OKLAHOMA GEOLOGICAL SURVEY

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Mineral Report No. 3

GLASS SANDS

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Mineral Reports:

No. 1, Volcanic Ash and Tripoli

No. 2, Phosphate

No. 3, Glass Sands

In Preparation:

Limestone

Dolomite

Iron Ore

Asphalt

FOREWORD

The purpose of this report is to make available for distribution a summary of general data on the more important known glass sand deposits of Oklahoma.

In 1930 a brief report on glass sands was prepared by the Oklahoma Geological Survey for the Oklahoma Corporation Commission. This report was printed by the Corporation Commission and several hundred copies supplied to the Survey. It was thought advisable to issue these pamphlets, supplemented by additional data on deposits, uses of glass products, list of Oklahoma glass plants and glass sand quarries, as one of the series of Mineral Reports.

Additional details on many deposits of these materials are available in the offices of the Oklahoma Geological Survey at Norman. Persons interested in particular deposits or in locating particular types for special purposes may secure additional information, so far as it is available, by writing or visiting the Survey offices.

Contents

PURPOSE

This brief report on the glass sands of Oklahoma is largely a summary of information contained in various U. S. Geological Survey and Oklahoma Geological Survey publications, compiled to meet the demand that has arisen for such information regarding the amount, quality, and location of favorable quarry sites of glass sand in this State.

ACKNOWLEDGEMENTS

The information for this report has been compiled chiefly from Bulletin 10, Glass Sands in Oklahoma, by Frank Buttram, Oklahoma Geological Survey, 1913, now out of print; from Bulletin 14, Chemical Analyses of Oklahoma Mineral Raw Materials, by A. C. Shead, Oklahoma Geological Survey, 1929; from the Mineral Resources of the United States for 1911 and 1915, published by the U. S. Geological Survey; and from a special report prepared by C. L. Cooper of the Oklahoma Geological Survey for use by the Oklahoma City Chamber of Commerce.

AMOUNT OF MATERIAL

There is probably enough glass sand in Oklahoma to manufacture all the glass used in the world. It may also be said that there is a sufficient variety of sands in Oklahoma to make practically all grades of commercial glass.

Sands suitable for the manufacture of various grades of glass occur in three general localities in Oklahoma, namely, in the Simpson formation in the Arbuckle Mountain region in Pontotoc, Johnston, Murray, and Carter Counties; in the Trinity sand north of Red River in south-central and southeastern Oklahoma, and in a small area in the Burgen sand near Tahlequah in northeastern Oklahoma.

The most important deposits of glass sand in Oklahoma are contained in the Simpson formation in the Arbuckle Mountain region, due to the uniform character of these deposits over wide areas. The Simpson is made up of 1,200 to 2,000 feet of sandstone, fossiliferous limestone, and interbedded shales. Practically pure silica sand suitable for glass making is found in four well-defined series of sandstone ledges in this

formation. Total thickness of the various ledges of glass sand in the Simpson is as much as 200 feet in some localities. In other areas the exposed ledges rarely are found less than 50 feet thick. The individual ledges vary in thickness from 8 to 91 feet. However, in the thicker ledges, the purity of the sand will vary to some extent between the upper and lower sections. The thickness of the glass sands in the Simpson together with the great areal extent of the formation on the surface provides an abundance of material for extensive quarrying over a long period of time.

One continuous outcrop of the Simpson formation extends from Poolville to Ravia, a distance of about 40 miles, and averages more than a mile wide. East and south of Sulphur there are large deposits covering parts of four townships; southeast of Dougherty the Simpson outcrops over half a township, and north of the same town a long narrow outcrop contains good glass sand. Small patches of Simpson occur between Sulphur and Wapanucka, and northwest of Bromide there is a large area covered by the same formation. East of Roff are large deposits of glass sand in the Simpson, and it is from this outcrop that the only quarry now utilizing these sands is operating.

The various localities where the Simpson formation occurs on the surface contain various grades and large amounts of glass sand.

The Burgen sand, containing a 50-foot ledge of high-grade silica sand, is exposed in T. 17 N., Rs. 22 and 23 E., about 5 miles northeast of Tahlequah. An exposure on the bluffs of the Illinois River is about one-fourth mile long and 50 feet thick.

