DESCRIPTION OF THE MILWAUKEE QUADRANGLE.

Prepared under the supervision of T. C. Chamberlain, geologist in charge.

By William C. Alden.

GEOGRAPHY.

Geographic relations.—The area mapped and described in this folio covers the greater part of Milwaukee County and extends about a mile westward into Waukesha County, Wis. It is bounded by parallels 42° 54' and 43° 09' north latitude and meridians 87° 45' and 89° 06' west longitude, thus comprising one-sixteenth of a square degree of the earth's surface, or about 2184 square miles. Of this area about 80 percent is land. On the east are the waters of Lake Michigan.

TOPOGRAPHY.

Relief.—The region is, in general, characterized by the moderately undulating drift topography common to the northern Mississippi Valley. Along the lake shore, except near the mouth of Milwaukee River, there is a bluff rising 60 to 120 feet above the lake. From the crest of this bluff the general topography slopes gradually toward the west, and in the western part of Milwaukee County elevations 220 to 260 feet above Lake Michigan, or 800 to 840 feet above sea level, are attained. This rise continuous westward beyond the area here described, reaching about 900 feet above sea level, the maximum elevation for southwestern Wiscon­sin, at Holy Hill, in the southwestern part of Washington County, 21 miles west of Lake Michigan, and 1240 feet, the next highest elevation, at Government Hill, 2 miles northeast of Delafield, in the eastern part of Waukesha County, 25 miles west of the lake. The relief of the undulations also becomes somewhat greater toward the west, in Waukesha County.

In Milwaukee County and in the eastern part of Waukesha County the undulations are of such magnitude as to be indicated by but few named levels or even by the streets. Smith’s Creek flows from the west and crosses Smith’s Creek all pour their waters into Lake Michigan.

The streams of the area Milwaukee, Menominee, Kinnickinnic, and Root rivers and Oak Creek—all pour their waters into Lake Michigan. The confined divide runs through the eastern part of Waukesha County and its proximity to the lake has so limited the drainage areas that none of the streams are of great size.

In consequence of the north-south trend of the lines of elevation, the streams, instead of following the general slope of the surface directly eastward to the lake, flow for considerable distances nearly par­allel to the lake shore, and reach it only by taking transverse courses at points where the continuity of the ridges is broken. Many of these courses, where the course of the stream has taken place, are in general sharply e-shaped, with valley bottoms narrower than the stream and abrupt slopes, showing that the present cycle of erosion is yet in its youth.

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Descrptive geology.

General relations of the regional formations.

The uppermost geological formation in this region is the glacial drift, consisting for the most part of unconsolidated clay, in which are embed­ded pebbles and boulders. Beneath the drift are in­durated rock formations which may be seen at the shore, and at some points on the land, and of several shades. Here and there the occurrence of soft beds of redish, bluish, or greenish clay material is reported, and rarely thin beds of magnesian limestones have been encountered.

The limestone member, which is generally present in the upper part of the formation in the vicinity of Madison, Wis., has not been reported as occurring in the area under discussion. Some of the wells encountered near this horizon have soft red sandy limestone, spoken of by the well drillers as "red mud." The well at Mr. Fred Miller's brewery (fig. 1), in the Menominee Valley just west of the city, is said to have penetrated 80 feet of this "red mud." Mr. Dixon's well, 14 miles south of the city, passed through considerable "red mud" at this horizon, one bed of which was 40 feet thick. The well at the E. P. Allis Company's works, near Milwaukee Harbor, penetrated 70 feet of similar reddish mater­ial, though this lay below a greater thickness of sandstone than that in the other wells. From the position of the "red mud," in Miller's well it might be inferred that it represented the Lower Magnesian limestone. In a well from other points, however, it appears more probable that the "red mud" belongs in the Cretaceous. The full thickness of these Cretaceous deposits is not known, inasmuch as none of the wells of the area have passed entirely through the formation. The well at Mr. Fred Miller's brewery is said to have penetrated 470 feet of sandstone below the "red mud." Above the Cretaceous sandstones generally throughout eastern Wisconsin lies a limestone known as the Lower Magnesian limestones. The well at the convent in Elm Grove penetrated 110 feet of this rock, and its presence is also shown by the log of the city wells in Waukesha, 8 miles further west. It is reported, however, that none of the wells in Milwaukee or in Waukesha encountered limestones at this horizon. This for­mation is hard, clary, magnesian limestone of dirty grayish-buff color and very uneven texture. Upon the uneven surface of this limestone lies the St. Peter sandstone, which is soft, friable, quartzitic, and usually white or light buff in color. Owing to the unevenness of the floor upon which the sand was laid down the formation varies consid­erably in thickness from point to point. At some places it is so thin as scarcely to cover the thicker parts of the limestone; at other places where the limestone is thinner the sandstone thickens. Where the limestone is about the drift passes into a gravelly material, which is red or brown in color and is the result of the action of the St. Peter for­mation on that of the Cretaceous, with inter­vening beds to mark the horizon. Thus the well
The Racine limestone of the Milwaukee district is overlain by certain beds of rock concerning which there is a lack of positive evidence, owing to the nearly destitute of fossils within them. Their stratigraphic position is above the Racine limestone and below the Milwaukee formation of the Hamilton group. In their position above the Racine limestone, and in their lithological character and chemical composition, these strata closely resemble certain beds exposed about 20 miles north of Wauwatosa, near the village of Wisconisn, in Ozaukee County, which have been corroborated on evidence with a portion of the Crygs group of New York. On the basis of this resemblance, for want of better evidence, these beds in the Milwaukee area have also been provisionally referred to the same group.

