

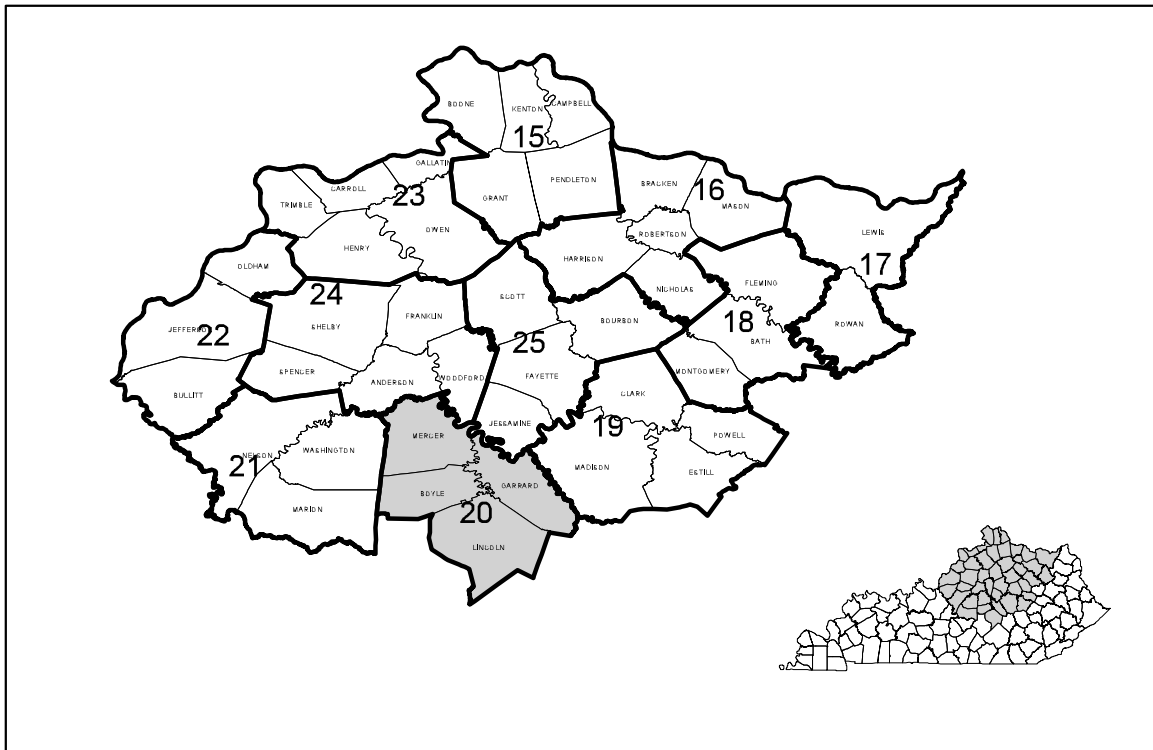
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY
AND THE KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY

