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DEPARTMENT OF REGISTRATION AND EDUCATION

STRUCTURAL FRAMEWORK OF SOUTHERNMOST ILLINOIS

Charles A. Ross

ILLINOIS STATE GEOLOGICAL SURVEY
John C. Frye, *Chief* URBANA

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ABSTRACT

New observations from field relations and surface and subsurface data in southernmost Illinois suggest that several episodes of recurrent faulting along the fault system cutting the Paleozoic rocks have displaced Cretaceous and younger strata. Isopachous and structural contour maps of post-Paleozoic sediments and a pre-Cretaceous geologic map based on the available data suggest that a late Cretaceous episode of renewed faulting caused the downward displacement of the America Graben and the Dixon Springs Graben. Another episode of faulting caused additional downward movement on the America Graben after Eocene deposition. Faulting and associated earthquakes along this system of faulting in historic times suggest that some anomalies in the "Lafayette" Gravel may be the result of continued warping and faulting in this area. This study suggests that the surface upon which the Cretaceous was deposited was one of relatively low relief and that the present relief is largely the result of later movements of the faulted blocks of Paleozoic rocks underlying the area.

INTRODUCTION

The tip of Illinois south of the broad valley drained by Cache Creek and Bay Creek (fig. 1) is an area where the resistant Paleozoic rocks that dominate the geology of the area to the north are covered by a relatively thin veneer of younger, unconsolidated strata that are part of the Mississippi Embayment sediments that thicken southward. Thus, the southernmost tip of Illinois is of considerable geological interest because it is the meeting ground of these two distinctly different kinds of sediments of which the younger unconsolidated sediments are not found farther north in Illinois. However, the repeated faulting and buckling that can be interpreted from the younger sediments in southernmost Illinois appear to be directly related to the structural framework of the Illinois-Kentucky Fluorspar District that lies to the northeast and to the zone of faulting that cuts across the southern end of the petroleum-rich Illinois Basin.

The southern tip of Illinois is covered by unconsolidated sands and clays of late Cretaceous and early Tertiary age (Lamar and Sutton, 1930; Pryor, 1960; Pryor and Glass, 1961; Pryor and Ross, 1962) that form the head of the Mississippi Embayment (fig. 2). This embayment is along a broad, nearly symmetrical syncline, called the Embayment Syncline, that plunges toward the Gulf of Mexico and that lies between the Nashville Dome on the east and the Ozark Uplift on the west. It extends across the Pascola Arch, and its northern boundary laps onto the southern end of the Illinois Basin. The Embayment Syncline is the youngest of the major tectonic features in this area and dates from late Cretaceous time. It is bounded on the south by the Monroe Uplift and Jackson Dome. The Embayment sediments conceal a beveled northwest trending structural arch of late Paleozoic age to which the name Pascola Arch (Grohskopf, 1955) is ascribed and which connects the Ozark Uplift and the Nashville Dome.

The Embayment sediments form a wedge of deposits that thicken southward from an erosional edge in southern Illinois to more than 3000 feet near Memphis, Tennessee (Stearns, 1958; Stearns and Marcher, 1962). These shallow marine sediments originally extended a few miles farther northward, but they have been eroded to their present position and are now found at elevations as high as 500 feet above sea level in southernmost Illinois. This implies considerable uplift of the Mississippi Embayment area since deposition of the sediments.

In this report several working hypotheses that generally have been followed in earlier interpretations of the northern part of the Mississippi Embayment Area and the southern part of Illinois are reexamined. The first of these hypotheses holds that the faults cutting the Paleozoic rocks in southern Illinois are post-Pennsylvanian—pre-late Cretaceous in age and that the Cretaceous rocks are not

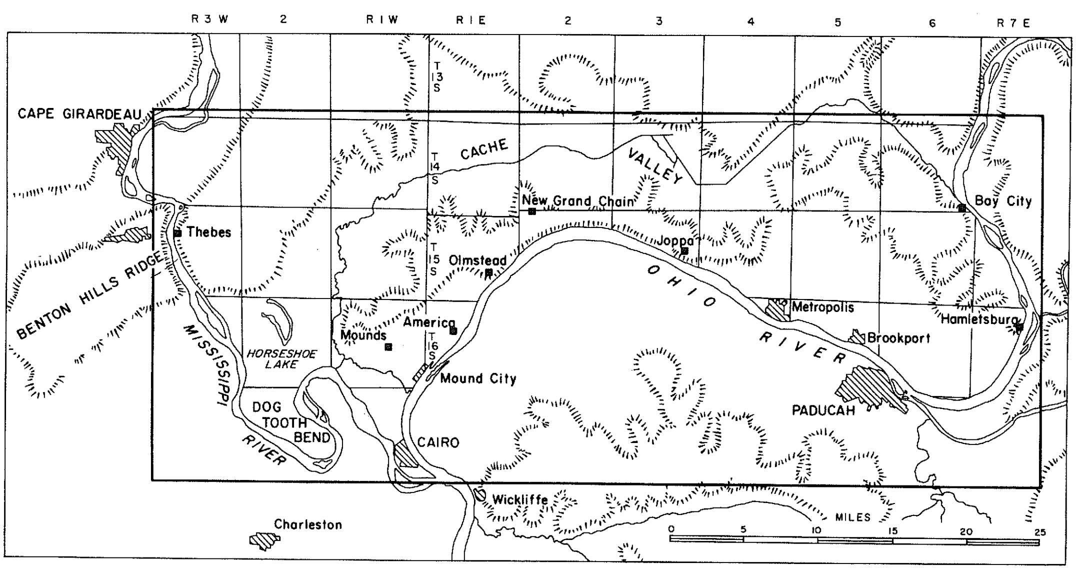

Fig. 1 - Physiographic map of the southern tip of Illinois and adjacent areas showing the uplands. The portion of Illinois outlined by rectangle is area in which exposures and well records were studied for this report.

faulted. If there has been renewed movement along some of these faults, as is suggested in this report, a second hypothesis that holds that the relief on the sub-Cretaceous surface is entirely pre-Cretaceous erosional relief also needs to be reexamined. It is suggested here that much of the relief is related to faulting which postdates the deposition of the Cretaceous and which, in part, postdates the deposition of the Eocene.

As shown by Moneymaker (1960, p. 2022), Stearns and Marcher (1962, p. 1939), and McGinnis (1963), the Mississippi Valley from Cairo southward to Memphis (essentially the axis of the Embayment Syncline) has been the site of numerous recorded earthquakes, and locally, as near Reelfoot Lake, faults have displaced Recent alluvial terraces (Fuller, 1919). The implications, when viewed in the light of the structure of southern Illinois, suggest that the fault system, which cuts the Paleozoic strata at the head of the Embayment, extends for a considerable distance southwestward beneath the Embayment sediments and has remained active to the present. This suggests the possibility that some of the locally anomalous levels

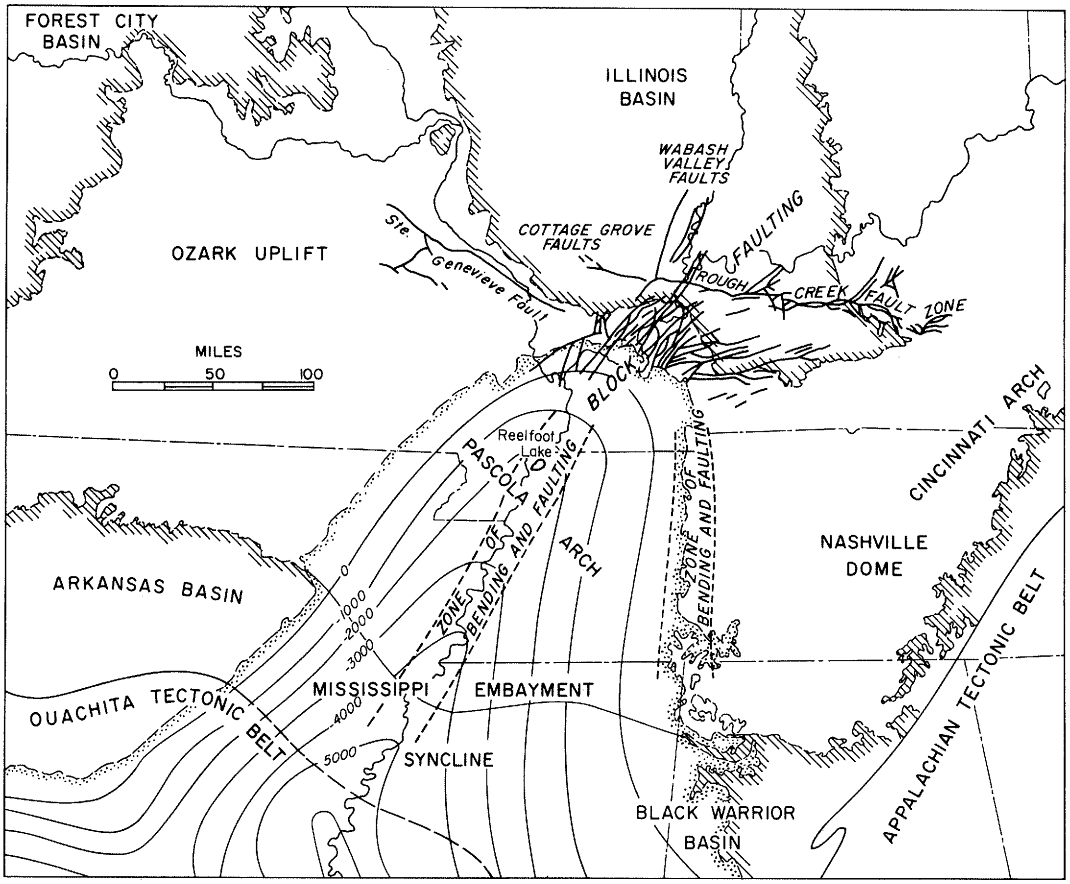

Fig. 2 - Generalized tectonic and structural map of the Mississippi Embayment area and adjacent tectonic features. (Adapted from the "Tectonic Map of the United Ststes," 1962). Zones of bending and faulting within the Embayment Syncline are those suggested by Stearns and Marcher, 1962, p. 1391. Diagonal shading outlines area of Pennsylvanian outcrops.

of the "Lafayette" Gravels may also be the result of renewed movements along part of this fault system.