The deposits are best exposed at Mr. Emil Petzold’s quarry on Mud Creek, 1 mile south of North Milwaukee. The main beds are exposed one-fourth of a mile further west, on the same creek. They are brownish-gray, finely laminated magnesian limestone, splitting readily into slabs one-half inch to 4 inches thick. A thickness of 10 to 12 feet is exposed. The lower strata are more unevenly bedded and contain streaks of blue clay. In general the strata are very nearly horizontal, but at the western exposure they dip 5° toward the east.

The Racine limestone is the highest member of the Quincy group, occurring above the Racine limestone and below the Milwaukee formation of the Hamilton group. In their position above the Racine limestone, and in their lithological character and chemical composition, these strata closely resemble certain beds exposed about 20 miles north of Wauwatosa, near the village of Wiseconisn, in Ozaukee County, which have been corroborated on evidence with a portion of the Crygs group of New York. On the basis of this resemblance, for want of better evidence, these beds in the Milwaukee area have also been provisionally referred to the same group.

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receded. Periodically there seem to have been
great oscillations in the size of the glacier and
effects so on to designated stages of the Pleistocene
epochs. During these stages of glaciation the ice
advanced far to the south, driving the plants and
animals before it, destroying and burying in the
drift such as remained, and introducing a fauna
and a flora of the higher latitudes. During the
stages of deglaciation a reversal of these conditions
took place. The climate became so much milder
that the ice was melted and a new soil developed,
and plants and animals returned to their former
habitats. Study of these buried soils and organic remnants
and of the conditions of the several drift sheets has led
to the determination that the Glacial epochs comprised
a series of series of glacial and interglacial
stages. The following classification has been made
of the deposits formed during these several stages of
glaciation and deglaciation of the northern
portion of the United States:

**Drift sheets and intervening soil horizons of the northern Wisconsin region.**

1. Late Wisconsin drift sheet.
2. Early Wisconsin drift sheet.
3. Pre-Wisconsin drift.
4. Till and outwash gravel, fourth interval of
   deposition or deglaciation.
5. Three drift sheet and mud deposition.
6. Five interval of soil, followed by
   the drift deposition.
7. Earth and till sheet.
8. Earth and soil sheet.

**Terminal moraines.**

The area at the margin of the lake shows gently flowing contours, as of drift over
the ice, whereas they appear to be of the
lodge-moraine type. Here and there groups of
kitchen holes pit the surface; and at some places considerable deposits of gravel occur. Surface
bottoms are very abundant in parts of Greenfield and Franklin townships. They were formerly much
more abundant on the ridges nearer the lake, but a large part of them have been collected and used
in the construction of piers, breakwaters, and other structures.

