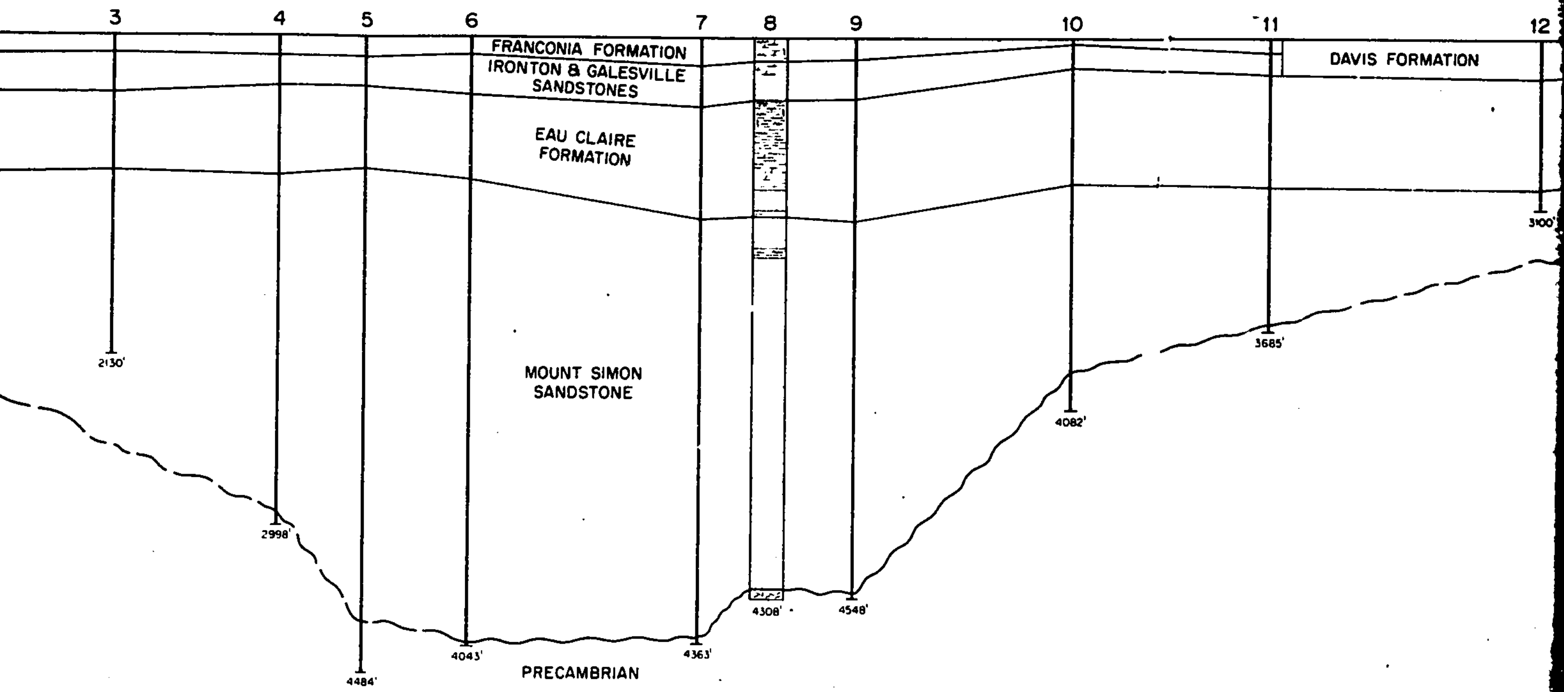
Becker, 1978: Correlates and carefully describes pre-Knox Cambrian sediments in Indiana using cores, cuttings and some thin sections. Tabulates all wells and lists formation tops in Indiana. Outlines the relationship of formations in Indiana to the Illinois basin, Wisconsin dome and to Ohio.

FIGURE 2

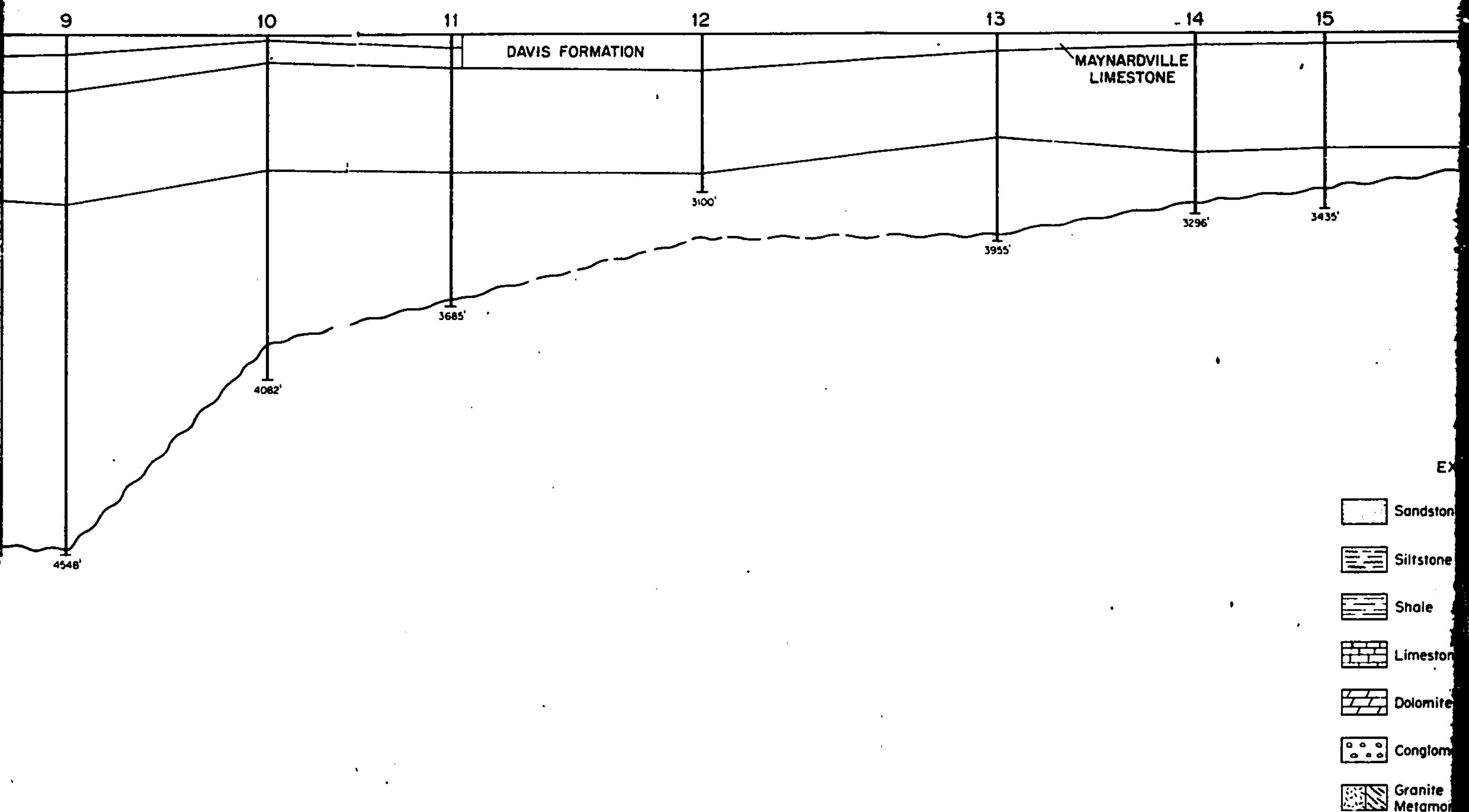
Cross section of Cambrian rocks, Wisconsin to Virginia with the base of the Knox Dolomite as a datum. Between sections 23a and 24 no adjustment was made for structural foreshortening.

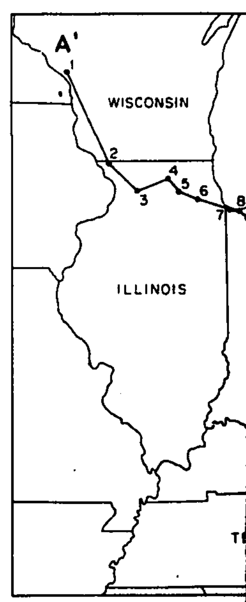


SYSTEM
SERIES
STAGE
UPPER CAMBRIAN
CROIXIAN
FRAN-CONIAN
DRESBACH-IAN
FRANCONIA FORMATION
IRONTON AND GALESVILLE SANDSTONES
EAU CLAIRE FORMATION
MOUNT SIMON SANDSTONE
A'
1
Datum: Base of Knox Dolomite
2
3
4
5
1502'
2130'
2998'
4484'



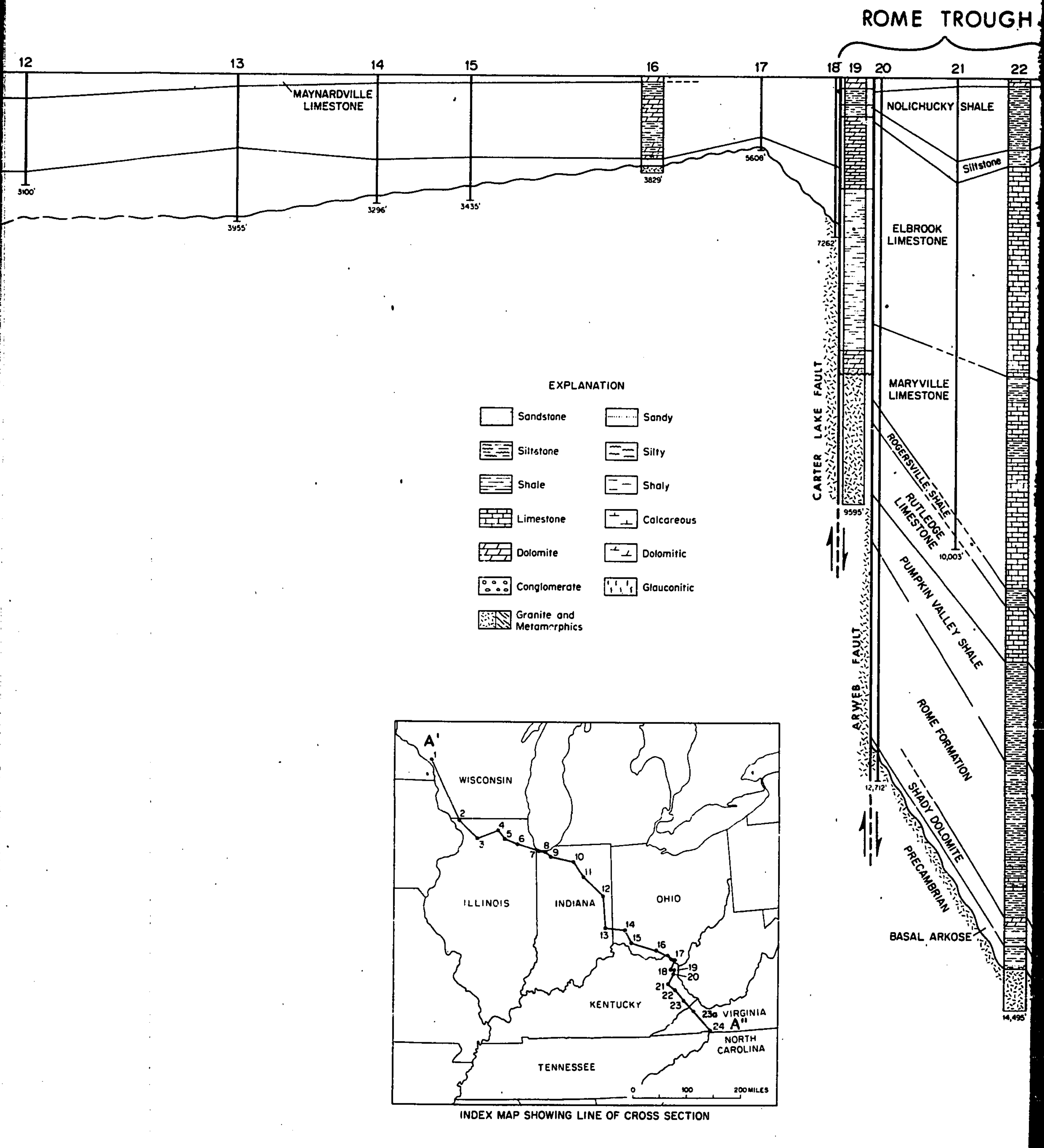
CROSS SECTION OF CAMBRIAN ROCK



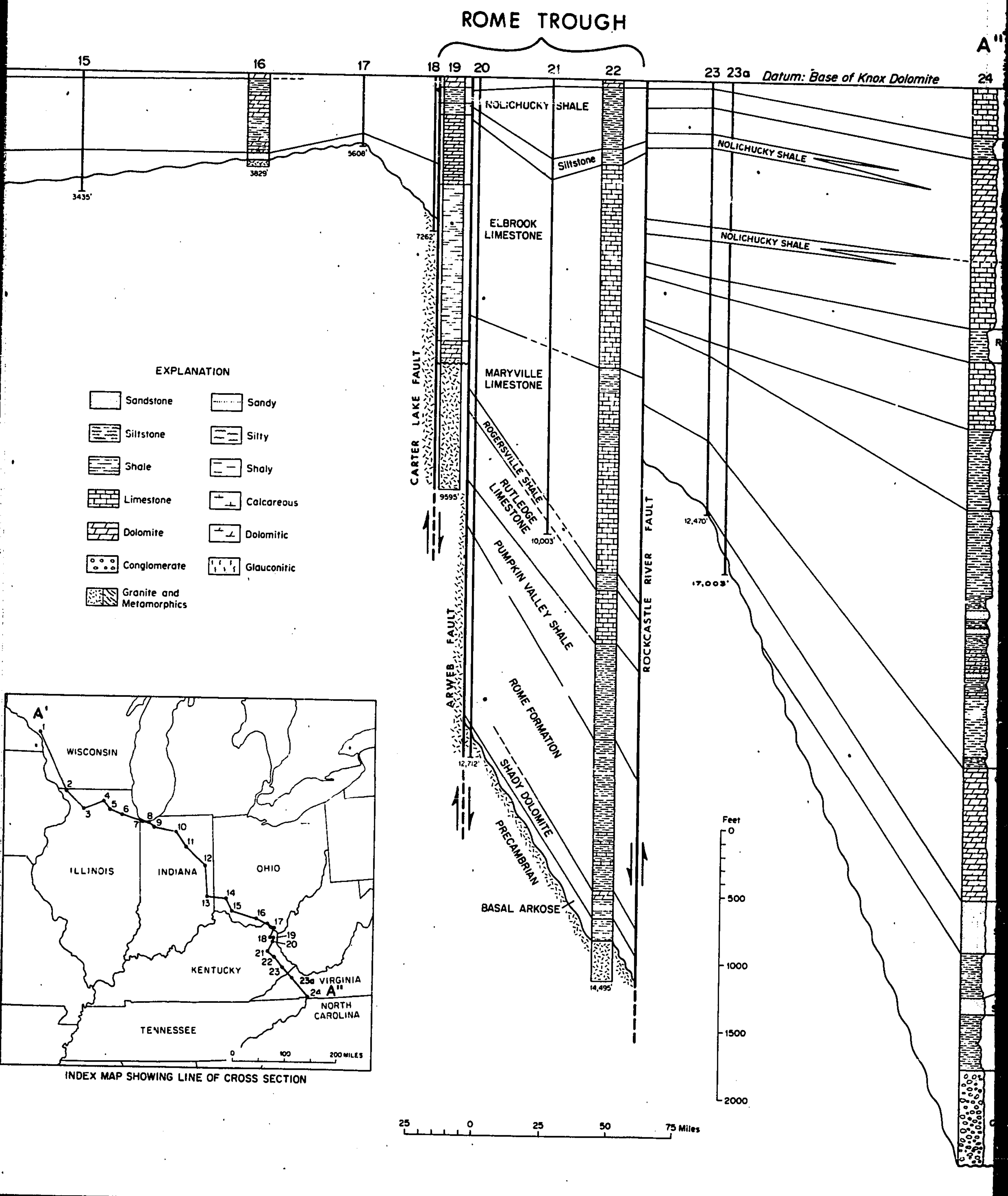


INDEX MAP SHO

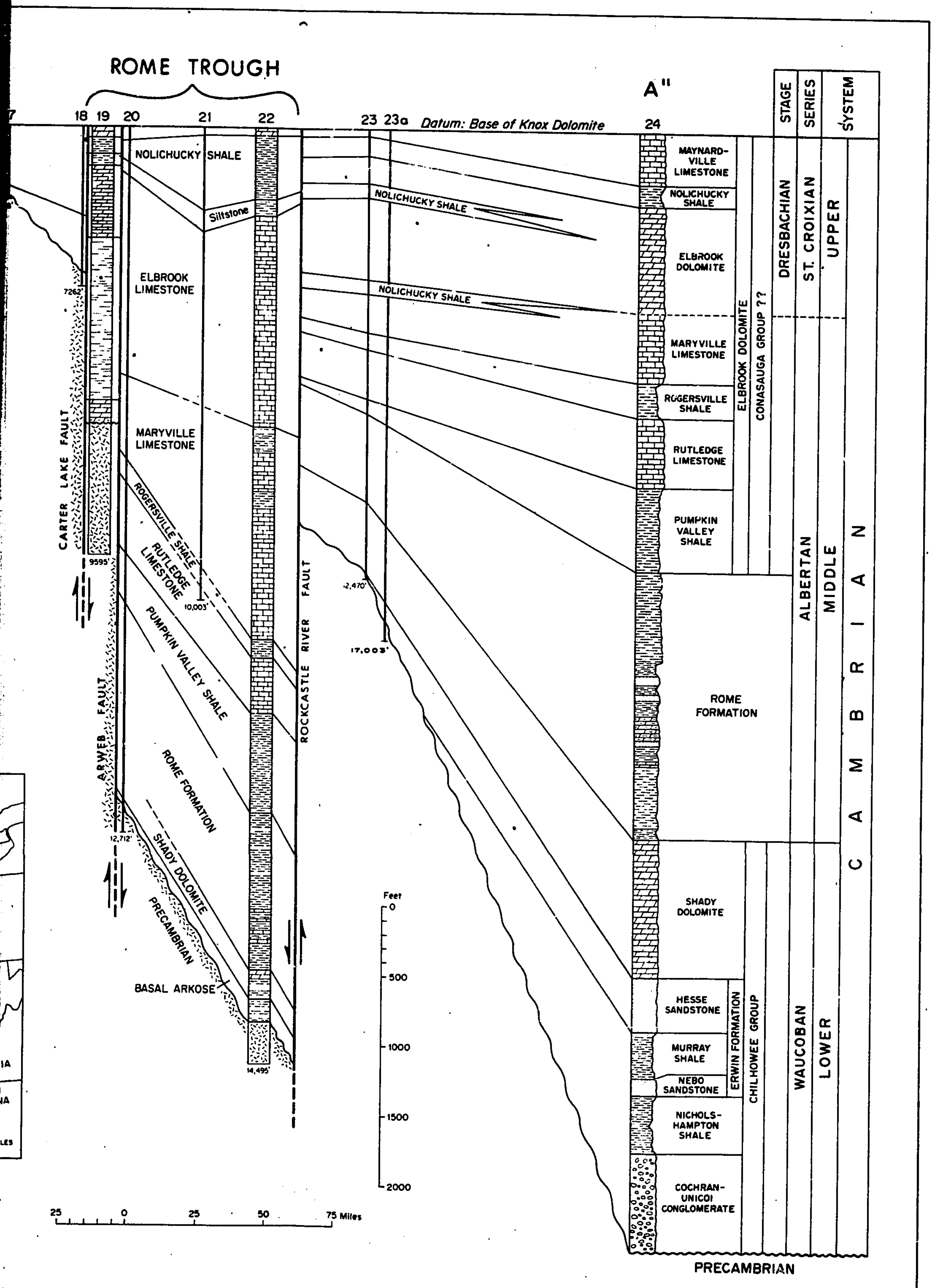
CROSS SECTION OF CAMBRIAN ROCKS, WISCONSIN TO VIRGINIA



OCKS, WISCONSIN TO VIRGINIA



INDEX MAP SHOWING LINE OF CROSS SECTION



ROME TROUGH
18 19 20 21 22 23 23a Datum: Base of Knox Dolomite 24
A"
NOLICHUCKY SHALE
Siltstone
ELBROOK LIMESTONE
MARYVILLE LIMESTONE
ROGERSVILLE SHALE
RUTLEDGE LIMESTONE
PUMPKIN VALLEY SHALE
ROME FORMATION
SHADY DOLOMITE
PRECAMBRIAN
BASAL ARKOSE
CARTER LAKE FAULT
ARWEB FAULT
ROCKCASTLE RIVER FAULT
7262'
9595'
10,003'
12,712'
14,495'
12,470'
17,003'
NOLICHUCKY SHALE
NOLICHUCKY SHALE
MAYNARD-VILLE LIMESTONE
NOLICHUCKY SHALE
ELBROOK DOLOMITE
MARYVILLE LIMESTONE
ROGERSVILLE SHALE
RUTLEDGE LIMESTONE
PUMPKIN VALLEY SHALE
ROME FORMATION
SHADY DOLOMITE
HESSE SANDSTONE
MURRAY SHALE
NEBO SANDSTONE
NICHOLS-HAMPTON SHALE
COCHRAN-UNICOI CONGLOMERATE
ELBROOK DOLOMITE
CONASAUGA GROUP ??
ERWIN FORMATION
CHILHOWEE GROUP
STAGE
SERIES
SYSTEM
DRESBACHIAN
ST. CROIXIAN
UPPER
ALBERTAN
MIDDLE
WAUCOBAN
LOWER
CAMBRIAN
PRECAMBRIAN
Feet
0
500
1000
1500
2000
25 0 25 50 75 Miles

FIGURE 2

TABLE 2

CONTROL WELLS FOR REGIONAL CROSS SECTION A'-A"
(See Figure 1 for location)

1. Composite Outcrop - Wisconsin
2. Varner #1 East Dubuque City, Section 20, T29N, R2W, Joe Daviess County, Illinois
3. Natural Gas Pipeline Co., #2 R. Keckler, Section 35, T24N, R7E, Ogle County, Illinois
4. Northern Illinois Gas Co. #1 E. Taylor, Section 28, T43N, R3E, Boone County, Illinois
5. Bull Schulte #1 E. Wyman, Section 35, T41N, R5E, DeKalb County, Illinois
6. American Steel Corp., WD #1, Section 9, T39N, R9E, DuPage County, Illinois
7. Inland Steel Corp., WD #1, Section 14, T37N, R9W, Lake County, Indiana
8. Midwest Steel Corp., WD #1, Section 25, T37N, R7W, Porter County, Indiana
9. Stoltenberg #1 Fee, Section 16, T35N, R5W, Porter County, Indiana
10. Northern Indiana Public Service Co., #1 Ames, Section 21, T34N, R3E, Marshall County, Indiana
11. Ashland Oil Co., #1 Hudson, Section 25, T29N, R6E, Wabash County, Indiana
12. Continental Oil Corp., #1 Resur, Section 31, T23N, R13E, Jay County, Indiana
13. Gulf Oil Corp. #1 Scott, Section 32, T13N, R13E, Fayette County, Indiana
14. Armco Steel Corp. #1 Fee, Lemon Township, Section 8, Butler County, Ohio
15. Continental Oil Corp., #1 C. Wikoff, Stonelick Township, VMSL 681, Clermont County, Ohio
16. Commonwealth Gas Corp. #1 G. Covert, Jefferson Township, VMSL 4040, Adams County, Ohio
17. U.S. Steel Chemicals Co., #1 Fee, Green Township, Scioto County, Ohio
18. Inland Gas Co., #538 Coalton Fee, Section 14, T-V, R81, Carter County, Kentucky
19. Inland Gas Co., #533 Coalton Fee, Section 11, T-V, R81, Boyd County, Kentucky
20. Inland Gas Co. #1 W. P. Young, Section 6, T-U, R82, Lawrence County, Kentucky

TABLE 2 - Continued

21. Columbia Gas Corp. #9784-PIT, J. H. Evans, Section 10, T-R, R79, Johnson County, Kentucky
22. U.S. Signal Oil #1 Elkhorn Coal Company, Section 7, T-P, R82, Johnson County, Kentucky
23. U.S. Signal Oil #1 H. Stratton, Section 8, T-L, R85, Pike County, Kentucky.
24. Gulf Oil Corp., #1 W. R. Prince, Section 15, T-E, R88, Castlewood district, Russell County, Virginia
25. Composite Outcrop - Virginia, Tennessee, North Carolina

ited consists of Keweenawan quartz-rich granites from the Wisconsin dome to the eastern flank of the ancestral Cincinnati arch (Fig. 1). On the eastern flank of the arch the "Grenville" front represents the boundary between granitic rocks and Grenvillian metasediments. Summerson (1962) early described how this boundary affects gravity maps, which reflect changes in composition of the basement. This boundary occurs between wells 15 and 16 (Fig. 2).

Abruptly, between wells 18 and 19, the cross section reveals normal faulting and greater thicknesses of Cambrian sediments within the well defined 75 miles (120 km) wide Rome trough (wells 19 through 22). Sedimentary facies within the trough also differ from those north of it, because more shale and carbonate are present.

Southeast of the south-bounding fault of the trough, at wells 23 and 23c, the section from the base of the Knox to the basement is about 3500 feet (1066 m); southeastward it increases to about 8700 feet (2650 m) in the outcrop at composite outcrop section 24. As far as is known, most of the units below the Elbrook Dolomite all thicken southeastward at about the same rate. The proportion of carbonate in the section increases, however, and sandstone is notably absent.

Judged in its entirety, the cross section shows a sandy fill from Wisconsin to the north boundary of the Rome trough, but southeastward the thick carbonates suggest an early fill of a miogeosyncline.

TABLE 3

STRATIGRAPHIC CLASSIFICATION OF CAMBRIAN STRATA (KENTUCKY AND ADJOINING STATES)

SERIES	STAGES	SOUTHEASTERN MISSOURI	ILLINOIS NORTHERN INDIANA	SOUTHERN INDIANA	SOUTHERN OHIO	NORTHERN KENTUCKY	ZONE OF BASIN MARGIN FAULTING	CENTRAL KENTUCKY ROME TROUGH	NORTHEASTERN TENNESSEE SOUTHWESTERN VIRGINIA	
UPPER ST. CROIXIAN	TREMPEALEAU	EMINENCE DOLOMITE POTOSI DOLOMITE	GUNTER SANDSTONE EMINENCE DOLOMITE POTOSI DOLOMITE	KNOX DOLOMITE	ROSE RUN SANDSTONE KNOX DOLOMITE	ROSE RUN SANDSTONE COPPER RIDGE DOLOMITE		ROSE RUN SANDSTONE COPPER RIDGE DOLOMITE	COPPER RIDGE DOLOMITE	KNOX GROUP
	FRANCONIAN	ELVINS: DOE RUN DERBY DOLOMITE DAVIS	FRANCONIA IRONTON GALESVILLE	DAVIS						
	DRESBACHIAN	BONNETERRE DOLOMITE LAMOTTE SANDSTONE	EAU CLAIRE SANDSTONE MT. SIMON SAND	EAU CLAIRE SILTSTONE - SHALE MT. SIMON SAND	KERBEL EAU CLAIRE SHALE ROME MT. SIMON SAND	EAU CLAIRE SILTSTONE AND SHALE MT. SIMON SAND		MAYNARDVILLE LIMESTONE NOLICHUCKY SHALE	MAYNARDVILLE LIMESTONE NOLICHUCKY SHALE ELBROOK DOLOMITE	CONASAUGA GROUP
MIDDLE ALBERTAN		ABSENT	BASAL ARKOSE ABSENT	BASAL ARKOSE ABSENT	BASAL ARKOSE ABSENT	BASAL ARKOSE ABSENT		ROME SANDSTONE AND SHALE BASAL ARKOSE	MARYSVILLE LIMESTONE RODGERSVILLE SHALE RUTLEDGE LIMESTONE PUMPKIN VALLEY SHALE HONAKER DOLOMITE ROME - WAYNESBORO SANDSTONE, SILTSTONE AND SHALE	
LOWER WAUCOBIAN		ABSENT	ABSENT	ABSENT	ABSENT	ABSENT		ABSENT	SHADY-TOMSTOWN DOLOMITE ERWIN QUARTZITE HAMPTON SHALE UNICOI ARKOSE	CHILHOWEE GROUP

PRECAMBRIAN

STRATIGRAPHY, LITHOLOGY AND DESCRIPTIVE PETROGRAPHY

Today, as a result of the work summarized in Table 1, there is a fairly well established stratigraphic nomenclature for preKnox sediments north of the Ohio River and in the Cambro-Ordovician outcrop of the Appalachians (Table 3).