AVAILABILITY OF GROUND WATER IN BOYLE, GARRARD,
LINCOLN, AND MERCER COUNTIES, KENTUCKY

By
W.N. Palmquist, Jr., and F.R. Hall

HYDROLOGIC INVESTIGATIONS
ATLAS HA-20



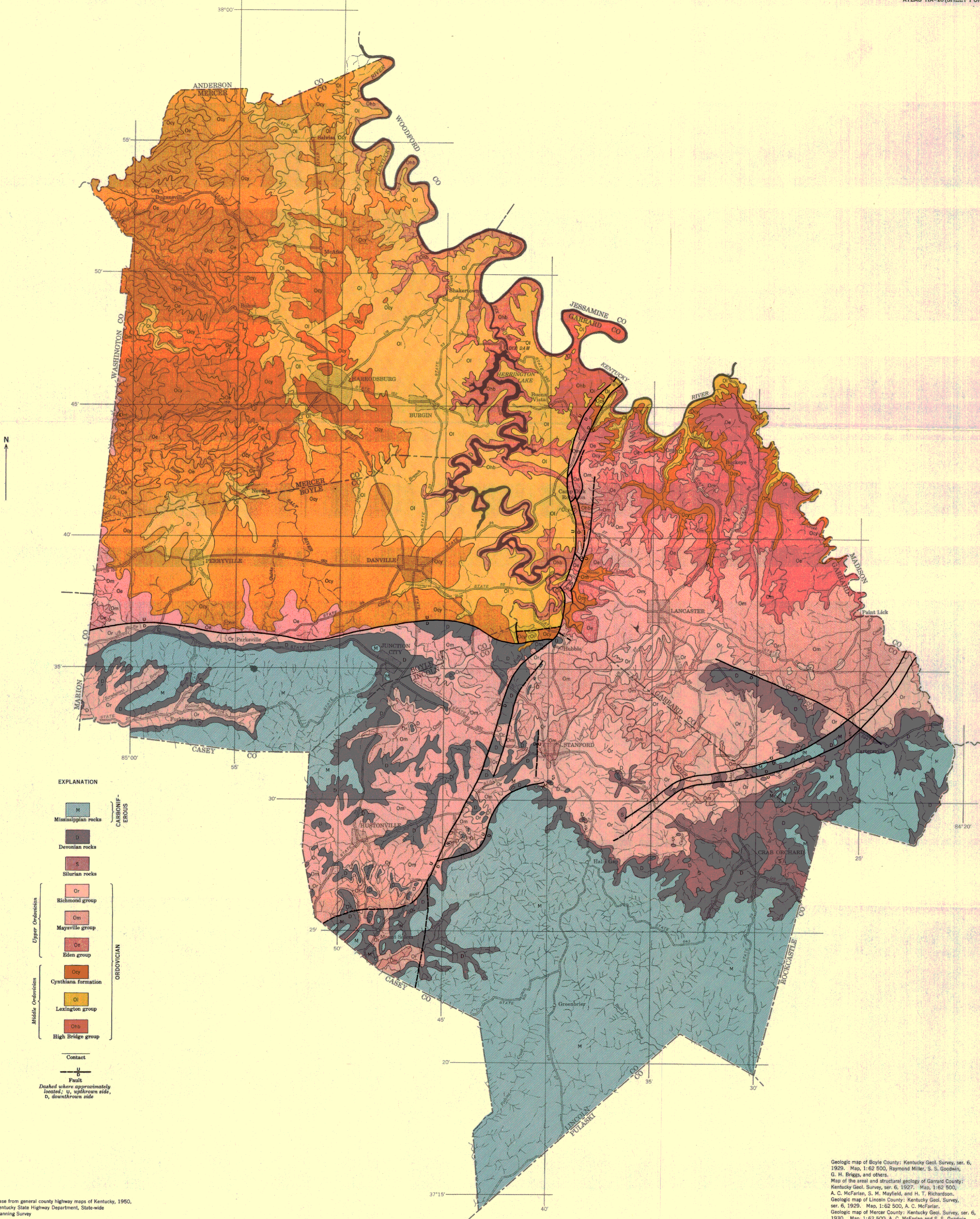
INDEX MAP OF THE BLUE GRASS REGION, KENTUCKY, SHOWING COUNTY
GROUPS AND AREA OF THIS ATLAS

This is 1 of 11 atlases (HA-15 to HA-25) showing geology and availability of ground water in the Blue Grass region, Kentucky U.S. Geological Survey Water-Supply Paper 1533 contains a text description and illustrations providing further information on the occurrence and quality of ground water in the Blue Grass region.

PUBLISHED BY THE U.S. GEOLOGICAL SURVEY

WASHINGTON, D.C.

1960



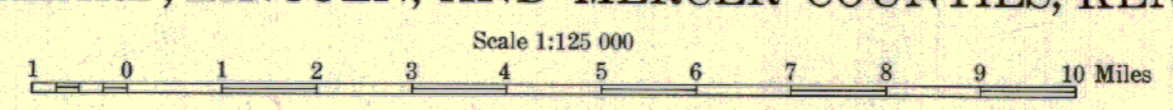
EXPLANATION

	Mississippian rocks	CARBONIFEROUS
	Devonian rocks	
	Silurian rocks	UPPER ORDOVICIAN
	Richmond group	
	Maysville group	
	Eden group	
	Cynthiana formation	
	Lexington group	MIDDLE ORDOVICIAN
	High Bridge group	
	Contact	
	Fault	

