DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINES, MINING AND GEOLOGY
425 STATE CAPITOL
ATLANTA, GEORGIA

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INFORMATION CIRCULAR NO. 11

GLASS SANDS AND GLASS MAKING MATERIALS IN GEORGIA

A Compilation

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The following report is largely a compilation of information from Georgia Geological Survey Bulletin 37 and from the files of the Division of Mines, Mining and Geology. Some introductory and relative material has been derived also from Industrial Minerals and Rocks, published by the American Institute of Mining and Metallurgical Engineers.

INTRODUCTION

Sand composes from 52 to 70 per cent of the bulk of the mixture of raw, glass-making materials, and upon it depends the transparency, lustre, and hardness of the glass. It may range from high-silica sand, containing but a small percentage of iron oxide, to material with several per cent less silica and as much as one per cent iron oxide. The grain may be round, subangular, or angular. 1/ A careful consideration of its qualities is, therefore, extremely important. Although purity and grading of the sand is essential, it is only rarely that these qualities are ideally developed in the natural product. It is interesting that generally throughout the world, the purest sands, from the standpoint of silica content, are found in the later geological formations. This is due to the longer period during which the quartz grains have been reworked by water many times and their impurities carried off. Both unconsolidated sand and cemented sand, or sandstone, are used in glass manufacture. When sandstone is used crushing is necessary, and consequently a fairly friable stone which breaks down easily between the grains, rather than across the grains, is desirable.

Frequent attempts have been made to use ground quartz in the manufacture of glass, but they have invariably been failures due to the great cost of crushing the tough quartz to the requisite fineness.

Chemical Composition

The chemical composition of a glass sand should show the percentages of silica (SiO_2), iron (Fe_2O_3), alumina (Al_2O_3) and the loss on ignition, (water and organic matter).

Silica. -- Boswell says that the silica percentage should be preferably over 98 per cent, although for common bottle glass the percentage may drop as low as 95 per cent and in the best optical glass at least 99.5 per cent silica should be in the sand. Some Illinois and Pennsylvania sands attain a content of 99.9 per cent silica. In 600 analyses

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1/ Am. Inst. Min. Met. Eng; Industrial minerals and rocks, p. 754. 1940 of 210 different glass sands cited by R. I. Frink, the highest silica content was 99.71 and the lowest 88.51, but it is said that the latter made better glass than the former, due to alumina in the sand.

Iron. -- Iron, either in the form of oxides, limonite or magnetite, or in other minerals, is particularly undesirable in glass sands, since it gives the glass a green or yellow color. Much more laxity has been allowed in the past few years in setting the iron content limits than formerly, since it has been found that for most purposes just as good glass can be made with a somewhat higher content. Although a glass sand, comparatively free from iron, is generally snow-white, the color of a sand alone is not an indication of its purity, since minute particles of magnetite or ilmenite may occur through the sand and be almost invisible, yet they will sometimes give the sand an iron content of as much as one per cent.

For the best flint and optical glass Boswell believes the iron, as Fe_2O_3, should not exceed 0.05 per cent, but for window and plate glass, 0.1, 0.2, and even 0.3 per cent are permissible. Burchard considers 0.2 per cent Fe_2O_3 as the limit for sand used in plate glass manufacture.

Buttram gives 0.3 to 0.4 per cent as permissible percentages in plate glass when decolorizing agents are used and calls attention to some grades of English plate and window glass containing as much as 1.92 per cent iron. French mechanically pressed plate glass averages 0.14 per cent iron. The same authority speaks of lead glass containing up to 1.93 per cent iron and 5 per cent iron in some lime glass, with the better grades of bottle glass averaging 0.65 per cent.

The Pittsburgh Plate Glass Company considers the iron limit for plate glass as 0.1 per cent, but prefers 0.05 per cent. For white bottles the iron content should not much exceed 0.5 per cent, but for other bottles the iron content may range from 0.5 per cent to 7 per cent.

ALUMINA. -- Alumina in glass for refractory work is desirable, since it makes a glass that stands melting without change. Alumina in the form of clay is generally thought to be highly undesirable, since it clouds the glass. Buttram gives 0.1 per cent Al_2O_3 as the limit in sands for the manufacture of high grade flint ware, while up to 0.6 to 0.7 per cent alumina occurs in many sands for window and plate glass manufacture. In bottle glass 2.2 per cent is about the average.

Frink believes that alumina is bad for optical glass, but that for most other glass, alumina is not harmful. He cites cases in which excellent glass was made from a sand containing 6 per cent and thinks even as much as 10 per cent not prohibitive. The alumina aids the annealing of the glass, reduces the coefficient of expansion, and prevents, to a large extent, the formation of cords or strings, making the glass more homogeneous. On the other hand alumina decreases the fusibility of glass, and increases the viscosity where it occurs in amounts over 3 per cent. On the whole, then, for most grades of glass, alumina in small amounts may be considered beneficial rather than harmful.

Magnesia. -- Formerly 0.2 to 0.4 per cent magnesia was believed the limit in the batch, but Fink mentions a plant producing good glass and using 6 to 9 per cent magnesia in the limestone alone. He believes, however, the total magnesia in sand and limestone should not exceed 6 per cent.