Acknowledgments

This study is partly an outgrowth of recent quadrangle mapping in the Paducah and Smithland Quadrangles (Ross, in preparation), and the Illinois parts of the Cairo, LaCenter, and Thebes Quadrangles (Pryor and Ross, 1962), which together form the five southern quadrangles in Illinois. I am indebted to J. C. Frye and H. B. Willman for their enthusiasm, valuable suggestions, and pertinent discussion concerning many of the various problems and questions connected with the study. I am grateful also to Elwood Atherton, J. E. Lamar, J. W. Baxter, and D. H. Swann for many helpful discussions about the stratigraphy of the area, and to W. A. Pryor, Gulf Research Corporation, T. W. Lambert, U. S. Geological Survey, and G. A. Desborough, University of Wisconsin, for helpful discussion during the field work. B. C. Moneymaker, Tennessee Valley Authority, kindly made available test boring information for a number of areas along the Ohio River.

STRATIGRAPHY

The general stratigraphic succession of southernmost Illinois is shown in figure 3. In contrast, the Paleozoic rocks that underlie the unconsolidated Cretaceous and younger sediments are competent strata that form the "basement" of the north end of the Mississippi Embayment. Cambrian and early Ordovician (Canadian) rocks are penetrated by only a few wells in southernmost Illinois and their distribution and stratigraphy is not thoroughly known. They are believed to be 4000 to 4500 feet in combined thickness and are overlain by almost 5600 feet of younger Ordovician, Silurian, Devonian, and Mississippian strata. The overlying Cretaceous strata are locally about 500 feet thick, and the early Tertiary strata are locally about 400 feet thick. The late Tertiary (Pliocene) gravels may reach 50 feet in thickness, and the Quaternary Pleistocene valley-fill deposits are locally 250 feet thick.

Paleozoic Strata

Ordovician System

The oldest strata encountered beneath the Cretaceous in southernmost Illinois belong to the Kimmswick Limestone of the Champlainian Series. The Kimmswick is composed of coarse, light-colored fossil fragments in a coarsely crystalline calcite cement, and it has thin bands of dark chert (Pryor and Ross, 1962, p. 4). Overlying the Kimmswick is the finer-grained Cape Limestone that is 8 to 10 feet thick in its outcrop area along the Mississippi River bluffs. The Cape Limestone passes conformably upwards into 150 to 220 feet of shale and siltstone of the Maquoketa Group, which forms the top of the Cinncinnatian Series in this area.

SYSTEM	SERIES	GROUP	FORMATION	THICKNESS
QUATERNARY	PLEISTOCENE			0-250
TERTIARY	PLIOCENE		"LAFAYETTE"	0- 50
	EOCENE		WILCOX	50-250
	PALEOCENE		PORTERS CREEK CLAYTON	50-170
CRETACEOUS	GULFIAN		OWL CREEK McNAIRY (Leving's mbr.)	120-490
			TUSCALOOSA	0- 20
MISSISSIPPIAN			LITTLE BEAR SOIL	
	CHESTERIAN		(formations not differentiated in this report)	1000
	VALMEYERAN	MERAMEC	STE. GENEVIEVE	200
			ST. LOUIS	350-400
			SALEM	600-700
		OSAGE	HARRODSBURG-FT. PAYNE-BORDEN (undifferentiated)	600-800
	KINDERHOOKIAN		NEW ALBANY	80-300
DEVONIAN	UPPER			
	MIDDLE		ALTO-LINGLE	0- 50
			GRAND TOWER	0-120
			DUTCH CREEK	0- 10
			CLEAR CREEK	300
	LOWER		BAILEY	350-700
SILURIAN	NIAGARAN		MOCCASIN SPRINGS	110-150
			ST. CLAIR	20- 50
	ALEXANDRIAN		SEXTON CREEK	20- 60
			EDGEWOOD	0- 15
			GIRARDEAU	0- 30
ORDOVICIAN	CINCINNATIAN	MAQUOKETA	SCALES CAPE	150-220
	CHAMPLAINIAN		KIMMSWICK	100-130
			PLATTIN	600-850
			JOACHIM	240-360
			DUTCHTOWN	130-160
			ST. PETER	0-150
			EVERTON	90-150

LITHOLOGY

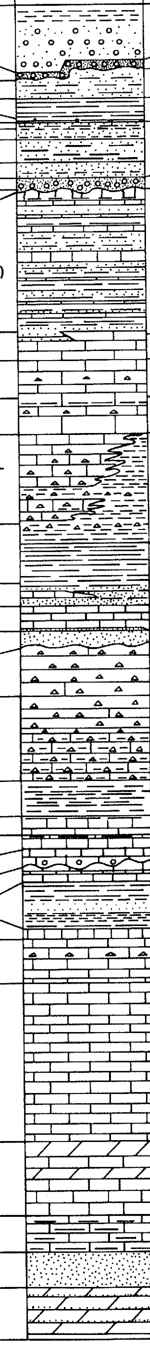

Fig. 3 - Sequence of strata underlying southernmost Illinois.

Silurian System

The lowest formation of the Silurian Alexandrian Series is the Girardeau Limestone, a very fine-grained, sublithographic limestone that is medium gray and grades downward into the underlying Maquoketa Group. The Girardeau is irregular in distribution and forms lenses on the top of the underlying Maquoketa Group. The Girardeau is assigned to the Silurian on the basis on Savage's (1913) study of its fauna (Pryor and Ross, 1962, p. 10).

The Edgewood Formation lies unconformable above the Girardeau and thickens and thins from 0 to 15 feet filling depressions on an irregular erosional surface. The Edgewood is a silty and dolomitic limestone. Overlying and locally overlapping the Edgewood are 20 to 50 feet of dolomitic, cherty, fine-grained, fossil-debris limestone of the Sexton Creek Formation. This widespread unit commonly contains glauconite and green shale partings.

The Niagaran Series is divided into the St. Clair Limestone at the base and the Moccasin Springs Formation above. In the area of outcrop along the Mississippi River bluffs, the St. Clair is a 50- to 80-foot, pink to red, fine-grained limestone and shale containing fossil fragments and is separated from the underlying Sexton Creek Limestone by a 1- to 6-inch bed of green silty shale. The upper part of the St. Clair consists of 30 to 40 feet of red-brown and green-gray calcareous shales and shaly limestone. The overlying Moccasin Springs Formation is a green calcareous shale about 100 feet thick with limestone lenses in its upper part. It passes conformably through several feet of transitional beds into the overlying early Devonian Bailey Limestone.

Devonian System

In the western part of the area the Lower Devonian is made up of the Bailey Limestone, a limestone with considerable amounts of siliceous silt and interbedded siltstone and chert (Lamar, 1953; Pryor and Ross, 1962). It reaches 350 to 700 feet in thickness and passes gradationally into the overlying Clear Creek Chert. In outcrop, particularly near the major fault zones, the Bailey is silicified and little limestone remains. The Middle Devonian Clear Creek Chert has more massive chert beds and is about 300 feet thick. The Backbone Limestone, which farther north near Grand Tower separates this chert from the underlying massive cherty upper part of the Bailey Formations, is absent in the southern part of the outcrop belt, and the name Clear Creek is commonly applied to the entire succession of massive-bedded cherts in many well sample studies in Alexander and Pulaski Counties.

The Dutch Creek Sandstone is up to 10 feet thick and has a major unconformity at its base. It passes upward into the Grand Tower Limestone, which is gray massive-bedded, and 120 feet thick. The subsurface distribution of the Grand Tower is not thoroughly known in southernmost Illinois. It thins southward from its type area, apparently as a result of erosion, and is missing in the outcrop belt south of Jonesboro. However, it is present in some wells in the LaCenter and Paducah Quadrangles to the southeast. Above the Grand Tower in outcrops in the western part of the area, thin shale, sandstone, and limestone, which may reach 50 feet in thickness, are complexly intertongued in the Alto-Lingle Formation. In the LaCenter and Paducah Quadrangles, well records indicate that the Alto-Lingle thickens to as much as 80 feet. The Upper Devonian includes most of the New Albany Shale Formation (Workman and Gillette, 1956), which thickens eastward from about 80 feet in the outcrop belt to over 300 feet in the Paducah Quadrangle.

