University of Kentucky

College of Arts and Sciences

KENTUCKY GEOLOGICAL SURVEY

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Lexington

REPORT OF INVESTIGATIONS — No. 2

Industrial Limestones of Kentucky

by

JOHN A. STOKLEY

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LEXINGTON, KENTUCKY

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Lexington, Kentucky
August 15, 1949

Dean M. M. White
Arts and Sciences
University of Kentucky

Dear Dean White:

I am transmitting for publication a Report of Investigation on the Limestones of Kentucky, by John Stokley. It is a preliminary report to make available now some of the essential facts about our limestone resources and their availability for commercial use. The final detailed report requires many more months of work and many hundreds of analyses from the quarries that we have systematically sampled.

The essential facts are:

High calcium limestone available from the chemical industry and in adequate thickness is widespread in the areas of Ste. Genevieve and lower Chester outcrop in both eastern and western Kentucky. Limestone of near high calcium content is also present in the Perryville beds of the southwestern Blue Grass.

Attention is called to an area in Johnson County in the eastern coal fields where along the axis of the Paint Creek Uplift these same Mississippian limestones occur at shallow depth suitable for mining. The importance of this is that in a region otherwise devoid of limestone, this material is made available without long distance hauling costs. That it also includes considerable thicknesses of high calcium rock is likely.

Sincerely yours,

ARTHUR C. McFARLAN
Director

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PURPOSE AND SCOPE OF REPORT

It is the purpose of this report to give general information on the chemical composition, character, thickness, and distribution of the more important limestone and dolomite formations of Kentucky and to indicate possible uses for these now essentially unused stones in the chemical industries. This information should be helpful to quarry operators and others interested in the expansion of the stone industry in the state. The physical properties of the different rocks are not here discussed, but from tests and from current operations it is evident that some of the limestones and dolomites are well suited for general construction purposes. It is hoped that the data in this report are sufficient to indicate the more important carbonate rock belts and to serve as a guide in selecting particular localities for more detailed investigation and testing. An extensive, systematic and detailed investigation is in progress, but it will require many months for completion.

DEFINITION OF TERMS

In this report the following terms are applied to rocks as explained below:

1. carbonate rocks - sedimentary rocks of which more than 50% is composed of calcium and magnesium carbonates. (includes limestones, magnesian limestones and dolomites).

2. pure - when applied to a carbonate rock indicates that it contains 95% or more carbonates.

3. impure - when applied to a carbonate rock indicates that it contains more than 5% of non-carbonates.

4. limestone - a carbonate rock with calcium carbonate composing 90% or more of the total carbonates.

*5. high-calcium limestone - a carbonate rock containing 95% or more calcium carbonate.

*6. pure limestone - a carbonate rock containing 95% or more carbonates and magnesium carbonate is less than 10% of the total carbonates. (includes high-calcium limestone)

*7. impure limestone - a carbonate rock containing more than 5% of non-carbonates and magnesium carbonate is less than 10% of the total carbonates.

8. magnesian limestone - a carbonate rock with magnesium carbonate composing from 10% to 30% of the total carbonates.

*9. pure magnesian limestone - a carbonate rock containing 95% or more carbonates with magnesium carbonate composing from 10% to 30% of the total carbonates.

*10. impure magnesian limestone - a carbonate rock containing more than 5% non-carbonates and magnesium carbonate composing from 10% to 30% of the total carbonates.

11. dolomite - a carbonate rock with magnesium carbonate composing from 30% to 46% of the total carbonates.

*12. high-magnesian dolomite - a carbonate rock containing 95% or more carbonates and magnesium carbonate composing from 40% to 46% of the total carbonates.

*13. pure dolomite - a carbonate rock containing 95% or more carbonates with magnesium carbonate composing from 30% to 46% of the total carbonates. (includes high-magnesian dolomite)

*14. impure dolomite - a carbonate rock containing more than 5% non-carbonates with magnesium carbonate composing from 30% to 46% of the total carbonates.

15. fine grained rock - mineral grains too small to be distinguished without magnification.

16. coarse grained rock - mineral grains average 2 millimeters or greater in diameter.

17. medium grained rock - mineral grains average less than 2 millimeters in diameter and can be distinguished by the unaided eye.

18. compact rock - a very fine grained, dense, homogeneous rock which breaks with a smooth fracture.

19. average (as used on reports of chemical analysis) - numerical average of chemical percentages of ledges without considering differences in thicknesses.

20. weighted average (as used on reports of chemical analysis) - numerical average of chemical percentages of ledges with differences in thicknesses considered.

21. composite (as used on reports of chemical analysis) - sample taken in part from all ledges indicated.

* See Figure 1.

CLASSIFICATION OF CARBONATE ROCKS

A system of classification giving exact definitions of the different classes of carbonate rocks seems desirable. No such system was found. This lack of definite limits for classes is due to the fact that calcite and dolomite exist in solid solution or isomorphous mixture to a considerable degree. Evidently up to a certain point dolomite is miscible with calcite without seriously affecting the latter's minerological properties and again as the composition of dolomite is approached calcite is miscible with dolomite without destroying the dolomite's individuality. The factors controlling the formation of dolomite crystals are not fully understood. Figure I outlines the ranges of chemical contents for each class as discussed in this report. Since the chemical uses are considered mainly, the distinction between classes is made almost entirely on a chemical basis with minor consideration given to minerology.

Carbonate rocks contain varying percentages of impurities, most of which are usually sand or materials of which shales are composed. The relations of carbonate rocks to these impurities and to sandstones, shales and magnesitic rocks are also indicated in Figure I.

USES OF LIMESTONE AND DOLOMITE

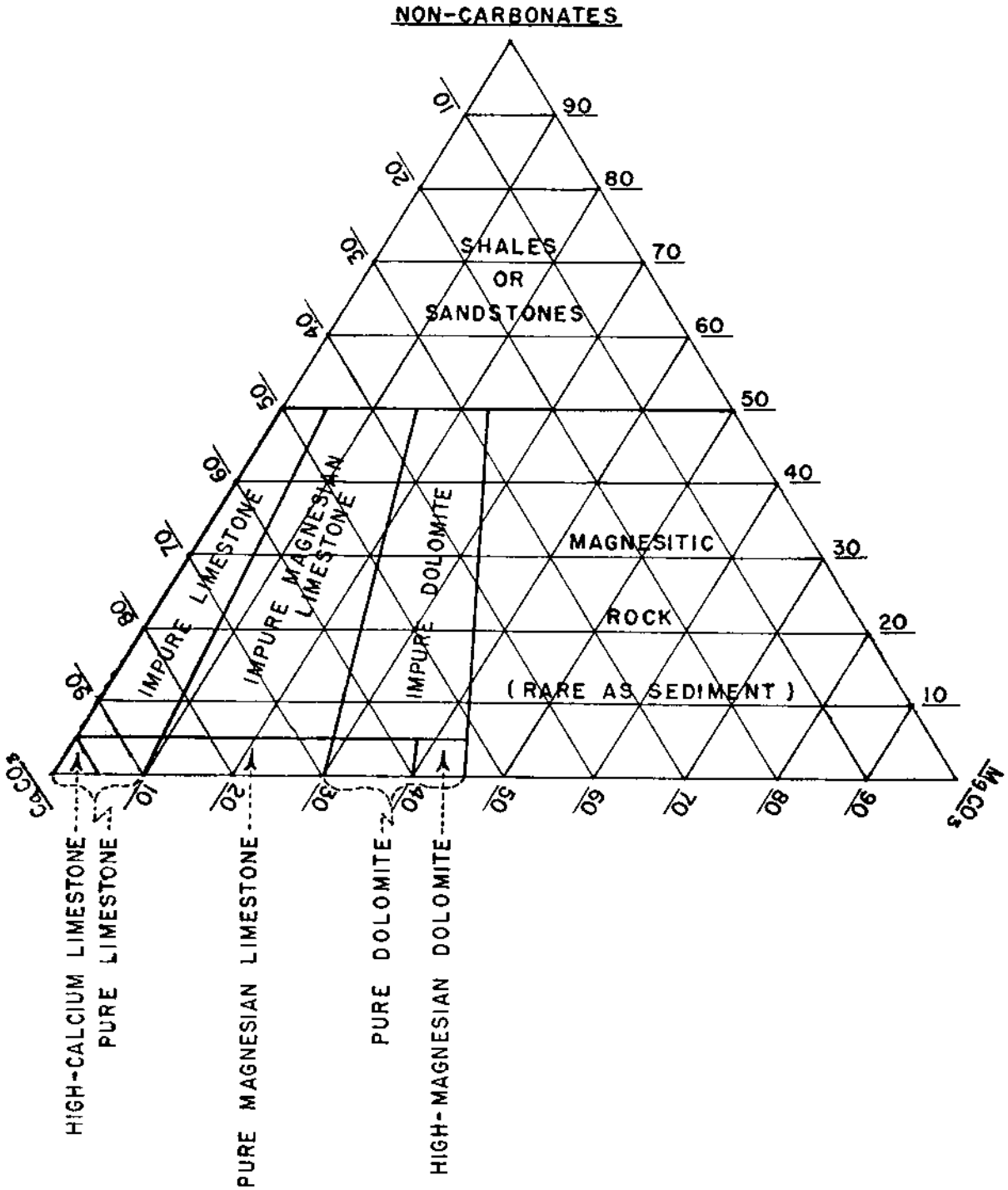
Certain uses of limestone and dolomite depend on their physical properties and others are controlled largely by their chemical composition. This report is chiefly concerned with those uses that depend on chemical composition.

Uses depending in a large part on physical properties include asphalt filler, concrete aggregate, concrete block manufacture, dimension stone, poultry grit, railroad ballast, roadstone, roofing gravel, riprap, sand, sewage filter beds, stucco, terrazo, whiting and whiting substitute.

The important industrial uses of carbonate rocks which are determined chiefly by their chemical composition are summarized in Table I. The approximate specifications applied to carbonate rocks for each use are summarized in Table II. Table III indicates the class or classes of carbonate rocks that may be suitable for each use. Table IV is a stratigraphic outline of the exposed formations of Kentucky, with those formations containing appreciable amounts of limestone indicated by * and the formations containing considerable quantities of high-calcium limestone are printed in heavy type. The carbonate rock formations of Kentucky are considered and classified in Table V and may be referred to Table III for an indication of possible uses.

FIG. I

CLASSIFICATION OF CARBONATE ROCKS



FOR DEFINITION OF CLASSES,
SEE "DEFINITION OF TERMS".

Table I

IMPORTANT CHEMICAL USES OF LIMESTONE AND DOLOMITE

Agricultural Limestone: Pulverized limestone is used on farm land to neutralize soil acid and acid clays, to supply nutrients for plant use and to improve the tilth of the soil.

Alkalies: Limestone is used in the Solvay process in the making of sodium hydroxide, the chief chemical base of industry. It is extensively used in the mercerizing of cottons and in soap manufacture.

Aluminum Oxide: Limestone is used in the Bayer process in the extraction of aluminum oxide from bauxite. Aluminum oxide is used as an abrasive or it may be converted into aluminum.

Ammonia: Limestone may be converted to a calcium carbide and used in the cyanamide process of ammonia manufacture. It may be burned to a lime and used for the recovery of ammonia from weak ammonia liquors. This use is limited.

Baking Powders: Limestone or lime is treated with purified acid to produce monocalcium phosphate, a constituent of certain types of baking powders.

Calcium Carbide: About two tons of limestone are used in making one ton of calcium carbide. Calcium carbide is employed with water to generate the combustible gas, acetylene, used in welding and cutting iron and steel.

Calcium Nitrate: A high-calcium limestone is treated with nitric acid to produce calcium nitrate. The nitrate is used in the manufacture of explosives, matches, pyrotechnics, and fertilizers.

Carbon Dioxide: A high-calcium limestone is used in the manufacture of CO_2. The burning of limestone to lime supplies a large part of the CO_2 of commerce. Carbon dioxide is used for a great many purposes among which are refrigeration, manufacture of explosives, food preservatives, manufacture of chemicals, in fire extenguishers, and for the carbonation of beverages.

Coal-Mine Dusting: A light colored limestone, free from grit and relatively easy to crush, is pulverized and used to dust coal mines to prevent explosions.

Dolomite Refractories: "Dead-burned dolomite", is produced by burning of dolomite or high-magnesian limestone at such temperatures, usually about 1500° C., as to make a hard, fully shrunk product. This material is used in basic open-hearth furnaces, electric furnace bottoms, basic Bessemer converters, lead refining reverberatory furnaces, lead cupelling furnaces, crucibles for lead blast furnaces, and in the form

of crucibles for the melting of metals.

Dye Works: $CaCO_3$ and lime are used in many ways in the manufacture of dyestuffs and dye intermediates.

Epsom Salts: Epsom Salts, the medicine, along with CO_2, is produced from dolomite by a series of processes involving as a primary reaction the treatment of dolomite with sulphuric acid.

Explosives: Limestone is used as a neutralizing agent for acids in many types of blasting explosives.

Fertilizers: Limestone and dolomite are used as fillers and conditioners of fertilizers. Limestone is also used in the manufacture of many nitrogenous fertilizers and fertilizer materials, such as cyanamide, calcium nitrate, ammonium citrophosphate, calcium ammonium nitrate, and ammonium sulphate.

