TOPOGRAPHY.

Description of the Chicago District. By William C. Alden.

The Chicago Plain and adjacent territory. The area covered by the sheet of the Chicago Plain is bounded by parallels 41° 30' and 42° north and meridians 82° 30' and 88° 30' west. It thus covers one-quarter of a square degree of the earth's surface, or about 892 square miles. This area, about 728,500 square miles, is land surface and the remaining 105 square miles are covered by the waters of Lake Michigan. The four sheets included in the folio are the Chicago sheet on the northeast, the Riverton sheet on the north, the Central sheet on the southeast, and the Desplaines sheet on the southwest.

We note in the margin that the area covered by this full sheet is bounded by Lake Michigan on the west, the Illinois River on the south, and Cook, DuPage, and Will counties, Illinois, on the east. It is furnished by their study.

The contribution to the history of the Great Lakes of this area is about 785 square miles are land surface by Lake Chicago during its greatest extension. From the shore of Lake Michigan, the surface of the plain broadens southward, attaining a width of 12 to 15 miles in a southwesterly direction from the city, where it again narrows as it passes toward the lake. The drainage of the plain in and about the city of Chicago is very poor, owing to the flatness of the surface and the consequent low gradient of the streams. This has made the sewage problem one of the most difficult with which the city has had to deal. Considerable areas within the city limits would be untenably unhealthy for artificial drainage systems.

This area is about 4 miles east of the city, and it is bounded by Lake Michigan on the west, the Illinois River on the south, and Cook, DuPage, and Will counties, Illinois, on the east. It is furnished by their study.

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One peculiarity of Calumet River is its appearance of the sea marshes of Louisiana. In this vicinity, it is an active line of drainage with a considerable gradient and has cut a sharp channel 20 to 25 feet in depth. Near Glenwood and at Thornton the erosion has reached the limit of the morainic ridge.

Desplaines River has its origin in the southern portion of Lake County, Wis., thence it flows about 45 miles, in a course slightly southward of east, to Summit, Ill. About 3 miles north of this point passes between Calumet Lake and the city of Chicago. This river, with its tributaries, is the chief natural drain of the Chicago Plain, together with the lakeward slopes of the morainic belt and the adjacent morainal depression. The drainage of the entire area is natural, having been shifted toward the north side of the valley to make room for the new drainage canal.

The principal tributary of Desplaines River in this region is Salt Creek. This flows in a direction slightly east of south, in a depression in the morainal belt. Its course is apparently controlled by the topography as far as Fullersburg. From this point, while the depression continues southward as the valley of Flag Creek, Salt Creek has abandoned its course and now flows to the southeast. This stream, which is an artificial channel, having been shifted toward the north side of the valley to make room for the new drainage canal, is a very anomalous course (fig. 14). It is a most interesting history, which is discussed under the heading "Rivers with little current in them." The drainage of the principal tributary of Desplaines River in this region is Salt Creek. This flows in a direction slightly east of south, in a depression in the morainal belt. Its course is apparently controlled by the topography as far as Fullersburg. From this point, while the depression continues southward as the valley of Flag Creek, Salt Creek has abandoned its course and now flows to the southeast. This stream, which is an artificial channel, having been shifted toward the north side of the valley to make room for the new drainage canal, is a very anomalous course (fig. 14). It is a most interesting history, which is discussed under the heading "Rivers with little current in them." The drainage of the principal tributary of Desplaines River in this region is Salt Creek. This flows in a direction slightly east of south, in a depression in the morainal belt. Its course is apparently controlled by the topography as far as Fullersburg. From this point, while the depression continues southward as the valley of Flag Creek, Salt Creek has abandoned its course and now flows to the southeast. This stream, which is an artificial channel, having been shifted toward the north side of the valley to make room for the new drainage canal, is a very anomalous course (fig. 14). It is a most interesting history, which is discussed under the heading "Rivers with little current in them." The drainage of the principal tributary of Desplaines River in this region is Salt Creek. This flows in a direction slightly east of south, in a depression in the morainal belt. Its course is apparently controlled by the topography as far as Fullersburg. From this point, while the depression continues southward as the valley of Flag Creek, Salt Creek has abandoned its course and now flows to the southeast. This stream, which is an artificial channel, having been shifted toward the north side of the valley to make room for the new drainage canal, is a very anomalous course (fig. 14). It is a most interesting history, which is discussed under the heading "Rivers with little current in them." The drainage of the principal tributary of Desplaines River in this region is Salt Creek. This flows in a direction slightly east of south, in a depression in the morainal belt. Its course is apparently controlled by the topography as far as Fullersburg. From this point, while the depression continues southward as the valley of Flag Creek, Salt Creek has abandoned its course and now flows to the southeast. This stream, which is an artificial channel, having been shifted toward the north side of the valley to make room for the new drainage canal, is a very anomalous course (fig. 14). It is a most interesting history, which is discussed under the heading "Rivers with little current in them."
between Sag Bridge station and Blue Island. The western part drains through the canal feeder to the Illinois and Michigan Canal at Sag Bridge station and the eastern part drains by South Creek to Calumet River at Blue Island. The valley bottom is marshy and covered by an extensive peat deposit.