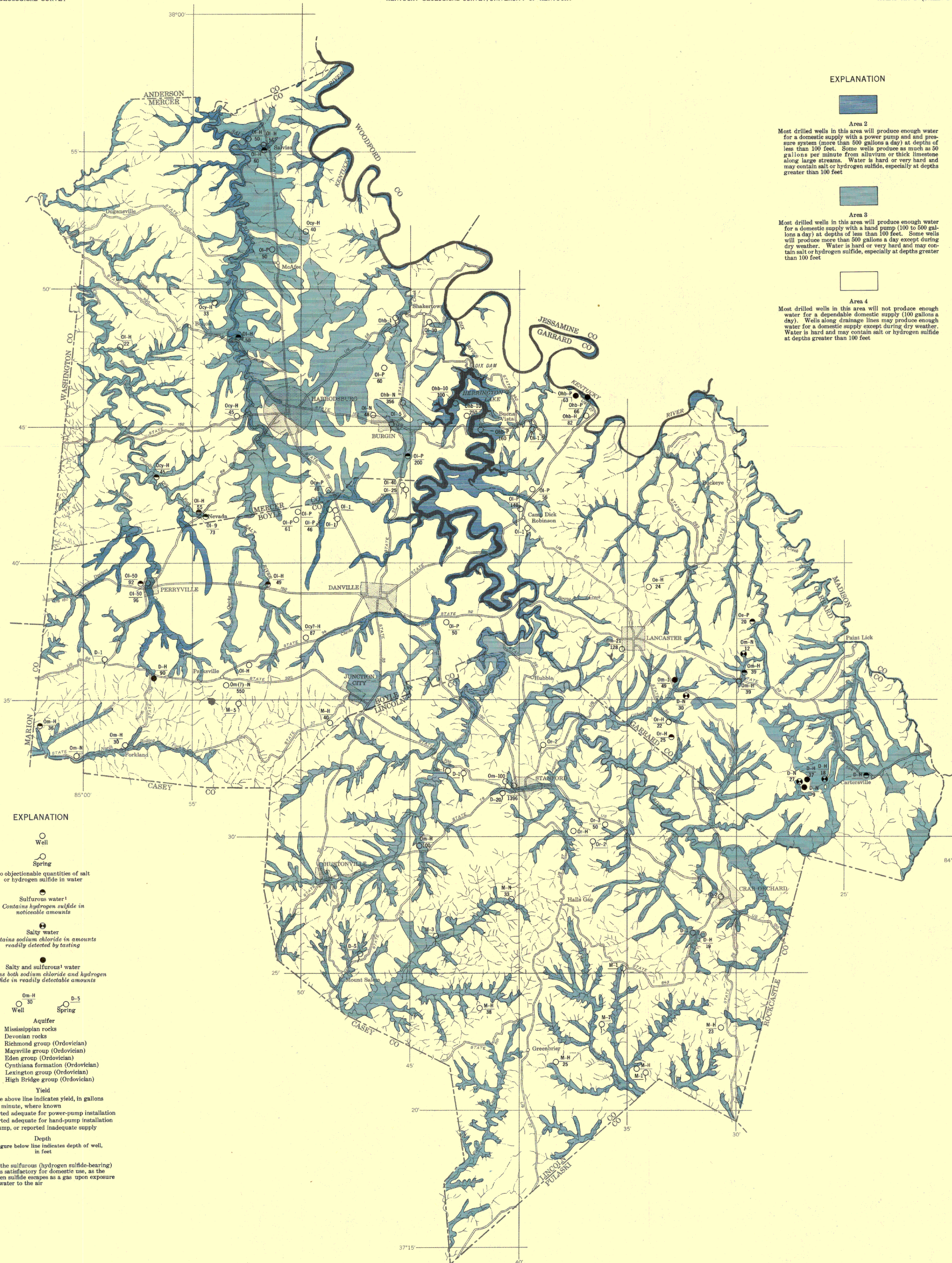
Dashed where approximately located; U, upthrown side, D, downthrown side

Geologic map of Boyle County: Kentucky Geol. Survey, ser. 6, 1929. Map, 1:62 500, Raymond Miller, S. S. Goodwin, G. H. Briggs, and others.
Map of the areal and structural geology of Garrard County: Kentucky Geol. Survey, ser. 6, 1927. Map, 1:62 500, A. C. McFarlan, S. M. Mayfield, and H. T. Richardson.
Geologic map of Lincoln County: Kentucky Geol. Survey, ser. 6, 1929. Map, 1:62 500, A. C. McFarlan.
Geologic map of Mercer County: Kentucky Geol. Survey, ser. 6, 1930. Map, 1:62 500, A. C. McFarlan and S. S. Goodwin.