The Cambrian System in the central Appalachian basin belongs to three series: the Waucoban (lower), the Albertan (middle) and the St. Croixan (upper) and attains an estimated maximum thickness of approximately 21,000 feet (6400 m) based on composited outcrop sections (Lochman-Balk, 1971). These sediments were deposited during an interval of 100 million years, beginning approximately 820 million years ago.

Stratigraphic nomenclature for the Cambrian in eastern Kentucky has long been a problem, because rocks seen in outcrop in southwestern Virginia and northeastern Tennessee are very different from those of the Kentucky subsurface (Fig. 2, compare outcrop section 24 to subsurface section 19, 20, 21 and 22) and, in addition, the eastern Kentucky section is very different from the outcrop of either Missouri or Wisconsin.

First I wish to describe the Middle and Lower Cambrian at the Virginia and Tennessee outcrop and then consider in detail the stratigraphy of the Rome trough.

Appalachian Outcrop

The oldest outcropping unit in North Carolina is the Chilhowee Group composed of the Unicoi Arkose, the Hampton Shale, the Erwin Quartzite, and the Shady Dolomite (Table 3). As sedimentation transgressed the craton, sands, silts and conglomerates of the lower Cambrian sequence accumulated to more than 8800 feet (2681 m) measured at the outcrop (Harris, 1975), although only a few hundred feet are present in eastern Kentucky. The Shady Dolomite is the uppermost unit of the Chilohowee Group and is thick, up to 1000 feet (305 m), in northeastern Tennessee and western Virginia, but is poorly developed, about 200 feet (61 m), in most of eastern Kentucky. The contact between the Lower and Middle Cambrian is at the top of the Shady Dolomite. However, this division is difficult to use, where the Shady is missing, because the Chilhowee Group is lithologically similar to the lower part of the overlying Rome Formation. In northeastern Tennessee and southwestern Virginia the Rome Formation attains a thickness of 3600 feet (1097 m) and consists, in outcrop, mostly of alternating limestone and shale. Above the Rome is a thick interval of alternating gray marine shales and impure limestones and some dolomites of which the Honaker Dolomite is the best known. The top of the Honaker Dolomite is the top of the Middle Cambrian.

The Elbrook Dolomite, about 2400 feet (731 m) thick, consists of dolomite and shale and differs from the underlying rocks in two ways: its dolomites are more coarsely crystalline and its shales are darker. Generally, it is easier to distinguish formational units in the outcrop, where their differences are enhanced by weathering, than in the subsurface. Thus the broader terms Elbrook Dolomite and Conasauga Group are more useful to subsurface geologists than names such as Pumpkin Valley, Rutledge Limestone, etc., which can only be recognized where the subsurface is close to the outcrop. At present the exact equivalence of the terms Elbrook Dolomite and Conasauga Group are not completely clear, although the term Elbrook Dolomite seems to be more widely used in the subsurface than in the outcrop.

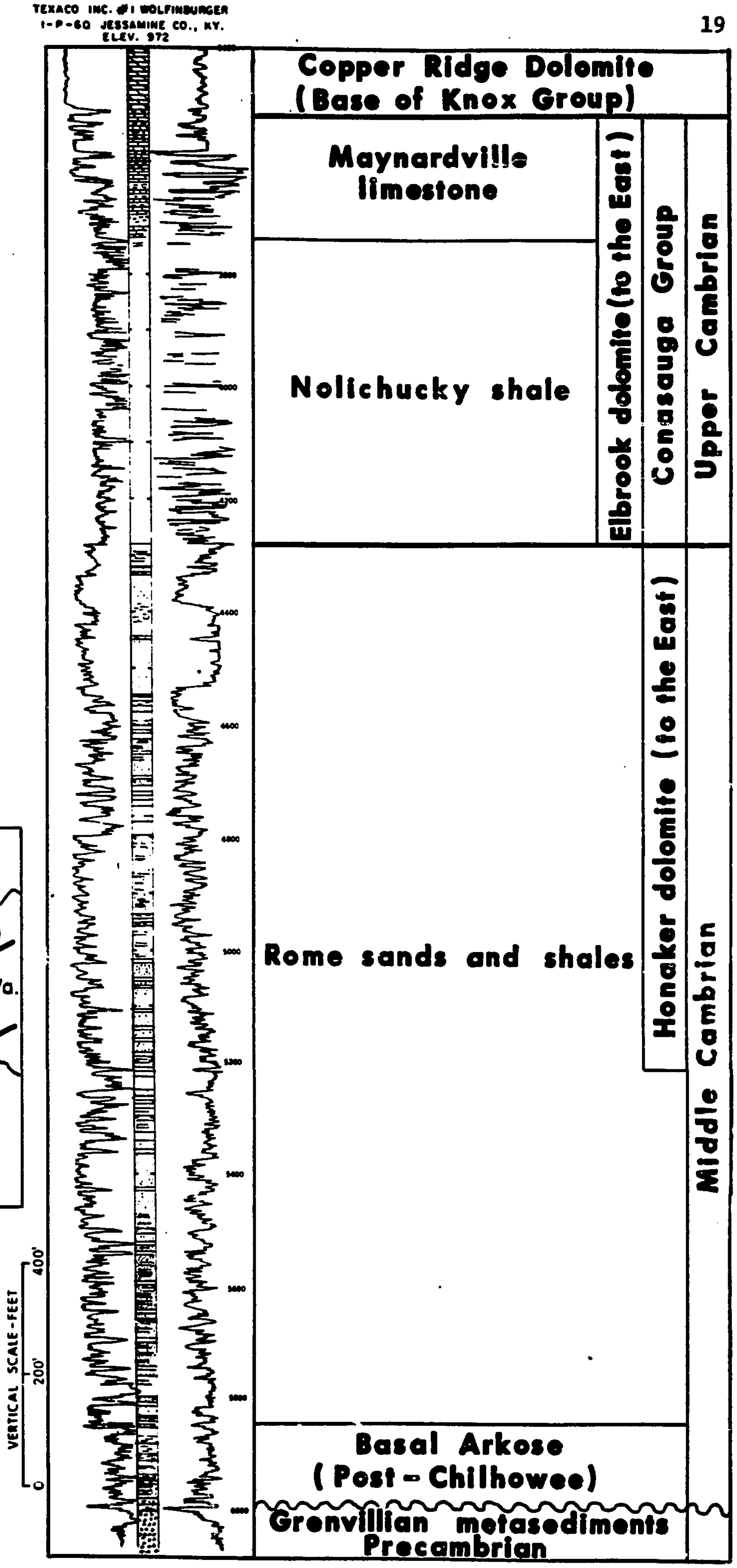
Variation of Fill along the Rome Trough in Kentucky

I wish to consider the sediments of the Rome trough and compare two key wells (Figs. 3 and 4). These wells, although only two out of thirty-six within the Rome trough, provide a good introduction to the stratigraphy and facies within it.

The easternmost well in Johnson County, Kentucky (Fig. 3) has a carbonate and shale facies very similar to that found in the outcrop. This well is also representative of other deep tests in the thickest part of the Rome trough; in this well there is a total thickness of 3200 feet (964 m) of preKnox sediment. The 80 foot thick (24 m) Shady Dolomite has a distinctive, boxy appearance on gamma-ray neutron logs and is easily correlated to other wells in extreme eastern Kentucky. In the Johnson County well the Rome Formation is predominantly siltstone and shale with some interbeds of dolomite. Note the massive limestones of the Rutledge, Marysville and the Elbrook Dolomite separated by dark gray to black, carbonaceous shales called the Pumpkin Valley,

FIGURE 3

Stratigraphic column of the Texaco No. 1 Wolfinburger, Section 1-P-60, Jessamine County, Kentucky.


TEXACO INC. #1 WOLFINBURGER
1-P-6Q JESSAMINE CO., KY.
ELEV. 972
Copper Ridge Dolomite
(Base of Knox Group)
Maynardville limestone
Nolichucky shale
Elbrook dolomite (to the East)
Conasauga Group
Upper Cambrian
Rome sands and shales
Honaker dolomite (to the East)
Middle Cambrian
Basal Arkose
(Post - Chilhowee)
Grenvillian metasediments
Precambrian
VERTICAL SCALE - FEET
0
200'
400'

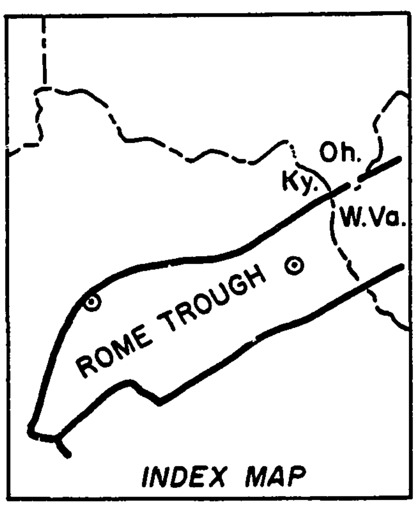
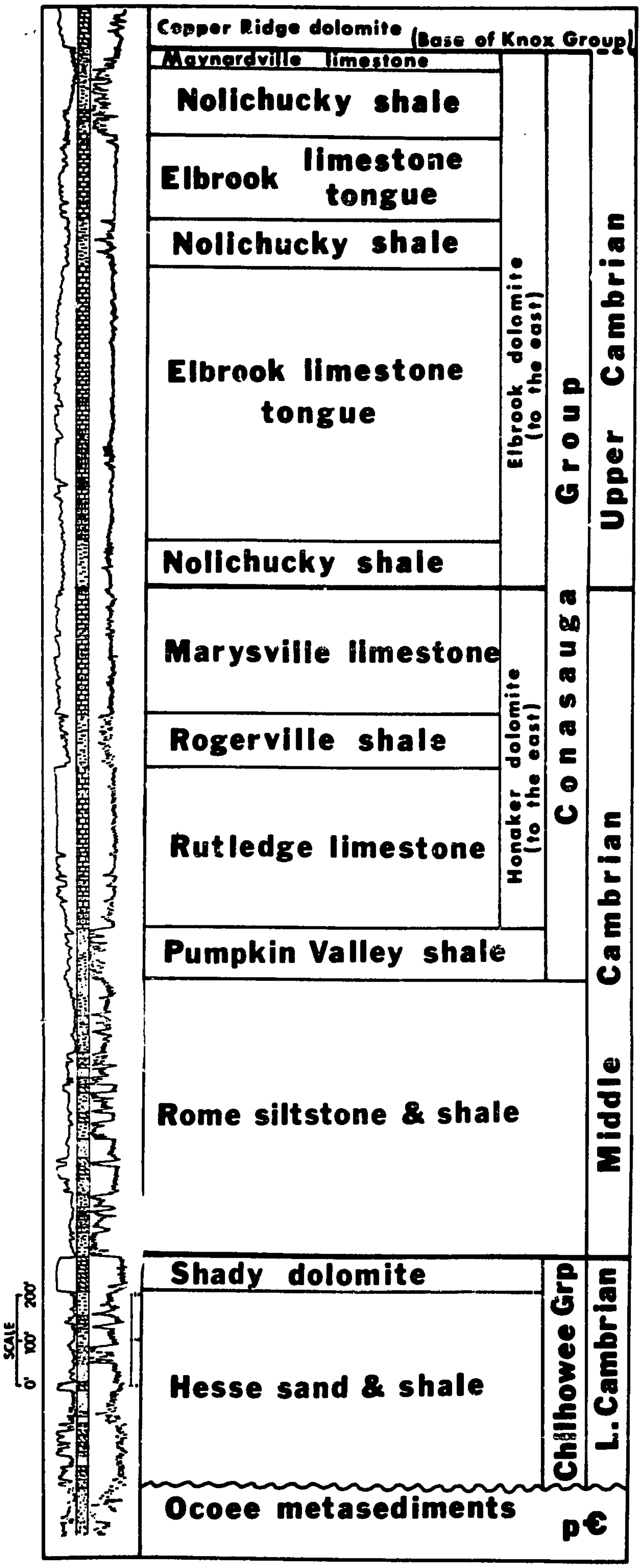

Oh.
Ky.
W.Va.
ROME TROUGH
INDEX MAP

FIGURE 4

Stratigraphic column of the U.S. Signal Oil Co. #1 Elkhorn Coal Co., Section 7-P-82, Johnson County, Kentucky.



Copper Ridge dolomite
(Base of Knox Group)
Maynardville limestone
Nolichucky shale
Elbrook limestone tongue
Nolichucky shale
Elbrook limestone tongue
Nolichucky shale
Marysville limestone
Rogerville shale
Rutledge limestone
Pumpkin Valley shale
Rome siltstone & shale
Shady dolomite
Hesse sand & shale
Ocoee metasediments
Elbrook dolomite (to the east)
Honaker dolomite (to the east)
Conasauga Group
Chilhowee Grp
Upper Cambrian
Middle Cambrian
L. Cambrian
p€
SCALE
0' 100' 200'

Rogersville and Nolichucky shales. Each shale section is approximately 125 feet (38 m) thick, whereas the massive limestones vary from 250 feet (76 m) to 600 feet (182 m) in thickness.

In contrast, the preKnox sediments in the Jessamine County well (Fig. 4), also in the Rome Trough, but 95 miles (153 km) west of the Johnson County well (Fig. 3), have a predominantly clastic section of 2500 feet (761 m). Approximately 70 percent more sand is present here than to the east in Johnson County. Moreover, in the Jessamine County well the Nolichucky Shale forms a massive unit about 700 feet (213 m) thick and only a few thin limestone beds are present in this portion of the trough.

Thus a comparison of two key wells in the trough, only 95 miles (153 km) apart, shows pronounced change in facies and contains far more sandstone and shale in south-central Kentucky than in eastern Kentucky. Thin section petrography was helpful to better describe and understand the lithologies that fill the trough and adjacent areas.

Petrography and Lithology of Formations in and near Rome Trough

My study of the petrography was based on 152 thin sections made from 72 core chips and 85 samples of drill cuttings. Five cores from five different wells were sampled (Table 4).

Basal arkose

The typical basal arkose is a medium-grained, moderately sorted and packed, sub-rounded, well-cemented, vari-colored, immature arkose. This description applies both in and outside the Rome trough. Thick-

TABLE 4

CORES STUDIED AND SAMPLED IN AND NEAR THE ROME TROUGH

Well Name	Location	Interval	Formation
Texas West-Bay #1 J. Burdette	Sec. 7-N-59 Garrard Co., Kentucky	4380-4468'	Rome siltstone Rome sandstone
Texaco #1 L. Kirby	Sec. 8-O-59 Garrard Co., Kentucky	4573-4583' 4612-4632' 5735-5745'	Rome siltstone Rome sandstone Precambrian
Texaco #1 Wolfinbarger	Sec. 1-P-60 Jessamine Co., Kentucky	4354-4384' 4540-4550' 6012-6022' 6062-6072'	Rome sandstone Rome sandstone Precambrian Precambrian
Texaco #1 Sherrer	Sec. 6-P-60 Jessamine Co., Kentucky	4170-4191' 4700-4710' 5285-5300' 5785-5800'	Precambrian Precambrian Precambrian Precambrian
Hope #9634 Sandhill	Walker Dist. Wood Co., West Virginia	13000-13312'	Mt. Simon sandstone Basal Arkose Precambrian
Amoco Steel #1 Fee	Sec. 8, Lemon Twp., Butler Co., Ohio	2860-3152'	Mt. Simon sandstone
U.S. Steel #1 Fee	Green Quad. Scioto Co., Ohio	5541-5616'	Mt. Simon sandstone Elbrook dolomite Precambrian
DuPont #1 Fee	Sec. 10-U-44 Jefferson Co. Kentucky	5180-5183' 5335-5337'	Mt. Simon sandstone Mt. Simon sandstone
Monitor #1 Stacy	Sec. 18-Q-74 Morgan Co., Kentucky	5881-5884' 5892-5900' 5924-5927' 6201-6204' 6259-6262' 7121-7124' 7459-7462' 7455-7458' 7519-7522'	Elbrook dolomite Elbrook dolomite Elbrook dolomite Elbrook dolomite Elbrook dolomite Elbrook dolomite Basal Arkose Basal Arkose Precambrian

ness varies from 0 to as much as 300 feet (91 m) and hence its lithologic continuity is probably poor. Also very variable is its color which ranges from red, maroon, light gray to black to shades of green.

The arkose typically has a composition of $Q_{60}F_{26}Rf_{14}$ and is cemented predominantly by quartz and feldspar overgrowths. The quartz is monocrystalline and finer grained than the associated microcline and orthoclase feldspars. The rock fragments are composed of siltstone, shale, chert and all the micas. There are traces of heavy minerals which include glauconite, zircon and tourmaline. Both the quartz and feldspar grains are subrounded, but because feldspar grains are coarser, more overgrowths occur on the feldspar. Model grain size is 0.15-0.2 mm. Grain-to-grain contacts are mostly long and concavo-convex. Rock fragments are usually more angular and coarser in size than are the feldspar grains. Cementation is primarily as anhedral pore-filling feldspar with some authigenic quartz overgrowths. Secondary cementation occurred with the formation of minor amounts of uinthahite (a black shiny asphaltite with a brown streak and conchoidal fracture (Gary, _et al_., 1972, p. 763)), 0.03 mm rhombs of dolomite, 0.1 mm patches of drusy ferroan calcite and 0.01 mm euhedra of hematite. The old name for uinthahite is gilsonite.

I propose to informally name this unit the Kirby arkose, because it has a distinctive petrography and lithology and can be recognized on gamma-ray neutron wireline logs by a significant increase in radioactivity. The name Kirby arkose is taken from the Texaco #1 Kirby (Well No. 28-K) in Garrard County in central Kentucky at a depth of

5510 to 5640 feet. This arkose is also readily apparent in the nearby Texaco #1 Williams (Well 18-K) and the Texaco #1 Perkins (Well No. 48-K).

Rome Formation

Sandstones: The typical sandstones of the Rome Formation are loosely packed, subrounded, submature, subarkoses and quartz arenites. The subarkose is near the basement, whereas quartz arenites prevail in the upper part of the formation. The typical subarkose has a framework of $Q_{72}F_{23}Rf_5$ and is cemented predominantly by authigenic quartz and feldspar with minor ferroan calcite. Porosities are normally very poor, less than 5 percent. The color of the subarkose is variable - from light gray to pale green and maroon.

Quartz arenites within the Rome Formation have an average framework composition of $Q_{95}F_4Rf_1$ (5 samples), and are very loosely packed, poorly cemented and friable with free quartz grains observed in cuttings. Porosities in sandstones in the upper portion of the Rome range from 14 to 24 percent as determined from core analyses and calculations on wireline logs. The quartz arenites are white to light gray in color.

The quartz is predominantly monocrystalline, subrounded to subangular and finer grained than associated feldspars. Microcline and orthoclase are the dominant feldspars, but there is a minor amount of plagioclase. Abundant authigenic overgrowths on both the quartz and feldspar serve as the cements along with a noticeable amount of uintahite. The latest cement is ferroan calcite, which etches both detrital grains and primary cement. The result is a fairly well cemented, but only a moderately packed sandstone. Long and concavo-convex grain contacts predominate and modal grain size varies from 0.15-0.18 mm. Carbonate cement occurs as anhedral pore-filling crystals and 0.1-0.2 mm euhedra of drusy, ferroan calcite. Rock fragments include chert, shale, and rare carbonate. Some glauconite is present in many of the sandstones. Trace amounts of heavy minerals are present and include tourmaline and zircon.

Within the trough, the Rome Formation can contain appreciable glauconite, especially in its upper part and especially on the down-thrown side of some of the growth faults found within the trough. The glauconite-rich zones appear to be interbedded with laminated quartz-rich sandstone, shales, and siltstones and at least some glauconite occurs as concentrations on bedding planes. In cores there are cycles about 1 meter thick that consist of glauconitic sandstone, followed by quartz sandstone, siltstone and shale. Petrographically a glauconitic sandstone has about 50 percent glauconite, 30 percent quartz and 15 percent hematite and the remainder is mostly rock fragments.

Rome Siltstone: Siltstones of the Rome Formation are dark gray to almost black, moderately sorted, very fine-grained, carbonaceous wackestones interlaminated with shale. A typical siltstone is composed of 60 percent fine-grained micas, potash-rich feldspar and carbonaceous material, 20 percent quartz and 20 percent calcite cement. The quartz is primarily monocrystalline and subangular and its modal grain size varies from 0.03 to 0.05 mm. The micas are predominantly muscovite and chlorite, with traces of biotite. Hematite in trace amounts is commonly present.

Carbonate: In the eastern part of the trough in Johnson County, Kentucky (please see Well No. 38K in the Appendix) the combined thickness of the Rome and Elbrook Formations is 5717 feet (1941 m) and in another well 25 miles (40 km) east in Mingo County, West Virginia, the Rome-Elbrook thickness is 8687 feet (2646 m). Carbonate rocks comprise approximately 60 percent of the interval in both wells. A typical limestone in this area is described by Donaldson, et al. (1975) from a core

> ....as 1 to 4 in. (2.5 to 10.1 cm) beds of argillaceous, finely crystalline dolomite, to calcitic, finely crystalline dolomite, dolomitic calcilutite, calcarenite and calcirudite occurring in cycles. Algal mats and stromatolites suggest a tidal flat depositional environment.

They identified fossils from a core of a shale, 646 feet (197 m) below the limestone, which included calyptoptomatids (Hyolithes), inarticulate brachiopods (Lingulids), and trilobites (Alokistocarella) all of which indicate a Middle-Late Cambrian age and suggest a shallow marine depositional environment.

The study of cuttings in thin section shows calcite to be more abundant than dolomite and some of the carbonate cuttings to be rich in organic material. Almost all the carbonate is microspar (0.1 to 0.3 mm) which contains some scattered rhombs and mosaics of dolomite so that recrystallization is extensive. Pellets, oolites and fragments of brachiopods and trilobites are present and possibly some debris is of algal origin. Original textural types range from micrites to grainstones. Porosity is minimal.

Nolichucky Shale

In northeast Tennessee the Nolichucky Shale, as described by Elton and Haney (1975, p. 15) is

> ....thinly bedded, in part calcareous, olive-gray shale ranging in thickness from approximately 100 to 650 feet. Cross laminations occur in isolated siltstone layers and mica flakes are common along the bedding planes. In the northwest portion of the study area a massive, medium dark-gray to blue-gray stromatolithic limestone exists within the Nolichucky Formation; however, in the southeast portion of the area no major limestones occur. ....Where present this stromatholithic unit varies in thickness from 35-175 feet. Algal laminations, flat pebble conglomerates, and trilobite fragments are common within the stromatolitic unit.

Others who have described the Nolichucky in outcrop include Harris (1975).

Petrographically, the study of shale cuttings from the Nolichucky reveals a wide variety of material - silty to silt free, poorly to moderately laminated shales and claystones in some of which organic material is sparse, whereas in others organic material is present as dark to subtranslucent blebs and aggregates. Extractable organic matter varies from 0.9 to 1.5 mg/g and hexane-soluble matter from 0.6 to 1.2 mg/g (Maynard, personal communication). Finely disseminated pyrite may be present, especially in the more organic-rich shales.

Some shales are calcite free whereas others contain as much as 20 to 30 percent calcite, plus a few, fine dolomitic rhombs. A few carbonate "microconcretions" are present in the shales, especially in the organic rich shales. Micas include mostly muscovite and minor chlorite. A very few shales show weak spherulitic structures defined by domains of clay minerals. The lack of many well laminated shales suggests the possibility of some burrowing on the sea bottom.

Interbedded siltstones have modal grain sizes that vary from 0.3 to 0.5 mm, most of the quartz is subangular and monocrystalline. These siltstones are glauconitic; contain some collophane as well as minor feldspar and some scattered chlorite. Calcite is the dominant cement, but there is some dolomite. Counts of a few siltstone fragments suggest a composition of about $Q_{58}F_{23}Rf_{19}$.

Maynardsville Limestone

Because this formation is gradational between the previously described Nolichucky Shale and the overlying Knox Dolomite, its limestones vary from fine micritic calcite at the base to coarse macrosparcalcite at the top. The thickness varies from 0 to 175 feet (53 m).

Cursory petrographic examination of a few cuttings indicates that most of the carbonate of the Maynardsville Limestone is calcite and that nearly all of it is recrystallized microspar with only scattered rhombs of dolomite, although a few cuttings consist mostly of coarse anhedral mosaics of dolomite. Original depositional textures, insofar as one can tell, range from micrites (0.1 mm) to a few grainstones (1 mm), mostly pelletal. A few of the micrites are finely laminated. Recognizable fossils include algae, although several other families are almost surely present, such as trilobites and brachiopods. Ghosts of fossils are common as are some scattered clasts of quartz silt and sand. Some scattered, well-rounded grains of glauconite are present.

Mount Simon Sandstone

On geophysical logs the Mount Simon Sandstone shows both long, thick sections of uniform, shale free sandstone as well as some thinly interbedded sandstones and shales. In some areas north of the Rome trough there is as much as 40 percent interbedded shale.

The typical sandstones of the Mount Simon Sandstone in western Kentucky and in southern Ohio are moderately to tightly packed, angular to subrounded, poorly sorted, submature, silica cemented, quartz arenites ($Q_{56}F_{24}Rf_{20}$ to $Q_{100}F_0Rf_0$).

Monocrystalline quartz comprises the majority of quartz (93 percent) with minor chert (3 percent) and polycrystalline grains (4 percent). In a few samples polycrystalline quartz content is as high as 42 percent. The dominant feldspars are microcline (40 percent) and plagioclase (60 percent) which is composed primarily of sodium-rich and very minor amounts of calcium-rich varieties. Both quartz and feldspar grains have long and point grain contacts except where carbonate cement masks grain to grain relationships. In southwestern Ohio the major cement is secondary silica in the form of quartz overgrowths, accounting for 97 percent of total cement. Authigenic clays comprise the remaining 3 percent, and no carbonate cement is observed. However, in southeastern Ohio, carbonate in the form of microcrystalline spar is the major cement and accounts for well over 50 percent of the total rock volume. Silica, anhydrite (crystals larger than 0.9 mm) and dolomite are minor cements in southeastern Ohio and West Virginia.

Small amounts of biotite and muscovite micas are present as oriented grains in shale laminae. Porosity is good, about 22 percent, as judged by core analyses and geophysical logs, where silica cement dominates, but poor, 9 percent, where carbonate is the chief cement.