Flux: Both limestone and dolomite are used for flux in the production of pig iron in blast furnaces. Limestone is used as a flux in the basic open-hearth process of making steel. Limestone is used as a flux in smelting copper, nickel, lead, zinc, gold, silver, antimony, and other metals.

Glass Manufacture: Limestone or dolomite is used as part of the mixture employed for making glass.

Lime: Lime is made by burning limestone or dolomite at a temperature which drives off the carbon dioxide. Limes of various properties are made according to the chemical properties of the raw stone, its physical characteristics, and the manner in which it is burned. Lime is employed in mortar, plaster, slag cement, sand-lime brick, stucco, cold-water paints, silica brick and stock feeds. It is used in drug and chemical manufacture, in the purification of water and in the treatment of sewage. It is involved in commercial processes such as tanning of leather, sugar refining, pulp and paper making, and in the manufacture of bleaching powder and caustic soda.

Magnesium: Some magnesium is made from dolomite. Magnesium is used as a refractory, as a polishing and cleansing powder, in medicines and as an antidote for swallowed acids.

Mineral Feeds: High-calcium limestone is crushed and used in mineral mixtures fed to stock to provide a diet containing the proper proportions of minerals.

Natural Cement: Limestone or dolomite is used for making natural cement for construction purposes.

Paper: Limestone and dolomite are used in the manufacture of paper by the sulphite, soda and sulphate processes.

Portland Cement: Limestone is used as a constituent of the raw mix for Portland cement manufacture.

Rock Wool: Impure limestones or dolomite are used in making rock wool. Rock wool is used for heat and sound insulation.

Salt Refining: High-calcium limestone is used for making lime which is employed in purifying salt.

Soap Purification: A high-calcium limestone is used to produce the lime which is employed as a precipitating agent in the purification of soap and may be employed as a neutralizing agent.

Sugar Refining: Limestone is used in refining beet sugar by the carbonation process.

Technical Carbonate: Dolomite is used for making technical carbonate which is employed for general heat insulation, especially pipe and boiler coverings, in pharmaceutical products, and in certain paints and varnishes.

Whiting Substitute: Whiting substitute, made by fine grinding of limestone, marble, or calcite, has numerous uses. It is used as a constituent of calcimine and cold water paints, paints, putty, ceramic glazes, ceramic enamels, cigarette papers, white ink, white shoe dressings, picture frame moldings, dolls, wire insulation, dyes, tooth paste and fireworks. It is used as a filler in rubber, oilcloth, window shades, linoleum, asphalt, magazine and book paper. It is used for compounding rubber goods, facing molds and cores in brass casting, a coating on glazed paper, neutralizing in fermentation processes, making buff brick from red-burning clay and dusting unburned brick to prevent sticking in the kiln. It is used in metal polish and the manufacture of citric acid. It is used in the following industries: structural iron, shipbuilding, locomotive works, file manufacture, explosives, medicines, leather, printing and engraving, shoe manufacturing, roofing cement, and chemical manufacture.

(Compiled from report[5] of the Illinois Geological Survey and other sources)

Table II

SUMMARY OF APPROXIMATE SPECIFICATIONS
FOR IMPORTANT CHEMICAL USES OF LIMESTONE AND DOLOMITE

USE	% $CaCO_3$	% $MgCO_3$	% SiO_2	% Alumina	% Fe Oxide	Remarks
Agricultural limestone						C. C. E. minimum 85%
Alkalies .....a.	96+	3-5	2-3			
b.	90-99	0-6	(..0....to....3.			SiO_2 max. 1%
Aluminum oxide	97+					
Ammonia (Cyan. process)						No specs. Seldom used
Baking powders	95+					"Selected" limestone
Calcium carbide	97+		1.2-	(...0.5-..)		Mg .5%-, P .004%-, S trace
Calcium nitrate	95+					
Carbon dioxide	97+					
Coal mine dusting						"Relatively pure", free from grit, easily crushed.
Dolomite refractories..	52-63	35-46	1-	(...1.5-..)		
Dye works	95+	low			low	For some uses - any high quality limestone.
Epsom salts	54	45	0.5	0.5	0.5	Average analysis of rock used
Explosives						High carbonate
Fertilizers	95+					For fertilizer manufacture.
						For filler - reasonably pure ls. or dol.
Flux:						
Open-hearth furnace..	88+	10-	1.0-	1.5-		
Blast furnace.....	(...90+...)		3-	2-		S .1%-, P .1%-
Nonferrous metal	95+					
Glass manufacture	(...96+...)		4-	3-	0.2-	Class 1) Sulphuric and
	(...91+...)		9-	5-	0.4-	Class 2) phosphoric anhy-
	(...83+...)		17-	5-	0.8-	Class 3) drides 1%-
Lime:						
High-calcium lime ...	91+	6-	(.....3-.....)			
Low magnesium lime...	68-95	5-29	(.....3-.....)			
High magnesium lime .	54-72	28-46	(.....3-.....)			
Hydraulic lime	(..77-91..)		(.....9-23.....)			
Magnesium		40+				New process limited use.
Mineral feeds	95+					
Natural cement	(..65-87..)		10-22	(...4-16..)		
Paper:						
Sulphite pulp (Tower)	95+	2.5-	(.....5-.....)			
Sulphite pulp (Milk-of-lime)..	52-60	40-46	(.....2.5-.....)			
Soda pulp and sulphate pulp...	93+	2-	(.....7-.....)			
Portland cement	75+	2-	(.....20.....)			Shales are added to purer ls. for Portland mix.
Rock wool.....	(..45-65..)		(..35-55.....)			Fe S undesirable.
Salt refining	95+					
Soap purification	98+	1.2-				.6%- insoluble material.
Sugar refining	97+	1-	1-			Fe Oxide undesirable.
						$CaSO_4$ objectionable.
Technical carbonate ...		40-45	1-			Total carbonates must be high.
Whiting substitute						Uses too varied for any general specification.

Compiled from a report[5] of the Illinois Geological Survey.
Abbreviations: 1. C. C. E. -calcium carbonate equivalent. 2. dol.- dolomite.
3. ls. - limestone. 4. max. - maximum.

Table III

CLASSES OF CARBONATE ROCKS THAT MAY BE USED FOR EACH OF THE IMPORTANT CHEMICAL USES OF LIMESTONES AND DOLOMITES.

USES	High-calcium limestone	Impure ls.	Impure Mg. ls.	Impure dol.	Pure ls.*	Pure Mg. ls.	Pure dol.**	High-magnesium dolomite.
Agricultural limestone	x	x			x			x
Alkalies	x				?			
Aluminum oxide	x							
Ammonia (cyanamide process)	x							
Baking powders	x							
Calcium carbide	x							
Calcium nitrate	x							
Carbon dioxide	x	?			?			x
Coal-mine dusting	x				x			x
Dolomite refractories					?			x
Dye works	x							
Epsom salts								x
Explosives	x	x			x			x
Fertilizers	x							?
Flux:								
Open-hearth furnace	x							
Blast furnace	x				x			x
Nonferrous metals	x							
Glass manufacture	x	?			x			x
Lime:								
High-calcium lime	x							
Low-magnesium lime					x			
High-magnesium lime					x			x
Hydraulic lime		x						
Magnesium								x
Mineral feeds	x							
Natural cement		x						
Paper:								
Sulphite pulp (Tower system)	x							x
Sulphite pulp (Milk-of-lime system)								x
Soda pulp and sulphate pulp	x							
Portland cement	x	x						
Rock wool	x	x			x			x
Salt refining	x							
Soap purification	x							
Sugar refining	x							
Technical carbonate								x
Whiting substitute	x							x

Abbreviations:
dol. - dolomite
Mg. - Magnesian
ls. - limestone

* - high-calcium ls. excepted.
** - high-magnesian dol. excepted.
? - only rocks of certain chem. content are used.

(Compiled from a report[5] of the Illinois Geological Survey.)

Table IV

STRATIGRAPHIC OUTLINE OF EXPOSED FORMATIONS
OF KENTUCKY

*-formations containing appreciable amounts of limestone
heavy print - formations containing considerable amounts of high-calcium limestone

PLEISTOCENE — Illinoian and pre-Illinoian drift, loess, and Wisconsin and earlier alluvial and lacustrine deposits.

TERTIARY

Jackson Purchase

Jackson form.
Wilcox
  Grenada form.
  Holly Springs form.
Midway
  Porter's Creek form.

Eastern Kentucky

Irvine form.

CRETACEOUS

Eastern Edge of Purchase

Ripley form.
Eutaw form.
Tuscaloosa form.

PENNSYLVANIAN

Eastern Kentucky

Cumberland Gap Coal Field	Pike County Vicinity	Laurel-Jackson County Vicinity	Boyd County Vicinity
Pottsville	Pottsville		Monongahela
Bryson form.	Harlan form.		Conemaugh
Hignite form.	Wise form.		Allegheny
Catron form.	Norton form.	Pottsville	Pottsville
Mingo form.	Lee form.	Breathitt form.	
Hance form.		Lee form.	
Lee form.			

Middlesboro Basin

Pottsville
  Harlan form.
  Wise form.
  Gladeville form.
  Norton form.
  Lee form.

Western Kentucky

Webster County

Conemaugh
  Dixon form.
  Lisman form. (contains *Madisonville ls.)
Allegheny
  Carbondale form. (contains *Providence ls.)
  Tradewater form (in part)
Pottsville
  Tradewater form. (main part)
  Caseyville form.

MISSISSIPIAN

Chester

Upper Chester)
*Kinkaid ls.)
Degonia ss.)
*Clore ls.) Leitchfield formation = Buffalo Wallow formation
Palestine ss.) - (eastern margin Western coal field) = Pennington
*Menard ls.) shale (eastern Kentucky)
Waltersburg ss.)
*Vienna ls.)
Tar Springs ss.)

Middle Chester

*Glen Dean ls.
Hardinsburg ss.
*Golconda ls.
Cypress ss.

Lower Chester

*Paint Creek ls.)
Bethel ss.) (*GASPER =*RENAULT-PAINT CREEK =*GIRKEN LS.)
*Renault ls.)
Aux Vases ss.)

Iowan

Meramec

*STE. GENEVIEVE LS.
*St. Louis ls.
Salem ls.
*Warsaw (Harrodsburg) ls.

Osage

Western Kentucky (Jefferson County and vicinity	
(After Butts)	(After Stockdale)
*	Borden Group
"Warsaw"	Muldraugh form.
	Floyd's Knob form.
Holtsclay ss.	Brodhead form.
Rosewood sh.	
Kenwood ss.	New Providence sh.
New Providence sh.	

Southern Kentucky

Fort Payne form. (Keokuk)
New Providence sh.

Eastern Kentucky

Waverly
Logan form. (Keokuk)
Cuyahoga form. (New Providence)

Kinderhook
Sunbury sh.
Berea ss.
Bedford sh.

DEVONIAN

Central Kentucky

New Albany sh. (Chattanooga-Ohio)
Duffin ls. (Tully)
Sellersburg ls.
*Casey ls.) -*Boyle
*Beechwood ls.)
*Silver Creek ls.
*Jeffersonville ls.

SILURIAN

Western Kentucky	Southern Ohio and Eastern Ky.
Cayugan	Greenfield dol.
.....	
Lockport	
.....	*Peebles dol.
*Louisville ls.	*Lilly dol.
Waldron sh.	
*Laurel ls.	
Clinton	
Osgood form.	
.....	*Bisher form.
.....	Kibolt sh.
.....	Estill sh.
.....	*Waco ls.
Basal Osgood	.....
	Lulbegrud sh.
	*Oldham ls.
Medinan	Plum Creek sh.
*Brassfield ls.	*Brassfield ls.

ORDOVICIAN

Richmond
*Saluda form. (Whitewater of Indiana and Ohio)
*Liberty form.
*Waynesville form.
*Arnheim form.
Oregonia
Sunset
Maysville
*McMillan

Central Kentucky	Northern Kentucky
*Mt. Auburn form.	*Mt. Auburn form.
*Gilbert ls.	*Corryville form.
*Tate form.	*Bellevue form.
Fairview	
*Fairmount ls.	*Fairmount
Garrard ss. (upper)	*Mt. Hope

ORDOVICIAN (Continued)

*Eden form.

Garrard ss. (lower) _____ McMicken
Southgate

Million _____ Economy
Fulton Fulton

*Cynthiana form.

Northern Kentucky		Central Kentucky	
Rogers Gap			Rogers Gap
			(*Nicholas
Point Pleasant	Groendale		( )
			( )
Bromley			) Millersburg

Lexington ls.

*Devil's Hollow form.
*Woodburn
*Brannon

	Mercer, Boyle, Garrard Cos.	
*Benson	(*Cornishville)	
	(*Salvisa)	- PERRYVILLE
	(*Faulconer)	
	(*Benson (lower))	

*Jessamine
*Logana (Hermitage)
*Curdsville

High Bridge ls.