The Trinity sandstone of Cretaceous age, much younger than the Simpson and Burgen sands, covers a considerable portion of southwestern and east-central Carter County, western Marshall, and southwestern Johnston Counties, and a strip of territory from 5 to 20 miles wide extending from the west line of Love County east to the Oklahoma-Arkansas line in McCurtain County.

While the Trinity sandstone covers a much larger area on the surface than does the Simpson formation, it is not so uniform in character and the deposits of good glass sand do not usually extend over a very large area. Much of the formation has included shale or clay in it, and often grades from a sandstone to clay within short distances.

While analyses show that portions of the Trinity contain sands suitable for making good grade glass, a careful investigation should be made

over a sufficient area of the deposit before money is invested in equipment and opening a quarry. This precaution is advisable because the better glass sands in the Trinity formation usually occur in "pockets" or lentils, although some deposits of apparently high-grade sand cover a considerable areal extent, and contain a sufficient amount of good sand to be commercially valuable.

It should also be noted that all these sands suitable for glass making in Oklahoma outcrop near limestone deposits of sufficident purity to be used in the glass industry. This is particularly true of the Simpson formation which outcrops between the Arbuckle and Viola limestones. In the Simpson formation itself are limy members, and in places the sandstone and limestone grade into each other. As suggested by Buttram in Bulletin 10, Oklahoma Geological Survey, some of the limy Simpson sands contain in their natural state about the correct amount of lime for glass making. The Goodland limestone is the next formation above the Trinity sand and provides an abundant supply of lime should operators of glass sand quarries find it profitable to operate in the Trinity sandstone.

PURITY OF MATERIALS

The quality of the glass sand deposits of Oklahoma compares very favorably with that of deposits in other states, and particularly the Mississippi Valley states which supply much of the sand used by glass plants in Oklahoma. For the purpose of this report, discussion will be limited chiefly to those deposits which are located near railroads.

For the better grades of glass, including plate glass, the sand should be almost pure silica, 99+ per cent, with a minimum of iron and alumina. Buttram in his report on the glass sands of Oklahoma says that for the manufacture of plate glass, 0.2 per cent each of alumina and iron is not injurious, and in some cases the sand usually contains 0.3 to 0.4 per cent of these materials. Within the three regions containing the principal glass sand deposits of Oklahoma there are practically unlimited amounts of sand, which are shown by chemical analyses to contain more than 99 per cent silica. In fact, one of the sands of the Simpson formation, and the Burgen sandstone, are of approximately the same geological age and represent about the same type of formation as the the St. Peter sandstone from which practically all the glass sand of Missouri, Illinois, and other central western states is obtained.

About fifty available analyses of sand from the Simpson formatior.

indicate that most of this sandstone varies from 92.0 to 99.95 per cent silica. Since the poorer grades of glass are made from sands running sometimes as low as 90 per cent silica, the Simpson formation carries sand suitable for making nearly every grade of commercial glass. In chemical composition and size grade of grains, the Simpson compares favorably with other glass sands of the middle west, and has apparently about the same amount of impurities as the better Missouri glass sands.

The table below gives complete analyses of several samples of the more pure sands located near railroad lines. The grade represents the uniformity of size of the sand grains, an important factor in fusion. The figures in this column represent the sieve sizes, number of meshes to the inch, between which 70 per cent or more of the sand is retained. The Oklahoma sands are of the medium to fine-grained sizes, a great advantage in the matter of fusion.

ANALYSES OF SIMPSON SAND, REPRESENTATIVE SAMPLES NEAR RAILROAD LINES

Fe_2O_3 (iron)	Al_2O_3 (alumina)	CaO	MgO	SiO_2 (silica)	Organic	Grade	Location Sec. T. R.	No.
.07	.353	.30	.0137	99.305	.012	60-100	35-4S-2E	A_1
.07	.213	.88	.0190	99.349	.029	80-115	35-2S-2E	A_2
.084	.249	.028	.0260	99.585	.0018	80-110	35-2S-2E	A_3
.042	.161	.150	.03	99.469	.0013	60-103	31-2S-2E	A_{14}
.028	.152	.37	.119	99.03	.008	60-100	31-2S-2E	A_{17}
.14	.08	.20	.039	99.362	.005	40-76	31-2S-2E	A_{18}
.056	.277	.11	.068	99.406	.0014	60-96	26-1S-7E	B_5
.125	.454	.31	.0245	98.82	.01	60-140	35-1S-7E	B_6
.28	.988	.13	.032	98.24	.229	60-128	18-2N-4E	C_1
.35	.56	.055	.188	98.782	.003	60-118	Nw.cor. 2S-5E	E_1
.05	.31	.11	----	99.56	----	-----	Roff Quarry	---
.14	.32	.18	.tr	99.22	.0028	40-86	Tahlequah*	I_1

*From Burgen sand five miles northeast of Tahlequah.