The outer slope of the moraine belt south of the DesPlaines Valley is drained westward and southwestward by numerous creeks, of which the largest is Hickory Creek in Will County. This unit underlies the Deep North River valley about 1 mile south of Joliet. Most of these streams drain marshes in the moraine belt.

Between South Chicago and Hammond, Ind., is a group of shallow, marshy lakes or ponds. These are Calumet Lake, Wolf Lake, and George Lake. The largest, Calumet Lake, covers about 4 square miles. Hyde Lake has been entirely drained. Considerable marsh areas surround these lakes. Extensive marshes also occur east of Golf Park, north of Stoney Island, south of Maynard, Ind., and all through the lake border region of Lake and Porter counties, Ind. Large parts of these marshes have been artificially drained.

GEOLGY.

Sedimentary rocks. General relations. The geologic history of this part of Illinois is here sketched only in the broad outlines.

The rock forming the substructure of this region may be seen in numerous quarries about the city, and is reached by all borings which pass through the drift. The formation exposed at the quarries and first reached in borings in the Niagara limestone. Where these borings have penetrated to depths of several hundred feet, not only the great rock formations are found, limestones, sandstones, and shales, but also marine fossils are rare. The older formations are exposed in the DesPlaines Valley.

The thickness, character, and general stratigraphic relations of the great sedimentary rock formations underlying this area, as determined by borings for artesian wells, are shown in figures 2 and 3. All the deepest wells in this region terminate in the middle of a great sandstone formation, the real rock surface, until at length even this lower sandstone reaches the surface, spreads over a great area, thin out, and disappears. From beneath this sandstone there appear crystalline rocks of yet remoter age. It is believed that these latter rocks everywhere underlie the formations found by the well borings beneath the Chicago area, and that their erosion originally furnished the material from which the overlying sedimentary formations were made.

Cambrian Period. Potsdam Group. This lower group of sediments, which is very widely distributed in the United States, is of later Cambrian age. Since this is the earliest of the Paleozoic formations in the northern interior, it is evident that a large part of the continent was land area and was exposed to denudation while the earlier Cambrian formations were being deposited in the eastern and western seas.

With the opening of later Cambrian time, however, the sea advanced upon the land from the north, until all of the northern interior of the United States, only the northern half of the state of Wisconsin and parts of northern Michigan and Minnesota remained above water. At the Joliet Steel Mills, 4 miles farther south, the section of the Potsdam group is as follows:

- Sandstone (Madison sandstone?) 350 feet
- Silty sandstone (lower Magnesian limestone?) 30 feet
- Carbonaceous bedding (Mendota limestone?) 125 feet
- Limestone and sand (Mendota limestone?) 35 feet
- Limestone (lower Magnesian limestone?) 35 feet
- Sandstone (Madison sandstone?) 75 feet
- Total 600 feet

These sections show deposition in water some 250 feet deep, where the water was calmer and the depression greater, but the water was not deep enough to cover the region lying farther east, for instead of so much sand, fine ashes were deposited that the fossil of the succeeding formation show that an interval occurred in which the marine fauna was almost entirely changed. When the sea again submersed the area a fauna composed almost entirely of new species made this habitat.

