THESIS

Subject THE BURIED ROCK SURFACE AND PRE-GLACIAL RIVER VALLEYS OF MINNEAPOLIS AND VICINITY.
(With maps and sections.)

Name EDGAR K. SOPER.

1914.

THE BURIED ROCK SURFACE AND PRE-GLACIAL

RIVER VALLEYS OF MINNEAPOLIS AND

VICINITY.

A thesis with accompanying map and sections
submitted to the Faculty of the Graduate School
of the
University of Minnesota

by

EDGAR K. SOPER.

In partial fulfillment of the requirements
for the degree of Master of Arts.

May 6, 1914.

The Buried Rock Surface and Pre-Glacial River Valleys

of Minneapolis and Vicinity.

By E. K. Soper.

CONTENTS.

REPORT

of

COMMITTEE ON THESIS

THE undersigned, acting as a committee of the Graduate School, have read the accompanying thesis submitted by Edgar K. Soper. for the degree of Master of Arts. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts.

W H E[illegible]
Chairman

Samuel L. Hoyt.

C. J. Posey

______191

The Buried Rock Surface and Pre-Glacial River Valleys of Minneapolis and Vicinity.

I. Introduction.

The rock formations underlying the mantle of glacial drift which covers the region around Minneapolis have been studied and described in detail by N.H.Winchell[1], Warren Upham[2], C. W. Hall[3], F. W. Sardeson[4], C.P.Berkey[5], and others. The character of the surface of this buried rock floor has been known only in a general way as revealed by local post-glacial erosion and, in part, by the present surface topography. The definite relations of this buried topography to the present one; the undulations of its surface; and the depth and courses of the buried river channels have been known only at scattered points where data have become available through occasional well borings or other artificial or natural excavations.

In the investigations

---

1. Final Report Geol.& Nat. Hist. Survey of Minn.
2. " " " " " " " " "
3. Geology and Underground Waters of Southern Minnesota: Water Supply U. S. Geol. Survey No. 256.
4. Galena Series: Bull. Geol. Society of America, vol.18, pp.179-194
5. Paleography of Saint Peter Time: Bull. Geol. Society of America, vol.17, pp.229-250.

herein described an attempt has been made: (1) to show in detail, in so far as available data will justify, the exact nature of the <u>surface</u> of the bed rock; (2) to determine the depth of the drift at all points within the city of Minneapolis; and (3) to trace the courses of the glacial and pre-glacial river channels, now filled with glacial debris, throughout the city. The results of these investigations are shown on the topographic map, on which surface and solid rock is contoured, and in the series of geologic structure sections which accompany this paper, and to which frequent reference will be made in the following discussion.

The results show the following essential facts. In Pre-Glacial time the region around Minneapolis was dissected by a large river (referred to as the Pre-Glacial Mississippi) and its tributaries, which cut deep valleys into the rock. At a later time, during the Glacial Period, the surface of the rock included in the areas between these old stream valleys was also deeply eroded by ice gouging and planation. While the effect of this glacial erosion was to produce a generally flat rock surface above the valleys, there were numerous irregularities of surface developed, many of which have never before been accurately delineated. The ancient valleys became filled with glacial debris which was brought down by the ice and left behind as a thick mantle covering the entire region when the ice sheet receded to the north. Not only were the old valleys choked up with glacial drift, but the entire rock surface was buried. The depth of this drift has been determined at as many points in the city as possible, and has been found to vary from 0 to 250 feet. It is thickest in the old buried valleys and thinnest where post-glacial erosion has been active. The depth, width, and courses of the old buried valleys have been determined and are shown in contour on the accompanying map which gives a picture of the buried rock surface throughout the city. In constructing the map the surface topography has been superimposed upon this buried topography so that the depth to bed rock at any point may be readily determined from the map by taking the difference between the elevations shown by the surface contours (in black) and the bed rock contours (in red). The rock outcrops occurring within the city have all been mapped, and the formations shown by appropriate colors. The large depression which is the site of Powderhown Lake has been found to be due to the heading of a small buried valley in this locality. Five secondary valleys which were tributary to the main buried river valley have been traced. These are shown on the map. Finally, it has been shown that the position of these buried valleys is a controlling factor in the choice of types of foundations for large buildings or other structures erected within the zone.