The first and westernmost of the ridges is that
which marks the position of the continental divide between the waters of the St.
Lawrence and the Mississippi river systems. It could not be seen in some places by the
streams and in some places conspicuous ridges are discernible, so there
might be some difference of opinion as to the ex	ent correlation here given. This is, however, of little
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To this class belong those terminal morainal
deposits formed at the margin of the
lake During the melting of the ice sheets or during
stages of final deglaciation, such a deposit occurred, as though subjected to lateral pressure by
the glacier when slight advances occurred. This
was probably deposited during the earlier ice
stage and also at places contiguous ridges are coalescent, so there
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extent correlation here given. This is, however, of little
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area are recognized.
the till is very stony, but in general the amount of stony material it contains is notably less than that in the drift of the cross-bedded till of the North Milwaukee. In places the clay near the surface is almost stonelike, but the stones which are generally of small size and well chipped, increase in number downward. Bowlders a foot or more in diameter are not plentiful. Most of the wells along this ridge penetrate only a foot or two and gravel. Possibly more than one-half draw their water from such shallow wells, however, bowlders a few feet in sand and gravel. Gravel deposits are not plentiful at the surface.

A group of small gravel knobs or knolls of 10 to 20 feet relief occurs 2 miles west of the village of Greenfield, just south of the Chicago and Northwestern Railway. These gravel cones consist of one-half miles southward as a terrace along the lower east slope of the ridge. A few miles southward, with 20 to 40 feet relief, occurs at Hales Corners and a single knoll lies 2 miles west.

The most strongly marked of the morainal ridges in the area extending from Milwaukee southward is that nearest the lake shore. From south to north this ridge is nearly paralleled by the lake shore. North of this area may be noted a distinct break in the series of ridges; many, however, show but a few feet of sand and gravel. Gravel deposits are not plentiful at the surface.

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such intervening deposits.
are not
the deposit of red clay has been narrowed in places
in the northward extension of the marginal lake or
that they overlie the blue till which constitutes the
drainage during glacial deposition of the red clay,
stratified sands and gravels exposed in the lake
margin of the ice front and discharging into the
rivers as an outwash deposit formed by glacial
strains. This laminated part usually contains no
sand, for it is often finely laminated below and shows no
overlap marks at the top of the stratified sands.
be one-fourth to one-
was to be little question that the associated drift does not have the
considerable eastward extension which its exposures in the
in situ section. The best evidence of some extension is well
found in the writer, about 100 square miles, principally in
Milwaukee and Ozaukee counties. This is a red pebbly clay,
in varying in color from light terra-cotta red to
brownish or yellowish, so as to be less easily dis-
tinguisheable from the weathered part of the bluish till.
The characteristic color of the drift underlying the red clay
is the pebbly clay and the underlying laminated red clay were deposited are still means-
what open to question. The question requires study over a more extended area than the present
investigation has yet included. Certain tentative conclusions, however, may be made, and their
hypothetical identity should be distinctly borne in
mind in regard to the next discussion.
possible conditions of the drift underlying the red clay were sketched in the earlier chapters. The relations of the bluish till to the
front of the glacier from this area by stages is found an
explanation of the gentle parallel ridging of the
area that is now land and have extended the
red clay and red pebbly clay as an offshore deposit.
One of the greatest objections to the explanation
of this hypothesis of combined glacial, fluvial, and glacio-
currents deposition of the beds presented above may be very briefly
without postulating a considerable northward depression or local shaping of the bottom. This hypothesis accounts for the
decided till-like character of the larger part of the
western margin of the ridge between Racine, Wis., and Holland, Mich., which is higher than any definitely marked level
of Milwaukee as had sufficiently low elevation
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Possible conditions of the deposition of the
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front. It is not necessary to suppose that the ice
front lay entirely unshaped from the vicinity of Mil-
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where the stranded beds were laid down. It is not improbable that the ice front may have been
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A somewhat different interpretation was placed upon the depositional history of the red clays and associated
assorted deposits by Professor Chamberlin in his
earlier studies, as presented in Geology of Wisconsin,
vol. 1, pages 292 to 296, and vol. 2, pages 219 to 233. As a result of these
studies a readvance of the glacier was definitely postulated, but a
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increase of wastage may have allowed extension of
the area that is now land and have extended the
red clay and red pebbly clay as an offshore deposit.
tion or the delicate luminescence, when during the previous advance the ice ground, sorted, and polished the solid rock and possibly contaminated the laminated beds of the deeper deposits; yet differences in conditions may have permitted this very appearance of contorted and polished bedrock. Some interior deposits are unconsolidated stratified drifts without seriously disturbing them appears to be shown by the studies of borings made at various places along the lake shore. At both the localities where the bedrock is in close fault contact, the surficial deposits consist of a shallow-water deposit. At intervals fine silt overlies the sand, giving beds of shelly sand which were then buried by the lake.
These reefs have yielded many specimens of corals, bryozoa, trilobites, etc., but the nearly horizontal strata in the outcrop mentioned were considered as being formed in a sea area of limited extent, and the fossils are distinctly benthonic.