Analyses of High-grade Glass Sand

Constituents	1	2	3	4	5	6
Silica (SiO_2)............	99.35	99.22	99.89	99.34	99.88	99.80
Alumina (Al_2O_3)...........	.14	.32	.105	.297	.18	.13
Iron oxide (Fe_2O_3)	.012	.14	.005	.043	.02	.006
Lime and manesia .... (CaO and MgO)	trace	.18	trace	.15	.....	trace
Total	100.002	99.86	100.00	99.830	100.08	99.936

1.- Oriskany sandstone, Mapleton, Pa.
2.- Dugen sandstone, Talbequah, Okla.
3.- Criskany sandstone, Berkely, W. Va.
4.- Dakota sandstone, Perry County, Mo.
5.- Best lippe sand, Saxony
6.- Fontainbleau sand, near Paris, France

As a rule, sands whose chonical composition conforms to the silica, iron, and alumina limits, will not show more than a trace of lime, magnesia, titania, and the alkalies. A high alumina content frequently means a high titania content. The effect of titania, although injurious, is little known. Water, since it causes air bubbles, and organic matter has reducing qualities; both are objectionable where a high grade of glass is desirable.

Mineral composition

In view of the fact that quartz is pure SiO_2, a sand that is almost entirely composed of quartz grains will most likely be free from impurities. The heavier and darker minerals such as magnetite, hornblende, leucoxene, titanite, and ilmenite, are undesirable, since such materials often contribute largely to the iron content of a sand. Their elimination, therefore, will greatly improve a sand. Examination of a sand mineralogically also serves as a check on its character and on the deposit from which the sand came, since usually glass sands are uniform in their mineral content, and any change noted will indicate a change in source, or the introduction of some impurity in transit.

A mineral examination of sand is readily made with a pocket magnifying glass. If some of the sand is placed in a drop of clove oil under a microscope, the fine quartz, since its index of refraction is about the same as that of the clove oil, will stand out in relief. Any coating, likely to account for a high iron content, can be observed in this way, since such coating cause otherwise pure quartz to be visible through the oil.

Mechanical Composition

Some glass makers who have studied their sand in great detail put the question of grain size on a par with that of chemical composition. Grading is indeed a most important factor as numerous mechanical analyses have shown, yet few glass makers give it much attention.

Boswell thinks a batch should have at least 70 per cent of the sand of one grade, preferable from $\frac{1}{4}$ to $\frac{1}{2}$mm. in diameter (30 to 55 mesh). Coarse grains are left unmelted as in the molten batch. Fine material such as silt and clay is particularly undesirable, since it clouds the glass and permits the inclusion of air which causes bubbles. Fine material also melts frst and sinking to the bottom causes layers of uneven density, which later produces "wavy" or "cordu" glass when blown.

Burchard considers that the sand should be of medium fineness passing a 20 to 50-mesh screen, and that sand uniformly finer than one sixieth of an inch is said to burn out. Boswell, however, says that sand of this latter size will not burn out. In general, finer sand is used by British glass-makers than by American glass-makers.

Kummel and Gage say "If the majority of the grains have a diameter less than 0.136 millimeter (passing a sieve having 120 meshes per linear inch) the sand is said to 'burn out' in the batch and will not produce as much glass per unit as when composed of coarser grains. When the grains are uniformly larger than 0.64 millimeter (30 mesh) in diameter more time is required to fuse them than otherwise, this lowers the amount of sand each furnace can melt per day and increases the cost of the glass produced."

Similar limits for the size of the grains are given by Buttram. The following mechanical analyses of typical glass sands from various sources are given:

Mechanical Analyses of Glass Sands

Operator	Locality	Color	Percentages passing			
			20 mesh	40 mesh	60 mesh	100 mesh
Ottawa Silica Co.	Ottawa, Ill.	White	99	85	18	3
E. J. Reynolds & Co.	Utica, Ill.	Grayish yellow	99	45	11	3
Tavern Rock Sand Co.	Klondike, Mo.	Faint pinkish yellow	100	82	17	2
Pacific Glass Sand Co. Direct from quarry	Pacific, Mo.	Faint yellow	100	96	46	2
West Virginia Sand Co. Finish product	Berkeley Springs, W.Va.	Grayish white	100	98	25	1

Shape of Grain

A sharp grain, since its edges fuse more readily, is generally believed more desirable. Many plants in the Mississippi Valley region and in other parts of the United States are producing all grades of glass, including the best flint ware, from sand of rounded grains. Whatever effect the shape of the sand grains may have upon the melting of the batch, or upon the glass, it is probably too insignificant to be worthy of consideration.

Methods of Improvement

Very often sand, apparently unsuited for the manufacture of glass, may be ridden of its impurities, by simply and comparatively inexpensive treatment. Sands used for making inferior grades of bottle glass can sometimes be improved in this way, so that they can be employed in the manufacture of better glass and so increase their value.

Washing.- As a means of removing the clay, with its iron and alumina content, washing has been most frequently resorted to, and it is surprising how many apparently worthless sands can be made suitable for glass by washing. The following table shows the result of washing a sand (No 1) from near Blackshear, Georgia (see Georgia Geol. Survey Bull. 37, p 228), the average analysis (No. 2) of a large number of sands made by the Pittsburgh Plate Glass Company, and the analysis of a slime from a washed Ottawa sand.

Analyses of Washed and Unwashed Glass Sands and Slime

	Unwashed		Washed		Slime
	1	2	1	2	
Silica (SiO_2)	95.20	99.405	99.49	99.782	87.21
Ferric oxide (Fe_2O_3)	2.11	.075	.31	.031	7.50
Alumina (Al_2O_3)	1.16	.210	.05	.049	.52
Alkalies	....	....	....	....	.20
Loss on ignition	.76	.170	.04	.100	....

