University of Kentucky
College of Arts and Sciences

KENTUCKY GEOLOGICAL SURVEY
Lexington

In Cooperation With

AGRICULTURAL AND INDUSTRIAL
DEVELOPMENT BOARD OF KENTUCKY
Frankfort

SERIES IX

REPORT OF INVESTIGATIONS — NO. 5

Recent Investigatons of Silica Sands of Kentucky

By

PRESTON McGRAIN

Printed by the Authority of the State of Kentucky

LEXINGTON, KENTUCKY
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ARTHUR C. McFARLAN, Director

DANIEL J. JONES, State Geologist

AGRICULTURAL AND INDUSTRIAL DEVELOPMENT BOARD OF KENTUCKY

GEORGE W. HUBLEY, JR., Executive Director

PHIL M. MILES, Chief, Maps and Minerals Division

LETTER OF TRANSMITTAL

September 25, 1952

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

Dear Dean White:

The Kentucky Geological Survey is publishing Report of Investigations No. 5, *Recent Investigations of Silica Sands of Kentucky,* by Preston McGrain, a preliminary report of a continuing investigation. High-grade glass sands have been found, though as yet specifications for first quality (optical glass) have not been met. Materials of the more common types are rather widespread. Isolated analyses are only a beginning. The essential thing is to fit these into the geological pattern of the state and obtain a concept of regional distribution.

