# Clays Ferry Formation (Ordovician)— A New Map Unit in South-Central Kentucky

*By* GORDON W. WEIR *and* ROBERT C. GREENE

CONTRIBUTIONS TO STRATIGRAPHY

GEOLOGICAL SURVEY BULLETIN 1224-B

*Prepared in cooperation with the Kentucky Geological Survey*

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON : 1965

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 15 cents (paper cover)

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# CLAYS FERRY FORMATION (ORDOVICIAN)—A NEW MAP UNIT IN SOUTH-CENTRAL KENTUCKY

By GORDON W. WEIR and ROBERT C. GREENE

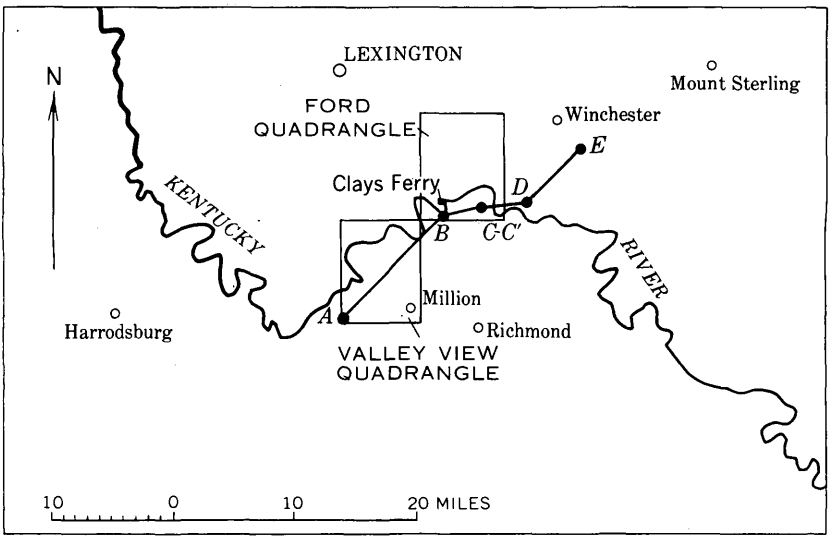
ABSTRACT

The Clays Ferry Formation is a newly recognized major rock-stratigraphic unit in south-central Kentucky. It includes strata that were previously divided on the basis of the fauna into (in ascending order) the Cynthiana Formation of A. F. Foerste, the Fulton Shale, and the Million Shale of J. M. Nickles as used by A. F. Foerste. The Clays Ferry consists of interstratified thin-bedded shale, limestone, and siltstone. It ranges from about 120 to 220 feet in thickness, and is of late Middle and early Late Ordovician age. The Clays Ferry Formation overlies and intertongues with thick-bedded limestone of the Lexington Limestone; it grades into the overlying Garrard Siltstone.

## INTRODUCTION

The name Clays Ferry Formation is here given to a mappable unit of interbedded shale, limestone, and siltstone that crops out in south-central Kentucky. The Clays Ferry Formation overlies thick-bedded granular limestone of the Lexington Limestone as defined by Black and others (1965). It is overlain by the Garrard Siltstone. The type locality (figs. 1 and 2) is on the south side of the Kentucky River in Madison County across the river from the settlement of Clays Ferry, Fayette County, Ky. The type section (p. B14) is exposed in a gully a few tens of feet northeast of the eastern span of the Interstate Highway 75 bridge over the Kentucky River at Clays Ferry and in roadcuts on the northeast side of the highway in the southern part of the Ford quadrangle, Kentucky.

This report is based in large part on the geological mapping of Kentucky being conducted by the U.S. Geological Survey in cooperation with the Kentucky Geological Survey. Areas not currently being mapped were studied chiefly in the spring and summer of 1963. The writers are indebted to D. F. B. Black, E. R. Cressman, and G. C. Simmons for information concerning the stratigraphy of the Clays Ferry Formation. R. J. Ross, Jr., helped collect fossils at the type locality.




SECTIONS

*A*. Sledd Branch
*B*. Clays Ferry (Type section of Clays Ferry Formation)
*C*. Boonesboro Beach West
*C'*. Boonesboro Beach
*D*. Fourmile Creek
*E*. Logan Lick Road

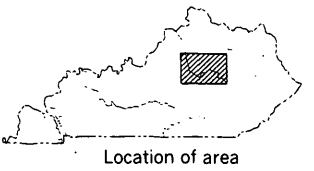



**FIGURE 1.—Map of central Kentucky showing location of type section and representative sections of the Clays Ferry Formation shown in figure 4.**

## PREVIOUS NOMENCLATURE

Campbell (1898) included the rocks of the Clays Ferry Formation in the Winchester Limestone (fig. 3), which he described from outcrops near the town of Winchester, Ky. Near this town the Winchester Limestone of Campbell (1898) is divisible into two lithologic units: a lower unit of thick-bedded granular limestone with seams of shale, and an upper unit of limy shale interstratified with thin-bedded aphanitic and granular limestone and minor thin-bedded limy siltstone. Southwestward from Winchester, the lower unit thins and probably intertongues with the upper unit, so south of the Kentucky River the Winchester Limestone of Campbell (1898) is characterized by much shale. The name Winchester was later restricted by Miller (1905, p. 9, 22–23) to the lower part of the Winchester Limestone of Campbell (1898), and Winchester was used in this restricted sense by Nickles (1905) and Matson (1909).

To approximately the same unit named Winchester by Miller (1905), Foerste (1906, p. 10, 13, 14, 211) gave the name Cynthiana Formation, from the town of Cynthiana about 25 miles northeast of

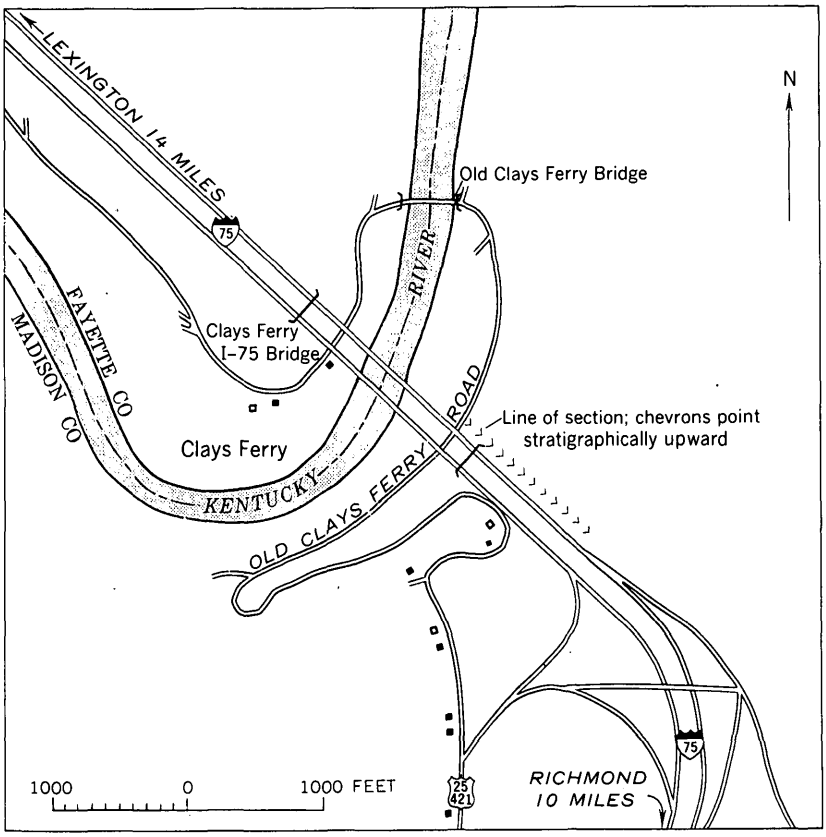



FIGURE 2.—Map of the Clays Ferry crossing of the Kentucky River showing location of the type section of Clays Ferry Formation.