Niagara Period. Lower Magnesian Group. Overlying the beds of the Potsdam group is a magnesium limestone formation 160 to 450 feet thick. This formation thickens toward the south and southwest, being 350 feet thick at the Chicago Heights well and 450 feet thick at Joliet. The deposition of the silts continued in the Lockport region, so that the well shows the following section:

- Sandstone (lower Magnesian limestone?) 350 feet
- Silty sandstone (lower Magnesian limestone?) 30 feet
- Limestone (Mendota limestone?) 125 feet
- Total 600 feet

As a general rule, however, clearer water prevailed and a new and different fauna was developed. While it is probable that the Lower Magnesian limestone was derived from the calcarous residues of this marine life, well-preserved remains of them are not abundant.

The dolomite character of the limestone is held by some to have been due to contemporaneous deposition from the magnesium salts of the sea water, and by others to have been due to subsequent alterations.

St. Peter Group. A return to conditions favorable to the deposition of sand and silt, marked the end of the deposition of limestone and the beginning of the Pleistocene. The sands and clays are the deposits of this region, which overlie the Lower Magnesian group.

This is a very porous, white sandstone, varying considerably in thickness. It ranges from 60 feet thick where it is reached in wells at Goose Island and Chicago Heights, to 2 miles thick near its northwest of the Chicago Harbor inlet, to 200 feet thick near Joliet, and to 450 feet at South Chicago.

Trenton Group. Limestones of the Trenton group were deposited in this region during the Pleistocene period which next followed. In the clear waters of this Trenton sea lived a profuse and varied fauna, as we may judge from the fossils remains at places where the rock is now exposed at the surface. This fauna consisted of corals, crinoids, mollusks, crassacrustaceans, and other invertebrates. The limestones are mostly magnesium. Wells in the vicinity of Chicago show strata 270 to 350 feet thick, referable to this group. The upper part of the formation, known as the Mendota limestone, is the lead-bearing formation of northwestern Illinois. The lower part is known as the Trenton limestone.

Chicagoland or Huben group. Overlying the Trenton limestone is a formation composed of thin-beded shales or mud stones. These are, for the most part, composed of the fine, muddy sediments carried into the sea by the drainage of the land. It is possible that these fine sediments so polluted the water so as to have a marked effect upon the living organisms therein. At any rate, there was a marked change in the fauna; new species came in, and such as could not adapt themselves to the new conditions were extinguished or forced to emigrate.

Under the Chicago area this shale formation is shown by wells to vary in thickness from 105 to 180 feet. It was found to have a thickness of 250 feet at the first Union Stock Yards well. A 30-foot bed of limestone occurring in the formation at this place shows an interval of clearer water.

At the close of the Huben epoch two great seas developed, one in the interior continental sea in the region of Indiana, Ohio, Kentucky, and Tennessee, which very materially affected the rock-making conditions. No marked disturbances of the strata are found in the vicinity of Chicago, but the sea was withdrawn for a considerable period, as is shown by the fact that formations which were elsewhere deposited between the Cincinnati group and the next forming group are not present in the Chicago area, and by the fact that the fossils of the succeeding formation show that an interval occurred in which the marine fauna was almost entirely changed. When the sea again submersed the area a fauna composed almost entirely of new species made this habitat.
The limestone is known to occur in several localities within the Lake Michigan basin, including:

- **Chicago district**: There are several localities where limestone is exposed, including:
  - **South Bend Formation**: Found in the Chicago area, this formation is composed of thin-bedded, gray limestone, massive below, weathering yellow.
  - **Gee's Bend Limestone**: A small lenticular elevation in the Elmhurst area, Illinois.
  - **Two blocks west of Humboldt Park, at the intersection of Division and Winona avenues**: A small quarry furnishes a dense, fine-grained, stratified limestone for roadbeds.
  - **Northwestern Indiana**: Limestone is exposed in the vicinity of Gary, Indiana.

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This information provides a comprehensive overview of the geology and paleontology of the limestone in the Chicago area, highlighting its significance in the region's history and development.
of North America. The remaining fish both are two new species of Ptyctodus, which have been described by Mr. Weller thus: "The presence of the remains of this fauna of the Wisconsin land to the north; during this interval the rock beds were covered with a layer of sediment which was then subjacent to carbonate and shale. The evidence of so great an advance in the life forms thus gives to these Elmhurst deposits a type of fauna which characterizes the Wisconsin area from the point of view of paleontological development and stratigraphic position.

