The Lexington Limestone (Middle Ordovician) of Central Kentucky

By DOUGLAS F. B. BLACK, EARLE R. CRESSMAN, *and* WILLIAM C. MACQUOWN, JR.

CONTRIBUTIONS TO STRATIGRAPHY

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By Douglas F. B. Black, Earle R. Cressman, and William C. MacQuown, Jr.

ABSTRACT

The Lexington Limestone is revised to include the entire sequence of dominantly bioclastic generally fossiliferous limestone lying above lithographic limestone of the Tyrone Limestone and below interbedded tabular limestone and shale of the Clays Ferry Formation. The name Cynthiana Formation, formerly applied to the upper part of this sequence, is abandoned. The names Curdsville Limestone Member, Logana Member, Grier Limestone Member, Brannon Member, and Devils Hollow Member are retained for subdivisions of the Lexington Limestone. The Millersburg Member and the Nicholas Limestone Member, proposed by Foerste (1909, 1914) for subdivisions of the Cynthiana Formation, are adopted as members of the Lexington Limestone. The new name Tanglewood Limestone Member is introduced for the body of bioclastic calcarenite, commonly phosphatic, that makes up much of the upper part of the Lexington; the name Woodburn Limestone Member, which included only a part of the calcarenite unit, is abandoned. Two new names, Macedonia Bed and Cane Run Bed, are applied to units within the Grier Limestone Member.

INTRODUCTION

Rocks of Middle Ordovician age that crop out in central Kentucky have in the past been divided into five formations. These were, in ascending order, the Camp Nelson, Oregon, and Tyrone Limestones (the three of which compose the High Bridge Group), the Lexington Limestone, and the Cynthiana Formation. The Camp Nelson and Tyrone consist mostly of lithographic limestone, and the Oregon consists of dolomite; these three formations are lithologically distinctive and easily recognizable throughout their area of outcrop.

In contrast, stratigraphic relations within the body of bioclastic limestone that overlies the rocks of the High Bridge Group are complex. Various rock types recur throughout the sequence, and facies changes are common. Limestone formerly assigned to the Cynthiana

Formation underlies and intertongues southward with interbedded shale and tabular limestone for which Weir and Greene (1965) have given the name Clays Ferry Formation.

The Lexington Limestone is herein redefined to include all the strata formerly assigned to both the Lexington Limestone and the Cynthiana Formation with the exception of those beds now included in the Clays Ferry Formation; the name Cynthiana is abandoned. The names Curdsville Limestone Member, Logana Member, Grier Limestone Member, Brannon Member, and Devils Hollow Member are retained for subdivisions of the Lexington. The terms Nicholas Limestone Member and Millersburg Member, proposed by earlier workers, are adopted. The name Tanglewood Limestone Member is used for the body of bioclastic calcarenite which is locally dominant in the upper part of the Lexington Limestone. The name Woodburn Limestone Member, which included only a part of this calcarenite, is here abandoned.

The revisions result from data gathered during the mapping of thirteen 7½-minute quadrangles. Approximately 35 stratigraphic sections have been measured and described from surface exposures and diamond-drill cores. In addition to the authors, the following members of the U.S. Geological Survey have participated in the mapping and measuring of sections: Ernest Dobrovolny, R. C. Greene, S. P. Kanizay, R. D. Miller, J. S. Pomeroy, and G. W. Weir. This report has been prepared in cooperation with the Kentucky Geological Survey.

The locations of stratigraphic sections mentioned in this report are shown on figures 1 and 2, and the locations of mapped quadrangles are shown on figure 2.

DEVELOPMENT OF NOMENCLATURE

The stratigraphic nomenclature as of 1943 of the Middle Ordovician rocks overlying the High Bridge Group is shown in the first column of figure 3. All names were derived from localities in central Kentucky except Hermitage, which was extended from Tennessee. All names but Sulphur Well (McFarlan, 1943, p. 20, 22) had been proposed by the year 1919. Most earlier workers had placed the Lexington-Cynthiana contact at the top of the Perryville Limestone, but McFarlan (1943, p. 18) proposed that the Perryville be excluded from the Lexington and given formational rank. The Perryville was thought to rest unconformably on the Lexington Limestone.

McFarlan and White (1948) demonstrated that the Perryville of the southern Blue Grass had been miscorrelated with younger beds of similar lithology to the north for which they proposed the name Devils Hollow division of the Cynthiana Formation (McFarlan and

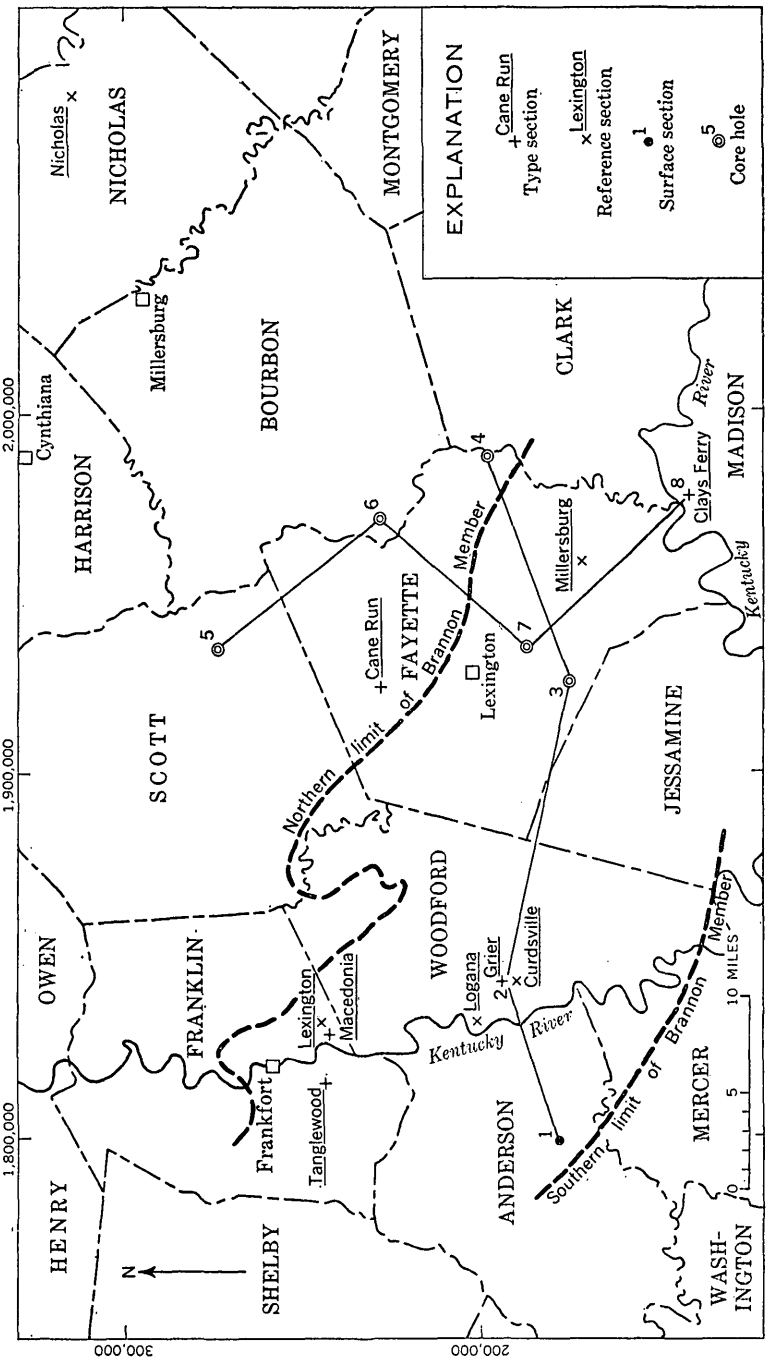


FIGURE 1.—Map of central Kentucky showing counties, location of lines of sections (1–4, fig. 4; 5–8, fig. 5), location of newly designated type and reference sections, and limits of Brannon Member of Lexington Limestone; 100,000-foot grids based on Kentucky coordinate system, north zone.