Siltstones of the Mount Simon Sandstone are typically angular to subrounded, moderately sorted, tightly packed, nonporous, carbonate and kaolinite cemented lithic arenites ($Q_{65}F_5Rf_{30}$). About half of the quartz grains are polycrystalline and about half are monocrystalline. Feldspar forms about 5 percent of the framework and surprisingly is mostly sodium-rich plagioclase. Micaeous rock fragments are abundant, about 30 percent and some glauconite is present. Cements are calcite and dolomite. Some minor kaolinitic books are also present.

INTERPRETIVE SANDSTONE PETROLOGY

I used thin section studies of texture - mean size and sorting - plus point counts of quartz, feldspar and rock fragments (Q:F:Rf ratios) to obtain conclusions about provenance. These conclusions were supplemented by regional knowledge of the paleogeography developed in the publications summarized in Table 1 and from binocular study of cuttings. Little effort was made to systematically study grain roundness, because of the presence of either secondary porosity, pressure solution, or quartz overgrowths.

Representative samples were point counted - five from the Rome Formation, thirteen from the Mount Simon Sandstone and six from the Kirby arkose - for both texture and framework mineralogy (Table 5). Samples were selected on the basis of geographic distribution and the availability of core cuttings.

Sandstones of the Rome Formation vary from arkoses (rare) to subarkoses and some lithic arenites are present (Table 5B) but binocular study indicates that many are quartz arenites, especially in the upper part of the Rome. Sandstones in the Mount Simon include subarkoses, rare lithic arenites and quartz arenites (Table 5B). Quartz arenites prevail in the upper part of both formations. Arkose and subarkose are the dominant petrographic type of the Kirby arkose.

Mean size and sorting were obtained by measuring the apparent long axes of 50 grains in each thin section and calculating phi graphic

TABLE 5

FRAMEWORK COMPOSITION OF SOME REPRESENTATIVE SANDSTONES OF ROME AND MT. SIMON FORMATIONS AND THE KIRBY BASAL ARKOSE FORMATION

Part A. Average values and samples

	Q	F	Rf	Samples
Rome Formation	71	20	9	5
Mt. Simon Formation	84	9	7	13
Basal Arkose	61	26	13	6

Part B. Locations of Thin Sections

Sample Number	Well Number	Depth (ft.)	Individual Analysis Q	F	Rf
		Rome Formation			
K-11	28K	4560-70	58	23	19
K-19	28K	4640-50	60	36	4
K-22	28K	4670-80	74	20	6
K-14	28K	4590-4600	76	11	13
K-25	28K	4700-10	83	12	5
		Mt. Simon Formation			
AF-48	2-0	3181	56	24	20
36	33-K	5338	62	5	33
AF-42	2-0	3170	74	17	9
2	2-WV	8530-40	78	22	0
33-A	33-K	5180	79	3	18
10	8-0	5541	84	16	0
11	8-0	5564	87	10	3
AF-22	2-0	3179	91	6	3
AF-27	2-0	3154	92	7	1
3	1-WV	7910-30	92	8	0
AF-9	2-0	3009	98	2	0
AF-4	2-0	2990	100	0	0
AF-13	2-0	3020	100	0	0

Table 5 - Continued

Sample Number	Well Number	Depth (ft.)	Individual Analysis Q	F	Rf
		Kirby Arkose			
K-38	28K	5670-80	49	20	31
K-36	28K	5600-10	53	34	13
K-28	28K	5730-40	57	28	15
K-30	28K	5520-30	64	24	12
K-34	28K	5570-80	69	27	4
K-32	28K	5540-50	71	22	8

mean and sorting (Folk, 1974, p. 45-46).

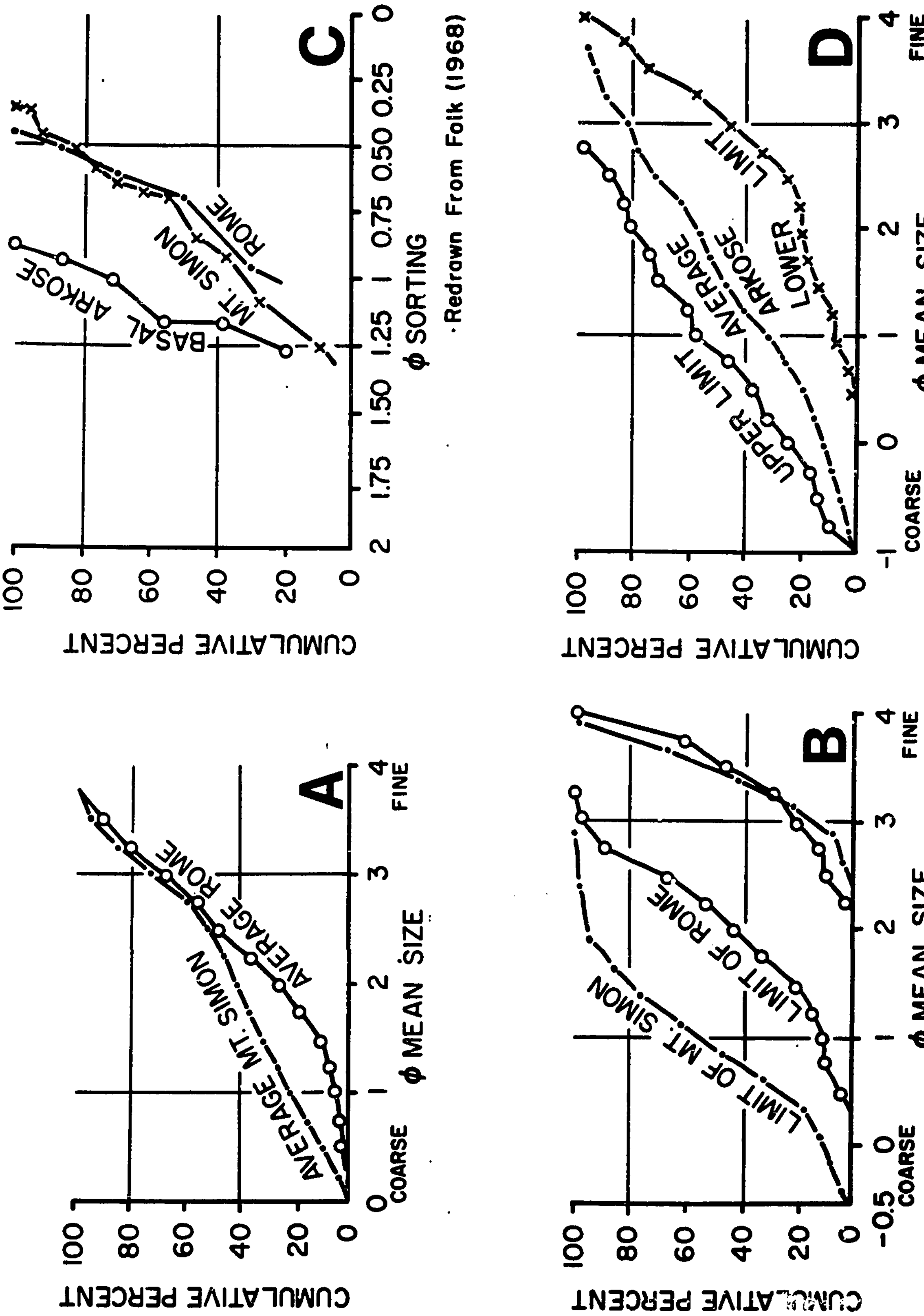
Texturally, the sandstones of the Mount Simon are somewhat coarser than those of the Rome Formation (Fig. 5A) and have a total range of sand sizes that is much larger (Fig. 5B). My binocular study of cuttings and cores also reveals granules and pebbles (see also Table 4), whereas they are rare in most of the sandstones of the Rome. Coarser material in the sandstones of the Mount Simon suggests either a different source than that of the Rome or that the Rome was deposited in a more distal (and largely marine?) basin such that coarse sand, granules, and pebbles mostly accumulated in far removed shoreline or alluvial deposits. That different kinds of sources controlled differences in sand sizes seems plausible, if sandstones of the Mount Simon were derived from the quartz-rich Keweenawan province and those of the Rome from the metasediments of the Grenville, The higher feldspar content of the sandstones of the Rome than those of the Mount Simon, 20 versus 9, also supports a difference in source areas. Most probably all were derived from the north or northeast.

Sorting, on the other hand, is almost the same in sandstones of the Rome and Mount Simon (Fig. 5C) - and is far better than that of the basal arkose (Fig. 5D). Color is also the same. The sandstones of the Mount Simon fine upwards because they are transitional to an off-shore marine basin whereas those of the Rome coarsen upward possibly because they represent the shallowing or shoaling of an initially deeply subsiding trough.

Now that the petrographic descriptions of the Rome sandstones

FIGURE 5

Grain size and sorting of the Mount Simon Sandstone, Rome sandstone and Kirby arkose.


A
B
C
D
CUMULATIVE PERCENT
ϕ MEAN SIZE
COARSE
FINE
AVERAGE MT. SIMON
AVERAGE ROME
LIMIT OF MT. SIMON
LIMIT OF ROME
ϕ SORTING
BASAL ARKOSE
MT. SIMON
ROME
Redrawn From Folk (1968)
UPPER LIMIT
AVERAGE ARKOSE
LOWER LIMIT

and Mount Simon sandstones have been completed, the following observations and comparisons can be made:

1. Sandstones of the Rome Formation are finer grained than those of the Mount Simon Sandstone but there are no major differences in either color or sorting.

2. Mount Simon sandstones coarsen downward over an interval from 200-500 feet (51-152 m) above the Precambrian, whereas the sandstones of the upper 300 feet (91 m) of the Rome become finer downward based on observations of geophysical logs and core data.

3. Both formations are composed of predominantly monocrystalline quartz, however the Mount Simon Sandstone does contain particular sandstone zones in which granules and pebbles of polycrystalline quartz grains are common.

4. Microcline and orthoclase are the dominant feldspars in the sandstones of the Rome Formation whereas microcline and plagioclase are major feldspars in the sandstones of the Mount Simon.

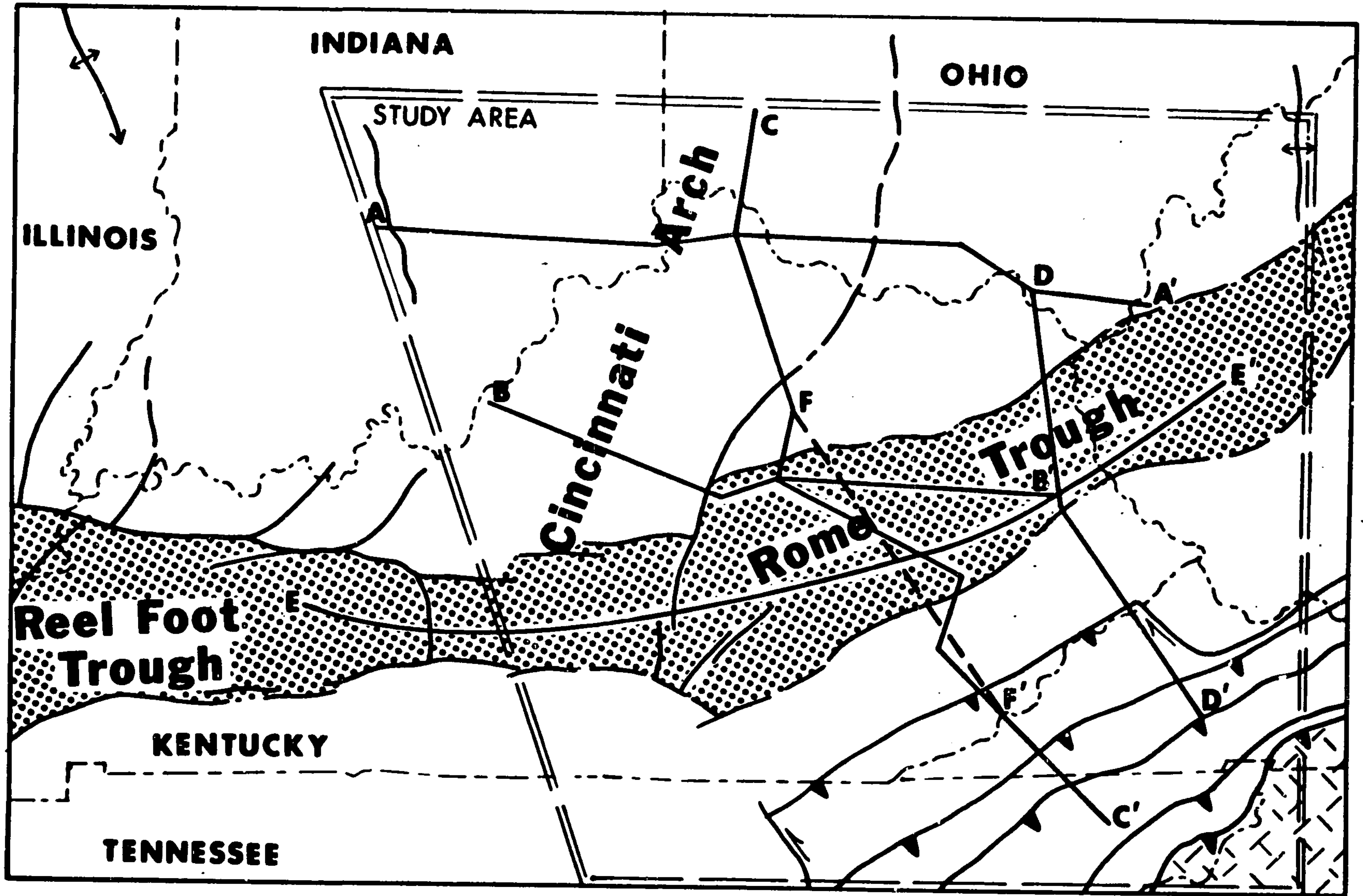
5. Quartz arenites prevail in the upper part of each formation, whereas lithic arenites and subarkoses are more prevalent in the lower parts.

6. Cementation in each formation is variable, but quartz overgrowths are more common to the Rome sandstones. From studies of cuttings it is noted the Mount Simon in the Indiana-

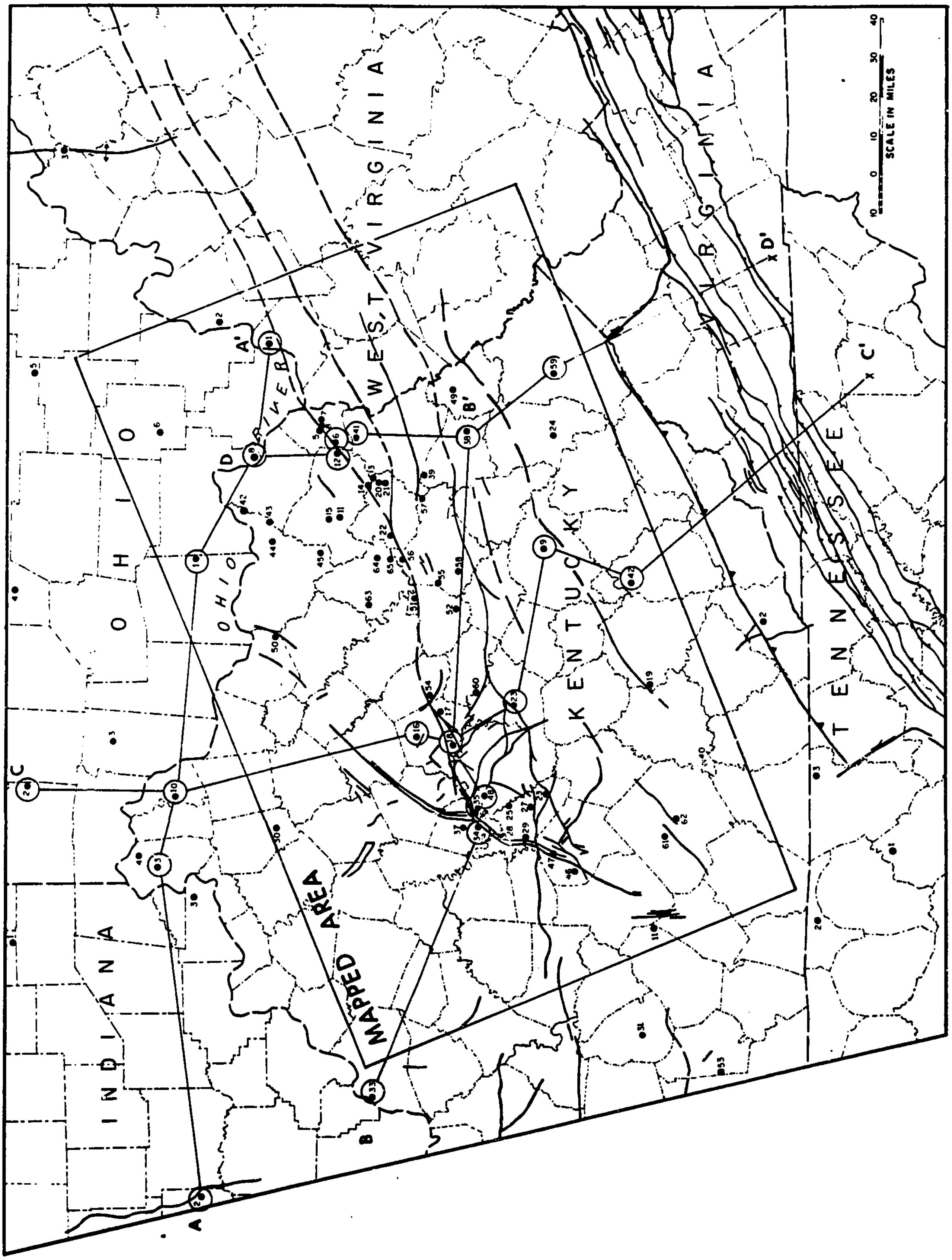
Illinois area is typically poorly cemented so the cuttings mostly consist of loose grains of quartz whereas in the Rome, cuttings of sandstones are aggregates and cementation is more complete.

FIGURE 6

Cross Section Index Map and index to mapped area.



CROSS SECTION INDEX MAP


WEST VIRGINIA
VIRGINIA
OHIO
INDIANA
KENTUCKY
TENNESSEE
OHIO RIVER
MAPPED AREA
A
A'
B
B'
C
C'
D
D'
SCALE IN MILES
10 0 10 20 30 40

SEDIMENTARY EVOLUTION OF ROME TROUGH

Most of my conclusions about the Rome trough are based on cross sections using the base of the Knox Dolomite as a datum (Fig. 6). These cross sections were an essential stepping stone to the construction of thickness, structure, and interpretive environmental maps.

Cross sections were constructed using those test wells which penetrated the Precambrian and which had good Cambrian stratigraphic and lithologic data from drill cuttings and cores. This information was then correlated with the geophysical logs of other test wells having published lithologic data. In making the interpretations needed to chart the sedimentary evolution of the Rome trough, I have utilized all the preceding stratigraphic and petrologic information and supplemented it with the facies relationships seen on the cross sections. Interpretation of the cross sections and maps is given full reign - as in fact it must be when a geologist is studying a large volume of rock as yet explored by only a few wells. Interpretation was greatly facilitated by making, in addition to lithologic interpretations from geophysical logs, interpretations using the log pattern.

Discussion of Cross Sections

Five major cross sections in and near the Rome trough were made and form the heart of my study (Fig. 6).

FIGURE 7

Cross Section A-A', a west to east section, north of and parallel to the Rome trough.

Control wells for Cross Section A-A'

2-I Indiana Farm Bureau #1 Brown, Section 20, Township 5 north, Range 2 east, Lawrence County, Indiana.

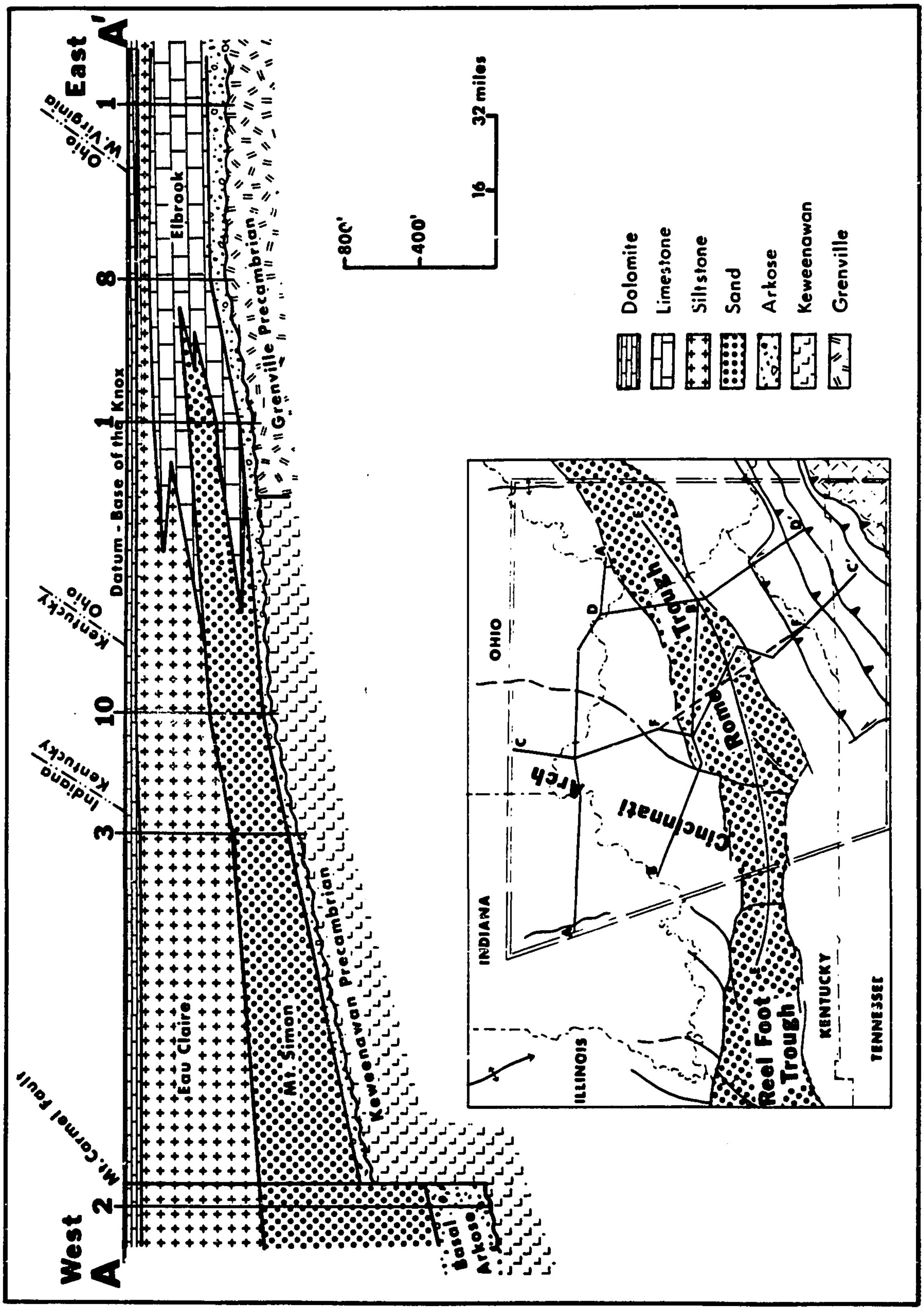
3-I Ashland Oil Company #1 Collins, Section 4, Township 2 north, Range 1 west, Switzerland County, Indiana.

10-K Ashland Oil Company #1 Wilson, Section 25, Township DD, Range 62, Campbell County, Kentucky.

1-0 Commonwealth Gas Corp. #1 Covert, VMSL-4040, Jefferson Township, Adams County, Ohio.

8-0 U.S. Steel Chemicals Corp. #1 Fee, Green Township, Scioto County, Ohio.

1-WV Cyclops Corp. #1 Kingery Unit, Athalia SE Quadrangle, Union District, Cabell County, West Virginia.


West
A
East
A'
Datum - Base of the Knox
Mt. Carmel Fault
Indiana
Kentucky
Kentucky
Ohio
Ohio
W. Virginia
2
3
10
1
8
1
Eau Claire
Mt. Simon
Keweenawan Precambrian
Basal Arkose
Elbrook
Grenville Precambrian
800'
400'
16
32 miles
Dolomite
Limestone
Siltstone
Sand
Arkose
Keweenawan
Grenville
OHIO
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
Rome Trough
Cincinnati Arch
Reel Foot Trough

Cross section A-A' (Fig. 7) is based on wells 2-I, 3-I, 10-K, I-D, 8-D and 1-WV (please see Appendix) and extends from the Indiana Farm Bureau No. 1 Brown in south-central Indiana, which was carefully analyzed by Dawson (1960), eastward to the well of the Cyclops Corp. No. 1 Kingery Unit in Cabell County, West Virginia with lithologic data by Calvert (1963). The lithologic and geophysical logs correlate very well and establish stratigraphic control and show the lithologic continuity for the area north of the Rome Trough. This cross section illustrates the facies relationships between the shale-siltstone interval of the Eau Claire Member of the Mount Simon Sandstone and the Elbrook Dolomite. The Elbrook is a typical platform carbonate (see Donaldson, et al., 1975), which interfingers with the sands, shales, and siltstones of the Eau Claire, derived from the craton to the northwest. The facies change between these formations occurs near the contact between the Precambrian Grenville and the Keweenawan, which extends in an approximately northeast-southwest direction from Lexington, Kentucky northward through central Ohio toward Detroit (Fig. 1). This coincidence suggests a Cambrian platform edge associated with a zone of Precambrian structural weakness (Freeman, 1953, p. 16). Closer subsurface control to the south near the Lexington Dome of central Kentucky (Fig. 1) proves the Grenville-Keweenawan contact was active along the Kentucky River fault zones during Middle Cambrian time (Webb, 1969, p. 14). Thus, the facies change may be related to gravity faulting along a slope margin.

Cross section B-B' (Fig. 8) based on wells 33-K, 34-K, 35-K, 48-K,

FIGURE 8

Cross section B-B', a west to east section from the Illinois basin, across the Cincinnati arch and parallel to the axis of the Rome trough.

Control Wells for Cross Section B-B'

33-K DuPont Chemical Corp. #1 (WAD) Fee, Section 10, Township U, Range 44, Jefferson County, Kentucky.

34-K Texaco Inc. #1 T. Sherrer, Section 6, Township P, Range 60, Jessamine County, Kentucky.

35-K Texaco Inc. #1 Wolfinbarger, Section 1, Township P, Range 60, Jessamine County, Kentucky.

48-K Texaco Inc. #1 Perkins, Section 11, Township P, Range 61, Madison County, Kentucky.

18-K Texaco Inc. #1 J. Williams, Section 9, Township Q, Range 64, Clark County, Kentucky.

41-K Inland Gas Co. #1 Young, Section 6, Township U, Range 82, Lawrence County, Kentucky.

38-K U.S. Signal Oil Co. #1 Elkhorn Coal Co., Section 7, Township P, Range 82, Johnson County, Kentucky.