Mississippian System

The early Mississippian Kinderhookian Series is thin, about 5 feet thick, and includes the upper part of the New Albany Shale and the thin, brown, silty, dolomitic Chouteau Limestone (Buschbach, 1952). The lower part of the middle Mississippian Valmeyeran Series, the Osage Group, consists of three intertonguing and gradational rock types: the shaly, calcareous, siliceous Borden Siltstone at the base; the silty, calcareous Ft. Payne Chert; and the light gray, crinoidal-fragmental Harrodsburg Limestone. This sequence thickens from about 600 feet in the western outcrop belt to over 800 feet in the subsurface of the Paducah Quadrangle. In general the siltstone forms the lower part of the succession, the chert the middle part, and the limestone the upper part. The upper part of the Valmeyeran Series, the Meramec Group, consists of (1) the Salem Limestone, a fine-grained, dark, dolomitic limestone in its lower 300 feet and a brown, fossiliferous limestone with scattered oolites in its upper 400 feet (table 1); (2) the St. Louis Limestone, a dark gray, medium-grained limestone with bands of fossil fragments about 350 to 400 feet thick; and (3) the Ste. Genevieve Limestone (Lamar, 1959), about 200 feet thick, generally a light gray, coarse-grained limestone with sandstone lenses, particularly in its upper part.

The late Mississippian Chesterian Series is about 1000 feet thick and consists of about 12 alternations of sandstone, shale, and limestone in nearly cyclic repetition (Weller, 1920; Weller and Sutton, 1940; Lamar, 1925, p. 26-77). Chesterian sediments grade into the underlying Ste. Genevieve Limestone and the series is unconformably overlain by Pennsylvanian sediments.

Pennsylvanian System

Although not found south of the Cache Valley in southern Illinois, Pennsylvanian sediments unconformably overlie Chesterian strata (Siever, 1951) to the north and to the east across the Ohio River in Kentucky. In the Shelterville Quadrangle in Kentucky, the Rock Creek Graben exposes shale, siltstone, and sandstone units of the Caseyville Formation.

Mesozoic Strata

Pre-Cretaceous Unconformity

The rocks immediately underlying Cretaceous strata commonly have a well-defined weathered zone called the Little Bear Soil with bands and nodules of limonite or hematite in residual carbonaceous clay (Pryor and Ross, 1962). Because it is widespread (see fig. 8), this soil profile forms an extremely valuable marker bed. It is developed on strata from Mississippian to Ordovician in age.

Cretaceous

In southernmost Illinois, the Tuscaloosa Formation overlies the Little Bear Soil, or in its absence, unweathered Paleozoic strata. The Tuscaloosa is thin and is composed of multicolored clays, coarse sands, and gravels consisting of black and gray chert pebbles. It locally thickens to about 20 feet. The local thickening and the extensive occurrence of the Little Bear Soil suggest that the Tuscaloosa filled shallow depressions on an otherwise fairly smooth erosion surface.

TABLE 1

Summary of log of Rigney & Dodson Oil Company, J. H. Lewis no. 1, SW¼, SW¼, NE¼, sec. 18, T. 16 S., R. 7 E., Pope County. Samples studied from 60 to 971 feet by E. Atherton, drillers logs from 1400-4100 feet. Elevation 351 feet.

	Thickness	Depth
No samples	60	60
Recent alluvium and Pliocene "Lafayette" Gravel	92	152
Mississippian System		
Meramec Group		
Salem Limestone		
Limestone, dark gray to brown, sublithographic, cherty; trace of oolite near base	100	252
Limestone, dark gray to brown, fine to coarse grained, cherty, fossiliferous (possibly includes some Harrodsburg)	394	646
Osage Group		
Harrodsburg Limestone		
Limestone, light gray, fine to coarse grained, fossiliferous, cherty near base	64	700
Ft. Payne Chert		
Limestone, brownish gray, cherty to very cherty, very silty, fine to coarse grained, fossiliferous	40	740
Limestone, brownish gray, cherty, mostly coarse grained, fossiliferous; some parts are mostly chert	92	832
Limestone, black to dark gray, silicified, very cherty, fine grained	141	971
No record		
Borden Siltstone	429	1400
Limestone, dark gray to black, silicified, silty, gray near base	130	1530
Devonian System		
New Albany Formation		
Shale, black and dark gray	288	1818
Devonian (undifferentiated)		
Limestone and dolomite, gray to light gray; salt at base	107	1925
Limestone, light gray, cherty	492	2417
Limestone, sandy	128	2545
Limestone, silicified	373	2918
Devonian, Silurian, and Ordovician (?)		
Limestone, sandy	602	3520
Ordovician System		
Maquoketa Group (undifferentiated)		
Shale, gray; contains thin lens of limestone	250	3770
Galena Group		
Kimmswick Limestone		
Limestone, light to medium gray	330	4100 T.D.

The concept of a large amount of relief on the pre-Tuscaloosa surface, which is commonly suggested to account for the marked differential thickness of Cretaceous strata (Pryor and Ross, 1962, p. 17), is now questioned because the basal Cretaceous gravels are widespread (see fig. 8) and are not marked by locally thick deposits, and numerous gravel lenses are not found in the overlying McNairy Formation. Where thick, the Tuscaloosa is predominantly gravel, and where thin, it is clay and sand with scattered chert pebbles. Marcher (1961) and Marcher and Stearns (1962) show the Tuscaloosa thickening eastward from the eroded and beveled Pascola Arch in western Tennessee (fig. 2) and passing into near-shore marine deposits near the eastern edge of its present outcrop area in Tennessee. East of Metropolis, it locally grades vertically into the McNairy Formation through several feet of coarse and fine sand beds.

The McNairy Formation, where protected by overlying sediments, may reach 500 feet in thickness, but it thins irregularly from its area of thickest deposition near Olmstead. It is composed of very fine sand, silt, and clay (Lamar, 1948; Lamar and Sutton, 1930; Potter and Pryor, 1961; Pryor, 1956, 1960; Pryor and Glass, 1961) and near the middle has a lignitic pyritic member about 175 feet above its base. The Owl Creek Formation, which disconformably overlies the McNairy, is about 15 feet thick in southernmost Illinois. It is a glauconitic, micaceous, green-gray clay (Pryor, 1960).

Cenozoic Strata

Tertiary—Paleocene Series

In southernmost Illinois the Paleocene Series consists of the Clayton and Porters Creek Formations. The Clayton is a light to dark green, glauconitic clay with sand, and it has scattered pebbles in its lower foot. It is 10 to 20 feet thick and is quite uniform in thickness in its area of distribution. The Porters Creek Formation conformably overlies the Clayton and is composed predominantly of ½- to 2-foot beds of dark gray to buff-colored banded clays that reach a thickness of nearly 170 feet (Lamar, 1928; Pryor and Glass, 1961; Pryor and Ross, 1962).

Tertiary—Eocene Series

The Eocene Series consists of the Wilcox Formation, which unconformably overlies the Porters Creek Formation and which in turn is unconformably overlain by Pliocene gravels and Pleistocene deposits. It reaches about 250 feet in thickness beneath Cairo and is composed of interbedded, micaceous, lignitic clays and fine sands (Shrode and Lamar, 1953; Pryor and Ross, 1962).

Tertiary—Pliocene Series

The Pliocene Series is represented by the "Lafayette" Gravel, a chert gravel that commonly reaches 30 to 40 feet in thickness. It is commonly cemented by limonite and hematite, which give the gravel a distinctive brown, red, or orange coloration. The pebbles and cobbles are up to 3 inches in diameter and the gravels are cross-bedded. Their widespread and relatively thin sheet-like distribution suggests that these gravels were deposited in broad, braiding channels. Although commonly widespread in parts of southernmost Illinois, small patches of similar gravels occur locally beneath glacial deposits farther north (Horberg, 1946, 1950;

Lamar and Reynolds, 1951; Leighton and Willman, 1948, 1949). Potter (1955) studied the petrology of these gravels in southernmost Illinois, Kentucky, Tennessee, and Missouri in the areas where they have nearly continuous distribution. Stratigraphically these gravels lie on a major unconformity in southernmost Illinois that cuts across strata from Ordovician to Eocene in age, and topographically they cap the higher hills.

Leighton and Willman (1949) recognized three erosional surfaces on which typical "Lafayette" Gravel is preserved: the highest, called the Lancaster surface and typically developed between 580 and 600 feet elevation in southern Illinois, is probably equivalent to the Williana surface of Fisk (1944); the second, called the Smithland surface and between 450 and 500 feet elevation in southern Illinois, is probably equivalent to the Bentley surface of Fisk; the third surface, at about 400 feet, was referred to the Havana Strath of Horberg and the Montgomery terrace of Fisk. Younger Pleistocene terraces locally contain large concentrations of reworked "Lafayette" Gravel.

Quaternary System

Pleistocene deposits form the Quaternary strata of the area and consist of three types. The Loveland, Roxana, and Peoria Loesses, up to 50 feet thick, are found on the higher hills and only the Peoria Loess is found on the highest Pleistocene terrace (Leighton and Willman, 1950; Leonard and Frye, 1960; Frye and Willman, 1960). Water-deposited silts, sands, and pebbly sands in the Metropolis area are 20 to 40 feet thick and form terraces. Sand and gravels derived from glacial outwash streams and rivers in the Cache Valley and Cairo areas reach 250 feet thick in the Pleistocene alluvial valleys of the major rivers. The distribution of these deposits is complicated by relatively recent shifts in the courses of both the Mississippi and Ohio Rivers from their former deep alluvial valleys into narrow bedrock channels. The Mississippi River shifted from its former course west of the Benton Hills into the Thebes Gorge. The Ohio River shifted from its former course in the Cache Valley southward into the lower reaches of the Cumberland River and then westward into the Tennessee River along a bedrock channel.