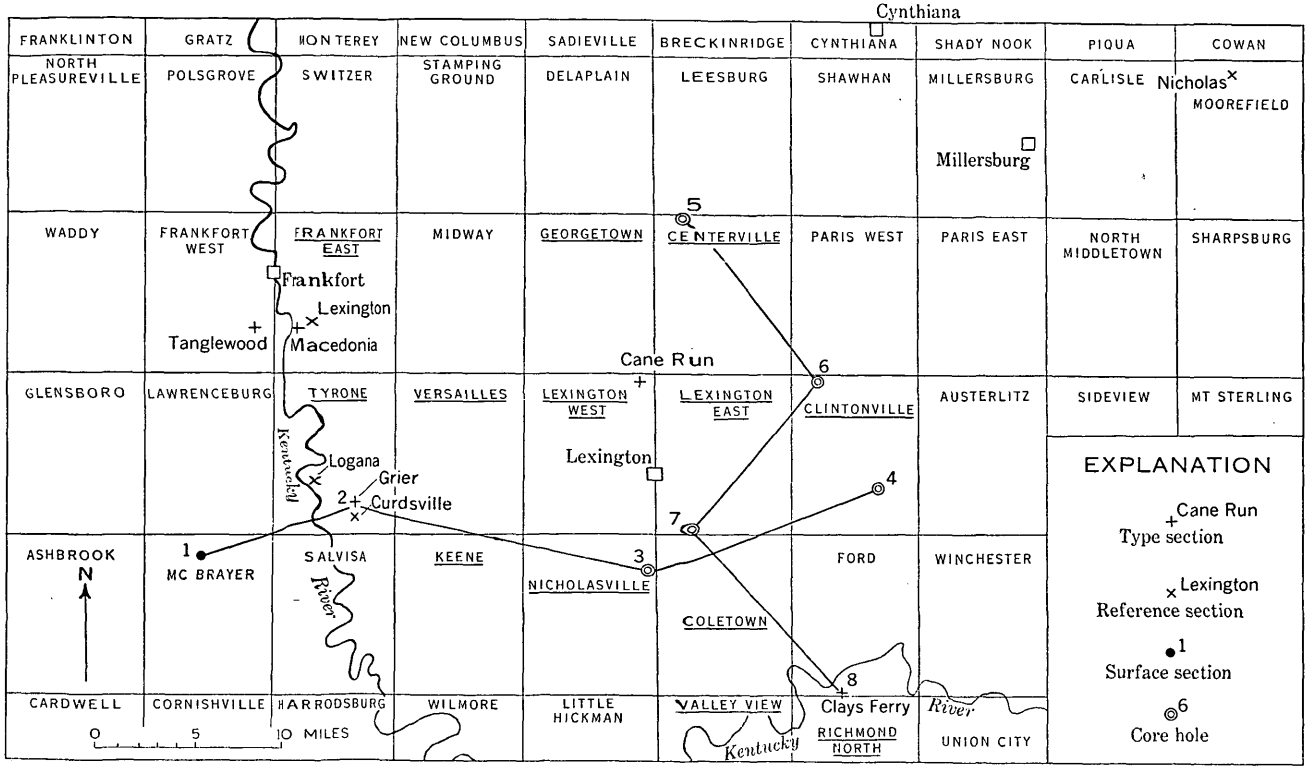
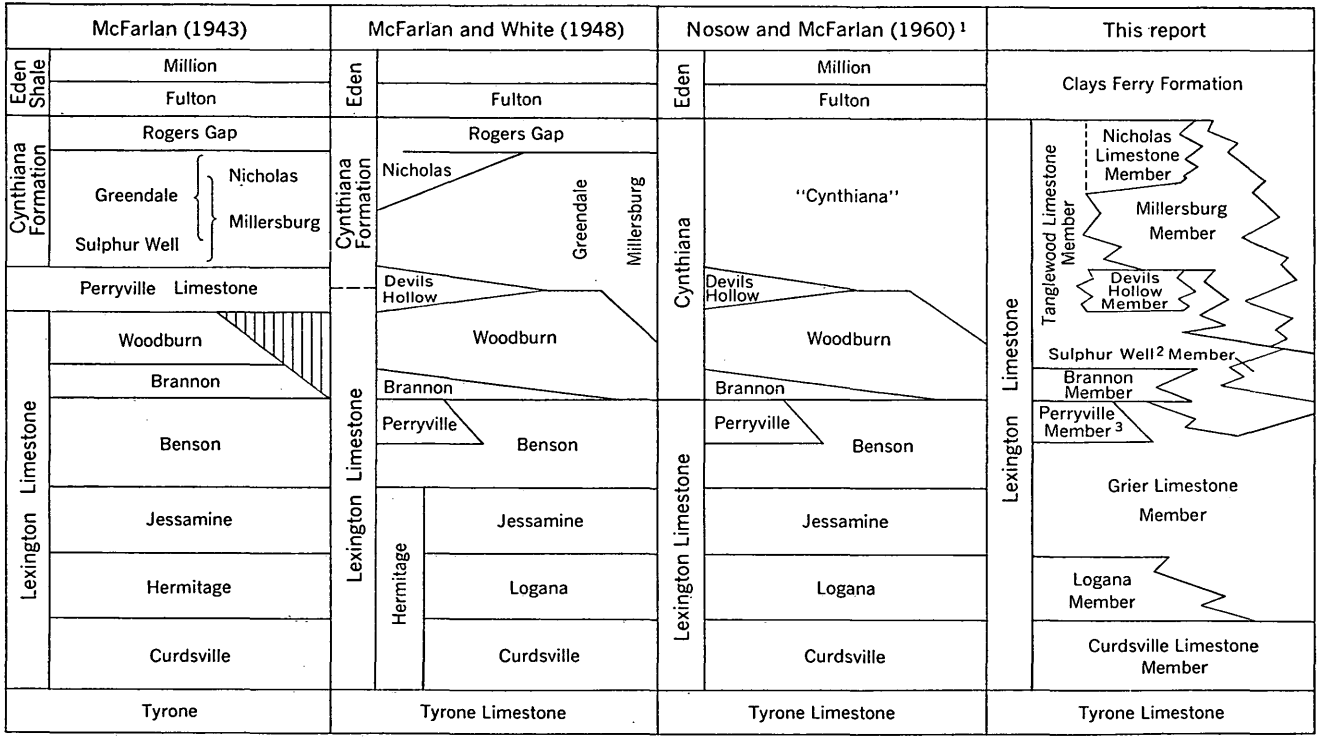


FIGURE 2.—Map of central Kentucky showing location of measured sections (1–4, fig. 4; 5–8, fig. 5) and 7½-minute quadrangles. Quadrangles with names underlined have been or are being mapped geologically, June 1964. Area same as in figure 1.



[1] Synthesized from Nosow and McFarlan (1960, figs. 3 and 14 and p. 37–42) [2] Of McFarlan (1943) [3] Of Nickles (1905) as used by Foerste (1912, p. 32)

FIGURE 3.—Comparison of nomenclature of this report with some past usages.

White, 1948, p. 1640). The resulting nomenclature is shown in the second column of figure 3. The contact between the Lexington Limestone and the Cynthiana Formation was placed at the top of the Devils Hollow or where the Devils Hollow is absent, at the top of the Woodburn. The name Logana was reintroduced for rocks earlier termed Hermitage.

Hamilton (1950, p. 18) noted that facies changes in the rocks above the Benson are common, perplexing, and difficult to map and remarked that the interval from the top of the Benson to the base of rocks of Eden age was relatively constant in thickness. He therefore redefined the name Cynthiana Formation to include all strata between the top of the Benson and the base of rocks of Eden age, and the Cynthiana thus included, from base upward, the Brannon Limestone Member, the Woodburn Limestone Member, and an unnamed upper member. Nosow and McFarlan (1960, p. 7) generally followed Hamilton's nomenclature (fig. 3, col. 3).

The Lexington was recently (Cressman, 1964) reduced to formational rank as the Lexington Limestone; the name Grier Limestone Member was introduced for rocks earlier included in the Jessamine and Benson Limestones, and the Logana and Curdsville were reduced to member rank.

In southern Fayette County and areas to the south, Weir and Greene (1965) applied the name Clays Ferry Formation to interbedded shale and tabular limestone that had been the Million Shale of Nickles (1905, p. 25) and the upper part of the Cynthiana Formation (fig. 5, section 8). The lower part of the Clays Ferry intertongues northward with the upper part of the Lexington Limestone as defined in this paper. Tongues of the lower part of the Clays Ferry have been mapped as far north as the suburbs of Lexington, and reconnaissance indicates that similar tongues may locally extend much farther northward.

Where the Brannon Member is present, the contact between the Lexington Limestone and Cynthiana Formation as revised by Hamilton (1950, p. 18) is mappable with little difficulty. However, as has been known for years, the Brannon pinches out to the north near Lexington and Frankfort and to the southwest in Mercer and Anderson Counties (fig. 1); it is therefore absent throughout much of the area. According to McFarlan and White (1948, p. 1635–1636), the top of the Lexington as later redefined by Hamilton can be identified in areas where the Brannon Member is absent by a faunal assemblage that includes *Stromatocerium pustulosum*, *Dinorthis ulrichi*, *Strophomena*

vicina, and *Cyphotrypa frankfortensis*. However, *Cyphotrypa* is not everywhere present; specimens of *Dinorthis ulrichi* and *Strophomena vicina* can seldom be identified with confidence in the field; and the conspicuous zone of *Stromatocerium pustulosum* that occurs a few feet below the base of the Brannon in areas south of Lexington rises stratigraphically northward, crossing mapped contacts between lithologic units. Furthermore, in much of the area where the Brannon Member is present, the Brannon is both overlain and underlain by well-sorted crossbedded medium-grained bioclastic phosphatic calcarenite, and where the Brannon pinches out these two calcarenite bodies merge into a single lithologic unit. For these reasons, the contact between the Lexington and Cynthiana as defined by Hamilton is not usable for detailed geologic mapping throughout most of the area of exposed Middle Ordovician rocks.