GEOLOGIC MAP OF BOYLE, GARRARD, LINCOLN, AND MERCER COUNTIES, KENTUCKY (COUNTY GROUP 20)



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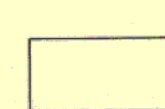
EXPLANATION



Area 2
Most drilled wells in this area will produce enough water for a domestic supply with a power pump and and pressure system (more than 500 gallons a day) at depths of less than 100 feet. Some wells produce as much as 50 gallons per minute from alluvium or thick limestone along large streams. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet



Area 3
Most drilled wells in this area will produce enough water for a domestic supply with a hand pump (100 to 500 gallons a day) at depths of less than 100 feet. Some wells will produce more than 500 gallons a day except during dry weather. Water is hard or very hard and may contain salt or hydrogen sulfide, especially at depths greater than 100 feet



Area 4
Most drilled wells in this area will not produce enough water for a dependable domestic supply (100 gallons a day). Wells along drainage lines may produce enough water for a domestic supply except during dry weather. Water is hard and may contain salt or hydrogen sulfide at depths greater than 100 feet

EXPLANATION

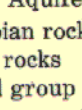
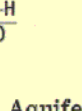


No objectionable quantities of salt or hydrogen sulfide in water

Sulfurous water¹
Contains hydrogen sulfide in noticeable amounts

Salty water
Contains sodium chloride in amounts readily detected by tasting

Salty and sulfurous¹ water
Contains both sodium chloride and hydrogen sulfide in readily detectable amounts



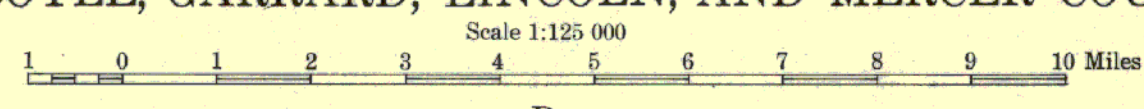
Aquifer
M Mississippian rocks
D Devonian rocks
Or Richmond group (Ordovician)
Om Maysville group (Ordovician)
Oe Eden group (Ordovician)
Ocy Cynthiana formation (Ordovician)
Ol Lexington group (Ordovician)
Ohb High Bridge group (Ordovician)

Yield
5 Figure above line indicates yield, in gallons per minute, where known
P Reported adequate for power-pump installation
H Reported adequate for hand-pump installation
N No pump, or reported inadequate supply

Depth
30 Figure below line indicates depth of well, in feet

¹ Much of the sulfurous (hydrogen sulfide-bearing) water is satisfactory for domestic use, as the hydrogen sulfide escapes as a gas upon exposure of the water to the air

AVAILABILITY OF GROUND WATER IN BOYLE, GARRARD, LINCOLN, AND MERCER COUNTIES, KENTUCKY (COUNTY GROUP 20)



