STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION

AREAL GEOLOGY OF THE ILLINOIS FLUORSPAR DISTRICT

Part 2 – Karbers Ridge and Rosiclare Quadrangles

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ABSTRACT

This is Part II in a series of three reports and geologic maps of the Illinois fluorspar district and outlying areas in Hardin, eastern Pope, and southern Saline and Gallatin Counties.

Part II considers the Karbers Ridge and the Illinois portion of the Rosiclare $7\frac{1}{2}$-minute quadrangles. These quadrangles occupy a position on and near the axis of a large northwest-trending anticlinal dome in an area of many faults. The anticlinal dome is transected by the Rock Creek Graben, which trends northeast. Hicks Dome structure, subsidiary to the larger dome, brings limestone and chert of Middle and Lower Devonian age to the surface north of the graben. North and northeast of Hicks Dome, the strata dip into the Moorman-Eagle Valley Syncline.

Thirty-one sedimentary rock units are differentiated by color and pattern on the geologic map. These include: undifferentiated Lower and Middle Devonian (1), Upper Devonian and Kinderhookian (1), Valmeyeran (7), Chesterian (16), Pennsylvanian (3), and Pleistocene (3). In addition, key sandstone members in strata of Pennsylvanian age are delineated by lines marking the top and bottom of major sandstones.

Sedimentary strata are intruded by a number of relatively small northwest-trending mica-peridotite and lamprophyre dikes. Breccias occur in association with structures that are interpreted as diatremes.

Fluorspar deposits occur near Rosiclare and in outlying areas. Large tonnages have been produced primarily from veins in the vicinity of Rosiclare. Outlying areas of less importance have produced sporadically. Limestone is quarried from limestone of Valmeyeran age near Elizabethtown, and thin coal seams in the Abbott (Pennsylvanian) Formation have been mined intermittently.

INTRODUCTION

This geologic map and report on the Karbers Ridge and Rosiclare Quadrangles constitute Part II in a series of three publications covering the Illinois fluorspar district. These quadrangles lie in the central part of the district and include portions of Hardin and Gallatin Counties (fig. 1). Part I of this series (Baxter et al., 1963) covered quadrangles in the eastern part of the district, and Part III, to be published at a later date, will be concerned with quadrangles in the western portion.

The quadrangles of this report were mapped by members of the Coal and Industrial Minerals Sections of the Illinois State Geological Survey. George A. Desborough mapped Pennsylvanian rocks and overlying Quaternary sediments, and was responsible primarily for field determination of the Mississippian-Pennsylvanian unconformity. Older sedimentary rocks and associated Quaternary sediments were mapped by James W. Baxter, assisted by David A. Schaefer and Albert Pernichele.

The cooperation of the mineral industries of the district is gratefully acknowledged. Other members of the Illinois Geological Survey staff, particularly Paul E. Potter, James C. Bradbury, and D. H. Swann, were consulted on various problems.

TOPOGRAPHY

The area of this report is underlain largely by Pennsylvanian and Upper Mississippian (Chesterian) formations that are characterized by cyclic alternations of resistant sandstone layers and less resistant shale and/or limestone layers. The topographic expression of this arrangement, where unaffected by major faulting, is one of alternating ridges and valleys. Areas underlain by thick limestone formations of Valmeyeran age generally are less rugged and locally exhibit sinkhole topography.

In the Karbers Ridge Quadrangle, Devonian limestone and intrusive breccia of uncertain age form a topographic high in the central part of a domal structure that has its apex near the southwest edge of the quadrangle. The central part of the dome is surrounded by a belt of less resistant New Albany Shale that forms a broad depression separating the limestone and breccia from the siltstone and chert of the Fort Payne Formation that cap a prominent ridge encircling the central part of the dome.

Three terrace levels of late Wisconsinan age are recognized along the Ohio River and its tributaries. A low terrace level has an elevation of 350 feet but generally cannot be

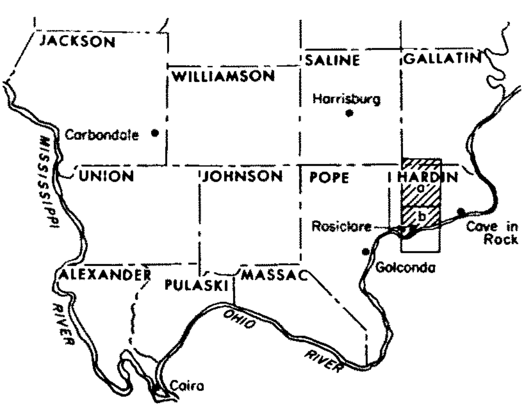


Figure 1 - Part of southern Illinois showing the location of (a) Karbers Ridge and (b) Rosiclare $7\frac{1}{2}$-minute Quadrangles.

differentiated from the present flood plain. An intermediate terrace level reaches an elevation of about 360 feet; a high terrace level reaches 380 to 390 feet.

STRATIGRAPHY

Part I of this series (Baxter et al., 1963) dealt with details of stratigraphic nomenclature, especially those related to recent reclassification of Chesterian and Genevievian rocks (Swann, 1963) and Pennsylvanian strata (Kosanke et al., 1960). Because these changes have been introduced, the following discussion is considerably less detailed. Figure 2 shows the rock stratigraphic classification used in the preparation of this report. The stratigraphic column (table 1) shows the units as differentiated on the geologic map.

DEVONIAN SYSTEM

HUNTON LIMESTONE MEGAGROUP

Devonian limestone and chert of the Hunton Limestone Megagroup (Swann and Willman, 1961, p. 478) are poorly exposed at the center of Hicks Dome in secs. 30 and 31, T. 11 S., R. 8 E. These strata have been penetrated by relatively shallow shafts at the Rose mine in the NE$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 30. Outcrops are insufficient, however, to permit the recognition of the various formations indicated by drill records. Rocks exposed at the Rose mine are siliceous and resemble silicified cherty limestone. Small pieces of medium-grained, crystalline limestone were observed on or near the mine dumps and indicated that strata of this type probably were encountered in the excavation for the shaft.

DEVONIAN AND MISSISSIPPIAN SYSTEMS

New Albany Shale Group

The New Albany Shale Group is the lowermost unit of the Knobs Megagroup (Swann and Willman, 1961, p. 480) as recognized in southern Illinois. Part of the New Albany of Hardin County is early Mississippian in age. It crops out in a circular belt that surrounds Devonian limestone and chert in the Hicks Dome area. The best exposures are along the east-west roadway in the north part of sec. 31 and just south of the road junction in the SW$\frac{1}{4}$ NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 32, T. 11 S., R. 8 E. The shale is dark gray to black, carbonaceous, and silty. It contains small flakes of mica and pyrite and weathers to a dirty brown color. Some weathered portions are quite fissile. Other portions have beds up to 1 foot thick that are compact and completely lacking in bedding structure. The New Albany is estimated to be 400-450 feet thick.

MISSISSIPPIAN SYSTEM

VALMEYERAN SERIES

Springville Shale

The New Albany black shale is overlain by 10-25 feet of gray to greenish gray shale that is assigned to the Springville Shale of Valmeyeran age. These beds

TABLE 1 - STRATIGRAPHIC COLUMN

		Approx. thickness (feet)
Quaternary System		
Pleistocene Series		
Recent (stream alluvium)		
Wisconsinan Stage (terrace deposits, silt and sand)		
Pennsylvanian System		
Kewanee Group		
Spoon Formation (shale)		?
McCormick Group		
Abbott Formation		
Murray Bluff Sandstone (coarse, micaceous sandstone)	80	
Undifferentiated (shale, thin-bedded argillaceous sandstone, Delwood Coal Member)	20–60	
Finnie Sandstone (micaceous, argillaceous sandstone)	25–60	* 200–330
Undifferentiated (shale, thin-bedded sandstone, Willis Coal Member)	20–70	
Grindstaff Sandstone (fine- to medium-grained sandstone)	10–80	
Undifferentiated (shale, thin-bedded sandstone)	40–100	
Caseyville Formation		
Pounds Sandstone (medium- to coarse-grained conglomeratic sandstone)	60–100	
Undifferentiated (shale, thin-bedded sandstone, Gentry Coal Member, Sellers Limestone Member)	60–100	* 250–350
Battery Rock Sandstone (medium- to coarse-grained conglomeratic sandstone)	0–100	
Lusk Shale (shale, thin-bedded sandstone)	0–100	
Mississippian System		
Top of Chesterian Series		
Pope Megagroup		
Kinkaid Formation (gray, cherty limestone)		0–40
Degonia Sandstone (shale, thin-bedded siltstone and sandstone, chert)		0–25
Clore Formation (shale, limestone, siltstone, thin-bedded sandstone)		80–110
Palestine Sandstone (sandstone, silty shale, siltstone)		50–60
Menard Limestone (limestone and shale)		100–130
Waltersburg Formation (shale, thin-bedded sandstone or siltstone)		15–50
Vienna Limestone (limestone, shaly limestone)		10–20
Tar Springs Sandstone (sandstone, shale, thin coals)		70–90
Glen Dean Limestone (limestone, shale)		40–60
Hardinsburg Sandstone (sandstone, shaly sandstone, shale)		90–110
Golconda Group		
Haney Limestone (medium- to thick-bedded limestone)	30–50	
Fraileys Shale (shale, siltstone, thin limestone beds)	80–90	* 120–130
Beech Creek Limestone (commonly silty limestone)	5–15	
West Baden Group		
Cypress Sandstone (sandstone, shale, siltstone)		80–100
Ridenhower Formation (shale, shaly sandstone, siltstone, thin limestone lenses)		25–65
Bethel Sandstone (sandstone, basal conglomerate)		70–100

TABLE 1 - continued

		(feet)
Mammoth Cave Megagroup		
Cedar Bluff Group		
Downeys Bluff Limestone (fossiliferous limestone, shale)		20–40
Yankeetown Shale (shale, siltstone, limestone)	15–30	* 30–45
Renault Limestone		
Shetlerville Member (medium gray, partly oolitic, dense limestone)	15–25	
Top of Valmeyeran Series		
Levias Member (light gray, oolitic limestone, fossiliferous limestone)		15–35
Pre-Cedar Bluff Formations		
Aux Vases Sandstone		
Rosiclare Member (calcareous sandstone, sandy limestone)		15–35
Ste. Genevieve Limestone		
Joppa Member (oolitic limestone, fine-grained limestone)	30±	* 140–160
Karnak Member (oolitic limestone)	30±	
Spar Mountain Sandstone (calcareous sandstone, sandy limestone)	0–7	
Fredonia Member (oolitic limestone, fine-grained limestone)	80–100	
St. Louis Limestone (cherty, fine-grained limestone)		350–400
Salem Limestone (dark-colored, fine-grained limestone, dolomitic limestone, foraminiferal limestone, some chert)		500–520
Harrodsburg Limestone (medium- to coarse-grained, crinoidal, bryozoan limestone)		80–300
Knobs Megagroup		
Fort Payne Formation (calcareous siltstone, silty limestone, chert)	270–615	* 280–640
Springville Shale (gray and greenish gray shale, lower 2-3 feet buff to gray shale with calcareous siltstone or limestone lenses possibly equal to Chouteau (Kinderhookian) Limestone)	10–25	
Mississippian and Devonian Systems		
New Albany Group (carbonaceous shale, upper part of Kinderhookian age)		400–450
Devonian System		
Hunton Megagroup		
Lingle Limestone (cherty, partly argillaceous limestone)	106**	* 350± exposed
Grand Tower Limestone (light colored, cherty limestone, sandy at base)	144**	
Clear Creek Formation (calcareous dolomite and chert, base not exposed)	?	

*Strata enclosed in brackets are mapped together as a unit (pl. 1, in pocket).

**Thicknesses from Maretta Oil Company and Northern Ordnance Company—Fricker No. 1 oil test in SE¼ SE¼ sec. 30, T. 11 S., R. 8 E., on south side of Hicks Dome.

THIS REPORT						J.M. WELLER ET AL., 1952		S. WELLER ET AL., 1920 BUTTS, 1925	
SYSTEM	SERIES	MEGA-GROUP	GROUP	FORMATION	MEMBER (Key members only, in Pennsylvanian)	FORMATION	MEMBER	FORMATION	MEMBER
PENNSYLVANIAN			Kewanee	Spoon		Macedonia		Tradewater	
			McCormick	Abbot	Murray Bluff				
					Finnie	Delwood			
					Grindstaff	Grindstaff			
				Caseyville	Pounds	Pounds		Caseyville	
					Battery Rock	Battery Rock			
					Lusk	Lusk			
MISSISSIPPIAN	CHESTERIAN	Pope		Kinkaid	Goreville *	Kinkaid		Kinkaid	
					Cave Hill *				
					Negli Creek				
				Degonia		Degonia			
				Clore	Ford Station	Clore			
					Tygett			Degonia	
					Cora			Clore	
				Palestine		Palestine		Palestine	
				Menard	Allard	Menard		Menard	
					Scottsburg				
					Walche				
				Waltersburg		Waltersburg		Waltersburg	
				Vienna		Vienna		Vienna	
				Tar Springs		Tar Springs		Tar Springs	
				Glen Dean		Glen Dean		Glen Dean	
				Hardinsburg		Hardinsburg		Hardinsburg	
			Golconda	Haney		Golconda		Golconda	
				Fraileys					
				Beech Creek					
			West Baden	Cypress		Cypress		Cypress	
				Ridenhower		Point Creek		Point Creek	
				Bethel		Bethel		Bethel	
		Mammoth Cave	Cedar Bluff	Downeys Bluff		Renault	Downeys Bluff	Renault	
				Yankeetown			Shetlerville	Shetlerville	
				Renault	Shetlerville				
	VALMEYERAN				Levias	Ste. Genevieve	Levias	Ste. Genevieve	Lower Ohara
				Aux Vases	Rosiclare		Rosiclare		Rosiclare
				Ste. Genevieve	Joppa		Upper Fredonia		Fredonia
					Karnak				
					Spar Mountain		Spar Mountain		
					Fredonia		Lower Fredonia		
				St. Louis		St. Louis		St. Louis	
				Salem					
				Harrodsburg		Warsaw-Salem		Warsaw	
		Knobs		Fort Payne					
				Springville		Osage Group		Osage	
	KIND.					Kinderhook Gp.		Chattanooga	
DEVONIAN	UPPER		New Albany			New Albany			
						Alto			
	MIDDLE	Hunton		Lingle		Lingle		"Limestone of Devonian Age"	
				Grand Tower		Grand Tower			
						Dutch Creek			
	LOWER			Clear Creek		Clear Creek			

* Removed by pre-Pennsylvania erosion in area of this report

Figure 2 - Development of stratigraphic classification.

are not well exposed in the map area but are exposed in the banks of Hicks Branch in the NW¼ SE¼ sec. 25, T. 11 S., R. 7 E., just west of the map area. At that location, gray to buff shale with lenses of very silty, fossiliferous limestone occurs at the base of the Springville. This basal unit of the Springville may be Kinderhookian in age and equivalent to the Chouteau Limestone. The Springville also is exposed along the east-west roadway near the center of the east line of sec. 36, T. 11 S., R. 7 E. This outcrop, also west of the map area, includes a zone containing glauconite.