There are several reasons for redefining the Lexington Limestone and abandoning the name Cynthiana rather than redefining both formations. First, similar rock types are found throughout the entire sequence. Second, a single formational term simplifies the problems of nomenclature presented by numerous local facies. Third, there is no lithologically defined contact sufficiently widespread to serve as a formation boundary.

LEXINGTON LIMESTONE

The name Lexington Limestone was first applied by Campbell (1898) to beds between the High Bridge Group below and the Flanagan Chert (subsequently abandoned) above. The lower part of Campbell's Flanagan Chert is the Brannon Member of the Lexington Limestone as defined in this paper. Campbell did not give a type section for the Lexington Limestone, but the type area was presumably in the Richmond 30-minute quadrangle (lat. 37°30′ to 38°00′, long. 84°00′ to 84°30′).

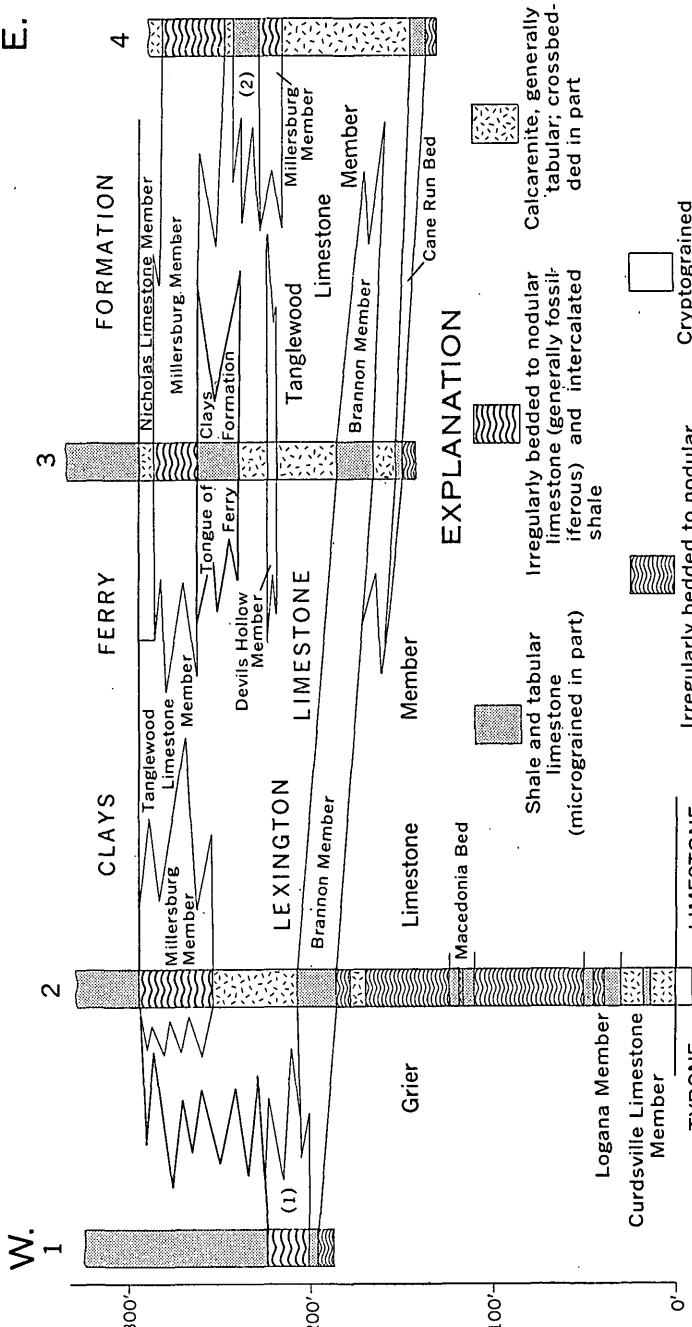
The Lexington Limestone is here revised to include the heterogeneous succession of bioclastic carbonate rocks, probably of Middle Ordovician age, bounded at the base by lithographic limestone of the Tyrone Limestone and overlain and in part laterally bounded by interbedded shale and tabular limestone which are included in the Clays Ferry Formation (Weir and Greene, 1965). Roadcuts along Interstate Highway 64 east of its crossing of the Kentucky River approximately 2½ miles south-southeast of Frankfort are designated as a reference section.

The Lexington Limestone is approximately 310 feet thick near Frankfort and Lexington. The upper part of the formation intertongues southward with the lower part of the Clays Ferry Formation, and the Lexington thereby thins to about 230 feet in northwestern Madison County and 210 feet in northern Mercer County. The area of outcrop of the Lexington Limestone closely approximates that shown on previous geologic maps for the Lexington Limestone and Cynthiana Formation combined.

Stratigraphic relations of the Lexington Limestone are shown on figures 4 and 5.

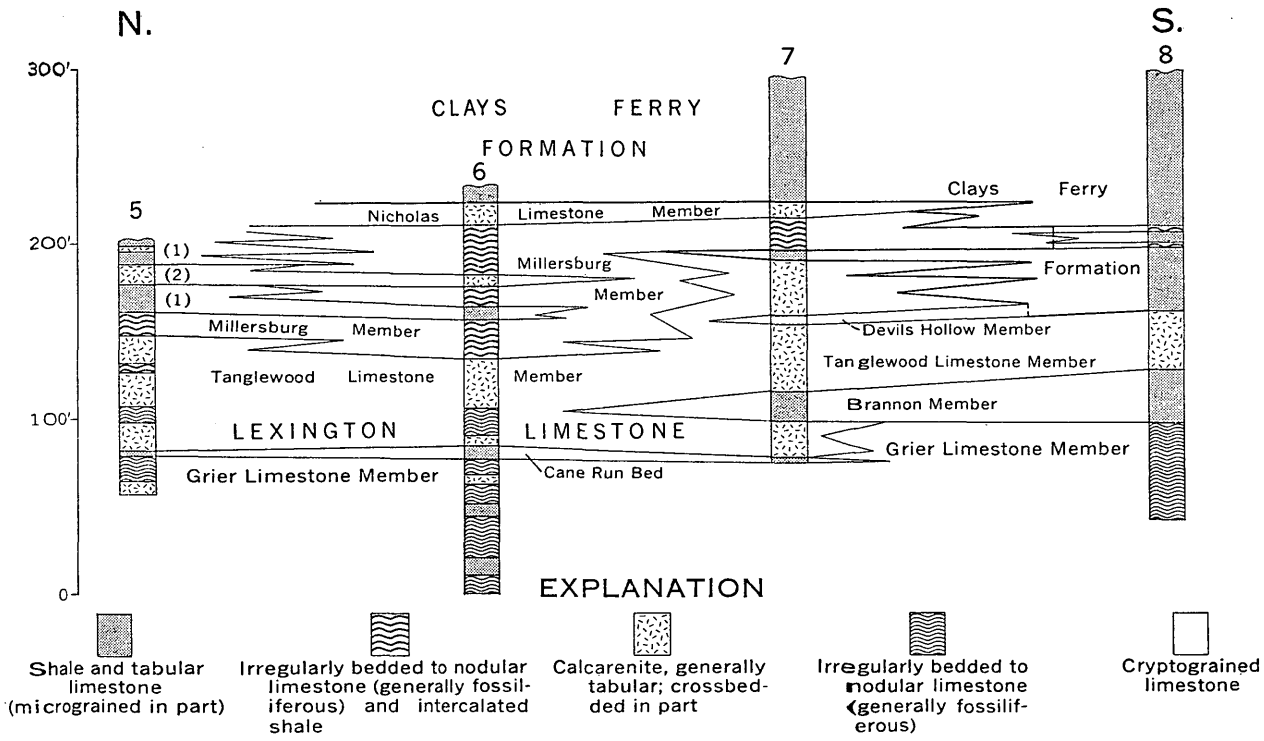
At the reference section the Lexington Limestone is divided into the following members, listed from oldest to youngest: The Curdsville Limestone Member, the Logana Member, the Grier Limestone Member, the Brannon Member, the Tanglewood Limestone Member, the Devils Hollow Member, the Millersburg Member, and the Nicholas Limestone Member. Of these, the Curdsville, Tanglewood, and Nicholas Members are characterized by calcarenite consisting of subrounded bioclastic carbonate sand grains in large part well sorted and cemented with crystalline calcite and generally occurring in relatively planar surfaced beds. Crossbedding is common. The Logana and Brannon Members and the upper part of the Devils Hollow Member are composed mostly of very thin to thin, tabular beds of micrograined, silty argillaceous limestone interbedded with gray shale. Most of the Grier Limestone Member is fossiliferous bioclastic limestone, commonly with cryptograined and micrograined matrix, that occurs generally in lumpy-surfaced beds with thin undulatory shale partings but also as rounded nodules surrounded by shale partings. The Millersburg Member is similar to the Grier in bedding character and limestone type but is much more shaly; the limestone is very fossiliferous and commonly ocurs as nodules in a matrix of gray shale and in discontinuous beds with very irregular surfaces.

At the reference section of the Lexington Limestone described below, the contact with the underlying Tyrone Limestone is exposed on the slope beneath the east bridge abutment about 80 feet below road level. The basal 50 feet of the Lexington is poorly exposed but can be seen in nearby outcrops.