The following analyses show that the Trinity contains deposits running very high in silica and low in iron. It will be noted that on the average the iron content will run higher than in the sands of the Simpson formation but is still well within the requirements for making good grade glass.

ANALYSES OF TRINITY SAND, REPRESENTATIVE SAMPLES NEAR RAILROAD LINES

Fe_2O_3 (iron)	Al_2O_3 (alumina)	CaO	MgO	SiO_2 (silica)	Organic	Grade	Location	No.
.322	.75	.105	.025	98.593	.23	60-140	Durwood	G_3
.112	.468	.115	.052	99.123	.04	40-66	Durwood	G_4
.126	.174	.07	.057	99.496	.022	60-88	Russett	G_5
.154	.636	.1	.061	98.89	.08	60-130	Madill	G_6
.098	.152	.04	.056	99.508	.117	60-130	N. of Caney	G_7

ACCESSIBILITY OF OKLAHOMA GLASS SAND

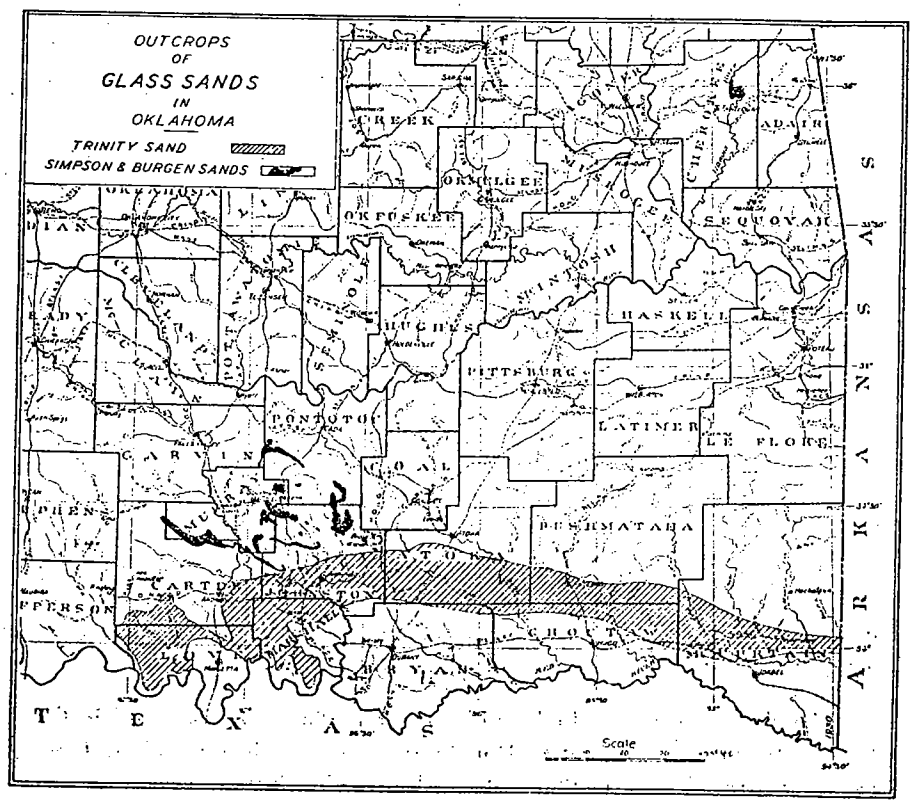
Unfortunately, most of the railroads which cross the formations carrying glass sand in Oklahoma cross approximately at righ angles to the greatest length of outcrop. This is particularly true of the Simpson formation in the Arbuckle Mountain region.

Simpson Formation

The Santa Fe and Frisco railroads cross outcrops of the Simpson, and the K., O. & G. and the Rock Island pass near the most eastern regions where this formation comes to the surface.