As the rock is exposed in places, it is evident that the drift in this region is a type of material which has been deposited in a glacial environment. The drift is composed of unconsolidated material, mainly consisting of sand and gravel, with lesser amounts of silt and clay. The drift is characterized by its irregular surface, with numerous small depressions and irregularities.

The drift is also characterized by its stratification, with layers of sand and gravel alternating with layers of clay and silt. These layers are often well-defined and can be traced over long distances. The drift is also characterized by its thickness, which varies from a few feet to several hundred feet in some areas.

The drift is an important geological feature in the region, as it provides evidence of past glacial activity and the history of the area. The drift is also an important resource, as it provides a source of building materials and is used in various industries.
cause, the fact that a great ice sheet, about 4,000 square miles in area, extended to within 20 miles of the southern boundary of the Great Basin, shows how far the climate was modified by it. The glaciers which had developed in the mountains were still advancing, and it is probable that some of the great ice sheets of the Pleistocene period occupied a series of these glacial and interglacial stages.

Chicagoland:

1. Lake Wisconsin drift sheets.
2. Postglacial drift sheets.
3. Wisconsin drift sheets.
4. Eolian drift sheets.
5. Drift sheets and weathered zone. (external and internal surfaces of North American drift sheets.)

Drift sheets and interlocking drift sheets of North America.

The surface of the ice to have had sufficient energy to move the material of its bottom up this slope, to cause the movement of its entire body, the glacier, would have had to be unconfined. This is the case with the Pleistocene sheet, which is more than 100 miles wide and extends over a large area. The glacier would therefore have had the energy to carry the load of the sheet and the debris on its surface, and to move it southward along the Lake Michigan shore. The glacier would have been able to move this load because it was supported by the weight of the water on the surface of the sea, which was higher than the level of the land.

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of the glacier, may be carried hundreds of miles to which reference has been made. Thus englacial what above the basal layers, may be carried presumably that most recently taken act cear of h sub-part of the ground moraine. Body or the ice, except such descent 01 superglacial material as could not afterward be during the retreat all the drift embedded in the some time, or if the ice front oscillated back and any considerable time, there was made _ . . , .

At the quarry near McCook station, on the Chicago and Central Railroad, the rock exposure shows distinct groovings about S. 60° W., to be the product of river erosion rather than overridden and commingled and spread out over the rock surface. There was probably not so great . . . moraine, as left by the glacier, was in the surface . . . moraine and the ground . . . the limits of the Chicago Plain. Southeastward into Dupage County, is apparently undulating. From a point near Lagrange to Homewood the present inner margin of the moraine is estimated at 35 feet above the lake. While the rock surface is higher under the moraine than under the plain, the elevation of the moraine and that of the Chicago drift ' . . . of drift and is not due to a rock core is shown by well borings. While the ridge has a relief of 10 to 15 feet above the surrounding plaines River in the towns of Norwood Park and Homewood, the rock core there is probably a mile along, the ridge being solid rock. While one ridge is inclined to correlate with it the bowlder clay. They are remnants of pre-Glacial or of inter-Glacial vegetation which was over­ ridden by the advancing glacier and buried in the drift. Stratified drift.—The stratified sands and gravels are extensively present on the Chicago Plain, although they are not here referred to as strata of great thickness. They are seen to be deflected 26° from parallel about a small prom­ 

The stratified sands and gravels, stratified and cross bedded in a beauti­ 

In the bed of the Sanitary and Ship Canal of Chicago, at the quarry near McCook station, on the Chicago and St. Paul Railway. In this part it ... to 200 feet above the surface of the drift whose place of derivation is at a con­ 

While the sand is less than 5 feet below the surface, a certain part of the drift was left upon the surface or partially or wholly overridden and commingled and spread out under the plain. The fine material, being small in amount, is not readily distinguished from the subglacial drift, but the bowlders are largely left upon the surface or partially or wholly overridden and commingled and spread out beneath the ice as the ground moraines. In the continental ice sheets the advance continued for hours or days, the glaciers traversed vast areas, melting out the drift in the extensive sheets near the glacier. When the rate of melting so nearly equalized the rate of advance so as to cause the ice front to halt for any considerable time, it was said to be a greater deposit of drift; because, though the front of the glacier halted, the ice itself continued to advance and bring up drift to be deposited at the melting front. Such deposition also took place beneath the thinned melting edge of the ice sheet. If it halted for some time, or if the ice front oscillated back and forth over a narrow area, these deposits were called ridge-like belts of thickened drift,—i. e., a border moraine or terminal moraine.