(1) Sulphur Well Member of McFarlan (1943) (2) Unnamed bed, may be tongue of Clays Ferry Formation

FIGURE 4.—Stratigraphic relations of Lexington Limestone from central Anderson County to eastern Fayette County, Ky.



(1) Unnamed bed, may be tongue of Clays Ferry Formation
(2) Unnamed bed, may be tongue of the Tanglewood Limestone Member

FIGURE 5.—Stratigraphic relations of Lexington Limestone from southeastern Scott County to northern Madison County, Ky.

Reference section of Lexington Limestone

[Measured in roadcuts along eastbound lane of Interstate Highway 64 on east side of Kentucky River, Frankfort East quadrangle, Franklin County, Ky.; base of section at 1,827,150 ft E., 241,350 ft N. (Kentucky coordinate system, north zone); Curdsville Limestone Member and Logana Member measured from cliff exposure immediately west of intersection of Hanley Lane and Glenns Creek Road, Frankfort East quadrangle, Woodford County, Ky.; base of section at 1,831,250 ft E., 236,950 ft N.]

	Thickness (feet)
Clays Ferry Formation (basal part only):	
35. Limestone (30 to 50 percent) and shale interbedded; very thin bedded medium-light-gray micrograined argillaceous limestone; very thin bedded medium-light-gray fine-grained limestone; thin-bedded crinoidal, brachiopodal limestone; fossiliferous micrograined argillaceous limestone; medium-gray (weathers grayish orange) shale; brachiopods, gastropods, trilobite fragments, and crinoid columnals abundant in fossiliferous limestone	25.0
Lexington Limestone:	
Nicholas Limestone Member:	
34. Limestone (70 percent) and shale interbedded. Limestone is thin bedded, grayish orange, coarse grained, bioclastic, phosphatic; contains abundant comminuted shell debris	4.0
33. Limestone, mostly thick bedded (but thin bedded near top), grayish-orange, coarse-grained, bioclastic, phosphatic; contains abundant comminuted shell debris	8.0
32. Limestone, very thin to thin-bedded, partly crossbedded, light-gray, medium- to coarse-grained, bioclastic, phosphatic; contains some shale partings	8.5
Millersburg Member:	
31. Limestone (70 to 75 percent) and shale interbedded. Limestone is very thin to thin bedded, in part irregularly bedded, medium light gray, fossiliferous, fine- to very coarse grained, bioclastic; some limestone occurs as nodules in shale matrix. Shale is medium dark gray. Brachiopod valves and bryozoan fragments are common	23.0
Devils Hollow Member:	
30. Limestone, partly argillaceous, thin-bedded, medium-gray to olive-gray, cryptograined; contains abundant ostracodes and some irregular, discontinuous laminae of comminuted shell debris	8.0
29. Limestone (25 percent) and shale interbedded. Limestone is very thin bedded, light gray, fossiliferous, micrograined to fine-grained. Shale is medium gray, calcareous. Limestone beds grade laterally and vertically into shale	3.4
28. Limestone, coquinoid, thin-bedded, medium-light-gray, brachiopodal; some layers composed largely of bryozoan fragments	3.5
Tanglewood Limestone Member:	
27. Limestone, argillaceous, medium-dark-gray to light-gray; consists mostly of bryozoan fragments in an argillaceous matrix; grades into unit above	2.5

Reference section of Lexington Limestone—Continued

	Thickness (feet)
Lexington Limestone—Continued	
Tanglewood Limestone Member—Continued	
26. Limestone, very thin to thin-bedded, partly crossbedded, medium-light-gray, coarse-grained, bioclastic, phosphatic; contains scattered bryozoan fragments	8.0
25. Limestone, nodularly bedded, dark- to medium-gray, fine-grained, bioclastic; interbedded with thin- and evenly bedded medium-gray medium-grained bioclastic phosphatic limestone; nodularly bedded limestone dominant; shale partings between many beds	13.0
24. Limestone, thin-bedded, partly crossbedded, light-gray to light-olive-gray, coarse-grained, bioclastic, partly phosphatic; phospatic shale and siltstone partings 1/25 to 1/8 in. thick between many beds	8.5
Brannon Member:	
23. Limestone, argillaceous, light-gray to medium-light-gray, micrograined; thin bed of medium-dark-gray to medium-gray shale at top; lower two-thirds of unit contains thick convoluted beds	3.0
22. Limestone, partly crossbedded; lower 5 ft is thin bedded, coarse grained, bioclastic, slightly phosphatic; upper 4.5 ft. very thin bedded and less phosphatic; dark-gray shale seam 3 ft above base; unit is a tongue of the Tanglewood Limestone Member	9.5
21. Limestone, argillaceous, medium-light-gray to light-gray, micrograined; subconchoidal fracture; contains some shale beds as much as 0.4 ft thick in upper half; convolute bedding, especially in lower 3 ft	5.3
Grier Limestone Member:	
20. Limestone, upper 7.0 ft is medium-dark-gray, medium- to coarse-grained, bioclastic, slightly phosphatic; stromatoporoids 1 ft and 4 ft above base; lower 5.2 ft rubbly appearing, medium-gray to medium-dark-gray, medium grained as nodules separated by undulant shale partings	12.2
19. Limestone, partly crossbedded, coarse-grained, bioclastic, phosphatic; abundant bryozoan fragments 1 ft below top	3.2
18. Limestone (85 to 90 percent) and shale interbedded. Limestone is fine to medium grained, bioclastic, argillaceous; interbedded with shale in lower and upper thirds; nodularly bedded, cryptograined, and argillaceous in middle third and convolutely bedded in lower third	4.3
17. Limestone, medium-gray, medium-grained, bioclastic; as nodules in cryptograined argillaceous limestone matrix; course-ribbed brachiopods abundant; contains some interbeds 0.5 ft thick of medium-dark-gray coarse-grained limestone composed of comminuted shell debris	11.0
16. Limestone, inaccessible, but is similar in appearance to nodular limestone described as unit 17	16.5
15. Limestone; very thin bedded, light-olive-gray, bioclastic, slightly phosphatic; weathered surfaces are rough	5.0

Reference section of Lexington Limestone—Continued

	Thickness (feet)
Lexington Limestone—Continued	
Grier Limestone Member—Continued	
14. Limestone, thin-bedded, brachiopodal, coarse-grained; limestone interbedded with nodular argillaceous limestone in beds about 2 ft thick; nodular limestone consists of medium-grained medium-dark-gray limestone nodules in a medium gray micrograined argillaceous limestone matrix	22.0
Macedonia Bed:	
13. Limestone (75 percent) and shale interbedded. Limestone is very thin to thin bedded, medium light gray, micrograined, argillaceous. Shale is very thin to thin bedded, fissile, medium dark gray to olive gray. Some limestone beds pinch and swell	5.5
12. Limestone, thin-bedded, light-gray, medium-grained, brachiopodal, slightly phosphatic; brachiopod valves are small and thin shelled	3.0
11. Limestone (90 percent) and shale interbedded. Limestone is very thin to thin bedded, medium light gray, micrograined, and argillaceous. Shale is very thin bedded, fissile, medium dark gray to dark gray. Shale is more abundant in lower half; limestone beds contain blebs and irregular layers of very coarse grained limestone consisting of comminuted shell debris	4.5
(Base of Macedonia Bed.)	
10. Limestone, thin bedded, medium-gray, brachiopodal, coarse to very coarse grained, bioclastic, slightly phosphatic; contains some very thin interbeds of irregularly bedded micrograined limestone; some shale interbeds 0.1 to 0.2 ft thick in upper 2 ft; grades from unit below	12.0
9. Limestone, thin-bedded, yellowish-gray, brachiopodal, coarse, grained, bioclastic; slightly phosphatic limestone interbedded with very thin and irregularly bedded medium-gray micrograined argillaceous limestone and brachiopodal coarse- and very coarse grained bioclastic limestone containing blebs and stringers of aphanitic argillaceous limestone; some shale partings in basal 10 ft; basal 5 to 10 ft is mostly thin-bedded brachiopodal limestone, whereas rest of unit is mostly irregularly bedded to nodular	48.0
Logana Member:	
8. Limestone (70 percent) and shale interbedded; similar to unit 5	5.2
7. Covered	1.2
6. Limestone, thin-bedded, light-brownish-gray to brownish-gray; brachiopod coquina with abundant sparry calcite cement; wavy striated appearance on weathered joint surfaces results from orientation of brachiopod valves subparallel to bedding; contains several shale interbeds as much as 0.1 ft thick; 2.0-ft zone, 3.6 ft above base, contains micrograined argillaceous limestone with thin-shelled brachiopod valves exposed on bedding surfaces, interbedded with shale and brachiopod coquina; brachiopods are small, thin shelled, and fine ribbed	6.8

Reference section of Lexington Limestone—Continued

	Thickness (feet)
Lexington Limestone—Continued	
Logana Member—Continued	
5. Limestone (70 percent) and shale interbedded. Limestone is very thin to thin bedded, light olive gray, and micrograined. Shale is brownish gray to medium gray, fissile, and calcareous. Small flat-shelled brachiopods on bedding surfaces	5.3
4. Covered	13.0
Curdsville Limestone Member:	
3. Limestone, thin-bedded, pale-yellowish-brown to light-brownish-gray, brachiopodal, coarse-grained, bioclastic; brachiopod valves are thin shelled and oriented subparallel to bedding	7.3
2. Covered	2.7
1. Limestone, thin-bedded, resistant, yellowish-gray, fine- to medium-grained, bioclastic	10.1
Total thickness of Lexington Limestone	307

Tyrone Limestone; lithographic limestone, 10 ft exposed.