Sometimes the improvement of the iron content by washing is too small to warrant the expense, in view of the corresponding loss in alumina, which, as previously pointed out, is a desirable constituent of the sand.

Washing not only removes a large part of the iron content, but it also removes, even from high-grade sands, considerable finely divided silica, which may be injurious, as well as organic matter and other impurities whose deterimental action it is desirable to reduce. If the iron occurs in the sand as magnetite, ilmenite, or similar materials, which occur in small grains; or if the quartz grains are coated with a persistent film of limonite, washing will not materially improve the sand.

Washing is extensively employed in Illinois, West Virginia, Pennsylvania, and to a lesser extent in Indiana, Ohio, and Missouri.

The methods are briefly described under Preparation of Sand for the Market. (See Georgia Geol. Survey Bull. 37, p. 120).

Magnetic Treatment. - Since magnetite and ilmenite, which frequently are a source of iron in glass sand, are magnetic, the possibility of removing these minerals by the use of electromagnets is suggested, as well as particles of iron abraded from the crushing machinery by the hard quartz grains. At least one glass maker uses this method to improve his sand.

Screening. -- Kummel and Gage have made experiments showing that minerals such as magnetite, titanite, ilmenite, and leucoxene, which are highly ferruginous, generally occur in sand as grains which pass an 80-mesh screen. Their suggestion, of screening out the grains passing 80-mesh, before marketing, is an excellent one, and should be investigated by producers wishing to increase the value of their sand, although it is likely that with the present methods of screening, considerable difficulty will be encountered in doing this economically. Not all sands, however, owe their iron content to these fine-grained black minerals. Many Georgia sands, as they occur in the pit are barred from use in glass-making by their limonite content, rather than their magnetite content.

Table Showing Improvement Effected by Screening Out Sand Passing 80 mesh.

	Sample 669 A		Sample 672 A	
	Before screening	After screening	Before screening	After screening
Iron oxide (Fe_2O_3)	0.0068	0.0022	0.0114	0.0029
Titania (TiO_2)	0.117	0.024	0.234	0.0434
Alumina (Al_2O_3)	0.276	0.085	0.366	0.106

Preparation of Glass Sand

In West Virginia, Pennsylvania, Missouri, Kansas, and Oklahoma, most of the glass sand produced is from sandstone. This must, of course, be quarried or mined, crushed, screened, washed, drained, dried, and finally screened into the desired sizes. If the sandstone is friable, hydraulic quarrying is generally employed but usually the use of some dynamite is necessary to loosen the harder ledges. Fairly pure sandstone is found in Walker County or Rocky Face in this State and an attempt was made in 1915 to work it.

Mining of Glass Sand.[1] -- The methods employed for working unconsolidated deposits are much the same as those employed for other grades of sand. Steam-shovel mining is possible, but at many plants suction dredges are employed. This is an advantageous method, as the sand has to be washed, and moreover, it undergoes a scrubbing in passing along the pipe line. Stripping should in some instances be carried on in advance of the working, to prevent impure overburden from caving or washing down into the pit where there is danger of this. The consolidated sand stones that are worked are mostly friable and easily crushed. The quarrying methods depend somewhat on whether the beds are steeply dipping or flat. In places, as in eastern Missouri, underground methods are used.

Glass sand obtained from the Coastal Plain area of Georgia is unconsolidated and may be removed by hand or power shovels, loaders, or centrifugal pumps. In many places the overburden is so unsuited for glass purposes that it is necessary to keep it and the glass sand apart, so that hand recovery has been found more satisfactory than mechanical means.

Specifications for Chemical Composition[2] of Glass Sand

	SiO_2 Minimum	Al_2O_3 Maximum	Fe_2O_3 Maximum	CaO - MgO Maximum
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

1/ Am. Inst. Min. Met. Eng., Industrial minerals and rocks p. 757. 1940

2/ Idem. p. 757.

The various methods of mining, washing, screening and other treatments of Georgia's glass sands are described in Georgia Geological Survey Bulletin 37.

It will be noted in the following that we have separated these materials into three classifications: (1) glass sand, (2) quartz, and (3) quartzite. It has been necessary to make this separation because of the fact that specific screen analyses may be desired. Glass sand can be used more easily when screen separation is required than can either quartz or quartzite for it is necessary that they have not only a preliminary and secondary grinding but also a screen separation.

It is apparent that by far the larger proportion of these analyses exceeds in one way or another the limits usually set. It is our opinion that, even though the iron and alumina contents are slightly in excess of the usual limits, a regularity of analyses from the entire deposit would be an easier matter to handle than one in which the component parts are variable. In other words, it may be possible by laboratory control to flux out the iron to the required amount. In any event, some treatment of the raw material will be required for whatever purposes it may be put. This is chiefly due to the fact that all such materials are composed of physical mixtures, such as sand, clay and mica, and, naturally, the clay and the mica must be removed before the sand can be treated and utilized for glass purposes.

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GLASS SAND

Baker County 1/

This, superficial sands, generally white, cover most of the area of Baker County. Bordering Flint River and Ichawaynochawmy and Chickasawhatchee creeks, irregular terrace deposits of rather inferior sand occur. Good coarse sand occurs generally in Flint River, and medium-grained sand is found in small bars along the two creeks mentioned above.