Lexington, Ky. Since Foerste proposed Cynthiana, the name Winchester has been little used. The Cynthiana Formation was redefined by Hall and Palmquist (1960) to include beds below those that made up Foerste's (1906) Cynthiana (see fig. 3). The Cynthiana was so recognized by the Geological Survey until the name was abandoned (Black and others, 1965).

For the beds of the Eden Group overlying the Winchester of Miller (1905) and underlying the Garrard Siltstone, Nickles (1905, p. 15, 25–26) proposed the name Million Shale, after the village of Million, 5 miles northeast of Richmond. The Million was distinguished by its shaly character and by the presence in its lower layers of the bryozoan "*Callopora sigillarioides*" (= ? *Hallopora onealli sigillarioides*) and by the abundant brachiopod "*Plectambonites sericeus*" (=*Sowerbyella rugosa*). North of the Kentucky River the lowest zone of abundant *Sowerbyella* generally is only a few feet to about 20 feet

| | * Campbell (1898) | Miller (1905) | Nickles (1905) | Foerste (1906) | Matson (1909) | Miller (1915, 1919) | Jillson (1929) | * McFarlan and Goodwin (1930) |
|---|---|---|---|---|---|---|---|---|
| OVERLYING UNIT (details omitted) | Garrard sandstone | Eden stage: Garrard substage | Eden group: Garrard sandstone | Eden Formation: Paint Lick member | Eden shale: Garrard sandstone member | Eden: Paint Lick (Garrard) sandstone | Garrard sandstone | Eden: Garrard |
| APPROXIMATE EQUIVALENT OF CLAYS FERRY FORMATION NEAR CLAYS FERRY | Winchester limestone | Eden stage: ?—? | Eden group: Million shale | Eden Formation: Million member; Utica Fm: Fulton bed | Eden shale | Eden: Million shale and limestone; Fulton | Eden shale | Eden: Million |
| | | Winchester substage | Winchester group | Cynthiana Fm: Point Pleasant member; Greendale member | Winchester limestone | Cynthiana: Point Pleasant limestone; Greendale limestone | Cynthiana limestone | Cynthiana |
| UNDERLYING UNIT (details omitted) | Lexington limestone | Bigby substage | Lexington group | Lexington Formation | Lexington limestone | Lexington | Woodburn limestone | Woodburn of Lexington series |

Continued below

| | * McFarlan (1938, 1943) McFarlan and Freeman (1935) | McFarlan (1954) | * McFarlan and Campbell (1955) | Hall * and Palmquist (1960) | Palmquist and Hall (1961) | * Templeton and Willman (1963) | * This report |
|---|---|---|---|---|---|---|---|
| | Eden shale: Garrard sandstone | Garrard siltstone | Eden: Garrard siltstone | Eden group: Garrard sandstone | Eden group: Garrard sandstone | Paint Lick Formation | Garrard Siltstone |
| | Eden shale: Million | Million shale | Eden: Million | Eden group | Eden group: Million shale of Nickles (1905) as used by Foerste (1906) | Fulton-Million Formations | Clays Ferry Formation |
| | Eden shale: Fulton | Fulton shale | Eden: Million | Eden group | Eden group: Fulton shale | Fulton-Million Formations | Clays Ferry Formation |
| | Cynthiana Formation: Rogers Gap | Cynthiana limestone | Cynthiana | Cynthiana Fm (upper part) | Cynthiana Fm (upper part): Rogers Gap Mbr as used by Foerste (1914) | Cynthiana Formation: Nicholas Member | Clays Ferry Formation |
| | Cynthiana Formation: Greendale | Cynthiana limestone | Cynthiana | Cynthiana Fm (upper part) | Cynthiana Fm (upper part): Greendale is Mbr of Foerste (1906) | Cynthiana Formation: Bromley Member | Clays Ferry Formation |
| | Cynthiana Formation: Bromley | Cynthiana limestone | Cynthiana | Cynthiana Fm (upper part) | Cynthiana Fm (upper part) | Cynthiana Formation | Clays Ferry Formation |
| | Woodburn limestone of Lexington limestone | Woodburn limestone of Lexington limestone | Woodburn of Lexington | Woodburn Limestone Member | Cynthiana Fm (upper part): Woodburn Limestone Mbr | Lexington Ls. (upper part): Devils Hollow Member | Lexington Limestone |
| | Woodburn limestone of Lexington limestone | Woodburn limestone of Lexington limestone | Woodburn of Lexington | Woodburn Limestone Member | Cynthiana Fm (upper part) | Lexington Ls. (upper part): Woodburn Member | Lexington Limestone |

FIGURE 3.—Nomenclature previously applied to stratigraphic units exposed at type section of the Clays Ferry Formation. Asterisks indicate reports with geologic map or description of rocks at type locality of the Clays Ferry Formation.