The data used in constructing the map and sections have been obtained from many sources, but chiefly from records of excavations for sewers and water mains, and from hundreds of well records supplied by the well drillers operating in the vicinity of Minneapolis. The surface topography is partly taken from the topographic maps of the United States Geological Survey covering the region around Minneapolis, and St. Paul, and partly compiled from elevations supplied by the city engineer, and from field work done in the spring of 1914.

The writer desires to express his thanks to all those who have given assistance in gathering data for this paper. Special acknowledgment should be made to City Engineer F. W. Cappelen, Dr. F. W. Sardeson, and to the engineers

in the Sewer and Water Departments of the City Engineer's office; to Mr. A. C. Godward, Engineer for the Minneapolis Board of Park Commissioners; Mr. James G. Houghton, City Building Inspector; Mr. J. F. McCarthy, Mr. E. F. McCarthy, The S. Swenson Artesian Well Co., and Mr. Max Renner.

II. Rock Formations Beneath the Drift.

The rock formations existing in the vicinity of Minneapolis, with the relative position, thickness, and characteristics of each, are shown in the following table.

General Geologic Section for Minneapolis.

Era	System & Series	Formation	Character of Strata	Approximate maximum thickness.
Genozoic	Pleistocene	Glacial drift	bowlder clay, sand, gravel clay, alluvium, etc.	175 feet
	Ordovician	Decorah shale	green limey shale	35
		Platteville limestone	Blue to gray thin bedded limestone	25-35
		St.Peter sandstone	white or yellow, fine-grained sandstone with some shale	175
		Shakopee dolomite	Yellow, buff, or pink dolomitic limestone	70
		New Richmond sandstone	White sandstone	40
		Oneota dolomite	Buff to reddish dolomite	100
Paleozoic	Cambrian	Jordan sandstone	coarse-grained white sandstone	80-100
		St.Lawrence formation	dolomite, shale, and a little sandstone	200
		Dresback sandstone	fine-grained white sandstone, shaley towards base	250
Proterozoic	Algonkian	Red Clastic Series	red sandstone and shale and some volcanic rocks	1000 (?)
Archean	Archean	Granite	granite and gneiss	?

Only four of the formations given in the table above may constitute the rock surface immediately beneath the glacial drift in Minneapolis. These are (1) the Decorah shale; (2) Platteville limestone; (3) St. Peter sandstone; and (4) Oneota dolomite. The existence of the latter in direct contact with the drift has been determined at only two or three localities within the city limits, where deep wells have penetrated the drift. The localities have been found to lie over the deepest part of the main buried river channel, as shown by the deep well records. Therefore it seems probable that the pre-glacial Mississippi had cut entirely through the overlying formations and flowed upon a rock bed of Oneota dolomite from a point near the mouth of Basset Creek in North Minneapolis southward to the city limits and beyond.

All four of the formations, each of which constitutes the first rock beneath the drift at different places, originally extended over the entire area of the city and far beyond. Before pre-glacial valleys were carved the rock now topmost was continuous over all others. The amount of this surface erosion has been greatest along the courses of the old abandoned river channel and its tributaries. These ancient streams had cut entirely through the Decorah shale, Platteville limestone, and well into the St. Peter sandstone throughout their courses, and, as explained above, the trunk channel had been so deeply eroded as to expose the Oneota in its bed along the lower portion of its course through the city.

This erosion was not confined to the pre-glacial streams, but was, in a smaller degree, universal over the entire area. The Decorah shale, which is a persistent formation in Goodhue, Olmsted, Rice, and other counties in southern Minnesota, has been almost completely eroded from the area included in the map. Only small isolated areas remain, capping some of the higher points in the south central and southeastern parts of the city, and especially along the banks of the present channel of the Mississippi from the University campus southward to Minnehaha Creek.