A large sand bank occurs below the mouth of Ichawaynochaway Creek on Flint River at the Kelly place, and the dunes of medium-grained, yellowish sand occur along Flint River 19 miles below Newton. This sand is quite similar to that occurring in Mitchell County opposite Newton.

The local sand supply of newton is obtained from the banks of Coosewahee Creek, half a mile north of the town on the Albany road. This sand is fine-grained, but is suitable for plaster or brick mortar. The whiteness of this sand suggested its use for glass-making and an analysis was made.

Analysis of Sand from Cooleewahee Creek, Newton

Magnesia (MgO)	0.12
Alumina (Al_2O_3	0.12
Iron oxide (Fe_2O_3)	1.27
Silica (SiO_2)	98.21
Total	99.72

Berrien County 2/

At many places thicknesses of from 3 to 5 feet of pure white sand occur associated with cypress swamps and other undrained depressions. The original yellow or gray sand has probably been leached of its iron content by the organic acids produced in the swamp humus, and the sand is apparently pure enough for glass manufacture. Deposits of this kind occur throughout the county; their thickness is uncertain and they depend upon the size of the swampy area for their extent. The sand is of little value now, due to lack of rail transportation, but it may be a future source of supply.

1/ Teas, L. P., Sand and gravel deposits of Georgia; Georgia Geol. Survey Bull. 37, p. 154, 1921

2/ Idem: p. 159

Pure, white sand also underlies the yellowish sand to a thickness of from 3 to 6 feet along Withlacoochee River and represents ancient deposits made by the river. No analyses were made of any of this sand, but the reader is referred to the following analysis of T-238 which is a similar sand occurring west of Little River on the Adel-Moultrie road.

Colquitt County 1/

Little River. -- On the Moultrie-Adel road west of Little River the following section is shown:

Section west of Little River on the Moultrie-Adel road

Dirty yellow, sandy clay and silty sand .... 6 feet
Fine-grained, white sand ....8 feet

A sample of the white sand was analyzed to see whether it was pure enough for glass and the following results obtained:

Analysis of Sand from Little River, Adel-Moultrie Road. T-238

Lime (CaO)	0.00
Magnesia (MgO)	0.11
Alumina (Al_2O_3)	0.11
Ferric oxide (Fe_2O_3)	0.94
Silica (SiO_2)	98.62
Total	99.78

It is not known whether this white sand extends to the Georgia & Florida Railway crossing one mile to the north, but it is typical of the sand so generally seen in this part of the "wire grass" region along streams and in swampy areas. A coarser-grained, white sand, probably of small thickness, parallels the west side of the river a few hundred feet back from it.

Early County. 2/

R. C. Singletary Property, Blakely, Georgia

Sample No. 615 Laboratory No. 6413

Soda (Na_2O)	.22
Ferric oxide (Fe_2O_3)	.63
Silica (SiO_2)	99.12
Total	99.97

Dr. Everhart, Chemist August 15, 1927

1/ Teas, L. P., Sand and gravel deposits of Georgia; Georgia Geol. Survey Bull. 37, p. 180, 1921.
2/ Files - Georgia Division of Mines, Mining and Geology.

Property near Blakely, Georgia

Laboratory No. 137 - M

Alumina (Al_2O_3)	0.13
Ferric oxide (Fe_2O_3)	2.79
Silicious Residue	97.75
Total	100.67

Silicious residue is almost entirely silica except for a very few flakes of micaceous material.

These two samples were apparently from the same property.

J. Thomas Adair, Chemist October 18, 1938

Heard County 1/

Property three miles east of Franklin

Laboratory No. 5137

Moisture at 100° C	.02
Loss on ignition	.12
Alumina (Al_2O_3)	.32
Ferric oxide (Fe_2O_3)	.58
Silica (SiO_2)	98.96
Total	100.00

Dr. Everhart, Chemist July 27, 1925

Johnson County 2/

Williams Property - On the C. L. Williams property 4 miles from Kite and within two miles of the Wadley Southern Railway, are four acres of white sand 6 feet in thickness and sufficiently pure to be used in the manufacture of bottle glass and the cheaper grades of window glass. An analysis of a sample of the sand sent by Mr. Williams from this deposit gave the following results:

1/-Files, Division of Mines, Mining and Geology
2/ Teas, L. P., Sand and gravel deposits of Georgia; Georgia Geol. Survey Bull. 37, pp. 210-211, 1921.

Johnson County, (Cont'd)

Analysis of Glass Sand from C. L. Williams Property
4 miles from Kite; Sample T - 272

Loss on ignition	.15
Lime (CaO)	.00
Magnesia (MgO)	.04
Alumina (Al_2O_3)..............	1.09
Ferric oxide (Fe_2O_3)	.24
Manganous oxide (MnO).........	trace
Titanium dioxide	.06
Silica (SiO_2)...............	98.45
Total	100.45

Pierce County 1/

Blackshear Fertilizer Co. Blackshear, Ga.

Ferric Oxide (Fe_2O_3)	1.90
Metallic iron equivalent (Fe)..	1.33

J. Thomas Adair, Chemist June 27, 1938

Richmond County 2/

E. G. Hancock's Pit Augusta, Ga.

Loss on ignition	.06
Soda (Na_2O)	.06
Potash (K_2O)	.10
Lime (CaO)	.21
Magnesia (Mgo)	.03
Alumina (Al_2O_3)	2.50
Ferric oxide (Fe_2O_3)	.78
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.31
Silica (SiO_2)	94.97
Rarer Earths	.00
Total	100.12

Laboratory No. 3855 Dr. Everhart, Chemist January 31, 1920

1/ Files, Division of Mines, Mining and Geology.