When the rate of melting equalized the overcutting rate of the advance, either from the increase in the melting or from the decrease in the advance, or from both causes, the ice front receded, and during the retreat all drift embedded in the ice was left upon the surface of the ground. It was only when the melting was less than the rate of advance that the ice front moved forward, and this freed material was overridden and commingled under the ice as the ground moraine. The continental ice sheets advanced for hours or days, the glaciers traversed vast areas, melting out the drift in the extensive sheets near the glacier. When the rate of melting so nearly equalized the rate of advance so as to cause the ice front to halt for any considerable time, it was said to be a greater deposit of drift; because, though the front of the glacier halted, the ice itself continued to advance and bring up drift to be deposited at the melting front. Such deposition also took place beneath the thinned melting edge of the ice sheet. If it halted for some time, or if the ice front oscillated back and forth over a narrow area, these deposits were called ridge-like belts of thickened drift,—i. e., a border moraine or terminal moraine.

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times of greater melting. The overlying unstratified till may indicate a slight advance of the ice over the region. Flinty, hardpan deposits of assorted gravels are also seen at various points in the side of the valley. Perhaps the best exposed is on the north side of the lake a mile north of Willow Springs. Here are several large gravels, and is very marked. Fault borders seem to indicate that the narrow hill east of Flag Creek in this vicinity is composed almost entirely of outwash gravels leading in the outer slope of the Valparaiso moraine have already been noted. Then, when the ice front first withdrew within the crest of the Valparaiso moraines, there were not such direct lines of discharge to draw off the water, as it collected in hollows in the surface of the moraines and in a string of ponds bordering the ice front and along the inner slope of the moraine. At first these ponds or lakes were presumably isolated and discharged over the moraines as they found opportunity. The scattered marsh areas indicated on the maps may mark the location of many of these localities. The ponds that were immediately contiguous to the moraine have long since drained away more and more and connected with one another. At lower outlets were opened the higher lines of discharge. The ice front, if the outwash meltwater became confluent into one marginal lake lying between the ice front and the inner slope of the moraine, a lake and valley bottoms to a marked degree and valley bottoms to a marked degree and valley bottoms to a marked degree and valley bottoms to a marked degree and valley bottoms to a marked degree. If the Chicago Outlet was a line of discharge.
From the bluff at Winnetka this Glenwood beach swings southwestward for several miles to the mouth of North Chicago Creek. The bottom of the lake near the shore slopes gently up to the water's edge, forming a wave-cut terrace. The horizontality of the landward margin, which also marks its junction with the cliff, is the essential characteristic of a wave-cut terrace. It should be noted, however, that in the case of the ancient terraces from which the lake has withdrawn, their landward margins may be locally rounded unevenly by alluvial fans formed at the degradational axes of ravines and gulches in the old cliff edge.

From Niles southward through Norwood Park to the Chicago, Milwaukee and St. Paul Railway and beyond, the Glenwood shore line lay along the east margin of a moderate height and slightly undulating tract. This tract is the southern part of the western till ridge of which Mr. Leverett regarded as composing the lake-border morainic system. West of this ridge there was a shallow estuary 3 or 3 miles in width at the time the Glenwood beach was forming. This estuary probably extended some distance northeasterly and brought to the lake the drainage of the inner slope of the Visconsin moraines. In the western part of this low area, Desplainsville River has now cut its channel. As there was little or no wave action in this estuary its shore lines, except in the southern part, are not clearly worked. The line of position as indicated on the maps has been assumed from the general topographic relations.