Not only has pre-glacial and glacial erosion removed most of the shale from the area, but the limestone is also more or less eroded at all points within the city and completely removed from much of the northern part of Minneapolis, especially the northwestern portion along the area drained by Shingle Creek. Nevertheless, the Platteville limestone is the principal rock formation immediately below the drift and covers by far the greater part of the area within Minneapolis. This limestone is absent only along the stream channels; in the northwestern part of the area and in a few scattered areas in north Minneapolis where erosion has reached the underlying sandstone. The distribution and relations of the formations within the city of Minneapolis may be seen on the map and sections accompanying this paper.

III. The Surface of the Buried Rock.

It will be seen from an inspection of the sections that the rock surface beneath the drift is generally nearly flat. The only notable features of relief are found along the old river channels which have been eroded to an average depth of 200 to 250 feet below the rock surface of the intervening upland plain. There are, however, numerous minor irregularities of surface due to the unequal erosion by the ice, ~~and the general surface may be described as that of a pitted plain~~. The dip of the rocks is so flat as not to be noticeable to the eye except along the north edge of the city where there is a slight upturn. Owing to the scarcity of outcrops, even this upturn is only evident when the elevations of the top of the rock are compared to those in the central and southern part of the city. The top of the limestone along the south edge of Minneapolis stands at an elevation of about 790 to 800 feet above sea level, depending upon the amount of erosion which has occurred. In the extreme north edge of the city, in an old quarry about 3400 feet east of the river, the top of the limestone is about 900 feet above the sea. About a quarter of a mile east of this quarry, underlying the Columbia Heights district, the limestone surface reaches its maximum elevation for the area, about 920 feet. This shows a rise of from 100 to 130 feet in a distance of about 8-1/2 miles. Most of the rise, however, is in the northernmost two miles, where the dip steepens appreciably. The dip in the south half of the city is practically negligible. The elevation of the sandstone is correspondingly higher in the northern portion of the area, although the rise is not quite as great as in the case of the limestone, due to the fact that the limestone is several feet thicker in the Columbia Heights district than in the south central portion of the city where erosion has removed the upper layers. There are several minor undulations in the strata between the north and south city limits, but these are so slight as to be unimportant.

The generally flat surface of this limestone plain, back from the buried river gorges, is broken here and there by small hillocks, These may be capped by a few feet of Decorah shale, which represent remnants of erosion. There are also several depressions or basins, probably gouged out by ice scouring, which, in several instances, are deep enough to extend through the limestone into the underlying sandstone. Another explanation for these basins is that they represent sink holes due to the caving of the limestone over solution cavities produced in the underlying strata by ground waters.

There is one cave about half a block long at 2d Avenue South, between 4th and 5th Streets, in the downtown district. This has not resulted in any noticeable surface depression, but in order to avoid such a possibility in the future, which might prove disastrous to buildings in the vicinity, it has been thoroughly walled up with concrete supports. This cave was due to mechanical action rather than to solution. The cavity occurs at the contact between the limestone and sandstone, but lies entirely within the sandstone. It is clearly due to the mechanical action of the ground water which has washed away the somewhat loosely consolidated sand at the contact, where the ground water tends to accumulate beneath an impervious bed of shale which separates the sandstone from the overlying limestone. This locality is only a few blocks from the river gorge along the sides of which the ground water comes to the surface. The production of open cavities or channels in the sandstone by circulating ground water was also observed in driving the tunnels through the sand rock on the University Campus for the hew heating plant. In the course of this work a fissure in the sandstone was encountered through which a large stream of water issued and temporarily flooded the tunnel. With this indisputable evidence of the occurrence of cavities in the rock below the surface, it is entirely possible that certain of the depressions in the limestone surface, as shown by excavations through the drift, may be due to the slumping of the limestone over similar cavities.