*Tyrone) - Lowville
*Oregon)
*Camp Nelson (Stones River)

DISTRIBUTION, THICKNESS AND CHARACTER OF THE CARBONATE ROCK FORMATIONS OF KENTUCKY

In Table V, following, the distribution, thickness and character of the carbonate rock formations of Kentucky are generalized and summarized. Comparatively little systematic, detailed work has been done on the chemistry of the carbonate rock formations of this state. Analyses or partial analyses of rather general samples of the carbonate rocks of approximately 125 quarries have been assembled for this report. The most of these are the work of the Kentucky State Highway Department's geologist, Mr. David L. Arnall, and the Highway Testing Laboratory at Frankfort, Kentucky. Others were donated by the Highway Materials Research Laboratory at Lexington, Kentucky and still others were taken from a report by Mr. H. E. Roerk of the Louisville Cement Co. of Louisville, Kentucky. Quarries were systematically sampled by the Kentucky Geologically Survey in the summer of 1948 and chemical analyses were made through a cooperative arrangement with the College of Engineering Chemical Laboratory but most of these records were lost in a recent fire. The work is being redone and expanded.

An estimate of the classification of the carbonate rocks of each formation considered has been italicized in the "CHARACTER" column of Table V. This estimate was based on the above rather general information in many cases. Adequate chemical analyses are not yet available for many of the formations. Estimates of the chemical character of the carbonate rocks of these formations were based on personal observations or on the descriptions of other geologic workers. The estimates, therefore, are intended to indicate only the general chemical character of the carbonate rocks of each formation. A more complete study is in progress.

STRUCTURE

For the most part, the carbonate rock formations of Kentucky lie essentially horizontal on the crest and flanks of the Cincinnati Arch, contributing to the ease of quarrying. Along the Pine Mt. Fault the rocks dip considerably to the southeast. Locally, in other parts of the state near faults, the rocks may have considerable dip. This is especially true in the much faulted zone west and southwest of the Western Kentucky Coal Field, and along the Kentucky River Fault in the Blue Grass area.

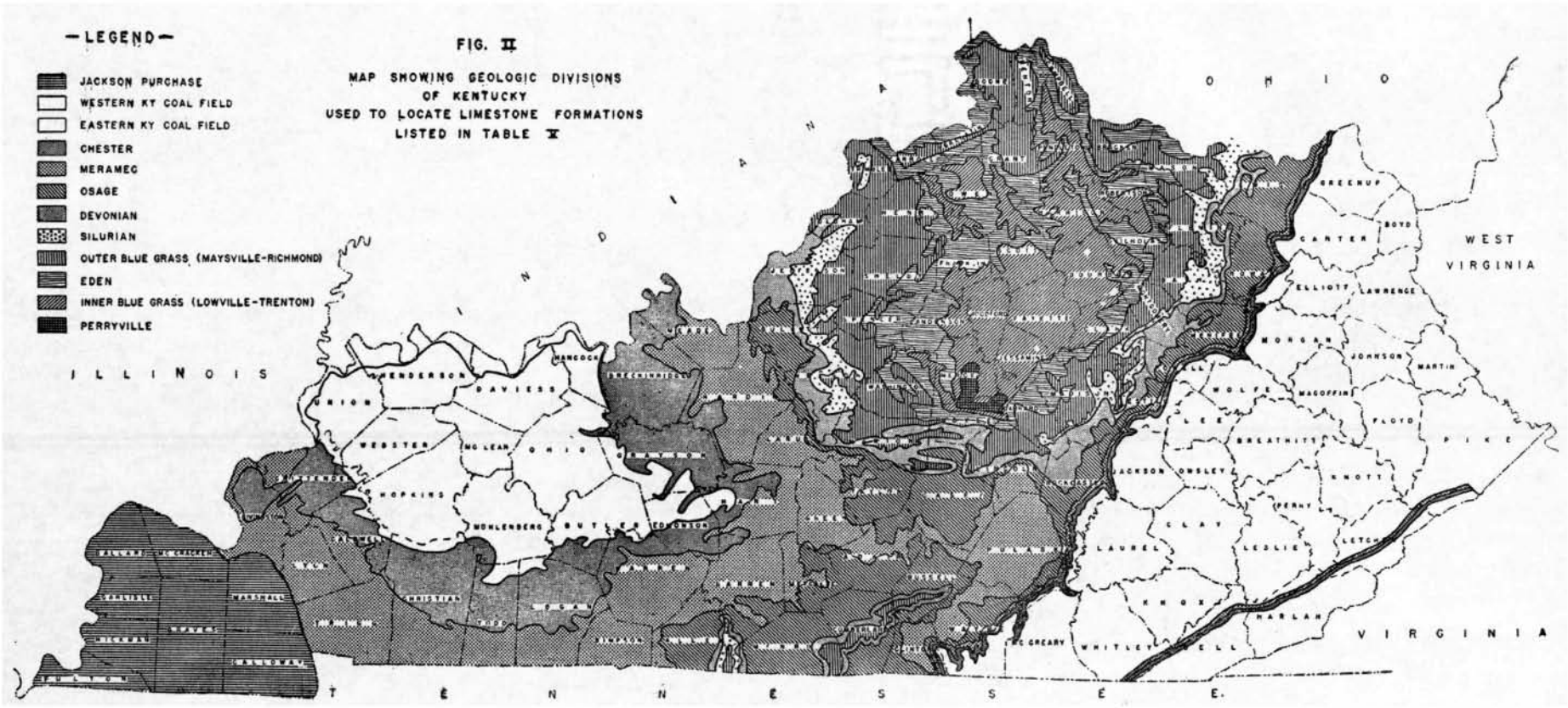

—LEGEND—
JACKSON PURCHASE
WESTERN KY COAL FIELD
EASTERN KY COAL FIELD
CHESTER
MERAMEC
OSAGE
DEVONIAN
SILURIAN
OUTER BLUE GRASS (MAYSVILLE-RICHMOND)
EDEN
INNER BLUE GRASS (LOWVILLE-TRENTON)
PERRYVILLE
FIG. II
MAP SHOWING GEOLOGIC DIVISIONS
OF KENTUCKY
USED TO LOCATE LIMESTONE FORMATIONS
LISTED IN TABLE X
ILLINOIS
INDIANA
OHIO
WEST VIRGINIA
VIRGINIA
TENNESSEE
HENDERSON
DAVIESS
UNION
WEBSTER
HOPKINS
MUHLENBERG
BUTLER
OHIO
GREENUP
BOYD
CARTER
ELLIOTT
LAWRENCE
MORGAN
JOHNSON
MARTIN
WOLFE
MAGOFFIN
FLOYD
PIKE
LEE
BREATHITT
JACKSON
OWSLEY
KNOTT
PERRY
CLAY
LESLIE
LAUREL
KNOX
HARLAN
WHITLEY
MC CREARY

Table V

DISTRIBUTION, THICKNESS, AND CHARACTER
OF CARBONATE ROCK FORMATIONS OF KENTUCKY

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map Fig. 2)	CHARACTER
(PENN.)			
Madisonville ls.	25-40	Western Kentucky Coal Field area. In central part only.	Blue to dark leaden gray, earthy, homogeneous to brecciated impure limestone interbedded with red shale. In Webster and Hopkins Counties it occurs in three ledges from 7 to 9 feet thick, and is quarried for road work.
Providence ls.	8(max.)	Western Kentucky Coal Field area. In central part only.	Blue, argillaceous impure limestone, variable in composition and irregular in bedding.
(MISS.)			
Kinkead ls.	variable, 200(max.)	Chester area near West. Ky. Coal Field area in Livingston, Caldwell, Christian, Logan, and Breckinridge Counties.	Hard, dense, gray, impure limestone in beds up to 2 feet thick interbedded with considerable shale. Often some chert. Thin and shaly in Breckinridge County.
Clore ls.	30 - 60	Chester area near West. Ky. Coal Field area in Crittenden, Livingston, Caldwell, and Christian Cos.	Impure limestone, commonly dense and hard, interbedded with shale. Locally the limestone may be shaly and fossiliferous. Beds up to 2 feet in thickness.
Menard ls.	80 - 140 from Livingston to Christian County 20± from Edmonson to Breckinridge Cos.	Chester area in Livingston, Crittenden, Caldwell, Edmonson, Hart, Grayson and Breckinridge Cos. to the south of the West. Ky. Coal Field it becomes part of the undifferentiated Leitchfield fm.	Mainly compact to dense, gray to dark blue impure limestone interbedded with minor amounts of shale. A little chert is often present.
Vienna ls.	thin and variable	Chester area in Livingston, Crittenden and Caldwell Cos. Elsewhere it is very thin and shaly.	The upper member is shale. The lower member is mainly fine grained, bluish gray to nearly black impure limestone in beds of 1 foot or less in thickness. Locally much dark chert occurs.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map, Fig. 2)	CHARACTER
Glen Dean ls.	40 - 80 in western Ky. 15 - 50 along western edge of East. Ky. Coal Field. Along Pine Mt. thickness undetermined.	Chester area in Livingston, Crittenden, Caldwell, Christian, Todd, Logan, Butler, Warren, Edmonson, Hart, Grayson, and Breckinridge Counties. Along western edge of East. Ky. Coal Field area in Clinton, Wayne, McCreary, Pulaski, Laurel, Rockcastle, Jackson, Madison, Lee, Estill, Powell, Wolfe, Menifee, Rowan, Lewis and Carter Counties. Along Pine Mt. in Whitley, Bell, Harlan, and Letcher Counties.	In west Ky. it has varying proportions of limestone and shale. In Livingston and Crittenden Counties the carbonate rock is gray, crystalline, somewhat massive limestone, with some dense beds. It is locally siliceous at the base. It is mainly impure limestone with some pure limestone. In Caldwell and Christian Cos. the formation is mainly shale with some interbedded limestone. From Warren to Breckinridge County the formation contains much more limestone. It is light colored, crystalline, and crinoidal with some beds of oolite near the top. It is mainly impure limestone with some interbedded pure limestone, part of which may be high-calcium limestone. Some chert is present in most areas. Along the western edge of the East. Ky. Coal Field it is predominantly blue, coarse grained, fossiliferous impure limestone with some pure limestone. It is moderately thick bedded but often contains much interbedded shale. Along Pine Mt. it is a succession of shales and limestones, the character of which is variable.
Golconda ls.	30 - 170	Chester area in Livingston, Crittenden, Caldwell, Christian, Todd, Logan, Warren, Edmonson, Hart, Grayson and Breckinridge Counties. Along western edge of East. Ky. Coal Field. Along Pine Mt.	Only 10% to 50% of the Golconda fm. is limestone. The remainder is shale. The character of the limestone varies widely. Mainly it is an impure limestone but locally it may contain pure limestone including some high-calcium limestone as it does north of Bowling Green where the limestone is a pure gray limestone with some beds of oolitic texture. Along the western border of the East. Ky. Coal Field and along Pine Mt. it is mainly shale.
Paint Creek	1 - 40 Crittenden, Livingston, Caldwell, and Christian Cos. 60 - 90 in Meade, Breckinridge, Ohio, Hardin and Grayson Cos.	Chester area in Crittenden, Livingston, Caldwell, Christian, Meade, Ohio, Breckinridge and some parts of Hardin and Grayson Cos.	In Crittenden and Livingston Counties the formation is mainly shale with small quantities of impure limestone. In Caldwell Co. the middle is shaly and the other consists of massive crystalline limestone which may be locally oolitic or sandy and classifies as impure limestone interbedded with some pure limestone part of which may be high-calcium limestone. In Meade, Breckinridge, Ohio, Hardin and Grayson Cos. it is composed of 5 members. The upper, middle and lower are shales. The intermediate two are

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map, Fig. 2)	CHARACTER
			(continued) massive limestone some of which are oolitic. These limestones are impure limestone with some interbedded pure limestone part of which may be high-calcium limestone.
Renault ls.	20 - 100 in Livingston, Crittenden, Caldwell, and Christian Counties. 60 - 70 in Meade, Breckinridge, Ohio, Hardin and Grayson Counties	Chester area in Crittenden, Livingston, Caldwell, Christian, Meade, Ohio, Breckinridge and Hardin and Grayson Counties.	In Crittenden, Livingston, Caldwell and Christian Counties the lower part consists mainly of shales with some interbedded dark gray, crystalline, cross bedded, impure limestone. The upper member is composed of gray to bluish gray, dense or crystalline limestone some of which is oolitic, cross bedded and more or less cherty in the upper part. The limestone beds are parted by thin calcareous shales. The probable classification is impure limestone with some interbedded pure limestone, some of which may be high-calcium limestone. Shaly members lessen to the east. In Meade, Breckinridge, Ohio, Hardin and Grayson Counties the formation is predominantly limestone which usually is siliceous at the bottom.
Renault-Paint Creek ls. or Gaspor ls.	80 - 200 in western Ky. 134 in Wayne Co. thinning northward to 95 at Mt. Vernon, 50 at Irvine, 40 at Olive Hill, and 20 in Carter Co. Locally absent.	Chester area. In western Ky. in Todd, Logan, Warren, Edmonson, Hart and Grayson Counties. Along western edge of East. Ky. Coal Field in Clinton, Wayne, McCreary, Pulaski, Laurel Rockcastle, Jackson, Madison, Lee, Estill, Powell, Wolfe, Menifee, Rowan, Lewis and Carter Cos. Along Pine Mt. in Whitley, Bell, Harlan and Letcher Cos.	The formation everywhere is practically all limestone. Locally shales are present in thicknesses up to 30 feet. In general the formation is very similar to the Ste. Genevieve formation on which it lies. It consists mainly of massive light gray limestone, much of which is highly oolitic and somewhat crossbedded. The remaining limestone is variable in texture and may be fossiliferous. It is impure limestone interbedded with pure limestone much of which is high-calcium limestone which may occur in ledges up to 20 feet thick. North of Bowling Green a 20 foot section of massively bedded, coarse oolite lies about 50 feet below the top of the formation. The rock is of a rather soft texture and splits freely. It is of high purity and has proven to be an excellent building stone. It is a large constituent of the formation from north of Bowling Green west to Caldwell Co. The rest of the formation is light