From the southeastern margin of this ancient lake shore the currents, moving southwestward, had cut a wave-cut terrace, marked by an arcuate scarp, and a cliff 15 to 30 feet high. The former material from this erosion was carried back into the deeper water, but the sand and gravel were left near the shore. A current moved along the shore in the direction indicated by the arrows (fig. 9). While flowing on the shallow bottom near the shore the current carried along more or less of this sand and gravel. As it reached the point of land below Galienake the current continued across the estuary in the general direction already assumed, instead of following the remnant of the shore. As it reached the deeper and more quiet waters its velocity was checked, its carrying power reduced, and the load dropped. More material was constantly brought forward, being carried out at some time a little further over the deposit already made, thus a narrow submerged ridge of sand and gravel was extended out from the headland in the direction of the shore currents.

As a current flows across the mouth of a bay, the sweep of the winds across the open water of the lake may throw up the material which is transported as a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar. When it is built up to the level of the quiet water of the bar, the waves of storms may throw up the entire mass and form a bar.
ture of the whole is that of a great curved bar, formed by a series of hooks extended one from the other with the same general front. As this bar is more or less coated with wind-deposited sand, the beach gravels of the Glenwood stage emerge from beneath the ridge of dune sand and continue southeastward toward Glenwood.

It is not known how long the waters stood at this upper level. It was long enough to accomplish considerable erosion of the outlet and of the inner margin of the moraine. Most of the debris seems to have been swept away from the outlet as the waters were lowered to the next stage. The uppermost level of drift seen in the wave-cut terraces and cliffs is capped by a thin deposit of sand and has layers of sand separated by yellowish-blue till which forms the base of the exposure there. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit. The peat is immediately overlain by a lacustrine deposit.

Along the east side of the island, where the waves began to drag upon the gently rising lake bottom and formed a line of breakers, the shore drift was built out into an elevated beach line. There were two stages in its development, forming an inner and an outer ridge. The outer one is the one whose margin is formed by the outlet at the northern end of the basin, blockmed to the west by the sand ridges. This beach was formed at the second succeeding lake stage, the Toledon stage, hence the soil (9) and the post bed (7) may be found forming an interval between the Calumet and Toledon stages. It is possible, however, that the surface was higher during this interval than the two other stages at the beach of the Glenwood stage. This deposit was later broken down into a series of lagoons which left a deposit of rich black loam over the surface of the till. The till in the plane of the beach is stratified, and the soils are best seen in the excavation just west of the beach before that beach and the bar under discussion were built.

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glacial drainage at a certain stage in the retreat of the ice front.

From Riverdale to the outlet, the head of which at this stage was at Summit, the Calumet shoreline was not well defined. At the Glenwood stage, Mount Forest Island and Blue Island were separated by an expanse of water. At the farther point of the beach, the intervening plain emerged and the whole area formed one large island between the headland of Linn and the outlet (fig. 13). Sag Bridge station marks the western extremity, Summit the northern, and Blue Island village the southeastern. The far part of this island may at times have been submerged during this stage, since its elevation is very nearly that of the lake surface at this time.

The east shore of the outlet was not at first coincident with the side of the valley as now seen, but lay upon the east at distances varying from a few yards to one-half mile from the present cliff. Its position is marked by an interrupted deposit of sand and gravel. The outlet at Summit was about 1 mile in width.

From Summit southeastward the lake shore line swung in a broad curve about the north end of the Blue Island ridge, and at Linn Heights. Throughout this distance of 111 miles the Calumet beach is marked by a continuous well-developed ridge of sand and gravel 5 to 10 feet high and 50 to 100 yards wide. North of Archer avenue, in the village of Summit, there is an excellent 10-foot section showing the structure of the beach. The material ranges in size from coarse sand to pebbles, and it is 2 to 3 feet in diameter. It is well set down and stratified in beds dipping northward at an angle of 30° to 40°. This is the ridge now traversed by Vine avenues.