IV. Relations of the Buried Rock Surface to the Existing Drift Surface.

The present topography of the surface of the ground throughout the city of Minneapolis is in general independent of the underlying rock, and this is what one might expect in a region so heavily glaciated. There are, however, certain relations between the present surface and the buried topography which are suggestive and which, when understood, can be used to advantage in interpreting the character of the buried surface. The localities where there is an evident relation between the two surfaces are along the buried river channels. These old stream courses, which have been filled with debris to a depth of 200 to 250 feet, may still be roughly traced across the city by a series of depressions or low areas in the drift, some of which are now the sites of lakes. These depressions do not form a continuous and unbroken course in the present drift, for occasionally the independence of the glacial topography is manifested by abrupt morainal hills extending across the chain of depressed areas. An inspection of the accompanying map will show that nearly every natural lake within the city lies in the course of some buried stream. Not only are these pre-glacial channels indicated by a chain of lakes and shallow basins, but the general depression of the drift over the old stream beds has, at several places, resulted in determining the direction of the present surface drainage. Basset's Creek and Minnehaha Creek both flow for at least parts of their courses, directly over much larger drift filled channels. ~~of much larger streams.~~ (See map). Even the present channel of the Mississippi River, north of the mouth of Basset's Creek, to the city limits and beyond, is superimposed upon the buried gorge of the Pre-Glacial Mississippi. Over the greater portion of the city, however, there is no suggestion in the surface topography of the irregularities in the buried rock surface. The topography of the existing surface is typically glacial in its character, and although the maximum relief is not as great as in the case of the underlying rock surface, yet the general relief is seen to be stronger than that of the underlying rock surface, if we do not consider the old buried gorges. The lowest point on the surface within the city is at the bottom of the Mississippi River just below the mouth of Minnehaha Creek, in the extreme southeastern corner of the city where the elevation is about 690 feet above sea level. The highest points are along the ridge of morainal hills in the northeastern part of the city from Columbia Heights to a point about one-fourth mile southeast of Hillside Cemetery where there are several points which attain an altitude of 965 feet, or thereabouts. This gives a maximum surface relief of about 275 feet. The lowest point accurately known on the surface of the bed rock was determined from the record of a well at the Bath House on the North shore of Lake Calhoun where the surface of the rock was encountered at an elevation of 619 feet. The highest point attained by the rock is in the Columbia Heights district where the top of the shale stands at about 930 feet. This gives a maximum relief of 311 feet for the rock surface, which is 36 feet greater than the relief of the existing drift surface.

There are probably two factors which are mainly responsible for the examples of superimposed drainage of this region and the general occurrence of low areas along the courses of the buried river valleys. Perhaps the most important one is the great depth to which these old gorges had been eroded. During the process of filling these valleys with glacial debris, it is not unnatural that the amount of material available should not have been always quite equal to the amount required to fill them level with the tops of the banks at all points. This would result in slight depressions at intervals along the courses of the former streams. Another important contributing factor is probably the settling of this newly deposited and loosely consolidated material. This settling would result from the saturation of the mass by ground water or from the gradual packing of the filling under its own weight. In either case the shrinkage in a mass 200 to 250 feet thick might be sufficient to produce low undrained areas on the surface. Where these areas of depression are shallow and unimportant, settling could account for their existence. Where the surface basins are large and deep, as in the areas occupied by Lake Calhoun, Lake Harriet, Lake Nokomis, and that portion of the Mississippi River gorge north of the mouth of Bassett's Creek, their origin may be due to the incomplete filling of the Pre-Glacial gorge.

Because of the relatively even erosion over the flat areas between the Pre-Glacial valleys, there are few prominent peaks or high points of rock beneath the drift, and hence few outcrops are to be found in the city. The principal rock exposures are found along the post-glacial valley of the Mississippi from St. Anthony Falls to Fort Snelling and along the gorge of Minnehaha Creek, which is also post-glacial in age, from its mouth to Minnehaha Falls. Also at a few localities in north Minneapolis where the drift is relatively thin, post-glacial erosion or artificial excavation has exposed the bed rock. There are also a few exposures near water level on Nicollet Island and along the river to the mouth of Bassett's Creek.