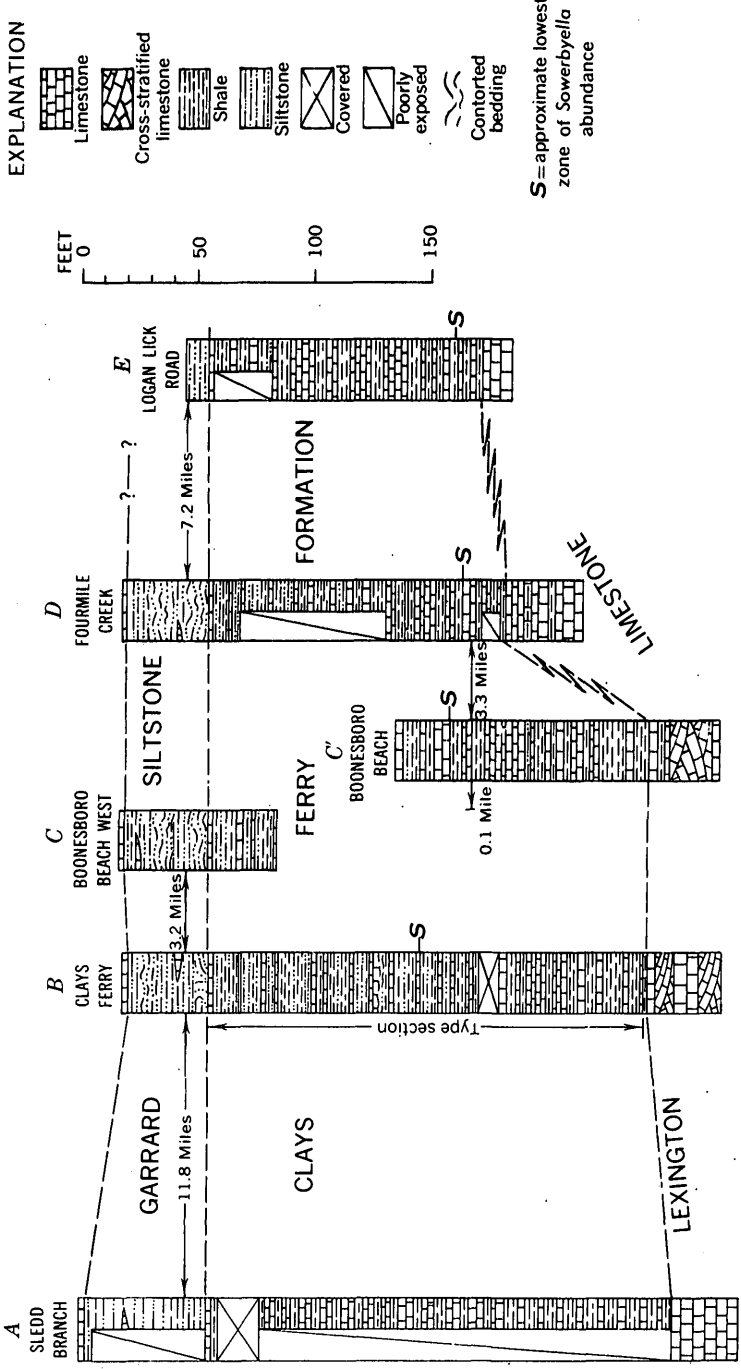



FIGURE 4.—Type section and representative sections of the Clays Ferry Formation in south-central Kentucky. Locations of sections shown on figure 1.

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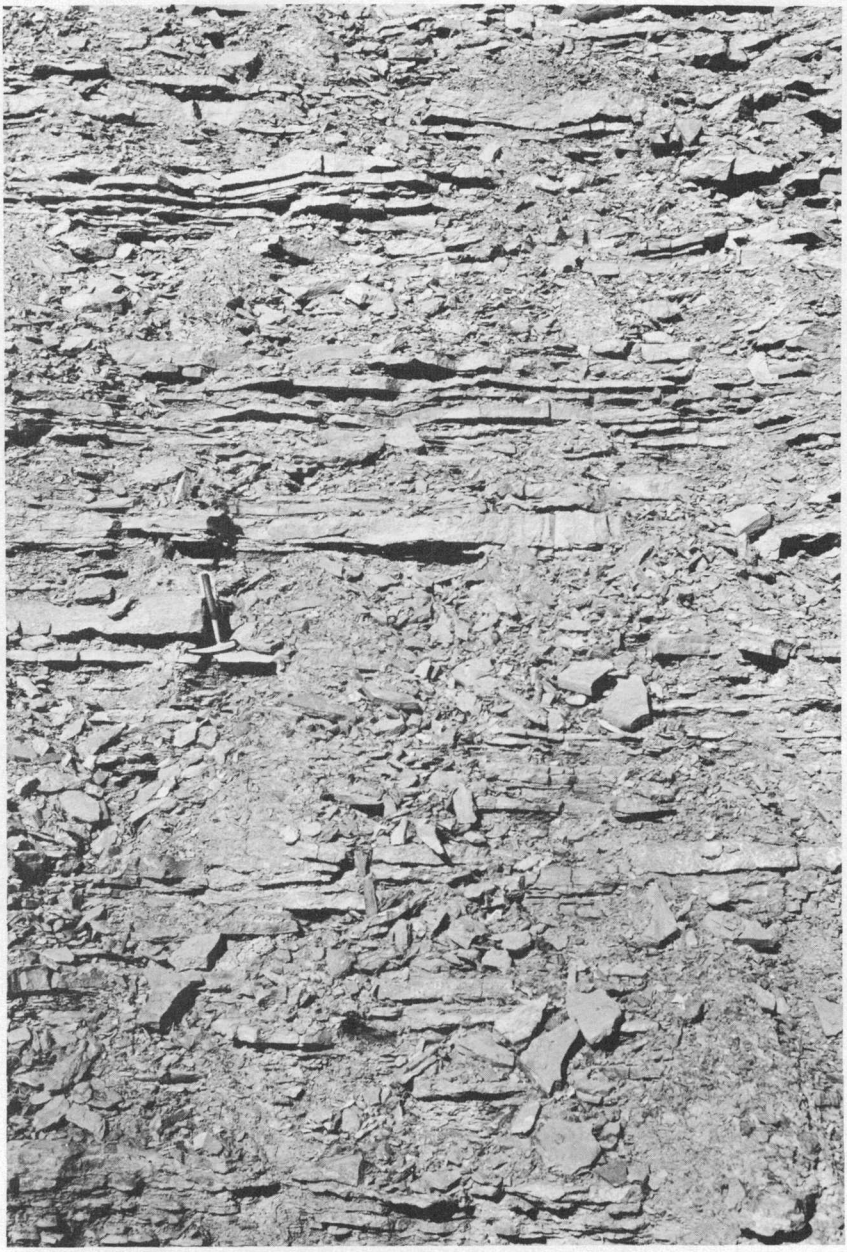

FIGURE 5.—Lowest zone of abundant *Sowerbyella* (at pick handle) in interstratified shale and thin-bedded limestone at type section of Clays Ferry Formation, roadcuts on northeast side of Interstate Highway 75 about 500 feet southeast of bridge over Kentucky River. This zone is the base of the Million Shale of Nickles (1905) and is about 100 feet above the base of the Clays Ferry Formation shown in figure 6.

above the lithologic break between granular limestone below and the interbedded shale and limestone above. However, near Million, the presumed type locality of the formation, and elsewhere south of the Kentucky River the lowest zone of abundant *Sowerbyella* is about 100 feet above the lithologic break (figs. 4 and 5). The paleontologic criteria for distinguishing the Million Shale of Nickles (1905) were used by Foerste (1906) and all later stratigraphers.

Foerste (1906) recognized the Fulton, the zone of *Triarthrus becki*, as a layer as much as 3 feet thick at the base of the Million Shale of Nickles (1905) in central Kentucky. Later workers who recognized the Fulton Shale considered it to be the basal formation of the Eden Group and to be a faunal unit characterized by abundant columnals of *Merocrinus curtus* (McFarlan and Freeman, 1935, p. 2001; McFarlan, 1943, p. 24).