The Santa Fe crosses the Simpson about five miles southeast of Dougherty and near the Washita River. One-half mile below Crusher is a good exposure of part of the Simpson formation which contains five beds of glass sand totaling 176 feet in thickness. Part of this section was cut through in the construction of the Santa Fe Railroad.

This outcrop of the Simpson formation extends for a considerable



distance to the east and west of the Santa Fe Railroad and no doubt glass sand similar to the above can be found in either direction as far as it would be practicable to operate from the main line of the railroad. However, in considering the deposits to the west of the road, it would be necessary to either cross the river or provide for transportation down the river a mile or two to where the railroad crosses to the west side of the stream. A partial section of the Simpson formation is exposed about two miles west of the Santa Fe and the Wishita River along Cool Creek. This exposure shows 211 feet of silica sand suitable for glass making.

The Frisco Railraod crosses outcrops of the Simpson east and south of Roff, again about ten miles southeast of Sulphur, a small area some eight miles north of Ravia, and passes within a mile of the Simpson formations at Ravia. About two miles northeast of Roff a quarry has been in operation and a good grade of glass sand secured from the basal sand of the Simpson. The railroad crosses this outcrop, but higher beds containing a poorer grade of sand outcrop not far from the railroad.

A test made by one of the glass companies at Tulsa about 1913, according to Buttram, showed that the sand obtained from the Roff quarry was superior to that shipped in from the St. Louis region for use in the Tulsa plant.

The other areas crossed by the Frisco south of Roff, in the Mill Creek and Hickory areas, have not been fully tested since the outcrops are covered by weathered material, but it is believed that high-grade sands could be found in those regions also. Faulting has also rendered the working out of the extent of workable deposits somewhat difficult.

East of Sulphur the Frisco branch line also crosses outcrops of the Simpson, but so far as determined, these sands contain too much impurities for use in anything but the poor grade bottle glass, although excavation beneath the weathered and soil zone may reveal high grade sands. However, the better available deposits elsewhere in the Arbuckle Mountains will probably prevent development of this area.

In the Falls Creek area 6 miles south of Davis and on the west side of the Washita are large quantities of good glass sands only a mile from the Santa Fe Railroad, but development of these deposits will likely be delayed since the railroad is on the opposite side of the river.

Another exposure of high grade Simpson glass sand is found in the Dougherty anticline, north of Dougherty. The northwest end of these exposures are adjacent to the Santa Fe Railroad. Buttram says:

"The sand is of good quality, and occurs in large quantities in the upper and middle beds. Only a part of the lower bed is present. Although the topography is somewhat rough and a few small streams traverse the formation, yet large amounts of the sand may be given transportation facilities, which is the chief factor in determining the value of the glass sand deposits in the Arbuckle Mountains."

Burgen Sand

The Burgen sand of northeastern Oklahoma is generally considered equivalent to one of the sands of the Simpson formation exposed in the Arbuckle Mountains and to the St. Peter sandstone which produces most of the glass sand in the upper Mississippi Valley states. An excellent exposure of thick deposits of high-grade Burgen glass sand are found along the bluffs of the Illinois River five miles northeast of Tahlequah, but since they are about five mile from the railroad and due to the rough topography of the region, it is unlikely they will be developed, at least under present conditions, unless a railroad should be built through that region.

Trinity Sand

Trinity glass sand deposits available to railroad transportation are found north of Marietta, near Durwood, at Russet, at Madill, north of Caddo, and south of Antlers.

North of Marietta, one-fourth mile west of the old town of Greenville, on a tributary of Hickory Creek, there are at least three good exposures of a sandstone, about 25 feet thick, that are near the railroad. The upper 15 feet is suitable only for bottle glass, but the lower 10 feet is sufficiently pure for the better grades of glass.

At Durwood, east of Ardmore, there is a large amount of sand on the Frisco and Rock Island railroads. One of these exposures, a 17-foot ledge of glass sand, is about one-half mile from the railroad, but the intervening territory is fairly level. Two miles southeast of Durwood is a 20-foot bluff of sand exposed in a small ravine. The upper 15 feet is impure, but the lower five feet is fairly good. The entire section is not exposed, and the bluff is not readily accessible.