The exact loealities where rock has been found at the surface, in addition to the outcrops in the river bluffs, are given in the following table. At some of these localities artificial filling, street grading, or building operations have obscured the rock from view. All of the areas of outcrops within the city are shown on the map.

ROCK OUTCROPS IN MINNEAPOLIS.

Locality	Formation	Elevation(feet) A.T.
1.Mississippi River bluffs, St.Anthony Falls to Fort Snelling.	shale,limestone,and sandstone	700 to 800 feet
2.Minnehaha gorge	limestone and sandstone	700 to 800
3.Mississippi River banks,Nicollet Island	limestone	800±
4.Main St. and 7th Ave.,N.E.	limestone	834
5.Main St. and 6th Ave.,N.E.	limestone	835
6.Colfax Ave.,between 41 and 42 Aves. N.	limestone	845-850
7.Dupont and 42 Aves. N.	limestone	860
8.Dupont and 43 Aves. N.	limestone	860

	Locality	Formation.	Elevation
9.	Broadway & 2d St. N.E.	limestone	830
10.	Aldrich & 42d Aves. N.	limestone	857
11.	University & 16th Ave.N.E.	limestone	828
12.	3d Ave. & 2d St. N.E.	limestone	833
13.	2d Ave. N.E. & Broadway	limestone	831
14.	2d Ave. N.E. & 10th Ave.	limestone	836
15.	2d Ave. N.E. & 9th Ave.	limestone	834
16.	2d Ave. N.E. & 12th Ave.	limestone	828
17.	4th St. N.E. & 12th Ave.	limestone	836
18.	4th St. N.E. & 13th Ave.	limestone	834
19.	4th St. N.E., & 14th Ave.	Limestone	825(?) (Filled)
20.	3d St. N.E. & 14th Ave.	limestone	833
21.	3d St. N.E. & 16th Ave.	limestone	834
22.	New Great Northern Depot Train Shed	limestone	820
23.	North Commons	limestone	870
24.	Washington & 36th Aves. N.	Limestone	840
25.	Washington & 39th Aves. N.	sandstone and limestone	830-840
26.	Washington & 40th Aves. N.	limestone	840
27.	Region around Camden Park and mouth of Shingle Creek	sandstone	800-840
28.	Along side of valley just east of N.P.R.R.tracks from 40th Ave.N.E. to Northtown Junction	limestone and sandstone	870-890 850-870

V. The Buried River Channels.

The history of the buried river channels of Minneapolis and vicinity, with an account of the origin and recession of St. Anthony Falls, has been worked out by N.H. Winchell[1], U.S. Grant[2], F.W. Sardeson[3], and others. The general course of the main Pre-Glacial channel of the Mississippi across Minneapolis has been known for many years, but until now there has been no attempt to accurately determine the boundaries of the river and its tributaries, and to construct a topographic map of the old rock surface beneath the drift that would show the depth and width of these buried gorges throughout their courses. The lack of data in former years made it impossible to construct such a map with any degree of accuracy. During the last decade, however, much additional data has been made available, especially at critical localities, through the sinking of wells, and the construction

1. Geol. Survey of Minn., Fifth Annual Report, 1877, p.175; also Final Report, vol.II, 1888, p.313
2. An Account of a Deserted Gorge of the Mississippi River near Minnehaha Falls: American Geologist, vol.V, 1890, p.1.
3. The Beginning and Recession of St. Anthony Falls: Bull. Geol. Soc. of America, vol.XIX, pp.29-52.

of sewer tunnels and ditches, and other excavations, so that it has become possible to show in some detail the character of the old drainage system. As will be seen from a study of the topographic map, the limestone which immediately underlies the drift over most of the city, has been cut into six segments by pre-glacial stream erosion, and had St. Anthony Falls cut its way about one mile further up the Mississippi to the mouth of Bassett's Creek before its progress was arrested by artificial means[1], there would have been seven separate areas of limestone instead of six. This seventh limestone outlier has been almost partly completed ~~because~~ by the post-glacial Mississippi, which, through the recession of St. Anthony Falls, has cut a new channel down to the sandstone from Fort Snelling to the present position of the Falls.