Some geologists considered the rocks between the Cynthiana and the Garrard to be the Eden Shale or an unnamed unit of the Eden Group (fig. 3). All geologists, however, apparently placed the upper contact of the Cynthiana Formation just below the lowest bed of abundant *Sowerbyella* or abundant *Merocrinus*. In much of south-central Kentucky these beds are about 100 feet above the change from granular limestone to interbedded shale and limestone, and are near the middle of the mappable lithologic unit (fig. 5).

In summary, the interbedded shale, limestone, and siltstone of the mappable rock-stratigraphic unit that is well exposed near Clays Ferry have in the past been assigned to the Winchester Limestone of Campbell (1898), or to the Winchester as restricted by Miller (1905), or to the Cynthiana Formation of Foerste (1906), and to an unnamed division of the Eden Group or to the Fulton Shale and Million Shale of Nickles (1905) as used by Foerste (1906). The name Winchester has, for all practical purposes, been abandoned. The Cynthiana Formation, the Fulton Shale, and the Million Shale of Nickles (1905) are faunally defined units that do not include all the Clays Ferry Formation. None of these old names can now be used without major changes of their definitions and consequent further confusion of the nomenclature. The rock-stratigraphic unit described in this report, therefore, is given a new name—the Clays Ferry Formation.

## LITHOLOGY

The Clays Ferry Formation consists of limestone, shale, and siltstone. Limestone and shale are irregularly interbedded throughout the formation, and locally either may be dominant. The Clays Ferry as a whole, however, is characterized by its shale content, which is much greater than in underlying and overlying formations. Siltstone

is a minor constituent but is common to abundant in the upper one-quarter of the formation. The proportions of limestone, shale, and siltstone differ from place to place (fig. 4), and few beds or sets of beds are traceable for more than several hundred feet.

Thin beds are characteristic of the Clays Ferry Formation (figs. 5, 6, and 7). Most beds are only a few inches thick; few are more than a foot thick.

Limestone is the most conspicuous rock in the Clays Ferry and makes up about 30 to 60 percent of the formation. The limestone is commonly light to dark gray and weathers gray or yellowish brown. It ranges from micrograined to very coarse grained but is mostly fine to medium grained. Limestones of different grain size are closely interbedded and in places intergrade. Fossils, chiefly brachiopods and bryozoans, are common in most beds of the limestone. Some coarse-grained layers are composed largely of brachiopod shells, but micrograined beds are barren or sparsely fossiliferous. The limestone is mostly in even beds 1 to 6 inches thick. Sparse thicker beds, as much as 3 feet thick, are generally lenticular, and some are contorted.

Shale makes up about 30 to 60 percent of the Clays Ferry Formation, but because of its poor exposure the percentage of shale in the formation is commonly difficult to measure. Most shale is dark greenish gray or olive gray and weathers yellowish gray or yellowish brown. Some shale is silty and limy, and locally grades into siltstone and limestone. Most shale is distinctly laminated in sets 1 to 12 inches thick. Fossils are generally sparse, though small bryozoans are locally common.

Siltstone makes up about 5 to 15 percent of the Clays Ferry and is mostly in the upper part of the formation. Where fresh, the rock is limy, greenish gray, and well indurated; where weathered and leached, it is yellowish brown, friable, and punky. Most siltstone is in even beds 1 to 3 inches thick. Some thicker units, as much as 3 feet thick, are contorted lenses that weather to form knobby outcrops. Fossils are sparse in the siltstone except where it is very limy or grades to limestone. Siltstone of the Clays Ferry resembles that of the overlying Garrard Siltstone but is more thinly bedded.

## OUTCROP

Because of its shale content, the Clays Ferry Formation generally is poorly exposed. It is less resistant than underlying and overlying formations and commonly forms moderate slopes littered with plates and thin slabs of limestone.

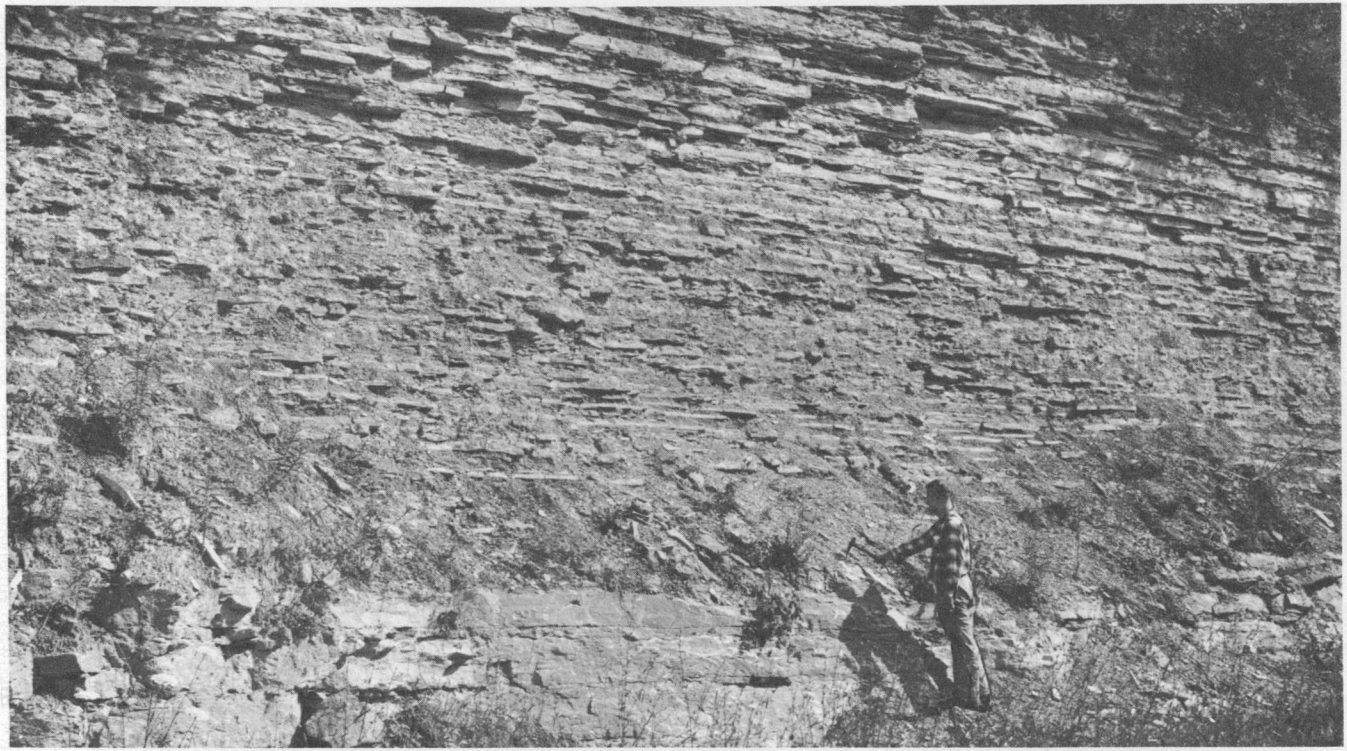

FIGURE 6.—Basal contact of Clays Ferry Formation (at pick point) exposed in a roadcut on old Clays Ferry road about 200 feet west of type section. Underlying rock is thick-bedded partly crossbedded medium- to coarse-grained phosphatic limestone at top of Lexington Limestone.