From the distribution of the fossil faunas at the various exposures, Professor Chamberlin concludes that: 1. A second set of fresher and more sharply cut striae ranging in direction from S. 20° W. to S. 48° W. The exposed rock was rounded and polished on the southeast aspect, while on the northwest faces it was rough and unmodified. 2. At Story Brothers’ quarry also there were seen two sets of striae with the same character and vector and very similar in direction ranging from N. 60° W. to S. 60° W.

The rock surface at the south end of the lake shows that the ice advanced far enough to freeze the lake, the only disturbance to which they appear to have been subjected is very slight warping and tilting consequent on gentle elevations and depressions to which the surface was subject and these are rarely more than 0.5 meters, scarcely enough to measure at the outcrops.

LATER FAUNAS, MEMORY, AND TEXTURAL EVENTS.

The following observations of glacial rock surface and drift were made by the writer near Milwaukee, Wisconsin:

Glaciation and Deglaciation.

Of the several drift sheets deposited by the Pleistocene glaciers in Wisconsin, the Wisconsin stage is the later one and the one on which the glaciologist must concentrate his attention. This stage is characterized by the presence of a great Wisconsin drift sheet, the Wisconsin drift sheet, is represented within the Milwaukee district. The occurrence of an older drift sheet in southwestern Walworth County, in Rock County, and in northeastern Illinois is not yet correctly established.

The Wisconsin drift sheet is a true glacier deposit, and the extent of its lateral deployment into the adjacent areas of Wisconsin is the result of movement of the ice which was the direct consequence of these conditions: (1) that deposited fine calcareous mud, the gigantic areas, that deposited fine calcareous mud, the gigantic

During the late Wisconsin glacial epoch the southern Wisconsin, the Wisconsin stage of glaciation. The Wisconsin stage of glacial activity, as indicated in the distribution of the terminal moraines of the Wisconsin drift sheet in southeastern Wisconsin, is represented in the southeastern Wisconsin by the Wisconsin drift sheet. The occurrence of an older drift sheet in southwestern Walworth County, in Rock County, and in northeastern Illinois is not yet correctly established.

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While the ice front stood at the west ridge in Winnebago and Racine counties the glacial waters either flowed directly to Fox River or were ponded over the low areas west of the ridge. When the ice withdrew from the crest of this ridge the waters flowed seaward along the glacial margin to enter the lake basins. In the deposition of these drift ridges the northward-moving waters bordering the ice front must have had a considerable part, especially in the case of the east ridge, stratified deposits of sand and gravel being found in the lake basins south of the Chicago area, where they were ponded up by the ice front. Drifting ice may also have aided in depositing the lower part of the drift ridge, or that part which was formed after the lowering of the lake level.

Between the stages of a marginal stream or lagoon and the definitely marked stages of Lake Chicago there was no red clay. As the glacial margin retreated the lake expanded, extending itself northward along the west side of the glacier. During this time the area that formed the outlet near Chicago was being cut out, so that the lake level was lowered, and with it was lowered the level of the water in the marginal lagoon.

Lake Chicago and the Deposition of the Red Clay.

The Glenwood Beach and Associated Deposits.—When the glaciers had finally withdrawn from the area of the lake-lake system the gradual lowering of the marginal waters lowered to the level at which the first and uppermost of the recognizable benches of Lake Chicago was formed. The position of this beach, the Glenwood beach, from a point 6 miles south of the Milwaukee district southward through northeastern Illinois and northwestern Indiana is shown in Fig. 8. This figure shows also the location of the lake so far north as Grand River, directly opposite Milwaukee, at nearly the same level. The lake stands at a level about 40 feet lower than the present level of Lake Michigan.