Sub-Cretaceous Areal Geology

The Paleozoic rocks beneath the overlapping Cretaceous sediments are poorly exposed south of the Cache Valley except for a few scattered outcrops and for the high area along the Cache Valley and Ohio River bluffs near Bay City. The sub-Cretaceous geologic map shows an interpretation of the distribution of the Paleozoic strata that underlie this area (table 2, fig. 4 and 5) based largely on well data and the southward projection of outcrop data. In general, the oldest rocks (fig. 6) are found to the west and dip gently to the northeast toward the Illinois Basin so that progressively younger rocks appear eastward. Nearly the entire Paleozoic succession, except for the Cambrian, lower Ordovician, and Pennsylvanian, in places lies directly beneath the Cretaceous sediments.

Structure

The Paleozoic strata are broken by numerous faults that are, for the most part, the southwestward extension of the structural pattern of the Illinois-Kentucky Fluorspar District, which lies adjacent to the northeast corner of the area of the

TABLE 2 – Continued

27.	Smith Cunningham, G. Gurley	SE¼ SW¼ NE¼, sec. 31, T.15S., R.5E.
28.	Smith Cunningham, Massac Co. Orchard	SW¼ NW¼ NE¼, sec. 32, T.15S., R.5E.
29.	Metropolis National Well, St. John's Church	NE¼ NW¼ NE¼, sec. 34, T.15S., R.5E.
30.	Wittig, School District #36-A	NE¼ NW¼ NW¼, sec. 1, T.16S., R.5E.
31.	Marshall, H. McGhee no. 1	NE¼ NE¼ NE¼, sec. 3, T.16S., R.5E.
32.	Diehl Pump & Supply, Metropolis Power and Light	SE¼ NE¼ NE¼, sec. 11, T.16S., R.4E.
33.	Luth, Metropolis City	NW¼ NE¼ NE¼, sec. 11, T.16S., R.4E.
34.	Wittig, Luke	SW¼ NE¼ NE¼, sec. 32, T.16S., R.6E.
35.	Tennessee Valley Authority, Paducah Dam Site Borings	
	POPE COUNTY	
1.	Smith Cunningham, P. Arensman	SE¼ SE¼ NW¼, sec. 16, T.14S., R.5E.
2.	Tennessee Valley Authority (a) Dog Island Dam Site borings (b) Upper Smithland Dam Site borings (c) Lower Smithland Dam Site borings	
3.	Rigney & Dodson, J. H. Lewis no. 1	SW¼, SW¼, NE¼, sec. 18, T.16S., R.7E.
	PULASKI COUNTY	
1.	Ullin, Anderson no. 1	SW¼ SE¼ SW¼, sec. 26, T.14S., R.1W.
2.	Mississippi River Comm., Crippin	SE¼ NW¼ NE¼, sec. 26, T.14S., R.1W.
3.	Columbia Quarry, Campbell no. 1	SE¼ SE¼ SW¼, sec. 7, T.14S., R.1E.
4.	Campbell, Ragsdale no. 1	NE¼ SW¼ NE¼, sec. 18, T.14S., R.1E.
5.	Sergent, C. Kraatz no. 1	NW¼ NW¼ NW¼, sec. 27, T.14S., R.1E.
6.	Gould, Transient Camp no. 1	NW¼ SE¼ SE¼, sec. 14, T.14S., R.2E.
7.	Sergent, C. Richardson no. 1	SE¼ SE¼ SW¼, sec. 32, T.14S., R.2E.
8.	Weldon, Illinois Central R.R.	SW¼ NE¼ NW¼, sec. 15, T.15S., R.1W.
9.	Weldon, A. O. Pawlisch	NW¼ SE¼ SW¼, sec. 27, T.15S., R.1W.
10.	Schneider, Whelan	NE¼ SE¼ SW¼, sec. 34, T.15S., R.1W.
11.	Schneider, Hay	SE¼ NW¼ SE¼, sec. 34, T.15S., R.1W.
12.	Weldon, Aldrich	sec. 35, T.15S., R.1W.
13.	Moore, Endicott no. 1	NE¼ NW¼ SE¼, sec. 36, T.15S., R.1W.
14.	Sergent, H. Richard no. 1	SW¼ SE¼ SW¼, sec. 4, T.15S., R.1E.
15.	Williams, W. L. Richey no. 1	NW¼ SE¼ SW¼, sec. 9, T.15S., R.1E.
16.	White, J. Goza no. 1	NE¼ SW¼ SE¼, sec. 20, T.15S., R.1E.
17.	Case Engr., Olmstead City	SE¼ SE¼ SW¼, sec. 22, T.15S., R.1E.
18.	Wittig, Grand Chain	SW¼ SE¼ SE¼, sec. 2, T.15S., R.2E.
19.	U. S. War Dept., Lock and Dam 53	SE¼ SW¼ NW¼, sec. 18, T.15S., R.2E.
20.	Schneider, Wheeler	SE¼ SW¼ NW¼, sec. 2, T.16S., R.1W.
21.	Vick, Boyd no. 1	NW¼ NE¼ SW¼, sec. 5, T.16S., R.1W.
22.	Schneider, Hansicker	NW¼ SW¼ NW¼, sec. 11, T.16S., R.1W.
23.	Cache, G. Moses no. 1	SW¼ NE¼ SW¼, sec. 17, T.16S., R.1W.
24.	Miller, J. Moses no. 1	SW¼ SE¼, sec. 17, T.16S., R.1W.
25.	Ice Plant Well, Mound City	sec. 36, T.16S., R.1W.
26.	Vick, Roberts no. 1	NW¼ SW¼ SW¼, sec. 5, T.16S., R.1E.

Source: Mineral Resource Records, Illinois State Geological Survey open file.

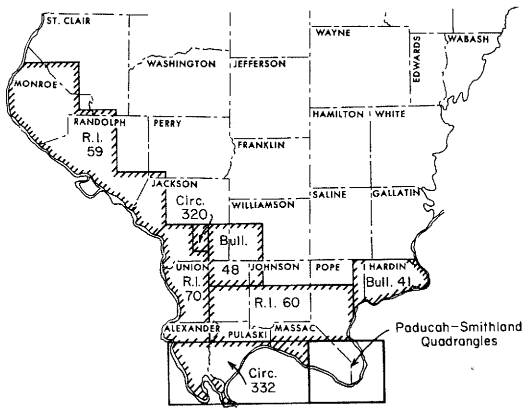

Fig. 4 - Location of areas in southern Illinois mapped in Bulletins, Reports of Investigation, and Circulars of the Illinois State Geological Survey.

map (Weller, 1920; Butts, 1925; Weller, 1940; Clark and Royds, 1948; Stonehouse and Wilson, 1955; Weller, Grogan, and Tippie, 1952; Weller and Sutton, 1951; Heyl and Brock, 1961). The major faults generally strike northeast and are aligned to form a series of subparallel grabens in which the beds generally dip irregularly northward causing marked changes in their stratigraphic displacements along the strike of the bounding faults. These faults persist farther than the main displacement of the downwarped grabens and appear to take up the main displacement in a narrow, extremely complex fault zone, where the displacement of the main grabens diminishes, as in the southwestern extension of the western fault zone on the Rock Creek Graben. In addition to the northeast trending fault system, there are a few northwest trending faults.

Four major graben belts are recognizable across the southern tip of Illinois: the Dixon Springs Graben extends into the area from the northeast; the Rock Creek Graben also extends under the Cretaceous sediments from the northeast; a poorly exposed graben, here named the Paducah Graben, extends toward Paducah, Kentucky, and is only a narrow complex fault zone in its Illinois length; and a fault complex that may be several closely spaced and related grabens, here named the America Graben for the village of America in the area north and east of Mound City.

The thin remnant of possibly another major graben is seen in outcrop near Aetna Hollow in the SE$\frac{1}{4}$, sec. 28, T. 15 S., R. 3 W., about one mile northwest of Fayville. This graben appears to widen and to form a part of the southern slopes of the Benton Hills on the Missouri side of the Mississippi River. Faulting near the mouth of Orchard Creek in the NW$\frac{1}{4}$, sec. 21, T. 15 S., R. 3 W., appears to be the north end of another major graben that may extend southwestward into the Benton Hills.

In addition to these major grabens, the intervening areas are commonly broken by faults that have considerable displacement and that generally parallel the the bounding faults of the grabens. The displacements on these faults are seldom as great as on those bounding the major grabens.