Fort Payne Formation

The Fort Payne Formation is a thick unit that consists of dark gray to black, calcareous siltstone or silty limestone. It is 280-640 feet thick, more calcareous at the top, and except for the lower 50-100 feet is extremely cherty. The Fort Payne is bounded by shale at the base and by relatively pure limestones of the Mammoth Cave Megagroup at the top. The Fort Payne is roughly equivalent in age to the more clastic Borden Group that crops out in Indiana and occurs in the subsurface of the Illinois Basin. The Hardin County section is, in general, less calcareous than strata of similar age in western Illinois. It cannot be divided into formations (i.e. Keokuk, Burlington, Warsaw).

Exposures in the Karbers Ridge Quadrangle occur in a hilly belt surrounding Hicks Dome, where the Fort Payne has been almost completely leached. Outcrops consist mainly of noncalcareous, nonfossiliferous "chert" that is in regular layers up to one foot thick with thin interlayers of clay. Beds of this lithology are exposed in an abandoned quarry in the NW¼ SE¼ NW¼ sec. 32, T. 11 S., R. 8 E.

Harrodsburg Limestone

The Harrodsburg Limestone, lowermost unit of the Mammoth Cave Limestone Megagroup (Swann and Willman, 1961, p. 481), is named for exposures near Harrodsburg in Monroe County, Indiana. The name Harrodsburg is applied here to a sequence of limestone beds that overlie the Fort Payne Formation and underlie the Salem Limestone. The Harrodsburg consists mainly of light gray limestone that is composed of medium- to coarse-grained fragments of crinoid ossicles with fine-grained detritus of other fossils, mainly bryozoa. A lower part of the sequence is darker colored, cherty, and in general less pure than the upper part.

Outcrops of the Harrodsburg are restricted to the area around Hicks Dome where poor exposures and possibly faulting obscure stratigraphic details. A complete section obtained from a deep core drilling near Cave in Rock showed a thickness of 300 feet. The best outcrops of the Harrodsburg occur on the south side of Hicks Dome where the total thickness appears to be much less than 300 feet, perhaps as little as 60 feet.

Salem Limestone

The Salem Limestone occupies a belt approximately ½-mile wide that encircles Hicks Dome. The best exposures are along the east-west flowing tributary of Big Creek in sec. 28, T. 11 S., R. 8 E. Other outcrops occur in the area between the Rock Creek Graben on the south and the Wolrab Mill Fault on the north.

The Salem conformably overlies the Harrodsburg Limestone. Its lower and upper limits are transitional; therefore, interpretations of its thickness may vary. A thickness of 500-520 feet, based on core drill information near Cave in Rock in Illinois and Kentucky, now is considered a reasonable estimate for Hardin County.

The Salem Limestone comprises three distinct units recognized on gross lithologic features. The lower unit, approximately 260 feet thick, consists of fossil-fragmental limestone similar to the Harrodsburg, which is intercalated with dark, fine-grained limestone. Portions of the lower part of the Salem are argillaceous, silty, and dolomitic with some prominent cherty beds. The middle unit, 100-120 feet thick, is largely medium brownish gray, calcarenitic limestone that is oolitic in part and contains abundant endothyroid foraminifera, including Endothyra baileyi. The upper unit, 120-150 feet thick, consists predominantly of medium gray to almost black, fine-grained limestone that is somewhat argillaceous and dolomitic. In the limestone, there are thin beds and lenses of medium to dark gray calcarenite that contain endothyroid foraminifera, including Endothyra baileyi. The colonial coral Lithostrotion proliferum also occurs in the upper unit. Chert is less abundant in the upper unit than in the lower part.

St. Louis Limestone

The St. Louis Limestone occurs in a belt ½- to 1 mile wide that encircles Hicks Dome. It also occurs in the area between the graben and the Wolrab Mill Fault. It underlies a considerable part of the Elizabethtown Plain along the Ohio River between Elizabethtown and the east edge of the map area.

The St. Louis is predominantly a cherty, brownish gray, sublithographic to fine-grained limestone with some interbedded, fossiliferous limestone; fine-grained dolomitic limestone; and, in its upper parts, oolitic limestone. Abundant chert in heavy bands and nodules is characteristic; large chert nodules occur in the upper part of the formation.

The upper and lower limits of the St. Louis are not well defined in the map area, for there is a gradual transition into the Ste. Genevieve above and into the Salem below. The total thickness is estimated to be 350-400 feet. Former estimates of thickness have varied greatly. Weller (1920) gives the total thickness as 350 feet, and more recent authors (Weller et al., 1952) have cited thicknesses as great as 500 feet.

Ste. Genevieve Limestone

The Ste. Genevieve Limestone overlies the St. Louis Limestone. Northeast of the Wolrab Mill Fault the Ste. Genevieve occupies a belt approximately 1/3-mile wide that partially encircles Hicks Dome. It also crops out in the area intermediate to the Wolrab Mill Fault and the graben. The best exposures are located south of the graben in the bluffs of the Ohio River near Rosiclare.

The Ste. Genevieve is 140-160 feet thick. It consists of limestone of varying lithologic character and several sandy lenses that are distributed erratically. The Spar Mountain Sandstone Member, the most persistent sandy zone, has been recognized in some drill records. It occurs about 60 feet below the Aux Vases Sandstone in the Rosiclare area and has served as a basis for further subdivision of the formation in limited areas.

The Fredonia Member occurs at the base of the Ste. Genevieve Limestone and consists of gray to light gray, oolitic limestone and medium gray, fine-grained dolomitic limestone. Oolitic limestones of the "McClosky type" found in the Illinois Basin area are well developed locally and have thick cross-bedded units. The Fredonia is about 60-80 feet thick. Most of this thickness is free of chert, although fine-grained, cherty limestone has been reported in the Ste. Genevieve within 25 feet below the Aux Vases Sandstone in outcrops just across the Ohio River in Kentucky (Dewey Amos, personal communication, 1961).

The Spar Mountain Sandstone Member is not recognized in outcrops in the Karbers Ridge or Rosiclare Quadrangles, although occasional sandstone float blocks that are encountered in areas underlain by low Ste. Genevieve or high St. Louis beds may come from this horizon.

The upper 50-60 feet of the Ste. Genevieve represent two members that cannot be accurately delimited. These are the Karnak and Joppa Members. The interval consists of medium- to thick-bedded limestone layers that are part fossiliferous and oolitic and generally medium gray in color. They are somewhat darker than the oolitic limestone of the Fredonia Member.

Aux Vases Sandstone

The Aux Vases Sandstone is represented by the Rosiclare Sandstone Member. The Rosiclare is equivalent to a part of the type Aux Vases of southwestern Illinois.

Rosiclare Member – The Rosiclare Member of the Aux Vases Sandstone overlies the Ste. Genevieve. It is 15-35 feet thick and consists of very fine-grained, gray or greenish gray, calcareous sandstone or siltstone, with interbedded limestone. The sandstone is commonly cross-bedded and, in some cases, ripple marked. Relatively thick beds occur locally, and when weathered these beds resemble sandstones of the Pope Megagroup. A foot or more of sandy, micaceous, greenish gray shale may occur at the base of the sandstone.

The best exposures of the Aux Vases occur in Downeys Bluff and Fairview Bluff of the Ohio River, south of Rosiclare.

Cedar Bluff Group

Renault Limestone

The Renault Limestone consists of two members, in ascending order, the Levias and Shetlerville. The total thickness of the Renault varies from 35 to perhaps 60 feet. The Levias appears as a separate unit on the geologic map (pl. 1); whereas the Shetlerville Member of the Renault and the Yankeetown Shale that overlies the Shetlerville are mapped together.

Levias Member – The Levias Member of the Renault Limestone overlies the Aux Vases Sandstone. This contact is generally conformable, although some drill records report a conglomeratic zone at the base of the Levias. The Levias consists of light gray, medium-grained limestone that is partly oolitic and medium gray, fine-grained limestone. Pink calcite crystals are diagnostic. The thickness of the Levias varies in Hardin County. It is about 25-35 feet in the Rosiclare district, and in other areas it may be removed almost completely by pre-Shetlerville erosion. Good exposures occur in Fairview Bluff and Downeys Bluff of the Ohio River, south of Rosiclare.

CHESTERIAN SERIES

Shetlerville Member – The Shetlerville Member of the Renault Limestone is the lowermost unit of Chesterian age. The contact with the subjacent Levias Member is unconformable and, in some cases, marked by a basal limestone conglomerate. The Shetlerville is about 25 feet thick. The lower part, 2-14 feet thick, is mostly argillaceous, coarsely crystalline, silty limestone. The more impure beds of the lower part grade to siltstone locally. The more calcareous beds are commonly finely oolitic. The upper 10-20 feet of the Shetlerville consists of relatively pure, partly oolitic, medium-grained to sublithographic limestone, with minor amounts of interbedded gray shale.

The Shetlerville Member does not crop out as extensively as does the Levias Member of the Renault Limestone. It did not prove practical to separate the Shetlerville from the overlying Yankeetown Shale for mapping purposes; therefore, these two units were mapped together. The Shetlerville is poorly exposed in the foreslopes of ridges capped by Bethel Sandstone. The stratigraphic relations are seen only in the bluffs of the Ohio River, near Rosiclare.

Yankeetown Shale

The Yankeetown Shale, due to its soft nature, does not generally crop out. It is present, however, underlying covered intervals in the foreslopes of ridges capped by the Bethel Sandstone and is exposed partially in Downeys Bluff of the Ohio River, near Rosiclare.

The Yankeetown is 15-30 feet thick in the map area. It consists of calcareous, greenish gray or red, fossiliferous shale; dark gray, fossiliferous shale; greenish gray and red mottled, argillaceous dolomite or dolomitic siltstone; and buff or greenish gray, medium- to coarse-grained, fossiliferous limestone. The contact between the Yankeetown and the Shetlerville Member of the Renault is gradational.

Downeys Bluff Limestone

The Downeys Bluff Limestone overlies the Yankeetown Shale. In the type section of the formation in Downeys Bluff, south of Rosiclare, this contact seems to be unconformable; however, it has not been observed at other localities. The Downeys Bluff Limestone ranges in thickness from 25-40 feet. It consists of medium-bedded, gray to brownish gray, fossiliferous limestone. Oolites are common and locally abundant. Gray or in some cases pink chert often is present, especially in the upper part of the formation. Some beds within the formation are dolomitic and fine grained, and interbedded light gray, calcareous shale may be present. A few feet of greenish or reddish gray shale occur at the top of the formation, although at many places it is absent because of pre-Bethel erosion. The upper shale is silty or sandy, commonly calcareous, and contains marine fossils.

West Baden Group

In Hardin County, the West Baden Group is a thick clastic unit that is composed predominantly of sandstone. In the Rosiclare area, the West Baden Group is over 200 feet thick and comprises three formations. In ascending order, they are the Bethel Sandstone, the Ridenhower Formation, and the Cypress Sandstone. The deposition of the Bethel Sandstone marked the beginning of a long period of alternating limestone, shale, and sandstone deposition. These alternating or cyclic formations compose the Pope Megagroup (Swann and Willman, 1961, p. 481). It is difficult to map the stratigraphic limits of the Ridenhower because this part of the West Baden Group is not exposed adequately. The upper limit of the Ridenhower is mapped largely on the topographic expression of shaly beds near the top of the formation. The lower contact is even more difficult to map because there is not a good lithologic break between the Ridenhower and the underlying Bethel. However, reasonable accuracy probably was attained in the mapping.

Bethel Sandstone

The Bethel Sandstone unconformably overlies the Downeys Bluff Limestone, and the contact is marked generally by a basal conglomerate. The Bethel is one of the more persistent bluff-forming sandstones of the area. It crops out on the north and northeast flanks of Hicks Dome, in a belt offset by northeast-trending faults. It also occupies a belt lying between the Wolrab Mill Fault and the Rock Creek Graben and is prominent in the bluff that rises above the limestone formations of the Elizabethtown Plain and parallels the southeast edge of the graben.

The Bethel is a light gray, fine- to medium-grained sandstone. It is 80-100 feet thick in the Rosiclare area but may be somewhat thinner to the north and east and slightly thicker to the south. Beds in the lower two-thirds are mostly 1-5 feet thick with intercalated thin-bedded units. The upper third has thinner beds, generally 2 feet to less than 1 inch.

The Bethel is exposed near Rosiclare where it caps the bluffs of the Ohio River in sec. 5, T. 13 S., R. 8 E. The upper part is exposed in an old abandoned quarry in the NE$\frac{1}{4}$ SE$\frac{1}{4}$ NW$\frac{1}{4}$ of sec. 6, T. 12 S., R. 9 E.

Ridenhower Formation

The Ridenhower Formation, formerly called the Paint Creek Formation, overlies the Bethel Sandstone. Diamond drill cores indicate that the contact is one of conformity with gradual transition from one lithology to the other. In Hardin County, thicknesses cited for the Ridenhower vary greatly owing to lack of adequate exposures and to use of different criteria for determining the stratigraphic limits of the formation.

The Ridenhower Formation consists of light gray, very fine-grained, thin-bedded sandstone; greenish gray, silty shale and/or siltstone; and in some cases, a layer of light gray, sandy limestone near the top of the formation. Four feet of limestone was reported in drilling in the vicinity of the Hillside mine near Rosiclare. The Ridenhower is at least 65 feet thick in the Rosiclare area but may be thinner elsewhere.

Cypress Sandstone

The Cypress Sandstone, a resistant formation, overlies the Ridenhower. The contact is unconformable and often marked by a conglomeratic zone that contains shale fragments and/or limestone pebbles. The distribution of Cypress Sandstone is similar to that of underlying formations of the West Baden Group. In the Karbers Ridge Quadrangle, it crops out in an area south of Pinhook Creek on the north flank of Hicks Dome; along a belt in the southern part of secs. 14 and 15, T. 11 S., R. 8 E.; and in a third area southeast of Harris Creek. In the Rosiclare Quadrangle, it occurs in complexly faulted areas west and northeast of Rosiclare.

The Cypress Sandstone is 80-100 feet thick. The lower part is a predominantly massive, light gray or buff colored, fine-grained sandstone. The upper half to one-third has considerable interbedded shale, and subsurface records report green shale and siltstone at the top of the formation.

Golconda Group

The Golconda Group consists of three formations with an aggregate thickness of 120-130 feet. Exposures that reveal the stratigraphic relations of the formational subdivisions are rare; therefore, the group was mapped as a single stratigraphic unit.

The Golconda crops out on the north flank of Hicks Dome in a narrow belt that lies just north of Pinhook Creek. This belt extends from the east edge of Karbers Ridge Quadrangle to a major offset by the Lee Fault near the Lee mine. Other belts lie north of the east-west trending valley in the south half of secs. 14 and 15, T. 11 S., R. 8 E., and north of Harris Creek in sec. 24. In the Rosiclare Quadrangle, strata of the Golconda Group crop out in the complexly faulted areas near Rosiclare and northeast of Rosiclare.

In ascending order, the formations that compose the Golconda Group are the Beech Creek Limestone, the Fraileys Shale, and the Haney Limestone. The Beech Creek may not be persistent, but where recognized it consists of slightly argillaceous fine- to medium-grained limestone that is dark to medium gray and commonly silty or sandy. It is generally less than 10 feet thick but may be as thick as 15 feet.