A 15-foot ledge of sand is exposed in a ravine one-half mile south of Russet and one-fourth mile southeast of the Rock Island Railroad. A ravine leads from the railroad to the deposit, rendering it accessible. This deposit is covered by only three feet of surface soil. The chemical analyses as given by Buttram shows this to be a good grade of glass sand.

Similar exposures to the Russet sand are seen just below Randolph near the Frisco, near Teller, with others reported near Tishomingo, Milburn, and Filmore on the Rock Island.

An outcrop of sand occurs one-half mile northeast of the public square at Madill, Marshall County. This is capped by five to ten feet of surface soil. The upper ten feet of the bed contains too many impurities, but the next ten feet below is sufficiently pure for good glass. This deposit is not regular in character, being cross-bedded and containing seams of impure sandstone. However, the lenticular pockets of white sand contain an almost pure, white, silica sand. The deposit is only a short distance from either branch of the Frisco, and can be reached easily. From the outcrop on the bluff, the sand ledge extends south, and underlies almost the entire town of Madill.

In addition to the deposits north of Marietta, northeast of Durwood, and at Madill which are known to contain commercial deposits of silica sand sufficiently pure for glass making and are accessible to railroads, there are other known localities in the Trinity where analyses show excellent sand in small pockets. Between Caddo and Atoka along the Missouri, Kansas and Texas Railroad several exposures of local pockets of high-grade sand have been examined. One of the most prominent of these lenticular deposits is in the cut of the railroad two and a half miles north of Caney where a 10-foot ledge 50 feet long is exposed. A sample from this locality showed on analysis 99.507 per cent silica and only 0.098 per cent iron and 0.152 per cent alumina. More detailed field work may show additional commercial deposits in this area.

Between Goodland and Antlers there are a few pockets of white sand in the Trinity along the Frisco Railroad, but Buttram stated that in the field work he was able to do he did not find any commercial deposits of the purer grades of sand. He suggested that boring might reveal a considerable quantity of good sand, but that the deposits would likely be in pockets or lentils.

SUMMARY

Oklahoma has high-grade silica or glass sands equal or superior to the sands found in other Mississippi Valley states, and better than the average sands shipped in to supply Oklahoma glass plants. As a rule the size-grade of these sands approaches the ideal for good fusion, being even better in this respect than most of the eastern glass sands, according

to information secured by C. L. Cooper, chief geologist of the Oklahoma Geological Survey.

Deposits of glass sand which are exposed and have been studied and examined contain sufficient material to supply the needs of the glass industry in this section. In addition to these deposits which have been studied in detail, and analyses made to determine their quality, there is no doubt that inexhaustible amounts of glass sand can be found in the Simpson formation of the Arbuckle Mountain region where this formation outcrops on the surface, but where the outcrops are covered by surface soil and no detailed studies have been made.

Several deposits of glass sand which have been studied and analyses made are favorably located for railroad transportation. Some of these localities are particularly favorable for development because of their location near railroad and an abundance of water. Other deposits could be reached by short spur lines from the main railroads.

CONCLUSIONS

The Oklahoma glass sand deposits are located within comparatively short distances of the chief glass making centers of the State. The haul is much shorter than from the quarries outside the State which now supply most of the glass sand used in Oklahoma, and also closer to many of the Kansas glass plants which secure their sand from Missouri and other nearby states.

Knowledge of these Oklahoma glass sand deposits has been general for many years. At the present time, however, the only quarry working any of these deposits is located near Roff in southwestern Pontotoc County. This quarry obtains its sand from the lower sand ledge of the Simpson formation.

Just why the glass sands of Oklahoma have not been more extensively exploited is not easily understood. The only apparent reason is that quarries opened farther north and east in Missouri and other states had already established a market and reputation for the material obtained in their territory, and that new operators are somewhat skeptical about trying to establish a market for material obtained near the Oklahoma and Kansas markets, but not so well known to the glass manufacturers.

If freight rates do not discriminate against the Oklahoma operators, there appears to be no obvious reason why quarrymen operating in this

State could not successfully compete with more distant operators. In many places the high-grade Oklahoma sands occur under conditions favorable for quarry operations. Climatic conditions here are more favorable for carrying on work during a greater part of the year, thus enabling the operator to maintain a more regular output during the various seasons and perhaps effecting certain economies of operation and giving more steady employment to a smaller operating force.