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER (continued)
			colored limestone much of which is an oolite of a more compact nature. In Rowan Co. south and east of Morehead, the upper Gasper is a massive, white, oolitic limestone 14 ½ feet in thickness. Tests of general samples indicate that it is an excellent high-calcium limestone. Elsewhere along the western edge of the Eastern Ky. Coal Field and along Pine Mt. there may be an occasional shale layer and some of the non-oolites may be siliceous and discolor on weathering.
Ste. Genevieve	Up to 250 in Livingston, Christian, and Caldwell Cos. 200 - 160 from Christian to Meade Co. 93 in Wayne thinning northward to 60 at Somerset, 45 near Berea, 25 from Irvine to Carter Co. where it thickens to 60. Locally absent in Rowan Co. 80 - 125 along Pine Mt.	Meramic area. In western Ky. in Crittenden, Livingston, Caldwell, Trigg, Christian, Todd, Logan, Simpson, Warren, Barren, Edmonson, Hart, Larue, Hardin, Breckinridge, and Meade Cos. Along western edge of Eastern Ky. Coal Field in Clinton, Wayne, McCreary, Pulaski, Rockcastle, Madison, Jackson, Lee, Estill, Powell, Wolfe, Menifee, Rowan, Elliott, Lewis, Carter, and Greenup Cos. Along Pine Mt. in Whitley, Bell, Harlan and Letcher Cos.	The St. Genevieve formation is divisible into three members, the Levias and Fredonia limestones separated by the Rosiclare sandstone. The Rosiclare, a calcareous sandstone from 2 to 20 feet thick, is not known east of Cerulean in Trigg Co. The Levias, which contains shaly zones up to 20 feet thick, varies from absent to 50 feet in thickness. The Fredonia member comprises the remainder. More than half of the formation is composed of thick bedded, coarsely oolitic, predominantly light colored limestone. These are interbedded with non-oolitic, compact to crystalline, drab to light gray limestone. The oolitic limestone is coarse textured and commonly composed in part of fossil fragments, mostly crinoid stem plates. Cross bedding is common. These oolitic limestones occur in ledges up to 30 feet in thickness and are of high purity. Analyses of general samples indicate for some of these ledges an average of 97 % or better of $CaCO_3$. It is quarried in Meade Co. and used by the Kosmodale Cement Co. Some oolitic layers are compact, brittle and have a glassy fracture. Its oolitic nature can be seen only on close inspection. Some beds of the formation have abundant chert. Tests indicate that the formation has pure limestone much of which is high-calcium limestone interbedded with impure limestone.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map, Fig 2.)	CHARACTER (continued)
			This character holds along the western edge of the Eastern Ky. Coal Field except it may be thinner bedded in the central part of the state and it contains small quartz pebbles and sand in the northern part. Along Pine Mt. it is generally similar to that of the other parts of the state.
St. Louis ls.	300 - 500 in western Ky. Along western border of Eastern Ky. Coal Field it is 117 at Monticello 100 at Somerset, 55 at Mt. Vernon, 25 at Irvine, and 30 at Frenchburg. 100 - 120 along Pine Mt.	Meramec area. In belt around Western Ky. Coal Field. The inner edge of this belt varies from 10 to 20 miles from the margin of the Western Ky. Coal Field according to locality. Along western edge of Eastern Ky. Coal Field from Clinton to Menifee Co. Along west face of Pine Mt. in Whitley, Bell, Harlan and Letcher Cos.	The St. Louis formation is all limestone. It is predominantly thick bedded. The great bulk of the formation is medium to fine grained. One or more beds of lithographic texture occur locally. Some very coarse grained layers have been noted near the bottom. In color the stone ranges from dark gray or nearly black to light gray, the greater part of the formation being of medium dark gray. An abundance of chert which appears on weathering indicates a high silica content. In many places the formation contains several layers of earthy and siliceous limestone with geodes. In eastern parts of the state there is much dark chert in the upper part. From Berea north much spally, yellow limestone is associated with the usual dark stone. Tests indicate that practically the entire formation is of the impure limestone class.
Warsaw fm.	Up to 240 in the counties of north-central Ky. 80 - 100 in south-central Ky. thinning to the north to its disappearance in Jackson Co.	Meramec area near the Keokuk-Waverly area. In Jefferson, Bullitt, Hardin, Larue, Taylor, Green, Adair, Metcalf, Cumberland, Clinton, Russell, Wayne, Pulaski, Casey, Lincoln, Rockcastle, and Jackson Cos.	The Warsaw is composed of limestone, shale and some sandstone in varying proportions. Changes from one to the other occur rapidly both vertically and horizontally. The predominant type of limestone is coarse grained, highly crinoidal, dark gray to blue in color. Locally it is very siliceous and may contain many geodes. Locally also, and especially in the east, are argillaceous layers that weather to an ochreous condition. Though varied, most of the limestone of this formation belongs to the impure limestone class.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER
(DEVONIAN)			
Casey ls.	3 - 8	Devonian area. Limited in Oldham, Jefferson and Bullitt Cos.	The upper part is a thick bedded, gray, fine grained limestone. The lower part is thinner bedded, gray and somewhat sandy. It contains much chert, especially in the upper part. It is an impure magnesian limestone.
Beechwood ls.	6 - 8	Devonian area. Limited in Oldham, Jefferson, and Bullitt Cos.	Gray, rather thick bedded, coarse grained, crinoidal limestone in the lower part. The upper part is finer grained and darker colored. Dark phosphate nodules are scattered throughout, but are more numerous in the lower part. It is mainly an impure limestone.
Silver Creek ls.	16 max. thinning east, south and west to extinction	Devonian area. So far as known its outcrop is limited in Ky. to a small area lying along the river bank immediately north of Louisville and extending eastward as a thin layer to lower part of Bear Grass Creek.	It is thick bedded, dark gray, fine grained, low to high magnesian, siliceous, and aluminous. Some beds contain much chalky white chert. Ranges of its chemical content are: $CaCO_3$ - 50% to 60%, $MgCO_3$ - 16% to 35%, silica - 10% to 25%, alumina 2% to 5%. It would therefore classify as an impure magnesian limestone or an impure dolomite. It is used as a cement rock in Indiana.
Boyle ls.	Up to 45 in Casey Co. 10 to 15 in Boyle Co. Varies from 18 to absent elsewhere.	Devonian area. In Bullitt, Nelson, Larue, Marion, Taylor, Casey, Boyle, Lincoln, Rockcastle, Garrard, Madison, Estill, Clark, Powell, Montgomery, Bath, Rowan and Fleming Cos.	Usually one or more thick layers of hard, rough, medium to fine grained, crystalline, gray to yellowish, impure magnesian limestone. It is usually very cherty, may be somewhat ferruginous and locally may contain an oil residue.
Jeffersonville ls.	25 max. along Ohio River, thinning to its disappearance to the south.	Devonian area. In northeast Jefferson Co. and in Oldham Co.	Character variable. The following types are interbedded; thick bedded, coarse grained, light gray limestone, locally cherty; fine grained, very hard, bluish gray limestone, siliceous and cherty; medium to coarse grained, light pinkish, bluish or brownish gray limestone; medium, thick bedded, very coarse, crystalline, brownish to gray limestone. All layers are fossiliferous. Tests indicate that all layers classify as impure limestone though the combined carbonates may exceed 90%.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER
(SILURIAN) Louisville ls.	40 - 100 Thickest at Jefferson - Bullitt Co. boundary	Silurian area, in Oldham, Jefferson, Bullitt and part of Nelson Cos.	It is mostly a gray, fine grained, thick bedded, magnesian limestone. The stone is somewhat siliceous and contains some dense gray or chalky white, nodular or platy chert. Probable variations of chemical content are: $MgCO_3$ from 2.1% to 29.8%, $CaCO_3$ from 48.8% to 91.8%, Silica from 3.4% to 15.9%. Alumina is seldom over 3%. The top two layers, the "Blue Ledges" are finer grained, have a compact, or earthy aspect, are bluish when fresh, weather yellowish and may have up to 26% silica. Most of the stone is in the impure limestone and impure magnesian limestone class.
Peebles dol. and Lilly dol.		Silurian Area. In Ky. known only in limited outcrop in Lewis Co. Lilly dol. not known in outcrop in Ky. Both are important oil producers along the western edge of the Eastern Coal field.	It is a fine grained, hard, gray dolomite.
Laurel ls.	35 - 40	Silurian area, in Oldham, Jefferson, Bullitt and part of Nelson Cos.	The texture is medium fine grained throughout. The color of the fresh rock is bluish gray in the lower part and light gray in the upper. It weathers to a buff or yellowish gray. Some layers weather with a cavernous or pitted surface. Approximately it is composed of $CaCO_3$ - 58%, $MgCO_3$ - 32%, silica - 6.5% with small amounts of alumina and iron oxide. In general it should be classed as an impure dolomite or impure magnesian limestone with some pure dolomite, but no high-magnesium dolomite.
Bisher formation		Silurian area. Limited outcrop in Lewis Co. only. Also an important oil producers along the western edge of the eastern coal field.	It is impure, gray, evenbedded, rather fine grained, granular dolomite, which weathers yellow or brown. Commonly fossiliferous. Mostly it is in an impure dolomite.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER
Waco ls.	Up to 10	Silurian area, in Madison, Clark Powell and Estill Counties	An imoure magnesian limestone in beds up to 2 ft. thick interbedded with thin calcareous shales.
Oldham ls.	Up to 12	Silurian area, in Madison, Estill, Powell, Montgomery and Bath Counties.	The Oldham is a thin to medium and unevenly bedded, imoure magnesium limestone interbedded with thin blue shale.
Brass-field ls.	9 - 19 east of the Blue Grass 3 - 9 west of the Blue Grass	Silurian area, in all counties as shown on map, Fig. 2.	The Brassfield consists of medium to coarsely crystalline, gray to pink, impure magnesian limestone. The lower part is usually massive. Above, it is relatively thin bedded, associated with shale and more fossiliferous. From Bath Co. northward and near Bardstown the lower part is very cherty. Locally it is ferruginous.
(ORDOVICIAN) Saluda fm.	Up to 40	Outer Blue Grass area. Near east and west borders.	Mostly a heavy, earthy to sandy, impure magnesian limestone. The upper few feet may be a purer limestone and the bottom may be finer and contain much shale.
Liberty fm.	35 - 50 in Jefferson Co. 65 - 70 in southern Blue Grass. 90 in Clark Co.	Outer Blue Grass area. Near east and west borders.	Earthy, impure magnesian limestone associated with much shale.
Waynesville fm.	40 - 60	Outer Blue Grass area. Toward the outer border on east, west and south sides.	Mostly a fine grained, gray, earthy, impure limestone with many thick beds of shale. Sometimes contains considerable impure magnesian limestone.
Arnheim fm.	80 - 100 in Jefferson Co. 20 - 50 elsewhere.	Outer Blue Grass area. East, west, and southern part	The lower (Sunset) member is composed of much shale and fine grained, argillaceous impure limestone which is sometimes magnesian. In Montgomery, Clark, Garrard and Lincoln Cos. it is capped by from 2 to 4 ft. or a purer, fine grained, hard limestone. The upper (Oregonia) member is mainly highly fossiliferous, rubbly, argillaceous impure limestone or impure magnesian limestone. It often contains much interbedded shale.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER
Mt. Auburn fm.	10 - 35	Outer Blue Grass area in Boone, Kenton, Campbell, Pendleton, Bracken, Mason, Fleming, Bath, Montgomery, Clark, Madison, Garrard, Lincoln, Boyle, Casey, Marion, Washington, Nelson, Spencer, Shelby, Henry, Carroll, Owen, Gallatin and Grant Cos.	Mainly a highly fossiliferous rubbly, argillaceous, impure limestone. It is a quarry rock in Fleming County and vicinity.
Gilbert ls.	0 - 20	Outer Blue Grass area. Important thickness only in Lincoln, Casey, Boyle, and Marion Cos.	This formation is composed almost entirely of a hard, dove to dark gray, fine grained to compact limestone. It varies from an impure limestone to a pure limestone.
Corryville fm.	35 - 60	Outer Blue Grass area. This formation can be traced for only a few miles south of the Ohio River.	Thin bedded, fossiliferous, argillaceous limestone and shale. The limestone is an impure limestone.
Tate fm.	60 - 80	Outer Blue Grass area in Montgomery, Clark, Madison, Garrard, Lincoln, Boyle Washington, Nelson and Spencer Cos.	Non-fossiliferous gray shale and fine grained, argillaceous limestone which is sometimes magnesian. It is an impure limestone or an impure magnesian limestone.
Bellevue fm.	15 - 40	Outer Blue Grass area in Shelby, Henry, Owen, Carroll, Gallatin, Grant, Boone, Campbell, Kenton, Pendleton, Bracken, Mason, Fleming, Nicholas, Bath, and Montgomery Cos.	Highly fossiliferous, often cross bedded, thin, rubbly, argillaceous impure limestone.
Fairmount fm.	50 - 75	Outer Blue Grass area in Boone, Kenton, Campbell, Pendleton, Bracken, Mason, Fleming, Bath, Montgomery, Clark, Madison, Garrard, Lincoln, Boyle, Casey, Marion, Washington, Nelson, Spencer, Shelby, Owen, Carroll, Gallatin and Grant Cos.	Fossiliferous, thin bedded, argillaceous, and sometimes rubbly limestone with interbedded shale. It is mostly impure limestone or impure magnesian limestone. It is a quarry rock in the vicinity of Cincinnati.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER
Eden fm	200 - 280	Eden area in counties as shown on map - Fig. 2.	Mainly calcareous shales interbedded with thin beds of fossiliferous to rubbly to hard, dense limestone. Most of the limestone is an impure limestone.
Cynthiana fm.	40 - 100	Inner Blue Grass area. Along Ohio River in Boone, Campbell, Kenton, Pendleton, Bracken and Mason Cos. Elsewhere in Campbell, Pendleton and Bracken Cos. Also in Robertson, Harrison, Nicholas, Bourbon, Grant, Owen, Henry, Franklin, Scott, Fayette, Clark, Jessamine, Garrard, Boyle, Mercer, Anderson, and Woodford Cos.	Limestone interbedded with some shale. The lithology of the limestone varies considerably. It may be fossiliferous, and crystalline, or fossiliferous, argillaceous and rubbly, or fine grained, siliceous and argillaceous, or as in the Nicholas member, which is considered next, it is heavy bedded, medium to coarse grained limestone. With the exception of the Nicholas member, it is believed that practically all of the Cynthiana limestone is impure limestone.
Nicholas ls. member of the Cynthiana fm.	Up to 35	Inner Blue Grass area. Boone, Campbell, Kenton, Pendleton, Robertson, Nicholas, Harrison, Bourbon, Scott, Franklin and Fayette Cos.	Heavy bedded, medium to coarse grained, somewhat crystalline limestone. Though it is probably the highest in carbonate content of any member of the Cynthiana formation, it is not thought to be high enough to classify as a pure limestone. In the southern Blue Grass it is a far more argillaceous rock.
Devil's Hollow fm.	Up to 25	Inner Blue Grass area. Small areas in Woodford and Franklin Cos.	It is composed of two types of limestone. Slightly more than the upper half is a compact limestone containing many small calcite crystals and stringers. It may approach a pure limestone. The lower part is a porous, coarsely crystalline, fossiliferous, massive, light grey limestone. It is an impure limestone.
Woodburn fm.	Up to 40	Inner Blue Grass area in Franklin, Scott, Bourbon, Woodford, Fayette and Jessamine Cos.	A crystalline, somewhat argillaceous limestone with an unusually high phosphorus content. It is impure limestone in the main.
Brannon fm.	15 - 20 Up to 30 locally.	Inner Blue Grass area in Franklin, Scott, Bourbon, Woodford, Jessamine, Fayette and Clark Cos.	Fine grained, siliceous, gnarly limestone with much shale in the lower part. On weathering it gives rise to a conspicuous zone of chert debris. It does not ordinarily carry chert nodules as such. All of the limestone is an impure limestone.