The Fraileys Shale is 80-90 feet thick. It consists largely of shale, but interbedded limestone occurs especially in the lower half. In the upper half, thin beds of limestone and calcareous siltstone are interbedded with shale. Limestone is commonly gray to buff and at some places very fossiliferous. Red or green siltstone occurs near the top of the formation.

The Haney Limestone is exposed with some regularity in the upper portions of ridges that are capped by Hardinsburg Sandstone. It consists of medium- to thick-bedded limestone usually with minor shale partings. The limestone is brownish gray, fine- to coarse-grained, usually fossiliferous, and locally oolitic. The Haney is 30-50 feet thick, averaging about 40 feet.

(End of Golconda Group)

Hardinsburg Sandstone

The Hardinsburg Sandstone, 90-110 feet thick, is a resistant formation that overlies the Haney Limestone. Although the contact between these units is generally considered to be unconformable, in some places massive sandstone of the Hardinsburg is separated from limestone of the Haney by 5-50 feet of shale and shaly sandstone without evidence of an unconformable relationship. In these cases, there is a gradual transition from soft greenish or reddish gray fossiliferous shale into more compact silty or sandy shale. Where the contact is unconformable, the shale is absent, and massive sandstone rests upon massive limestone beds of the Haney.

Hardinsburg caps the ridge just north of Pinhook Creek, occupying a belt of outcrop that extends from the west edge of the Karbers Ridge Quadrangle to a point northeast of the Lee mine. It also reaches the surface in an area south of the Lee mine, mostly in secs. 14 and 15, T. 11 S., R. 8 E., and it caps the first ridge north of the Goose Creek Fault near the east edge of the Karbers Ridge Quadrangle. Hardinsburg Sandstone occurs at the surface in several fault blocks in the Rosiclare Quadrangle.

The Hardinsburg is, in large part, thin-bedded, shaly sandstone or interlayered sandstone and shale. The sandstone is light gray, very fine grained, and usually has irregularly shaped ripple marks. The shale is light gray or light greenish gray, but there is some dark gray shale in the upper part of the formation. The lower half has medium- to thick-bedded, fine-grained sandstone that is, in many cases, cross-bedded. Some drill records show several feet of thin-bedded, shaly sandstone at the base of the formation.

Glen Dean Limestone

The Glen Dean Limestone is one of the thinner and more poorly exposed limestone formations of the Pope Megagroup. Its distribution in the Karbers Ridge Quadrangle is shown by occasional outcrops of relatively thick-bedded limestone in the upper part of the formation. The pattern of distribution is similar to that of the Hardinsburg Sandstone. The Glen Dean Limestone occupies the foreslopes of a line of low hills that lie north of the belt of Hardinsburg outcrops previously described. It also occurs in fault blocks northeast of Rosiclare.

The Glen Dean is 50-60 feet thick and consists of limestone and shale. The limestone occurs principally in two benches; is brownish gray, fine- to coarse-grained, and fossiliferous; and contains conspicuous crinoid segments and bryozoan fragments. The upper bench, up to 25 feet thick, is fairly light colored, relatively pure, and locally oolitic; some chert is generally present. The lower bench is generally less pure, more fossiliferous, and in some places grades to silty or sandy dolomite at or near the base. Most beds are 1 inch to 1 foot thick and have intervening dark shale laminae. The shale that separates the two benches is medium to dark gray, calcareous with a few thin limestone beds. The Glen Dean lies conformably on the Hardinsburg.

Tar Springs Sandstone

The Tar Springs Sandstone caps a line of low hills on the north flank of Hicks Dome and extends from the west edge of the Karbers Ridge Quadrangle to the Lee Fault in sec. 11, T. 11 S., R. 8 E. Between the Lee and Wolrab Mill Faults, the Tar Springs Sandstone crops out on either side of a subsidiary fault, principally in secs. 14 and 15. The best exposures are along Harris Creek in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 18, T. 11 S., R. 9 E., where the creek cuts across a belt extending from the Wolrab Mill Fault zone to the east edge of the quadrangle. The Tar Springs also occupies portions of several fault blocks in the Rosiclare Quadrangle. Massive sandstone of the formation is exposed north of the road fork in the SE$\frac{1}{4}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 11, T. 12 S., R. 8 E.

The Tar Springs is about 90 feet thick in the map area. At some places, massive sandstone unconformably overlies the Glen Dean. In other areas, silty shale occurs at the base of the formation, and the unconformable contact is not well defined because there seems to be a transition from calcareous shale to silty shale. The Tar Springs consists of alternating layers of light gray or buff colored, fine-grained, cross-bedded sandstone and shaly, relatively thin- and even-bedded sandstone. Shale is most common in the upper 20 feet and in a middle portion of the formation. Thin impure coal seams occur near the top and in the middle shale. The uppermost coal crops out at various places in the Karbers Ridge Quadrangle and is well exposed at the Harris Creek area in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 18, T. 11 S., R. 9 E.

Vienna Limestone

The Vienna Limestone is a thin unit that is poorly exposed in the map area. Exposures occur in a gully south of Rose Creek in the SW¼ SE¼ sec. 6, T. 11 S., R. 8 E., and in the bank of Harris Creek in the SW¼ SE¼ NW¼ sec. 18, T. 11 S., R. 9 E. At the latter location, the conformable contact of the Vienna with the underlying Tar Springs is exposed.

The Vienna is 10-20 feet thick. It consists of impure, commonly siliceous, dark brownish gray, fine-grained limestone. When very siliceous portions weather, they yield characteristic blocky chert fragments. The limestone is overlain locally by a few feet of dark greenish gray shale that is fossiliferous and calcareous. In some cases, the limestone portion has interbedded, medium to dark gray shale. Shale is less abundant in other places, and there is local development of light colored, medium- to coarse-grained, fossiliferous limestone that is, in part, oolitic.

Waltersburg Formation

The Waltersburg Formation is a moderately resistant formation that supports a dissected ridge line, just south of Rose Creek, that extends from the west edge of the Karbers Ridge Quadrangle to the Lee Fault. At other localities in the Karbers Ridge Quadrangle, it is exposed in the lower foreslopes of ridges that are capped by Palestine Sandstone. The best exposures occurring under this condition are located north and west of the sharp curve of Harris Creek in sec. 18, T. 11 S., R. 9 E. In the Rosiclare Quadrangle, the Waltersburg is exposed poorly in several fault blocks north and northeast of Rosiclare.

The Waltersburg is about 40 feet thick in the map area. It consists of very shaly, thin-bedded sandstone or interlaminated shale and sandstone similar to portions of the Hardinsburg. The lower 10-20 feet is mainly dark gray shale with ironstone concretions. It is not known to crop out in this area.

Menard Limestone

The Menard Limestone occurs in a belt that extends across the Karbers Ridge Quadrangle with major offsets by the Lee and Wolrab Mill Faults. It occupies the foreslopes of prominent ridges capped by Palestine Sandstone. Good exposures occur along the tributaries of Harris Creek in the N½ sec. 18, T. 11 S., R. 9 E. In the Rosiclare Quadrangle, exposures occur north of Elizabethtown and west and north of Rosiclare. A fairly good exposure in the Rock Creek Graben is located west of the roadway ¼-mile southwest of Keeling Hill, near the center of sec. 11, T. 12 S., R. 8 E.

The Menard Limestone conformably overlies the Waltersburg Formation. It is 100-130 feet thick and consists of three limestone members, the Walche, Scottsburg, and Allard Members, with intervening unnamed shale members.

The Walche Member, at the base of the formation, is 3-8 feet thick, mostly dark gray, argillaceous, fossiliferous limestone. Five to seven feet of gray shale normally separate the Walche from the overlying Scottsburg Member.

The Scottsburg Member is 30-40 feet thick, mainly thick-bedded, grayish brown, sublithographic limestone with minor shale partings. A bed in the lower part has abundant specimens of brachiopods *Composita subquadrata* and *Spirifer increbescens*. The Scottsburg is separated from the overlying Allard Member by 10 to 20 feet of gray or in some cases partly red or greenish gray shale.

The Allard Member is 30 to 35 feet thick and mostly composed of slightly cherty, dark gray, fine-grained limestone. Dolomitic limestone occurs near the center of the member.

Ten or more feet of dark gray, fissile, unfossiliferous shale usually occur at the top of the formation.

Palestine Sandstone

The Palestine Sandstone is the youngest major ridge-forming sandstone of the Pope Megagroup. The contact with the underlying Menard Limestone is one of abrupt lithologic change and, like the lower contact of other sandstones of the Pope, is thought to be unconformable.

Palestine Sandstone supports a prominent ridge that stands in front of the Pennsylvanian sandstone escarpment throughout the latter's extent in the Karbers Ridge Quadrangle. A good exposure of the Palestine is in a tributary of Harris Creek in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 18, T. 11 S., R. 9 E. Palestine also occurs in fault blocks in the Rosiclare Quadrangle. An exposure of the lower contact is in the roadcut at the crest of the hill just over $\frac{1}{4}$-mile south of Keeling School in sec. 11, T. 12 S., R. 8 E.

The Palestine is about 60 feet thick and consists of light gray to yellowish gray, fine-grained sandstone. Generally, it is a thin- and even-bedded, ripple-marked sandstone that has considerable interbedded shale and siltstone, especially in the upper part. The shale is dark gray, arenaceous, and commonly carbonaceous. Thick-bedded and cross-bedded sandstone also occurs particularly in the lower part of the formation.

Clore Formation

The Clore Formation overlies the Palestine Sandstone and occurs at or near the surface in the lower parts of the slopes south of the Pennsylvanian escarpment just south of the county line in the Karbers Ridge Quadrangle. The best exposures are along the tributary to Harris Creek in the NW$\frac{1}{4}$ sec. 18, T. 11 S., R. 9 E., and the SE$\frac{1}{4}$ sec. 12, T. 11 S., R. 8 E. The Clore also is exposed poorly in graben exposures west and north of Rosiclare, and north and east of Elizabethtown in the Rosiclare Quadrangle.

The Clore and younger Mississippian formations are mainly nonresistant and generally covered by talus from the overlying Pennsylvanian strata. The Clore consists of three members, but the internal stratigraphy of the formation cannot be delimited accurately in the map area because of poor exposure and paucity of subsurface data. In ascending order, the members are the Cora Member, Tygett Sandstone Member, and Ford Station Member. The Tygett Sandstone Member is the most prominent of several siltstone and sandstone horizons and most commonly occurs about 40 feet above the base of the formation, separating shale and limestone strata of the Cora Member from the Ford Station. Siltstone that probably grades laterally into a prominent sandstone occurs, interbedded with shale of the Ford Station Member, about 80 feet above the base of the formation. The Clore is about 100 to 110 feet thick, mostly shale and limestone. The shales are quite variable as are the limestone beds. The latter are generally beds of medium thickness and consist of fine- to medium-grained limestone in various shades of gray and brownish gray color. Some limestone is quite fossiliferous.

The contact with the underlying Palestine probably is always one of conformity. The Clore is overlain by either the Degonia Sandstone or the Caseyville Formation depending on the local relief of the pre-Pennsylvanian erosional surface.

Degonia Sandstone

The Degonia Sandstone is thin and poorly exposed throughout its extent in the Karbers Ridge Quadrangle. Exposures are fragmentary and do not reveal the full stratigraphic sequence normally comprising the formation. Locally the Degonia has been partially or completely removed by pre-Pennsylvanian erosion.

The Degonia occurs in the foreslopes of the Caseyville escarpment in the Karbers Ridge Quadrangle. It crops out for a distance of $1\frac{1}{2}$ miles extending west from a point in the N$\frac{1}{2}$ of sec. 4, T. 11 S., R. 8 E., just south of High Knob located near the south line of sec. 33, T. 10 S., R. 8 E. The Degonia is present in each of the fault segments east of High Knob but is cut out by the Lusk Shale Member near the east edge of the quadrangle. Clore Limestone occurs at the unconformity in the southeast corner of the Karbers Ridge Quadrangle, but Degonia is present, separating the Clore Formation from limestone of the Kinkaid in exposures within the graben near Keeling School and in other fault blocks north and east of Rosiclare.

The Degonia Sandstone is probably 20 to 35 feet thick throughout most of its extent in the map area. A lower part is composed of interbedded siltstone and greenish gray, thin- to medium-bedded, fine-grained micaceous sandstone. An upper part is largely shale, in mottled shades of brown, greenish gray and red. Extremely fine-grained, calcareous siltstone at the top and bottom of the formation weather to yield blocky, chert-like fragments. These beds have been observed in place at various localities in eastern Pope County and in adjacent portions of the Rock Creek Graben in Kentucky, opposite Rosiclare. They are even bedded and invariably ripple marked.

The Degonia probably overlies the Clore unconformably, although the contact has not been observed.

Kinkaid Formation

The Kinkaid Formation is the youngest unit of Chesterian age present in the Illinois fluorspar district. It consists principally of limestone and shale that, where fully developed and unaffected by late Mississippian and early Pennsylvanian erosion, has an aggregate thickness of at least 140 feet. The formation is comprised by three members. The members and their dominant lithology are, in ascending order : the Negli Creek Limestone Member, the Cave Hill Member (shale and limestone), and the Goreville Limestone Member. The Negli Creek is the only unit that is recognized with certainty in the map area, although shale of the Cave Hill Member may be present locally.

Limestone of the Negli Creek Member is exposed at various places along the Caseyville escarpment in the northern part of the map area, but the best outcrops of the member are exposed in the graben west of Rosiclare. It crops out in the vicinity of Lavender Hill in sec. 30, T. 12 S., R. 8 E. The Negli Creek is gray to dark gray limestone that is very fine-grained to medium-crystalline, medium- to thick-bedded, and has small nodules and thin layers of gray chert in its middle part. A characteristic zone bearing fossil snails of considerable size occurs about 10 feet above the base.

The thickness of the Kinkaid strata cannot be accurately estimated, but probably does not exceed 50 feet at any point in the quadrangles. Of this the lower 30 feet is the Negli Creek Member that conformably overlies the Degonia Sandstone.

THE MISSISSIPPIAN-PENNSYLVANIAN UNCONFORMITY

The Mississippian-Pennsylvanian unconformity is an irregular surface with a relief of at least 100 feet in the Karbers Ridge Quadrangle. Late Mississippian or early Pennsylvanian erosion was responsible for the local removal of formations of late Chesterian age above the Clore Formation. At some localities, much of the Clore was eroded. The highest Chesterian unit present in the area is the lowest massive limestone of the Kinkaid Formation, the Negli Creek Member. This quadrangle is on the west border of the Evansville channel (Wanless, 1955, p. 1763), a prominent southwestward trending channel that is incised into the Mississippian rocks as low as the Menard Formation (Baxter et al., 1963, p. 21).

It appears that the surface on which Pennsylvanian strata were deposited in the Karbers Ridge Quadrangle is irregular because interfluves or "islands" capped by Kinkaid are adjacent to valleys in which erosion cut down into the Clore Formation. The Pennsylvanian sediments rest on Clore in the SE$\frac{1}{4}$ sec. 7, T. 11 S., R. 9 E., but on the Kinkaid in the SW$\frac{1}{4}$ sec. 7, T. 11 S., R. 9 E., suggesting that the local relief exceeds 60 feet. The Pennsylvanian rests on the red and green shales of the Degonia Formation in the SE$\frac{1}{4}$ sec. 2, T. 11 S., R. 8 E., but in the NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 2, the Clore is the highest formation of Chesterian age present. Westward, in the SW$\frac{1}{4}$ sec. 33, T. 10 S., R. 8 E., just west of High Knob, the Kinkaid Limestone occurs at the unconformity. At the west border of the Karbers Ridge Quadrangle, the Clore is the highest formation of Chesterian age present.