The occurrence of a bed of pebbles at this level in the area of the Wisconsin River valley has been noted by Prof. J. W. Goldthwait at a level 25 feet above the present level of Lake Michigan, and at the mouth of the Chicago Outlet near Chicago, 111., to the old shore line. As the present location of the shore line through so long a distance is well illustrated by the conditions on Milwaukee and Kenosha counties, the former for a distance of 15 miles above the confluence, on Clinton street south of the confluence.

The occurrence of this stage at the old shore line of Lake Michigan has been noted by Prof. J. W. Goldthwait at a level 25 feet above the present level of Lake Michigan. These facts indicate that at some stage the waters of the lake were driven down to a lower level even than that of the present lake, causing an emergence of some portion of the shore. This stage was probably cut by erosion and the accumulation of a deposit of peat. This might have resulted if the ice front had retreated so far to the northward as to open a lower outlet.

Along the west shore of the lake in Illinois and Wisconsin the shore work in recent times has been confined to erosion and vegetation. The formation of the lower courses of Milwaukee, Racine, Kenosha, and Milwaukee counties. The work of cutting back the bluff is going on continually at certain points, as may be seen north of Lake Park, at some points along the Bayview bluff, and south of the mouth of Oak Creek. In some places where the material of the bluff is very soft cutting has been very rapid.

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practically ceased and a prominent point resulted. Near Milwaukee the relation between the topography and the constitution of the bluff sections appears to be such that what seems to have been initial sinuosity of the shore line have been perpetuated rather than destroyed. It is also noticeable that the changes in material from the top to the base of the bluff have had an influence on the rate of erosion during the successive stages of the lake, so that where active erosion was going on at one stage in the older beds (94, 95), or 96 feet above the lake, little or no erosion of the more resistant beds lower in the bluff took place at a later stage. This is illustrated by the continuance of the Fox Point terrace.

Over the area in discussion the work of stream erosion has been comparatively small since the retreat of the glacier. There are very few breaks and many sandy areas, some of which have been artificially drained. Owing to the trend of the topography but little drainage goes directly to the lake, and the recession of the bluff has been so rapid that it is cut by few ravines. The most notable stream work is the erosion of the lower part of Menomonee Valley, which was accomplished at the low-water stage of the lake. Doubtless the large amount of sand, gravel, and loose clay in the drift along the line of this valley had much to do with the amount of erosion accomplished.

The course of Milwaukee River through Milwaukee and Waukesha counties was probably established by drainages along the flanks of the glacier while the red clay was being deposited. The perishing of the waters behind the ridge of drift at Northport caused the formation of the broad sandy flat which borders the river north of that place. When the stream cut through the drift barrier a new floodplain was developed about 25 feet below the broad flat. The moderate slope of the valley between the drum and the junction with the Menomonee are due very largely to artificial grading. It is said that when the region was first settled steep slopes bordered the march through which the stream flowed in this part of its course. With the growth of the Milwaukee the slopes were cut down, and the marsh was filled.

### MINERAL RESOURCES

**Building stone.**—The building-stone industry of Wauwatosa has been fully discussed in a bulletin by Mr. E. K. Buckley. The part of the various formations exposed in the vicinity of Milwaukee may be grouped as follows:

1. The heavy marly clay soils.
2. The red marly clay soils.
3. The sandy loams.
4. Prairie loam.
5. The humus soils.

**Clay brick industries.**—The heavy marly clay type, the heavy clay loam, or the brown clay loam, is the clay used in this area. The clay is generally of the same appearance and is satisfactory for the manufacture of vitrified and refractory ware.

**Sand and gravel.**—Deposits of sand and gravel at many places afford material for building sand and filling and gravel for road material, ballast, and other purposes. Their distribution is indicated in the descriptive map.

**Drift cobbles.**—No valuable metallic deposits have been found in this area. The drift contains occasional pieces of metallic cobble which have undoubtedly been carried there from the Lake Superior region by the glaciers. The largest piece that has come to the notice of the writer was in the possession of Mr. E. K. Buckley. The interesting piece was brought from Cold Springs and Thirty-fifth streets and weighed 111 pounds.

### ECONOMIC GEOLOGY

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### ECONOMIC GEOLOGY

**Mineral Resources.**

**Building stone.**—The building-stone industry of Wauwatosa has been fully discussed in a bulletin by Mr. E. K. Buckley.

|分析结果 | Mantle of Milwaukee clay bricks
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The city of Wauwatosa has a 1357-foot artesian well at the pumping station in the Menomonee Valley. This well draws from the Potsdam sandstone and has a full capacity of 337 gallons per minute.