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SYSTEM	SERIES	GROUP	FORMATION	THICKNESS, IN FEET	SECTION	LITHOLOGY	TOPOGRAPHY	HYDROLOGY			
QUATERNARY	PLEISTOCENE AND RECENT		ALLUVIUM	0-60		Sand and silt, and some coarser material along the Kentucky River. Material in other stream valleys is thin and fine grained.	Narrow, discontinuous flood plains and terraces.	Yields 100 to 500 gpd (gallons per day) to wells in thick deposits along the Kentucky River; too thin and fine-grained elsewhere to yield much water. Water is hard.			
			UNDIFFERENTIATED LIMESTONE AND SHALE	85±		Thin- to thick-bedded fine- to coarse-grained limestone, locally siliceous, with interbedded shale and geodes.	Tops of flat-topped ridges in southern Lincoln County. Thick limestone beds form ledges and cliffs.	Yields 100 to 500 gpd to drilled wells where rocks occur below streams on upland; yields almost no water to wells on narrow ridgetops or hillsides; yields water to small springs on hillsides and at the heads of streams. Water is hard to very hard.			
CARBONIFEROUS	UPPER MISSISSIPPIAN	BORDEN ¹	MULDRAUGH FORMATION ²	35-75		Silty or siliceous limestone and much unevenly bedded chert; slightly calcareous sandstone bed near top, and thin zone of glauconitic silt near base in southwestern Lincoln County; massive to well-bedded siliceous dense limestone and shale partings interbedded with thick shale in eastern Lincoln County.	Dissected upper slopes and tops of some knobs and ridges. Limestone beds form ledges and small cliffs.	Yields 100 to 500 gpd to wells in valley bottoms and along streams in upland, but almost no water to wells on hills; yields water to small springs in limestone and siltstone. Where siltstone occurs at and below stream level, wells may produce more than 500 gpd. Water from the shale is soft; from the siltstone, hard; and from the limestone, very hard. At shallow depths below stream level, water may contain salt, sulfate, or iron. Silty shale and siltstone are favorable for construction of dug wells, which are common in this area. Most dug wells produce less than 500 gpd, and many yield very little, or go dry, in late summer and fall.			
			FLOYDS KNOB FORMATION ¹	1±		Thin streak of bright blackish-green glauconitic silt.	No characteristic topographic expression.				
			BRODHEAD FORMATION ²	135-175		Silty or calcareous shale or limestone in upper part, massive siltstone or shale with limestone lenses in middle part, gray drab silty resistant shale in lower part.	Main part of Mississippian escarpment, ridges, and knobs. Shale forms steep slopes, and more resistant beds form ledges on slopes and in ravines.				
			NEW PROVIDENCE FORMATION ¹	125±		Clayey shale with many ferruginous concretions in upper part, massive siltstone in middle part, argillaceous to silty shale in lower part.	Dissected lower slopes and broad, flat valleys.				
DEVONIAN	UPPER DEVONIAN		OHIO SHALE	50-75		Black, locally green, fissile shale with thin sandstone or calcareous layers. Shale contains grains of quartz, pyrite, and other minerals, and black organic matter. Thin layer of pyrite at base.	Moderately steep slopes at base of knobs, and broad, flat valleys along major streams.	Yields 100 to 500 gpd to drilled wells at depths of less than 50 feet; water from greater depths is highly mineralized. Water is hard and may contain large amounts of iron and hydrogen sulfide.			
			BOYLE LIMESTONE ³	0-12		Massive dolomitic limestone with chert and silicified coral.	Resistant ledges on valley sides between shale slopes above and below.	Yields almost no water to drilled wells, but some water to small perennial springs. Water is hard but otherwise of good quality.			
SILURIAN	MIDDLE DEVONIAN	ORANGE	BRASSFIELD LIMESTONE	0-5		Thin- to medium-bedded greenish-gray lumpy shale with thin interbedded dolomitic limestone beds.	Moderately rolling surface with gentle slopes. The Brassfield limestone at the base forms ledges in the sides of valleys.	Yields almost no water to wells and springs. Water is of poor quality.			
			WHITWATER AND LIBERTY FORMATIONS UNDIFFERENTIATED	60±		Coarse bluish-gray shale with thin beds of dolomitic crystalline limestone in lower part.	Dissected upland with moderately steep slopes where shale predominates and moderately undulating upland where limestone predominates. Slopes are steep and cliffy along the valleys, and characteristically dotted with weathered limestone slabs.	Yields 100 to 500 gpd to drilled wells in valley bottoms and along streams in upland, but almost no water to drilled wells on hillsides or ridgetops; may yield some water to dug wells on ridgetops; yields water to small springs. Water is hard and in valley bottoms may contain salt or hydrogen sulfide. The amount of shale impedes circulation of ground water and prevents development of openings by solution in most of the thick limestone beds.			
			WAYNESVILLE LIMESTONE	75		Massive green fine-grained argillaceous limestone and thin beds of green shale.					