Oklahoma, with an abundance of cheap fuel, is becoming one of the centers of glass manufacture, most of the plants at the present time being centered in the east-central portion of the State. There are glass plants in Kansas which could easily be supplied with glass sand from Oklahoma. It has been constantly stated, and chemical analyses by Buttram, Shead, and others indicate these statements to be true, that Oklahoma has vast amounts of glass sands equal or superior in purity and size-grade to the sands found elsewhere in the Mississippi Valley region. Most of the Oklahoma deposits are located much nearer the Oklahoma glass plants than any other deposits of glass sand.

With the above conditions existing, the glass sand deposits of Oklahoma are the logical sources of supply for the glass plants of this area. The freight haul is shorter, while the high quality of many of the Oklahoma deposits should give them preference, even with equal competitive conditions; over the average sands that are shipped in from greater distances.

Recent Developments in Glass Industry

Research and experiments with glass and glass products during the past few years have resulted in new uses for glass and in possibilities for production on commercial scale of a number of glass products. Some of the recent developments promise to increase the industrial importance of glass. As a whole, glass and materials made from glass have probably gained more ground in recent years as a result of entering new fields, than they have lost to competing products.

The automobile industry has been an important user of plate glass for a number of years and continues to be a leading consumer of this product. The development and use of safety glass, requiring two thin sheets of plate glass, has further increased the use of plate glass in automobiles.

A full list of the materials made from glass and their uses would be rather lengthy and out of place in a brief report such as this. It would include all the grades of glass made, ranging from the finest quartz glass, used for lenses in telescopes, microscopes and other optical instruments, to the lowest grade bottle glasses; and include all the great variety of common and specialized glassware products used in the home and in industry.

Recent developments which may become of considerable importance in the glass industry include: hollow glass brick used as building material; processes for making glass wool and glass fibers on commercial scale; and quartz-glass wool which has much higher resistance to temperature than ordinary glass wool.

Glass bricks for use as construction material have been produced commercially for only a few years. Glass bricks are hollow, and are made from two sections sealed together at fairly high temperature, a process that results in a partial va-

cuum on cooling, which increases efficiency for insulating against heat and cold. Greatest use for glass bricks, apparently, has been in office and factory buildings, but they are being used to some extent in residence buildings. Glass floor tile has been used in library stack rooms and under other similar conditions, for the advantage of admitting light through the floors.

Equipment and processes for manufacturing glass wool, recently developed, have made large scale production of this product possible. Glass wool is finding a variety of uses, especially for insulation, and additional improvements in glass textile fibers appear probable, which may open new opportunities to manufacturers of this type of glass product. Processes for making textile fiber and spinning it into yarn to be made into textile products have been developed, but the present product has not received wide use. It is adapted to a number of technical and industrial requirements, such as insulation, filters, battery plate retainers, packings, netting, and woven and knitted cloths.

Quartz-glass wool is similar to other glass wools except, as the name indicates, it is made from quartz glass. It will withstand temperatures of almost 1,200 degrees C. and can be used for insulation where high medium temperatures are reached, for lining acid containers, as filtering material and for other technical uses.

So far none of the above newly developed glass products have been reported as manufactured in Oklahoma.

The following table gives the grading of glass sands recommended by the American Ceramic Society and the National Bureau of Standards, based on sieve analyses. All commercial glass sands do not fall within the recommended sizes, especially with reference to the amount finer than 100 sieve.

Recommended Size Grade of Glass Sand

Passing	Retained On	Percent
No. 20 Sieve		100
No. 20 Sieve	No. 40 Sieve	40 to 60
No. 40 Sieve	No. 60 Sieve	30 to 40
No. 60 Sieve	No. 100 Sieve	10 to 20
No. 100 Sieve		0 to 5

Composition of glass sands, based on ignited samples, recommended by American Ceramic Society and National Bureau of Standards

Qualities	SiO_2 Minimum	Al_2O_3 Maximum	Fe_2O_3 Maximum	CaO plus MgO Maximum
1. Optical glass	99.8	0.1	0.02	0.1
2. Flint glass containers and tableware	98.5	0.5	0.035	0.2
3. Flint glass	95.0	4.0	0.035	0.5
4. Sheet glass, rolled and polished plate	98.5	0.5	0.06	0.5
5. Sheet glass, rolled and polished plate	95.0	4.0	0.06	0.5
6. Green glass containers and window glass	98.0	0.5	0.3	0.5
7. Green glass	95.0	4.0	0.3	0.5
8. Amber glass containers	98.0	0.5	1.0	0.5
9. Amber	95.0	4.0	1.0	0.5

Iron is undesirable in glass sand since it effects the color, and it will be noted in the above table of recommendations that the iron oxide content gradually increases from higher to lower grades. Calcium and Magnesium oxides are also objectionable and the maximum percentage allowed is 0.5 percent.