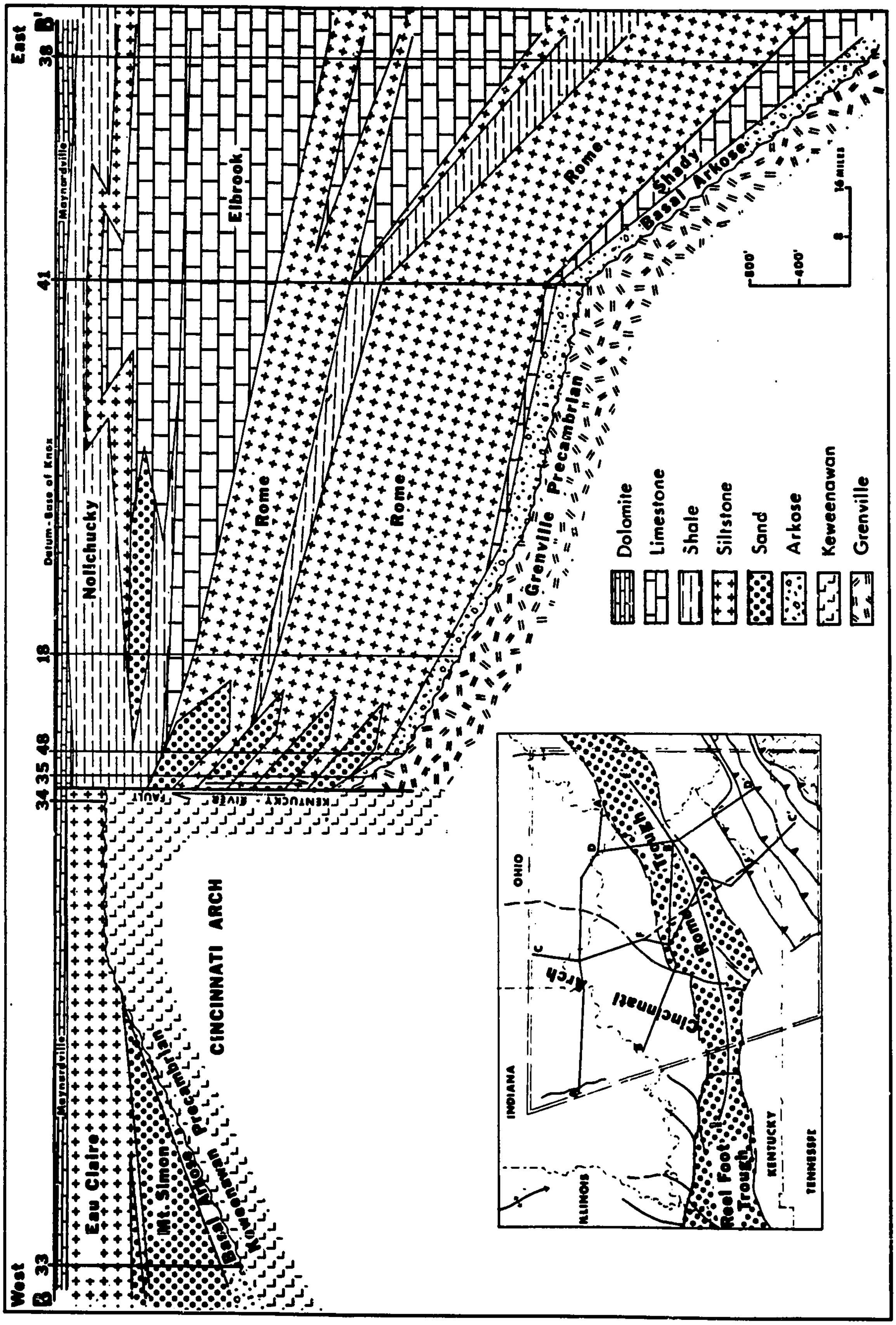

West
B
33
34 35 48
18
41
38
East
B'
Maynardville
Datum - Base of Knox
Eau Claire
Mt. Simon
Basal Arkose
Precambrian
Keweenawan
CINCINNATI ARCH
FAULT
KENTUCKY RIVER
Nolichucky
Rome
Rome
Elbrook
Rome
Shady
Basal Arkose
Grenville Precambrian
800'
400'
0
10 MILES
Dolomite
Limestone
Shale
Siltstone
Sand
Arkose
Keweenawan
Grenville
OHIO
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
Cincinnati Arch
Rome Trough
Rough Creek Trough

FIGURE 9

Cross section C-C', a north-south section, normal to the axis of the Rome trough. Parallel to Seismic Section F-F'.

Control Wells for Cross Section C-C'

2-0 Armco Steel Corp. #1 Fee, Section 8, Lemon Township, Butler County, Ohio.

10-K Ashland Oil Company #1 Wilson, Section 25, Township DD, Range 62, Campbell County, Kentucky.

16-K Ashland Oil Co. #1 Miller, Section 15, Township S, Range 65, Clark County, Kentucky.

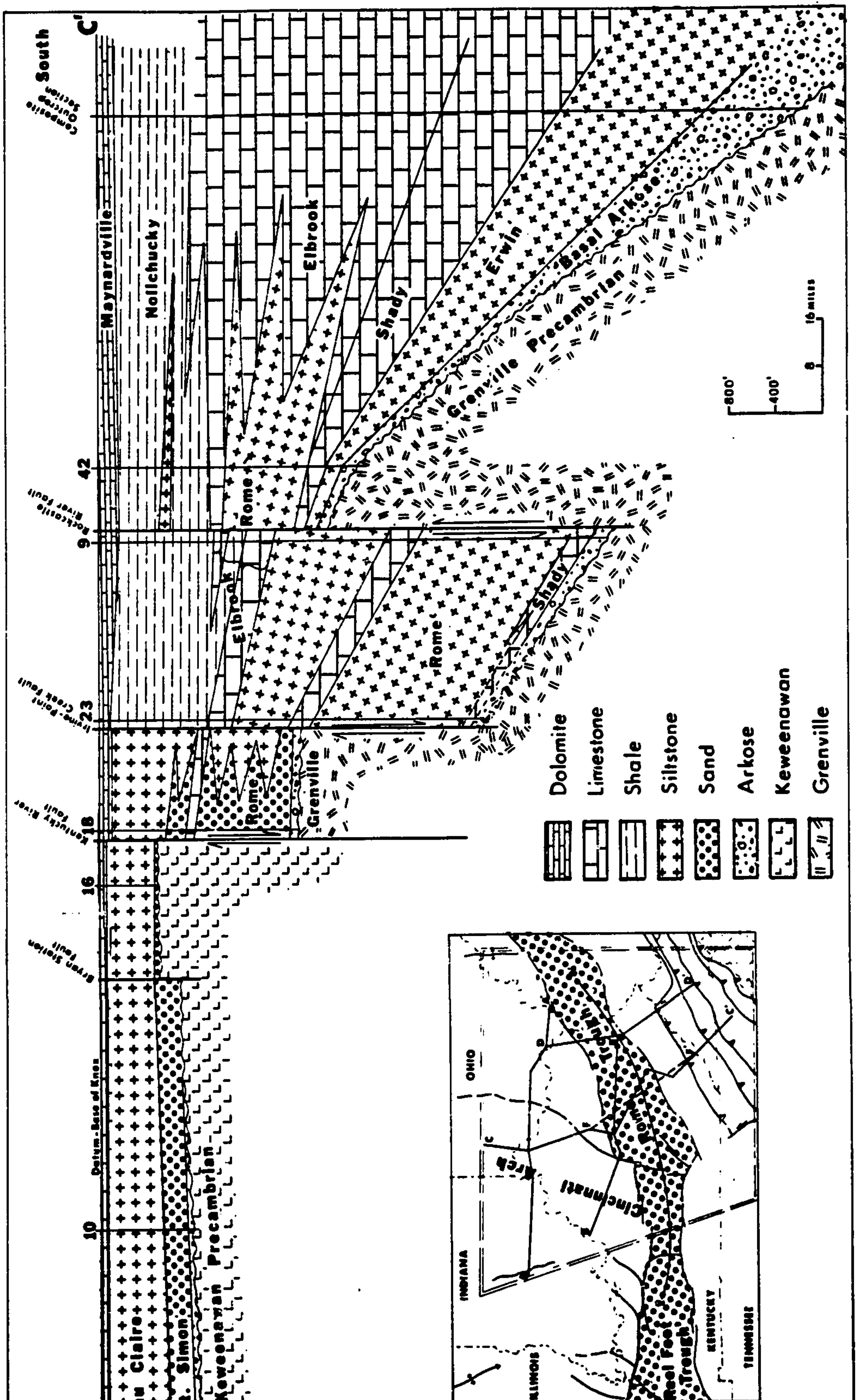
18-K Texaco Inc. #1 J. Williams, Section 9, Township Q, Range 64, Clark County, Kentucky.

23-K Texaco Inc. #1 G. Tipton, Section 21, Township O, Range 66, Estill County, Kentucky.

9-K United Fuel Gas Co., #1 S. B. Williams, Section 13, Township M, Range 75, Breathitt County, Kentucky.

42-K United Fuel Gas Co. #8437 Fordson Coal Co., Section 8, Township I, Range 73, Leslie County, Kentucky

Composite Cambrian Outcrop Section in Northeast Tennessee.


North
C
2
10
16
18
23
9
42
C'
South
Composite Section
Bryan Station Fault
Kentucky River Fault
Irvine-Paint Creek Fault
Rockcastle River Fault
Datum-Base of Knox
Eau Claire
Mt. Simon
Keweenawan Precambrian
Maynardville
Nolichucky
Elbrook
Rome
Shady
Erwin
Basal Arkose
Grenville Precambrian
Grenville
800'
400'
8
16 MILES
Dolomite
Limestone
Shale
Siltstone
Sand
Arkose
Keweenawan
Grenville
OHIO
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
Cincinnati Arch
Rome Trough
Reel Foot Trough

18-K, 41-K, and 38-K (please see Appendix) begins near Louisville, Kentucky with a key well, the DuPont Chamical Co. No. 1 (WAD) Fee. Eastward the section crosses the Jessamine Dome (see Fig. 1), intersects the Kentucky River fault and follows the axis of the Rome trough to the U.S. Signal Oil Co. No. 1 Elkhorn Coal Co. in east-central Kentucky. The influence of the Grenville front-Kentucky River fault upon sedimentation on the east flank of the Cincinnati arch is readily apparent by the influx of sand. By late Middle Cambrian time (Elbrook-Nolichucky) the carbonate build-up within the trough had restricted marine circulation to the western portion of the rift causing deposition of black carbonaceous shale and quartz sandstones in a stagnant, anerobic environment. Carbonate in the Rome Formation increases eastward and ultimately becomes the Honaker Dolomite.

Cross section C-C' (Fig. 9) based on wells 2-D, 10-K, 16-K, 18-K, 23-K, 9-K and 42-K (please see Appendix) begins with the Armco Steel Corp. No. 1 Fee well on the axis of the Cincinnati arch in southwestern Ohio and extends south across the trough into the outcrop area of northeast Tennessee. This section shows that most of the sandstone in the Rome trough is south of the Kentucky River fault system and north of the Irvine-Paint Creek system whereas the area between the latter fault system and the Rockcastle River uplift (Fig. 1) is almost devoid of sandstone.

In northeastern Tennessee the effect of miogeosynclinal sedimentation is shown on Cross Section C-C' by the increased thickness and predominance of carbonate. Harris (1975) also illustrates this carbo-

FIGURE 10

Cross section D-D', a north-south sect-on, normal to the axis of the Rome trough, in extreme eastern Kentucky.

Control Wells for Cross Section D-D'

8-0 U.S. Steel Chemicals Corp. #1 Fee, Green Township, Scioto County, Ohio.

12-K Inland Gas Co., #538 Coalton Fee, Section 14, Township V, Range 81, Boyd County, Kentucky.

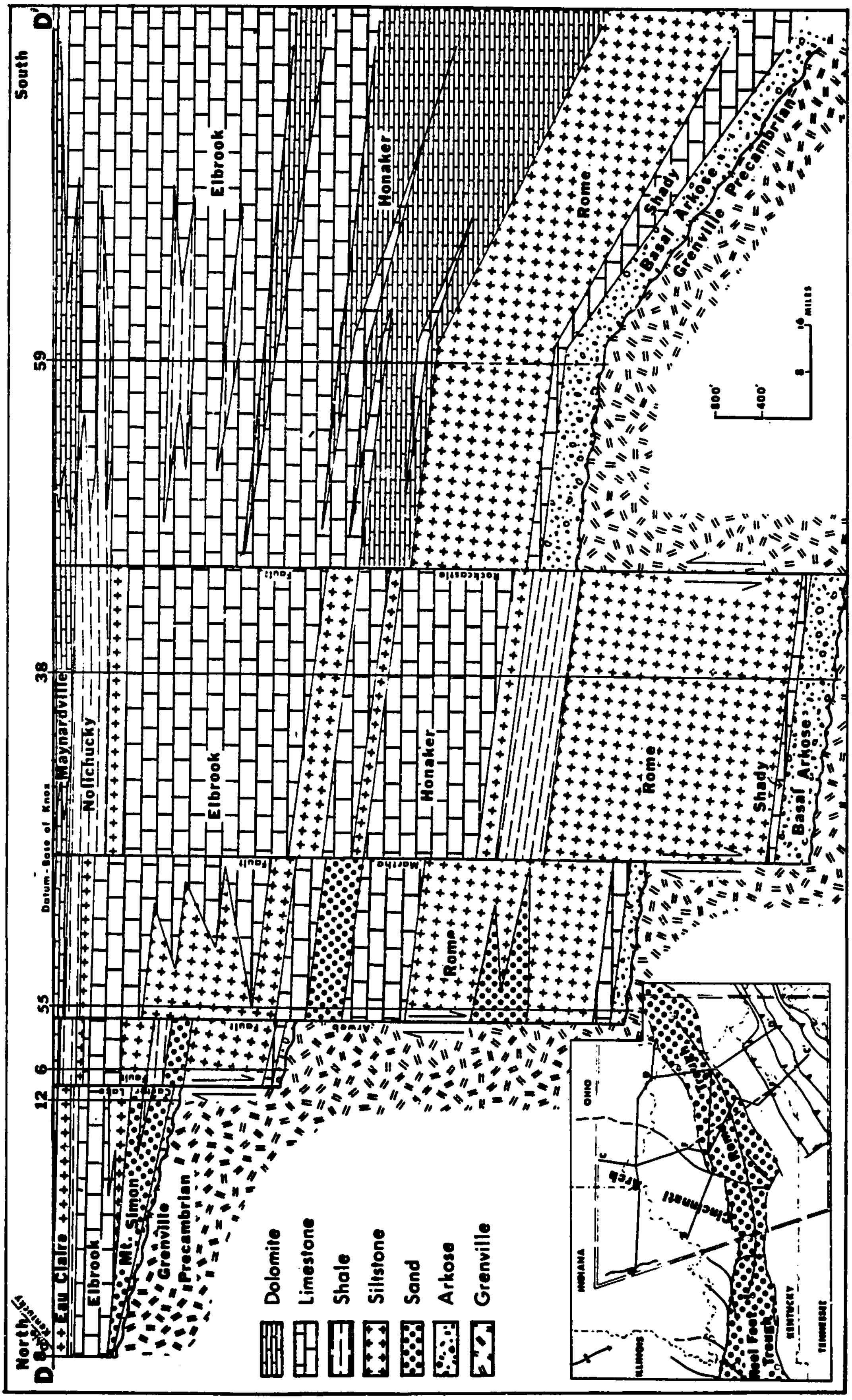
6-K Inland Gas Co., #533 Coalton Fee, Section 11, Township V, Range 81, Boyd County, Kentucky.

41-K Inland Gas Co. #1 Young, Section 6, Township U., Range 82, Lawrence County, Kentucky

38-K U.S. Signal Oil Co. #1 Elkhorn Coal Co., Section 7, Township P, Range 82, Johnson County, Kentucky.

59-K U.S. Signal Oil Co. #1 Stratton, Section 8, Township L, Range 85, Pike County, Kentucky.

Composite Cambrian Outcrop Section in southwest Virginia.


North
D
South
D'
12
6
55
38
59
Datum - Base of Knox
Eau Claire
Elbrook
Mt. Simon
Grenville
Precambrian
Maynardville
Nolichucky
Elbrook
Honaker
Rome
Shady
Basal Arkose
Grenville Precambrian
Fault
Martha
Rockcastle
800'
400'
0
8
16
MILES
Dolomite
Limestone
Shale
Siltstone
Sand
Arkose
Grenville
OHIO
INDIANA
ILLINOIS
KENTUCKY
TENNESSEE
Cincinnati Arch
Rome Trough

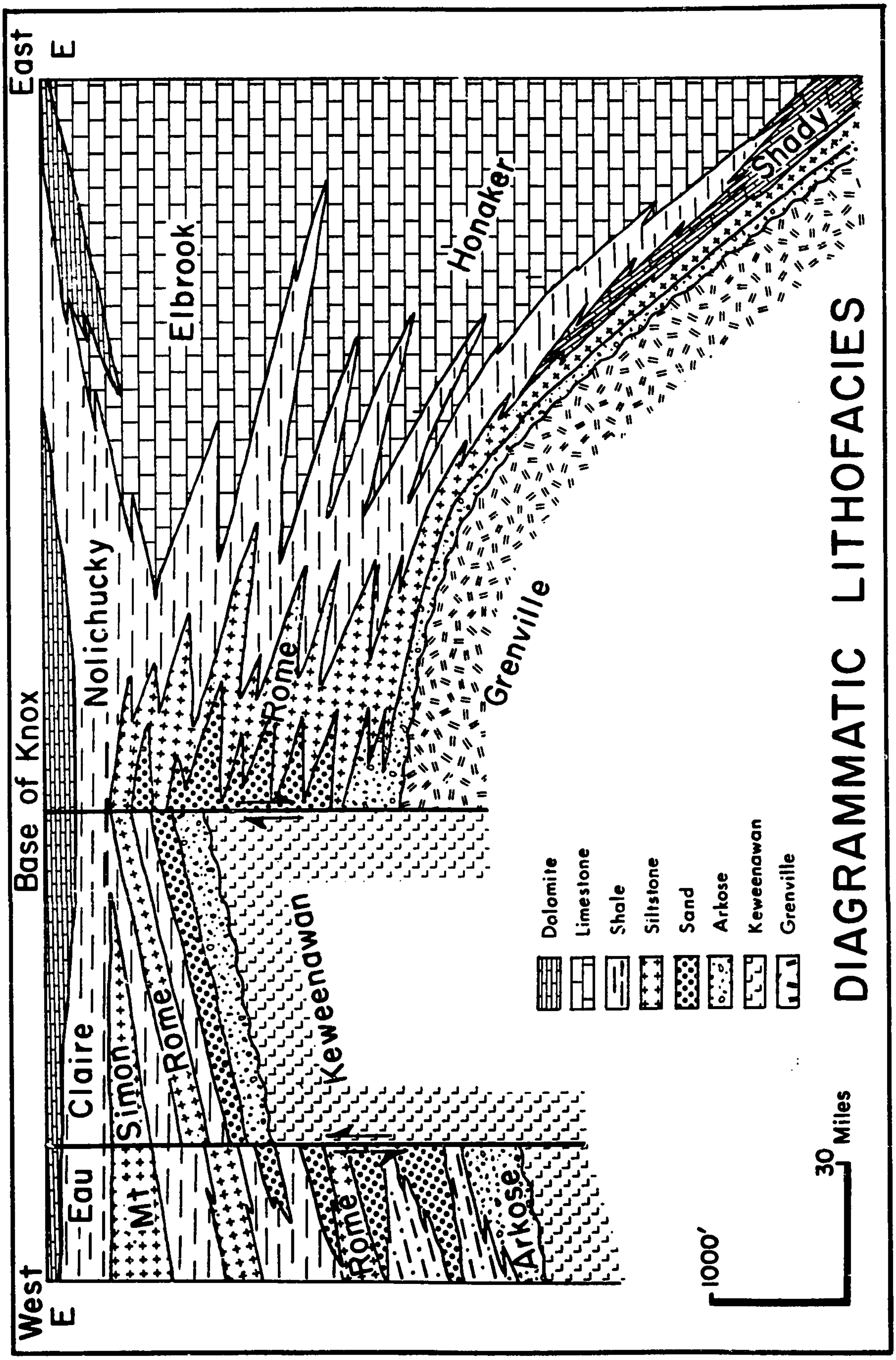
nate sequence on his cross sections 2-2' and 3-3'. The cross section contains the composite sequence as confirmed by outcrop studies of Cambrian strata in eastern Tennessee. The greater thickness may be misleading as this is the effect of basin foreshortening as a result of post Paleozoic overthrusting in the southern Appalachians (Cook, et al., 1979).

Cross section D-D' (Fig. 10) based on wells 8-D, 12-K, 6-K, 41-K, 38-K and 59-K (please see Appendix) extends from the U.S. Steel Chemical Co. No. 1 Fee in southeastern Ohio, across the Rome trough to the outcrop sections exposed in western Virginia and North Carolina. The uniform thickness of the Shady Dolomite is easily correlated north of the Arweb and Carter Lake Faults and, because the Shady has the same thickness in each block, it dates the majority of fault movement as post-Shady (Lower Cambrian). There is a facies change within the Eau Claire portion of the Mount Simon to the shale, limestone and dolomite of the Maynardsville Limestone south and east into the thicker part of the basin. The Elbrook Formation also thickens to the southeast and sandstones of the Rome Formation interfinger with the dolomites of the Elbrook.

Cross section E-E' (Fig. 11) is a diagrammatic, lithologic profile based on all wells drilled within the rift system and extends from the Reelfoot trough across the Cincinnati arch into the Rome trough and does not reflect the numerous thin facies changes present within individual formation units. Again the eastern terminus of the profile is based on projecting surface data and, as the basin has been

FIGURE 11

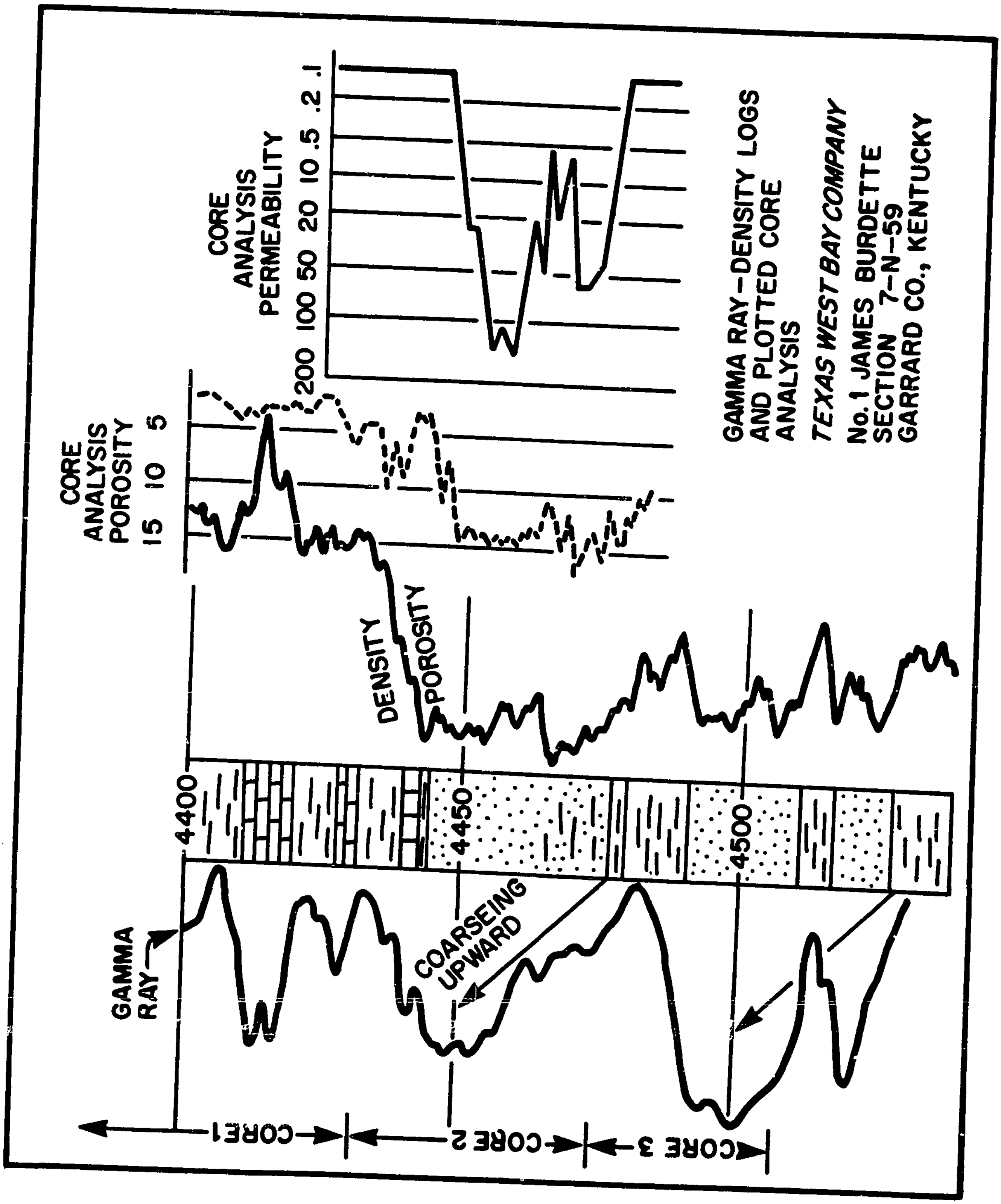
Diagrammatic lithofacies, a west to east idealized profile E-E' displaying lithfacies utilizing all Precambrian test wells within the Rome trough.



DIAGRAMMATIC LITHOFACIES

FIGURE 12

Barrier bar sandstone: a portion of the Gamma Ray-Density logs covering a 150 foot interval of the Rome formation. The core analysis of porosity and permeability are plotted to illustrate use of geophysical logs in determination of depositional environments.


GAMMA RAY–DENSITY LOGS
AND PLOTTED CORE
ANALYSIS
TEXAS WEST BAY COMPANY
No.1 JAMES BURDETTE
SECTION 7–N–59
GARRARD CO., KENTUCKY
CORE
ANALYSIS
PERMEABILITY
200 100 50 20 10 .5 .2 .1
CORE
ANALYSIS
POROSITY
15 10 5
DENSITY
POROSITY
GAMMA
RAY
COARSEING
UPWARD
4400
4450
4500
CORE 1
CORE 2
CORE 3

structurally foreshortened, a more gradual change in facies exists in the trough.

Environmental Interpretation

Essential to many of my conclusions was the environmental interpretation provided by sedimentologic data and geophysical logs. In the last 15 years sedimentologists have learned that patterns on geophysical logs can be used to interpret the depositional environments of homogeneous sandstone-shale sequences. Some references to this literature include Allen (1975), Ruoff (1979) and Selley (1976). A summary of this methodology is given by a tabulation (Table 6) of depositional environments derived from subsurface data and illustrates information utilized on the correlation of rock sequences shown on the cross sections. A prograding longshore bar (Fig. 12) provides a good example of one of the environments summarized in Table 6.

Analysis of well cuttings, cores, and geophysical logs has permitted a general interpretation of depositional environments for the upper 300 feet (91 m) of the Rome Formation (Fig. 13). This interval was chosen because it has been penetrated by the largest number of wells and hence more pertinent data is available.