Thus, it appears that there are parts of three local channels represented in the study area, although if more three-dimensional data were available, the interfluves might prove to be islands in a single broad valley.

PENNSYLVANIAN SYSTEM

Pennsylvanian sediments occupy a portion of the area in the north part of the Karbers Ridge Quadrangle, where they have a maximum thickness of about 700 feet, dip northward, and form gentle, dissected cuestas. The dominant lithologies are sandstone and shale in about equal amounts and in all gradations, but massive sandstone units can be differentiated from those composed largely of thin-bedded sandstone and shale. Other exposures of strata of Pennsylvanian age are restricted to downfaulted blocks associated with the Rock Creek Graben in the west and north portions of the Rosiclare Quadrangle and in the southeast corner of the Karbers Ridge Quadrangle.

Three formations, the Caseyville (base of Pennsylvanian to top of Pounds Sandstone Member), the Abbott (top of Pounds Sandstone to top of the Murray Bluff Sandstone Member), and the Spoon (top of Murray Bluff Sandstone to base of the Colchester (No. 2) Coal Member) were mapped and are differentiated by color on the geologic map (pl. 1). Lines marking the top and bottom of named sandstone members, where such can be recognized, serve to further subdivide the formations.

In ascending order, the named sandstone members are the Battery Rock and Pounds in the Caseyville Formation, and the Grindstaff, Finnie, and Murray Bluff in the Abbott Formation. Strata belonging to the Spoon Formation were not observed in the field, but it is assumed that shale occurring above the Murray Bluff Sandstone lies at the surface in a small area in the northeast corner of the Karbers Ridge Quadrangle.

McCormick Group

The McCormick Group has a composite maximum thickness of 700 feet and a minimum thickness of about 400 feet. This group includes the Caseyville and Abbott Formations, all strata from the base of the Pennsylvanian to the top of the Murray Bluff Sandstone Member.

Caseyville Formation

The Caseyville Formation ranges from 250 to 350 feet in thickness. Massive sandstone generally constitutes more than half of this formation while shale and thin-bedded sandstone compose the remaining portion. Two thick, massive sandstone units, the Battery Rock and Pounds, were mapped, but the Battery Rock is not laterally persistent along the outcrop area in the eastern part of the quadrangle.

Lithologically the massive Caseyville sandstones are clean and contain abundant quartz granules or pebbles. The shales are commonly flaggy or fissile, carbonaceous, and may be arenaceous. The intervals between the massive sandstones generally have good topographic expression, but in some cases lateral lithologic change from thin-bedded to massive sandstone complicates field mapping. Local lenses of massive sandstone up to 40 feet thick occur in the Lusk Shale Member.

Lusk Shale Member—The Lusk Shale Member is the interval of sandstone and shale above the Mississippian strata and below the Battery Rock Sandstone. Where the Battery Rock Sandstone pinches out laterally, definition of the Lusk is lacking unless it is assumed to be absent. The Lusk is largely thin-bedded and massive sandstone—shale is a minor constituent in this area. Massive sandstone lenses up to 40 feet thick are present and generally appear where Pennsylvanian rocks rest on strata older than Kinkaid. The 40-foot massive sandstone lens is exposed in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 3, T. 11 S., R. 8 E. At this locality, the Lusk rests on the middle or lower part of the Clore and is about 100 feet thick. About a mile to the northwest in the SW$\frac{1}{4}$ sec. 33, T. 10 S., R. 8 E., the Lusk rests on Kinkaid and is less than 40 feet thick. The Lusk is absent in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 7, T. 11 S., R. 9 E., and here the Battery Rock Sandstone rests on Kinkaid; one-half mile to the east (cen. S$\frac{1}{2}$ SE$\frac{1}{4}$ sec. 7) the Lusk is about 80 feet thick and rests on the Clore Formation. At the latter locality, a 35-foot thick, massive sandstone is developed in the Lusk.

The Lusk Shale Member also is recognized in downdropped blocks within the Rock Creek Graben. In the southeastern corner of the Karbers Ridge Quadrangle, it is exposed in the small westward flowing stream in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 31, T. 11 S., R. 9 E. About 20 to 30 feet of thin-bedded sandstone and arenaceous shale are present beneath about 20 feet of massive, conglomeratic sandstone, probably the Battery Rock Sandstone Member. The lateral persistence of the Lusk is unknown in much of the graben area, but thin-bedded sandstone in the SW$\frac{1}{4}$ SW$\frac{1}{4}$

NE$\frac{1}{4}$ sec. 1, T. 12 S., R. 8 E., is probably the Lusk Member. It occurs above the unconformity in secs. 11 and 12, T. 12 S., R. 8 E., but appears to be discontinuous in secs. 17, 18, 19, and 20 and in secs. 30 and 31, T. 12 S., R. 8 E., where the Battery Rock Sandstone Member directly overlies the Negli Creek Member of the Kinkaid Formation at many localities.

Generally, the massive sandstone beds of the Lusk contain quartz granules and pebbles, but they are not nearly as abundant as in the higher massive Caseyville sandstones. The thin-bedded sandstones are frequently ripple marked and show other primary depositional features. Plant impressions are common. Irregular masses of sub-botryoidal limonite are present near the base of the Lusk in the roadcut in the SE$\frac{1}{4}$ sec. 2, T. 11 S., R. 8 E. The Lusk is well exposed in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 6, T. 11 S., R. 8 E.

Battery Rock Sandstone Member—The Battery Rock Sandstone is the first persistent, bluff-forming Pennsylvanian sandstone above the unconformity. This definition must be modified somewhat because the Battery Rock Sandstone is not persistent in the eastern part of the Karbers Ridge Quadrangle. In the SW$\frac{1}{4}$ sec. 7, T. 11 S., R. 9 E., it forms a 35-foot bluff that diminishes westward. The Battery Rock is not recognized definitely in outcrop for a distance of about a mile along the Caseyville outcrop belt. Except for the small area in the eastern part of the Karbers Ridge Quadrangle where it is not laterally persistent, the Battery Rock is well developed.

The Battery Rock Sandstone is well exposed in the Rock Creek Graben in the S$\frac{1}{2}$ NW$\frac{1}{4}$ sec. 6, T. 12 S., R. 9 E., where it forms a bluff and in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ NE$\frac{1}{4}$ and the SW$\frac{1}{4}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 1, T. 12 S., R. 8 E. At these localities, the Battery Rock Sandstone Member seems to be between 40 and 80 feet thick, but it is defined poorly by overlying strata. Considering the regional dip in the graben, there appears to be a great thickness of massive sandstone in the N$\frac{1}{2}$ NW$\frac{1}{4}$ sec. 6, T. 12 S., R. 9 E. This may be the Battery Rock Sandstone but is probably an undifferentiated sequence of Battery Rock and massive sandstones of the Lusk. The Battery Rock also is exposed in fault blocks in the Rosiclare Quadrangle.

The Battery Rock consists of massive, cross-bedded sandstone that contains abundant quartz pebbles and granules. The maximum thickness is about 100 feet at the west edge of the Karbers Ridge Quadrangle. Massive sandstone of the Battery Rock Member may be observed in the NW$\frac{1}{4}$ sec. 6, T. 11 S., R. 8 E., where it fills a prominent channel that is cut into the Lusk Member and appears to trend southwest. Typically, the Battery Rock Sandstone is between 50 and 80 feet thick. The best exposures of Battery Rock Sandstone may be found between High Knob and the west edge of the quadrangle where it forms a prominent scarp.

Section between Battery Rock and Pounds Sandstone Members—The section between the top of the Battery Rock Sandstone and the base of the Pounds Sandstone has been named Drury Shale in southwestern Illinois by Lamar (1925, p. 91-95). The name Drury Shale Member, however, cannot be used in southeastern Illinois because the Gentry Coal and Sellers Limestone Members are recognized in the interval. Approximately 60 to 100 feet of strata are present in this interval. The strata often are exposed poorly due to their nonresistant nature. About 75 percent of the interval is composed of shale and thinly bedded sandstone that are commonly interbedded. The interval is exposed in secs. 7 and 8, T. 11 S., R. 9 E., where it includes a persistent massive sandstone 20 to 30 feet thick that crops out along Bear Creek. This sandstone also was observed in the SE$\frac{1}{4}$ sec. 34, T. 10 S., R. 8 E., and apparently is developed best in the eastern half of the Karbers Ridge Quadrangle.

The Sellers Limestone and the Gentry Coal are two members that have been recognized in this interval in southeastern Illinois. The Sellers Limestone was not recognized in the Karbers Ridge Quadrangle, but the Gentry Coal Member is exposed in the SE$\frac{1}{4}$ sec. 6 and the W$\frac{1}{2}$ sec. 7, T. 11 S., R. 9 E., and in the SE$\frac{1}{4}$ sec. 34, T. 10 S., R. 8 E. This coal appears to lie below the persistent massive sandstone discussed above and probably is less than 2 feet thick. It was not observed in the western part of the Karbers Ridge Quadrangle.

A graben exposure of the interval above the Battery Rock Sandstone and below the next massive sandstone occurs in the road in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 31, T. 11 S., R. 9 E., in the Karbers Ridge Quadrangle. It is about 40 feet thick, consists of arenaceous shale, and has thin coalified layers in black shale near the base of an overlying massive conglomeratic sandstone. The highly carbonaceous layers in the upper part of the sequence may represent the position of the Gentry Coal. A massive sandstone caps the hill but less than 15 feet is exposed. It may be the lower part of the Pounds Sandstone Member. The interval above the Battery Rock Sandstone and below the Pounds Sandstone also is exposed within graben blocks in the Rosiclare Quadrangle—the best outcrops being in the NE$\frac{1}{4}$ sec. 11, T. 12 S., R. 8 E., in the vicinity of Keeling Hill and in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 17, T. 12 S., R. 8 E.

Pounds Sandstone Member—The Pounds Sandstone is a thick, bluff-forming conglomeratic unit that is less variable than other Caseyville sandstones in thickness and lateral persistence. It is recognizable in all the Caseyville outcrop belt in the Karbers Ridge Quadrangle but may be confused with the Battery Rock except for its stratigraphic position. It rests unconformably on the interval below, and the contact may be observed at the Pounds type locality in the NW$\frac{1}{4}$ sec. 36, T. 10 S., R. 8 E. Here the thickness of the Pounds may exceed 100 feet, although it is generally 60 to 100 feet thick. The Pounds Sandstone is well exposed in the NW$\frac{1}{4}$ sec. 6, T. 11 S., R. 9 E., and in the vicinity of High Knob, a prominent hill which it caps in sec. 33, T. 10 S., R. 8 E.

The Pounds Sandstone was not identified definitely in the Rock Creek Graben in the Karbers Ridge Quadrangle but does occur in a downdropped block in sec. 17, T. 12 S., R. 8 E., and caps hills in the NW$\frac{1}{4}$ sec. 30 and NE$\frac{1}{4}$ sec. 11, T. 12 S., R. 8 E., all in the Rosiclare Quadrangle.

The Pounds consists of clean, medium- to coarse-grained thick-bedded sandstone with quartz pebbles. It has excellent topographic expression throughout the area.

A 10- to 20-foot thick, massive sandstone containing quartz pebbles and granules lies between 5 and 15 feet above the top of the main massive bench of the Pounds Sandstone in most of its outcrop area in the northern part of the Karbers Ridge Quadrangle. This higher massive sandstone has lithologic characteristics of both the Caseyville and the Abbott, inasmuch as it commonly contains quartz pebbles and is slightly micaceous. Owing to the presence of abundant quartz pebbles and granules, the top of this sandstone was mapped as the top of the Pounds. This procedure was adopted because the overlying Grindstaff Sandstone of the Abbott Formation generally does not contain quartz granules or pebbles and an abundance of quartz pebbles is a characteristic normally associated with the Caseyville. Mapping this massive sandstone unit as part of the Pounds Sandstone, however, increases the thickness of the latter by 20 to 35 feet in some areas. This "rider" sandstone is well exposed above the top of the Pounds in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 28, the SE$\frac{1}{4}$ sec. 35, and the NE$\frac{1}{4}$ NW$\frac{1}{4}$ and SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 36, all T. 10 S., R. 8 E.

Abbott Formation

The Abbott Formation is the interval between the top of the Pounds Sandstone and the top of the Murray Bluff Sandstone. It crops out along the north edge of the Karbers Ridge Quadrangle and in a single block within the Rock Creek Graben in sec. 17, T. 12 S., R. 8 E., in the Rosiclare Quadrangle. It appears that the thickness varies from about 200 to 330 feet—as estimated from combined minimum and maximum interval thicknesses. The Abbott has three named sandstone members—the Grindstaff, the Finnie, and the Murray Bluff. All generally are separated by intervals of shale, siltstone, or thin-bedded sandstone. The sandstones of this formation are more micaceous and generally finer grained than sandstones of the Caseyville. Quartz pebbles or granules were found in the Grindstaff and Finnie Sandstones, and granules of quartz are present in the Murray Bluff; but these occurrences are relatively rare and inconspicuous. Shale pebbles and ironstone concretions are the principal conglomeratic constituents of strata of the Abbott Formation. The sandstones of the Abbott Formation are not clean quartz sandstones like those of the Caseyville Formation. Clay, minor amounts of feldspar, and mica flakes are particularly conspicuous in the Finnie and Murray Bluff. Ferruginous cementing material is more prominent in the sandstones of the Abbott than in those of the Caseyville. The shales and thin-bedded sandstones are commonly carbonaceous and micaceous. Plant fossils are common in the shales. Most of the siltstones and shales have flaggy bedding, and black fissile shales are not common. Marine fossils may be present in the siltstones and sandstones between the massive sandstones.

Section below the Grindstaff Sandstone Member—This interval is composed principally of shale and thin-bedded, argillaceous sandstone with a thickness of about 40 feet in the eastern part and possibly 100 feet at some localities in the western part of the Karbers Ridge Quadrangle. The section below the Grindstaff rarely is well exposed, but the upper part may be observed at Pounds Lake in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 25, T. 10 S., R. 8 E. Other exposures are found in Captain Vinyard Hollow in the SW$\frac{1}{4}$ sec. 28, the W$\frac{1}{2}$ SW$\frac{1}{4}$ sec. 29, and in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 27, all T. 10 S., R. 8 E. At these three localities, the interval is composed principally of medium- and thin-bedded sandstone interbedded with arenaceous and carbonaceous shale. Very poorly preserved marine fossils—crinoid columnals, solitary corals, and brachiopod impressions—are present in ferruginous sandstone in the upper part of the interval at these localities, indicating that the fossil zone is laterally persistent for a distance of at least five miles. The fossiliferous sandstone at most of the localities also contains quartz pebbles, particularly that exposed in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 28, T. 10 S., R. 8 E. Shale pebbles also occur in the fossil-bearing beds. Calcareous cement was noted at one locality in a single bed of black siltstone. Desborough (1959) has described a similar fossiliferous sandstone that contains quartz pebbles in the interval above the Pounds in extreme southwestern Illinois. He suggested it was correlative with strata just below, or in the lower part of, the Grindstaff Sandstone in southeastern Illinois. Although a few fragments of marine fossils may occur higher in the Abbott Formation, they are very rare in this area. The association of a few poorly preserved marine fossils and small quartz pebbles or granules is locally persistent enough to utilize this bed as a marker. It may be most helpful where the massive phase of the Grindstaff is developed poorly.