CURDSVILLE LIMESTONE MEMBER

The Curdsville Limestone Member was named by Miller (1905, p. 18) the Curdsville Bed of the Lexington Limestone. The type locality is Curdsville in Mercer County. The unit was described as consisting of 30 feet of crystalline fossiliferous limestone, cherty in the lower half. Although Miller's description was brief and no measured section was given, the Curdsville generally contrasts with the units above and below, and little difficulty has been encountered in identifying it. The only obvious variation in past usage has been in the rank assigned to the Curdsville.

The Curdsville Limestone Member is dominantly well-sorted bioclastic calcarenite, crossbedded in part and phosphatic in part. It contains a few thin beds of micrograined limestone and shale and some very fine grained nodularly bedded limestone. Convolute bedding occurs in some of the finer grained beds. Silicified fossils, mostly brachiopods, are abundant in some beds. Nodular chert is abundant in the lower part of the member in southern Jessamine and Woodford Counties. Bentonitic shale occurs locally within the Curdsville; at Clays Ferry in the southwestern part of the Ford quadrangle three thin bentonite beds are present in the lower 10 feet of the member.

The contact between the bioclastic calcarenite of the Curdsville Limestone Member and lithographic limestone of the underlying Tyrone Limestone is sharp. Locally, the Curdsville rests on a bentonite bed that is included in the Tyrone Limestone. Where we have observed the contact the two units appear to be conformable, but Miller (1925, p. 131 and 132) presented evidence of an unconformity.

In most of its area of outcrop the Curdsville is overlain conformably by interbedded micrograined limestone and shale of the Logana Member of the Lexington Limestone, but in southern Fayette County it is directly overlain by thin and irregularly bedded to nodular fossiliferous limestone of the Grier Limestone Member. Where the Grier rests directly on the Curdsville, the contact is gradational.

The Curdsville is about 20 to 30 feet thick throughout most of Franklin, Woodford, and Jessamine Counties. It is exposed on both sides of the Kentucky River and for some distance up the tributaries. The following section is representative of the member.

Section of Curdsville Limestone Member of Lexington Limestone

[Measured in small quarry on west side of Shryocks Ferry Road, 1 mile S. 10° W. of Milner, Tyrone quadrangle, Woodford County, Ky.; base of section at 1,838,500 ft E., 189,650 ft N. (Kentucky coordinate system, north zone)]

	Thickness (feet)
Lexington Limestone:	
Curdsville Limestone Member:	
7. Limestone, thin-bedded, pale-yellowish-brown to pale-orange, slightly phosphatic(?), medium-grained, bioclastic. Overlain by tabular micrograined limestone float from Logana Member of Lexington Limestone	11.0
6. Shale	.3
5. Limestone, crosslaminated, very pale orange, slightly phosphatic(?), fine- to medium-grained, bioclastic	.8
4. Limestone and shale interbedded. Limestone is very thin to thin bedded, light gray, micrograined, argillaceous. Shale is yellowish gray	2.7
3. Limestone, thick-bedded, pale-yellowish-brown, fine-grained, slightly phosphatic(?), bioclastic; about 10 percent of unit is chert occurring as irregular nodules 0.1 to 1.2 ft in diameter	2.9
2. Limestone, very thin bedded, pale-yellowish-brown, micrograined, argillaceous	.8
1. Limestone, thin-bedded, very pale orange, fine- to medium-grained, slightly phosphatic, bioclastic; abundant broken shells in some beds; chert layer 0.2 ft thick, 2 ft below top of unit	8.6
Thickness of Curdsville Limestone Member	27
Tyrone Limestone.	

LOGANA MEMBER

The Logana Member of the Lexington Limestone was named by Miller (1905, p. 19) for Logana Station (now abandoned) in southern Jessamine County. He described it at its type locality as consisting of 10 feet of argillaceous limestone containing abundant molluscan fossils. According to Miller, the Logana persists through Jessamine, Woodford, and Franklin Counties, but shale was said to predominate

over limestone in Franklin County. Miller (1913, p. 321) subsequently abandoned the name Logana and replaced it with Hermitage, a term extended from Tennessee. Miller (1925, p. 133) described the Hermitage in Woodford County as 35 to 40 feet of thin-bedded fine-grained argillaceous or siliceous limestone and intercalated shale, containing beds of closely packed *Dalmanella bassleri* (identified by R. B. Neuman as *Onniella bassleri* in Cressman, 1964) in the upper part. The upper contact was placed at the top of the highest bed containing abundant *O. bassleri*. Huffman (1945, p. 169) reintroduced the name Logana in central Kentucky, apparently for the same unit Miller called Hermitage.

The upper contact was defined by Miller on the basis of faunal rather than lithologic characteristics and cannot be used in geologic mapping. Limestone bearing abundant dalmanellid brachiopods occurs throughout much of the Logana and the lower part of the overlying Grier Limestone Member. We therefore place the upper contact of the Logana at the top of the uppermost unit of interbedded micrograined limestone and shale. Near Nicholasville in Jessamine County, both the upper and lower boundaries of the Logana are gradational.

At Miller's type section near Logana Station the rocks typical of the Logana Member, as identified by Miller in Woodford County, grade eastward into irregularly bedded fossiliferous limestone. These fossiliferous limestone beds are indistinguishable lithologically from the overlying Grier Limestone Member; however, in western Jessamine County and in Woodford, Anderson, and Franklin Counties, the gross unit termed Logana, and subsequently Hermitage by Miller, is distinct from the overlying Grier Limestone Member. We therefore designate the section described below as a reference section.

Reference Section of Logana Member of Lexington Limestone

[Measured in roadcut along entrance to Kentucky Utilities Plant, east side of Blackburn Memorial Bridge, U.S. Highway 62, Tyrone quadrangle, Woodford County, Ky.; base of section at 1,828,840 ft E., 198,350 ft N. (Kentucky coordinate system, north zone)]

	Thickness (feet)
Lexington Limestone:	
Grier Limestone Member (basal part only):	
12. Limestone, brachiopodal, very fine to coarse-grained, in irregular to lenticular beds 0.05 to 0.2 ft thick separated by irregular shale partings	2.5
Logana Member:	
11. Limestone (50 percent) and shale interbedded; similar to unit 2, but limestone beds are wavy and less than 0.2 ft thick. Some beds contain brachiopod values	0.9
10. Limestone, light-brownish-gray, slightly phosphatic, medium-grained, bioclastic, grades from brachiopodal micrograined limestone at base	0.8

Reference Section of Logana Member of Lexington Limestone—Continued

Lexington Limestone—Continued Logana Member—Continued	*Thickness (feet)*
9. Limestone (60 percent) and shale interbedded; similar to unit 2, but limestone beds are generally 0.3 to 0.4 ft thick and do not contain pelecypods	3.2
8. Limestone, brachiopodal; similar to unit 3; wavy beds 0.1 ft thick apparent on weathered joint surfaces but are not separated by partings; conspicuous partings parallel to bedding spaced 0.2 to 1.5 ft apart	4.1
7. Limestone, light-brownish-gray, coarse-grained, bioclastic, brachiopodal; in single even bed	0.6
6. Limestone, medium-gray to light-brownish-gray, medium- to coarse-grained, bioclastic, brachiopodal; in lenses and nodules separated by irregular shale partings	1.4
5. Limestone, brachiopodal, similar to unit 3	1.7
4. Limestone (50 percent) and shale interbedded; similar to unit 2 but contains a few lenses and beds of brachiopodal limestone	3.1
3. Limestone, brachiopodal, light-brownish-gray, in wavy to irregular beds 0.1 to 0.6 ft thick; a coquina of brachiopod shells oriented subparallel to bedding with a matrix of coarse bryozoan and brachiopod fragments and cemented by sparry calcite	2.0
2. Limestone (50 percent) and shale interbedded. Limestone is argillaceous or silty, brownish gray to olive brown, micrograined, in tabular beds generally 0.2 to 0.3 ft thick; petroliferous odor. Shale is brownish gray, fissile, in beds 0.05 ft thick. Pelecypods common in some limestone beds	13.0
Total thickness of Logana Member	31
Curdsville Limestone Member (uppermost part only):	
1. Limestone, in tabular to slightly wavy beds 0.3 to 0.9 ft thick; light brownish gray, phosphatic in part, fine grained, bioclastic; silified brachiopod valves abundant; uppermost most 0.2 ft contains micrograined calcite matrix	2.0

As redefined, the Logana Member is 22 to about 30 feet thick throughout most of Jessamine, Woodford, and Franklin Counties. In easternmost Jessamine County it grades eastward into the basal part of the Grier Limestone Member and is absent in southernmost Fayette County.