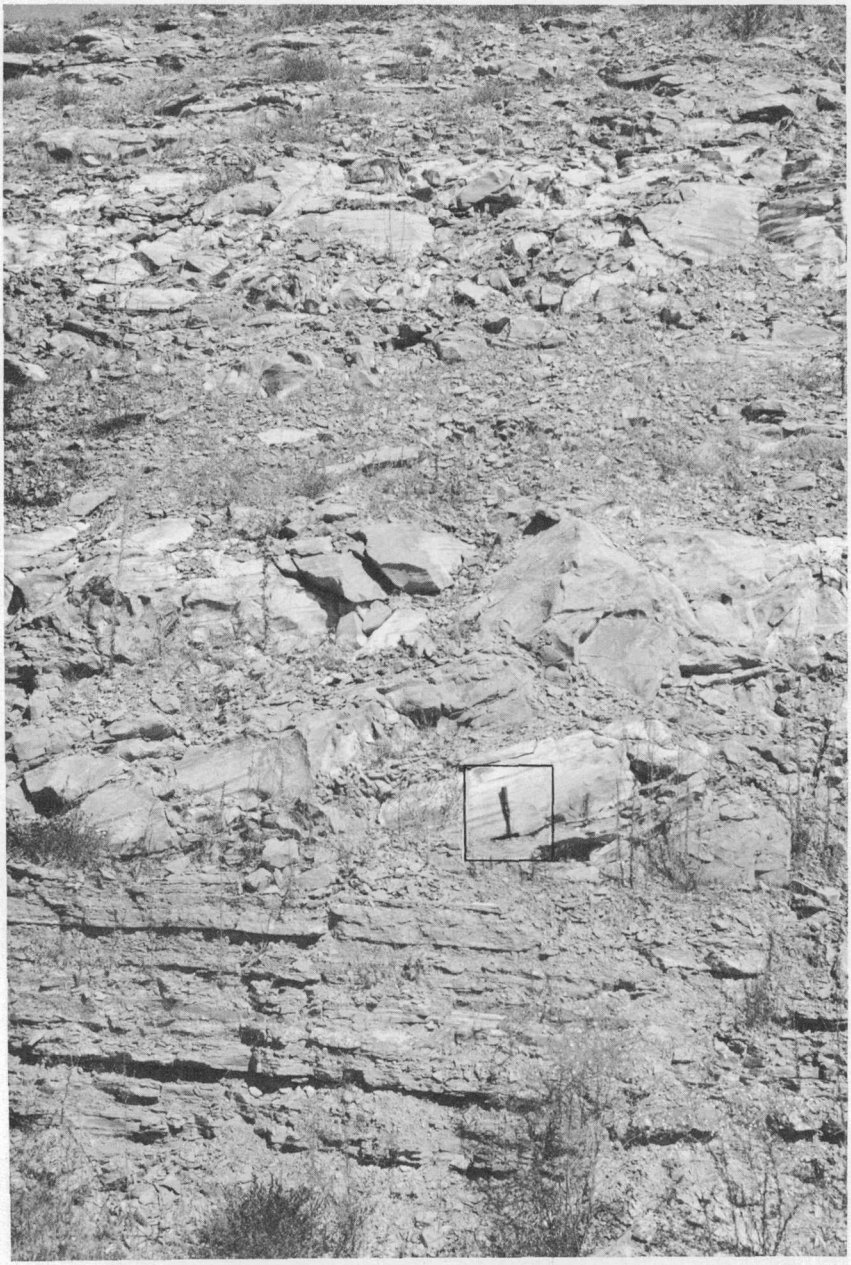

FIGURE 7.—Upper contact of Clays Ferry Formation (about 1 ft below pick) at type section of Clays Ferry Formation in roadcut on northeast side of Interstate Highway 75 about 1,000 feet southeast of bridge over Kentucky River. Overlying unit is Garrard Siltstone. Basal unit of Garrard (at pick) is contorted, resulting in steep dips and local discordance at the contact.

## CONTACTS

The Clays Ferry Formation overlies thick-bedded granular limestone of the Lexington Limestone in south-central Kentucky (Black and others, 1965). The basal contact of the Clays Ferry is fairly sharp at the type locality (fig. 6). East of the type locality, the base of the Clays Ferry is transitional through a few feet to a few tens of feet; the contact is placed so as to exclude thick-bedded granular limestone and to include, in the Clays Ferry, thin-bedded limestone, micrograined limestone, and persistent shale units.

The Clays Ferry Formation grades into the overlying Garrard Siltstone, which consists of thick beds of limy siltstone and sparse thin lentils of shale and limestone. Beds of siltstone are thicker and more abundant near the top of the Clays Ferry Formation, and beds of limestone and shale are less abundant. The upper contact is placed at the top of the highest relatively persistent bed of limestone in the Clays Ferry Formation. Locally, the basal bed of the Garrard Siltstone is thick and contorted into bulbous lenses with crumpled internal layers. At such localities (fig. 7) the contact is sharp and appears discordant, though it may lose this character as the basal bed of the Garrard thins.

## FOSSILS

Table 1 shows the megafossil fauna of the Clays Ferry Formation at the type locality. The most conspicuous element of this fauna is the large flat brachiopod *Rafinesquina*.

Fossil collections of other sections of the Clays Ferry Formation are incomplete or not yet studied. The faunas listed by McFarlan and Freeman (1935) for units they called the Rogers Gap and Fulton Formations at localities south of the Kentucky River are from beds that are here included in the Clays Ferry Formation.

## THICKNESS AND EXTENT

The Clays Ferry Formation is 190 feet thick at its type section. It ranges from about 120 feet thick near Winchester to about 220 feet in the western part of the Valley View quadrangle. North and east of the type locality the formation thins markedly within less than 10 miles (fig. 4), as the lower part of the Clays Ferry grades into and intertongues with the upper part of the Lexington Limestone (Black and others, 1965).

The Clays Ferry Formation crops out widely in south-central Kentucky. The formation has been mapped in the Valley View quadrangle and adjacent quadrangles, and it has been recognized in many sections between Richmond, Harrodsburg, Lexington, and Mount Sterling. Determination of its northern and western extent requires further field study.