The Reynoldsburg Coal Member was not identified in this area, as no coal was found in the interval below the Grindstaff Sandstone Member. The Grindstaff unconformably overlies this interval.

Grindstaff Sandstone Member–The Grindstaff Sandstone is the most variable sandstone member of the Abbott Formation. The thickness varies from about 10 to 80 feet. In the NE$\frac{1}{4}$ sec. 35 and SE$\frac{1}{4}$ sec. 26, T. 10 S., R. 8 E., the Grindstaff is very thin and accurate mapping is difficult. In this area, there is no sandstone unit thicker than 15 feet between the Pounds and Finnie Sandstones. At the west edge of the Karbers Ridge Quadrangle, however, in the center of sec. 31, T. 10 S., R. 8 E., the Grindstaff forms a prominent bluff almost 70 feet high. Lithologically the Grindstaff is generally fine to medium grained, sparingly micaceous, and medium to thick bedded. Cross-bedding and ripple marks are present, but locally they may not be conspicuous because the bedding commonly is disturbed. Shale pebbles and small ironstone concretions are common. In the eastern half of the Karbers Ridge Quadrangle, quartz pebbles and granules were not observed. Where the Grindstaff forms the bluff in the center of sec. 31, T. 10 S., R. 8 E., however, quartz granules and pebbles are common in the lower part. A 2-foot thick, quartz pebble conglomerate is found in the basal part of the Grindstaff in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 29, T. 10 S., R. 8 E. This bed of conglomerate is extremely ferruginous and contains crinoid columnals and solitary coral remains, which are poorly preserved. The exposure most typical of the Grindstaff in the eastern part of the Karbers Ridge Quadrangle is in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 25, T. 10 S., R. 8 E., at Pounds Lake. Here the Grindstaff is about 40 feet thick, irregularly medium bedded, and contains some thin-bedded sandstone lenses. Of exposures in the western part of the Karbers Ridge Quadrangle, the bluff in the center of sec. 31, T. 10 S., R. 8 E., is the most typical. At this locality, quartz pebbles and granules are present, and the sandstone is slightly ferruginous. In the stream flowing northeastward, west of Grindstaff Hollow in the NW$\frac{1}{4}$ sec. 28, T. 10 S., R. 8 E., a continuous exposure of more than 125 feet of massive sandstone is present. It is possible that the Finnie may rest on the Grindstaff here with the intervening strata absent due to erosion prior to deposition of the Finnie. This interval has been mapped as Grindstaff west of Grindstaff Hollow. Measurement of the downdip direction of foreset beds indicates that the local transport direction during the time of Grindstaff Sandstone deposition was south-southwest.

In the SW$\frac{1}{4}$ SW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 27, T. 10 S., R. 8 E., near the stream junction, the Grindstaff Sandstone forms a continuous ledge along the northeast side of the stream and gives rise to a small waterfall in the northwestward flowing stream above the stream junction. Beneath the Grindstaff ledge and between the waterfall and stream junction, thin-bedded sandstone and shale underlie the Grindstaff with angular unconformity. The angle of discordance is about 20 degrees; the Grindstaff dips northward at the angle of regional dip, the underlying strata dip southeastward at an angle of 15 degrees. This unconformity may be due to gravity sliding but could be related to minor local tectonism. Potter (1957) has described a similar unconformity at the base of the Grindstaff Sandstone from a locality in Pope County, Illinois, approximately 15 miles west of the Karbers Ridge Quadrangle. Although these are minor local structural features, it is essential to recognize them because their presence complicates field mapping and locally has influenced sedimentation.

Section between Grindstaff Sandstone and Finnie Sandstone Members–Between 20 and 70 feet of shale and thin-bedded sandstone rest on the Grindstaff. Locally the Willis Coal Member is present in this interval, occurring from 10 to

40 feet above the top of the Grindstaff. Locally the Finnie Sandstone is found on top of or cuts out this coal, and thus the lateral persistence of the coal is unpredictable. An excellent exposure in the northeastward flowing stream in the SW¼ NE¼ sec. 27, T. 10 S., R. 8 E., demonstrates this relation. The interval below the Finnie is exposed as a window in the Finnie. At the north edge of the exposure, the Willis Coal is about 6 inches thick and is overlain by a shale-pebble and ironstone-concretion conglomerate; on the south side of the exposure, the Finnie is found at the position of the coal. West of this locality, the Willis Coal has not been recognized. Currently it is mined at the Blue Blaze Block mine in the SW¼ SE¼ sec. 30, T. 10 S., R. 9 E., where it is reported to be 40 inches thick. The coal also is present in the NE¼ SW¼ sec. 30, T. 10 S., R. 9 E., where it has been mined in the past. Old diggings and coal float in the NW¼ SE¼ sec. 26, T. 10 S., R. 8 E., indicate the Willis Coal is present in that area.

The interval between the Grindstaff and Finnie is principally thin-bedded sandstone and carbonaceous gray shale that are commonly interbedded. Excellent exposures of this interval are found in the northeastward flowing stream in the N½ SE¼ sec. 27 and the NW¼ NE¼ SE¼ sec. 25, T. 10 S., R. 8 E. West of sec. 27, T. 10 S., R. 8 E., this interval either is exposed poorly or possibly absent. In the E½ NW¼ SE¼ sec. 27, T. 10 S., R. 8 E., a conglomeratic sandstone contains quartz pebbles and is about 5 feet thick. This sandstone bed may be in the upper part of this interval or possibly at the base of the Finnie Sandstone.

Finnie Sandstone Member—The Finnie Sandstone typically contains more mica and argillaceous matrix than underlying Pennsylvanian sandstones. In the Karbers Ridge Quadrangle, it generally is finer grained than the other massive sandstone members of the Abbott Formation. It is well exposed in the extreme northeastern part of the Karbers Ridge Quadrangle. Thickness varies from 25 to 60 feet; the maximum is represented in the western part of the outcrop area and the minimum in the east, but considerable local variation exists. The Finnie Sandstone is conspicuously cross-bedded. Primary slump structures are not uncommon and are well developed in the NW¼ SW¼ NE¼ sec. 27, T. 10 S., R. 8 E., where the basal part of the Finnie is exposed. The best exposures of the Finnie Sandstone are found in the SW¼ SE¼ sec. 25 at Pounds Lake, the NE¼ sec. 27, and the N½ SE¼ sec. 26, all in T. 10 S., R. 8 E. At these localities, the Finnie forms small bluffs. In the SW¼ NE¼ NE¼ sec. 27, T. 10 S., R. 8 E., barely beyond the north edge of the Karbers Ridge Quadrangle, the Finnie forms an impressive bluff and is at least 50 feet thick. The Finnie Sandstone shows a prominent west and subordinate northwesterly direction of transport according to cross-bedding studies conducted in this area.

Section between Finnie Sandstone and Murray Bluff Sandstone Members—This interval is composed principally of shale and thin-bedded, argillaceous sandstone. The Delwood Coal Member occurs in the upper part. Thickness of the interval varies from 20 to 60 feet and the outcrop area is restricted to the extreme northeastern part of the Karbers Ridge Quadrangle. The best exposures are found in the N½ SW¼ NE¼ sec. 30, T. 10 S., R. 9 E., and the NW¼ SE¼ NE¼ sec. 25 and the E½ SW¼ NW¼ sec. 26, both in T. 10 S., R. 8 E. The Delwood Coal is well exposed just beneath the Murray Bluff Sandstone in the NW¼ SW¼ NE¼ sec. 30, T. 10 S., R. 9 E.; here the coal is 12 inches thick and is underlain by 2 feet of underclay. At this locality and in the SE¼ SW¼ NE¼ sec. 26, T. 10 S., R. 8 E., diggings indicate the Delwood Coal was extracted on a small scale. Inasmuch as the Murray Bluff Sandstone rests on top of the Delwood Coal at one locality, it is likely that the coal is locally cut out by this sandstone in adjacent areas.

Murray Bluff Sandstone Member—The Murray Bluff Sandstone is well exposed in the SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 25, T. 10 S., R. 8 E., the NW$\frac{1}{4}$ SW$\frac{1}{4}$ NE$\frac{1}{4}$ and the N$\frac{1}{2}$ S$\frac{1}{2}$ NW$\frac{1}{4}$ sec. 30, T. 10 S., R. 9 E. At these localities, it is massive and forms bluffs up to 40 feet high. The Murray Bluff is rather easy to distinguish from the lower sandstone as it is uniformly coarse to very coarse grained and very micaceous. Quartz granules up to 4mm in diameter have been observed in the NW$\frac{1}{4}$ sec. 26, T. 10 S., R. 8 E. Quartz pebbles were not observed but are believed to be present, since large quartz granules are common at one locality. The Murray Bluff achieves a thickness as great as 80 feet; this thickness was observed in the SW$\frac{1}{4}$ NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 30, T. 10 S., R. 8 E. (Equality Quadrangle), just 300 feet north of the Karbers Ridge Quadrangle boundary.

Spoon Formation

The top of the Murray Bluff Sandstone was not observed in outcrop. Based on topographic expression and relationships in the adjacent Equality Quadrangle, strata of the Spoon Formation are thought to be present in the northeastern part of the Karbers Ridge Quadrangle, although no exposures of this interval were recognized. It is possible, however, that strata as high as the Bidwell Coal Member, or higher, may be present in the area.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

Pleistocene deposits include residuum that accumulated in situ from weathering of bedrock, alluvial deposits of rivers and streams, loess deposited by wind, and colluvium deposited on steep slopes by rain wash and the forces of gravity. Only the alluvial deposits—recent alluvium and terraces of Wisconsinan age—are shown on the geologic map.

Residuum

At many places, limestone bedrock is overlain by clay that is a residuum from the solution of the limestone by ground water. The accumulation of this material probably began long before Pleistocene time, but the older residuum cannot be differentiated from the younger. The clay is usually red, brown, or yellow and often contains an abundance of angular chert fragments. The residuum is generally only a few feet thick, but some concentration is produced by slumpage and wash from nearby hills. Greater thicknesses occur locally along faults and fractures.

Alluvial Deposits

Recent alluvium and three terraces constitute the alluvial deposits. The terraces are remnants of old levels of valley fill and date back to the Wisconsinan Stage of the Pleistocene Series. The alluvial deposits consist mainly of interbedded sand and silt, but beds of coarse gravel, mostly chert derived from local bedrock, occur along many of the tributary valleys. A low terrace that has an elevation of about 350 feet is present locally, but in general it cannot be differentiated from Recent alluvium. An intermediate terrace (pl. 1, Qwi) with an elevation of about 360 feet is widespread and prominent along the Ohio River. The highest terrace (pl. 1, Qwh) present locally has an elevation of 380 to 390 feet and is most conspicuous near the Ohio River in S$\frac{1}{2}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 31, T. 12 S., R. 8 E.

Colluvium

The lower part of steep hills throughout the area is covered by colluvium derived from the upper slopes by creep, slump, and slope wash. Silt, mostly reworked loess, is dominant in this material, but angular rock fragments are common. The colluvium is as much as 30 feet thick and is thickest in many steep-sloped alluvial fans at the mouths of small ravines. Here it may be crudely sorted and may contain lenses of stream gravel.

Loess

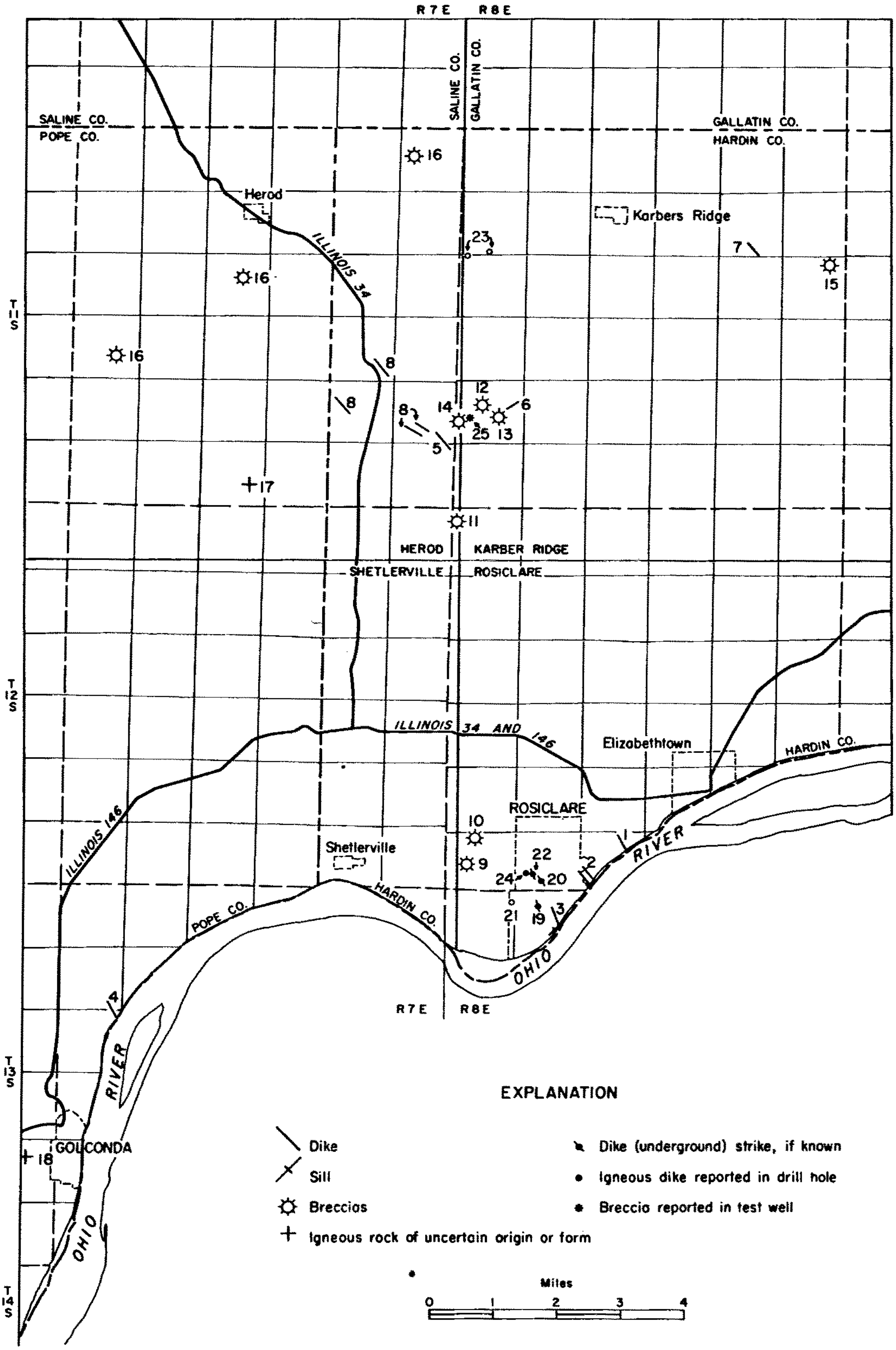
The uplands of the area are covered by loess—a nonbedded, buff to light brown, clayey silt—that was deposited by winds and blown onto the uplands from the Ohio River bottomlands, which were repeatedly flooded and covered with silt during glacial times. The loess is commonly 5 to 15 feet thick but is as much as 30 feet thick in the Ohio River bluffs.