GRIER LIMESTONE MEMBER

The Grier Limestone Member, named by Cressman (1964), includes about 135 feet of irregularly surfaced thin-bedded fossiliferous limestone overlying the Logana Member and underlying the Brannon Mem-

ber. The name was derived from Grier Creek in west-central Woodford County. A description of the type section follows:

Type section of Grier Limestone Member of Lexington Limestone

[Measured in roadcut along Shryocks Ferry Road 1 mile S. 10° W. of Milner, Tyrone quadrangle, Woodford County, Ky.; base of section at 1,838,500 ft E., 189,650 ft N. (Kentucky coordinate system, north zone). Measured by Jacob staff and corrected for dip as determined from structure contours on the geologic map]

	Thickness (feet)
Lexington Limestone:	
Grier Limestone Member:	
22. Limestone, irregularly bedded, very fine grained; covered interval above contains micrograined limestone float from Brannon Member of Lexington Limestone. Described from exposures in gully on west side of road	1.0
21. Limestone, in beds 0.04 to 0.4 ft thick; light gray, slightly phosphatic, medium grained, bioclastic, crossbedded in upper 3 ft; stromatoporoids 0.5 ft below top	11.0
20. Limestone, nodular, light-gray to light-brownish-gray; irregular nodules of very fine grained bioclastic limestone in a micrograined argillaceous limestone matrix; contains abundant silicified brachiopods; bedding obscure, but irregular partings are spaced 0.2 to 0.5 ft apart	9.0
19. Limestone, in beds 0.1 to 0.3 ft thick; medium gray to very pale orange, phosphatic, medium grained, bioclastic, cross-laminated in upper part	8.0
18. Limestone, nodular, mottled light-gray and grayish-orange; irregular nodules of very fine grained bioclastic limestone in a micrograined argillaceous limestone matrix; contains abundant silicified brachiopods and some branching bryozoans; some interbeds of light-brownish-gray aphanitic limestone containing gastropods in lower third of unit; bedding obscure, but irregular partings are spaced 0.2 to 2 ft apart	16.0
17. Limestone, light-gray to pale-yellowish-brown, slightly phosphatic, medium- to coarse-grained, bioclastic, in beds averaging 0.5 ft in thickness; contains brachiopods and trilobite fragments; interbedded with micrograined argillaceous limestone and very thin bedded very fine grained nodular limestone containing abundant brachiopods	18.0
16. Macedonia Bed: consists of limestone that is argillaceous, light-olive-gray, and micrograined; in beds 0.1 to 0.3 ft thick; about one-fourth of unit is interbedded shale	7.0
15. Limestone, thin- to thick-bedded, light-brownish-gray, phosphatic, medium-grained, bioclastic; contains some brachiopods	5.0
14. Limestone, very thin and irregularly bedded, light-brownish-gray, slightly phosphatic, micrograined to fine-grained; contains some interbeds of medium- to coarse-grained limestone	8.0
13. Limestone, thin- to very thin bedded, grayish-pink to very pale orange, slightly phosphatic, medium- to coarse-grained, bioclastic; contains abundant brachiopods	5.0

Type section of Grier Limestone Member of Lexington Limestone—Continued

Lexington Limestone—Continued Grier Limestone Member—Continued	*Thickness (feet)*
12. Limestone, similar to unit 14	17.0
11. Limestone, light-gray to yellowish-gray, slightly phosphatic, medium- to coarse-grained, bioclastic, in beds 0.5 to 0.7 ft thick; interbedded with very thin and irregularly bedded to lenticular or nodular limestone and light-olive-gray to medium-gray micrograined to fine-grained limestone; commonly contains abundant brachiopods and some subconical bryozoans; micrograined argillaceous limestone in irregular to lenticular beds commonly contains gastropod shells; medium- to coarse-grained limestone makes up one-third of unit	30.0
Total thickness of Grier Limestone Member	135

Logana Member; argillaceous micrograined limestone and shale.

At the type locality the Grier Limestone Member is underlain by interbedded micrograined limestone and shale of the Logana Member, but in southeastern Jessamine and southern Fayette Counties the Grier rests directly on the Curdsville Limestone Member.

In eastern Woodford and western Fayette Counties, micrograined limestone and shale of the Brannon Member rest directly on thin- and irregularly bedded to nodular fossiliferous limestone of the Grier; however, in southern Fayette, Jessamine, and much of western Woodford Counties the two members are separated by a unit of crossbedded phosphatic calcarenite, locally as much as 30 feet thick, that is a tongue of the Tanglewood Limestone Member (fig. 4, section 3; fig. 5, section 7). Where the Brannon Member terminates in northern Fayette, Scott, and Franklin Counties, this tongue merges with the main body of the Tanglewood.

The Grier Limestone Member is present throughout the area of figure 1.

Macedonia Bed.—A distinctive unit of interbedded tabular argillaceous micrograined limestone and shale as much as 15 feet thick and 60 to 65 feet above the base of the Grier Limestone Member has been noted in Franklin, Woodford, and western Fayette and Jessamine Counties. We herein name this unit the Macedonia Bed and designate the type section to be in the roadcuts on the south side of the east-bound lane along Interstate Highway 64 on the east side of the Kentucky River (units 11 through 13 in the reference section of the Lexington Limestone). It is represented by bed 16 in the type section description of the Grier Limestone Member and figure 4, section 2. The name is derived from Macedonia Church in northwestern Woodford County 2 miles south of the type section. The Macedonia Bed grades eastward into irregularly bedded fossiliferous

limestone that cannot be distinguished from the rest of the Grier in eastern Jessamine and southern Fayette Counties.

Cane Run Bed.—In much of the area in which the Brannon Member is present, a bed of argillaceous micrograined limestone as much as 5 feet thick and similar in character to the Brannon occurs at or near the top of the Grier Limestone Member. The base of the bed ranges from 15 to 25 feet below the base of the Brannon Member. The bed extends past the northern pinch-out edge of the Brannon into northern Fayette and southern Scott and Bourbon Counties (fig. 4, section 4; fig. 5, sections 5 and 6). This bed is herein named the Cane Run Bed for Cane Run in north-central Fayette County. A description of the type section follows:

Upper part of Grier Limestone Member of the Lexington Limestone

[Measured in Pemberton Quarry on east side of U.S. Highway 25, 0.9 mile north of Linlee School, Lexington West quadrangle, Fayette County, Ky.; quarry at 1,922,550 ft E., 224,600 ft N. (Kentucky coordinate system, north zone)]

	Thickness (feet)
Lexington Limestone:	
Tanglewood Limestone Member (medium-grained bioclastic phosphatic limestone).	
Grier Limestone Member:	
3. Cane Run Bed: consists of limestone that is medium to light gray, argillaceous, micrograined, and contorted and convoluted; shaly partings in upper 1 ft; breaks into angular fragments with subconchoidal fracture	4.2
2. Limestone (85 percent) and shale interbedded; fossiliferous granular bioclastic limestone interbedded with micrograined limestone and shale; in even beds 0.2 to 0.7 ft thick	5.6
1. Limestone, medium- to dark gray, fossiliferous, coarse-grained, bioclastic, in even to irregular beds 0.3 to 0.5 ft thick interbedded with very fine grained limestone in nodular beds 1 to 2 in. thick	8.1

In many exposures the Cane Run Bed contains abundant irregular chert nodules, and in areas of poor exposure its position can commonly be located by the abundance of chert in the float.

The Cane Run Bed is present in southern Scott and Bourbon Counties and most of Fayette County. A similar bed in about the same stratigraphic position in south-central Woodford County and eastern Mercer County may be continuous with the Cane Run of the type area.

BRANNON MEMBER

The name Brannon Limestone Member is here shortened to Brannon Member of the Lexington Limestone. The unit generally includes abundant shale.

The name Brannon was introduced and its type locality described by Miller (1913, p. 324). He stated,

We propose for this siliceous bed (it really is only siliceous though its appearance suggests an argillaceous limestone) the name "Brannon" from Brannon Station on the Q. & C. R.R., a little south of the southern boundary of the [Georgetown, Ky., 15-minute] quadrangle. The first two railroad cuts south of the station expose this formation, the first one the upper, or "bouldery" phase, the second one about a mile from the station, both this upper portion and also the lower even bedded layers which are more argillaceous looking.

Brannon Station is several miles south-southwest of Lexington in the Nicholasville quadrangle near the northern edge of Jessamine County.

The Brannon Member consists of a succession of intercalated tabular (locally convoluted) micrograined limestone and shale beds. Limestone is generally dominant, though in some areas the shale content approaches 50 percent. Individual micrograined limestone beds are generally less than 6 inches thick where the bedding is planar, but convoluted beds are generally thicker. Locally, large slumped blocks of clastic limestone of the Tanglewood Limestone Member are included within the convoluted micrograined limestone and shale.