The city of Milwaukee has a 130-foot deep artesian well at the North Avenue Bridge. This well draws from the Kaskaskia sandstone and has a capacity of 400 gallons per minute.

Other mineral waters from this area are found on the west side of Milwaukee. These include the Sodus Spring, which draws from the Lower Magnesian limestone, and the Silver Spring, which draws from the Menomonee Formation.

The city of Milwaukee is served by a 1300-foot deep artesian well at the North Avenue Bridge. This well draws from the Kaskaskia sandstone and has a capacity of 400 gallons per minute.

The city of Waukesha has a 1350-foot deep artesian well at the pumping station in the Menomonee Valley. This well draws from the Potsdam sandstone and has a full capacity of 337 gallons per minute.

The city of Racine has a 1300-foot deep artesian well at the pumping station in the Menomonee Valley. This well draws from the Potsdam sandstone and has a full capacity of 400 gallons per minute.

The city of Kenosha has a 1300-foot deep artesian well at the pumping station in the Menomonee Valley. This well draws from the Potsdam sandstone and has a full capacity of 400 gallons per minute.

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upper surfaces of the St. Peter and Cambrian sandstone formations throughout the Milwaukee area. The results of this determination for the St. Peter sandstone are shown by contour lines on the geologic map. These lines, which are drawn at intervals of 100 feet vertically, show the depth below sea level at which the sandstone may be encountered in drilling. Comparison with the elevations of the surface as shown by the topographic contours will indicate the depths below the surface at which the sandstone lies in the various parts of the area.

Owing to the general absence of the Lower Magnesian limestone in this vicinity it has not been found possible, with the data at hand, to determine the position of the upper surface of the Cambrian sandstone very satisfactorily. Where the Lower Magnesian limestone is present, as in the Elm Grove and Waukesha wells, the upper horizon of the lower sandstone lies at variable depths below that of the St. Peter sandstone. Where the Lower Magnesian limestone is absent, as in the Elm Grove well, the upper horizon of the lower sandstone will be reached in drilling can not be predicted with such confidence as that to the upper surface as shown by the topographic map, there appears to be good probability of obtaining flows from this sandstone. Mr. Gray states that the head of a well in this region is usually somewhat lower than that from the St. Peter sandstone. Whether or not these formations are separated by limstone or shale at this point the writer is not informed.

The results of this determination for the St. Peter and Cambrian sandstone formations throughout the Milwaukee area are reported that where the Lower Magnesian limestone is absent, the upper horizon of the Cambrian sandstone is usually somewhat lower than that from the St. Peter sandstone. In the Elm Grove well the top of the Cambrian sandstone is 270 feet below that of the St. Peter; in the Waukesha well it is 140 feet; at Racine it is 148 feet. At the Miller brewery well the base of the red marly rock is 425 feet below that of the St. Peter sandstone. Unfinished when visited in 1894, it is probable that the base of the red marly rock is 480 to 500 feet below the top of the Cambrian sandstone. Unfinished when visited in 1894, it is probable that the base of the red marly rock is 480 to 500 feet below the top of the Cambrian sandstone. Mr. Gray states that the water from the well at the convert in Elm Grove rose to a height of 210 feet above the lake, or approximately 750 feet above sea level. This is the highest head which has been reported to the writer in this area. Mr. Story's well and one of those at the National Soldiers' Home, one-half mile further south, originally flowed with pressure sufficient to carry the water to elevations of about 720 and 760 feet, respectively, but in both these, as in some other, the head has decreased until the wells no longer flow.

The head of water from the St. Peter sandstone is usually somewhat lower than that from the Cambrian sandstone in the region. The 1700-foot well at the Blatz brewery, with a head of 598 feet, probably draws from the Cambrian, while the 800-foot well, with a head of 705 feet, probably draws from the St. Peter sandstone. Weather conditions are reported to be without limit or influence on the flow from the St. Peter sandstone.