2/ Idem

Taylor County 1/

Carolina China Clay Company — Butler, Georgia

The following analysis was made of the sand, after washing and drying at 110° C.

Ferric oxide (Fe_2O_3)	0.065
Alumina (Al_2O_3)	0.557
Lime (CaO)	0.000
Magnesia (MgO)	0.001
Silica (SiO_2) (Calculated)	99.377
Total	100.000

Screen Analysis of the Washed Sand

Mesh	% material
10	0.5
20	16.3
30	25.2
40	30.0
60	22.6
80	4.5
100	0.9
200	0.4

The per cent clay in the unwashed sand of the fore-going analysis was 5.25%.

J. Thomas Adair, Chemist — June 27, 1938

Telfair County and Wheeler County — Hinson Sand Mines 2/

The property of the Hinson Sand Mines is listed in Georgia Geological Survey Bulletin No. 37 under Wheeler County, whereas the analyses are cited as of Lumber City, Telfair County. Lumber City lies just across the Little Ocmulgee River and in close proximity to the Hinson Mines, which extend from the river into Wheeler County. As Mr. Hinson's residence and place of business were both located across the river from the main pits, at Lumber City, so the deposits were listed under that name.

1/ Files, Division of Mines, Mining and Geology

2/ Teas. L. P., Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, p. 270-271. 1921

Telfair County 1/

Hinson Sand Mines. -- The property of the Hinson Sand Mines lies along Little Ocmulgee River eastward from the Alamo-Lumber City road and includes lots 370 and 371.

The pit has been operated since before 1900, having been opened by L. F. Hinson, and at present is carried on by Mrs. A. H. Mobley, of Lumber City. The deposit is reached by a standard gage spur from the Southern Railway at Lumber City, about 2,500 feet in length. The sand is shipped principally to Chattanooga, Tenn., and to Tallapoosa, Ga., for use in the manufacture of soft-drink bottles. The topography of the deposit is gently rolling, and the surface is covered with a growth of scrub oak. The deposit occupies a ridge or terrace paralleling the river and from 25 to 30 feet above it. It is believed to represent the Satilla formation and is probably an ancient stream deposit.

Section at Hinson Mines, Lumber City

	Feet
Sandy, gray soil	1-2
Yellow, fine-grained sand	2-4
Medium-grained, yellow to yellowish-white sand	1-2
White, clean, glass sand	6-9
Yellow, sandy clay	7

The glass sand grades sharply into yellow sand above and is firmer than the yellow material, as it stands unsupported in faces 8 feet high, although the sand above quickly slumps down. The white sand is usually massive with little indication of stratification and no cross bedding. Fulgurities, or lightning tubes, produced by fusion of the sand by lightning, have been found in the white sand at least 12 feet below the surface.

Due to the occurrence of patches of inferior sand, the deposit is worked by hand, since a steam shovel would not permit a proper selection to be made. The upper cover is first removed by loading the sand in wheelbarrows and depositing it either in the previously worked-out portion of the pit, or loading it on cars and shipping it for building and locomotive purposes. This leaves a bench of white sand from which cars are loaded for shipment to the glass factories. The present pit is about 200 feet wide at the face and extends southeastward over 1,500 feet almost to Little Ocmulgee River. The glass sand deposit on this property appears to be very extensive as prospect pits and auger borings have shown it at practically every place they have been made.

1/ Teas, L. P., Sand and gravel deposits of Georgia; Georgia Geol. Survey Bull. 37, pp. 270-271, 1921.

Telfair County 1/ (continued)

Copy of Analysis of Sand from Hinson Sand Mines
Lumber City, Ga.

Chemical Analysis:

Loss on ignition	.12
Alumina (Al_2O_3)	.78
Feric oxide (Fe_2O_3)	.06
Lime (CaO)	.01
Magnesia (MgO)	.11

Sieve Analysis:

	%
On #14 Screen	2.0
Through #14 & remaining on #30	16.00
" #30 " " " #35	13.0
" #35 " " " #60	39.0
" #60 " " " #80	25.0
" #80 " " " #100	6.3
" #100 Screen	.5

Miscellaneous Observation:

Has a light brown color which, when ignited, turns on an "Off White." This sample contains very little magnetic iron but is a little coarser than ordinary glass sand.

Analysis of Sample Submitted by L. F. Hinson
Lumber City, Ga.

Loss on ignition	.56
Ferric oxide (Fe_2O_3)	.14
Titanium dioxide (TiO_2)	trace
Silica (SiO_2)	97.45
Undetermined	1.85
Total	100.00

Laboratory No. 1113
Dr. Edgar Everhart, Chemist

March 24, 1909

1/ Files - Georgia Division of Mines, Mining and Geology

Telfair County, (continued)

Analyses of Glass Sand from Hinson Sand Mines
Lumber City

Constituents	T-14	T-16	T-17	T-18	1113
Moisture at 100o C	0.07	0.01	0.02	0.02	....
Loss on ignition	0.14	0.30	0.24	0.29	0.05
Lime (CaO)	0.22	0.00	trace	0.00)	1.85
Magnesia (MgO)	0.11	0.03	0.30	0.08)	
Alumina (Al_2O_3)	0.31	0.58	0.96	1.59	
Ferric oxide (Fe_2O_3)........	0.61	0.72	0.48	0.64	0.14
Titanium dioxide (TiO_2)	0.14	0.18	0.18	0.18	trace
Silica (SiO_2)	98.26	98.03	97.36	97.34	97.45
	99.96	99.85	99.54	100.14	100.00

T-14 West side of pit face.
T-16 North bank of Little Ocmulgee River near railway trestle.
T-17 East side of pit face.
T-18 Center of pit face.
1113 Sample sent in by L. F. Hinson in 1909.