Provenance areas were some distance to the north, perhaps 50 to 100 miles, of the trough in early middle Cambrian time when the Rome subarkose was being deposited. In later Middle Cambrian time, provenance areas were even further to the north as the trough filled and Cambrian seas expanded. The higher sand-shale ratios on the sand per-

TABLE 6

EXAMPLES OF DEPOSITIONAL ENVIRONMENT INFERRED FROM GEOPHYSICAL LOGS AND SUPPLEMENTED BY CORES AND CUTTINGS

Upper Delta Plain: Widespread, poorly sorted corase- to fine-grained lithic arenites. Upper delta plain has about 60 percent sand and 40 percent shale. Forms heart of a delta system in central Kentucky adjacent to north boundary fault. Recognized on geophysical logs by an interbedded mixture of cylindrical (channel), bell-shaped (point bars) and thin irregular splay sandstones all of which may be stacked. Wells No. 35K, 4300 to 4800 ft.; No. 36K, 4270 to 4944 ft.; and No. 48K, 4415 to 4800 ft.

Lower Delta Plain: About 30 percent sandstones and 70 percent shale with dominance of fine- to medium-grained sandstone. No point bars or clay plugs, but thin limestones interspersed randomly throughout section. Stacking of thin channel sandstones produces continuous vertical sandstone bodies of 50 to 100 feet in thickness. Best developed in some central Kentucky tests, 10 to 15 miles (16 km) from the north bounding fault. Geophysical logs display cylinder character of channel sandstones; sharp, thin curves of limestones and splay sandstones and predominant shale sequence. Wells No. 25K, 4420 to 5536 ft.; No. 27K, 4850 to 5073 ft.; and No. 46K, 5120 to 5600 ft.

Point Bars: Fining upward grain size is noted in bell-shaped curves of logs. Typical thickness ranges from 20 to 40 feet. A gradational contact exists between the sandstone and overlying shale formation. Found only in the western part of the trough near the northern boundary fault in late Rome time. Wells No. 29K, 4400 to 4460 ft. and No. 46K, 5125 to 5275 ft.

Channel Sandstones: Recognized by fairly consistent uniform grain size. Response of geophysical logs are curves shaped like a cylinder with sharp contacts between lithologies. Most channels interpreted to be delta distributaries occur in the western part of the Rome trough in central Kentucky. Wells No. 18K, 3640 to 3810 ft. and No. 36K, 4260 to 4300 ft.

Longshore and Barrier Bars: Recognized by coarsening upward grain size distribution. Response of geophysical log curves is that of a widening upward funnel with basal gradational contact with underlying shale. Most sandstone barriers are found in the western and central part of the trough on flanks of the delta system in central Kentucky. Wells No. 48K, 5080 to 5200 ft. and 4850 to 4950 ft. plus No. 18K, 3900 to 4700 ft.

Table 6 - Continued

Mixed Carbonate-Sandstone Banks: Widespread fine- to medium-grained, well sorted sandstones interbedded with carbonate grainstones. Carbonates are usually more common and thicker than sandstones. Few shale interbeds but glauconite recognizable on logs at limestone-shale contacts. Absence of channel, point bar and longshore sandstone bodies. Geophysical log curves depict massive carbonates with sharp lithologic boundaries and thin shales and sandstones interbedded between the carbonates. Mixed carbonate-sandstone banks are noted in the central and eastern portion of the trough throughout the Elbrook and Rome Formations. Wells No. 55K through 58K

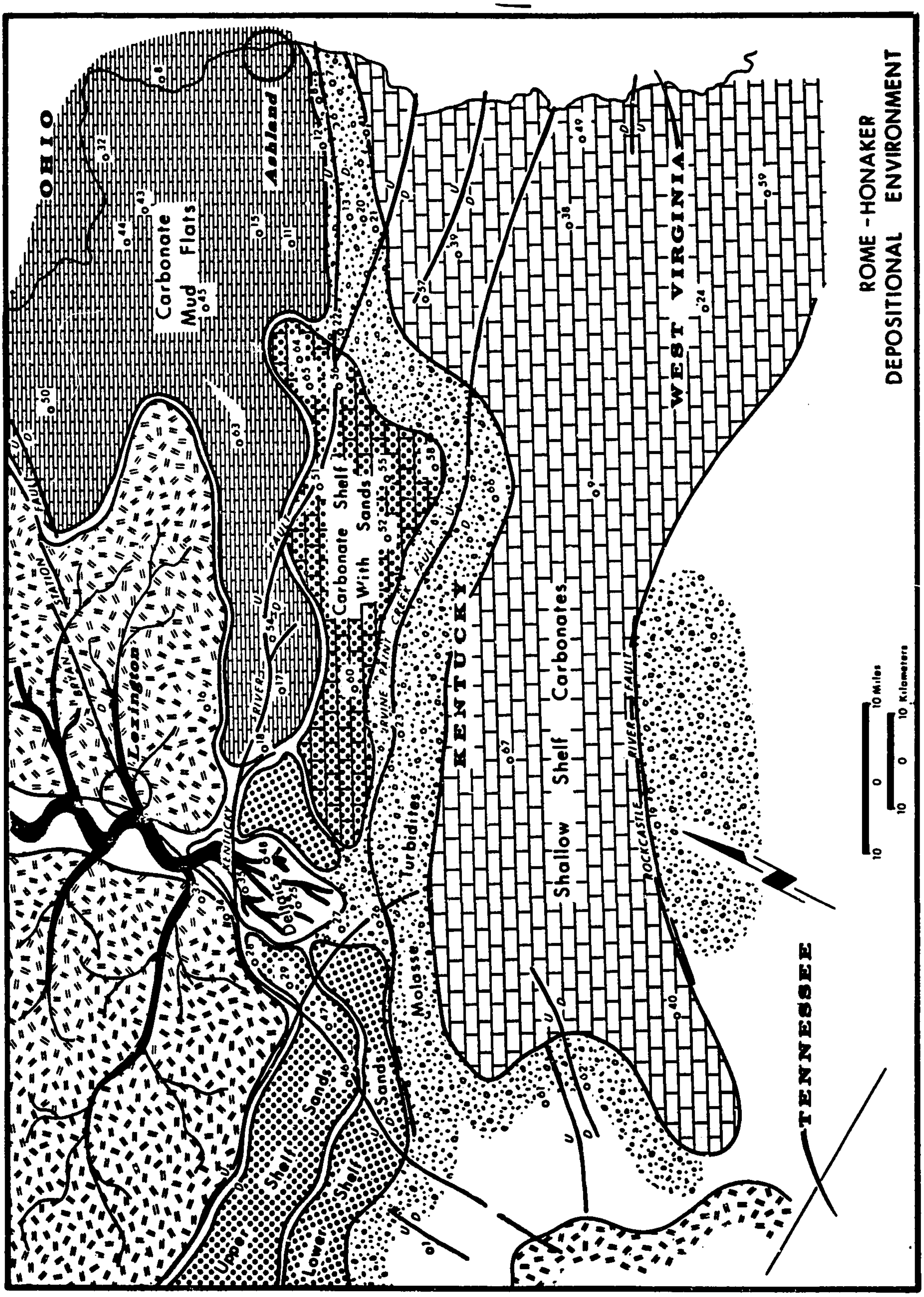
Carbonates Banks and Barriers: Massive carbonate grainstone facies adjcante to shale facies. Log pattern similar to that of mixed carbonate-sandstone banks but sandstones are missing. May represent barrier between shale basin of western trough and carbonate platform of each shelf. On wireline logs in three wells in central portion of trough. Well No. 6K displays thick, massive dolomite intervals from 6750 to 7300 ft. and in well No. 7K, 7270 to 7800 ft.

Turbidites: Recognized by irregular and erratic, unusually thin beds of sandstone in thick shale sequences. Sharp sandstone-shale contacts. There are no point bars, channels, longshore or barrier bars associated with these logs and the section is 80 to 90 percent shale. Well No. 26K, 3900 to 4200 ft.; No. 23K, 12,040 to 13,300 ft. Definite turbidite sequences are present in well No. 62K adjacent to the Pulaski fault, 7400 to 7600 ft. and from 7700 to 7820 ft.

Anerobic Basin: Massive black, highly organic, carbonaceous shale having a high radioactivity on wireline logs. Well 17K, 3630 to 4383 ft.; No. 35K, 3600 to 4275 ft.; No. 48K, 3700 to 4400 ft.; and No. 33K, 4500 to 5100 ft.

FIGURE 13

Rome-Honaker depositional environment map.



ROME - HONAKER DEPOSITIONAL ENVIRONMENT

centage map (Fig. 14) and the depositional environment map (Fig. 13) display the interpretation - a lobate delta system draining longitudinally along much of the length of the trough. This delta system is called the Garrard Delta because of its presence and areal extent in Garrard County.

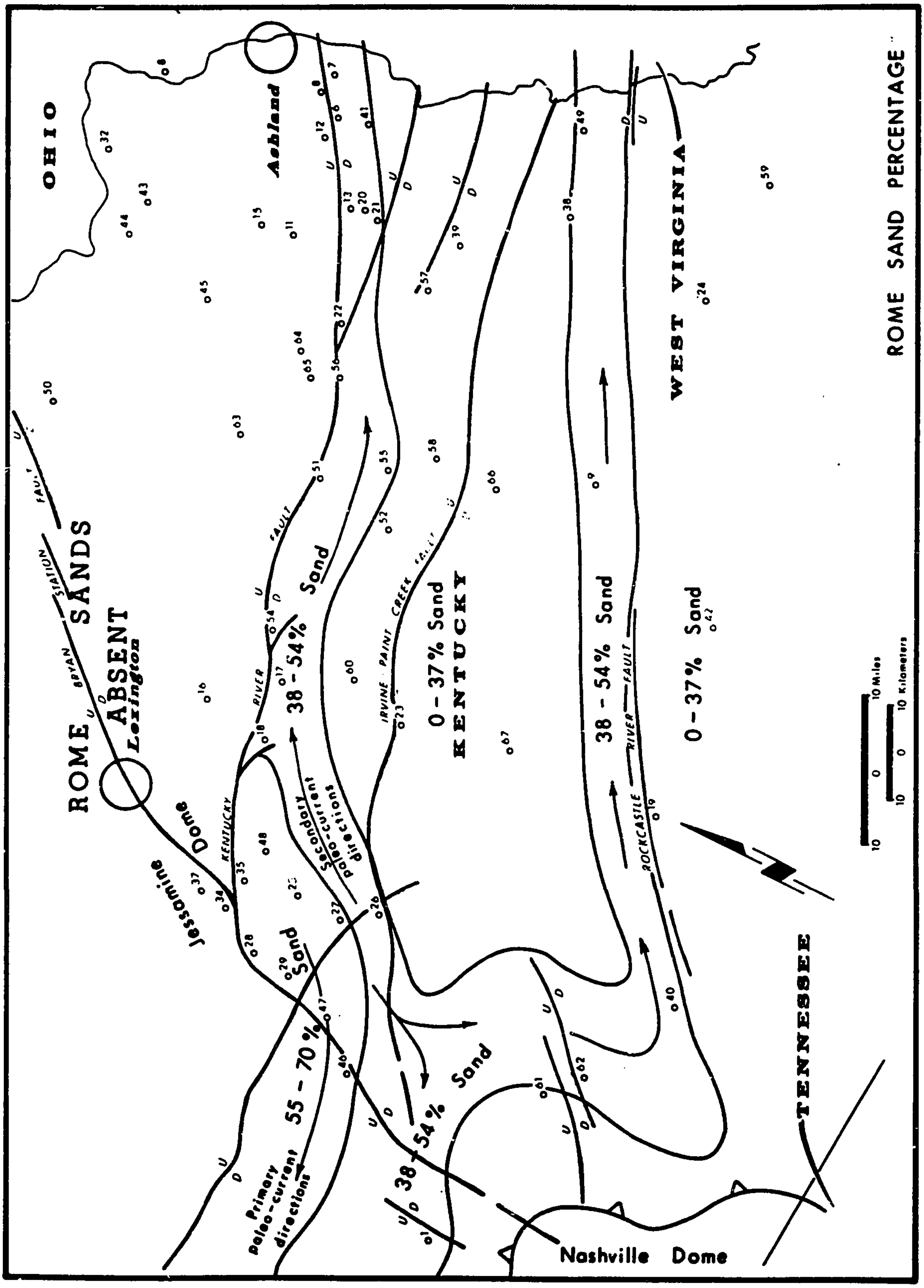
Source rocks for the Rome appear to be shared by the quartz-rich Keweenawan bedrock to the northwest and the Grenvillian metasedimentary surface to the northeast. The medium-grained quartz arenites of upper Rome sediments must have been derived from the quartz-rich Keweenawan, while the subrounded feldspars and finer grain size quartz of early Rome sandstones are more diagnostic of the Grenvillian metasedimentary terrain.

The distance of sediment transport could be from 25 to 50 miles (40 to 80 km) to hundreds of miles as all the Precambrian craton was explosed during Middle Cambrian north of a narrow and shallow platform area bounding the trough. As the Rome Formation is absent north of the fault, and all Rome sediments in the trough are marine, it is difficult to reconstruct whether the Rome was deposited on the shallow platform and subsequently eroded prior to Nolichucky Shale deposition and thus served as a source of sediments for the Mount Simon formation.

Paleocurrents came from the northeast, parallel to the trough boundary and turned southwest in central Kentucky. Current velocities appear to have been moderate because prograding longshore bars mapped in central Kentucky, average 20 feet (6 m) in thickness (Fig. 12) and have a wide areal distribution (2800 ft. by 25000 ft.). Water depths

FIGURE 14

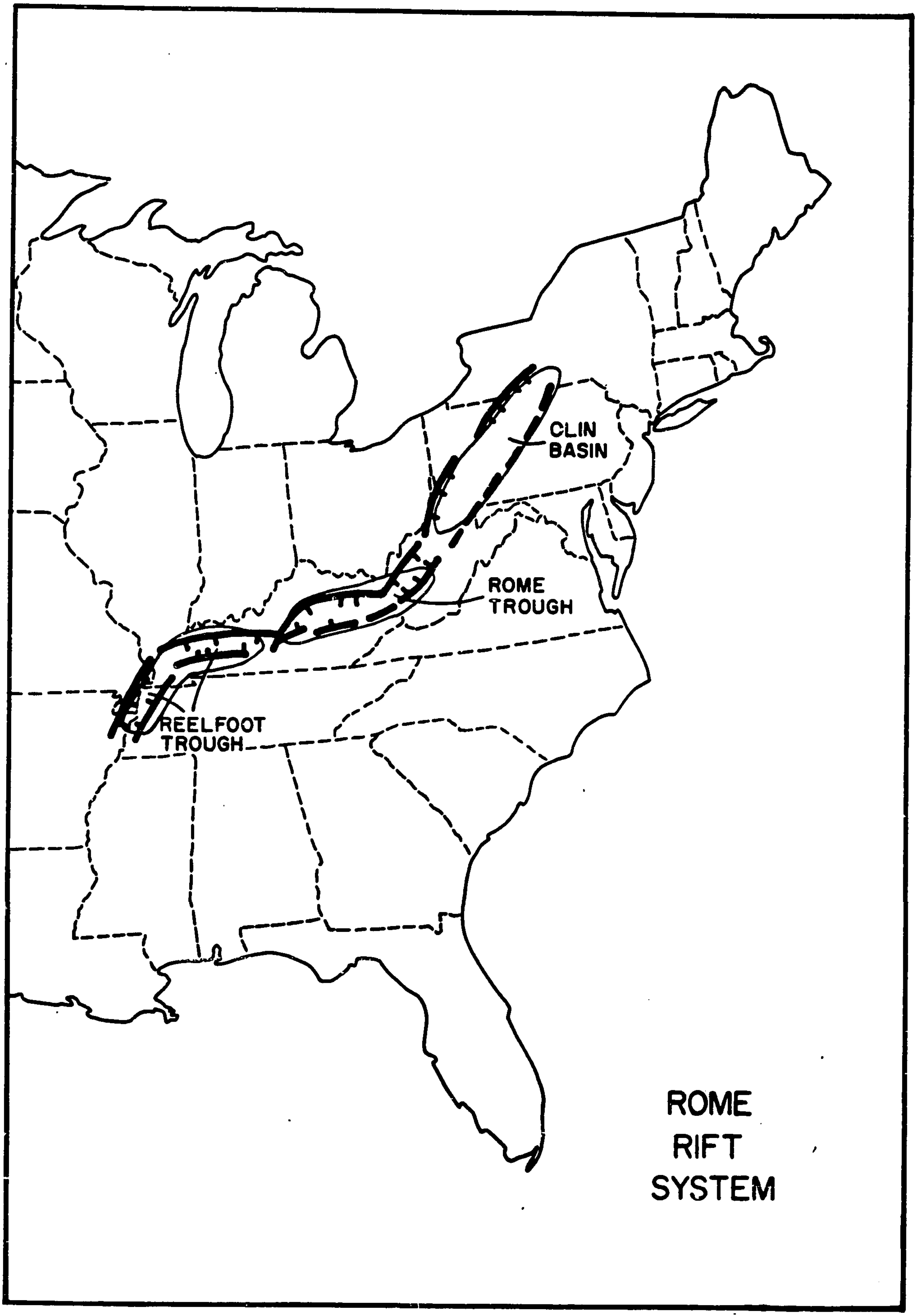
Rome sandstone percentage map. Rome sandstones are absent north of the Kentucky River fault and on the Nashville dome.


OHIO
Ashland
WEST VIRGINIA
KENTUCKY
TENNESSEE
ROME SANDS ABSENT
Lexington
Jessamine Dome
Nashville Dome
BRYAN STATION FAULT
KENTUCKY RIVER FAULT
IRVINE - PAINT CREEK FAULT
ROCKCASTLE RIVER FAULT
0 - 37% Sand
38 - 54% Sand
55 - 70% Sand
Secondary paleo-current directions
Primary paleo-current directions
10 Miles
10 Kilometers
ROME SAND PERCENTAGE

were shallow, 30 to 90 feet (9-27 m), in the central Kentucky portion of the trough between the Kentucky River and the Irvine-Paint Creek faults. South of the Irvine-Paint Creek fault, water depth was greater than wave base but never deeper than 600 feet (182 m). The sediments, because of long, lateral distribution of bars and permanence of the delta appear to be current dominated. Paleocurrents transported sands to the southwest; however, a few longshore bars are noted east of the delta indicating a periodic change in current direction. The paleo-slope may have been - as shear guess - approximately twenty-five feet to the mile toward the southeast.

FIGURE 15

Rome rift system. The Rome trough is a part of a more extensive intra-continental rift system. This system has been recognized from Pennsylvania to western Tennessee.


CLIN
BASIN
ROME
TROUGH
REELFOOT
TROUGH
ROME
RIFT
SYSTEM

STRUCTURAL EVOLUTION OF THE ROME TROUGH

The Rome trough is part of an extensive rift system extending east-west across Kentucky (Fig. 15). The troughs or rifts which constitute this rift system have been recognized in the West Virginia plateau (Ping Fan Chen, 1975), in the Pennsylvanian plateau (Wagner, 1976) and since 1961 in Kentucky (Woodward, 1961). Woodward postulated (p. 347) a "coastal declivity which may be a fault scarp or a steep coastwise cliff that is responsible for an abrupt thickening of Early Cambrian deposits on its southeast side." The thicker Cambrian formations were considered to have been deposited in the "Rome trough" (McGuire and Howell, 1963, p.   ). Webb (1969), Silverman (1972), Harris (1975) and Ammermann and Keller (1979) delineated the trough more accurately and Webb (1969) determined that the greater part of the synsedimentary faulting occurred in the Middle Cambrian.

The northern boundary fault (Kentucky River fault) of the Rome trough shows a much greater vertical displacement than the southern boundary fault (the Rockcastle River fault). Heyl (1972, p. 879). considered the Kentucky River fault as a part of a large fault system ("38th parallel lineament") which could be followed over a distance of more than 800 miles (1287 km) from northeastern Virginia to south-central Missouri. The presence of troughs may be more diagnostic of an extensive fracture system than the presence of a single fault, and I therefore postulate that the Rome Rift system is the major, east-west

FIGURE 16

Precambrian structure map, showing the present day structural attitude of basement rocks in the Rome trough area.

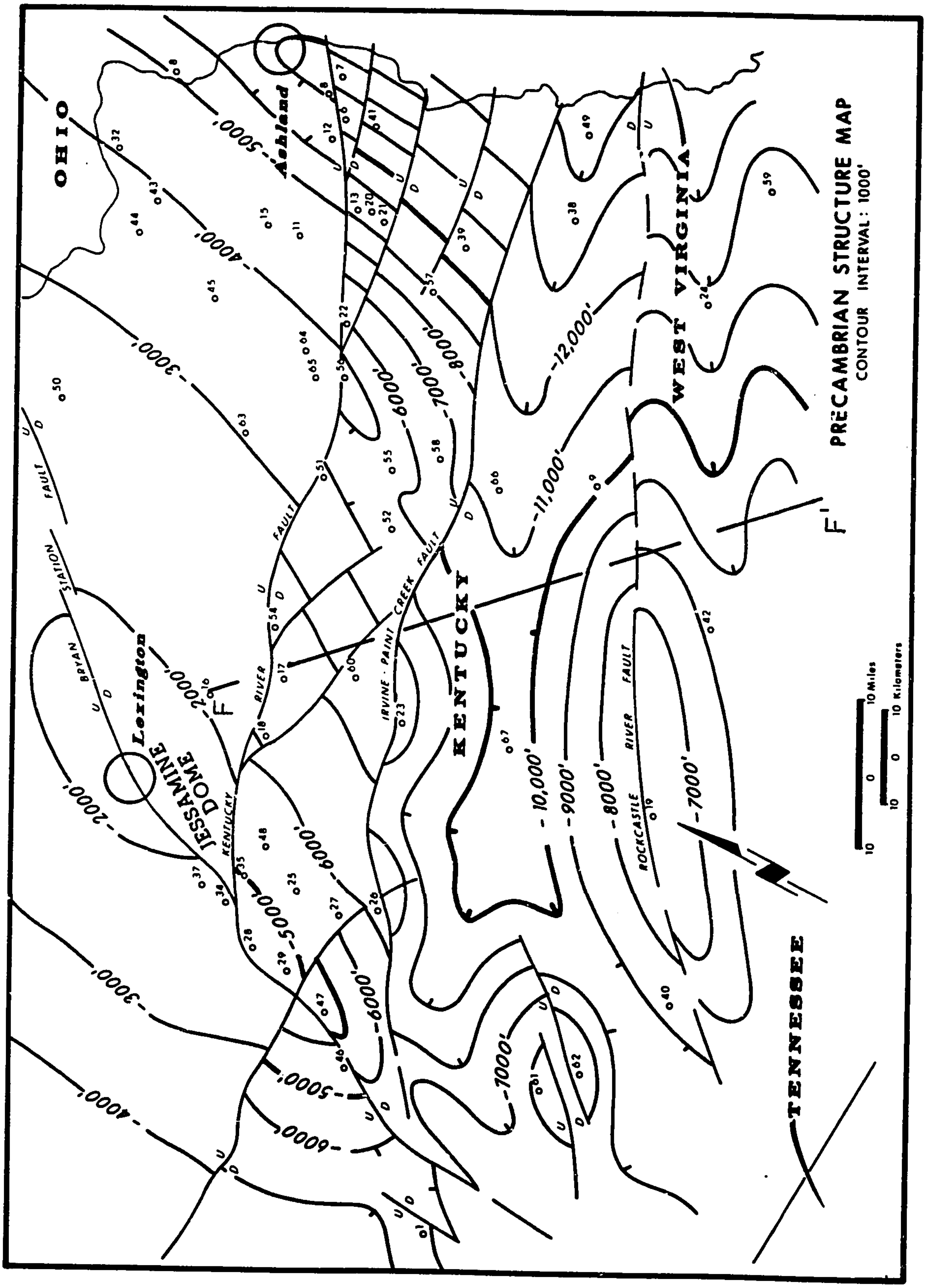

PRECAMBRIAN STRUCTURE MAP
CONTOUR INTERVAL: 1000'
OHIO
WEST VIRGINIA
KENTUCKY
TENNESSEE
Ashland
Lexington
JESSAMINE DOME
KENTUCKY RIVER FAULT
IRVINE - PAINT CREEK FAULT
BRYAN STATION FAULT
ROCKCASTLE RIVER FAULT
F
F'
-2000'
-3000'
-4000'
-5000'
-6000'
-7000'
-8000'
-9000'
-10,000'
-11,000'
-12,000'
10 Miles
10 Kilometers

FIGURE 17

Pre-Knox isopach, shows the amount of Cambrian sediment fill in Rome trough. Note the thin area north of the Kentucky River fault and south of the Rockcastle River fault.