The contacts with the coarser grained calcarenites of the overlying and underlying units are sharp where well exposed. A discontinuous bed of bentonite just above the base of the Brannon Member is present at Versailles City Park in the Versailles quadrangle, at three widely separate locations in the Coletown quadrangle, and at one location in the Lexington West quadrangle. These local occurrences of bentonite at about the same stratigraphic horizon suggest that the lower contact is isochronal.

In the area mapped to date (1964), the Brannon Member reaches a maximum thickness of slightly more than 30 feet. It pinches out northeastward and southwestward (figs. 1, 4, and 5).

Near its northern edge the Brannon Member is locally divided into two tongues separated by a tongue of calcarenite of the Tanglewood Limestone Member. This relation is apparent in the reference section of the Lexington Limestone, in phosphate excavations near Wallace, Versailles quadrangle, and in roadcuts along the bypass north of Lexington.

TANGLEWOOD LIMESTONE MEMBER

The name Tanglewood Limestone Member is here given to the extensive irregularly shaped body of bioclastic calcarenite which in the Central Blue Grass Region of Kentucky makes up much of the upper half of the Lexington Limestone. The name Tanglewood is taken from a suburban area south of Frankfort, Ky.

The following section, selected as the type section for this member, was measured from roadcuts along Interstate Highway 64 west of its crossing of the Kentucky River near the Frankfort-Lawrenceburg interchange.

Type section of Tanglewood Limestone Member of Lexington Limestone

[Measured in roadcuts along Interstate Highway 64 on west side of Kentucky River, Frankfort West quadrangle, Franklin County, Ky., in December, 1962; base of section at 1,816,000 ft E., 240,200 ft N.; top of section at 1,813,900 ft E., 240,300 ft N. (Kentucky coordinate system, north zone)]

	Thickness (feet)
Clays Ferry Formation:	
17. Limestone (50 percent) and shale (50 percent) interbedded; very thin bedded medium-dark-gray micrograined argillaceous limestone; thin-bedded medium-dark-gray crinoidal limestone that locally contains abundant brachiopod valves; micrograined limestone containing abundant gastropods; medium-gray fissile shale	19
Lexington Limestone:	
Tanglewood Limestone Member (upper part):	
16. Limestone, thin-bedded, grayish-pink, phosphatic, coarse and very coarse grained, bioclastic; some beds contain abundant bryozoan fragments	9.0
15. Limestone, very thin bedded, partly crossbedded, light-gray to pinkish-gray, phosphatic, medium-grained, bioclastic	6.3
14. Limestone, very thin to thin-bedded, party crossbedded, light-gray to pinkish-gray, phosphatic, medium- to coarse-grained, bioclastic; dark-reddish-brown phosphatic siltstone or shale laminae between many beds; uppermost 2 ft contain abundant bryozoan fragments	7.5
13. Limestone, thin- to thick-bedded, light-gray, slightly phosphatic, coarse to very coarse grained, bioclastic; some strata are largely composed of pebble-sized bryozoan fragments which are abundant throughout unit; basal 1.5 ft is crinoidal and crossbedded	6.0
12. Limestone, thin-bedded, medium-gray to medium-dark-gray, coarse- to fine-grained bioclastic; in middle of unit, nodular limestone with intercalated shale laminae	3.0
Devils Hollow Member:	
11. Limestone, thin-bedded, laminated, light-gray, lithographic; contains blebs and tubules of sparry calcite; bed not present where unit 12 was measured. Section offset; correlation made on top of unit 10	1.0
10. Limestone coquina, yellowish-gray; alternating thin and thick beds composed largely of gastropod and brachiopod shells and bryozoan fragments	9.0
Tanglewood Limestone Member (lower part):	
9. Limestone (75 percent) and shale (25 percent) interbedded. Limestone is thin bedded, medium dark gray, medium grained, bioclastic. Shale is dark gray, fissile. Abundant bryozoan fragments in several of the limestone beds	4.6
8. Limestone, thin- to thick-bedded, partly crossbedded, medium-light-gray to medium-dark-gray, phosphatic, medium- to coarse-grained, bioclastic; contains some nodular limestone interbeds in zones 1 to 3 ft thick; shale partings common in upper part; bryozoan fragments abundant in upper 15 ft	25.0
Total thickness of Tanglewood Limestone Member (upper and lower parts)	61
Brannon Member; micrograined limestone.	

In the type section, the Tanglewood Limestone Member is divided into two parts by the Devils Hollow Member of the Lexington Limestone, but several miles to the south where the Devils Hollow Member is absent the Tanglewood extends uninterrupted from the Brannon Member to the Clays Ferry Formation.

The Tanglewood Limestone Member is characterized by calcarenite, much of which is phosphatic, composed predominantly of subrounded skeletal fragments, ranging from fine to coarse sand and generally cemented by sparry calcite. Its bedding character is somewhat variable, though bedding surfaces are commonly smooth and cross-bedding is common.

Throughout much of its area of outcrop this member is underlain by the micrograined limestone and shale of the Brannon Member. Where the Brannon is absent, bioclastic calcarenite of the Tanglewood rests directly on thin- and irregularly-bedded fossiliferous limestone of the Grier Limestone Member. Locally, the Cane Run Bed of the Grier Limestone Member immediately underlies the Tanglewood. The Tanglewood Limestone Member in large areas east of its type locality underlies and intertongues with nodular fossiliferous limestone and shale of the Millersburg Member (figs. 4 and 5). Where the Millersburg Member is absent, the Tanglewood calcarenite directly underlies the planar-bedded limestone and shale of the Clays Ferry Formation. The Tanglewood Limestone Member is locally divided into two parts by the Devils Hollow Member. The part of the Tanglewood between the Devils Hollow and Brannon Members in the past has been called the Woodburn Limestone Member (Miller, 1913, p. 326 and 327). Vertical extension of the name Woodburn to include all of the rock here included in the Tanglewood Limestone Member is inadvisable as major redefinition would be required.

DEVILS HOLLOW MEMBER

The Devils Hollow was named and the type locality established by McFarlan and White (1948, p. 1640) who stated, "An excellent development of these beds having a thickness of 25 feet is found along the Devils Hollow road a few miles west of Frankfort, and the name Devils Hollow division of the upper Lexington limestone is proposed for them." The name was subsequently adopted by the U.S. Geological Survey (Cressman, 1964) as the Devils Hollow Member of the Cynthiana Formation. It is amended herein to the Devils Hollow Member of the Lexington Limestone.

The Devils Hollow Member is divisible into two parts at the type locality. The lower 15 feet was described by McFarlan and White (1948, p. 1637) as "porous coarsely crystalline light gray massive

limestone containing in its typical development a crowded mass of gastropod shells, chiefly *Bellerophon troosti*, *Oxydiscus subacutus*, and *Lophospira medialis*. Silicification in weathering gives rise to a conspicuous fossiliferous chert horizon." Unit 10 on page C22 represents this rock type. At its type section the upper 10 feet of this member was described as "compact limestone suggesting Tyrone. Characteristic fossils are *Isochilina jonesi*, *Leperditia* (several species), and *Orthorhynchula linneyi*. Locally it is softer and more argillaceous." This rock-type is represented by unit 11 on page C22 and units 29 and 30 on page C11. The simple twofold division described from the type locality does not everywhere apply. In Woodford County south of Versailles the Devils Hollow Member is composed entirely of coquinoid limestone similar to that described for the lower 15 feet at the type section. North of Versailles this coquina is overlain by cryptograined limestone and dull, earthy ostracode-bearing micrograined limestone, the member thereby presenting the twofold aspect described by McFarlan. In the northwestern part of the Coletown quadrangle and the northeastern part of the Nicholasville quadrangle, the Devils Hollow Member is dominantly micrograined to cryptograined limestone containing some ostracodes; locally, it contains abundant coarse-ribbed brachiopods rarely seen elsewhere in this rock type. In the northeastern part of the Nicholasville quadrangle and in parts of the Tyrone and Frankfort East quadrangles, the micrograined and coquinoid lithologies locally intertongue. In the Clintonville quadrangle the Devils Hollow is discontinuous; locally, it occurs as thin beds in the transition zone between the Tanglewood and Millersburg Members. The lateral extent of the Devils Hollow Member has been shown by McFarlan and White (1948, fig. 4, p. 1633).

MILLERSBURG MEMBER

The name Millersburg Member of the Lexington Limestone is here adopted for the nodular, irregularly bedded fossiliferous limestone and shale unit of that formation. Rocks to be included in this member have in the past been variously named Greendale and Millersburg. The name Greendale is abandoned; according to McFarlan (1943, p. 20), it has been used with little precision, and less than 5 feet of the unit is exposed at the type locality.

The name Millersburg was proposed by Foerste (1914, p. 112):

"For the richly fossiliferous, argillaceous, irregularly bedded limestones, frequently weathering into the irregular fragments called rubble and containing *Orthorhynchula linneyi*, *Hebertella parksensis*, *Platystrophia colbiensis*, *Rafinesquina winchesterensis*, *Cyclonema varicosum*, *Constellaria emaciata*, *Homotrypella norwoodi*, *Heterotrypa parvulipora*, and numerous other species, the term Millersburg limestone is proposed."