Other Oklahoma Deposits

Since the better known glass sand deposits are located in south-central and southeastern Oklahoma, some attention has been given to possibilities of using sands found in other sections of the state for making glass. The following deposits offer some possibilities for certain grades of glass:

Sand dune area near Waynoka, Woods County. Samples were collected by workers on WPA State Mineral Survey project 65-65-538, who made sieve analyses of the samples. The grain sizes are close to the standards recommended by the American Ceramic Society and the National Bureau of Standards. Approximate analyses indicate an iron content too high for the better grades of glass, although there is a possibility this may be reduced by washing. Silica content has not been determined exactly, but microscopic examination indicates a part of the insoluble sand grains are feldspar rather than quartz. This would lower the apparent silica content indicated by insoluble residue methods of analysis.

In sec. 32, T. 6 S., R. 5 W., Jefferson County, a deposit of high silica sand is reported. The grain size of this deposit is a little larger than recommended. Silica content of better than 99 percent is indicated by insoluble residue method, but microscopic examination indicates a part of the insoluble material is feldspar. In sec. 14, T. 20 N., R. 13 W., Major County, a similar deposit is reported, with the iron content higher than the recommended standard.

No recommendations can be made at this time regarding any of the sands mentioned, other than that they are in an area remote from other known glass sand deposits. Cheap fuel may be available near some of them, and any plans to establish glass plants in those areas should include further investigations to determine their suitability for making glass products. The Waynoka dune sands would be es-

pecially attractive from a mining standpoint, because of ease of quarrying, and location with reference to transportation facilities, and water for washing can doubtless be found in shallow wells.

Uses of Oklahoma Glass Sands

Two quarries operating in high silica sandstone members of the Simpson group are producing and marketing glass sands in Oklahoma at present. These quarries are operated by Mid Continent Sand Company, quarry near Roff, Pontotoc County; and Mill Creek Sand Company, quarry near Mill Creek, Johnston County. From information available, these quarries furnish sand to a majority of the glass manufacturing plants now operating in Oklahoma.

Glass Plants in Oklahoma

The following is a partial list of glass plants in the state, and the types of glass products made by each:

Ada	Hazel-Atlas Glass Company	Packers' ware fruit jars, bottles
Henryetta	Pittsburgh Plate Glass	Window glass
Okmulgee	Ball Bros. Company	Shut down at present
Okmulgee	Southwestern Sheet Glass Company	Rolled, figured and wire glass
Poteau	Hyatt Glass Company	Glass cylinders for gasoline pumps, 5 gal. bottles, jars

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3. Industrial Minerals and Rocks; Am. Inst. Min. & Met. Engr., New York; pp. 379-380 754-757, 1937.

4. U. S. Bureau of Mines, chapters on Glass Sand and Glass Wool, in Minerals Yearbook for 1936, 1937, and 1938.

5. Mineral Trade Notes; U. S. Bur. of Mines, vol. 6, no. 4, April 20, 1933.

6. Engineering and Mining Journal, vol. 138, no. 9, p. 42, Sept. 19, 1937.

Sand Springs	Kerr Glass Mfg. Corp.	Fruit jars
	Kerr-Hubbard-Kelly Inc.	Glass lamp chimneys
Sapulpa	Bartlett Collins Company	Glassware
Sapulpa	George F. Collins & Co.	Glass drawe knobs, glas mail boxes, pen bases, etc., clear and colors
Sapulpa	Liberty Glass Company	Milk and soda water bottles

Other glass plants that have been listed in Oklahoma are as follows. No information on their present status nor products is available:

W. B. Pine, Owens Illinois Glass Co., and Convex Glass Co., Okmulgee; Hazel-Atlas Glass Company, Blackwell.