TABLE 1.—*Fossils from the Clays Ferry Formation*

[Brachiopods and trilobites identified by R. J. Ross, Jr.; bryozoans identified by O. L. Karklins; and gastropods identified by E. L. Yochelson]

| | USGS colln. No. | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D1168-CO | D1169-CO | D1170-CO | D1171-CO | D1172-CO | D1173-CO | D1174-CO | D1175-CO | D1176-CO | D1178-CO | D1177-CO | D1179-CO | D1180-CO | D1181-CO | D1195-CO | D1182-CO | D1183-CO | D1184-CO | D1185-CO | D1186-CO | D1187-CO | D1189-CO | D1188-CO | D1190-CO | D1191-CO |
| Bryozoans: | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Arthropora* sp | | | | | | | | | | | | | | | | X | | | | | X | | | | |
| *Atactoporella* sp | | | | | | | | | | | | | | | | | | | | | X | | | | |
| *Batostoma implicatum* (Nicholson) | | | | | | | | | | | | | | | | | | | | | | | X | | |
| *Batostomella* sp | | | | | | | | X | | | | | | | | | | | | | | | | | |
| *Dekayella ulrichi* (Nicholson) | | | | | | | | | | | | | | | | | | | | | X | | | | |
| *Eridotrypa* sp | | | | X | X | | | | | | | X | | | | | | | | | | | | | |
| *Hallopora* sp | | | | | | | | | | | | | | | | X | | | | | | | | | |
| *Heterotrypa* cf. *frondosa* (d'Orbigny) | | | | | X | | | X | | | | | | | | X | | | | | X | X | | | |
| *Homotrypa* sp | | | | | | | | X | | | X | | | | | | | | | | | | | | |
| *Peronopora* cf. *decipiens* (Rominger) | | | | | | | | | | | X | | | | | | | | | | | | | | |
| *Stictopora* sp | | | | | | | | | | | | | | | | | | | | | X | | | | |
| Brachiopods: | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Dalmanella* sp | | | | | | | | | | | | | | | | | | | | | X | | | | |
| Dalmanellid | | | | | | | | | | | | | | | | | | | X | | | | | | |
| *Dinorthis*? sp | | | | | | | X | | | X | | | | | | | | | | | | | | | |
| *Fardenia*? sp | | | | | | | | | | | | | | | | | | | | | | | X | | |
| *Hebertella* cf. *H. occidentalis* Hall | | | | | | X | | | | | | | | | | | | | | | | | | | |
| sp | | | | | | | | | | | | | | | | | | | X | | | | | | |
| *Platystrophia* sp | | | | | | | X | | | X | | X | X | | | | | | | | | | | | |
| ?sp | | | | | | X | | | | | | | | | | | | | | | | | | | |
| *Rafinesquina winchesterensis* Foerste | | | | | | | | | | X | | | | | | | | | | | | | | | |
| cf. *R. winchesterensis filistriata* Foerste | | | | | | | | | | X | | | | | | | | | | | | | | | |
| sp | X | X | X | X | X | X | X | | X | | | X | X | | X | X | X | X | | X | X | | X | X | X |
| Rhynchonellid? | | | | | | | | | | | | | | | | | X | | | | | | | | |
| *Sowerbyella* sp | | | | | | | | | | | | | | X | X | | | X | X | X | X | | X | | |
| *Zygospira* aff. *Z. cincinnatiensis* Meek | | | | | | | | | | | | | | | | X | X | | | | | | | | |
| cf. *Z. modesta* Hall | | | | | | | | | | | X | | X | | | | X | | | | | | | | |
| cf. *Z. lebanonensis* Cooper | | | X | | | | | | | | | | | | | | | | | | | | | | |
| *recurvirostris* Hall | | | | | | | | | | | X | | | | | | | | | | | | | | |
| sp | X | X | | X | X | X | X | | X | X | | X | X | | X | | | X | X | X | X | | | | |
| ?sp | | | X | | | | | | | | | | | | | | | | | | | | | | |
| Gastropods: | | | | | | | | | | | | | | | | | | | | | | | | | |
| *Cyclonema* sp | | | | | X | | | | | | | X | | | | | | | | | | | | | |
| Platyceratid, juvenile | | X | | | | | | | | | | | | | | | | | | | | | | | |
| Trilobites: | | | | | | | | | | | | | | | | | | | | | | | | | |
| Calymenid pygidium | | | X | | | | | | | | | | | | | | | | | | | | | | |
| *Flexicalymene* sp | | | | | | | | | | | | | | | | | X | | X | | | | X | | |
| *Isotelus*? sp | | | X | | | | | | | | | | | | | | | | | | | | | | |
| *Proetus*? sp | | | | X | | | | | | | | | | | | | | | | | | | | | |

TABLE 2—*Source of fossils collected from Clays Ferry Formation*

[Collins D1168–CO through D1181–CO made from Clays Ferry Formation exposed in roadcuts 500 to 2,000 ft. west of the type section along the Old Clays Ferry Road. Collins D1182–CO through D1191–CO and D1195–CO made from the type section of the Clays Ferry Formation in roadcuts along Interstate Highway 75 from 20 to 1,000 ft southeast of the I–75 bridge over the Kentucky River at Clays Ferry. Asterisk indicates float; all other samples are from outcrop]

| *USGS colln. No.* | *Height above base of Clays Ferry Formation (feet)* |
|---|---|
| D1168–CO | 6 |
| 1169–CO | 8 |
| 1170–CO | 10 |
| 1171–CO | 15 |
| 1172–CO | 24 |
| 1173–CO | 30 |
| 1174–CO | 37 |
| 1175–CO | 38 |
| 1176–CO | 46 |
| 1178–CO* | 55–60 |
| 1177–CO | 60 |
| 1179–CO | 71–75 |
| 1180–CO* | 75 |
| D1181–CO | 97 |
| 1195–CO | 101 |
| 1182–CO | 120 |
| 1183–CO | 124 |
| 1184–CO | 125 |
| 1185–CO | 130 |
| 1186–CO | 159 |
| 1187–CO* | 159 |
| 1189–CO | 165 |
| 1188–CO | 171 |
| 1190–CO | 182 |
| 1191–CO | 187–190 |

## AGE AND CORRELATION

The Clays Ferry Formation south of the Kentucky River is probably of late Middle Ordovician and early Late Ordovician age. It is mostly of Late Ordovician age near Lexington and Winchester where the formation is thinner because of intertonguing of its lower part with the Lexington Limestone (Black and others, 1965). The underlying Lexington Limestone is Middle Ordovician in age (Black and others, 1965), and the overlying Garrard Siltstone is Late Ordovician (Hall and Palmquist, 1960). McFarlan and Freeman (1935, p. 1986–1992, 2001) placed the boundary between the "Trenton" (Middle Ordovician) and "Eden" (Upper Ordovician) in fossiliferous strata that are near the middle of the Clays Ferry Formation at the type locality and elsewhere south of the Kentucky River. Because of lithologic changes northward, these fossiliferous strata are near the base of the Clays Ferry Formation near Lexington and Winchester.

The age assignments and previously identified faunal units suggest that the Clays Ferry Formation of south-central Kentucky correlates with all or part of the Latonia Shale, the Fulton Shale, and the upper part of the Cynthiana Formation, as these terms were used in northern Kentucky by Palmquist and Hall (1961).