The name was derived from the town of Millersburg in northeastern Bourbon County.

Rocks of the Millersburg Member are readily distinguished from those of the overlying and underlying units by their irregular to nodular bedding, general profusion of fossils, and relative abundance of shale. On weathering, the Millersburg produces a thick yellowish soil which near bedrock generally contains fossiliferous limestone rubble.

The Millersburg Member varies considerably in thickness (figs. 4 and 5). It intertongues with and is vertically bounded by calcarenite of the Tanglewood and Nicholas Limestone Members and, in some areas, by micrograined limestone and shale of the Clays Ferry Formation. In northeastern Fayette, western Bourbon, and southeastern Scott Counties, the Millersburg Member contains a microgained limestone and shale unit (fig. 5, sections 5 and 6) which, as mapping proceeds, may prove to be laterally connected to the main body of the Clays Ferry Formation. The Millersburg Member is locally more than 60 feet thick in the Clintonville quadrangle.

Though we have not yet mapped near the type area of this member, reconnaissance indicates lateral continunity between the Millersburg of the type locality and similar rocks near Lexington. The following stratigraphic section, measured from roadside exposures along the Athens-Boonesboro road just west of the Interstate Highway 75 overpass, is a reference section.

Reference section of Millersburg Member of Lexington Limestone

[Measured in roadcut on Athens-Boonesboro road 0.4 mile northwest of interchange with Interstate Highway 75, Coletown quadrangle, Fayette County, Ky.; base of section in creek bottom at 1,958,650 ft E., 178,050 ft N. (Kentucky coordinate system, north zone)]

	Thickness (feet)
Lexington Limestone:	
Millersburg Member:	
13. Limestone (50 percent) and shale; nodules of medium-gray fine- to medium-grained bioclastic limestone in medium-dark-gray shale matrix; very fossiliferous; covered above, but probably less than 5 ft to base of Nicholas Limestone Member of Lexington Limestone	7.0
12. Limestone and shale; similar to unit 13 but contains stromatoporoids at base and top	2.0
11. Limestone and shale; similar to unit 13 but contains thin greenish-gray claystone bed at base	7.0
10. Limestone and shale; similar to unit 13 but contains some thin interbeds of bioclastic limestone throughout and stromatoporoids in light-gray mudstone bed at base	7.6
9. Limestone, medium-grained, bioclastic, in resistant beds with irregular surfaces; fossiliferous nodular limestone near middle of unit	2.0

Reference section of Millersburg Member of Lexington Limestone—Continued

Lexington Limestone—Continued Millersburg Member—Continued	*Thickness (feet)*
8. Limestone (50 percent) and shale; similar to unit 13 but less fossiliferous	6.8
7. Limestone, medium-dark-gray, very fine to fine-grained bioclastic; in very thin tabular beds, crossbedded in part; contains some interbeds of medium-dark-gray shale	2.9
6. Limestone (60 percent) and shale; similar to unit 13 but less fossiliferous; contains some thin, even beds of very fine grained dark-gray limestone; locally convoluted 3 ft above base of unit	4.7
5. Limestone, medium-grained, bioclastic; contains abundant brachiopod fragments; minor bluish-gray shale as interbeds near base; unit forms resistant ledge	2.4
4. Limestone, medium-grained, bioclastic; sparry calcite cement; in planar surfaced to slightly wavy beds averaging 3 in. thick	3.6
3. Limestone (80 percent) and shale. Limestone is nodular, medium-gray, bioclastic, and somewhat fossiliferous. Shale occurs as undulatory laminae	7.0
2. Covered	4.0
Total exposed Millersburg Member	57
Tanglewood Limestone Member:	
1. Limestone, medium- to coarse-grained, bioclastic, in irregular, crenulated, and gently wavy beds; contains some fossiliferous interbeds; poorly exposed. Underlain by Brannon Member	35.0

NICHOLAS LIMESTONE MEMBER

The Nicholas Limestone Member, formerly a member of the Cynthiana Formation, is here applied to the extensive unit of calcarenite which throughout much of the area overlies the Millersburg Member and forms the top of the Lexington Limestone. Where the Millersburg is absent, the calcarenite rocks of the Tanglewood Limestone Member locally merge with and cannot be differentiated from those of the Nicholas Limestone Member (fig. 4). Where the two members merge, the Tanglewood Limestone Member is extended upward and its lateral boundary with the Nicholas is established arbitrarily.

The term Nicholas bed was first applied by Foerste (1909, p. 294) to "the upper part of the Cynthiana Formation, consisting of rather coarse-grained limestone with relatively few fossils. This part is typically exposed between Pleasant Valley and Millersburg." The Nicholas Limestone Member is composed in large part of tabular beds of coarse-grained and poorly fossiliferous calcarenite. Crossbedding is common. The Nicholas weathers to a fertile reddish-

brown soil. In fresh exposures both upper and lower contacts are well defined by change in bedding character, limestone type, and a marked increase in the abundance of shale. The following stratigraphic section from this type area was measured from steep exposures on the southwest side of the Licking River near the Parks Ferry Road.

Reference section of Nicholas Limestone Member of Lexington Limestone

[Measured in two parts; lower 48.5 ft from roadcut in Kentucky State Highway 32 at south end of bridge across Licking River, 1.5 miles southwest of Pleasant Valley, Moorefield quadrangle, Nicholas County, Ky.; remainder of section from steep exposures between railroad tracks and Parks Ferry Road ¼ mile to the west; base of section at 2,087,050 ft E., 312,650 ft N.; top of section at 2,085,550 ft E., 313,950 ft N. (Kentucky coordinate system, north zone)]

	Thickness (feet)
Clays Ferrry Formation (basal part only; from exposure west of Parks Ferry Road):	
14. Limestone (50–60 percent) and shale. Limestone is mostly micrograined but some is coarsely clastic; in very thin, tabular beds; crinoid fragments and delicate brachiopods abundant; partly covered. Not measured.	
Lexington Limestone:	
Nicholas Limestone Member:	
13. Limestone, coarse-grained, bioclastic; sparry calcite cement; commonly iron stained; in thin to very thin, planar to wavy surfaced beds that become thinner and more irregular toward base; weathered surface rough to hackly; poorly fossiliferous; limestone with included crinoid stem plates approximately 3 ft below poorly exposed upper contact; unit forms resistant ledge	20.0
12. Limestone (80 percent) and shale. Limestone is fossiliferous, mostly fine grained, bioclastic; occurs as elongate nodules and in very thin crenulated to irregular beds. Shale is medium gray; occurs as matrix of limestone nodules and as thin undulatory partings. Micrograined limy mudstone bed 1 ft thick about 1.5 ft above base of unit; stromatoporoids throughout; unit is poorly resistant, forms recess in cliff exposure	6.8
11. Limestone, fine-grained, bioclastic, in very thin irregularly surfaced beds with thin interbeds of very coarse grained bioclastic calcarenite as below	4.7
10. Limestone, coarse to very coarse grained, bioclastic; sparry calcite cement; in thin, wavy-surfaced beds	2.6
9. Limestone, medium-grained, bioclastic; sparry calcite cement; in very thin tabular beds; crossbedded in part	2.8
8. Limestone, bioclastic, as below but in thick convoluted beds; very thin clay bed at base of unit	3.0
7. Limestone, medium-grained, well-sorted, bioclastic; in very thin tabular beds, partly crossbedded; basal contact clearly defined, forms resistant overhanging ledge	4.0
Total Nicholas Limestone Member	44

Reference section of Nicholas Limestone Member of Lexington Limestone—Con.

Lexington Limestone—Continued Millersburg Member:	*Thickness (feet)*
6. Limestone and shale. Limestone is fine to medium grained, bioclastic, mixed with blebs of micrograined limestone, very fossiliferous; as nodules and in very thin lumpy beds. Shale is medium to medium dark gray; occurs as matrix of nodular limestone; varies in amount approaching 50 percent in upper part of unit; yields nodular rubble on weathering	17.5
5. Limestone and minor shale; in very irregular to crenulated beds; forms resistant ledge	4.0
4. Limestone (70 percent) and shale. Limestone is fine to medium grained, bioclastic, fossiliferous in very thin crenulated beds with intercalated zones of nodular limestone and shale. Shale is medium to medium dark gray and occurs as matrix of limestone nodules and as undulatory interbeds	7.0
3. Limestone and shale. Limestone is nodular to crenulated, bioclastic, fossiliferous as above; thin zone of micrograined limestone and flat-bedded shale at top of unit	5.0
2. Limestone (70 percent) and shale. Limestone is micrograined, in very thin tabular smooth-surfaced beds. Shale is medium gray and approximately 30 percent of unit. Discontinuous stratum of crossbedded medium-grained bioclastic calcarenite, 1 ft thick, at top of unit	8.0
1. Limestone (80 percent) and shale. Limestone is bryozoan bearing, medium to coarse grained, bioclastic, in irregular to crenulated beds as much as 8 in. thick. Shale is medium gray to medium dark gray; as undulatory interbeds; yields nodular rubble on weathering. Covered below	7.0

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