Sample T-18 representing the glass sand, has a fineness modulus of 1.83 and 65 per cent coarser than 48 mesh. The organic color factor is 50.

Analyses of Glass Sand from McLeod Property, near
Lumber City 1/ (Also in Wheeler Co.)

Constituents	T-21	T-25
Moisture at 100o C	0.03	0.01
Loss on ignition	0.12	0.12
Lime (CaO)	0.00	0.03
Magnesia (MgO)	0.16	0.00
Alumina (Al_2O_3)	0.44	0.47
Ferric oxide (Fe_2O_3)	0.56	0.48
Titanium dioxide (TiO_2)	0.14	0.36
Silica (SiO_2)	98.38	98.34
Total	99.83	99.81

T-21.-General sample obtained from the collapsed face at the end pit.

T-25.-Sample from the upper part of the glass sand at the south end of the pit. Not a representative sample.

1/ Teas, L. P., Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, p. 272, 1921.

Telfair County - (continued)

The deposit is covered with yellow and pale yellow sand, from 3 to 10 feet thick, which apparently becomes thicker as the river is approached. Due to the faces of the pit having caved in, it was impossible to obtain a section of the material or to measure the thickness of the glass sand, but Mr. McLeod reports that the thickness ranges from 5 to 10 feet. A mechanical analysis of T-21 shows a fineness modulus of 1.95 and 71 per cent coarser than the 48-mesh sieve. The organic color value is 60.

The operations to date have not limited the extent of the glass sand deposits in this vicinity, and it is reasonable to believe that should the demand warrant it, further prospecting along Little Ocmulgee River, on the Satilla or upper terrace, will produce good results, although the quality of the sand is likely to differ considerably over short distances.

Ware County 1/

Satilla River. -- In the bed of the Satilla River along most of its course in Ware County, and particularly along that part of it northeast of Waycross, which forms a boundary of the county, white, medium-to-coarse-grained sand, suitable for either concrete or the poorer grades of glass, occurs. The Atlantic Coast Line Railroad crosses the river $2\frac{1}{2}$ miles northeast of Waycross. The sand in the river bars, which are usually along the right bank, is somewhat finer-grained than the sand in the river channel proper. The main difficulty in recovering the sand would be in raising it from the river to the railroad, a distance of 25 feet. Unless the demand was large and steady, it is doubtful whether it would pay to install the necessary equipment to properly recover the sand.

Analysis of Sand from Bed of Satilla River at Atlantic Coast Line Railroad Bridge, Northeast of Waycross

Moisture at 100° C	0.04
Loss on ignition	0.35
Lime (CaO)	0.00
Magnesia (MgO)	0.06
Alumina (Al_2O_3)	0.51
Ferric oxide (Fe_2O_3)	0.72
Titanium dioxide (TiO_2)	trace
Silica (SiO_2)	97.91

Sand-hill deposits occur on both sides of Satilla River, westward from Walkertown to the Coffee County line. The sand is medium-grained, yellow and has practically no clay. It ranges in thickness from 10 to 20 feet, and continuous acres of several hundred acres are common. The most

1/ Teas, L. P., Sand and gravel deposits of Georgia; Georgia Geol. Survey Bull. 37, p. 266, 1921.

Ware County (continued)

extensive deposits lie just northwest of Waltertown south of the river and extends westward for 2½ miles. The railroad approaches to within a half mile of the eastern end of the deposit. North of the river, opposite the deposit just mentioned, a less extensive deposit occurs, but more favorably situated with respect to the railroad. This deposit was formerly worked just over the line to the east, in Pierce County. Southwest of the river along the Atlantic Coast Line Railroad and 1½ miles northeast of Waycross, a small deposit of fine-grained, yellow sand occurs.

Analysis of Sand three miles northeast of Waycross

Loss on ignition	.60
Ferric oxide (Fe_2O_3)	.55
Titanium dioxide (TiO_2)	.18
Silica (SiO_2)	97.73
Undetermined	.94
Total	100.00

Laboratory No. 1109
Dr. Edgar Everhart, Chemist   March 24, 1909

Wayne County 1/

Analysis of Sand from South Side of Altamaha River on State Route No. 28 Wayne County

Metallic iron (Fe) .... .06

Sand washed free of clay, screened. Sizes 20 to 80 mesh mixed for sample.

Laboratory No. 194-M
J. Thomas Adair, Chemist   January 14, 1939

Wheeler County

The Hinson Sand Mines and McLeod property, listed as at and near Lumber City, Telfair County are to be found under Telfair County, p. 14

Alligator Creek: 2/ A sand belt from 200 to 600 feet wide parallels the north side of Alligator Creek along most of its course. The most suitable place in case of development would be at the Seaboard Air line Railway crossing, 1 mile south of Alamo. Suitable for glass, extent unknown.