			ARNHEIM FORMATION	50		Lumpy or thin-bedded bluish-gray shale with interbedded argillaceous and rubby or massive dolomitic limestone.	Gently to moderately rolling upland away from major streams. More highly dissected where shale predominates; small sinkholes, minor underground drainage, and broad, flat valleys where limestone predominates. Lower part forms broad, flat ridges between steep-sided valleys cut into underlying shale of the Eden group.	Yield 100 to 500 gpd to drilled wells in valley bottoms and along streams in upland; may yield more than 500 gpd to drilled wells where thick limestone beds occur at and below stream level; yield almost no water to drilled wells on hillsides and ridgetops, although may yield some water to dug wells on ridgetops; yield water to small springs from the thick limestone beds. Water is hard and in valley bottoms may contain salt or hydrogen sulfide. Where thick limestone beds occur at and below stream level, fractures and bedding-plane openings have been enlarged by solution.			
			MC MILLAN FORMATION	120		Argillaceous rubby light- to dark-gray crystalline fine-grained massive dolomitic limestone with interbedded lumpy calcareous shale; chert in lower part.					
			FAIRVIEW FORMATION	75		Thin to medium-thick beds of gray limestone, rubby in places, with much interbedded bluish-gray calcareous shale.					
			UPPER	EDEN		UNNAMED SANDSTONE MEMBER	20-90		Light-colored fine-grained sandstone or siltstone grading upward and downward into sandy shale, mudstone, and limestone.	Rugged topography of narrow, steep-sided ridges and narrow, V-shaped valleys of detritic drainage. Steep slopes erode easily and are covered with thin limestone slabs in many places.	Yields up to 100 gpd to drilled wells in valley bottoms, but almost no water to drilled wells on hillsides or ridgetops; may yield some water to dug wells in valley bottoms and on ridgetops; yields water to small springs. Water is hard and in valley bottoms may contain salt or hydrogen sulfide. Shale has small, poorly connected openings, and ground-water circulation is slow; as a result, little water is available to wells and springs. On ridgetops the shale prevents downward percolation of water, and creates small semiperched water bodies in lower part of soil and upper part of weathered bedrock.
						GARRARD SANDSTONE	80-110		Lumpy bluish-gray calcareous shale with thin, evenly bedded argillaceous limestone layers common toward the base. May consist almost entirely of shale in some places.		
						MILLION SHALE ⁵	110-135		Thin- to thick-bedded fine- to coarse-grained siliceous and argillaceous limestone, locally crossbedded, rubby, or bouldery, with various amounts of drab or bluish-gray shale.	Gently to moderately rolling upland with small sinkholes and some underground drainage where limestone predominates; forms broad valleys between hills on fringe of Eden shale belt.	Yields 100 to 500 gpd to drilled wells in valley bottoms and along streams on upland; yields water to springs from resistant Brannon limestone member. Water is hard and below stream level may contain salt or hydrogen sulfide.
						ORDOVICIAN	LEXINGTON		WOODBURN LIMESTONE MEMBER	45	
BRANNON LIMESTONE MEMBER	25		Fine-grained siliceous limestone, at places bouldery; contains chert.								
PERRYVILLE FACIES ⁶	42		Massive light- to dark-gray coarse- to fine-grained limestone, locally siliceous or argillaceous.								
BENSON LIMESTONE	45		Thin to medium-thick beds of blue-gray medium-crystalline to coarsely crystalline limestone with some shale partings.								
JESSAMINE LIMESTONE	75-80		Hard gray-blue fine-grained siliceous limestone in thin to medium-thick beds; much interbedded shale.								
LOGANA FORMATION	30-35		Siliceous limestone and shale.								
CURDSVILLE LIMESTONE	2		Cherty crystalline limestone.								
MIDDLE	HIGH BRIDGE		TYRONE LIMESTONE	90					Pure essentially lithographic limestone in medium-thick beds; scattered inclusions of coarsely crystalline calcite; contains several thin to thick bentonite beds; weathers chalky white with dark calcite crystals faces standing in relief (Birdseye limestone).	Steep slopes and high cliffs along the Kentucky and Dix Rivers and lower parts of tributaries; relatively flat, broad valleys extending nearly to upland surface. Camp Nelson limestone crops out only in cliffs of gorges of the Kentucky and Dix Rivers. Tyrone and Oregon limestones form relatively broad, flat floors of major tributary valleys as they approach upland level.	Yields 100 to more than 500 gpd to drilled wells in valleys of the Dix and Kentucky Rivers and large tributaries; yields as much as 30 gpm (gallons per minute) to drilled wells along the shore of Herrington Lake, from solution channels and fractures; yields water to springs on hillsides and in steep walls along large streams. Water is hard but of good quality. Wells drilled into the Highbridge through overlying rocks produce almost no water because bentonite beds prevent recharge to underlying rocks.
			OREGON LIMESTONE	15-35					Massive gray to cream-colored granular magnesian limestone.		
			CAMP NELSON LIMESTONE	315 EXP.					Massive limestone characterized by intergrowth of limestone of the Oregon and Tyrone types; irregular patches of gray-buff finely crystalline magnesian limestone in a matrix of dense dove-gray limestone with scattered small calcite crystals; weathers to honeycombed surfaces with less soluble magnesian limestone standing in relief.		

¹As used by Stockdale (1939). ²Of Stockdale (1939). ³Of Foerste (1906) as used by Savage (1930). ⁴As used by Foerste (1935). ⁵Of Nickles (1905) as used by Foerste (1906). ⁶As used by McFarlan and White (1948).

GENERALIZED COLUMNAR SECTION AND WATER-BEARING CHARACTER OF THE ROCKS IN BOYLE, GARRARD, LINCOLN, AND MERCER COUNTIES, KENTUCKY (COUNTY GROUP 20)

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