Sincerely,

ARTHUR C. MCFARLAN
Director

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ILLUSTRATION

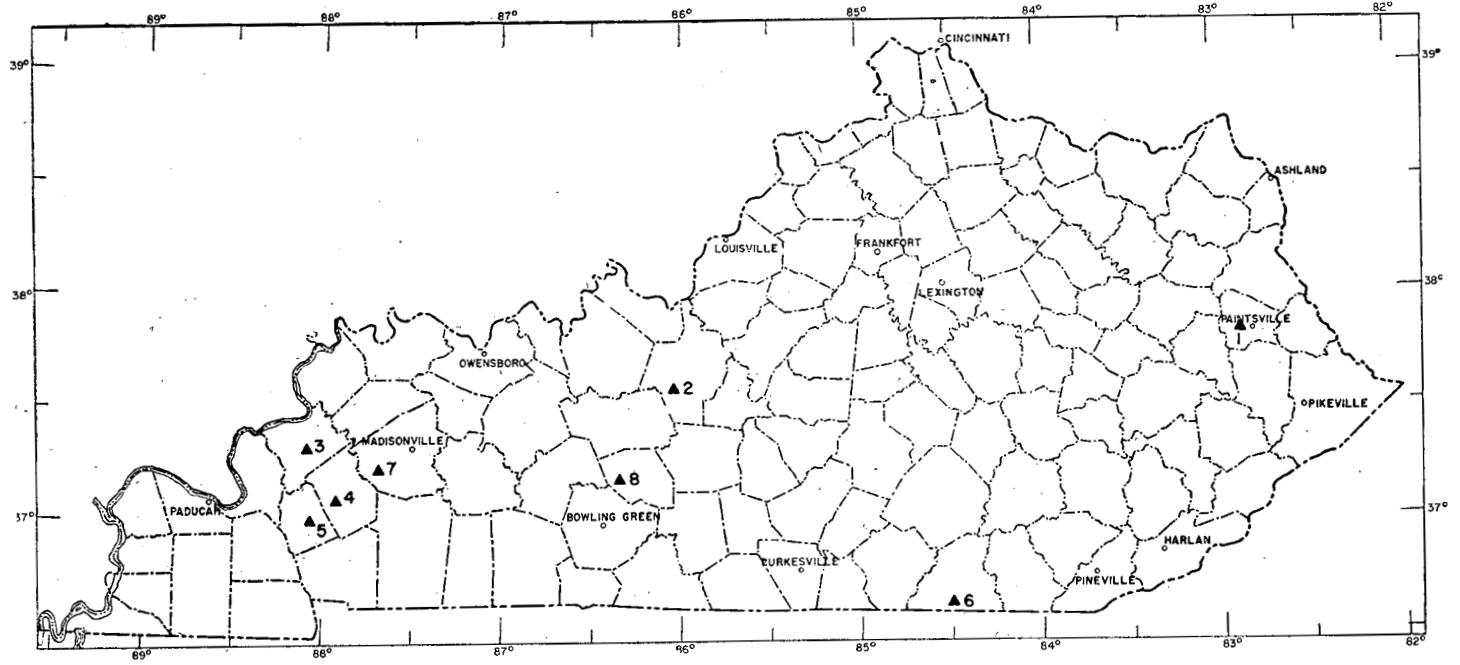
INTRODUCTION

Expanded geological and mineral resources investigations by the Kentucky Geological Survey in cooperation with the Agricultural and Industrial Development Board of Kentucky has created a renewed interest in special sands and sandstones for industrial purposes. The sands discussed herein are primarily those used for glass manufacture but also may have economic value for foundry purposes, filter beds, abrasives, sand blasting, engine sand, plaster, and the like. Industrial expansion and the erection of new glass manufacturing plants has given this investigation added impetus. Since silica or quartz sands constitute at least 70 percent of the raw material used in the manufacture of glass the freight cost is an important item. Thus, the proximity of raw materials must be considered.

Some information is already available on sands and sandstones of Kentucky which were reported by Richardson (1920 and 1927) and McFarlan (1943). None of the deposits described by these older reports are being used currently for glass sand. Santmyers (1931) and Ries (1949) have described properties, requirements, and specifications of these special sands.

The present report is the result of recent investigations of this resource (fig. 1). It includes a review of some of the outcrops reported on by other workers and analytical data made available by various interested industries and individuals. Specific credit will be noted elsewhere in the text.

Silica sand has been defined as a material composed of grains of silicon dioxide which has been derived from quartz. In Kentucky it is found in both unconsolidated sand (Tertiary and Quaternary) and indurated sandstone formations (Mississippian and Pennsylvanian). The sands are found principally in the Gulf Embayment portion of extreme southwestern Kentucky and along the discharge route of glacial meltwaters in the Ohio River Valley. Sandstones which are considered potential glass sands are found in the Chester series (Mississippian) and the Pottsville group (Pennsylvanian). The Tip Top sands of Hardin and Meade Counties, which were once exploited to some extent, were not sampled in the current investigation because they lie almost entirely within the confines of the Fort Knox Military Reservation and are thus considered unavailable for commercial development at the present time.



LOCATION MAP
SHOWING SOURCES OF SANDS ANALYZED

FIGURE 1

REQUIREMENTS AND SPECIFICATIONS

Sand used in the manufacture of different grades of glass is called glass sand. In general, the specifications are rather exacting, being high in silica and low in iron. Iron oxide, yielding amber, yellow, or green tints in the finished glass, is regarded as the chief impurity. Certain physical properties, particularly grain size, are also desired. In order to facilitate mixing and to maintain uniform melting the grains should be fairly uniform in size; unusually large particles or excessive amounts of fines cannot be used. The degree of angularity apparently makes little difference to the user. Chemical and physical properties outlined by Santmyers (1931, p. 8) and Ries (1949, pp. 972-973) are shown in tables 1 and 2.

TABLE 1

Chemical Specifications of Glass Sand (Percent Composition)

Qualities	SiO_2 (Min.)	Al_2O_3 (Max.)	Fe_2O_3 (Max.)	CaO+MgO (Max.)
First quality – optical glass	99.8	0.1	0.02	0.1
Second quality – flint-glass containers and tableware	98.5	0.5	0.035	0.2
Third quality – flint glass	95.0	4.0	0.035	0.5
Fourth quality – sheet glass, rolled and polished plate	98.5	0.5	0.06	0.5
Fifth quality – sheet glass, rolled and polished plate	95.0	4.0	0.06	0.5
Sixth quality – green glass containers and window glass	98.0	0.5	0.3	0.5
Seventh quality – green glass	95.0	4.0	0.3	0.5
Eighth quality – amber glass containers	98.0	0.5	1.0	0.5
Ninth quality – amber	95.0	4.0	1.0	0.5

TABLE 2

Physical Specifications of Glass Sand (Grain Size)

Passing Sieve	Retained on Seive	Percentage
No. 20		100
No. 20	No. 40	40-60
No. 40	No. 60	30-40
No. 60	No. 100	10-20
No. 100		0-5

It should be kept in mind that different manufacturers and individual purchasers have definite specifications. Those outlined above are general.

ANALYSES

Since the average sandstone being investigated runs about 95 percent or more in silica, and since alkalies and alumina are neither critical nor undesired constituents, most of the chemical work was directed to determinations of iron content.

SAND NO. 1:

Collected by R. E. Hauser and G. R. Thomas, Kentucky Geological Survey, from an exposure of Lee sandstone in a cut on Kentucky Highway 172 near Staffordsville, Johnson County. About 50 feet of indurated sandstone is exposed in this road cut. Analyses made by the Corning Glass Works, Corning, New York,[1] indicate that 0.11 percent Fe_2O_3 and 3.1 percent nonsilica remained in the sand after being washed.