The present river follows its ancient course, which it has partially re-excavated, from a point beyond the north city limits to the mouth of Bassett's Creek in the north central part of the city. At this point the river leaves its pre-glacial channel, turns to the east, and

1. A protecting apron of timber was built over the rock at the point of fall to protect the rock from further erosion, which threatened to completely destroy the falls.

flows southeastward through a young narrow gorge to Fort Snelling, at which point it is joined by the Minnesota River which flows into it from the south. As the map clearly shows, the ancient river valley continued southward from the point where Bassett's Creek now has its outlet and flowed in a broad valley with gradual sloping banks southward across the region now occupied by the chain of lakes which comprises Lake of the Isles, Lake Calhoun, and Lake Harriet. At Bryn Mawr Meadows a tributary stream joined the river from the northwest, and its buried channel is now the course of Bassett's Creek between Glenwood Lake and Bryn Mawr Meadows. Glenwood Lake also lies within this tributary valley. A second tributary stream joined the main river from the west, just opposite Lake of the Isles. The presence of a buried valley east of this point is suggested by a series of basin-like depressions, one of which is the site of Cedar Lake. The existence of a third tributary valley opposite the south end of Lake Calhoun is indicated by well records. This valley also joins the main valley from the west, but there is little evidence of its existence in the present surface topography, which consists of low hills of drift and completely obliterates any underlying channel.

The Pre-Glacial Mississippi flowed almost due south from Lake Harriet, but no attempt has been made to outline its exact course beyond the city limits. In a general way this course can be traced for about five miles south of Minneapolis through Grass Lake, Wood Lake, and numerous small lakes and ponds to its junction with the Minnesota River Valley somewhere east of the village of Bloomington.

An important tributary valley had its confluence with the main valley just south of Lake Harriet, at which point it entered from the east. Evidence of this buried valley may be seen in the present topography, especially along Minnehaha Creek, which follows the course of the ancient channel, between Lake Harriet and Lake Nokomis. At the latter point the old valley turns sharply to the south.

At Powderhorn Lake a small valley heads and flows southward to Rice Lake where it joins the tributary just described. This region around Powderhorn Lake is particularly interesting in this connection, for it has usually been considered to be a large depression of glacial origin, in the drift.

North of the mouth of Bassett's Creek the Mississippi River flows over the same course that it formerly occupied in Pre-Glacial time. The old channel has been almost filled with sediments and drift so that the present stream bed, which consists of glacial debris and recent silts, lies in this region at an elevation of at least 160 feet above the bottom of the buried valley. At a point about half way between the mouth of Bassett's Creek and the north city limits, along the river between 26th Avenue North and 31st Avenue North, a large tributary valley joined the Pre-Glacial Mississippi. This buried valley follows a course indicated in the present topography by a low swampy zone extending northeastward from the river through Sandy Lake (now dry), across Columbia Park and beyond the city to Silver Lake. The exact course of the valley north of Silver Lake has not been determined.

VI. The Drift.

The glacial drift which was spread over the land upon the retreat of the ice, and which covers the rock surface throughout the city, is variable in its composition. It ranges from typical bowlder clay, which consists of a heterogeneous mixture of clay, sand, gravel, and bowlders, to sorted deposits of fine sand or clayey loam. Most of the drift consists of a mixture of clay, sand, and bowlders of all sizes. Where the sand in the drift is free from clay and gravel, it may have been deposited in two ways: either it represents a wind-blown deposit and originated as a sand dune, or it is a flood plain deposit, washed up by glacial streams, and sorted by water action. The only place in the city where clay occurs in large quantity free from pebbles or bowlders is along the banks of the Mississippi River north of the mouth of Shingle Creek. These clay beds probably represent river deposits rather than accumulations due to glacial action. They are indirectly the product of glacial action, since they were deposited during the Glacial stage of the river.