DISTRIBUTION OF CRETACEOUS SEDIMENTS

Figure 7 is a structure contour map drawn on the base of the Cretaceous and figure 8 is an isopachous map of Cretaceous sediments, where they are overlain by Paleocene strata. In general features, these two maps are closely parallel. Where the structure contours show structural lows, the sediments thicken; where the contours show structural highs, the sediments thin. In addition, a comparison of figures 7 and 8 with the sub-Cretaceous geologic map (fig. 6) shows that the

TABLE 2 - WELLS USED IN COMPILING SUB-CRETACEOUS GEOLOGIC MAP, STRUCTURAL CONTOUR MAPS, AND ISOPACHOUS MAPS

(Keyed to figure 5 by county and number)

	Name	Location
	ALEXANDER COUNTY	
1.	Ozark Farm no. 1.	NW¼ NW¼ SE¼, sec. 8, T.14S., R.1W.
2.	Arnold & Middleton, Hodges no. 1.	SE¼ SE¼ NW¼, sec. 35, T.15S., R.2W.
3.	Schneider, G. C. Droge no. 1.	SE¼ NW¼ NW¼, sec. 18, T.16S., R.1W.
4.	Gould, Bourland no. 1	SE¼ SE¼ SW¼, sec. 19, T.16S., R.1W.
5.	Prindle & Vick, Petty no. 1	SE¼ SW¼ NE¼, sec. 19, T.16S., R.2W.
6.	Gould, Transient Camp no. 1	NW¼ NW¼ NW¼, sec. 24, T.16S., R.2W.
7.	Halliday estate no. 3	NE¼ SW¼ NE¼, sec. 2, T.17S., R.1W.
8.	Halliday no. 1 (Cario Electric light and power)	8th and Washington Streets, sec. 25, T.17S. R.1W.
9.	E. W. Halliday (1903) no. 4	SW¼, sec. 25, T.17S., R.1W.
10.	Vick, Smith no. 1	NW¼ NW¼ NW¼, sec. 15, T.17S., R.2W.
	MASSAC COUNTY	
1.	Smith Cunningham, A. J. Bunchman no. 1.	SW¼ SW¼ NE¼, sec. 14, T.14S., R.3E.
2.	Smith Cunningham, M. G. Roberts no. 1	SW¼ SW¼ NE¼, sec. 14, T.14S., R.3E.
3.	Glen Kahle and others, Harvick no. 1.	SW¼ SW¼ SW¼, sec. 23, T.14S., R.3E.
4.	Fred Foss, Foss no. 1	SE¼ SE¼ SE¼, sec. 1, T.14S., R.4E.
5.	Clark, Wm. Croft no. 1.	sec. 5, T.14S., R.4E.
6.	Campbell, Teckenbrock no. 1	SW¼ NW¼ NW¼, sec. 29, T.14S., R.4E.
7.	Wittig, Davidson.	SW¼ SE¼, sec. 35, T.14S., R.5E.
8.	Layne Western, Compressor Station #7, no. 1 . .	SE¼ SW¼, sec. 10, T.15S., R.3E.
9.	Layne Western, Compressor Station #7, no. 2 . .	SW¼ SE¼, sec. 10, T.15S., R.3E.
10.	Wittig, School District #17	SE¼ SE¼ NE¼, sec. 10, T.15S., R.3E.
11.	Layne Western, Electric Energy no. 4.	NW¼ SW¼ SW¼, sec. 14, T.15S., R.3E.
12.	Layne Western, Electric Energy no. 2.	SW¼ NW¼ SW¼, sec. 14, T.15S., R.3E.
13.	Smith Cunningham, Joppa Grade School.	SE¼ NW¼ SE¼, sec. 14, T.15S., R.3E.
14.	Layne Western, Electrical Energy Plant no. 3. .	SW¼ SW¼ NW¼, sec. 14, T.15S., R.3E.
15.	Layne Western, Electric Energy no. 1.	SE¼ NE¼ SW¼, sec. 15, T.15S., R.3E.
16.	Layne Western, Missouri Portland Cement no. 1a.	NW¼ SW¼, sec. 15, T.15S., R.3E.
17.	Smith Cunningham, Marie Wilson no. 1.	sec. 23, T.15S., R.3E.
18.	Smith Cunningham, Joppa Colored School no. 1. .	NE¼ NE¼ NW¼, sec. 23, T.15S., R.3E.
19.	Smith Cunningham, J. Weinke	SE¼ SE¼ NW¼, sec. 4, T.15S., R.4E.
20.	Smith Cunningham, L. Chick no. 1.	SE¼ NW¼ NE¼, sec. 7, T.15S., R.4E.
21.	Metropolis Natl., Allied Chemical no. 1	NE¼ SE¼ NW¼, sec. 34, T.15S., R.4E.
22.	Smith Cunningham, Wade no. 1.	NW¼ SE¼ NW¼, sec. 35, T.15S., R.4E.
23.	Smith Cunningham, Hansman	NE¼ SW¼ SW¼, sec. 5, T.15S., R.5E.
24.	Smith Cunningham, L. C. Johnson	NE¼ SW¼ SW¼, sec. 20, T.15S., R.5E.
25.	Smith Cunningham, Powers School	NE¼ NE¼ SW¼, sec. 29, T.15S., R.5E.
26.	Wittig, Country Club.	NW¼ NE¼, sec. 30, T.15S., R.5E.

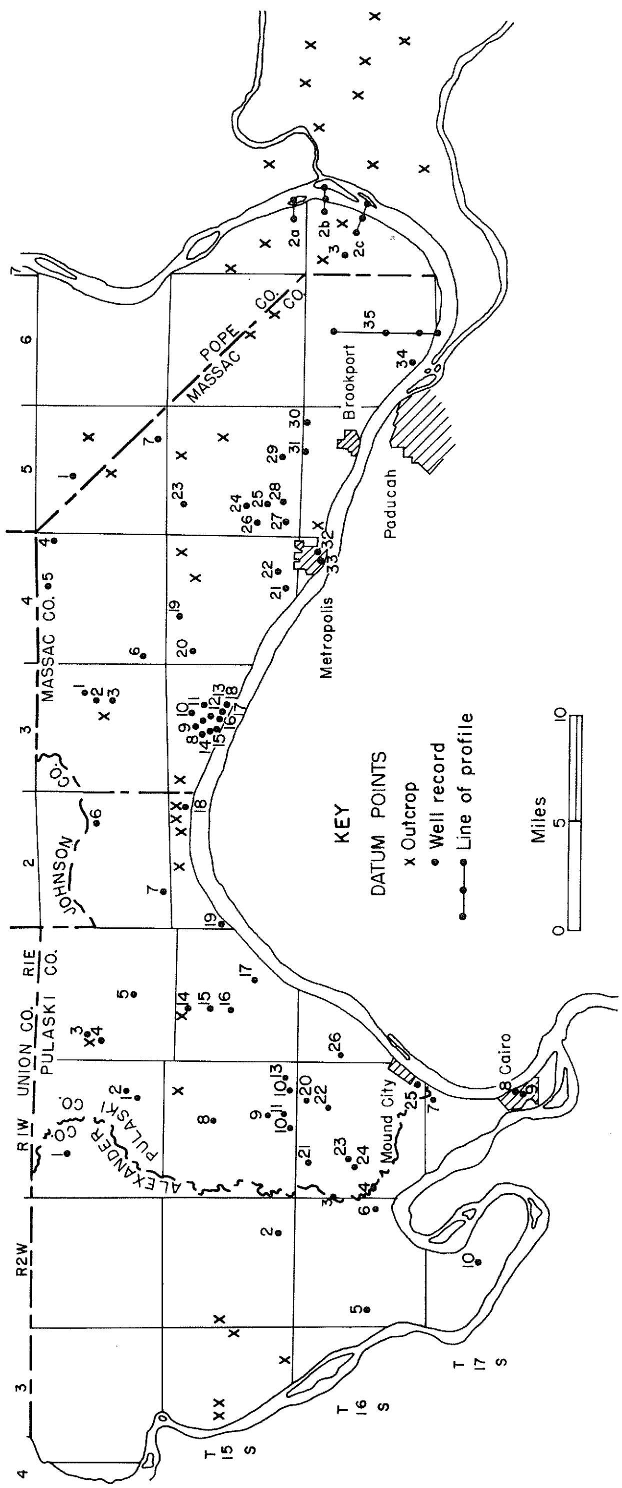

Fig. 5 - Distribution of wells and outcrops used in compiling figures 6, 7, 8, and 9. For more exact location of well sites see table 2.