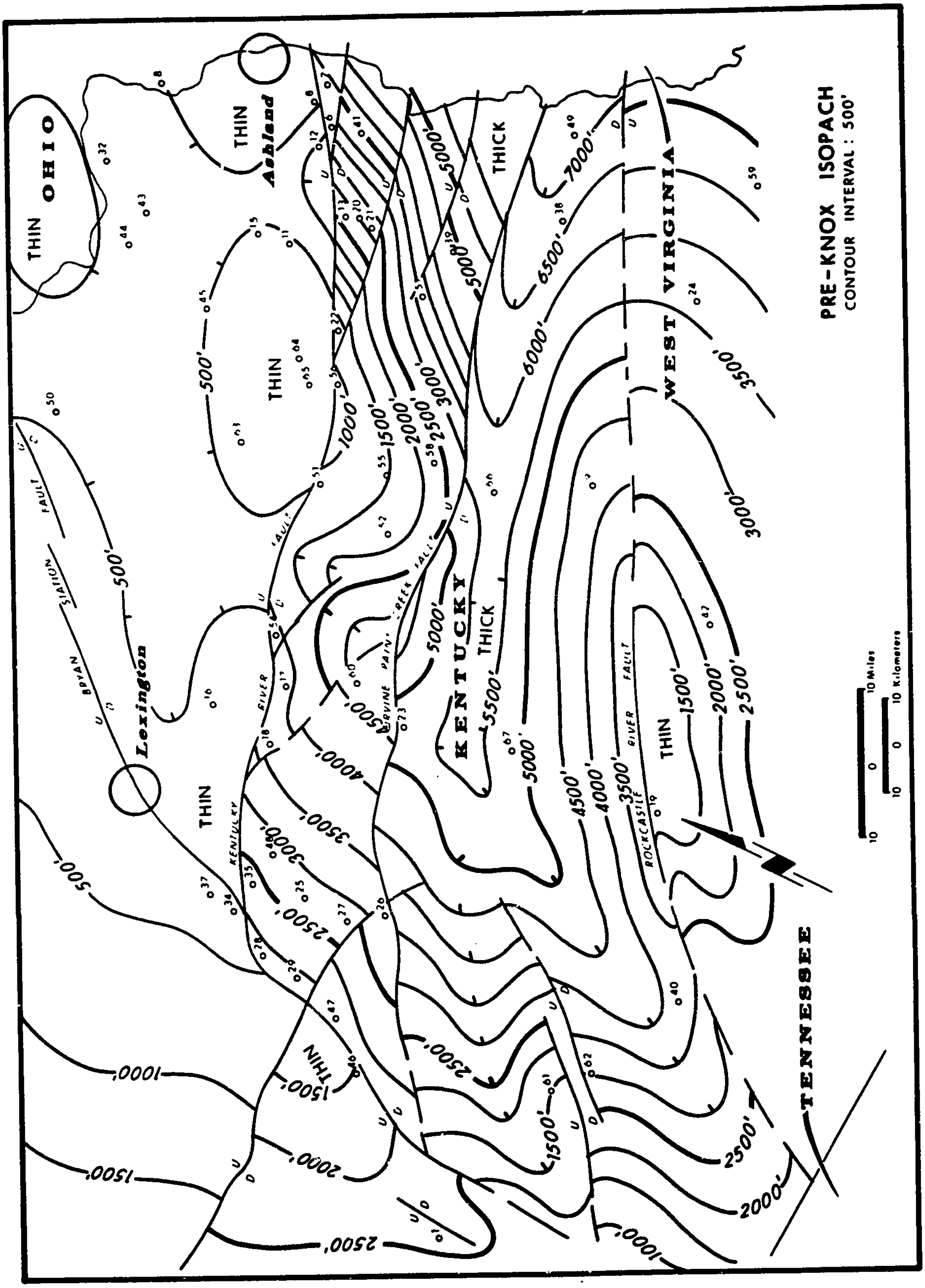

PRE-KNOX ISOPACH
CONTOUR INTERVAL : 500'
OHIO
KENTUCKY
WEST VIRGINIA
TENNESSEE
Lexington
Ashland
THIN
THICK
BRYAN STATION FAULT
KENTUCKY RIVER FAULT
IRVINE PAINT CREEK FAULT
ROCKCASTLE RIVER FAULT
10 Miles
10 Kilometers

FIGURE 18

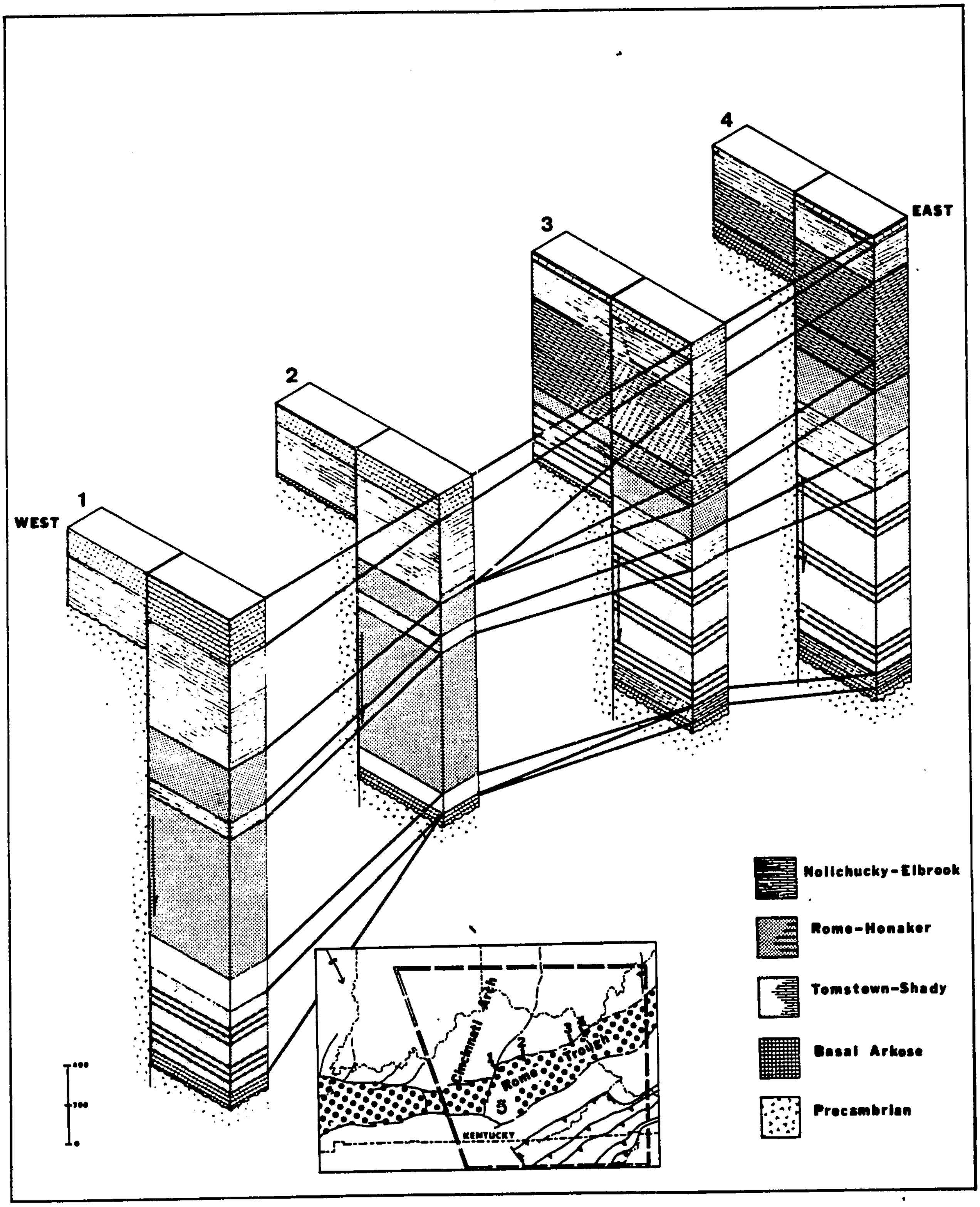
Block diagrams displaying fault displacement and facies change associated with the north bounding fault of the Rome trough.

Block diagram #1 between the Texaco Inc. #1 T. Sherrer, section 6-P-60 and the Texaco #1 Wolfinbarger, section 1-P-60, Jessamine County, Kentucky.

Block diagram #2 between the Texaco Inc. #1 J. Williams, section 9-Q-64 and the Ashland Oil Co. #1 M. W. Miller, section 16-S-65, Clark County, Kentucky.

Block diagram #3 between the Ashland Oil Co. #1 W. Stapleton, section 12-V-77, and the Inalnd Gas Co., #546 McDavid, section 22-U-79, Carter County, Kentucky.

Block diagram #4 between the Inland Gas Co. #537 C. E. Fannin, section 22-W-82 and the Inland Gas Co. #535 S. McKeand, section 25-W-83, Boyd County, Kentucky.


1
WEST
2
3
4
EAST
Cincinnati Arch
Rome Trough
5
KENTUCKY
Nolichucky-Elbrook
Rome-Honaker
Tomstown-Shady
Basal Arkose
Precambrian

oriented fracture system of the eastern United States platform and the western Appalachian basin. This rift system extends from the Olin basin of Pennsylvania (Wagner, 1976) through West Virginia (Ping Fan Chen, 1977) to southeast Missouri to the New Madrid rift (Ervin and McGinnis, 1975) and perhaps even further to the southwest (Fig. 15).

Trough Boundaries

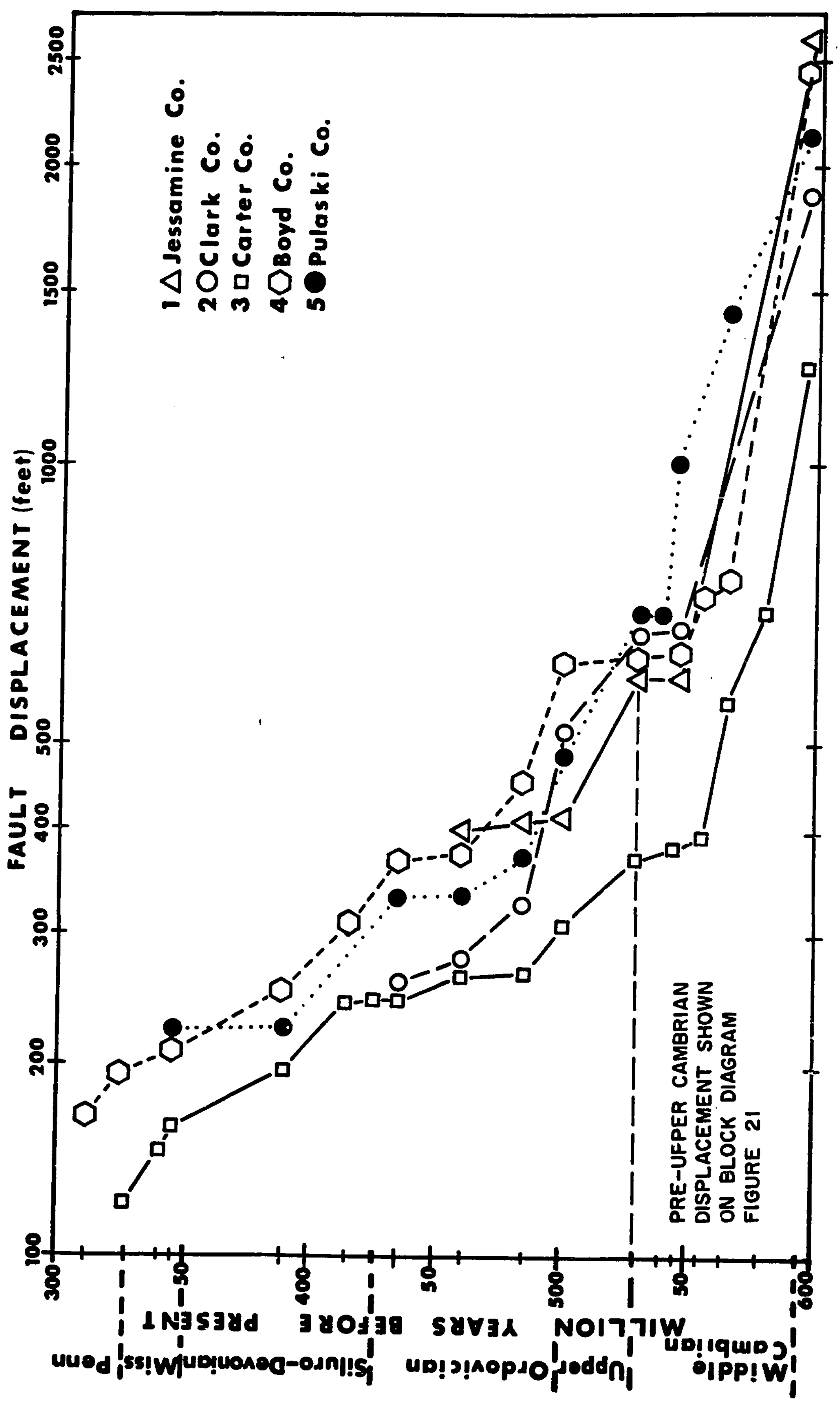
The Rome trough in Kentucky is about 40 miles (64 km) wide and 150 miles (240 km) long. The trough is bounded on the west by the Lexington fault of Keweenawan age which was rejuvenated during Middle Cambrian time (Ammerman and Keller, 1979). Near the Lexington fault the depth of the Precambrian basement is an average of 6000 feet (1828 m), whereas in eastern Kentucky the depth to basement is below 12,300 feet (3747 m). The Precambrian structure map (Fig. 16) illustrates the eastward plunge of this surface and the preKnox isopach map (Fig. 17), the thickening of Cambrian sediments into the eastern portion of the trough.

The displacement along the trough's northern boundary, the Kentucky River fault, is depicted by a series of block diagrams using deep test wells on opposite sides of the fault. The block diagrams illustrate the amount of throw (Fig. 18) and the facies variations from upthrown to downthrown blocks as well as the facies variations parallel to the strike of the fault.

The southern boundary fault of the Rome trough is not documented by wells which have penetrated Cambrian sediments as is the northern

FIGURE 19

Rate of Faulting (Displacement versus Time). Notice logarithmic scale of displacement. Illustrates that approximately 80 percent of fault movement occurred during Middle Cambrian time.


FAULT DISPLACEMENT (feet)
100
200
300
400
500
1000
1500
2000
2500
1 △ Jessamine Co.
2 ○ Clark Co.
3 □ Carter Co.
4 ⬡ Boyd Co.
5 ● Pulaski Co.
PRE-UPPER CAMBRIAN
DISPLACEMENT SHOWN
ON BLOCK DIAGRAM
FIGURE 21
300
50
400
50
500
50
600
MILLION YEARS BEFORE PRESENT
Penn
Miss
Siluro-Devonian
Upper Ordovician
Middle Cambrian

boundary fault. Upper Ordovician and Siluro-Devonian well data plus seismic work shows, however, a down-to-the north fault on the north flank of the Rockcastle River uplift.

Age of Faulting

The age of the Rome trough can be deduced from the age of the fault displacements along the Kentucky River fault. The fault displacements have been determined by subsurface correlation across the fault. The results of these correlations are presented in two figures: the block diagrams (Fig. 18) illustrate the fault displacements at four sites, and a graph (Fig. 19) shows the rate of displacement at five sites. The graph indicates clearly that most of the fault movement occurred during middle Cambrian time. Fault movement also occurred at the end of the Ordovician, Silurian(?), Devonian and Mississippian periods, and was probably associated with mountain building in the Appalachians. Pennsylvanian formations which outcrop in the northeastern portion of the Rome trough in Kentucky reveal juvenation of the trough boundary faults during this period (Dever, et al., 1977, p. 49).

Structure

The structure of the Rome trough is illustrated with structure contour maps (Figs. 16 and 20) and cross sections (Figs. 7, 8, 9, 10 and 11). Details of the structure can be most easily read from a seismic reflection profile (Fig. 21), which is parallel to cross sec-

FIGURE 20

Nolichucky structure map showing present attitude of the top of the Middle Cambrian.

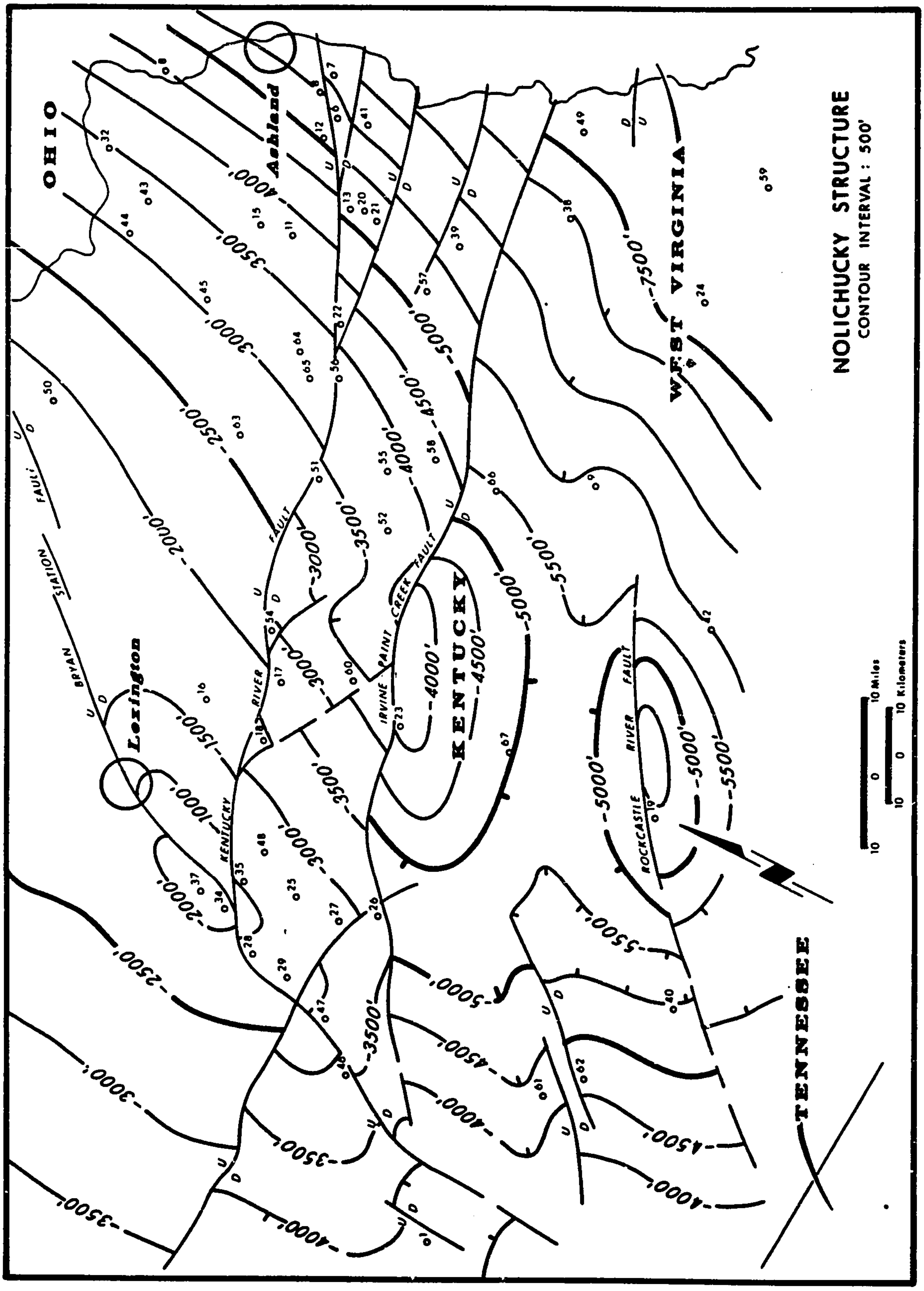

NOLICHUCKY STRUCTURE
CONTOUR INTERVAL : 500'
OHIO
WEST VIRGINIA
KENTUCKY
TENNESSEE
Ashland
Lexington
BRYAN STATION FAULT
KENTUCKY RIVER FAULT
IRVINE PAINT CREEK FAULT
ROCKCASTLE RIVER FAULT
10 Miles
10 Kilometers

FIGURE 21

Cross section F-F', a south to north profile, parallel to cross section C-C', tied to the following wells:

42-K United Fuel Gas Co. #8437 Fordson Coal Co., Section 8, Township I, Range 73, Leslie County, Kentucky.

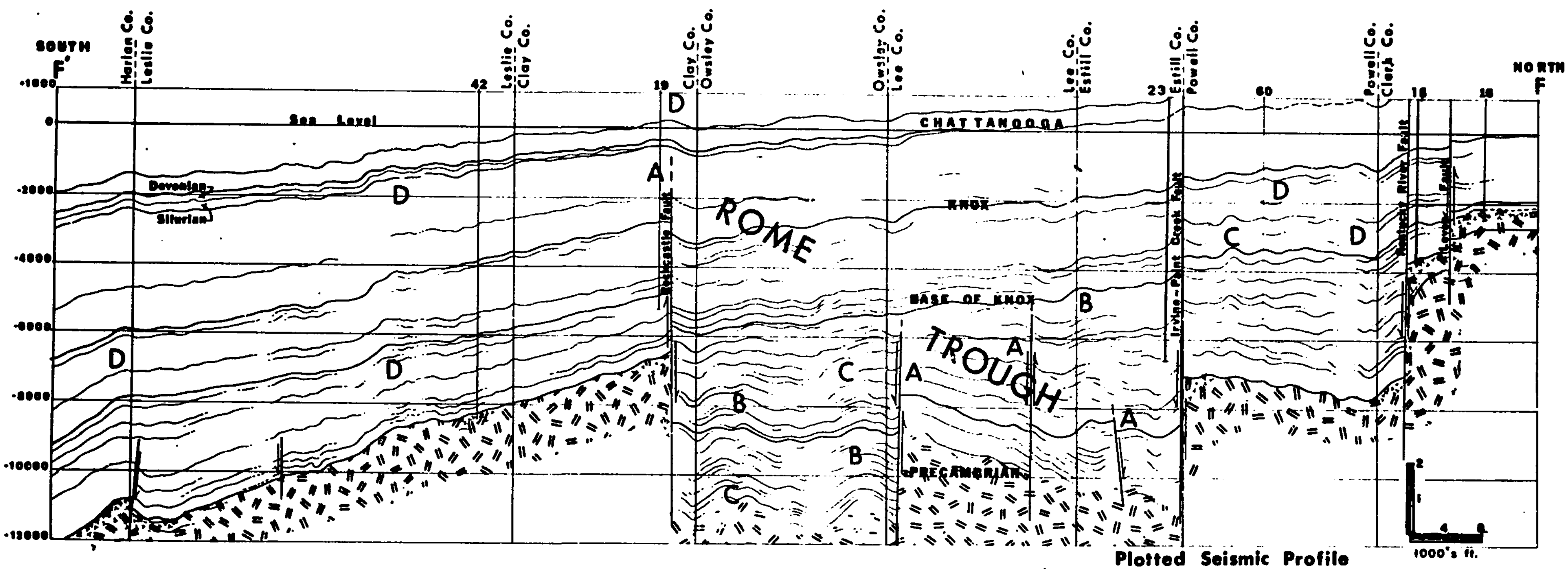
19-K Algonquin #1B. Hubbard Section 21, Township I, Range 67, Clay County, Kentucky.

23-K Texaco Inc. #1G, Tipton, Section 21, Township O, Range 66, Estill County, Kentucky.

60-K South Central Petroleum Co., #1 J. Hall, Section 8, Township P, Range 57, Powell County, Kentucky.

18-K Texaco Inc. #1 J. Williams, Section 9, Township Q, Range 64, Clark County, Kentucky.

16-K Ashland Oil Co., #1 M. W. Miller, Section 16, Township S, Range 65, Clark County, Kentucky.



A - Faults which do not extend to the surface.

B - Folds which do not extend to the surface.

C - Folds which increase in magnitude with depth.

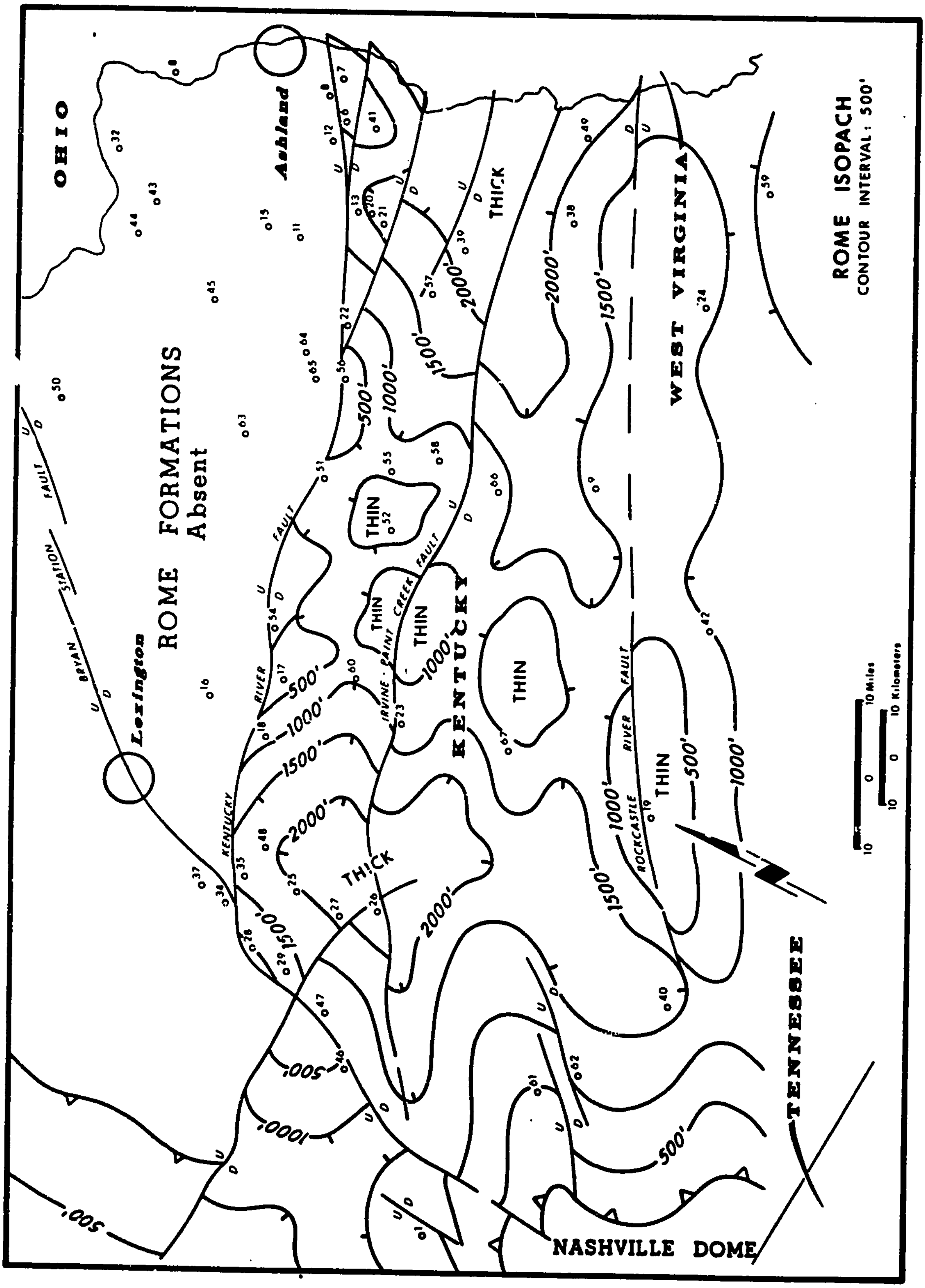
D - Folds expressed at the surface which do not increase with depth.

tion C-C', and extends from Harlan to Clark Counties, Kentucky and is tied to subsurface test wells in Leslie, Breathhitt, Powell, Estill, Madison and Clark Counties (Wells 42-K, 19-K, 23-K, 60-K, 18-K and 16-K listed in Appendix). The profile utilizes sea-level as a datum and includes the complete Phanerozoic section. The profile illustrates the continuity of reflecting horizons from the top of the Mississippian to the Precambrian. It shows that many of the intra-trough faults do not extend to the surface whereas the boundary faults had periodic movement throughout the Paleozoic. The profile suggests that individual blocks, some of substantial dimensions, within the rift system were tilted during Middle Cambrian time. The interpretation is supported by the isopach maps (Figs. 17, 22, 23, and 24). The seismic section (Fig. 21) also shows several faults which die out within Lower Cambrian units, while others extend into middle and upper Cambrian sections. The faults are syndepositional and seem to have been rejuvenated as various fault blocks received sediments at various times. As the blocks were tilted, local compression resulted in anticlinal folds. Other structural features include scissor faults and "slump structures", which are linear depressions indicative of faulting at depth. Still younger faults were found as a result of surface mapping the U.S. Geological Survey in central and eastern Kentucky. Many of these faults, such as the Pulaski County fault, have been verified to exist in deeper horizons by geophysical techniques as illustrated by Keller, _et al_. (1975).

The fault blocks within the Rome trough are shown in Figure 25.

FIGURE 22

Rome Isopach, displays the thicknesses of the Rome Formation within various blocks in the Rome trough.



ROME ISOPACH
CONTOUR INTERVAL: 500'
ROME FORMATIONS Absent
OHIO
WEST VIRGINIA
KENTUCKY
TENNESSEE
NASHVILLE DOME
Lexington
Ashland
THICK
THIN
KENTUCKY RIVER FAULT
IRVINE - PAINT CREEK FAULT
ROCKCASTLE RIVER FAULT
BRYAN STATION FAULT
10 Miles
10 Kilometers

FIGURE 23

Elbook isopach: illustrates the carbonate fill in the Rome trough.