## TYPE SECTION

*Type section of the Clays Ferry Formation*

[Section begins about 45 ft above old Clays Ferry Road, a few tens of feet northeast of eastern span of Interstate Highway 75 in unnamed gully, continues southeastward up to highway level and thence about 1,000 southeastward along northbound lanes of the highway in southern part of Ford quadrangle, Madison County, Ky.]

| | *Thickness (feet)* |
|---|---|
| Garrard Siltstone: | |
| Siltstone, greenish-gray (5*GY* 7/1) [1]; weathers slightly darker; limy, in even beds a few inches to several feet thick, but most thick beds in flow rolls, contorted lenses with crumpled internal layers. Limestone is light gray, medium to coarse grained; in sparse discontinuous thin lentils, 1 to 3 in. thick; abundant flat brachiopods. Basal contact of Garrard is sharp and distinct on east side of highway at highway level, where contorted beds mark the base, but contact on west side of highway is gradational and less distinct where basal siltstone is more thinly and evenly bedded | 31 |
| Total Garrard Siltstone | 31 |
| Clays Ferry Formation: | |
| Shale (50 percent), siltstone (25 percent), and limestone (25 percent). Shale is dark greenish gray (5*GY* 4/1), slightly silty to silty; in laminae 2 to 3 mm thick, grouped in sets 1 to 12 in. thick; sparse bryozoans. Siltstone is dark greenish gray (5*GY* 4/1) to greenish gray (5*GY* 7/1); limy and locally grades to silty limestone; interstratified irregularly throughout unit but dominant near top, in even beds 1 to 3 in. thick; sparse brachiopods. Limestone is medium light gray (*N*6), light olive gray (5*Y* 6/1), and medium gray (*N*5), mostly poorly sorted, chiefly very fine to coarse grained; disseminated grains and flakes of silt and common fine to coarse fossil fragments mostly in gently wavy beds 1 to 8 in. thick; also fine grained in fairly even beds, 1 to 6 in. thick, and very fine grained, well sorted in beds less than 1 in. thick and in lenticles 1 to 2 in. long in shale. Fossils, sparse to very abundant, chiefly brachiopods, gastropods, and bryozoans; less abundant are pelecypod and trilobite fragments. Thickness approximate because of variation in upper contact.<br>The following fossil collections were made from this unit: D1186–CO, 20 ft above base of unit; D1187–CO, float, 20 ft above base; D1189–CO, 25 ft below top; D1188–CO, 32 ft above base; D1190–CO, 8 ft below top, D1191–CO, 0 to 3 ft below top | 51 |

[1] Color names with numbers based on color chart by Goddard and others (1948).

*Type section of the Clays Ferry Formation*—Continued

| Clays Ferry Formation—Continued | Thickness (feet) |
|---|---|
| Shale (50 percent), limestone (30 percent), and siltstone (20) percent). Generally similar to overlying unit but contains less siltstone. Limestone is dominantly medium to coarse grained, in beds 1 to 6 in. thick interstratified with equal or greater thicknesses of shale and siltstone; a few intervals about 5 to 10 ft thick are 50 to 70 percent limestone. Whole and broken large flat brachiopods abundant in coarse-grained limestone; other fossils sparse. Top arbitrarily placed at top of shale bed below steepening of slope, which probably reflects upward increase in percentage of siltstone. The following fossil collections were made from this unit: D1182–CO, 1 ft above base of unit; D1183–CO, 5 ft above base, D1184–CO, 6 ft above base; D1185–CO, 11 ft above base | 20 |
| Siltstone, greenish-gray (5*GY* 6/1), limy, admixed with 10 to 20 percent silty, medium- to coarse-grained limestone; in prominent bed; pinches and swells along strike but persistent; ranges from about 1 to 3 ft in thickness; partly contorted into flow rolls; weathers to form rounded protuberances. Brachiopods abundant and bryozoans common in limestone; siltstone mostly barren but contains sparse brachiopods adjacent to fossiliferous limestone lenses | 2 |
| Shale (50 percent), limestone (35 percent), and siltstone (15 percent). Similar to overlying interbedded shale, limestone, and siltstone. About 7 ft above base is silty, coarse-grained limestone about 1 ft thick that contains abundant small brachiopods, *Sowerbyella*; fossil colln. D1195–CO made from this bed; shale grades to limestone and siltstone about 100 ft farther south. *Sowerbyella* also abundant in limestone bed at top of unit. Note: Lowest bed with *Sowerbyella* in profusion is approximately the base of the Million Shale of Nickles (1905); see McFarlan and Freeman (1935) and McFarlan (1943, p. 24) | 23.5 |
| Limestone (50 percent), shale (45 percent), and siltstone (5 percent). Generally similar to units described above; chief differences are percentages of rock types; lowest unit with significant amount of siltstone. Limestone contains common to abundant medium to very coarse fossil fragments and sparse whole large flat brachiopods. Siltstone is dark greenish gray (5*GY* 4/1); very limy and in part grading to silty, very fine grained limestone; in contorted bed 4 to 10 in. thick at top of unit and in beds about 1 in. thick interstratified with shale and limestone | 13 |
| Limestone (70 percent) and shale (30 percent). Limestone is light gray (*N*7) to medium light gray (*N*6); weathers about same with brownish tint; fine to medium grained; mostly in gnarly, rough-surfaced beds 1 to 4 in. thick and in discontinuous lenticles a few inches to a few feet long with irregular wavy silty shale partings and seams as much as 2 in. thick. Abundant jumbled large brachiopods and sparse crinoid columnals. Top of unit marked by bed of limestone about 2 ft thick; highest conspicuous thick bed of limestone in section; along strike this bed thins and is vague. Shale, dominantly greenish gray (5*GY* 6/1), similar to that described above | 3 |