The loess is principally the Peoria Loess of Woodfordian age, but in places the lower part contains a few feet of dark brown Roxana Silt of early Wisconsinan age. Even more locally, there is a thin deposit of reddish brown, very clayey silt correlated with the Loveland Loess of Illinoian age.

IGNEOUS ROCKS

The Illinois portion of the fluorspar district is one of two areas of the state in which numerous bodies of intrusive igneous rocks have been observed and studied. The other, an area extending along the southern periphery of the Illinois coal basin in Gallatin, Saline, and Williamson Counties, may in fact combine with that of the fluorspar district to form a single large area of igneous activity. However, direct evidence of an interconnection cannot be demonstrated. The intrusives of southern Illinois have been investigated recently by Clegg and Bradbury (1956) and by Bradbury (1962).

Figure 3 shows the distribution of known occurrences of intrusive rocks in the fluorspar district. It includes those observed in outcrop, recorded underground in mines, and reported in exploratory drilling for fluorspar. They are concentrated in the two general areas of Rosiclare and of Hicks Dome. The location of the various occurrences in the Karbers Ridge and Rosiclare Quadrangles are given below. Those exposed at the surface are shown by appropriate symbols on the geologic map (pl. 1).


R7E R8E
SALINE CO.
GALLATIN CO.
SALINE CO.
POPE CO.
GALLATIN CO.
HARDIN CO.
Herod
Karbers Ridge
ILLINOIS 34
T 11 S
T 12 S
T 13 S
T 14 S
HEROD
KARBER RIDGE
SHETLERVILLE
ROSICLARE
ILLINOIS 34 AND 146
ILLINOIS 146
Elizabethtown
HARDIN CO.
ROSICLARE
Shetlerville
HARDIN CO.
POPE CO.
OHIO RIVER
OHIO RIVER
GOLCONDA
EXPLANATION
Dike
Sill
Breccias
Igneous rock of uncertain origin or form
Dike (underground) strike, if known
Igneous dike reported in drill hole
Breccia reported in test well
Miles
0 1 2 3 4

Dikes and Sills

Dikes in the area range from a few inches to over 100 feet in width and strike to the northwest. The single exception is the Robinson dike in the SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 30, T. 11 S., R. 8 E., which strikes to the northeast. At Downeys Bluff in the Ohio River at Rosiclare, igneous rock was intruded in the form of several thin horizontal sills. This is the only occurrence known of this type, although others probably occur.

The petrography of the dikes and sills has been described by Johannsen (in Bain, 1905), Currier (Weller et al., 1920), Grogan (Weller et al., 1952), and Bradbury (Clegg and Bradbury, 1956). The dike and sill rock generally is dark gray or greenish gray and porphyritic with fine- to medium-grained groundmass. Primary minerals include brown mica, pyroxene, and olivine with accessory titaniferous magnetite, apatite, perovskite, titanite, and garnet (?) (Clegg and Bradbury, 1956, p. 13). Olivine almost always is altered to serpentine, and there has been intense alteration to carbonate and chlorite as well. Mineralogic differences led early workers to recognize two different types of dike rock, lamprophyre and mica-peridotite. The lamprophyre is characterized by the absence of olivine or its alteration products and by the presence of lath-shaped, dusty inclusions in the carbonate groundmass. The inclusions suggest the former presence of feldspar. The mica-peridotite is characterized by the presence of olivine or serpentine and the absence of evidence of former feldspar.

The dikes occur in northwest-trending fractures and minor faults but are displaced by major northeast-trending faults and clearly predate fluorspar mineralization (Weller et al., 1952, p. 72).

The name, location, and character of known dikes and sills are as follows:

Downeys Bluff Sills and Dike - NW$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 5, T. 13 S., R. 8 E., near Rosiclare; thin lamprophyre (?).

Orrs Landing Dike - NE$\frac{1}{4}$ SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 33, T. 12 S., R. 8 E., near Rosiclare; small lamprophyre.

Figure 3 - Distribution of igneous rocks.

Dikes and Sill (exposed or reported at surface)

1. Orr's Landing Dike
2. Rosiclare dikes
3. Sills and Dike at Downeys Bluff
4. Mix Dike
5. Joiner Dike
6. Robinson Dike
7. Philadelphia School Dike
8. Unnamed dikes (4)

Breccias (exposed or reported at surface)

9. Soward "Plug"
10. North Soward "Plug"
11. Grants "intrusive"
12. Hicks Dome "Plug"
13. Rose mine "Plug"
14. Large breccia boulder (?)
15. Sparks Hill "Plug"
16. Unnamed breccia occurrences (3)

Igneous Rocks of uncertain form

17. Pope County granite fragments,
18. Golconda "Dike"

Dikes Underground in mines

19. Good Hope Dike
20. Blue Diggings 600 and 700 Level Dike
21. Blue Diggings 300 Level Dike
22. Argo dikes
23. Hamp mine dikes

Igneous Rocks reported in drill holes

24. Dike
25. Breccia (Hamp test well)

Rosiclare Dikes - SW¼ SW¼ sec. 33, T. 12 S., R. 8 E., near Rosiclare; no petrographic information.

Robinson Farm Dike - NE¼ SE¼ NE¼ sec. 30, T. 11 S., R. 8 E., in pit on hillside near Hicks Dome; weathered mica-peridotite (?).

Philadelphia School Dike - NW¼ SW¼ SE¼ sec. 11, T. 11 S., R. 8 E., in north bank of creek near Karbers Ridge; no petrographic information.

Good Hope Dike - NE¼ NW¼ sec. 5, T. 13 S., R. 8 E., in drift of Good Hope mine near Rosiclare; lamprophyre (?).

Argo 500 Level Dike - NE¼ SW¼ sec. 32, T. 12 S., R. 8 E., on 500-foot level of Argo vein near Rosiclare; lamprophyre.

Argo 240 Level Dike - NW¼ SW¼ sec. 32, T. 12 S., R. 8 E., at 240-foot level of Argo vein near Rosiclare; no petrographic information.

Blue Diggings 600 and 700 Levels Dike - SE¼ SW¼ sec. 32, T. 12 S., R. 8 E., on two levels in Blue Diggings mine near Rosiclare; no petrographic information.

Blue Diggings 300 Level Dike - SW¼ NW¼ sec. 5, T. 13 S., R. 8 E., in crosscut from middle shaft on 300-foot level of Blue Diggings mine near Rosiclare; no petrographic information.

Hamp Mine Dikes - SE¼ SW¼ sec. 7 and NW¼ NW¼ sec. 18, T. 11 S., R. 8 E., at least two dikes reported in mine workings near Karbers Ridge; no petrographic information.

Alcoa Deep Boring Dikes - Aluminum Ore Co. No. 104, collar in NW¼ SW¼ sec. 32, T. 12 S., R. 8 E., cut at vertical depths of 970 and 1150 feet in NE¼ SW¼ sec. 32, T. 12 S., R. 8 E., near Rosiclare; no petrographic information.

BRECCIAS

The breccias are associated with structures that have been interpreted as diatremes and have been considered "explosion" breccias (Brown et al., 1954; Clegg and Bradbury, 1956). The inferred circular or eliptic shape of the areas of breccia outcrop and their size, up to 200 feet in diameter, have resulted in the application of such terms as plug and pipe. However, the true geometric configuration of the breccia bodies is not accurately known.

The breccias consist of angular to subrounded fragments of sedimentary, metamorphosed sedimentary, and igneous rocks in a matrix of finely ground rock and mineral fragments. The mineral fragments include quartz, pyroxene, augite, hornblende, apatite, mica, and feldspar. The feldspar fragments are plagioclase of oligoclase-andesine composition (Clegg and Bradbury, 1956, p. 15). In some specimens, the true nature of the matrix is obliterated by almost complete replacement by calcite. The name and location of known occurrences of breccia are as follows:

Soward Farm Breccia - NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 31, T. 12 S., R. 8 E., near Rosiclare.

North Soward Breccia - NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 31, T. 12 S., R. 8 E., near Rosiclare.

Sparks Hill Breccia - S$\frac{1}{2}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 13, T. 11 S., R. 8 E., near Karbers Ridge.

Rose Mine Breccia - NE$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 30, T. 11 S., R. 8 E., near center of Hicks Dome.

Hicks Dome Breccia - SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 30, T. 11 S., R. 8 E., near center of Hicks Dome.

Hamp Breccia - St. Joseph Lead Company - Henry Hamp, Jr., No. 1 deep well in NE$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 30, T. 11 S., R. 8 E., near center of Hicks Dome.

STRUCTURE

The Karbers Ridge and Rosiclare Quadrangles are located in an area marked by complex faulting, the regional aspects of which were discussed by Stuart Weller et al. (1920, p. 55-75), J. M. Weller et al. (1952, p. 78-83), and Heyl and Brock (1961, p. D3-D6). The area is transected by a major downdropped segment, the Rock Creek Graben, that trends N20 to N60 degrees east. Hicks Dome is located northwest of the graben; and north and northeast of Hicks Dome, the sedimentary strata dip steeply into the Moorman-Eagle Valley Syncline. Southeast of the graben in Kentucky, the rock formations bend around the Tolu Dome, a broad flat structure that has its apex in the vicinity of Tolu, Kentucky.

Hicks Dome is the most striking structural feature shown on the geologic map (pl. 1). The apex of the domal structure is located in sec. 30, T. 11 S., R. 8 E., in the Karbers Ridge Quadrangle. Limestone and chert of Middle and Lower Devonian age occur at or near the surface at the apex, occupying a topographic high that is completely surrounded by a belt underlain by shales of the New Albany Group. The New Albany Shale with the thin overlying Springville Shale forms a depression separating the chert and limestone of Devonian age from the overlying resistant unit—chert, siltstone, and limestone of the Fort Payne Formation. The beds dip away from the apex in all directions, the steepest dip being to the northwest where the strata descend at a rate of approximately 1000 feet per mile. The dip flattens rapidly in all directions away from the dome.

Hicks Dome is surrounded by discontinuous, radial and arcuate faults and is truncated on the south by the Wolrab Mill Fault following the northeast-southwest trend of most major faults in the area.

The Rock Creek Graben is 1$\frac{1}{4}$ to 1$\frac{1}{2}$ miles wide in the Karbers Ridge and Rosiclare Quadrangles. The downdropped block trends approximately N 55 E in the eastern part of its extent in the map area, where it is bounded on the northwest by the Hogthief Creek Fault. On the southeast, its border is related to faults of the Peters Creek System. This trend changes abruptly north of Rosiclare so that in the area west and northwest of Rosiclare, where bounded on the west by the Wallace Branch and Interstate Faults, the graben trends N 20 E. Throughout the latter extent, the graben is bounded on the east by the Big Creek Fault and related faults in the vicinity of Rosiclare. A number of northwest and northeast-trending faults divide the graben into many blocks and slices.

Characteristics of Faults

The names and general distribution of faults and fault systems are shown on a scale of 1 inch to the mile (pl. 2). Most of the faults are classified as to the amount of throw, and the downdropped side is indicated. The classes are as follows: Class I, faults of large displacement (more than 500 feet); Class II, faults of moderate displacement (50-500 feet); and Class III, faults of small displacement (less than 50 feet).

Most major faults in the area trend northeast-southwest; but a number, mostly of smaller displacement, trend northwest-southeast. Northwest-southeast-trending faults are especially conspicuous in the graben and south of the graben. Arcuate faults occur north and northeast of Hicks Dome and have a concentric relation to the dome. The spatial arrangement of other faults in those areas appear to have a radial relation to the dome, although the development of radial faults is less pronounced than on the west and northwest flanks of the dome. Most faults in the area have been described as high-angle normal faults, the approximate dip of fault planes in the Rosiclare area being 70-80 degrees. Weller et al. (1952, p. 79) suggest the possibility of local high angle reverse faults associated with the Hogthief Creek Fault Zone. Horizontal slickensides, reported from mine workings in the fluorspar district near Cave in Rock (Currier, 1944, p. 27), indicate that strike slip faulting has been another active factor in the structural history of the area. The relative importance of strike slip and high angle reverse faulting as compared to normal faulting in the fluorspar district probably has been underestimated.

Description of Important Faults

Names have been given to a number of faults that are important for economic or geologic reasons. The location and other information on these are given.

Argo Fault –The Argo Fault carries the Argo fluorspar vein and extends east of north from the SE$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 12 S., R. 8 E., where it joins the Blue Diggings Fault. It is nearly vertical, locally overturned, and has approximately 75 feet of displacement that diminishes rapidly to the northeast.

Big Creek Fault –The Big Creek Fault extends northeastward from the Ohio River, beginning in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 6, T. 13 S., R. 8 E., and crossing State Highway 146 near its juncture with State Highway 34 north of Rosiclare. It is shown on the geologic map as a single fault, but the situation probably is more complex, with several more or less parallel faults contributing to the total displacement of about 350 feet. The over-all effect is downthrow to the northwest. The Big Creek Fault is not known to carry extensive mineralization.

Blue Diggings Fault –The Blue Diggings Fault extends northwestward from the Ohio River in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 8, T. 13 S., R. 8 E., to a point just inside sec. 6, where it swings northeastward crossing the NW$\frac{1}{4}$ of sec. 5 and then continues east of north to the north line of sec. 32, T. 12 S., R. 8 E. It is downthrown to the east, in contrast to other faults in the area, and is less steeply inclined, locally as little as 45 degrees. It carries the Blue Diggings fluorspar vein, one of the largest ore producers in the district.

Daisy Fault –The Daisy Fault branches from the Blue Diggings Fault near the center of the E½ SW¼ sec. 32, T. 12 S., R. 8 E., and extends northeastward to the northern limits of the city of Rosiclare, where it joins the Hillside Fault. It is inclined steeply to the northwest and has a maximum displacement of 350 feet in that direction. It carries the Daisy fluorspar vein.

Eureka Fault –The Eureka Fault Zone is a series of short intersecting faults that extends northeastward, as an east branch of the Hillside Fault, from the SE¼ NW¼ SE¼ sec. 29, T. 12 S., R. 8 E., across the NW corner of section 28 and into section 21. Downthrow is to the northwest and displacement diminishes to the northeast from a maximum of about 100 feet. Eureka faults are mineralized by fluorspar at various places along their courses.

Goose Creek Fault –The Goose Creek Fault enters the Karbers Ridge Quadrangle from the east 1/8-mile north of the center line of sec. 19, T. 11 S., R. 9 E. It is downthrown to the northwest with maximum displacement approaching 500 feet. It forms the northeast margin of a small graben and east of the map area joins a major north-bounding fault of the Rock Creek Graben. It is extensively mineralized by fluorspar at the Goose Creek, Hoeb, and Greene mines.

Hamp Fault –The Hamp Fault is an arcuate structural feature that occurs on the north and northeast flanks of Hicks Dome. It extends nearly east and west for about one mile near the west edge of the Karbers Ridge Quadrangle in secs. 7 and 18, T. 11 S., R. 8 E. There it dips steeply and is downthrown to the south. Its further extent in the Karbers Ridge Quadrangle is not known accurately, but it appears to swing gradually to the south in a wide arc with reversal of throw. The Hamp Fault carries fluorspar in the area near the west edge of the map area.