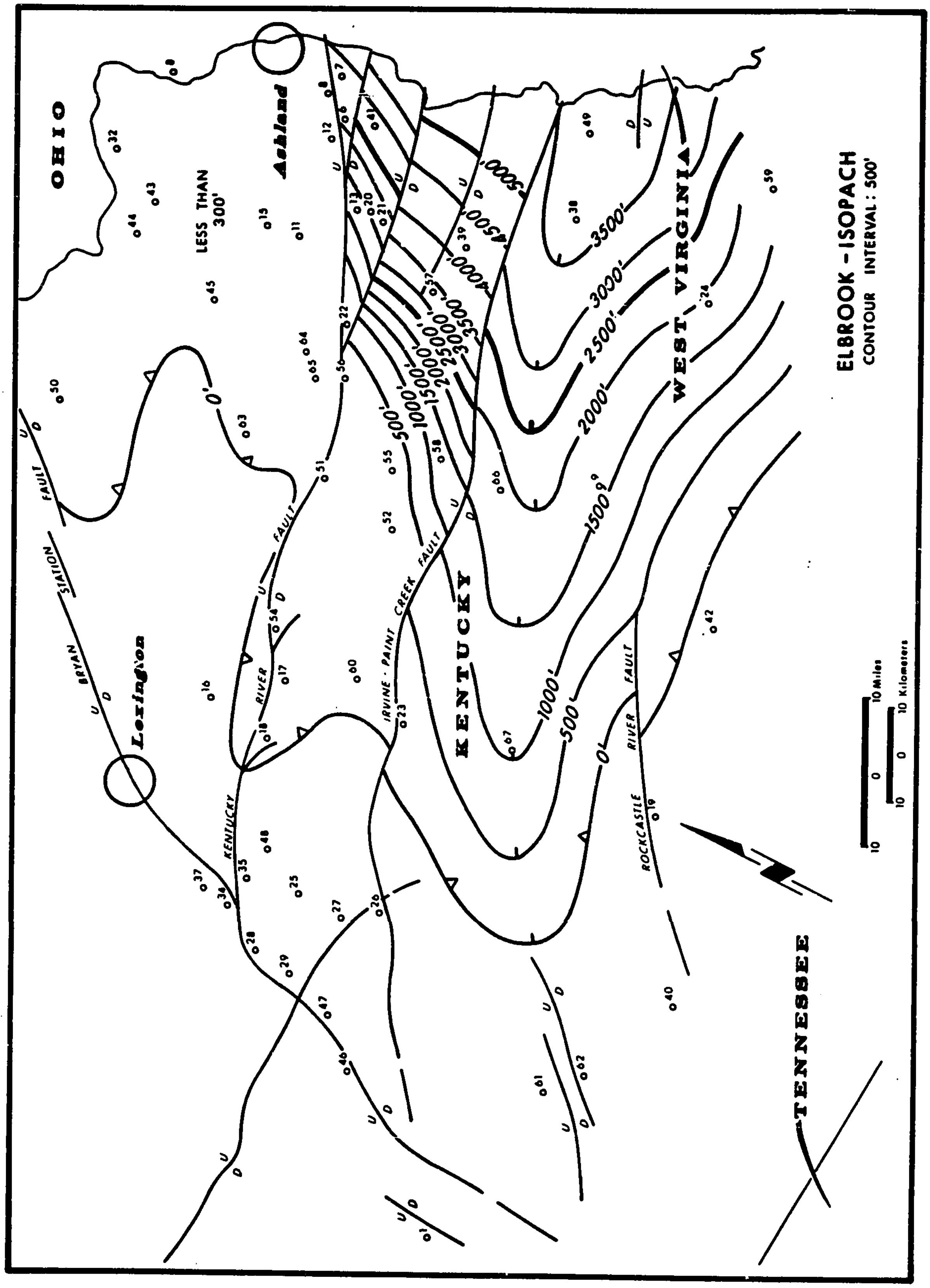

ELBROOK - ISOPACH
CONTOUR INTERVAL: 500'
OHIO
KENTUCKY
WEST VIRGINIA
TENNESSEE
Ashland
Lexington
LESS THAN 300'
BRYAN STATION FAULT
KENTUCKY RIVER FAULT
IRVINE - PAINT CREEK FAULT
ROCKCASTLE RIVER FAULT
10 Miles
10 Kilometers

FIGURE 24

Eau Claire-Nolichucky isopach shows the thick area of organic-rich black shale in the western portion of the Rome trough.

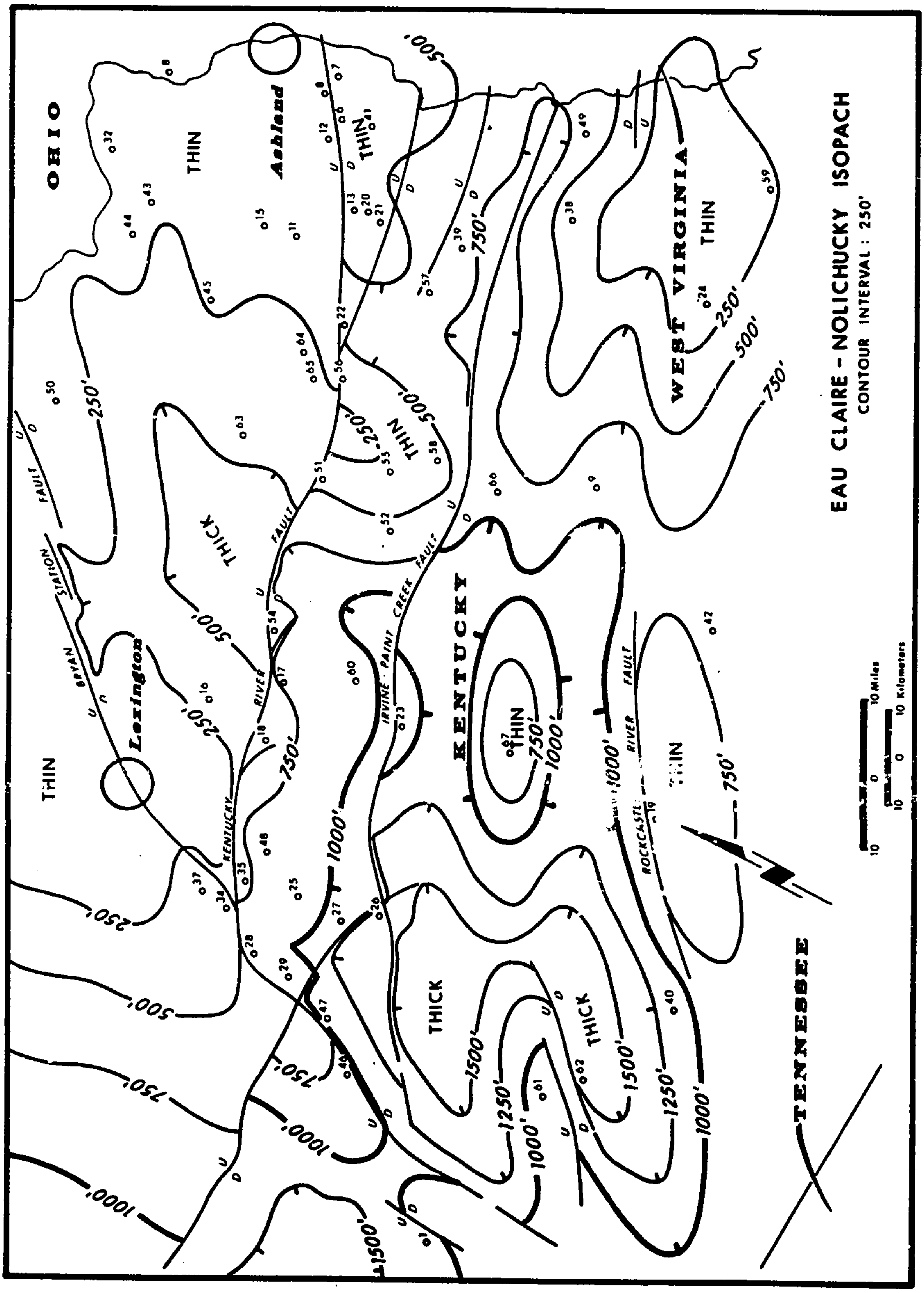
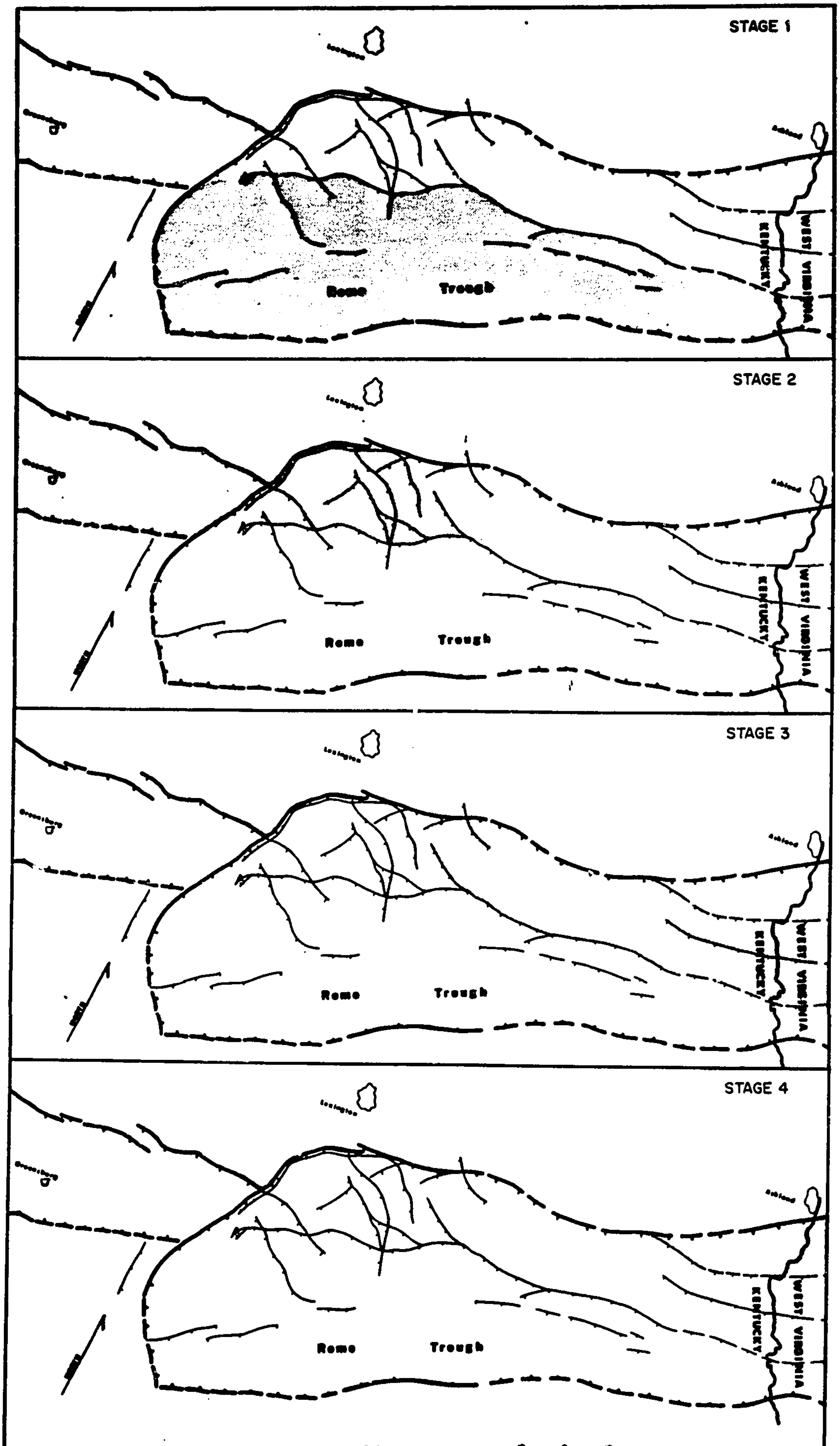

EAU CLAIRE - NOLICHUCKY ISOPACH
CONTOUR INTERVAL : 250'
OHIO
WEST VIRGINIA
KENTUCKY
TENNESSEE
Ashland
Lexington
THIN
THICK
KENTUCKY RIVER
IRVINE - PAINT CREEK FAULT
ROCKCASTLE RIVER FAULT
BRYAN STATION FAULT
250'
500'
750'
1000'
1250'
1500'
10 Miles
10 Kilometers

FIGURE 25

Stages of rifting in the Rome trough. Based on isopach mapping, four stages in rift development are noted.



STAGES OF RIFTING

FIGURE 25

They can be delineated on the basis of the age of the major faults; the amount of displacement along these faults; the thicknesses of the various Middle Cambrian units; and the differences and similarities of lithofacies of trough formations. Maximum subsidence occurred successively and it is therefore possible to distinguish several stages in the structural evolution of the Rome trough. During a particular stage a fault block within the Rome trough subsided deeper than the adjacent blocks and received more sediments. Displacements along the Rome trough faults appear to have varied periodically, thus creating separate subtroughs at different times (Fig. 25, stages 1-4).

Rejuvenation of Precambrian Faults

Several lines of evidence suggest that the location of the Rome trough in Kentucky was determined by faults older than the Middle Cambrian. Heyl (1972, p. 879) originally suggested a Precambrian age of the 38th parallel lineament on the basis of the distribution of Bouguer gravity anomalies in Kentucky. These anomalies were studied by Black, et al. (1977) and Ammerman and Keller (1979) who concluded that Heyl's lineament is pre-Keweenawan, without any strike-slip displacements in post-Keweenawan time. Rifting of the continental crust began in the Cambrian, and the observation (Fig. 15) that the Rome Rift in West Virginia and Pennsylvania has a trend parallel to the Appalachian geocline suggests that this part of the rift system ("eastern Rome rift") has not been preceded by Precambrian faulting. In Kentucky, however, the Appalachian basin changes its direction, and its margin coincides with the northern boundary fault of the Rome trough during the Middle Cambrian (sections C-C and D-D, Figs. 9 and 10. This change in direction, and the separation between the western Rome rift and the Appalachian geocline suggest a Precambrian age for the initial faulting. I believe these faults became rejuvenated during the rifting. Rejuvenation of ancient faults appears also to be typical of other major continental rifts as well: e.g., the East African rift (Baker, et al., 1972; McConnell, 1974), the Rhine graben (Illies and Müller, 1970) and the Rio Grande rift (Chaplin and Seager, 1975).

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APPENDIX OF WELL DATA

I N D I A N A W E L L D A T A

STATE	OPERATOR - FARM NAME		COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness
1-I	Gulf Oil Corp.		Fayette	32-13N-13E	959 KB	2880 (530)			3410 (380)
	#1 Scott					-1921			-2451
		Sand				111' (21%)			243' (64%)
		Shale				419' (79%)			137' (36%)
		Carb.				0'			0'
2-I	Indiana Farm Bureau		Lawrence	20-5N-2E	800 KB	4800 (650)			5450 (885)
	#1 Brown					-4000			-4650
		Sand				33' (5%)			585' (66%)
		Shale				617' (95%)			300' (34%)
		Carb.				0'			0'
3-I	Ashland Oil Co.		Switzerland	4-2N-1W	880 KB	3076 (560)			3636 (304)
	#1 Collins					-2196			-2756
		Sand				67' (12%)			195' (64%)
		Shale				493' (88%)			109' (36%)
		Carb.				0'			0'

T E N N E S S E E W E L L D A T A

STATE	OPERATOR - FARM NAME		COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness
1-T	Edward Riley		Morgan	11-3S-57E	1485 DF		6605 (875)		
	#1 Lanham						-5120		
		Sand					60' (7%)		
		Shale					210' (24%)		
		Carb.					605' (69%)		
2-T	Associated Oil Corp.		Pickett	3-A-54E	895 DF		4721 (203)		
	#1 Sells						-3826		
		Sand					0'		
		Shale					77' (38%)		
		Carb.					126' (62%)		
3-T	Ind. Farm Bureau		Scott	8-A-62E	1179 KB		6838 (697+)		
	#1 Ketchen Coal Co.						-5659		
		Sand					312' (45%)		
		Shale					316' (45%)		
		Carb.					69' (10%)		

W E S T V I R G I N I A W E L L D A T A

STATE	OPERATOR - FARM NAME		COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness
1-WV	Cyclops Corp.		Cabell	Union	667 KB	7964 (106)		8070 (405)	
	#1 Kingery Unit			District		-7297		-7403	
		Sand				0'		20' (5%)	
		Shale				85' (80%)		28' (7%)	
		Carb.				21' (20%)		375' (88%)	
2-WV	United Fuel Gas Co.		Mason	Clendenin	609 KB	8034 (83)		8117 (441)	
	#1 Arrington			District		-7425		-7508	
		Sand				0'		0'	
		Shale				10' (12%)		110' (25%)	
		Carb.				73' (88%)		331' (75%)	
3-WV	Hope Natural Gas Co.		Wood	Walker	1050 KB	12485 (505)		12990 (270)	12990 (270)
	#9634 Power Oil Co.			District		-11435		-11940	-11435
		Sand				27' (6%)		185' (68%)	184' (68%)
		Shale				73' (14%)		5' (2%)	5' (2%)
		Carb.				405' (80%)		81' (30%)	81' (30%)

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
2880 (530) -1921 111' (21%) 419' (79%) 0'			3410 (380) -2451 243' (64%) 137' (36%) 0'			3790 (130) -2831 98' (75%) 32' (25%) 0'	3920 (35+) -2961	3955 -2996
4800 (650) -4000 33' (5%) 617' (95%) 0'			5450 (885) -4650 585' (66%) 300' (34%) 0'			6335 (295) -5535 165' (56%) 121' (41%) 9' (3%)	6630 (173+) -5830	6806 -6006
3076 (560) -2196 67' (12%) 493' (88%) 0'			3636 (304) -2756 195' (64%) 109' (36%) 0'			3940 (60+) -3060 26' (43%) 34' (57%) 0'		4000 -3120

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
	6605 (875) -5120 60' (7%) 210' (24%) 605' (69%)			7480 (541+) -5995 384' (71%) 127' (23%) 30' (6%)				8021 -6536
	4721 (203) -3826 0' 77' (38%) 126' (62%)						4924 (893+) -4029	5817 -4922
	6838 (697+) -5659 312' (45%) 316' (45%) 69' (10%)							7535 -6356

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
7964 (106) -7297 0' 85' (80%) 21' (20%)		8070 (405) -7403 20' (5%) 28' (7%) 375' (88%)					8475 (76+) -7808	8551 -7884
8034 (83) -7425 0' 10' (12%) 73' (88%)		8117 (441) -7508 0' 110' (25%) 331' (75%)					8558 (77+) -7949	8635 -8026
12485 (505) -11435 27' (6%) 73' (14%) 405' (80%)		12990 (270) -11940 105' (68%) 5' (2%) 81' (30%)	12990 (270) -11435 184' (68%) 5' (2%) 81' (30%)			13260 (12) -12210 3' (25%) 6' (50%) 3' (25%)	13272 (59+) -12222	13331 -12281

K E N T U C K Y   W E L L   D A T A

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness
1-K	Ashland Oil Co.	Adair	24-I-54	858 KB	4983 (1063)			
	31 R.F. Tarter				-4125			
	Sand				0'			
	Shale				1007' (95%)			
	Carb.				56' (5%)			
2-K	United Fuel Gas Co.	Bell	5-C-71	1490 KB		8448 (1376)		
	#8801 J. Knuckles					-6958		
	Sand					100' (7%)		
	Shale					1130' (82%)		
	Carb.					146' (11%)		
3-K	Continental Oil Co.	Boone	5-DD-58	865 KB	2917 (294+)			
	#1 Snow				-2052			
	Sand				0'			
	Shale				277+'			
	Carb.				17'			
4-K	F.M. Ford	Boone	9-EE-58	908 KB	2870 (555)			3425 (269)
	#1 C. Conner				-1962			-2517
	Sand				0'			234' (87%)
	Shale				545' (98%)			35' (13%)
	Carb.				10' (2%)			0'
5-K	Inland Gas Co. Inc.	Boyd	21-W-82	652 Kb	6664 (198)		6862 (410)	7272 (404+)
	#529 F.O. White				-6012		-6210	-6620
	Sand				10' (5%)		0'	238' (59%)
	Shale				182' (92%)		0'	136' (34%)
	Carb.				6' (3%)		410' (100%)	30' (7%)
6-K	Inland Gas Co. Inc.	Boyd	11-V-81	862 KB		6504 (266)	6770 (545)	
	#533 Coalton Fee					-5642	-5908	
	Sand					20' (7%)	0'	
	Shale					223' (84%)	126' (23%)	
	Carb.					23' (9%)	419' (77%)	
7-K	Inland Gas Co. Inc.	Boyd	25-W-83	868 KB		7016 (256)	7272 (622)	
	#535 S. McKeand					-6148	-6404	
	Sand					26' (10%)	0'	
	Shale					206' (80%)	114' (18%)	
	Carb.					24' (10%)	508' (82%)	
8-K	Inland Gas Co. Inc.	Boyd	22-W-82	708 KB	6228 (156)		6384 (206)	
	#537 C.E. Fannin				-5520		-5676	
	Sand				10' (6%)		0'	
	Shale				140' (90%)		0'	
	Carb.				6' (4%)		206' (100%)	
9-K	United Fuel Gas Co.	Breathitt	13-H-75	762 KB		6732 (858)	7586 (1744)	
	#1 S.B. Williams					-5970	-6824	
	Sand					0'	0'	
	Shale					814' (95%)	744' (43%)	
	Carb.					40' (5%)	1000' (47%)	
10-K	Ashland Oil Co.	Campbell	25-DD-62	758 KB	2616 (537)			3153 (215)
	#1 H. Wilson				-1858			-2395
	Sand				32' (6%)			200' (93%)
	Shale				494' (92%)			15' (7%)
	Carb.				11' (2%)			0'
11-K	Ashland Oil Co.	Carter	12-V-77	956 KB	4758 (185)		4943 (245)	
	#1 W. Stapleton				-3832		-3987	
	Sand				24' (13%)		0'	
	Shale				151' (82%)		24' (10%)	
	Carb.				10' (5%)		221' (90%)	

ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
858 KB	4983 (1063) -4125 0' 1007' (95%) 56' (5%)				6046 (624) -5188 140' (22%) 484' (78%) 0'		6670 (7+) -5812 7' 0' 0'		6677 -5819
1490 KB		8448 (1376) -6958 100' (7%) 1130' (82%) 146' (11%)			9824 (210+) -8334 110' (52%) 100' (48%) 0'				10034 -8544
865 KB	2917 (294+) -2052 0' 277+' 17'								3211 -2346
908 KB	2870 (555) -1962 0' 545' (98%) 10' (2%)			3425 (269) -2517 234' (87%) 35' (13%) 0'				3694 (395+) -2786	4089 -3181
652 Kb	6664 (198) -6012 10' (5%) 182' (92%) 6' (3%)		6862 (410) -6210 0' 0' 410' (100%)	7272 (404+) -6620 238' (59%) 136' (34%) 30' (7%)					7676 -7024
862 KB		6504 (266) -5642 20' (7%) 223' (84%) 23' (9%)	6770 (545) -5908 0' 126' (23%) 419' (77%)		7315 (1033) -6453 397' (38%) 636' (62%) 0'	8348 (158) -7486 0' 118' (75%) 40' (25%)		8506 (1089+) -7644	9595 -8733
868 KB		7016 (256) -6148 26' (10%) 206' (80%) 24' (10%)	7272 (622) -6404 0' 114' (18%) 508' (82%)		7894 (1352 -7026 375' (28%) 947' (70%) 30' (2%)	9246 (139) -8378 0' 98' (71%) 41' (29%)		9385 (64+) -8517	9449 -8581
708 KB	6228 (156) -5520 10' (6%) 140' (90%) 6' (4%)		6384 (206) -5676 0' 0' 206' (100%)				6590 (122) -5882 24' (20%) 98' (80%) 0'	6712 (1116+) -6004	7828 -7120
762 KB		6732 (858) -5970 0' 814' (95%) 40' (5%)	7586 (1744) -6824 0' 744' (43%) 1000' (47%)		9330 (1260) -8568 197' (16%) 1063' (84%) 0'	10590 (266) -9828 0' 166' (62%) 100' (38%)	10856 (114) -10094 100' (88%) 14' (12%) 0'	10970 (160+) -10208	11130 -10368
758 KB	2616 (537) -1858 32' (6%) 494' (92%) 11' (2%)			3153 (215) -2395 200' (93%) 15' (7%) 0'			3368 (20) -2610 0' 20' (100%) 0'	3388 (216+) -2630	3604 -2846
956 KB	4758 (185) -3832 24' (13%) 151' (82%) 10' (5%)		4943 (245) -3987 0' 24' (10%) 221' (90%)				5188 (34) -4232 18' (53%) 16' (47%) 0'	5222 (29+) -4266	5251 -4295

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness
12-K	Inland Gas Co. Inc.	Carter	14-V-81	796 KB	6100 (198)		6298 (452)	6750 (154)
	#538 Coalton Fee				-5304		-5502	-5954
	Sand				16' (8%)		0'	28' (18%)
	Shale				172' (87%)		90' (20%)	126' (82%)
	Carb.				10' (5%)		362' (80%)	0'
13-K	Inland Gas Co. Inc.	Carter	22-U-79	808 KB		6460 (360)	6820 (1126)	
	#546 E. McDavid					-5652	-6012	
	Sand					0'	0'	
	Shale					340' (94%)	95' (8%)	
	Carb.					20' (6%)	1031' (92%)	
14-K	Monitor Petr. Co.	Carter	23-U-79	676 KB	6170 (366)		6536 (1200)	7736 (92+)
	#1 W.E. Robinson				-5494		-5860	-7060
	Sand				0'		25' (2%)	92' (100%)
	Shale				316' (86%)		425' (35%)	0'
	Carb.				50' (14%)		750' (63%)	0'
15-K	United Fuel Gas Co.	Carter	3-V-77	857 KB	4562 (188)		4750 (248)	
	#8807 L. Stamper				-3705		-3893	
	Sand				10' (5%)		0'	
	Shale				164' (87%)		22' (9%)	
	Carb.				14' (8%)		226' (91%)	
16-K	Ashland Oil Co.	Clark	16-S-65	949 KB	2685 (365)			
	#1 M.W. Miller				-1736			
	Sand				10' (3%)			
	Shale				321' (88%)			
	Carb.				34' (9%)			
17-K	Widener Oil Co.	Clark	18-R-66	918 KB		3630 (752)	4382 (307+)	
	#1 Glover					-2712	-3464	
	Sand					0'	65'	
	Shale					718' (95%)	80'	
	Carb.					34' (5%)	126'	
18-K	Texaco Inc.	Clark	9-Q-64	661 KB		3066 (575)	3641 (259)	
	#1 J. Williams					-2407	-2982	
	Sand					0'	0'	
	Shale					535' (93%)	45' (17%)	
	Carb.					40' (7%)	214' (83%)	
19-K	Algonquin	Clay	21-I-67	1187 KB		5786 (603+)		
	#1 B. Hubbard					-4599		
	Sand					0'		
	Shale					553'		
	Carb.					50'		
20-K	Monitor Petr. Co.	Elliott	8-T-79	686 KB		6364 (548)	6912 (1630)	
	#1 C. Ison					-5678	-6626	
	Sand					0'	0'	
	Shale					531' (97%)	107' (7%)	
	Carb.					17' (3%)	1523' (93%)	
21-K	Monitor Petr. Co.	Elliott	13-T-79	793 KB		6580 (536)	7116 (1803)	
	#1 I.T. Ison					-5787	-6323	
	Sand					0'	0'	
	Shale					519' (97%)	180' (10%)	
	Carb.					17' (3%)	1623' (90%)	
22-K	United Fuel Gas Co.	Elliott	22-T-76	968 KB	4786 (296)		5082 (104)	
	#8802-T J.H. Litton				-3813		-4114	
	Sand				8' (3%)		0'	
	Shale				272' (92%)		18' (17%)	
	Carb.				16' (5%)		86' (83%)	