1/ Files, Division of Mines, Mining and Geology
2/ Teas, L. P., Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, p. 272. 1921

Whitfield County 1/

Analysis of Glass Sand at Rocky Face, Ga.

Moisture at 100° C	.10
Loss on ignition	.36
Lime (CaO)	.00
Magnesia (MgO)	.28
Alumina (Al_2O_3)	.03
Ferric oxide (Fe_2O_3)	.49
Titanium dioxide (TiO_3) ..	.18
Silica (SiO_2)	98.42
Total	99.86

Laboratory No. 5215
Dr. Everhart, Chemist

Sample No. 2175
August 27, 1923

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QUARTZ

Fannin County

Big Stony Battery:- Big Stony Battery is a knoll or ridge composed of ledges of pure quartz, some looking granular like quartzite and, at other places, the material is white and looks like vein quartz. The rock is exposed about 50 feet high and at least 100 feet wide and 300 feet long. It looks remarkably pure and shows only a few slightly pink surface stains. Samples have said to analyze 99.97% silica and no iron. The east slope is fairly gentle, but the south slope is steep for a short way. The west and north slopes are precipitous, The long axis of the peak is striking N. 50° W. 2/ Quantities of this material from this vicinity are now being used for the manufacture of glass and as ferro-silicon.

There has been some difference of opinion as to whether this deposit is quartz or quartzite, Mr. R. W. Smith of the Georgia Geological Survey visited the deposit in 1932 and reported it as lense-shaped vein quartz; Mr. D. W. Johnson of the U. S. Geological Survey, in 1934, reported it also as quartz; whereas Dr. T. Poole Maynard in his report of 1940 speaks of it as quartzite.

1/ Files, Division of Mines, Mining and Geology

2/ Idem

Fannin County (continued)

Analysis of quartz from Big Stony Battery 1/

Lime (CaO)	trace			
Magnesia (MgO)	.027%			
Alumina (Al_2O_3)	.48			
Ferric oxide (Fe_2O_3)......	.033	(avg)	038%	.27%
Silica (SiO_2, by difference)	99.16			
Total	100.00%			

Laboratory No. 385 - M J. Thomas Adair, Chemist

Quartz ground sample said to have been prepared and cut from 200-pound quarry sample.

The following is an analysis made on a selected sample of quartz from the Big Stony Battery deposit which was submitted by Mr. S. L. Hurt to the laboratory of one of the major glass manufacturing companies.

Alumina oxide	.011%	Magnesium oxide.........	.002%
Iron oxide	.003%	Phosphorus oxide	.001%
Titanium oxide	.001%	Alkalies	.04 %
Calcium oxide	.004%	Loss on ignition	.10 %

Silica (by difference) 99.91%

For a full description of the Big Stony Battery quartz deposit, see Special Geologic Report by Dr. T. Poole Maynard, geologist and technologist, under date of October 20, 1940.

Towns County 2/.

Analysis of quartz (colored) at Bell Mountain

Vein Quartz

Moisture at 100 C	.03
Loss on ignition	.19
Ferric oxide (Fe_2O_3)	.38
Manganous oxide (MnO)	.56
Silica (SiO_2)..................	98.78
Total	99.94

Laboratory No. 3725 Dr. Edgar Everhart, Chemist
September 17, 1919

1/ Files, Division of Mines, Mining and Geology
2/ Idem.

Towns County (continued)

Analysis of quartz (white) at Bell Mountain 1/

Moisture at 100° C	.00
Loss on ignition	.00
Ferric oxide (Fe_2O_3)	.12
Silica (SiO_2)	99.85
Total	99.97

Laboratory No. 3726 Dr. Edgar Everhart, Chemist
September 17, 1919

Analysis of quartz from highest peak of Bell Mountain, Hiwassee 2/

Constituents	T-190	T-191
Moisture at 100° C	0.00	0.03
Loss on ignition	0.00	0.19
Ferric oxide (Fe_2O_3)	0.12	0.38
Manganous oxide (MnO) ...	0.00	0.58
Silica (SiO)	98.85	98.78
Total	99.97	99.94

This material is suitable for glass, or other uses to which high-grade silica is put, but its inaccessibility would eliminate it for this purpose. Its use in lining furnaces and for flux is also suggested.

1/ Files, Division of Mines, Mining and Geology
2/ Teas, L. P. Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, p. 329, 1921

QUARTZITE

Harris County 1/

Pine Mountain Quartzite:- Pine Mountain extends across the northern part of the county from Hargett on Chattahoochee River to the Meriwether county line southwest to Warm Springs. White, gray and yellowish quartzite, in various stages of metamorphism, composes the mountain and dips uniformly to the northwest 30° to 50°, with a strike of about N. 70° E. Oak Mountain, a much shorter and lower ridge, extending eastward from Hamilton to the county line, is composed of the same quartzite. On Oak Mountain the quartzite dips southward from 30° to 40°, indicating a simple anticlinal structure between it and Pine Mountain in this county. Layers of gneiss and schist, sometimes graphitic, are interbedded with the quartzite and may sometimes grade into it, particularly that exposed on Oak Mountain. Outcrop s of the quartzite are almost continuous and very prominent on the south side of Pine Mountain, but the bed rock is usually concealed on the north side by a mantle of fragmental quartzite, sand, and clay, except in the cuts along the new Columbus road, The quartzite has two well-defined joint systems; the one having a general northwest-southeast trend, and the other a northeast-southwest trend. The bedding planes are unusually prominent, and the strata range from a fraction of an inch to four or five inches in thickness. Metamorphic action has crushed the quartzite in many places, giving it a schistose appearance as well as flattening the individual quartz grains and causing secondary crystallization. In texture, it ranges from a dense vitreous quartzite to a friable sandstone. Mica flakes, apparently of secondary origin, are common and are found in the bedding planes. Secondary quartz stringers and lenses due to crystallization of the silica, are also found. Pyrite crystals occur through the quartzite, sometimes in considerable amounts. The quartzite ranges in color from almost pure white to a pinkish-, or even a reddish-brown. Mica flakes and quartz crystals may give a mottled appearance to the quartzite.