Since the surface of the drift constitutes the surface of the land, except where it has been covered by postglacial deposits of alluvium, sand, or loess of slight thickness, it controls the topography of the region. Therefore, what has been said concerning the characteristics of the topography of the city will apply also to the drift.

The thickness of the drift is variable and ranges from 0 to 250 feet. As shown by the scarcity of outcrops (see map) the drift is present nearly everywhere except along the river bluffs. The localities where it is thinnest are those which border the rock outcrops. In north Minneapolis there is an area bounded by Central Avenue on the south and east, 23d Avenue on the north, and Main Street on the west, where the drift is thin, ranging from 0 to 15 or 20 feet. Throughout the greater part of south Minneapolis, in the large area bounded by the Mississippi River on the east and north, the Pre-Glacial Mississippi River Valley on the west, and Minnehaha Creek on the south, the thickness of the drift is very uniform. The average depth over most of this area is from 30 to 50 feet, the greatest thickness being in the southern portion.

Both the surface of the drift and the surface of the underlying limestone are generally flat over this region. The only noteworthy breaks in the otherwise almost flat surface are at Powderhorn Lake, where a small buried valley heads, and at Lowry Hill and the region around Loring Park, where a belt of low morainal hills extends from the west across the edge of the area and breaks the monotony of the surface.

In some portions of the city, especially in Southeast Minneapolis, in the vicinity of the University and northeastward to the city limits, there is a bed of peat several feet thick which occurs only a few feet below the surface. This peat bed rests upon drift largely composed of sand, clay, or gravel, or a mixture of the three, and is covered by recent deposits of sand or soil which are of post-glacial or glacial origin.

In East Minneapolis, near Tower Hill in the Prospect Park district, deposits of loess, a formation of loamy material of aeolian origin, occur at the surface. Therefore, it is apparent that while the retreating ice left a mantle of drift over the entire region, the surface of this drift has been slightly modified by post-glacial deposition. These deposits of sand, silt, and other material, were chiefly laid down as flood plain deposits in the streams and marshes fed by waters from the melting ice. A small amount of post-glacial erosion has also operated to modify the original drift surface, but this has been unimportant except along the river channel and its tributaries.

The origin, composition, and character of different drift deposits and their modification by post-glacial agencies have all been described in detail in reports by N.H.Winchell[1], Warren Upham[2], F.W. Sardeson[3], F.F. Grout and F.K. Soper[4], to which papers the reader is referred.

---

1. Final Report Minn. Geol. and Nat. Hist. Survey.
2. " " " " " " " "
3. Geology of the Twin Cities. Minneapolis and St.Paul Folio, U. S. Geol. Survey (now in press) 1914.
4. The Clays of Minnesota. Grout and Soper. Bull. #1, Minnesota Geological Survey. Chapter on Hennepin County. Now in press. (1914)
5. Ibid.

VII. Influence of Buried River Channels upon Building Construction.

In those portions of the city which are underlain by the buried valleys and in other parts of the city where the drift is deep, it is impracticable to carry excavations to bed rock for building foundations and cellars. For the ordinary small store or residence, or for light buildings of any description, it is not necessary to have a perfectly rigid foundation. The drift throughout Minneapolis is usually fairly solid at moderate depths below the surface, and is quite safe for foundations for buildings of average size. But in the regions along the courses of the buried river valleys where the drift may be from 100 to 250 feet deep, it frequently contains areas of loose sand which often has a tendency to run. In such localities it has been found necessary to use piling in constructing foundations for large buildings. The buildings which, up to the present date (1914), have been so constructed include the following:

1. Andrews building. Re-inforced concrete warehouse, Washington Avenue N., at Great Northern Railroad crossing.

2. Ford building. Re-inforced concrete factory and warehouse. Fourth Street No., at Great Northern Railroad crossing.

3. Minneapolis Armory. Parade Grounds.

4. Fawkes Auto Company building. Re-inforced concrete. 1625 Hennepin Avenue, near Loring Park.

5. Lake Calhoun Bath House. South shore Lake Calhoun.

6. Lake Harriet Pavilion. Northwest shore Lake Harriet.

7. Chimney stack for Power Plant, Great Northern Depot, Hennepin Avenue and Mississippi River.

8. St. Mark's Church. Stone structure. Hennepin Avenue at Loring Park.

9. Plaza Hotel. Concrete. Hennepin Avenue and **Kenwood Parkway.**

10. Chicago, St.Paul, Minneapolis & Omaha R.R. roundhouse, 24th Avenue and Washington Avenue N.

11. Small garage near shore of Lake Calhoun.

The main business section of the city lies back from the buried valley and in the downtown district the average distance to bed rock is only 25 to 30 feet, ~~on an average~~. The rock in this locality consists of limestone or hard shale and can be easily reached if necessary in building operations. For this reason it has been necessary to use piling in the construction of only a few buildings in the city. Should the zone of large buildings north of Hennepin Avenue be extended in the future a few blocks further west beyond the Great Northern Railroad tracks, it will be found necessary to use piling, caissons, or some type of foundation adapted to soft ground, for many, if not all of the large structures. The side of the buried valley in this vicinity drops off rapidly so that points along the present channel of Bassett's Creek overlie the very bottom of the old valley nearly 200 feet below. Much of the material filling the old gorge in this vicinity is loose sand. At all points in the city except those along the sides and courses of the buried valleys, the foundations are generally good.

TOPOGRAPHIC MAP CITY OF
MINNEAPOLIS
SHOWING
·BURIED·ROCK·SURFACE·
— AND —
·PRE-GLACIAL·RIVER·CHANNELS·
1914
E. K. SOPER – MINNEAPOLIS, MINN.
SCALE:
0 500 1000 2000 3000 4000 5000 feet.
0 1/8 1/4 1/2 1 Mile.
Base furnished by the Board of Park Commissioners, Minneapolis, Minnesota.
900
Surface Contours. Interval 20ft.
800
Buried Rock Surface Contours. Interval 10ft.
COPYRIGHT 1915 BY. E.K SOPER
N.
Note:
To determine the distance from the Surface to Bed Rock at any point, find the difference between the elevations of the nearest "Surface-Contour" (full lines) and the nearest "Buried-Surface-Contour" (dotted lines). This difference will be the approximate distance in feet, to rock.
The mantle material which covers the rock throughout this area consists of clay, sand, gravel or mixtures of these, and is loose and unconsolidated. This loose mantle material attains a thickness of 100 to 250 feet along the course of the old, buried river channel, and in building construction in this area piling is usually necessary for all large structures.
CITY LIMITS
MISSISSIPPI
RIVER
BURIED RIVER VALLEY
LAKE CALHOUN.
LAKE HARRIET.
CEDAR LAKE
LAKE OF THE ISLES
LAKEWOOD CEMETERY
CRYSTAL LAKE CEMETERY
COLUMBIA
PARKWAY
THE PARADE
LORING PARK
UNIVERSITY OF MINNESOTA
HILLSIDE CEMETERY
POWDERHORN LAKE PARK
LAYMANS CEMETERY
ST. MARYS CEMETERY
RICE LAKE
LAKE NOKOMIS
MINNEHAHA PARK
N-S Section along Chicago Ave. S. and University Ave. N.E.
Old River Channel
City Limits
Lake St.
Mississippi River
Shingle Creek
Mississippi River Old River Channel below.
Old Channel
E-W Section along 44th Avenue N. and City Limits N.E.
900' 950'
E-W Section along Broadway N.E and 19th Avenue N.
Old River Channel Glenwood Lake Basset's Creek.
Basset's Creek Old River Channel
Mississippi River.
840' 870'
E-W Section along 6th Avenue N. and Elm Street.
Lake Calhoun Old River Channel.
880' 905'
Section along Lake Street East-West.
Legend.
Drift and Soil Limestone Shale Sandstone S'st. L'st & Shale.
Scale: 1 Inch = 1200 ft.