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER
Benson ls.	40 - 75	Inner Blue Grass area in Harrison, Bourbon, Scott, Fayette, Franklin, Anderson, Woodford, Mercer, Jessamine, Clark, Garrard and Boyle Cos.	Fine to coarsely crystalline, light gray to dark gray, fossiliferous, argillaceous limestone. It often contains thim partings of shale. Although some of the better beds may contain as high as 90% or higher of carbonates, the entire formation is an impure limestone. It becomes finer and harder in its southern extent.
Cornishville ls.	6 - 8	Perryville area as shown on map, Fig. 2	Crystalline, fossiliferous, gray limestone. It is mainly an impure limestone.
Salvisa ls.	15 max.	Perryville area as shown on map, Fig. 2	A compact dove gray to dark gray-black limestone often dotted with small calcite crystals (birdseye ls.). Much of it approaches high-calcium limestone. Locally it is soft and argillaceous.
Faulconer ls.	20 max.	Perryville area as shown on map. Fig.2	A porous, coarsely crystalline, light gray, massive limestone. It is mainly an impure limestone. The weathering of this formation produces much fossiliferous chert indicating that it has a considerable silica content.
Jessamine ls.	75 - 80	Inner Blue Grass area in Harrison, Nicholas, Bourbon, Scott, Franklin, Woodford, Fayette, Clark, Jessamine, Mercer, Madison, Garrard and Boyle Cos.	Fine to coarsely crystalline, light gray to dark gray, fossiliferous, argillaceous limestone. It often contains thin partings of shale. It is mainly an impure limestone.
Logana fm.	30 - 35	Inner Blue Grass area in Bourbon, Scott, Franklin, Woodford, Fayette, Clark, Jessamine, Mercer, Boyle and Garrard Cos.	Very similar to the Jessamine formation.
Curdsville fm.	20 max.	Inner Blue Grass area in Franklin, Woodford, Fayette, Clark, Jessamine, Mercer, Boyle, and Garrard Cos.	Coarsely crystalline, medium to heavy bedded, gray limestone with much light gray chert. It is mainly impure limestone.
Tyrone ls.	60 - 90	Inner Blue Grass area. Along the Ky. River and its tributaries in Franklin, Anderson, Woodford, Mercer, Boyle, Garrard, Jessamine, Fayette, Clark and Madison Cos.	Gray, dove, or cream colored compact limestone. On breaking small facets of coarsely crystalline calcite often spot the surface. On weathering the surface becomes white in which the darker facets are conspicuous giving rise to the name "Birdseye Limestone". One or more beds of green, bentonitic clay occur in the upper part and some of the limestone beds locally may contain this clay as im-

FORMATION	THICKNESS (in feet)	DISTRIBUTION (referred to map) Fig. 2	CHARACTER (continued)
			purities. Much of this formation is impure limestone and part is pure limestone, some of which may be high-calcium limestone.
Oregon fm.	15 - 35	Inner Blue Grass area. Along the Ky. River and its tributaries in Franklin, Anderson, Woodford, Mercer, Boyle, Garrard, Jessamine, Madison, Fayette and Clark Cos.	Gray, cream, or buff, fine grained magnesian limestone. Most of it is pure magnesian limestone. Some beds are impure magnesian limestone but all are high in total carbonates. Some beds contain enough $MgCO_3$ and $CaCO_3$ to be classed as pure dolomites, but none are thought to contain enough $MgCO_3$ to classify as a high-magnesian dolomite. Some beds may even be high-calcium limestone.
Camp Nelson ls.	300 is max. exposed above drainage.	Inner Blue Grass area. Along the Ky. River and its tributaries in Anderson, Woodford, Mercer, Boyle, Garrard, Jessamine, Madison, Fayette and Clark Cos.	Limestone composed of irregular patches and ramifications of granular rock of the Oregon type, interpreted as branching fucoids and presumably algal in origin, distributed through a matrix of compact limestone of the Tyrone type. On weathering, the surface becomes honeycombed. Like the Tyrone limestone, most of it is an impure limestone, though some of it may be a pure limestone but not a high-calcium limestone.

SUMMARY OF THE DISTRIBUTION OF THE CARBONATE ROCK CLASSES IN KENTUCKY

HIGH-CALCIUM LIMESTONE: The Ste. Genevieve and Renault-Paint Creek (Gasper) formations contain quantities of potential industrial limestone. These two formations often contain high-calcium limestone in ledges up to 20 feet thick and ledges 30 feet thick are present in some places. Investigations indicate especially favorable thicknesses of the Ste. Genevieve limestone in Caldwell County and vicinity, and of the Renault-Paint Creek (Gasper) limestone from Warren County northwest to Caldwell County. Ledges only slightly less thick are present throughout most of the rest of their outcrop areas. East and south of Morehead, Rowan County, a 14½ foot thick, massive, white, oolitic ledge of the upper Gasper (Paint Creek) has given consistently good analyses. Favorable tests of the Ste. Genevieve and/or the Gasper formations (boundaries undetermined) were obtained in the vicinities of Carter City and Lawton in Carter County, Morehead in Rowan County, Wrigley in Morgan County, Stanton in Powell County, Ravenna in Estill County, Beattyville in Lee County, Mt. Vernon in Rockcastle County, Somerset and Tateville in Pulaski County, Monticello in Wayne County, Albany in Clinton County, Glasgow in Barren County, Upton and Ringyville in Hardin County, Irvington in Meade County, Bowling Green in Warren County, Franklin in Simpson County, Russellville and Auburn in Logan County, Elkton in Todd County, Princeton and Fredonia in Caldwell County and Marion in Crittenden County. Analyses are insufficient for the Pine Mountain area. Since the Ste. Genevieve and the Gasper formations can be and often are quarried together in the same site, they are potentially great producers of industrial limestones both for construction purposes and for chemical uses. For reports of chemical analysis of the Ste. Genevieve and/or Renault-Paint Creek (Gasper) limestones see Tables VI through XXX.

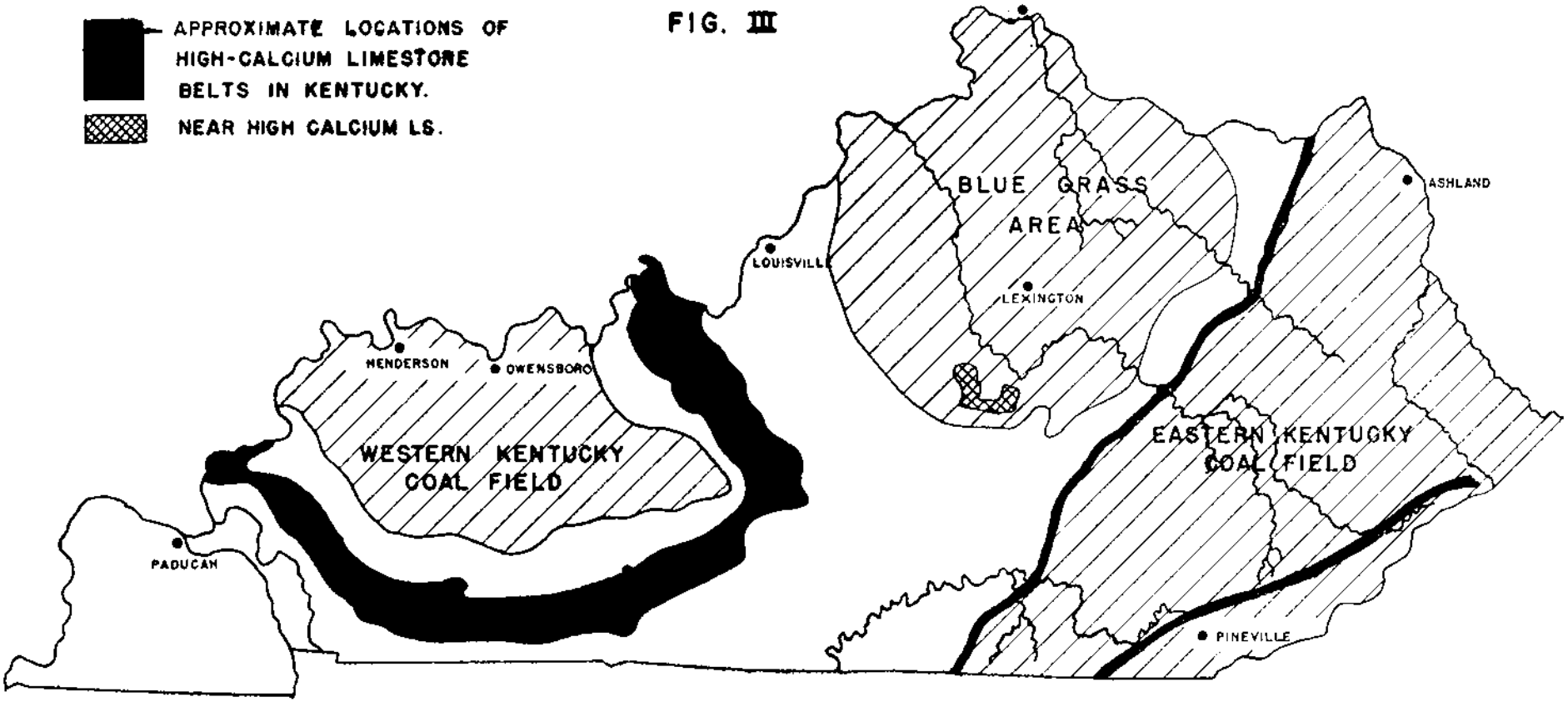
In Boyle and Mercer Counties the Perryville formation (Benson) contains near high-calcium limestone in thicknesses up to 20 feet. This limestone is also used extensively for construction purposes. For report of chemical analysis see Table XXII. Limited thicknesses of high-calcium limestone are present in the outcrops of the Renault and of the Paint Creek formations where they occur separately. Locally the Golconda and Glen Dean formations may also contain high-calcium limestone, but in what thickness is not known. Present investigations indicate no other formations in which high-calcium limestone may be present in any considerable thicknesses.