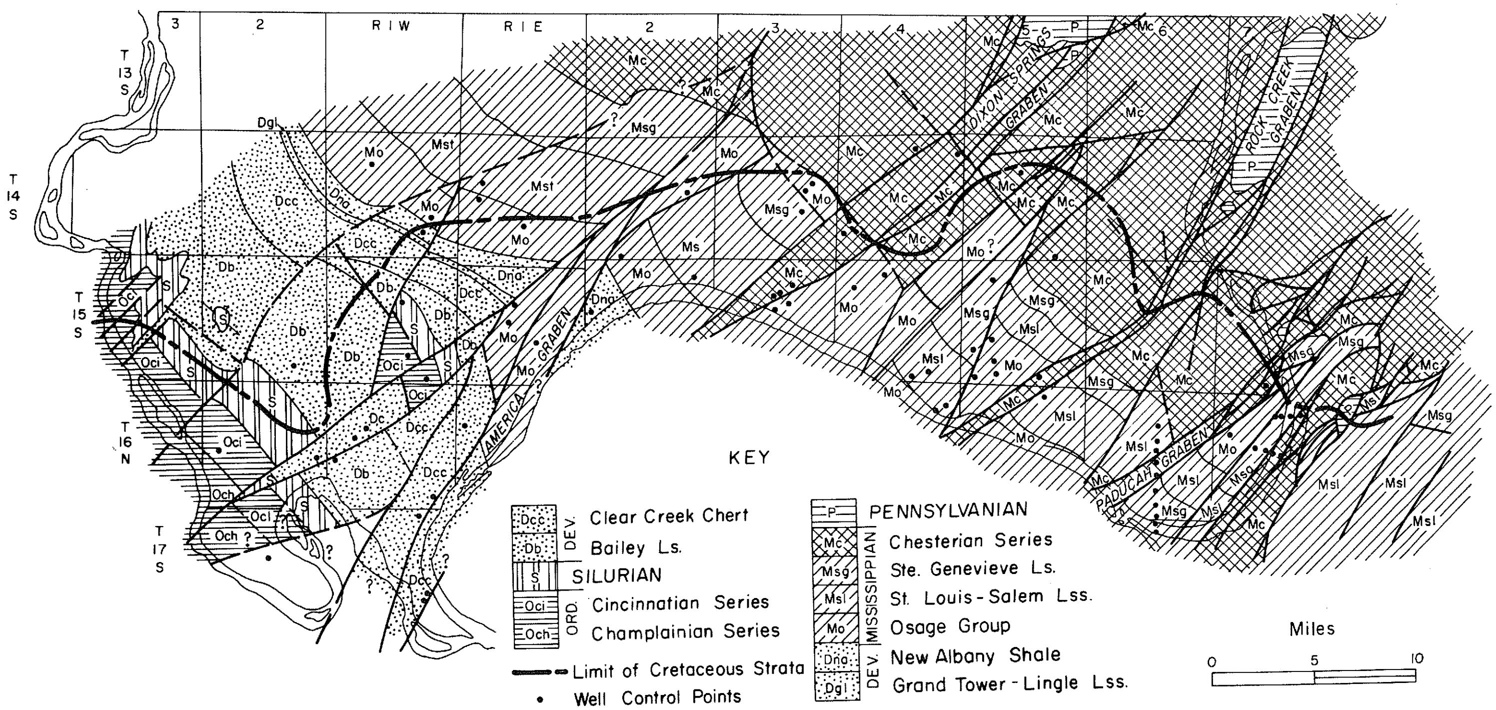

Fig. 6 - Sub-Cretaceous geologic map as interpreted from well records and geologic maps in southernmost Illinois (Pryor and Ross, 1962; Weller and Krey, 1939; Weller and Ekblaw, 1940); Kentucky part compiled from Weller and Sutton (1951).

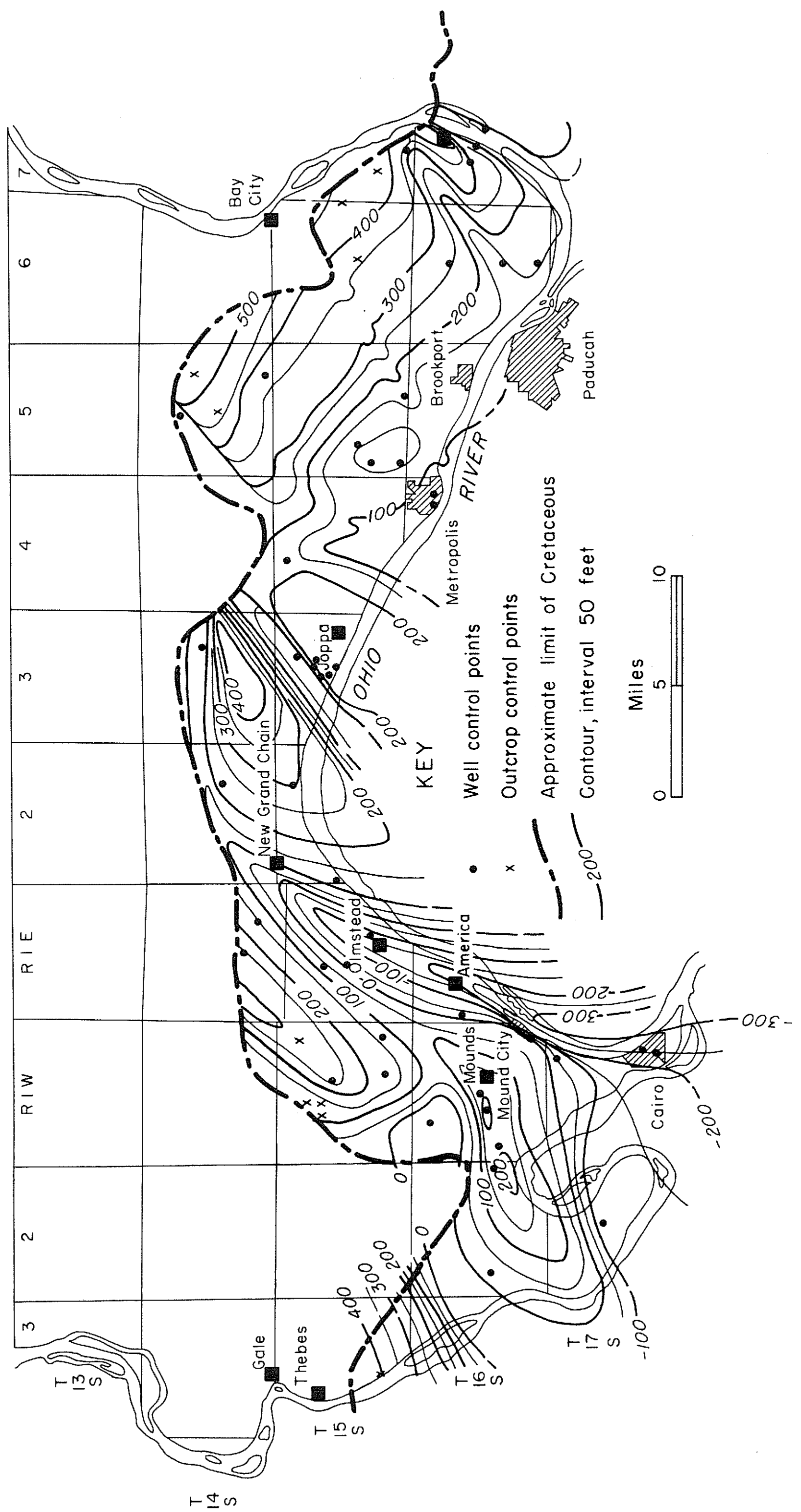

Fig. 7 - Structural contour map drawn on the base of Cretaceous strata.

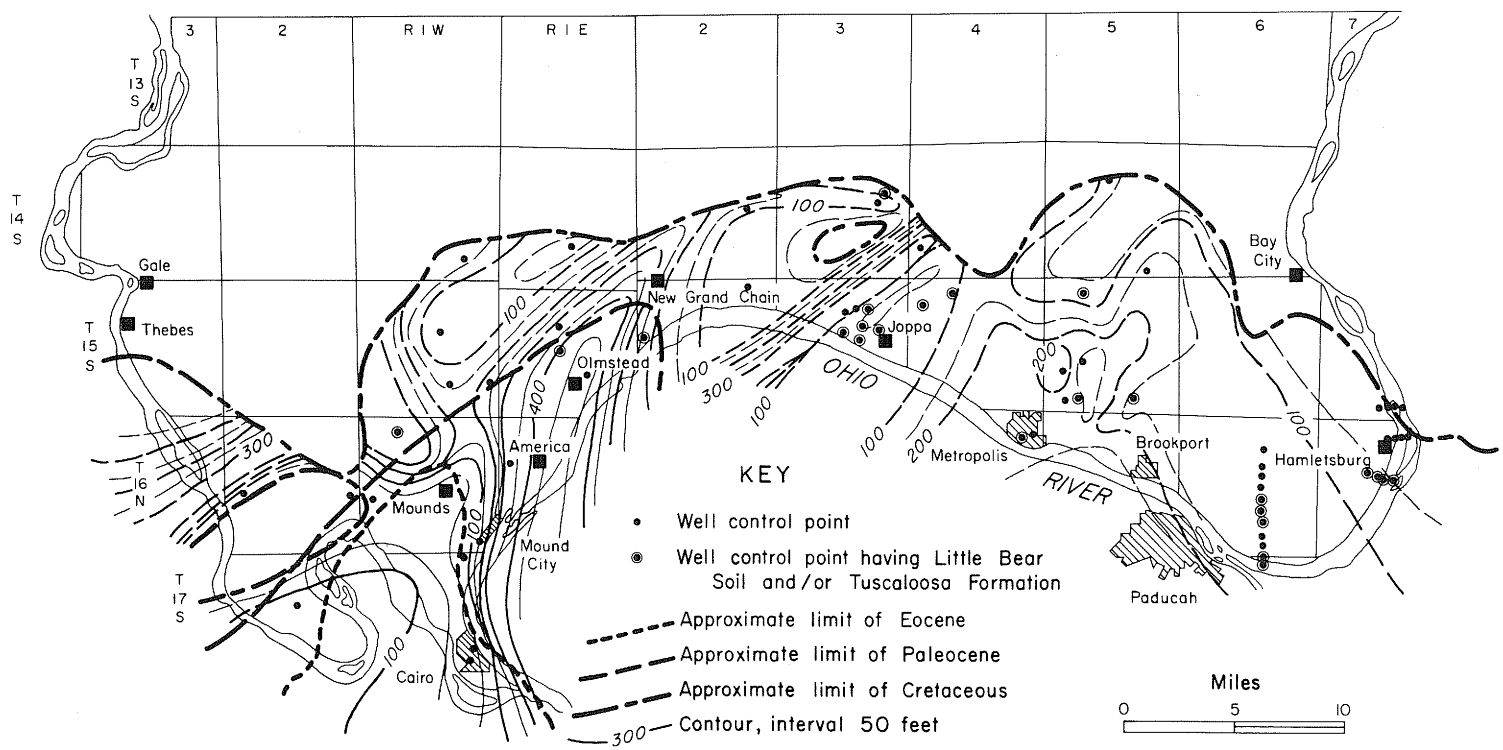

Fig. 8 - Isopachous map showing thickness of Cretaceous strata; solid contour lines in area where it is overlain by Paleocene strata; dashed contour lines in area where Paleocene strata are missing.

most prominent structural low is located over the America Graben. For the America Graben area, the structural contour map of the base of the Clayton Formation (fig. 9) indicates the top of the Cretaceous in that area.