A decrease in the head of artesian wells may be due to several causes. It can not be due to the water in the supply in this region, the rainfall and the collecting areas are ample and the porous formations are of the best. The multiplication of wells in a given area may, however, cause an excessive drain upon the supply reach the water-bearing strata is great. The interests of all might be conserved by shutting off the flow except when the water is needed. If there is danger of clogging the pipes, sufficient flow could be allowed to prevent such clogging and not draw heavily upon the supply.

A number of wells that flowed for a time have ceased to flow. Among these are the wells at the Soldiers' Home, at Mr. Story's, and Mr. Ladlind's.

The water from the St. Peter sandstone is reported to be unusually good, while that from the lower sandstone, though generally of good quality, is usually higher in mineral salts. Its mineral content is often large enough to make it unfit for certain uses. The following analysis by Mr. Gustavus Bode (Geology of Wisconsin, vol. 2, p. 31, 164) show that the water from the St. Peter sandstone contains more mineral salts than that from the Cambrian sandstone:

### Analysis of artesian water, Milwaukee, Wisc.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Parts per million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium carbonate</td>
<td>155.00</td>
</tr>
<tr>
<td>Magnesium carbonate</td>
<td>110.00</td>
</tr>
<tr>
<td>Iron carbonate</td>
<td>10.00</td>
</tr>
<tr>
<td>Aluminum</td>
<td>3.20</td>
</tr>
<tr>
<td>Silica</td>
<td>61.00</td>
</tr>
</tbody>
</table>

The Market square well draws its water from the St. Peter sandstone at a depth of 1048 feet, while that of Senator Jacobs draws from the Cambrian at a depth of 1230 feet. Water from one of the wells at the National Soldiers' Home, drawing from the Cambrian sandstone, carried 783.345 parts of mineral salts per million, of which 282.082 parts were calcium carbonate. Water corroded the pipes very badly. Water drawn from the Cambrian sandstone by the well at the E. P. Allis company's works contained 897.707 parts of mineral salts per million.

February, 1906.

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**Data concerning artesian wells in Milwaukee, Wis., and vicinity.**

<table>
<thead>
<tr>
<th>Location and source</th>
<th>Depth from curb (feet)</th>
<th>Depth of water below surface (feet)</th>
<th>Elevation of water above street level (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Park, Milwaukee</td>
<td>630</td>
<td>350</td>
<td>170</td>
</tr>
<tr>
<td>Market square, Milwaukee</td>
<td>150</td>
<td>400</td>
<td>70</td>
</tr>
<tr>
<td>E. P. Allis Co., Clinton and Florida streets, Milwaukee</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Miller Brewing Co., 318 North Thirty-ninth street, Milwaukee</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Story Bros., 125 North Forty-sixth street, Milwaukee</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>National Soldiers' Home, Milwaukee</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Mr. Dina, 48th and Forty-sixth avenues, Milwaukee</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Wauwatosa waterworks</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Mr. Leslie, NW 2 1/2 St, Wauwatosa Township</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
<tr>
<td>Elm Grove cemetery</td>
<td>300</td>
<td>350</td>
<td>200</td>
</tr>
</tbody>
</table>

---

**Addition data concerning deep wells in Milwaukee.**

<table>
<thead>
<tr>
<th>Company</th>
<th>Location</th>
<th>Date</th>
<th>Depth from ground (feet)</th>
<th>Depth of water below surface (feet)</th>
<th>Elevation of water above street level (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blatz Brewing Co.</td>
<td>Johnson st</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>E. P. Allis Co.</td>
<td>Clinton and Mass st</td>
<td>1894</td>
<td>150</td>
<td>140</td>
<td>160</td>
</tr>
<tr>
<td>Franklin street, between Second and Water streets.</td>
<td>1894</td>
<td>150</td>
<td>140</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>George Bode</td>
<td>115 E. Florida</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Scholten Brewing Co.</td>
<td>Walnut and Thirty-first street</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Miller Brewing Co.</td>
<td>Front and Thirty-first street</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Forest Home Cemetery</td>
<td>110 E. Florida</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Park Brewing Co.</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Mrs. Colman Jacob</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>John Johnston</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>John Meyers</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Michaelson</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Northwestern owner of railway</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Milwaukee sewage system</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
<tr>
<td>Cudahy parking house</td>
<td>1303 N. Broadway</td>
<td>1894</td>
<td>160</td>
<td>150</td>
<td>170</td>
</tr>
</tbody>
</table>