HIGH-MAGNESIUM DOLOMITE: Such rocks are not known to outcrop in any considerable thickness in Kentucky. However, carbonate rocks containing a high percentage of $MgCO_3$ are present in some of the formations. The Laurel dolomite in Oldham, Jefferson, Bullitt and Nelson Counties averages up to 33% $MgCO_3$. The Oregon formation, present along the Kentucky River in Woodford, Jessamine, Mercer, Garrard, Madison and Fayette Counties, averages up to 20% $MgCO_3$ within one quarry site. Lesser percentages of $MgCO_3$ are present in beds of several other formations. For reports of chemical analysis of the Laurel dolomite and the Oregon formation see Tables XXXII and XXXIII.

CARBONATE ROCKS WHOSE TOTAL CARBONATES EXCEED 95% (excluding high-calcium limestone and high-magnesium dolomite): These rocks include the classes Pure Limestone (excluding High-Calcium Limestone); Pure Dolomite (excluding High-Magnesium Dolomite) and Pure Magnesian Limestone. Such rocks are present in some quantities in many formations. They are most often found associated with the high-calcium limestones in the formations named. They occur in considerable thicknesses in the Laurel dolomite, most of the Oregon formation, and at least locally in the Tyrone and Camp Nelson formations. For reports of chemical analysis of the Tyrone formation and Camp Nelson formation see Tables XXXIV and XXXV.

IMPURE LIMESTONE, IMPURE MAGNESIAN LIMESTONE, AND IMPURE DOLOMITE: The occurrences of such rocks are so many, widespread and varied that it is impractical to discuss them in this report.

FIG. III


APPROXIMATE LOCATIONS OF HIGH-CALCIUM LIMESTONE BELTS IN KENTUCKY.
NEAR HIGH CALCIUM LS.
BLUE GRASS AREA
LOUISVILLE
LEXINGTON
ASHLAND
HENDERSON
OWENSBORO
WESTERN KENTUCKY COAL FIELD
EASTERN KENTUCKY COAL FIELD
PADUCAH
PINEVILLE

in the formations named. They also occur in considerable thicknesses in the Laurel dolomite, most of the Oregon formation, and at least locally in the Tyrone and Camp Nelson formations. For reports of chemical analysis of the Tyrone formation and Camp Nelson formation see Tables XXXIV and XXXV.

IMPURE LIMESTONE, IMPURE MAGNESIAN LIMESTONE, AND IMPURE DOLOMITE: The occurrences of such rocks are so many, wide spread and varied that it is impractical to discuss them in this report.

Table VI
STE.GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Standard Slag and Stone Co. Quarry, 1½ miles west of Carter City, Carter Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 99-110	1	1.32%	0.28%	97.22%	0.13%
87-99		Shale			
81-87	2	6.76%	0.10%	92.03%	0.74%
80-81		Shale			
70-80	3	24.02%	0.50%	73.49%	0.09%
69-70		Shale			
53-69	4	5.54%	0.58%	92.87%	0.34%
8-53	5	13.24%	1.18%	80.45%	4.80%
0-8	6	15.54%	0.72%	78.34%	4.71%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table VII
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Standard Slag and Stone Co. Quarry, Lawton, Carter County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 17-21	4	1.24%	0.40%	98.02%	0.34%
- 14-17	3	3.20%	0.54%	96.07%	0.19%
- 10-14	2	1.88%	0.20%	97.82%	0.10%
- 0-10	1	0.64%	0.30%	98.60%	0.46%
Weighted Average		1.37%	0.32%	97.98%	0.33%

Report by H. E. Roerk of Louisville Cement Company

Table VIII
GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Jones Quarry, 8 miles east of Morehead, Rowan County, Kentucky

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 6-20	1	1.92%	0.60%	96.50%	0.59%
0-6	2	8.04%	0.78%	90.00%	0.86%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table IX
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Lee Clay Products Co. Quarry, 5 miles northwest of Wrigley, Morgan Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 20	1	1.10%	0.24%	97.32%	1.34%
- .	2	0.74%	0.22%	97.90%	1.14%
- .	3	0.72%	0.32%	98.10%	0.86%
- .	4	0.44%	0.28%	98.30%	0.98%
- .	5	0.80%	0.14%	98.30%	0.76%
- 0	6	0.54%	0.12%	98.30%	1.04%
Weighted Average		0.63%	0.20%	98.18%	1.00%

Report by H. H. Roerk of Louisville Cement Co.

Table X
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Old W. P. A. Quarry, southeast of Stanton, Powell County, Kentucky

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
26-28	1	1.10%	1.54%	86.63%	10.13%
-19-26	2	0.68%	0.46%	98.41%	0.45%
- 9-19	3	0.64%	0.36%	98.61%	0.39%
- 2- 9	4	0.70%	0.50%	98.21%	0.59%
- 0- 2	5	0.62%	0.20%	98.02%	1.16%
Weighted Average of bottom four samples		0.66%	0.41%	98.40%	0.53%

Report by H. H. Roerk of Louisville Cement Co.

Table XI
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Highway cut between Ravenna and Beattyville, Estill Co., Kentucky

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 42	8	1.22%	0.18%	97.51%	1.09%
- .	7	1.30%	0.36%	97.51%	0.83%
- .	6	1.46%	0.42%	96.47%	1.65%
- .	5	0.74%	0.40%	97.71%	1.15%
- .	4	0.54%	0.24%	98.10%	1.12%
- .	3	0.60%	0.36%	97.90%	1.14%
- .	2	0.82%	0.44%	97.32%	1.42%
- 16	1	0.88%	0.18%	98.30%	0.64%
- 0-10	X	0.80%	0.26%	98.30%	0.64%
Composite		0.94%	0.32%	97.60%	1.14%

Report by H. H. Roerk of Louisville Cement Co.

Table XII
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Ky. Stone Co. Quarry, Yellow Rock, Lee Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 46	11	3.28%	0.32%	95.68%	0.72%
- .	10	0.84%	0.44%	97.23%	1.49%
- .	9	1.66%	0.48%	97.03%	0.83%
- .	8	2.00%	0.60%	96.44%	0.96%
- .	7	0.92%	0.32%	97.43%	1.13%
- .	6	1.40%	0.16%	97.43%	1.01%
- .	5	0.74%	0.42%	98.60%	0.24%
- 18	4	0.60%	0.54%	98.41%	0.45%
--------10 feet of shale ----------					
8	3	6.60%	0.44%	92.12%	0.84%
.	2	5.04%	0.44%	93.93%	0.59%
0	1	4.78%	0.46%	94.48%	0.28%
Composite of zones 4 to 11		2.48%	0.40%	96.44%	0.68%

Report by H. H. Roerk of Louisville Cement Co.

Table XIII

STE. GENEVIEVE AND RENAULT-PAINT CREEK LIMESTONES
REPORT OF CHEMICAL ANALYSIS

Kentucky Stone Co. Quarry, 1 mile west of Mt. Vernon, Rockcastle Co., Kentucky

	Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
RENAULT-PAINT CREEK FORMATION	135	24	3.65%	0.71%	94.04%	1.64%
	134	23	3.25%	1.23%	92.41%	3.73%
	124-133	22	8.03%	1.56%	85.43%	3.53%
	113-123	21	11.14%	1.40%	86.54%	0.66%
	108-112	20	5.55%	1.26%	91.26%	0.33%
	104-107	19	2.31%	1.13%	95.21%	0.58%
	101-103	18	2.83%	1.54%	92.35%	0.50%
	97-100	17	2.41%	1.23%	92.26%	0.66%
	87-96	16	2.72%	0.68%	94.28%	1.01%
	83-86	15	3.15%	0.79%	94.15%	4.49%
	79-82	14	3.98%	3.47%	73.72%	18.01%
	64-78	13	2.95%	0.79%	91.19%	4.59%
Levias	61-63	12	1.98%	0.85%	93.71%	5.82%
	55-60	11	1.67%	0.71%	96.17%	3.24%
	51-54	10	2.42%	0.82%	95.60%	0.79%
	46-50	9	2.24%	0.66%	96.67%	1.14%
STE. GENEVIEVE FORMATION Fredonia	35-45	8	5.10%	1.03%	90.98%	2.33%
	30-34	7	3.25%	0.69%	95.39%	1.04$
	23-29	6	3.98%	1.55%	94.30%	Trace
	17-22	5	4.56%	1.23%	94.10%	Trace
	10-16	4	1.34%	0.71%	98.22%	Trace
	7-9	3	2.59%	1.02%	97.10%	Trace
	2-6	2	4.70%	1.21%	96.16%	Trace
	1	1	3.22%	0.64%	95.10%	1.01%
			bottom of quarry			
	Average		3.71%	1.12%	92.76%	2.30%

Chemical analysis by Highway Materials Research Laboratory - Lexington, Kentucky

The lower 34 feet averages 95.77% $CaCO_3$ and the lower 63 feet averages 95.3% $CaCO_3$.

Table XIV
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Somerset Stone Co. Quarry, 1 mile east of Somerset, Pulaski Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 54-58	1	1.40%	0.56%	97.10%	----
- 48-54	2	1.40%	0.86%	96.00%	0.88%
- 38-48	3	1.94%	0.76%	95.60%	1.57%
- 33-38	4	3.39%	0.32%	94.40%	1.66%
- 28-33	5	2.32%	0.54%	95.30%	1.11%
16-28	6	4.00%	0.92%	92.95%	1.64%
14-16	------Shale ----------				
6-14	7	8.00%	0.70%	83.05%	8.22%
0-6½	8	3.39%	0.42%	89.50%	6.01%
Weighted Average top 5 zones		2.07%	0.64%	95.63%	----

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XV
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Ky. Highway Dept. Quarry, Tateville, Pulaski Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 37-55	1	3.34%	0.58%	94.60%	0.20%
- 31-37	2	1.42%	0.40%	98.00%	0.05%
- 20-31	3	1.60%	0.44%	97.80%	-----
14-20	4	6.88%	1.18%	90.85%	0.16%
13-14	------Shale ----------				
8-13	5	2.18%	0.32%	97.50%	-----
0-8	6	5.72%	0.54%	92.30%	0.27%
Weighted Average top 3 zones		2.47%	0.51%	96.20%	-----

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XVI
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Bassett Products Co. Quarry, Monticello, Wayne Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 46-103	1-7	abandoned ledges, not tested			
43-46	8	4.94%	0.60%	82.97%	11.28%
40-43	9	6.54%	0.92%	84.50%	7.93%
- 34-40	10	1.50%	0.22%	95.25%	1.75%
- 30-34	11	2.06%	0.30%	96.64%	0.95%
- 27-30	12	2.20%	0.56%	96.50%	0.66%
20½-27	13	9.04%	1.30%	69.86%	19.73%
13-20½	14	1.88%	0.38%	96.70%	1.01%
0-13	15	0.94%	0.32%	97.02%	0.63%
Weighted Average bottom 2 zones		1.28%	0.34%	96.90%	0.77%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XVII
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Huddleston Quarry, 2 miles N. of Albany, Clinton Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
82½-87½	1	4.40%	1.42%	86.00%	7.48%
- 77-82½	2	1.74%	0.56%	96.30%	1.12%
- 72-77	3	1.52%	0.56%	96.60%	1.08%
- 68-72	4	1.86%	0.58%	96.40%	1.03%
65-68	5	7.08%	0.26%	75.40%	16.73%
64-65		------Shale --------			
- 51-64	6	1.86%	0.68%	96.10%	1.31%
44-51	7	4.54%	0.64%	81.71%	12.33%
40-44	8	8.98%	0.66%	88.03%	1.48%
31-40	9	1.92%	0.48%	94.78%	1.48%
26-31	10	7.16%	2.34%	65.65%	24.39%
20-26	11	4.84%	0.50%	86.39%	7.21%
19-20		------- Shale -------			
- 7-19	12	1.70%	0.50%	96.28%	1.09%
6-7		------- Shaly Stone -------			
0-6	13	2.54%	1.06%	94.60%	1.69%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XVIII
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
B. H. Jackson Quarry, 4½ miles northeast
of Glasgow, Barren County, Kentucky