Hillside Fault –The Hillside Fault extends in a north-south direction for about ½-mile near the center of the NE¼ sec. 32, T. 12 S., R. 8 E. It joins the Daisy Fault on the north and is connected to the Rosiclare Fault on the south. Along this course, it is downthrown to the west with displacement of about 200 feet. The continuation of the Hillside Fault south of the split joining it to the Rosiclare Fault is not well known, but the Hillside Fault probably continues to the Ohio River with decreased displacement. Mineralization occurs along the Hillside Fault, which contained the greatest width of fluorspar known in the district.

Hogthief Creek Fault –The Hogthief Creek Fault bounds the Rock Creek Graben on the northwest with displacement as much as 1600 feet. It is roughly arcuate for a portion of its extent, lies ½- to 1 mile southeast of Hogthief Creek, and merges into a complexly faulted area approximately 3½ miles north of Rosiclare. High angle reverse faulting is probably involved. It is not known to be extensively mineralized.

Interstate Fault –The Interstate Fault is actually a complex system of branching and parallel faults that extends northeastward from the vicinity of the DuBois mine in the SW¼ sec. 19, T. 12 S., R. 8 E. It is downthrown to the southeast, bordering the Rock Creek Graben with maximum displacement in excess of 2000 feet. Commercial and marginal fluorspar deposits related to the Interstate System have been worked and prospected.

Illinois Furnace Fault -The Illinois Furnace Fault is a northeast extension of the Interstate Fault. It cuts across the alluvial valley of Big Creek in secs. 8 and 9, T. 12 S., R. 8 E., and bisects the small hill ¼-mile northeast of the junction of Big Creek and Hogthief Creek. It is downthrown to the southeast and has a maximum displacement of more than 500 feet in sec. 3, where beds of the Salem Limestone lie against the Aux Vases Sandstone. The Illinois Furnace Fault is believed to extend northeast to a point near the north line of sec. 26, T. 11 S., R. 8 E., where it probably joins the Wolrab Mill Fault. Extensive mineralization is not known.

Lee Fault -The Lee Fault has been traced with some accuracy northeastward from the arcuate fault that cuts the SW¼ of sec. 15, T. 11 S., R. 8 E., through the Lee mine area in the NE¼ sec. 14. At the Lee mine, this fault or closely spaced system of parallel faults has a displacement of 450 feet, downthrown on the southeast side. Fluorspar mineralization has been found for a distance of nearly 1½ miles along its course.

Peters Creek Faults -The Peters Creek Faults include a number of separate northeast trending parallel faults that bound the Rock Creek Graben on the southeast. Downthrow is to the north and the aggregate displacement approaches a maximum of 1000 feet. The northernmost of these can be traced along the front of the escarpment north of Elizabethtown to a point north of Rosiclare, where it is associated with the Eureka Fault. Other faults of the Peters Creek System can be traced with some certainty into the limestone area north and northeast of Elizabethtown, but their displacement decreases to the southeast, and as a result their position is difficult to determine. No commercial mineralization occurs.

Ridge Fault -The Ridge Fault trends northeast-southwest, crossing the Pounds Hollow blacktop road 1½ miles east of Karbers Ridge and joining the Lee Fault in sec. 31, T. 10 S., R. 9 E. Along the northern portion of its extent, the northwest side is downthrown a little more than 50 feet. Displacement diminishes to the southwest so that at the Ridge mine in the SW¼ sec. 10, T. 11 S., R. 8 E., displacement is considerably less. Minor fluorspar mineralization has been prospected in the vicinity of the Ridge mine.

Rosiclare Fault -The Rosiclare Fault joins the Hillside Fault on the north and along most of its course trends east of north; but at the south end of its extent in Illinois, it swings gently to trend east of south, where it reaches the Ohio River. The southern part sometimes is referred to as the Extension or Good Hope Fault. This fault is nearly vertical, downthrown 200-300 feet on the west side, and carries the Rosiclare vein that was reached by a number of mine shafts. The Rosiclare vein has produced more fluorspar than any other vein deposit in the Illinois-Kentucky fluorspar district.

Steel Fault -The Steel Fault, as indicated by core drilling, passes through the southwest corner of sec. 32, T. 12 S., R. 8 E., and trends northeast-southwest roughly parallel to the Blue Diggings Fault. It is downthrown 25 to 90 feet on the west side, where cut by drill cores, but its northern extent is not determined. It is not known to be mineralized.

Three Mile Creek Fault —The Three Mile Creek Fault enters the map area from the west near the DuBois mine in the SW$\frac{1}{4}$ sec. 19, T. 12 S., R. 8 E. It apparently offsets the Interstate Fault to the west. South of the Three Mile Creek Fault the name Wallace Branch Fault is applied to the fault bounding the Rock Creek Graben. Minor fluorspar mineralization occurs at the DuBois mine that probably lies within this fault zone.

Wolrab Mill Fault —The Wolrab Mill Fault extends northeast-southwest across the southeast flank of Hicks Dome and is joined by the Illinois Furnace Fault, as the latter is extended, near the north line of sec. 26, T. 11 S., R. 8 E. The exact course of the Wolrab Mill Fault through the limestone areas in the southwest and south-central portions of the Karbers Ridge Quadrangle is not well known. The area is more complexly faulted than previous maps show. The Wolrab Mill Fault is not known to be extensively mineralized.

Joints

Good joint sets occur throughout the area but appear to be better developed and more closely spaced near faults. The most common orientation is northeast-southwest, and in most cases the joint planes are essentially vertical.

Plate 2 shows a wind rose of the strike orientations of 383 joints measured at Pennsylvanian and Mississippian outcrops, chiefly sandstone and limestone. The primary joints are in the northeast-southwest direction of major faulting, and secondary joints are perpendicular to it. This relation is less evident in these quadrangles than in those to the east (Baxter et al., 1963, p. 32).

ECONOMIC GEOLOGY

Mining and milling of fluorspar (fluorite, CaF_2) dates back to an early period in the history of Hardin County. Mining operations, begun in 1839, were directed at first to the extraction of lead ore (galena, PbS) that, mixed with zinc (sphalerite, ZnS), occurs with fluorspar in some deposits. The geology, mining methods, and metallurgical details involved have been reported in various publications (Weller, 1920; Bastin, 1931; Hatmaker and Davis, 1938; Weller et al., 1952). Publications that discuss the occurrence, use, and possible value of other mineral resources available in the area are cited in sections that follow.

FLUORSPAR, LEAD, AND ZINC

Fluorspar occurs in three types of deposits in the Illinois-Kentucky mining district. These are (1) bedded deposits, formed by selective replacement of limestone strata; (2) fissure-filling or vein deposits, found along faults; and (3) residual deposits, derived from one of the other types. Most ore bodies known within the area of this report are of the vein type. Some are residual and probably derived from veins. In past years mines located in and near Rosiclare have provided the bulk of mineral production, but intermittently outlying areas have supported mining and considerable prospecting.

Mixed ores that include, in addition to fluorspar, significant amounts of lead and zinc resulted in the early construction of flotation mills for separation of the metallic concentrates.

Rosiclare Area

The Rosiclare area is composed of a system of fluorspar-bearing veins that extend from the Ohio River west of Rosiclare for a distance of about 4 miles to the northeast. The veins occur along faults trending about 20 to 30 degrees east of north. The faults are normal, at most places, and mostly downthrown to the west along fault planes that dip to the west at angles of 70 to 80 degrees. The displacements vary from a few feet on some faults to more than 650 on others.

The easternmost major fault of the system carried the most extensively mineralized and most continuous vein in the Illinois-Kentucky district. It extends from the Ohio River to a point near the center of the SE$\frac{1}{4}$ sec. 29, T. 12 S., R. 8 E., a distance of about 2$\frac{1}{2}$ miles. The Hillside mine is located just south of the north line of sec. 32, T. 12 S., R. 8 E., where for a distance of about $\frac{1}{2}$-mile, the fault trends almost north-south and the vein is called the Hillside vein. One-quarter mile south of the north line of section 32, the fault branches; and south of this point, the west branch carries the Rosiclare vein that has been mined by a series of shafts of the Rosiclare mine. Near the Ohio River, the Rosiclare Fault and vein swing and trend slightly east of south. Here extensive mining has been carried out and has been centered principally at the Good Hope mine and the Annex shaft.

A second system of vein deposits occurs west of and roughly parallel to the Rosiclare Fault. These deposits are related to a rather complex zone of interconnected faulting that involves the Daisy, Blue Diggings, and Argo Faults. The veins have been prospected and mined by means of a number of shafts located along the course of the fault system. The principal mines or mine shafts are the Blue Diggings-Fairview shaft, NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 5, T. 13 S., R. 8 E.; Blue Diggings-main shaft, NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 12 S., R. 8 E.; and the Daisy mine, NE$\frac{1}{4}$ NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 32, T. 12 S., R. 8 E.

The Daisy and Hillside (Rosiclare) Faults intersect at a point near the center of sec. 29, T. 12 S., R. 8 E., just south of the Dimmick mine. The Dimmick and Eureka properties to the north have produced some ore.

Outlying Areas

Commercial production of fluorspar has come from a few outlying properties and intermittent commercial production from a number of widely scattered properties in the quadrangles. The more important outlying producers have been: the Lee mine, N$\frac{1}{2}$ NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 14, T. 11 S., R. 8 E.; Hamp mine, N. line NW$\frac{1}{4}$ sec. 18, T. 11 S., R. 8 E.; Indiana mine, W$\frac{1}{2}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 19, T. 12 S., R. 8 E.; DuBois mine, NE$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 19, T. 12 S., R. 8 E.; and the Interstate, Cullum, and Gibbons mines, all located on the Interstate Fault, mostly in sec. 17, T. 12 S., R. 8 E.

From outlying areas, a major portion of the production has come from ore bodies of the fissure-filling, or vein types, or from residual deposits that are related to faults and derived probably from veins. Some mines, notably the Hamp, produced considerable replacement ore usually from a limestone stratum in the foot wall.

List of Mines and Prospects

Some of the more important mines are identified by name on the geologic map (pl. 1). These and other properties listed below are each identified by a reference number that appears at the proper location on the geologic map (pl. 1).

1. Alcoa mines, Good Hope mine
2. Alcoa mines, Buzzards Roost shaft
3. Alcoa mines, pump shaft
4. Alcoa mines, Blue Diggings mine, Fairview shaft
5. Alcoa mines, Blue Diggings mine, prospect
6. Alcoa mines, Blue Diggings mine, Last Chance shaft
7. Alcoa mines, Blue Diggings mine, Blue Diggings shaft
8. Alcoa mines, Argo shaft
9. Rosiclare mines, Rosiclare mine, South Boundary shaft
10. Rosiclare mines, Rosiclare mine, Recovery shaft
11. Rosiclare mines, Rosiclare mine, plant and plant shaft
12. Rosiclare mines, Rosiclare mine, New Ghelia shaft
13. Rosiclare mines, Rosiclare mine, air shaft
14. Rosiclare mines, Daisy mine, No. 2 shaft
15. Hillside mine, plant and plant shaft
16. Dimmick mine
17. Eureka mine, No. 6 shaft
18. Eureka mine, No. 1 shaft
19. Stewart shaft
20. DuBois mine
21. Indiana mines
22. Preen mine
23. Gibbons shaft
24. Gibbons (K and R) mine
25. Rosiclare mines, Interstate property, Austin shaft
26. Rosiclare mines, Interstate property, Austin mine
27. Rosiclare mines, Interstate property, Martin mine (pit)
28. Rosiclare mines, Interstate property, Martin mine (pit)
29. Rosiclare mines, Interstate property, prospect shaft
30. Peckerwood prospect

31. Berry mine
32. Prospect shaft
33. Gibson property prospects
34. Prospect
35. Prospect shaft
36. Lacey mine
37. Rose mine
38. Hamp mines
39. Ridge mine
40. Lee mine
41. J. M. Jackson property

COAL

The coal resources of Gallatin and Hardin Counties have been evaluated by Cady (1952) and Smith (1957). Coals of the Caseyville and Abbott Formations are known to occur in the northeastern part of the Karbers Ridge Quadrangle but are generally thin and probably not persistent, possibly locally cut out by overlying sandstones.

The Willis Coal in the Abbott Formation is reported to be 40 inches thick, where it is mined currently at the Blue Blaze Block mine in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 30, T. 10 S., R. 9 E. The Willis Coal also is present in the NE$\frac{1}{4}$ SW$\frac{1}{4}$ of sec. 30, where it has been mined on a small scale; and there are old diggings and coal float in the NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 30, T. 10 S., R. 8 E., indicating its presence in that area. The Delwood Coal Member of the Abbott Formation is well exposed in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 30, T. 10 S., R. 9 E.; there it is 12 inches thick, directly overlain by the Murray Bluff Sandstone and underlain by 2 feet of underclay. Coal apparently has been dug for about 50 feet along the outcrop. The Delwood Coal also was probably extracted on a small scale from diggings in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 26, T. 10 S., R. 8 E. The Reynoldsburg Coal of the Abbott Formation was not recognized in this area.

The Gentry Coal Member of the Caseyville Formation is exposed in the SE$\frac{1}{4}$ sec. 6 and in the W$\frac{1}{2}$ sec. 7, T. 11 S., R. 9 E., and in the SE$\frac{1}{4}$ sec. 34, T. 10 S., R. 8 E. The Gentry probably does not exceed a thickness of 2 feet, generally has a thickness of a foot or less, and may be absent in the western portion of the Karbers Ridge Quadrangle.

LIMESTONE

The limestone resources of Hardin and Pope Counties and their possible uses are discussed in a recent report (Lamar, 1959). Cement making materials are considered in some detail in an earlier report (Lamar et al., 1956).

One limestone quarry is now in operation in the map area. It is located just west of the Elizabethtown ferry landing in the SW¼ of sec. 27, T. 12 S., R. 8 E., and operated by Denny and Simpson Quarry Company. The beds quarried are transitional between the St. Louis and Ste. Genevieve Limestones, but the dominant lithology is that of the St. Louis. Limestone from the lower part of the St. Louis was quarried at one time just west of Decker Spring near the S line, SE¼ SE¼ sec. 35, T. 11 S., R. 8 E.

Limestone formations of the Mammoth Cave Megagroup are the thickest and generally most quarryable in the area mapped. Of these only the Ste. Genevieve and St. Louis have been quarried to any extent in Hardin County, but the lower formations, Salem and Harrodsburg, also may be of commercial interest. Parts of the Ste. Genevieve, St. Louis, and possibly the lower formations – particularly the Harrodsburg – are of suitable composition for the manufacture of cement. The Salem has beds of dark gray to black, fine-grained limestone that, in preliminary tests, show promise for use as terrazo chips in the construction of terrazo floors. All formations of the Mammoth Cave Megagroup probably are, in part, suitable for roadstone, riprap, and agricultural limestone. Portions of the Ste. Genevieve and St. Louis and possibly portions of the Salem appear to be of sufficient hardness for use as concrete aggregate.