There are several possible explanations for the present relief on the sub-Cretaceous surface: (1) the relief represents topographic configuration of the surface before the deposition of the Tuscaloosa and McNairy Formations; (2) the relief is the result of post-Tuscaloosa faulting and warping; or (3) the relief is a combination of the two preceding possibilities.

Several lines of evidence suggest that the sub-Cretaceous surface had relatively little relief. The Little Bear Soil is widely distributed except in a narrow area on the west side of the America Graben. The Tuscaloosa Formation, a basal conglomerate, is widely present but is thin, locally reaching as much as 20 feet in thickness but usually less than 15 feet thick. The McNairy is composed of fine sands, silts, and clays with only a few pebble bands in its upper part. If the relief on the sub-Cretaceous surface was as great when the Cretaceous strata were deposited as it is now, the Tuscaloosa should locally be much thicker, and its distribution more irregular. Thus it seems probable that (1) the pre-Cretaceous surface with its Little Bear Soil had only slight relief at the beginning of Cretaceous sedimentation and (2) the structural contour map mainly depicts later structural adjustments that were made after the start of Cretaceous deposition or after the end of Cretaceous deposition. The lack of coarse sand or gravel within the McNairy suggests that these adjustments postdate the deposition of the McNairy. The close parallel between the major structural features of the sub-Cretaceous geologic map, the structure contour of the base of the Cretaceous, and the projected trends of exposed structures indicates that the faults and the fault zones bounding the major graben blocks of Paleozoic strata were sites of renewed movement after Cretaceous deposition and that this mechanism can account for these different features.

DISTRIBUTION OF PALEOCENE AND EOCENE SEDIMENTS

Paleocene and Eocene sediments reach into Illinois only in a relatively small area from Dogtooth Bend northeast nearly to Levings and then southeastward to the Ohio River (fig. 9).

Within its area of distribution, the Clayton Formation has a fairly uniform thickness of 10 to 20 feet and dips toward the south-southeast at about 50 feet per mile (fig. 9). The overlying Porters Creek Formation has nearly the same distribution and dips as the Clayton, but it is overlain unconformably by Pliocene "Lafayette" Gravel for the most part, except in a small area near Cache and to the south where it is overlain by Eocene sediments. A comparison of Paleocene distribution with the Cretaceous structural features (fig. 7) and the sub-Cretaceous geologic map (fig. 6) shows that the distribution of Paleocene sediments closely approximates the area of the America Graben. The structural contours at the base of the Clayton also show a similarity to the sub-Cretaceous structural contours, although the Clayton structure is weaker. The uniformity of both the Clayton and Porters Creek sediments suggests that these marine deposits had shorelines considerably farther north of their present distribution.

The distribution of the Eocene Wilcox Formation shows that it was largely confined to a small area north of Cairo and west of Mounds (fig. 8). Isolated

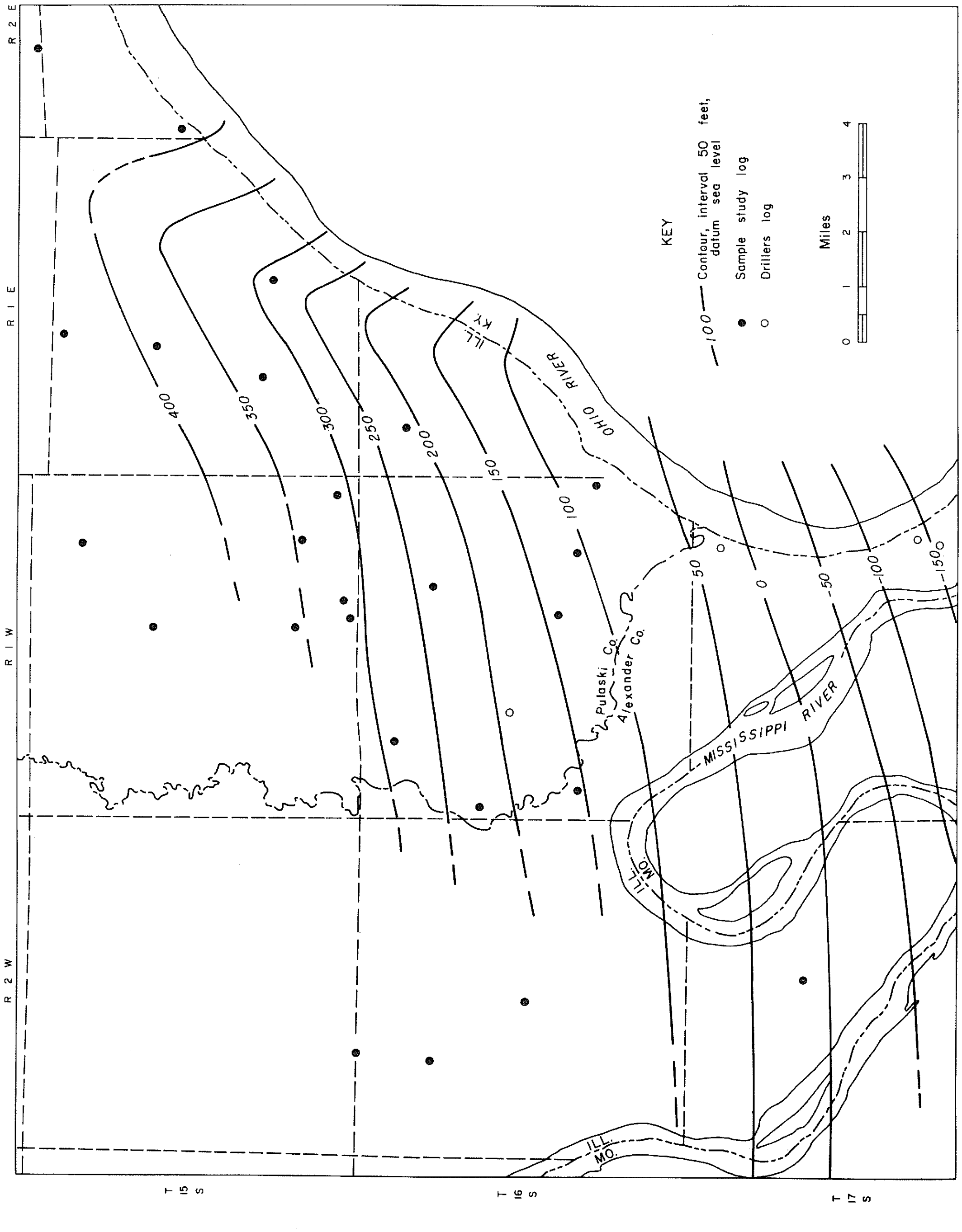

Fig. 9 - Structural contour map drawn on the base of the Paleocene Clayton Formation. (From Pryor and Ross, 1962).

remnants of probable Wilcox are known as far north as Olmstead, but these are thin and discontinuous beneath the Pliocene gravels, and it is only near Mounds that the dip of the Wilcox carries it continuously beneath the level of Pliocene gravel deposition. The distribution of the Wilcox is similar to that of the Clayton and restricted almost entirely to the area just west of the major structural sag in the America Graben.

DISTRIBUTION OF PLIOCENE GRAVELS

The Pliocene "Lafayette" Gravel presents several special problems. It is widespread on hilly divides between the Cache Valley and the Ohio River Valley and caps most hills above 450 feet. Locally, similar deposits occur at considerably lower elevations. Isolated occurrences of gravels of this general type occur in scattered outcrops in southern, central, and northern Illinois and in the Ozark area. Southward along the edges of the Mississippi alluvial valley similar gravels are widespread on several erosional surfaces (Fisk, 1944, 1951).

In southernmost Illinois, exposures are not continuous and these gravels commonly are found at different elevations within rather short distances. The gravels, being more resistant than the underlying sediments, may readily move down hill slopes as colluvial material, and it is commonly difficult to determine from small or isolated exposures whether the gravels are in place or are slumped.

Exposures in the bed of a small creek (SE$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 28, T. 14 S., R. 5 E.) show the Cretaceous McNairy Formation and "Lafayette" Gravel with steep dips, which apparently result from faulting with vertical displacement of more than 20 feet. Whether this post-"Lafayette" faulting also is younger than the Pleistocene terraces is difficult to ascertain; however, it may be responsible for the locally irregular surface on some terraces north of Metropolis. Post-"Lafayette" faulting has also been reported along the Thebes gorge in Missouri (McQueen and others, 1939).

Faulting of this type introduces the possibility that other anomalous "levels" of "Lafayette" Gravel may also be the result of faulting, particularly in those areas adjacent to or overlying the major grabens of the northeast trending fault system. In the area near the village of Round Knob, about 6 miles north of Metropolis, there are marked changes in the elevation of the "Lafayette" Gravel within short distances, suggesting a faulted situation near the edge of the Dixon Springs Graben. With more than one surface or depositional level of "Lafayette" Gravel, it is difficult to demonstrate how extensive such faulting may be with the available information. On the other hand, in areas where post-"Lafayette" faults are suspected, it is difficult to assign each gravel exposure to a particular erosional level based only on its elevation. If, as is indicated by the Cretaceous sediments and their distribution and the amount of recorded earthquake activity (Moneymaker, 1960; McGinnis, 1963), the fault blocks beneath the Embayment have had several intervals of renewed displacement and are currently active, there seems no reason to expect that these blocks have ever been completely inactive since their initial faulting. Thus, some of the anomalous patches and local lack of consistent elevation for the "Lafayette" Gravel surfaces may be the result of faulting, and some of the broader flexures may be the result of warping.