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
45–50	1	1.58%	0.42%	89.95%	7.09%
40–45	2	1.84%	1.44%	93.70%	2.39%
37–40	3	-----	-----	-----	-----
34⅓–37	4	-----	-----	-----	-----
– 25⅓–34⅓	5	0.98%	0.24%	95.88%	2.64%
– 20–25⅓	6	1.56%	0.64%	94.70%	2.83%
19–20	7	-----	-----	-----	-----
16–19	8	-----	-----	-----	-----
14–16	9	-----	-----	-----	-----
10–14	10	1.78%	0.90%	85.35%	11.37%
5–10	11	7.34%	1.68%	75.71%	15.21%
0–5	12	3.40%	0.60%	94.03%	1.37%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XIX
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Ky. Stone Co. Quarry, 1 mile south
of Upton, Hardin County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
– 20–24	1	2.18%	0.56%	95.73%	1.37%
– 13–20	2	3.00%	1.04%	80.03%	15.74%
– 8–13	3	2.04%	0.70%	95.00%	1.87%
– 2–8	4	2.02%	0.62%	95.75%	0.76%
– 0–2	5	3.08%	0.78%	94.60%	1.51%
Weighted Average		2.43%	0.76%	91.08%	5.52%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky

Table XX
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
H. L. Shearer Quarry, 4 miles northwest of Rineyville, Hardin County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 54-63	10	1.24%	0.90%	95.85%	1.29%
48-54	9	3.84%	1.00%	89.64%	5.40%
- 45-48	8	5.08%	0.36%	92.00%	2.50%
- 40-45	7	1.30%	1.14%	96.04%	1.15%
32-40	6	2.92%	0.84%	82.90%	13.30%
28-32	5	----	-----	-----	----
- 19-28	4	0.72%	0.56%	97.50%	1.07%
- 17-19	3	1.82%	0.40%	94.25%	1.56%
- 7-17	2	1.88%	0.58%	94.52%	2.06%
5-7		-----	-----	-----	----
- 0-5	1	0.98%	0.30%	97.38%	0.73%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXI
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
A. D. Wallace Quarry, 7 miles northeast of Irvington, Meade County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 31-39½	1	2.68%	0.36%	95.67%	1.07%
- 28-31	2	3.34%	0.18%	95.52%	0.15%
- 17-28	3	2.84%	0.38%	94.38%	2.00%
13-17	4	10.62%	0.68%	88.56%	0.07%
11-13	5	10.64%	1.58%	84.92%	2.19%
6-11	6	9.80%	1.18%	72.69%	15.76%
0-6	7	3.86%	0.88%	79.60%	15.62%
Weighted Average top 22½ feet		2.85%	0.35%	95.02%	1.40%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXII
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
W. W. Holman Quarry, 2 miles north of Bowling Green, Warren County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 32-40	1	1.16%	0.82%	95.30%	2.20%
- 14-32	2	1.54%	0.58%	95.00%	2.83%
- 10-14	3	1.80%	0.54%	95.10%	2.23%
4-10	4	4.76%	1.54%	88.60%	4.65%
0-4	5	1.38%	0.66%	96.10%	1.69%
Weighted Average of top 30 feet		1.47%	0.64%	95.1%	2.87%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXIII
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Harris & Crowden Quarry, 6 miles north of Franklin, Simpson County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
38-41	1	-----	----	----	----
32-38	2	4.70%	0.84%	94.01%	0.26%
28-32	3	9.20%	2.24%	79.00%	7.52%
23-28	4	2.94%	0.96%	92.95%	2.39%
$20\frac{1}{2}$-23	5	-----	----	-----	----
15-$20\frac{1}{2}$	6	6.64%	0.68%	92.34%	0.09%
- $10\frac{1}{2}$-15	7	1.62%	0.86%	95.59%	1.56%
8-$10\frac{1}{2}$	8	-----	----	----	----
- 0-8	9	2.50%	0.72%	95.00%	1.62%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXIV
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Scott Hall, Jr. Quarry, 1 mile northeast of Auburn, Logan County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 43-53	1	1.12%	1.18%	96.40%	1.21%
- 33-43	2	1.46%	0.44%	94.60%	3.28%
26-33	3	3.80%	0.30%	89.60%	6.20%
23-26	4	11.50%	1.04%	69.85%	17.24%
19-23	5	6.26%	1.28%	66.30%	26.00%
16-19	6	6.24%	0.38%	88.40%	4.90%
14-16	7	6.66%	0.60%	89.10%	2.43%
- 0-14	8	3.28%	0.44%	94.00%	1.67%
Weighted Average of top 20 feet		1.29%	0.81%	95.50%	2.25%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXV
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Ky. Stone Co. Quarry, ½ mile northeast of Russellville, Logan County, Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 25-31	1	2.12%	0.42%	95.68%	0.76%
- 19-25	2	3.46%	0.58%	86.47%	9.20%
10-19	3	4.10%	5.78%	81.75%	6.18%
4-10	4	3.84%	0.64%	86.50%	6.30%
0-4	5	7.42%	0.94%	76.40%	15.24%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXVI
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Stinson and Oldham Quarry, 1.4 miles east of Elkton, Todd County, Kentucky

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 39-50	1	2.32%	0.52%	95.02%	2.10%
37-39	2	3.68%	1.12%	89.36%	5.78%
28-37	3	4.42%	0.72%	74.40%	19.83%
25-28	4	7.52%	0.88%	84.39%	7.11%
24-25		----	shale	------	------
20-24	5	8.82%	0.80%	81.68%	8.53%
14-20	6	4.72%	0.46%	88.80%	5.92%
12⅓-14		----	shale	------	------
- 0-12⅓	7	1.68%	0.42%	95.00%	2.84%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXVIII
STE. GENEVIEVE LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Cedar Bluff Stone Co. Quarry, 2⅓ miles east of Princeton, Caldwell Co., Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
52⅓-55½	5	4.06%	0.78%	94.20%	0.73%
40⅓-52⅓	4	8.44%	0.46%	78.60%	11.39%
-32⅓-40⅓	3	3.78%	0.72%	94.59%	0.91%
28-32⅓	2	4.58%	0.70%	88.28%	5.28%
- 0-28	1	1.00%	0.40%	97.56%	0.26%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXVIII
STE. GENEVIEVE LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Wilford Baker Quarry, 2½ miles south of Fredonia, Caldwell Co., Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
45-55	1	3.40%	0.64%	93.60%	2.20%
42⅔-45		---------- shale ----------			
40-42⅔	2	3.48%	0.72%	89.11%	6.50%
36-40	3	1.74%	0.76%	95.01%	2.46%
33-36	4	3.82%	1.80%	70.80%	22.40%
- 30-33	5	1.62%	0.78%	95.10%	2.44%
-- 0-30	6	0.74%	0.42%	98.20%	0.33%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXIX
STE. GENEVIEVE AND/OR GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Turner Brother's Quarry, 4 miles southwest of Marion, Crittenden County, Ky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
- 18-24	6	2.48%	0.38%	97.02%	0.12%
- 16-18	5	0.94%	0.46%	98.42%	0.18%
-12⅔-16	4	2.96%	0.56%	95.95%	0.53%
- 6⅔-12⅔	3	0.88%	0.46%	98.22%	0.44%
- 4-6⅔	2	1.66%	0.56%	96.10%	1.64%
- 0-4	1	1.56%	0.46%	95.63%	2.27%
Weighted Average		1.90%	0.49%	96.95%	0.78%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky

Table XXX
STE. GENEVIEVE AND GASPER LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Chester Green Quarry, 8 miles northwest of Harlan, Harlan County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
140-166	1	5.12%	0.82%	86.81%	6.35%
137-140		----	----	----	----
- 131-137	2	1.44%	0.34%	96.64%	1.48%
- 108-131	3	2.18%	0.42%	94.00%	3.05%
101-108	4	14.10%	2.02%	80.57%	3.30%
81-101	5	5.48%	0.70%	88.99%	4.03%
78-81		---- shale ----		----	----
69-78	6	6.04%	0.48%	91.06%	1.73%
54-69	7	11.94%	0.96%	83.70%	2.22%
- 37-54	8	2.20%	0.34%	96.00%	0.35%
23-37	9	6.36%	0.76%	89.40%	1.20%
- 15-23	10	1.18%	0.22%	96.70%	1.70%
- 0-15	11	1.34%	0.26%	94.15%	3.73%
Weighted Average of Zones 10 and 11 (23 ft.)		1.26%	0.25%	95.04%	2.43%

Notice that Zone 3 represents 23 feet and Zone 8 represents 17 feet.

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXXI
PERRYVILLE LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Caldwell Stone Co. Quarry, 1 mile south of Danville, Boyle County, Kentucky.

Level	Zone	$CaCO_3$	$MgCO_3$	SiO_2	Iron Oxide	Alumina
51½-52½	1	68.9%	3.89%	23.00%	1.18%	3.02%
50-51½	2	79.0%	5.03%	10.24%	0.92%	3.98%
49-50	3	80.5%	5.90%	7.54%	2.85%	3.20%
48-49	4	84.8%	5.47%	6.00%	1.55%	1.73%
47-48	5	81.6%	4.20%	8.17%	1.18%	4.82%
46-47	6	84.6%	3.92%	6.28%	1.30%	4.36%
45-46	7	88.5%	3.33%	4.90%	0.80%	1.75%
44-45	8	86.9%	4.97%	4.55%	0.60%	0.90%
43-44	9	88.5%	3.25%	4.82%	0.67%	1.09%
42-43	10	94.2%	1.94%	2.40%	0.35%	0.49%
41-42	11	94.8%	1.86%	1.93%	0.28%	0.77%
40-41	12	95.7%	2.00%	1.48%	0.24%	0.56%
39½-40	13	87.1%	3.46%	6.40%	0.58%	1.82%
38½-39½	14	95.3%	1.10%	2.04%	0.30%	0.74%
37½-38½	15	93.8%	2.24%	2.35%	0.45%	0.81%
36½-37½	16	95.3%	1.86%	1.61%	0.30%	0.52%
35½-36½	17	94.3%	1.68%	1.94%	0.45%	0.57%
34½-35½	18	91.6%	1.86%	4.50%	0.30%	0.76%
33-34½	19	91.5%	2.53%	4.11%	0.37%	0.93%
32-33	20	94.6%	1.80%	2.28%	0.23%	0.73%
31-32	21	92.7%	1.89%	3.65%	0.33%	1.01%
30-31	22	86.1%	3.39%	6.23%	0.61%	1.91%
29-30	23	89.7%	3.32%	4.56%	0.48%	1.54%
28-29	24	86.6%	7.86%	6.68%	0.65%	1.19%
27-28	25	82.8%	7.45%	8.16%	0.67%	1.31%

Table XXXI - Continued

Level	Zone	$CaCO_3$	$MgCO_3$	SiO_2	Iron Oxide	Alumina
26-27	26	96.2%	1.56%	1.52%	0.23%	0.57%
25-26	27	91.9%	2.46%	3.06%	0.40%	0.98%
23½-25	28	92.7%	4.23%	1.88%	0.52%	0.60%
22½-23½	29	91.2%	4.99%	2.30%	0.50%	0.62%
21½-22½	30	87.7%	2.68%	7.50%	0.67%	1.19%
- 20½-21½	31	91.4%	3.76%	3.65%	0.47%	0.71%
- 19½-20½	32	93.4%	2.39%	2.72%	0.60%	0.70%
- 18½-19½	33	94.4%	2.89%	1.47%	0.40%	0.42%
- 17½-18½	34	94.3%	2.65%	2.02%	0.30%	0.48%
- 16-17½	35	96.1%	1.80%	1.85%	0.25%	0.59%
- 14½-16	36	97.6%	1.44%	1.04%	0.18%	0.56%
- 13½-14½	37	94.9%	3.57%	1.27%	0.30%	0.49%
- 12½-13½	38	95.5%	1.96%	1.64%	0.33%	0.64%
- 11½-12½	39	-----	-----	-----	-----	-----
- 10-11½	40	93.8%	1.96%	2.64%	0.30%	0.22%
- 9-10	41	95.3%	1.78%	1.86%	0.25%	0.49%
- 8-9	42	95.3%	2.52%	1.24%	0.36%	0.46%
- 7-8	43	95.3%	2.95%	0.84%	0.30%	0.62%
- 6-7	44	96.1%	2.18%	0.92%	0.35%	0.60%
- 5-6	45	96.7%	1.80%	0.81%	0.33%	0.64%
- 4-5	46	97.0%	2.34%	0.52%	0.25%	0.45%
- 3-4	47	94.5%	3.80%	0.60%	0.38%	0.56%
- 2-3	48	96.9%	2.27%	0.26%	0.30%	0.38%
- 1-2	49	94.3%	2.92%	1.74%	0.33%	0.46%
- 0-1	50	92.8%	3.51%	2.63%	0.38%	0.74%
Average of zones 31 to 50		95.03%	2.54%	1.58%	0.34%	0.54%

Table XXXII
LAUREL DOLOMITE
REPORT OF CHEMICAL ANALYSIS
Jefferson Co. Quarry, Avoca, Jefferson County, Kentucky.

LAUREL DOLOMITE

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
29-33	7	6.19%	1.12%	68.82%	23.78%
24-28	6	6.34%	1.14%	69.99%	23.01%
19-23	5	3.96%	0.96%	57.37%	39.37%
12-18	4	2.39%	1.78%	59.57%	37.24%
10-11	3	1.36%	2.22%	61.37%	35.09%
4-9	2	3.72%	1.90%	59.10%	35.79%
0-3	1	5.96%	2.76%	55.89%	35.40%
bottom of quarry					
Average		4.355%	1.631%	61.73%	32.91%

Chemical analysis by Highway Materials Research Laboratory,

Lexington, Kentucky

Table XXXIII
OREGON MAGNESIAN LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Central Rock Co. Quarry, Clays Ferry, Fayette County, Kentucky.