SAND NO. 2:

Analyzed by Corning Glass Works, represents a channel sample of an 18-foot exposed face at an abandoned sand pit at Eastview, Hardin County, taken by F. H. Walker and the writer. The sand, a friable facies of the Cypress (Big Clifty) sandstone, is intermittently exposed for a mile or more in a series of cuts along the Illinois Central Railroad. The pit is located immediately adjacent to the railroad at the east edge of Eastview.

Chemical Analysis (in percent)

	Sample as Received	*Sample Washed*
Fe_2O_3	0.15	0.11
TiO_2	0.25	0.18
Nonvolatile	4.2	
$R_2O_3+RO_2$		2.09
CaO		Trace
MgO		Undetected
Na_2O		0.03

Physical Analysis

Tyler Mesh No.	*Cumulative Percent*
On 20	0.44
28	0.80
35	2.50
48	5.16
65	11.01
100	41.01
150	93.71
−150	100.00

[1] All analyses by Corning Glass Works were made in their Corning, New York, laboratories.

SAND NO. 3:

Considerable attention has been given at various times to a deposit of Hardinsburg sandstone near Marion, Crittenden County. A sample taken by T. J. Tate of Marion and submitted to Corning Glass Works gave the following analyses.

Chemical Analysis (in percent)

Fe_2O_3	0.034
Al_2O_3	0.71

Physical Analysis

Tyler Scale	*Percent Retention*
+14	0
−14+20	0
−20+28	0.1
−28+35	4.7
−35+48	11.3
−48+60	9.3
−60+80	38.4
−80+100	25.3
−100+150	9.5
−150	1.4

Another analysis of this sand was made by Owens-Illinois Glass Company from a sample submitted by T. J. Tate. These data were made available to the Kentucky Geological Survey by Charles L. Cassady of Marion.

Chemical Analysis (in percent)

Alumina	.42
Iron oxide	.022
Titanium oxide	.074

Screen Test

Screen	*Percent*
8	0
16	0
20	.1
30	3.4
40	6.0
50	11.2
60	10.1
80	38.0
100	21.9
140	8.3

E. M. Luttrell and H. W. Settle, on the staff of the Kentucky Geological Survey, sampled a 30-foot exposure of this Hardinsburg sandstone on the McDonald farm about one mile south of the center of Marion. It is located less than one-half mile from the Illinois Central Railroad and Kentucky Highway 91. The deposit is an indurated sandstone formation occupying considerable area. It is iron-stained on weathered surfaces and along some bedding planes. The top part of the formation is considerably more iron-stained than the section sampled, which occurs on the west side of a high ridge. Chemical analysis by Corning indicated 0.036 percent Fe_2O_3 and 1.3 percent nonsilica in the washed sample. An analysis of another sample from this locality by the Chemistry Department, University of Kentucky, Lexington, gives a silicon dioxide content of 98.96 percent.

SAND NO. 4:

Sampled by H. W. Settle and the writer at the east edge of the city limits of Princeton, Caldwell County, from the face of an abandoned pit which has a maximum of 20 feet of sandstone exposed. The deposit is indurated, generally grayish-white sandstone with an occasional streak of yellow sand or a very thin shale parting. It is identified as the Bethel sandstone. Preliminary analysis by Corning Glass Works shows 0.046 percent Fe_2O_3 and 0.7 percent nonsilica in the washed sample.

SAND NO. 5:

An unidentified deposit in a gulley on a tributary of Lick Creek on the Porter Ladd farm 3 miles northeast of Eddyville, Lyon County, taken by H. W. Settle, Kentucky Geological Survey. It contains much clay but when washed contains a clear quartz sand with small amounts of mica. Only a few feet are exposed but the land owner reports that 40 feet of this deposit have been cored. It is not near a highway but is only a few hundred yards from the Illinois Central Railroad. Analyses were by Corning Glass Works.

Chemical Analysis (in percent)

	Sample as Received	*Sample Washed*
Fe_2O_3	0.44	0.12
TiO_2	0.63	0.70
Nonvolatile	20.3	
$R_2O_3+RO_2$		1.77
CaO		Trace
MgO		Undetected
Na_2O		0.05

Physical Analysis

Tyler Mesh No.	*Cumulative Percent*
On 20	2.3
28	5.4
35	10.6
48	16.9
65	35.9
100	64.7
−100	100.0

Further physical tests showed that the clay content of the sample submitted was so great that it took six parts of unwashed sample to produce one part of clear sand. Observations at the outcrop suggest that the clay content will vary in different parts of the deposit.