*Type section of the Clays Ferry Formation*—Continued

| Clays Ferry Formation—Continued | Thickness (feet) |
|---|---|
| Mostly covered; a few poor outcrops suggest that this interval is shale and limestone similar to underlying unit. Limestone is light brownish gray (5*YR* 6/1), poorly sorted, micrograined to coarse grained; crinoidal in wavy bed about 6 in. thick; crinoid columnals, 1/32 to 1/8 in. in diameter, very abundant; sparse fragments of small brachiopods and bryozoans; also limestone, very fine grained in even bed, 3 in. thick, containing brachiopods, bryozoans and fragments of trilobites, and very sparse crinoid columnals. Top of unit approximately level with highway at bridge | 11 |
| Shale (60 percent) and limestone (40 percent). Shale is grayish yellow (5*Y* 8/4) and yellowish gray (5*Y* 8/1); clayey, in part limy; laminated in sets 1 to 12 in. thick and locally contains a few lenticles of limestone; interbedded with limestone; bryozoans sparse to common. Limestone is light brownish gray (5*YR* 6/1); weathers same and yellowish gray; fine to coarse grained and silty; poorly sorted; in irregular lensing beds 1/8 to 4 in. thick; irregularly interstratified with shale; fragmental and whole flat brachiopods abundant, bryozoans common to abundant, and gastropods common in bed about 5 ft above base; small crinoid columnals common to abundant in upper part of unit | 10 |
| Limestone (70 percent) and shale (30 percent). Limestone is chiefly yellowish gray (5*YR* 6/1), in part light brownish gray (5*YR* 6/1) and medium gray (*N*5), chiefly poorly sorted, silty, fine to medium grained but in part coarse grained and in part fairly sorted, silty, very fine grained; chiefly in rough beds about 8 to 12 in. thick; lower part of unit has flow rolls of silty very fine grained limestone, contorted lenses 5 to 20 in. thick with obscure internal layering but in part with crumpled laminae; flat brachiopods abundant and jumbled in many beds; cylindrical bryozoans common, gastropods sparse. Shale similar to shale in overlying unit. Top of unit marked by limestone with much reddish-weathering phosphatic(?) granular material; base marked by flow roll 6 to 14 in. thick of laminated very fine grained limestone | 26.5 |
| Shale (65 percent) and limestone (35 percent). Shale is similar to shale in overlying unit. Limestone is yellowish gray (5*YR* 6/1); well sorted in individual beds; chiefly fine and medium grained, in part silty, very fine grained and in part coarse grained with streaks and flakes of limy siltstone; in even and mildly contorted beds 1/8 to 8 in. thick and in discontinuous lenticles as much as 2 in. thick. Fossils common to abundant in most beds of limestone but generally very sparse within even beds of silty micrograined limestone; flat brachiopods and cylindrical bryozoans abundant, gastropods and trilobite fragments sparse to common. Some silty fine-grained limestone grades to limy fossiliferous shale. Limestone more abundant in upper part of the unit; percentage of limestone and shale are about equal at top | 30 |
| Total Clays Ferry Formation | 190 |

*Type section of the Clays Ferry Formation*—Continued

| | Thickness (feet) |
|---|---|
| Lexington Limestone (incomplete): | |
| Limestone, light-brownish-gray (5Y 6/1), weathering medium-light-gray (N6), medium to very coarse grained, fossils fragmental. In part is in planar sets of crossbeds; in part is horizontally bedded with wavy bedding planes; some bedding planes marked by silty and shaly partings and seams, which are emphasized by reddish iron stain. Fossil fragments abundant, chiefly large cylindrical bryozoans and brachiopods; whole fossils very sparse; patches of bryozoans give spotty appearance to some beds. Patches of irregularly crystallized white calcite locally conspicuous. Upper part contains common to abundant brownish-, reddish-weathering interstitial phosphatic material | 33 |

NOTE.—Arbitrary base of section, not base of exposure; underlying the medium- to coarse-grained partly crossbedded limestone described above is about 30 ft of limy shale interstratified with fine-grained limestone, commonly in contorted beds; below this is about 50 ft of unevenly bedded fine- to medium-grained fossiliferous limestone; base of local exposure is at Kentucky River fault about 500 ft southwest of old Clays Ferry bridge.

## REFERENCES


Black, D. F. B., Cressman, E. R., and MacQuown, W. C., Jr., 1965, The Lexington Limestone (Middle Ordovician) of central Kentucky: U.S. Geol. Survey Bull. 1224–C. (In press.)

Campbell, M. R., 1898, Description of the Richmond quadrangle [Kentucky]: U.S. Geol. Survey Geol. Atlas, Folio 46, 4 p., 4 maps (scale, 1:125,000).

Foerste, A. F., 1906, The Silurian, Devonian, and Irvine formations of east-central Kentucky, with an account of their clays and limestones: Kentucky Geol. Survey Bull. 7, 369 p., 10 figs., 8 pls.

——— 1914, The Rogers Gap fauna of central Kentucky: Cincinnati Soc. Nat. History Jour., v. 21, p. 109–156.

Goddard, E. N., chm., and others, 1948, Rock-color chart: Washington, Natl. Research Council (repub. by Geol. Soc. America, 1951), 6 p.

Hall, F. R., and Palmquist, W. N., Jr., 1960, Availability of ground water in Clark, Estill, Madison, and Powell Counties, Kentucky: U.S. Geol. Survey Hydrol. Inv. Atlas HA–19.

Jillson, W. R., 1929, Geologic map of Kentucky: Kentucky Geol. Survey, ser. 6.

McFarlan, A. C., 1938, Stratigraphic relationships of Lexington, Perryville, and Cynthiana (Trenton) rocks of central Kentucky: Geol. Soc. America Bull., v. 49, p. 989–996.

——— 1943, Geology of Kentucky: Lexington, Ky., Univ. Kentucky, 531 p., 117 pls., 42 figs.

——— 1954, Central Kentucky [column in correlation chart] *in* Twenhofel, W. H., chm., and others; Correlation of the Ordovician formations of North America Geol. Soc. America Bull., v. 65, pl. 1 (facing p. 298).

McFarlan, A. C., and Campbell, L. J., 1955, Geological itinerary—Kentucky highways, *in* Russell, R. J., ed., Guides to southeastern geology, prepared for the 1955 ann. mtg. of the Geol. Soc. America and associated societies: New York, Geol. Soc. America, p. 100–194, 51 figs.

McFarlan, A. C., and Freeman, L. B., 1935, Rogers Gap and Fulton formations in central Kentucky: Geol. Soc. America Bull., v. 46, p. 1975–2006, 3 pls., 2 figs.

McFarlan, A. C., and Goodwin, S. S., 1930, Areal geologic map of Madison County, Kentucky: Kentucky Geol. Survey, ser. 6 (scale, 1:63,360).

Matson, G. C., 1909, Water resources of the Blue Grass region, Kentucky: U. S. Geol. Survey Water-Supply Paper 233, 223 p., 6 figs., 3 pls.

Miller, A. M., 1905, The lead and zinc-bearing rocks of central Kentucky with notes on the mineral veins: Kentucky Geol. Survey Bull. 2, 35 p., 13 photographs, map of Highbridge and Trenton area showing location of mineral veins (scale, 1:300,000).

———1915, The Ordovician Cynthiana formation: Am. Jour. Sci., ser. 4, v. 40, p. 651–657.

———1919, The geology of Kentucky: Kentucky Dept. Geology and Forestry, ser. 5, Bull. 2, 392 p.

Nickles, J. M., 1905, The Upper Ordovician rocks of Kentucky and their Bryozoa: Kentucky Geol. Survey Bull. 5, 64 p., 3 pls.

Palmquist, W. N., Jr., and Hall, F. R., 1961, Reconnaissance of ground-water resources in the Blue Grass region, Kentucky: U.S. Geol. Survey Water-Supply Paper 1533, 39 p.

Templeton, J. S., and Willman, H. B., 1963, Champlainian Series (Middle Ordovician) in Illinois: Illinois State Geol. Survey Bull. 89, 260 p., 41 figs.

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