Analysis of quartzite from Pine Mountain,
Shiloh-Warm Springs road, T-99

Loss on ignition	1.28
Soda (Na_2O)	0.08
Potash (K_2O)	0.03
Lime (CaO)	0.00
Magnesia (MgO)	0.00
Alumina (Al_2O_3)	4.99
Ferric oxide (Fe_2O_3)	1.10
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	0.28
Silica (SiO_2)	92.11
Total	99.27

1/Teas, L. P., Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, pp. 305 - 308. 1921

Harris County (continued)

Although the iron content seems too high for glass manufacture, the silica per cent appears suitable for silica brick purposes, especially as it can be easily crushed. The high alumina content would reduce its melting point somewhat.

Oak Mountain:- On the Shiloh-Columbus road, on the southern slope of Oak Mountain, the quartzite outcrops for a distance of 50 feet dipping southward 36° and striking S. 85° E. A small displacement of a few hundred yards appears to have acted approximately north and south at the site of the gap. The quartzite is thinly bedded but more vitreous and finer than the Pine Mountain variety in this county. One thousand feet further north and separated by thinly-bedded, impure quartzite, a 20-foot exposure of the quartzite may be seen. It is more granular, more thinly-bedded, and not so hard as the first outcrop. Adjoining, and underlying the exposure, badly-weathered schist may be seen. The soil of Oak Mountain has a more reddish tinge than that of Pine Mountain, so it is likely that the quartzite is more generally interbedded than the schist. Sample T-98, taken from the south outcrop, has the following analysis:

Analysis of quartzite from Oak Mountain
Shiloh-Columbus road, T-98

Loss on ignition	0.54
Lime (CaO)	0.00
Magnesia (MgO)	0.00
Alumina (Al_2O_3)	1.21
Ferric oxide (Fe_2O_3)	0.55
Titanium dioxide (TiO_2)	0.19
Silica (SiO_2)	97.18
Total	99.67

The iron content is low enough to warrant the use of this material for the cheaper grades of glass, and its physical characteristics are such as to indicate its value for refractory brick-making as well.

Pickens County [1]

Payne Property:- A deposit of remarkably pure sandstone, known as the "Rhodes Silica Deposit", is located 5 miles southwest of Jasper and a little over 4 miles from the Louisville & Nashville Railroad. According to Veatch[1] the principal exposure of the sandstone bed shows 8 feet of almost pure white sandstone. The deposit is massively bedded and jointed, fine grained, and sufficiently friable to permit of easy crushing. Iron occurs in the rock as an oxide film in the joint and bedding places and as scattered cubes of pyrites, which have in some places altered to limonite, but it is not in sufficient quantities to harm the rock for use in high-grade glass manufacture. No accurate estimate of the tonnage of the deposit could be obtained from the exposures, but it is likely from its

[1] Teas, L. P., Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, p. 360. 1921

[1] Veatch, Otto, Unpublished report of Georgia Geol. Survey. 1907

Pickens County (continued)

origin that it is extensive.

Analysis of sandstone from "Rhodes Silica Deposit", Pickens County

Constituents	1	2
Volatile matter	0.10	0.08
Iron oxide (Fe_2O_3)	0.008	0.03
Alumina (Al_2O_3)	0.11	0.07
Lime (CaO)	0.07	....
Silica (SiO_2)	99.75	99.82

1.- Analysis by W. Simonson, Cincinnati, Ohio
2.- Analysis by Dr. Edgar Everhart, of purest rock collected by Otto Veatch.

Walton County [1]

Alcovy Mountain, 5 miles south-southwest of Monroe, rises almost 350 feet above the general level. It is composed entirely of a highly crystalline quartzite, which appears to be largely a secondary material produced by solution and subsequent crystallization of the original sandstone or quartzite. No analysis of the quartzite was made, but it does not appear to be pure enough for any but the cheapest grades of glass. Its use in silica-brick manufacture, and as a flux, is also suggested, but its remoteness from transportation will prevent its utilization for a long time.

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Since there are only a very few producers of high-grade silica sands in Georgia, unless materials are purchased from them, it will be necessary to undertake some treatment for many of the materials mentioned in the fore-going report.

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1 /Teas, L. P., Sand and gravel deposits of Georgia: Georgia Geol. Survey Bull. 37, p. 334, 1921

Information has just been received that the Dawes Silica Company is installing a magnetic separator and other apparatus which will enable them to satisfactorily meet required specifications. It is suggested that samples and analyses of sand for any particular purpose be requested of this company

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This report is compiled by the members of the Staff of the Georgia Division of Mines, Mining and Geology under the direction of Garland Peyton, Director.

October, 1940