Level	Zone	$CaCO_3$	$MgCO_3$	SiO_2	Iron Oxide	Alumina
26.5-27.5	26	71.0%	26.2%	1.80%	0.34%	0.30%
25.5-26.5	25	69.6%	27.2%	2.10%	0.40%	0.50%
24.5-25.5	24	78.0%	19.0%	2.48%	0.35%	0.61%
23-24.5	23	72.8%	24.5%	2.38%	0.37%	0.59%
22-23	22	69.1%	27.2%	2.66%	0.35%	0.77%
20.5-22	21	70.0%	25.7%	2.60%	0.40%	0.90%
19.5-20.5	20	73.1%	23.9%	2.44%	0.30%	0.50%
18.5-19.5	19	73.0%	24.7%	2.23%	0.29%	0.41%
17-18.5	18	67.4%	28.3%	3.24%	0.43%	0.57%
16-17	17	71.6%	34.7%	3.10%	0.38%	0.66%
15-16	16	82.2%	13.8%	2.52%	0.30%	0.50%
14-15	15	92.8%	5.1%	1.34%	0.21%	0.34%
13-14	14	88.2%	9.3%	1.55%	0.31%	0.40%
12-13	13	90.4%	6.8%	1.29%	0.35%	0.45%
11-12	12	81.7%	15.3%	2.25%	0.23%	0.60%
10-11	11	79.6%	17.3%	2.28%	0.29%	0.57%
9-10	10	80.4%	16.6%	2.26%	0.26%	0.56%
8-9	9	76.5%	18.2%	2.46%	0.50%	0.45%
7-8	8	64.6%	30.3%	3.65%	0.48%	1.24%
6-7	7	75.7%	21.9%	2.06%	0.25%	0.67%
5-6	6	80.2%	17.6%	2.03%	0.30%	0.64%
4-5	5	93.1%	5.0%	1.09%	0.22%	0.67%
3-4	4	63.0%	32.2%	3.32%	0.50%	0.94%
2-3	3	64.1%	31.1%	3.14%	0.48%	1.14%
1-2	2	82.6%	9.9%	4.06%	0.47%	1.70%
0-1	1	96.7%	2.2%	1.09%	0.21%	0.54%
Average		77.21%	19.73%	2.36%	0.345%	0.547%

Total Carbonate Average - 96.94%

OREGON FORMATION

Table XXXIV
TYRONE LIMESTONE
REPORT OF CHEMICAL ANALYSIS
H. H. Given Quarry, 11 miles southeast of Lexington, Fayette County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
52-57	1	2.18%	0.76%	94.33%	2.53%
51-52		---- shale -----		-----	-----
41-51	2	2.48%	0.56%	93.46%	2.03%
34-41		---- shale -----		-----	-----
27-34	3	11.94%	1.54%	82.43%	2.75%
20-27	4	4.40%	1.02%	88.23%	3.96%
10-20	5	3.87%	0.62%	87.72%	6.02%
3-10	6	3.84%	0.62%	91.28%	4.06%
0-3	7	3.56%	0.58%	92.05%	3.74%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

Table XXXV
CAMP NELSON LIMESTONE
REPORT OF CHEMICAL ANALYSIS
Levie Goff Quarry, 8 miles southwest of Winchester, Clark County, Kentucky.

Level	Zone	Insol. Res.	R_2O_3	$CaCO_3$	$MgCO_3$
$20\frac{1}{2}$-$31\frac{1}{2}$	1	5.32%	0.86%	89.50%	4.28%
11-$20\frac{1}{2}$	2	2.92%	0.62%	89.00%	7.00%
0-11	3	2.22%	0.60%	88.30%	8.52%
Weighted Average		3.51%	0.70%	88.94%	6.58%

Total Carbonate Average - - 95.52%

Chemical analysis by Highway Testing Laboratory, Frankfort, Kentucky.

CONDITIONS FAVORING MINING OF LIMESTONE IN JOHNSON COUNTY, KENTUCKY

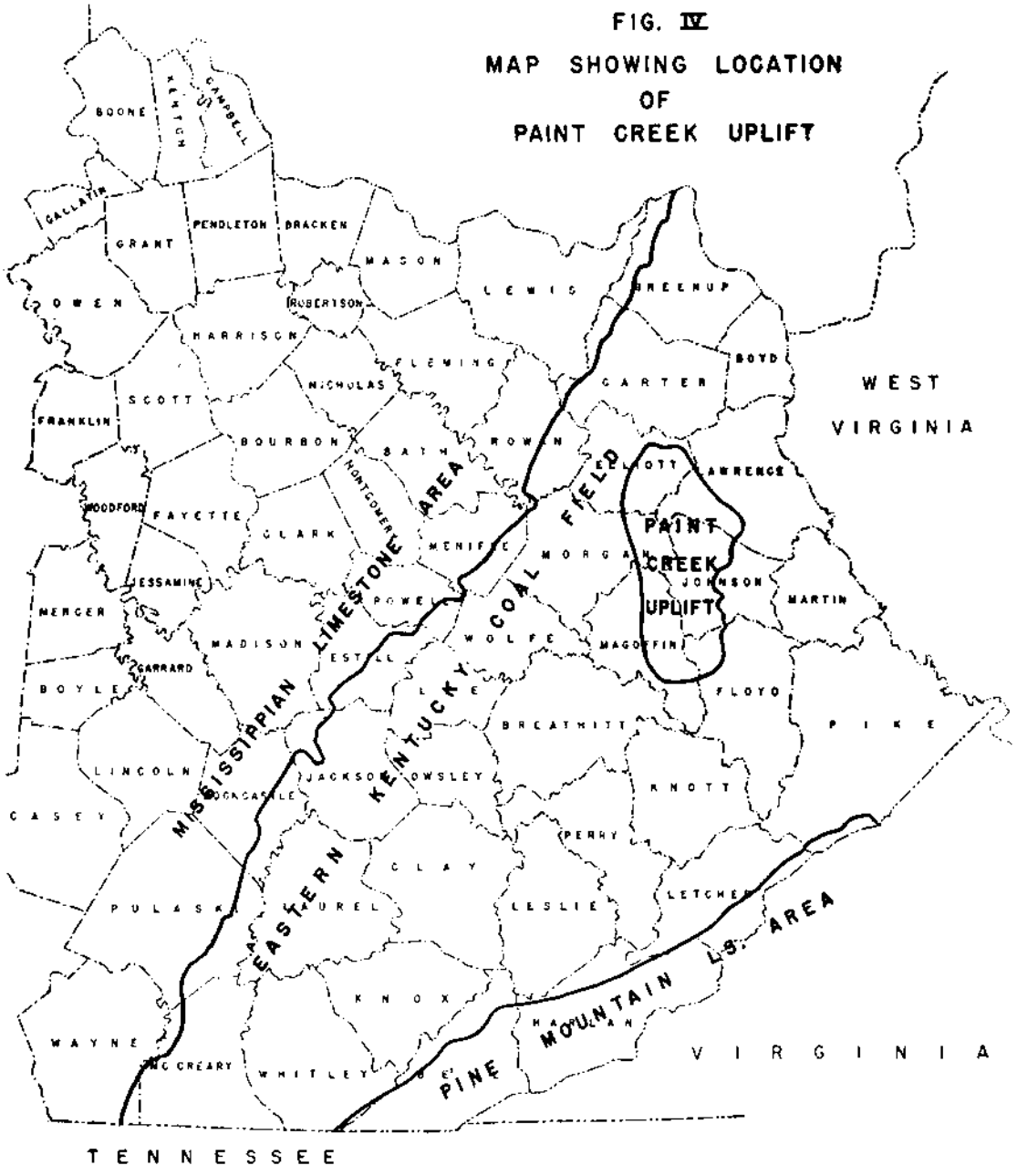
Well logs indicate that limestone is present in Johnson County at depths of as little as 190 feet. Limestone is now mined profitably near Lexington, Kentucky at depths exceeding 250 feet. The limestone to be reached at these depths in Johnson County is the so-called "Big Lime" which includes the Renault-Paint Creek (Gasper), Ste. Genevieve and St. Louis formations. Thicknesses vary from 50 to 160 feet but are usually in the neighborhood of 100 feet. It is thought that mineable thicknesses of limestone are present in the Renault-Paint Creek and St. Genevieve formations. Though not tested it is expected that it is of a quality that could be used for construction purposes and probably for chemical uses, as the formations involved include those which over a wide area have important thicknesses of the purer limestones. Its quality, depth and overburden conditions should be tested by taking cores.

In general the area of least depths centers about nine miles west of Paintsville and the depths increase in all directions. At Paintsville the depths are nearer 400 feet, measured from creek bottoms to the top of the "Big Lime". This limestone is brought near the surface by the Paint Creek Anticline, a faulted uplift with a general north and south axis. (Fig. 4)

The importance of this shallow occurrence due to structural conditions is that it is in a region essentially devoid of limestone in surface outcrop. Limestone must be hauled from many miles for construction and other purposes. It is thought that the possibilities of mining limestone here is certainly worth investigation by commercial producers.

FIG. IV

MAP SHOWING LOCATION
OF
PAINT CREEK UPLIFT



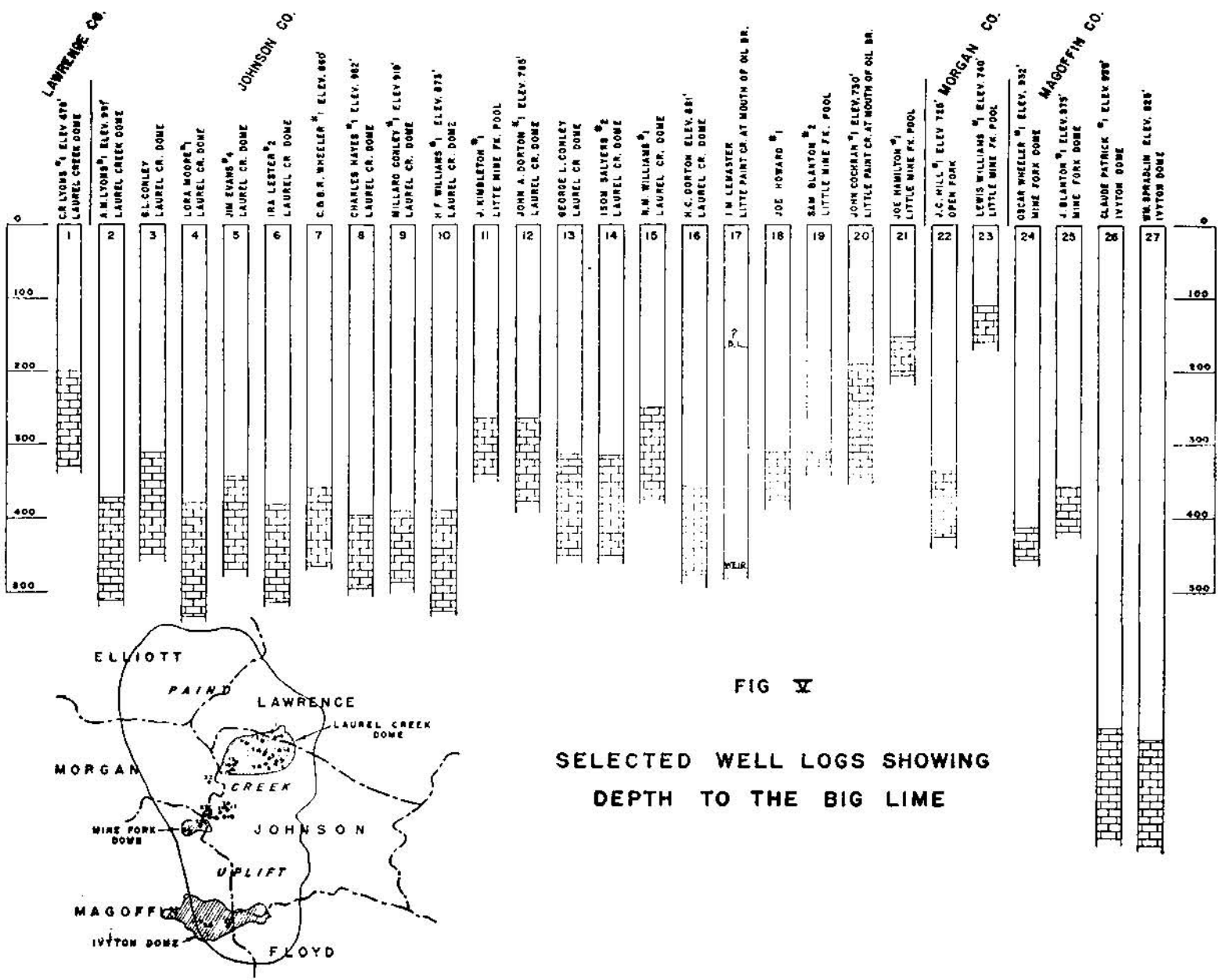


FIG V

SELECTED WELL LOGS SHOWING DEPTH TO THE BIG LIME

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