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
6100 (198) -5304 16' (8%) 172' (87%) 10' (5%)		6298 (452) -5502 0' 90' (20%) 362' (80%)	6750 (154) -5954 28' (18%) 126' (82%) 0'			6904 (252) -6108 102' (41%) 150' (59%) 0'	7156 (106+) -6360	7262 -6466
	6460 (360) -5652 0' 340' (94%) 20' (6%)	6820 (1126) -6012 0' 95' (8%) 1031' (92%)		7946 (1668) -7138 614' (36%) 1071' (64%) 0'		9614 (366+) -8806 210' (57%) 156' (43%) 0'		9980 -9172
6170 (366) -5494 0' 316' (86%) 50' (14%)		6536 (1200) -5860 25' (2%) 425' (35%) 750' (63%)	7736 (92+) -7060 92' (100%) 0' 0'					7828 -7152
4562 (188) -3705 10' (5%) 164' (87%) 14' (8%)		4750 (248) -3893 0' 22' (9%) 226' (91%)				4998 (55) -4141 40' (73%) 15' (27%) 0'	5053 (32+) -4196	5085 -4228
2685 (365) -1736 10' (3%) 321' (88%) 34' (9%)						3050 (22) -2141 18' (82%) 4' (18%) 0'	3072 (353+) -2123	3425 -2475
	3630 (752) -2712 0' 718' (95%) 34' (5%)	4382 (307+) -3464 65' 80' 126'						4689 -3771
	3066 (575) -2407 0' 535' (93%) 40' (7%)	3641 (259) -2982 0' 45' (17%) 214' (83%)		3900 (866) -3239 362' (42%) 504' (58%) 0'			4766 (170+) -4105	4936 -4275
	5786 (603+) -4599 0' 553' 50'							6389 -5202
	6364 (548) -5678 0' 531' (97%) 17' (3%)	6912 (1630) -6626 0' 107' (7%) 1523' (93%)		8542 (1110+) -7856 772' (71%) 318' (29%) 0'				9652 -8966
	6580 (536) -5787 0' 519' (97%) 17' (3%)	7116 (1803) -6323 0' 180' (10%) 1623' (90%)		8920 (553+) -8127 233'+ (42%) 320'+ (58%) 0'				9473 -8680
4786 (296) -3813 8' (3%) 272' (92%) 16' (5%)		5082 (104) -4114 0' 18' (17%) 86' (83%)					5186 (209+) -4218	5394 -4427

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	To
23-K	Texaco, Inc. #1 G. Tipton Sand Shale Carb.	Estill	21-O-66	647 KB		4360 (902) -3713 0' 890' (99%) 12' (1%)	5262 (208) -4615 0' 20' (10%) 188' (90%)		547 -48 620 727 0
24-K	Signal Oil & Gas Co. #1 M. & P. Hall Hrs. Sand Shale Carb.	Floyd	1-L-81						
25-K	Clinton Oil Co. #1 G. Hale Sand Shale Carb.	Garrard	15-O-61	695 KB		3460 (957) -2765 0' 893' (93%) 64' (7%)			441 -37 355 764 0
26-K	L & M Gas Co. #1 C.B. Causey Sand Shale Carb.	Garrard	10-M-61	931 KB		4196 (1301+) -3265 0' 1257'+ 44'			
27-K	Patrick Petr. Co. #1 C.C. Broadus Sand Shale Carb.	Garrard	15-N-61	949 KB		3840 (1012) -2891 0' 958' (95%) 54' (5%)			485 -39 121 100 0
28-K	Texaco Inc. #1 L. Kirby Sand Shale Carb.	Garrard	8-O-59	972 KB		3684 (860) -2712 0' 782' (91%) 78' (9%)			454 -35 587 509 0
29-K	Widaner Oil Co. #1 A. Burdette Unit Sand Shale Carb.	Garrard	7-N-59	828 KB		3558 (842) -2730 0' 795' (94%) 47' (6%)			440 -35 46' 19' 0'
30-K	R.C. Ford, Jr. #1 E. Delaney Sand Shale Carb.	Grant	6-Y-60	847 KB	2865 (523) -1998			3388 (169+) -2521	
31-K	Moore Oil Co. #1 C. Perkins Sand Shale Carb.	Green	7-I-48	675 DF		5260 (126+) -4585 0' 126'+ 0'			
32-K	Commonwealth Gas Co. #771 D.P. Newell Sand Shale Carb.	Greenup	7-Z-78	1044 KB	4564 (199) -3520 0' 179' (90%) 20' (10%)		4763 (227) -3719 0' 0' 227' (100%)	4990 (136) -3946 61' (45%) 75' (55%) 0'	
33-K	DuPont Chemical Co. #1 (WAD) Fee Sand Shale Carb.	Jefferson	10-U-44	465 KB	4508 (570) -4043 0' 562' (99%) 8' (1%)			5078 (865) -4613 324' (37%) 541' (63%) 0'	

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
	4360 (902) -3713 0' 890' (99%) 12' (1%)	5262 (208) -4615 0' 20' (10%) 188' (90%)		5470 (1347+) -4823 620'+ (46%) 727'+ (54%) 0'				6817 -6170
								13035 -12335
	3460 (957) -2765 0' 893' (93%) 64' (7%)			4417 (1119+) -3722 355'+ (32%) 764'+ (68%) 0'				5536 -4841
	4196 (1301+) -3265 0' 1257'+ 44'							5497 -4566
	3840 (1012) -2891 0' 958' (95%) 54' (5%)			4852 (221+) -3903 121'+ (55%) 100'+ (45%) 0'				5073 -4124
	3684 (860) -2712 0' 782' (91%) 78' (9%)			4544 (1096) -3572 587' (54%) 509' (46%) 0'			5640 (105+) -4668	5745 -4773
	3558 (842) -2730 0' 795' (94%) 47' (6%)			4400 (65+) -3572 46'+ (71%) 19'+ (29%) 0'				4465 -3637
2865 (523) -1998			3388 (169+) -2521					3557 -2690
	5260 (126+) -4585 0' 126'+ 0'							5386 -4711
4564 (199) -3520 0' 179' (90%) 20' (10%)		4763 (227) -3719 0' 0' 227' (100%)	4990 (136) -3946 61' (45%) 75' (55%) 0'				5126 (67+) -4082	5193 -4149
4508 (570) -4043 0' 562' (99%) 8' (1%)			5078 (865) -4613 324' (37%) 541' (63%) 0'			5943 (11) -5478 4' (36%) 7' (64%) 0'	5954 (57+) -5489	6011 -5546

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness
34-K	Texaco Inc.	Jessamine	6-P-60	956 KB	2890 (392)			
	#1 T. Sherrer				-1934			
	Sand				0'			
	Shale				318' (81%)			
	Carb.				74' (19%)			
35-K	Texaco Inc.	Jessamine	1-P-60	972 KB		3508 (772)		
	#1 P. Wolfinbarger					-2536		
	Sand					0'		
	Shale					732' (95%)		
	Carb.					40' (5%)		
36-K	Kin-Ark Oil Co.	Jessamine	2-P-60	797 KB		3268 (998)		
	#1 A. Hager					-2471		
	Sand					0'		
	Shale					909' (91%)		
	Carb.					89' (9%)		
37-K	Wilson & Aker	Jessamine	16-Q-60	929 KB	3029 (156+)			
	#1 W. Hoover				-2100			
	Sand				0'			
	Shale				80'+			
	Carb.				76'			
38-K	US Signal Oil Co.	Johnson	7-P-82	737 KB		7683 (475)	8273 (3769)	
	#1 Elkhorn Coal Co.					-6946	-7536	
	Sand					0'	66' (2%)	
	Shale					394' (83%)	522' (14%)	
	Carb.					61' (17%)	3181' (84%)	
39-K	Columbia Gas Corp.	Johnson	10-R-79	939 KB		6594 (760)	7354 (2649+)	
	#9784-PIT, J.H. Evans					-5655	-6415	
	Sand					0'	0'	
	Shale					685' (90%)	250' (10%)	
	Carb.					75' (10%)	2399'+ (90%)	
40-K	H. Sober	Laurel	9-P-63	1171 KB		6664 (626+)		
	#3 Cumberland					-5493		
	Minerals Sand					0'		
	Shale					496 (79%)		
	Carb.					130 (21%)		
41-K	Inland Gas Co.	Lawrence	6-U-82	884 KB		7554 (352)	7906 (2724)	
	#1 W.P. Young					-6670	-7022	
	Sand					0'	0'	
	Shale					296' (84%)	670' (25%)	
	Carb.					56' (16%)	2054' (75%)	
42-K	United Fuel Gas Co.	Leslie	8-I-73	1191 KB		7192 (794)		
	#8437 Fordson Coal Co.					-6001		
	Sand					12' (2%)		
	Shale					700' (88%)		
	Carb.					82' (10%)		
43-K	Ashland Oil Co.	Lewis	13-Y-77	1113 KB	4450 (240)		4654 (332)	
	#1 D. Wolfe				-3337		-3541	
	Sand				0'		21' (6%)	
	Shale				178' (87%)		0'	
	Carb.				26' (13%)		311' (94%)	
44-K	R. Thomas	Lewis	13-Y-76	560 KB	3620 (220)		3840 (320)	
	#1 D. Adams				-3060		-3280	
	Sand				0'			
	Shale				190' (86%)			
	Carb.				30' (14%)			

TION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
KB	2890 (392) -1934 0' 318' (81%) 74' (19%)							3282 (2518+) -2326	5800 -4844
2 KB		3508 (772) -2536 0' 732' (95%) 40' (5%)			4280 (1710) -3308 1180' (69%) 530' (31%) 0'			5990 (82+) -5018	6072 -5100
7 KB		3268 (998) -2471 0' 909' (91%) 89' (9%)			4266 (678+) -3469 472'+ (70%) 206'+ (30%) 0'				4944 -4147
9 KB	3029 (156+) -2100 0' 60'+ 76'								3185 -2256
7 KB		7683 (475) -6946 0' 394' (83%) 61' (17%)	8273 (3769) -7536 66' (2%) 522' (14%) 3181' (84%)		12042 (1948) -11305 837' (43%) 875' (45%) 236' (12%)		13990 (305) -13253 80' (26%) 225' (74%) 0'	14295 (200+) -13558	14495 -13758
9 KB		6594 (760) -5655 0' 685' (90%) 75' (10%)	7354 (2649+) -6415 0' 250' (10%) 2399'+ (90%)						10003 -9064
71 KB		6664 (626+) -5493 0' 496 (79%) 130 (21%)							7290 -6119
KB		7554 (352) -6670 0' 296' (84%) 56' (16%)	7906 (2724) -7022 0' 670' (25%) 2054' (75%)		10630 (1548) -9746 455' (29%) 1093' (71%) 0'		12178 (345) -11294 104' (30%) 242' (70%) 0'	12524 (188+) -11640	12712 -11828
91 KB		7192 (794) -6001 12' (2%) 700' (88%) 82' (10%)			7986 (996) -6795 175' (18%) 821' (82%) 0'	8982 (170) -7791 0' 94' (55%) 76' (45%)	9152 (258) -7961 128' (50%) 130' (50%) 0'	9410 (22+) -8219	9432 -8241
13 KB	4450 (240) -3337 0' 178' (87%) 26' (13%)		4654 (332) -3541 21' (6%) 0' 311' (94%)				4986 (38) -3873 38' (100%) 0' 0'	5024 (58+) -3911	5082 -3969
0 KB	3620 (220) -3060 0' 190' (86%) 30' (14%)		3840 (320) -3280				4160 (15) -3600 15' (100%) 0' 0'	4175 (15+) -3615	4190 -3630

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickne
45-K	United Fuel Gas Co.	Lewis	19-W-75	915 KB	4035 (240)		4275 (210)	
	#9060-T, A. Shepherd				-3120		-3360	
	Sand				0'		0'	
	Shale				215' (90%)		30' (14%)	
	Carb.				25' (10%)		180' (86%)	
46-K	California Co.	Lincoln	13-L-57	1138 KB		4240 (882)		
	#1 A.R. Spears					-3120		
	Sand					0'		
	Shale					838' (95%)		
	Carb.					44' (5%)		
47-K	Rome Oil & Gas Co.	Lincoln	13-M-58	1032 KB		4364 (1026)		
	#1 Foster-Morrow Unit					-3332		
	Sand					0'		
	Shale					1000' (97%)		
	Carb.					46' (3%)		
48-K	Texaco Inc.	Madison	11-P-61	951 KB		3563 (851)		
	#1 B. Perkins					-2612		
	Sand					0'		
	Shale					793' (93%)		
	Carb.					58' (7%)		
49-K	United Fuel Gas Co.	Martin	19-Q-84	659 KB		8374 (606	8980 (3482)	
	#8610-T, J.James					-7871	-8321	
	Sand					0'	0'	
	Shale					450' (74%)	422' (12%)	
	Carb.					156' (26%)	3060' (88%)	
50-K	United Fuel Gas Co.	Mason	15-Y-71	769 KB	2740 (183)		2923 (334)	
	#9061-T, W. Rawlings				-1971		-2154	
	Sand				0'		8' (2%)	
	Shale				163' (89%)		142' (43%)	
	Carb.				20' (11%)		184' (55%)	
51-K	United Fuel Gas Co.	Menifee	21-S-72	989 KB		4418 (442)	4860 (315)	
	#9380-T, F. Brown					-3429	-3871	
	Sand					0'	0'	
	Shale					434' (99%)	40' (13%)	
	Carb.					8' (1%)	275' (87%)	
52-K	Monitor Petr. Co.	Menifee	14-Q-72	1128 KB		4940 (635)	5450 (332)	
	#1 Campbell					-3812	-4322	
	Sand					0'	10' (3%)	
	Shale					587' (92%)	82' (25%)	
	Carb.					48' (8%)	240' (72%)	
53-K	Benz Oil Co.	Metcalfe	16-P-46	766 KB		5212 (486)		
	#1 C. Nunnally					-4446		
	Sand					0'		
	Shale					366' (75%)		
	Carb.					120' (25%)		
54-K	Ferguson & Bosworth	Montgomery	8-R-67	989 KB	3464 (636)		4100 (312)	
	#1 A. Potter				-2475		-3111	
	Sand				0'		0'	
	Shale				587' (92%)		55' (18%)	
	Carb.				49' (8%)		257' (82%)	
55-K	Monitor Pet Co.	Morgan	23-R-73	996 KB		4838 (286)	5124 (152)	
	#1 B. Blanton					-3842	-4128	
	Sand					0'	0'	
	Shale					127' (44%)	152' (100%)	
	Carb.					15[illegible]' (56%)	0'	

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
4035 (240) -3120 0' 215' (90%) 25' (10%)		4275 (210) -3360 0' 30' (14%) 180' (86%)				4485 (50) -3570 50' (100%) 0' 0'	4535 (15+) -3620	4550 -3635
	4240 (882) -3120 0' 838' (95%) 44' (5%)			5122 (548) -3984 173' (32%) 375' (68%) 0'		5670 (86) -4532 23' (27%) 63' (73%) 0'	5756 (36+) -4618	6117 -4979
	4364 (1026) -3332 0' 1000' (97%) 46' (3%)			5390 (391+) -4358 170'+(43%) 221'+(57%) 0'				5781 -4749
	3563 (851) -2612 0' 793' (93%) 58' (7%)			4414 (1853) -3463 845' (46%) 1008' (54%) 0'		6267 (96) -5316 22' (23%) 74' (77%) 0'	6363 (56+) -5412	6419 -5468
	8374 (606 -7871 0' 450' (74%) 156' (26%)	8980 (3482) -8321 0' 422' (12%) 3060' (88%)		12462 (710+) -11803 710'+ (100%)				13172 -12513
2740 (183) -1971 0' 163' (89%) 20' (11%)		2923 (334) -2154 8' (2%) 142' (43%) 184' (55%)				5257 (17) -2488 10' (59%) 7' (41%) 0'	3274 (40+) -2505	3314 -2545
	4418 (442) -3429 0' 434' (99%) 8' (1%)	4860 (315) -3871 0' 40' (13%) 275' (87%)		5175 (460) -4186 216' (47%) 244' (53%) 0'		5635 (155) -4646 139' (90%) 16' (10%) 0'	5790 (68+) -4801	5858 -4869
	4940 (635) -3812 0' 587' (92%) 48' (8%)	5450 (332) -4322 10' (3%) 82' (25%) 240' (72%)		5782 (480) -4654 180'(37%) 300'(63%) 0'		6262 (450) -5134 130' (29%) 320' (71%) 0'	6712 (67+) -5584	6779 -5651
	5212 (486) -4446 0' 366' (75%) 120' (25%)			5689 (162) -4932 0' 18' (11%) 144' (89%)		5860 (24) -5094 24' (100%) 0' 0'	5884 (230+) -5118	6114 -5348
3464 (636) -2475 0' 587' (92%) 49' (8%)		4100 (312) -3111 0' 55' (18%) 257' (82%)				4412 (42) -3423 16' (38%) 26' (62%) 0'	4454 (27+) -3465	4481 -3492
	4838 (286) -3842 0' 127' (44%) 159' (56%)	5124 (152) -4128 0' 152' (100%) 0'		5276 (752) -4280 218' (29%) 313' (50%) 158' (21%)		6028 (284) -5032 71' (25%) 213' (75%) 0'	6312 (1292+) -5316	7604 -6608

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickne
56-K	Ashland Oil Co.	Morgan	14-S-75	789 KB	4639 (352)		4991 (238)	5229 (196)
	#1 Lee Clay Products				-3850		-4202	-4440
	Sand				0'		0'	65' (33%)
	Shale				337' (96%)		40' (17%)	131' (67%)
	Carb.				15' (4%)		198' (83%)	0'
57-K	Monitor Petr. Co.	Morgan	3-R-78	821 KB		6276 (622)	6898 (3114+)	
	#1 F. Ison					-5455	-6077	
	Sand					0'	0'	
	Shale					587' (94%)	855' (27%)	
	Carb.					35' (6%)	2259' (73%)	
58-K	Monitor Petr. Co.	Morgan	18-Q-74	819 KB		5296 (446)	5742 (920)	
	#1 Stacy Heirs					-4477	-4923	
	Sand					0'	212' (23%)	
	Shale					290' (65%)	395' (43%)	
	Carb.					156' (35%)	313' (34%)	
59-K	US Signal 1972 Co.	Pike	8-L-85	1199 KB		9231 (211)	9442 (1707)	
	#1 H. Stratton					-8032	-8243	
	Sand					10' (5%)	0'	
	Shale					175' (83%)	386' (23%)	
	Carb.					26' (12%)	1321' (77%)	
60-K	South Central Petr. Co.	Powell	8-P-67	757 KB		4190 (898)	5088 (228)	
	#1 J. Hall					-3433	-4331	
	Sand					210' (23%)	29' (30%)	
	Shale					678' (76%)	0'	
	Carb.					10' (1%)	159' (70%)	
61-K	Amerada-Hess Corp.	Pulaski	14-H-59	1062 KB		5162 (856)		
	#1 H. Daulton					-4100		
	Sand					0'		
	Shale					820' (96%)		
	Carb.					36' (4%)		
62-K	Amerada-Hess Corp.	Pulaski	24-H-60	968 KB		5757 (1643)		
	#1 R. Edwards					-4789		
	Sand					0'		
	Shale					1607' (98%)		
	Carb.					36' (2%)		
63-K	Henderson Oil Co.	Rowan	19-U-72	737 KB	3350 (320)		3670 (84)	
	#1 W.Y. Bailey				-2613		-2933	
	Sand				0'		0'	
	Shale				303' (95%)		26' (31%)	
	Carb.				17' (5%)		58' (69%)	
64-K	Pennzoil Inc.	Rowan	4-T-75	1199 KB	4562 (280)		4842 (98)	
	#1 C. Jones				-3363		-3643	
	Sand				0'		0'	
	Shale				268' (96%)		24' (24%)	
	Carb.				12' (4%)		74' (76%)	
65-K	Kentucky Central	Rowan	21-T-74	1240 KB	4582 (286)		4868 (97)	
	#1 Perkins				-3342		-3628	
	Sand				0'		0'	
	Shale				274' (96%)		12' (12%)	
	Carb.				12' (4%)		85' (88%)	

EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
4639 (352) -3850 0' 337' (96%) 15' (4%)		4991 (238) -4202 0' 40' (17%) 198' (83%)	5229 (196) -4440 65' (33%) 131' (67%) 0'			5425 (115) -4636 27' (23%) 88' (77%) 0'	5540 (217+) -4751	5757 -4968
	6276 (622) -5455 0' 587' (94%) 35' (6%)	6898 (3114+) -6077 0' 855' (27%) 2259' (73%)						10012 -9191
	5296 (446) -4477 0' 290' (65%) 156' (35%)	5742 (920) -4923 212' (23%) 395' (43%) 313' (34%)		6662 (706) -5843 170' (24%) 536' (76%) 0'	7368 (23) -6549 23' (100%)	7392 (73) -6573 19' (25%) 54' (75%) 0'	7465 (409+) -6646	7874 -7055
	9231 (211) -8032 10' (5%) 175' (83%) 26' (12%)	9442 (1707) -8243 0' 386' (23%) 1321' (77%)		11149 (719) -9950 55' (6%) 664' (94%) 0'	11868 (500) -10669 106' (22%) 317' (63%) 77' (15%)	12368 (102+) -11169 10' (19%) 82' (81%) 0'		12470 -11271
	4190 (898) -3433 210' (23%) 678' (76%) 10' (1%)	5088 (228) -4331 29' (30%) 0' 159' (70%)		5316 (765+) -4559 477' (62%) 288' (38%) 0'				6081 -5324
	5162 (856) -4100 0' 820' (96%) 36' (4%)			6018 (552) -4956 130' (24%) 422' (76%) 0'		6570 (96) -5508 55' (57%) 41' (43%) 0'	6666 (56+) -5604	6722 -5660
	5757 (1643) -4789 0' 1607' (98%) 36' (2%)			7400 (1304) -6432 174' (13%) 1130' (87%) 0'		8704 (130) -7736 77' (59%) 53' (41%) 0'	8834 (22+) -7866	8856 -7888
3350 (320) -2613 0' 303' (95%) 17' (5%)		3670 (84) -2933 0' 26' (31%) 58' (69%)				3754 (24) -3017 24' (100%) 0' 0'	3778 (22+) -3041	3800 -3063
4562 (280) -3363 0' 268' (96%) 12' (4%)		4842 (98) -3643 0' 24' (24%) 74' (76%)				4940 (27) -3741 27' (100%) 0' 0'	4967 (24+) -3768	4991 -3792
4582 (286) -3342 0' 274' (96%) 12' (4%)		4868 (97) -3628 0' 12' (12%) 85' (88%)					4965 (9+) -3725	4974 -3734

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
66-K	Exxon Corporation #1 Orville Banks Sand Shale Carb.	Wolfe	13-O-74	1058 KB		6619 (958) -5561 0' 651' (68%) 307' (32%)	7577 (1819) -6519 0' 1299' (71%) 520' (29%)		9396 (2464) -8338 616' (24%) 1848' (76%) 0'		11860 (394) -10802 79' (20%) 315' (80%) 0'	12254 (34+) -11196	12288 -11230
67-K	Monitor Petr. Co. #1 S. Neeley Sand Shale Carb.	Jackson	12-L-67	1355 KB		6158 (552) -4803 0' 342' (62%) 210' (38%)	6710 (1057) -5355 0' 320' (30%) 737' (70%)		7767 (1168) -6412 0' 580' (50%) 588' (50%)	8935 (215) -7580 0' 0' 215' (100%)	9150 (1055+) -7795 211' (20%) 844' (80%) 0'		10205 -8850
68-K	Cities Service Oil #1 A. Garrett Sand Shale Carb.	Casey	7-I-57	1242 KB		5180 (1745) -3938			6925 (1087) -5683		8012 (153) -6770	8165 (97+) -6923	8262 -7020

OHIO WELL DATA

STATE	OPERATOR - FARM NAME	COUNTY	LOCATION	ELEVATION	EAU CLAIRE Top Thickness	NOLICHUCKY Top Thickness	ELBROOK Top Thickness	MT. SIMON Top Thickness	ROME Top Thickness	SHADY Top Thickness	BASAL ARKOSE Top Thickness	PRECAMBRIAN Top Thickness	TOTAL DEPTH
1-O	Commonwealth Gas Corp.	Adams	Jefferson	624 KB	3132 (130)		3262 (306)	3440 (160) tongue			3728 (44)	3772 (57+)	3829
	#1 George Covert		VMSL 4040		-2516		-2638	-2816			-3104	-3148	-3205
	Sand				0'		0'	73' (46%)			44' (100%)		
	Shale				110' (86%)		159' (52%)	87' (54%)			0'		
	Carb.				20' (14%)		147' (48%)	0'			0'		
2-O	Armco Steel Corp.	Butler	Lemon Twp.	667 KB	2364 (616)			2980 (185)			3165 (75)	3240 (56+)	3296
	#1 Fee		Sec.8		-1697			-2313			-2498	-2573	-2629
	Sand				29' (5%)			105' (57%)			30' (40%)		
	Shale				557' (90%)			80' (43%)			45' (60%)		
	Carb.				30' (5%)			0'			0'		
3-O	Continental Oil Corp.	Clermont	Stonelick	817 KB	2528 (596)			3124 (171)			3295 (33)	3328 (107+)	3435
	#1 C. Wikoff		VMSL 681		-1711			-2307			-2478	-2511	-2618
	Sand				20' (3%)			125' (73%)			24' (73%)		
	Shale				547' (92%)			46' (27%)			9' (27%)		
	Carb.				29' (5%)			0'			0'		
4-O	Kewanee Oil Corp.	Fayette	Union Twp	965 KB	2790 (318)		3108 (192)	3320 (200)			3520 (28)	3548 (1160+)	4708
	#1 Hopkins		VMSL 663		-1825		-2143	-2355			-2555	-2583	-3743
	Sand				116' (36%)		0'	180' (90%)			10' (35%)		
	Shale				202' (64%)		0'	20' (10%)			18' (65%)		
	Carb.				0'		192' (100%)	0'			0'		
5-O	Dunigan	Hocking	Starr Twp	970 KB	5870 (95)		5965 (403)				6368 (92)	6460 (28+)	648C
	#1 Hockman		Sec 31		-4900		-4995				-5398	-5490	-5518
	Sand				32' (34%)		0'				44' (48%)		
	Shale				63' (66%)		36' (9%)				48' (52%)		
	Carb.				0'		367' (91%)				0'		
6-O	Halbert	Jackson	Franklin Twp	816 KB	5592 (145)		5737 (205)	5942 (225)			6167 (50)	6217 (91+)	6308
	#1 Wood		Sec 23		-4776		-4921	-5126			-5351	-5401	-5492
	Sand				22' (15%)		0'	70' (31%)			18' (36%)		
	Shale				123' (85%)		10' (5%)	135' (69%)			32' (64%)		
	Carb.				0'		195' (95%)	0'			0'		
7-O	Amerada Oil Corp.	Noble	Elk Twp	1035 KB	10535 (120)		10655 (572)	11227 (108)			11335 (75)	11410 (32+)	11442
	#1 Ullman		Sec 31		-9500		-9620	-10192			-10300	-10375	-10407
	Sand				50' (42%)		0'	86' (80%)			45' (60%)		
	Shale				55' (46%)		29' (5%)	22' (20%)			30' (40%)		
	Carb.				15' (12%)		543' (95%)	0'			0'		
8-O	US Steel Chemicals Co.	Sciota	Green Twp	557 KB	5076 (144)		5220 (302)				5522 (58)	5580 (28+)	5608
	#1 Fee				-4519		-4663				-4965	-5023	-5051
	Sand				20' (14%)		0'				43' (74%)		
	Shale				118' (82%)		24' (8%)				0'		
	Carb.				6' (4%)		278' (92%)				15' (26%)		