SAND NO. 6:

Two samples of a deposit near Pine Knot, McCreary County, were submitted to Corning Glass Works by E. B. Ditto of Lexington. They represent a 6- to 8-foot exposure of friable, grayish-white Pottsville sandstone situated in a hollow about 0.25 mile southwest of the junction of U. S. Highway 27 and Kentucky Highway 92 at Pine Knot. It is about 0.2 mile from the Southern Railroad.

The following analytical data were supplied by Corning Glass Works.

	Sample A		Sample B	
	Original Sand	*Water-washed Sand*	*Original Sand*	*Water-washed Sand*
% Fe_2O_3	0.178	0.115	0.15	0.12
% Nonvolatile	.....	3.1	3.6	2.3

The original material occurred in chunks which were easily crushed to pass at least a 40-mesh Tyler screen.

Local land owners expressed an opinion that the light-colored sand exceeds 50 feet in thickness, but because of soil and vegetation cover this could not be accurately ascertained. A water well, drilled in 1950 at the residence of W. C. Prater, about one-half mile northeast from the outcrop from which the samples were taken, was reported to have encountered the following section.

	Depth in feet
Soil and clay	0-5
Brown and red sandstone	5-50
White sandstone	50-90 (bottom of hole)

SAND NO. 7:

Submitted to Corning Glass Works by E. H. Schwab of Morton's Gap from a deposit of loose, unconsolidated sand, 4 feet thick, exposed by coal-stripping operations in Lick Creek valley near Charleston, Hopkins County. The sand appears to represent a stream deposit of variable thickness and undetermined extent. A detailed drilling program would be necessary to ascertain the extent and to evaluate the commercial possibilities. A partial chemical analysis by Corning Glass Works indicates Fe_2O_3 content of 0.06 percent and 2.2 percent nonvolatile material. It is a grayish sand with fairly uniform grain size which would pass a 20-mesh Tyler screen.

SAND NO. 8:

A Pottsville sandstone submitted to Corning Glass Works by V. H. Jones of Glasgow. The sample was taken from the abandoned pit of Kentucky Natural Rock Asphalt Company located near the mouth of Gulf Hollow, 6 miles northwest of Brownsville, Edmonson County. The exact source could not be located but it is thought to have come from a single 3-foot ledge of sandstone which overlies the asphalt-bearing rock and is separated from it by several feet of gray shale.

A partial chemical analysis shows:

	Original Sand	*Crushed and Water-washed Sand*
% Fe_2O_3	0.134	0.061
% Nonvolatile	.....	0.78

The crushing and washing procedure not only removed much of the objectionable iron but also produced a sand of good grain distribution. A few sand grains remained on the No. 20 Tyler mesh, 4 to 5 percent were between 20 and 40 mesh, and the balance were under 40-mesh size.

SUMMARY AND CONCLUSIONS

A commercial deposit of glass sand in Kentucky is likely to be a bed of reasonably soft sandstone, having adequate tonnage of easily mineable rock, well located for transportation to manufacturing centers, and having suitable grain size and chemical composition (or amenability to economic treatment). Most silica sand for glass is beneficated by some metallurgical means to improve its quality before it is used. Hence, analyses of the raw sand do not correspond closely with analyses of the treated sand ready to go into the glass batch.

Samples 3 and 4, located at Marion and Princeton respectively, appear to offer the best possibilities for sources of sand for high-grade glass. Both are near rail transportation.

A seemingly unlimited supply of sand suitable for green glass is present at Eastview, at the site of sample 2, and at Pine Knot, the site of sample 6. The proximity to railroads has already been pointed out.

A cursory examination of many outcrops suggests that there are numerous deposits of sandstone in Kentucky which would probably be satisfactory for sixth, seventh, eighth, or ninth quality glass. The Bethel sandstone along Crooked Creek, 1.5 miles north of the city limits of Marion, and on the O. B. Wardlow farm, on Kentucky Highway 91, about 1.25 miles south of Crayne, both in Crittenden County, appear to offer definite possibilities for this quality glass. Other areas for possible exploration for sands for lower grade glass include the Lee formation in the Pine Mountain area, particularly near Pineville, Middlesboro, and Harlan; near Olive Hill in Carter County, and near Paintsville in Johnson County.

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