Limestone formations of the Pope Megagroup usually contain considerable interbedded shale and may offer combinations of materials for cement making. Limestones of the Pope Megagroup do not reach the Ohio River, except in a small area near Rosiclare, so easy access to water transportation is limited. The same is true of the Salem and Harrodsburg Limestones that crop out in the area surrounding Hicks Dome.

SHALE AND CLAY

Shales of Pennsylvanian and Mississippian age have not been examined in detail to determine their suitability for various uses. Pennsylvanian shales are generally sitly or sandy but could perhaps be used for the manufacture of structural clay products. Shales of the Pope Megagroup are likely to be calcareous, but while some may be suitable for use in the manufacture of cement, their usefulness for ceramic products is limited. Some possibly could be used for making common brick or drain tile.

The New Albany Shale is about 400 feet thick in the vicinity of Hicks Dome. The shale is dark gray to black, carbonaceous, and generally carries small quantities of pyrite. It is believed to be more siliceous than shale of similar age at other places in southern Illinois. However, it has been observed only in outcrop, and fresh material may well be of suitable compostion for the manufacture of cement if mixed with a properly selected limestone.

Residual clays that in some cases contain chert fragments overlie limestone bedrock surfaces but are variable in thickness. Large areas underlain by limestone indicate the possibility of considerable quantities of this type. A sample near Eichorn, derived from the Ste. Genevieve Limestone, was tested and found suitable for making common and face brick (Lamar, 1948).

The use of loess for brick and drain tile manufacture has declined in recent years; shale now is used almost exclusively. Loess deposits in the map area are generally thin but in some areas may have suitable thicknesses of material that would make structural clay products.

CHERT AND CHERT GRAVEL

Chert deposits of two types afford a large reserve of material that has been used locally for road improvement. Creek gravel, composed of chert fragments derived from the St. Louis and Salem Formations and from the Fort Payne Group, is available in considerable quantity as it underlies portions of the floodplains of Goose Creek southeast of Hicks Dome and occurs along the course of Big Creek and Hogthief Creek to the east. Hills underlain by Fort Payne commonly are covered by a residuum of variable thickness that consists of broken chert. The bedded chert of the Fort Payne is minutely jointed and when quarried breaks into sizes suitable for use in some types of road construction. Material of the latter type has been extracted from a pit located in the NW$\frac{1}{4}$ SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 32, T. 11 S., R. 8 E.

SANDSTONE

The economic value of thick sandstone formations of the Pennsylvanian System and Pope Megagroup appears to be limited for presently known uses. Some, perhaps those of the West Baden Group, are a possible source of building stone in shades of brown, cream, or almost white. Sandstone at one time was quarried and used locally as building stone from a locality north of Peters Creek in NE$\frac{1}{4}$ SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 7, T. 12 S., R. 9 E.

IRON ORE

Pig iron was produced during the early history of Hardin County from limonitic ore that occurs in pockets of comparatively small size. Material that ranges in dimension from gravel to large masses is associated with thick accumulations of residual clay and in some cases with abundant chert. This residuum overlies thick limestones of the Mammoth Cave Megagroup, particularly the Ste. Genevieve and St. Louis Limestones. Smelting operations were centered about 4 miles north of Elizabethtown at the Illinois Furnace in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 4, T. 12 S., R. 8 E., and the Martha Furnace in sec. 2, R. 12 S., R. 8 E. Little is known of early mining and smelting operations, but they were continued, probably sporadically, from about 1840 until the early 1880's. Ore was obtained from sites near the smelters, a considerable quantity from a pit in the NE$\frac{1}{4}$ sec. 9, T. 12 S., R. 8 E. The effect of faults and associated fractures on the accumulation of ore, by allowing deeper penetration of weathering, has not been considered in detail, but the linearity of some pits indicate the possibility of some relationship to faults.

OIL AND GAS POSSIBILITIES

Structural conditions in the Karbers Ridge and Rosiclare Quadrangles are similar to those that at other places have favored the accumulation of oil and gas. Oil tests have been drilled in the immediate vicinity of Hicks Dome without encountering commercial accumulations. Stratigraphic traps related to faults have yielded oil in fields about 30 miles to the northeast, but the signigicance of faulting of such intensity as is evident here is problematical. The oil possibilities of Hardin County have been considered in some detail by Weller (1940).

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PLATE I

SURFICIAL GEOLOGY OF THE KARBERS RIDGE AND THE ILLINOIS PART OF THE ROSICLARE QUADRANGLES

Topographic base surveyed by the U.S. Geological Survey in cooperation with the Illinois State Geological Survey in 1957-1959.

Geologically surveyed by James W. Baxter and George A. Desborough assisted by David A. Schaefer and Albert D. Pernichele in 1960 and 1961

GENERALIZED COLUMNAR SECTION OF EXPOSED ROCKS

SYSTEM	SERIES	MEGAGROUP	GROUP	FORMATION	MEMBER	SYMBOL	THICKNESS IN FEET
PENNSYLVANIAN			Kewanee	Spoon		Ps	30±
			McCormick	Abbott	Murray Bluff; Delwood Coal; Finnie; Willis Coal; Grindstaff	Pa	200-330
				Caseyville	Pounds; Gentry Coal; Sellers; Battery Rock; Lusk	Pcv	250-350
MISSISSIPPIAN	CHESTERIAN	Pope		Kinkaid	Negli Creek	Mk	0-40
				Degonia		Md	0-30
				Clore	Ford Station; Tygett; Cora	Mcl	70-120
				Palestine		Mp	50-60
				Menard	Allard; Scottsburg; Walche	Mm	100-130
				Waltersburg		Mw	15-50
				Vienna		Mv	10-20
				Tar Springs		Mts	70-90
				Glen Dean		Mgd	40-60
				Hardinsburg		Mh	90-110
			Golconda	Haney; Fraileys; Beech Creek		Mg	120-130
			West Baden	Cypress		Mc	80-100
				Ridenhower		Mr	25-65
				Bethel		Mb	70-100
		Mammoth Cave	Cedar Bluff	Downeys Bluff		Mdb	20-40
				Yankeetown		Mys	30-45
				Renault	Shetlerville		
					Levias	Ml	10-35
	VALMEYERAN			Aux Vases	Rosiclare	Mav	15-35
				Ste. Genevieve	Joppa; Karnak; Spar Mountain; Fredonia	Msg	140-180
				St. Louis		Msl	350-400
				Salem		Ms	500-520
				Harrodsburg		Mhg	60-300
		Knobs		Fort Payne		Mfp	280-640
				Springville			
DEVONIAN AND MISSISSIPPIAN	UPPER DEVONIAN AND KINDERHOOKIAN		New Albany			Dna	450±
DEVONIAN	MIDDLE	Hunton		Lingle		Dh	350+
				Grand Tower			
	LOWER			Clear Creek			

EXPLANATION

PLEISTOCENE

RECENT

Qal — Stream alluvium; includes some areas of low terrace
Silt, clay, sand, and gravel

WISCONSINAN

Qwi — Intermediate terrace
Well bedded, calcareous, clayey silts; a few sandy lenses

Qwh — High terrace
Sand with occasional silt beds

PENNSYLVANIAN

Ps — Spoon Formation
Shale of the lower part of the formation

Pa (bmb, tf, bf, tg, bg) — Abbott Formation
Shale, sandstone, thin coal; top (tg) and base (bg) of Grindstaff Sandstone, top (tf) and base (bf) of Finnie Sandstone, and base (bmb) of Murray Bluff Sandstone

Pcv (bp, tbr, bbr) — Caseyville Formation
Sandstone, shale, conglomerate, thin coal, and limestone; top (tbr) and base (bbr) of Battery Rock Sandstone and base (bp) of the Pounds Sandstone shown in some areas

MISSISSIPPIAN

Mk — Kinkaid Formation
Gray, cherty limestone

Md — Degonia Sandstone
Fine-grained sandstone, red and green shale, siltstone, and chert

Mcl — Clore Formation
Gray shale, limestone, siltstone, and thin-bedded sandstone

Mp — Palestine Sandstone
Fine-grained standstone, mostly thin bedded; shale

Mm — Menard Limestone
Dark, fine-grained, partly fossiliferous limestone; shale

Mw — Waltersburg Formation
Shale; shaly sandstone

Mv — Vienna Limestone
Dark, fine-grained, partly cherty, locally calcarenitic limestone; shale

Mts — Tar Springs Sandstone
Fine-grained, partly cross-bedded sandstone; shale

Mgd — Glen Dean Limestone
Fine- to coarse-grained, fossiliferous, partly oolitic limestone; shale

Mh — Hardinsburg Sandstone
Sandstone; upper part is interlaminated greenish gray shale and sandstone

Mg — Golconda Group
Haney Limestone — fine- to coarse-grained, fossiliferous limestone; Fraileys Shale — shale, siltstone, some limestone; Beech Creek Limestone — argillaceous, dark, fine- to medium-grained limestone

Mc — Cypress Sandstone
Fine-grained sandstone, shaly in upper part

Mr — Ridenhower Formation
Interlaminated, wavy-bedded shale and sandstone; soft, dark shale; light colored thin- to medium-bedded sandstone; thin, discontinuous limestone beds

Mb — Bethel Sandstone
Light gray, fine- to medium-grained sandstone; basal conglomerate

Mdb — Downeys Bluff Limestone
Medium-grained, crinoidal, locally oolitic limestone; some chert at top

Mys — Yankeetown Shale and the Shelterville Member of the Renault Limestone
Yankeetown Shale — calcareous, gray shale with thin siltstone and limestone beds; Shetlerville Member — gray, more or less oolitic limestone that grades to dark, fine-grained limestone at top

Ml — Levias Member of the Renault Limestone
Light colored, oolitic, locally fine-grained limestone

Mav — Aux Vases Sandstone
Rosiclare Member — very fine-grained, very calcareous sandstone; siltstone; some sandy limestone; shale at base

Msg — Ste. Genevieve Limestone
Gray to almost white, variable textured but largely oolitic limestone; thin, calcareous sandstone lenses

Msl — St. Louis Limestone
Fine-grained, cherty limestone; partly oolitic in upper half

Ms — Salem Limestone
Gray to almost black, argillaceous limestone; foraminiferal calcarenite; oolitic calcarenite; lower half has interbedded light-colored, coarse-grained, fossiliferous limestone and cherty, dolomitic limestone; silty limestone at base grades laterally to siltstone

Mhg — Harrodsburg Limestone
Light-colored, crinoidal, bryozoan limestone

Mfp — Fort Payne Formation and Springville Shale
Calcareous siltstone; silty, dark-colored limestone; cherty limestone; chert; Springville Shale at base

DEVONIAN AND MISSISSIPPIAN

Dna — New Albany Group
Dark gray to black shale

DEVONIAN

Dh — Hunton Limestone
Limestone and chert

IGNEOUS ROCKS

Dikes, sills, and breccias
Dikes are lamprophyres and mica-peridotites; sills are lamprophyres; breccias are intrusion and/or explosion types

ECONOMIC AND STRUCTURE DATA

Fault *Dashed where inferred*

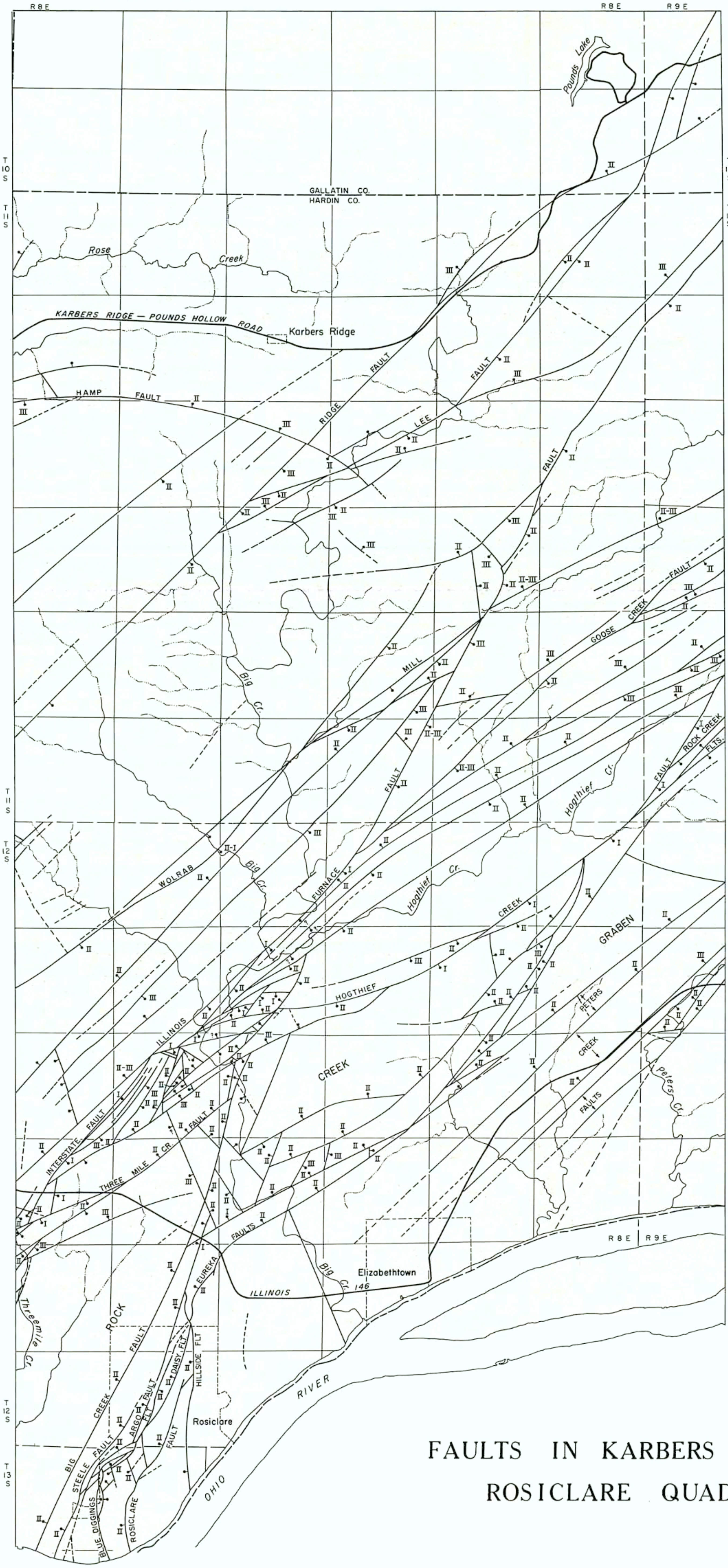
10° Strike and dip of bedding

6 Mines and quarries

Mine shaft

Adit

Williams & Heintz Map Corporation, Washington 27, D.C.



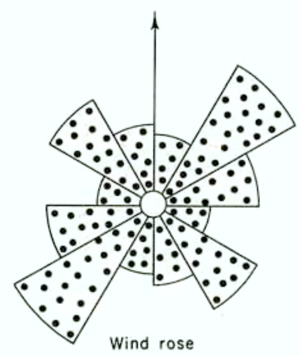
EXPLANATION

Fault, downthrown side indicated

I > 500 feet displacement

II 50-500 feet displacement

III < 50 feet displacement



Wind rose showing strike orientation of 383 measured joints

MILES
0 1 2

FAULTS IN KARBERS RIDGE AND ROSICLARE QUADRANGLES

CIRCULAR 385

ILLINOIS STATE GEOLOGICAL SURVEY

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