Shift of River Courses

In glaciated areas, the major changes in the large river courses commonly can be attributed fairly directly to causes such as filling and obliteration of older courses by glacial drift or the establishment of new paths of major drainage in front of the ice sheets.

On the other hand, the changes in the courses of both the Mississippi and Ohio Rivers in southernmost Illinois present several questions. In both instances, these two major rivers shifted from broad alluvial valleys into narrow bedrock channels. Both of these rivers apparently changed their channels at about the same time, that is after the establishment of a 330- to 340-foot terrace level and before the end of Peoria Loess deposition.

A high river level, called the Kankakee Flood, associated with the rapid glacial retreat in the later part of the Woodfordian Substage of the Wisconsinan glaciation and particularly prominent in the upper Illinois and Kankakee Valleys, may have caused the shift of the Mississippi River into the Thebes Gorge (Leighton and Willman, 1949; Pryor and Ross, 1962). The same event may have raised the level of the Ohio River so that it overflowed the low divide between the Cumberland and Tennessee Rivers in the Paducah Graben area.

Fisk (1944, p. 39, 40) believed the Tennessee River flowed northeastward from Paducah into the Cumberland River and hence into the Cache Valley of the Ohio River near Bay City. However, the Cumberland River is entrenched in a meander valley that closely parallels the Cretaceous-Paleozoic contact and the Tennessee River is similarly entrenched in a valley that closely parallels the Cretaceous-Tertiary boundary in this area, suggesting that the Tennessee River flowed westward across the southwestern extension of the Dixon Springs Graben and that the Cumberland River flowed northward to the Cache Valley. The transfer of the Ohio River, thus, was up the Cumberland River, across the divide near Hamletsburg, and down the lower reaches of the Tennessee River. This divide is abreast of the Paducah Graben and in line with faults farther to the southwest that are known to have been active in relatively recent time. It is suggested that renewed movement on this structure could be in part responsible for such a drainage transfer.

RELATION TO ADJACENT AREAS

As shown by the continuity of many structural features such as grabens and by the general similarity in the northeast-southwest alignment of other faults, (fig. 2), southernmost Illinois is structurally a part of the same system of faulting that forms the Fluorspar District. Movement along these fault systems was largely post-Pennsylvanian and pre-Cretaceous. However, Currier (1944, p. 48) believed that related northeast-trending faults in Kentucky displaced strata as young as Cretaceous; this also appears to be the case in southernmost Illinois. Weller, Grogan, and Tippie (1952, p. 78-83) considered that the northeast margins of the major grabens in the Fluorspar District commonly were formed by a zone of complex faulting in which high angle reverse faults were important. Most of these complexly faulted zones are aligned northeast, but they curve abruptly eastward as they join the Shawneetown–Rough Creek Fault Zone.

The Shawneetown–Rough Creek Fault Zone is a major zone of high-angle reverse faults, trending east-west, that enter Illinois from Kentucky. The south side of the zone is upthrown as a sharp anticline, which may have an overturned north flank adjacent to the faults. Horizontal components are known on this fault zone, but most of the displacement is vertical. Stratigraphic displacement is as much as 2000 feet and the movement was probably mostly post-Pennsylvanian and pre-Cretaceous in age. The Cottage Grove Fault Zone continues this fault trend to the west but with diminished displacement. It is difficult to trace west of the DuQuoin Monocline, which forms the western break in slope of the Illinois Basin. The Ste. Genevieve-Rattle Snake Ferry Fault Zone, along the northeast flank of the Ozark Uplift, is approximately parallel to the Cottage Grove Fault Zone but offset to the southwest. Movement has been dominantly vertical and reversals in the direction of displacement have been noted by Desborough (1957, 1961) on faults associated with this fault zone. Faulting has been intermittent since middle or late Devonian time. North of the Shawneetown–Rough Creek Fault Zone, a set of nearly symmetrical horst and grabens, collectively termed the Wabash Valley Fault Zone, trend northeast and appear to continue the same trend of faulting that is seen in the northeast trending grabens of the Fluorspar District.

The ages of these various structural features are difficult to determine. They may represent renewed movement along Precambrian structural patterns, or they may all be younger and of different ages. The persistent northeast trend of the Wabash Valley faults and the Fluorspar District faults suggests that this is the oldest trend, which was later broken by the nearly east-west Shawneetown–Rough Creek Fault Zone. If this is true, then it seems likely that much of the displacement caused by high-angle reverse faulting along the Shawneetown–Rough Creek Fault Zone was accommodated by diverting part of the displacement onto the fault planes bounding the northwest sides of the grabens in the Fluorspar District. Later relaxation of stresses apparently caused many of the uplifted blocks to drop back to a lower position but not necessarily along exactly the same faults or fault planes. The later movements—such as those after the Cretaceous, or those after Eocene, and perhaps those continuing at present—may well be the result of shifting of these blocks caused by slight changes in the overall stress system.

The stratigraphy and subsurface relations of the upper part of the Mississippi Embayment area have been discussed recently by Pryor (1960), Stearns (1958), Marcher and Stearns (1962), and Stearns and Marcher (1962). Grohskopf (1955) studied subsurface relations in the Missouri part of the Embayment and Caplan (1954) studied the Arkansas part. Marcher (1961) and Marcher and Stearns (1962) showed that the distribution of the Tuscaloosa Formation in Tennessee and across the Pascola Arch is east of the crescentic outcrop pattern of the Devonian chert formations. North of Memphis, Tennessee, the Cretaceous and early Tertiary sediments are predominantly fine sand, silt, and silty clay and, in part, are near-shore shallow water deposits. They are poorly compacted and uncemented and thicken toward the axis of the Embayment Syncline and toward the south.

Marcher and Stearns (1962, p. 1380) believed that the present configuration of the Mississippi Embayment Syncline is the result of a progressive westward shift in the axis of greatest deposition from Tuscaloosa time into Paleocene time. This shift, accomplished by downward bending of a beveled pre-Tuscaloosa surface that was perhaps reduced to a peneplain, crosses former structural features such as the Pascola Arch and the southern end of the Illinois Basin. Stearns and Marcher (1962, p. 1393), in discussing the changes in the shape of the pre-Tuscaloosa surface, showed that two areas of flexures and faulting probably account for the movements. The first is a zone along the axis of the Mississippi Embayment Syncline (along the present course of the Mississippi River) from southern Kentucky into northern Mississippi, and the second a zone that trends north-south along the eastern edge of the Embayment (along the western valley of the Tennessee River). Moneymaker (1960) and McGinnis (1963) illustrated the pattern of recorded earthquakes which closely parallel these flexure zones in this area.

The flexure zone along the axis of the Mississippi Embayment has a similar trend to the faults of the Fluorspar District and it seems likely that this system of faults continues southwestward and in part forms the zone of flexure and faulting along the axis of the Embayment. The Reelfoot Lake Fault Escarpment is along this trend and is still traceable after its movement of 1811 and 1812 (Fuller, 1919). McGinnis (1963) suggested that high water conditions may be a triggering mechanism for these earthquakes.

Intrusive Rocks

Intrusive igneous rocks are locally associated with the major zones of faulting (Diller, 1892; Rust, 1937; Weller and Grogan, 1945; English and Grogan, 1948; Clegg, 1955; Clegg and Bradbury, 1956; Bradbury, 1962). Two general types can be recognized: breccia pipes composed of fragments of many different kinds of rocks including quartz and feldspathic minerals; dikes and sills consisting of basic alkaline rocks, such as lamprophyre, and basic olivine-rich rocks, such as peridotite, and possibly pyroxenite. The strike of most of these intrusive bodies of Illinois is to the northwest (Currier, 1944; Clegg and Bradbury, 1956) nearly at right angles to the lineation of major fault blocks and thus presumably along small tension faults.

Because most of the basic igneous intrusives are commonly of about the same composition, it has generally been held that they represent related intrusions. Weller, Grogan, and Tippie (1952, p. 78-83) have shown that the intrusions of the Fluorspar District both occupy fault planes and are cut by faults. This suggests that the intrusions occurred after the fault pattern was established but before movements ceased. Kidwell (1951) showed that similar intrusive rocks intrude late Cretaceous strata near the axis of the Embayment Syncline from Memphis north to the New Madrid–Reelfoot Lake area.

SUMMARY OF STRUCTURAL HISTORY

The structural framework of southernmost Illinois is closely related to the structure of the Illinois-Kentucky Fluorspar District and to the structure of the Mississippi Embayment. The northeast-trending system of faulting that dominates the structure of southernmost Illinois apparently was recurrently active, and perhaps it was never completely inactive after its initial development. Of particular note are renewed displacements in latest Cretaceous time after the deposition of the McNairy Formation and before the deposition of the Owl Creek Formation. Movement after Eocene deposition, but before the deposition of "Lafayette" Gravel, aided in preserving a portion of the Wilcox Sand north of Mound City. Evidence suggests that locally some faulting has displaced beds as young as the Pliocene "Lafayette" Gravel. Earthquake activity in the upper part of the Mississippi Embayment suggests that this system of faults is still active.

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