The head of the Sag outlet at this stage may be considered as lying between the south end of the Blue Island ridge and the inner margins of the moraines about 3 miles further south. The waters passing through this outlet were divided by a low body of land known as Lanes Island. This has a width of one-fourth to one-half mile and a length of 3 miles. Its outline is traced by a low, narrow ridge of beach sand and gravel. This island was submergence during the Glenwood stage, but the lowering of the lake left the cretaceous exposed. Stone Creek now traverses the north channel. The total width of the Sag outlet, including Lanes Island, was nearly 3 miles. West of this island the channels unite and the beach is marked by a well-defined outlet of the lake at Riverdale and Thornton. A careful consideration of the relations, however, seems to indicate that at least during the earlier part of the Calumet stage the shore line lay along the beach ridge and dunes of Linn Heights and the village of Blue Island. As indicated, the beach grade of the Glenwood stage is a well-marked deposit of dune sand east of Beach Street, and the shore line during and after the Calumet stage. The deposit consists of ridges and hillocks of fine sand and gravel 20 to 30 feet in height. These ridges are now well covered with vegetation, so that the sand is no longer shifting.

The extensive deposit of dune sand east of Thornton is largely in parallel ridges, the formation of which probably began during the Calumet stage. These ridges are also largely covered with vegetation.

From a point on the Calumet beach north of Chicago there extended into the Chicago embayment at this stage a conspicuous bar, but now is marked by only three or four feet of water. At the northern end of the outlet the beach has largely been destroyed by the city of Chicago which lies between North Branch and Chicago. The shoreline now is a cut terrace and bank.

The relations of land and water at this stage, so far as the vicinity of Chicago is concerned, are shown on the map (fig. 15).

In the discussion of the low-water stage between the Calumet and Glenwood stages, reference is made to certain phenomena which indicate the possible occurrence of a second low-water stage between the occurrence of the Calumet stage and the change during which the northeast outlet was reopened and the spit closed. In the present article, however, the evidence is not considered conclusive.
been nearly or quite continuous through the city; but now as the result of city improvements, it is scarcely recognizable for a distance of 4 miles southwestward. Thus, the edge of Green Island, at Cottage Grove avenue and Thirty-fourth street, extends southwestward a distance of 7 miles, through the northwestern part of Washington Park, Englewood, and Auburn Park to South Englewood, where it unites with the Lake Shore line shore described. The course of this bar southward from Green Island is that of a series of overhanging cliffs, with their dental ledges or cliffs that turn into the bay as the west, extended southwestward one from another with the same general front, in the manner already described. A deposit of sand about 1 mile in width is spread over the bowlder clay west of this bar.

The advance of this bar controlled the channel of free flow toward the outlet; at the same time the lowering of the lake level diminished the outflow in that direction, so that the current was unable to keep a clear channel and the bar was finally completed across the bay to the farther shore at South Englewood. This is the most notable instance, within the area studied, of the cutting off of embayments in the simplification of shore lines. The southern part of the area west of this bar eventually drifted out to the east through the depression now occupied by the Auburn Park lagoon, and the establishment of Chicago River probably the remainder. It was probably while this bar was being built and the outlet to the west diminished that the present outlet of the lake to the northwest was being established. As the flow to the north increased, that by way of the Chicago Outlet diminished.

At the Tolleston stage of the lake Stoney Island had begun to emerge as a reef or as an island, and in its position (fig. 12) gave it a controlling influence on the currents. Under these conditions the currents that had shifted southward by the extension of the bar just described, now came to work upon the gentle till slope, and a terrace and sandy beach developed from South Englewood through Burnside to the lee of Stoney Island. These southeasterly currents were here met by westward currents south of Stoney Island, and the drift was turned abruptly southeastward toward the site of Pulaski. With the lowering of the lake level this new line became the shore and the original line through Farwood was abandoned. The relations of the line through Farwood to that through Burnside are somewhat obscure.

The large island formed at the Calumet stage by the emergence of the area between Blue Island and Mount Forest Park is possibly the remainder of the Tolleston stage. This was the necessary result of the lowering of the lake level.

In striking contrast to the Glenwood and Calumet beaches the Tolleston beach contains abundant traces of relation to the life of Lake Michigan, if not identical with it. As one of the best exposures of the structure of the Tolleston bar, Mr. Leverett has given, with the section observed in 1854 by Dr. Oliver Marcy at the border of the Illinois Ledge, 49° 48'.

The advance stage, the 6th, 7th, 8th, and 9th of the last section and the 10th of Dr. Marcy's section contain numerous gasterostracous. Dr. Marcy has noted the following life of the Adamanian stage from this horizon, among which there are Lake, apparently not especially well preserved. The Fossil Smith has identified the life of this stage: mollusks and Echinodermata are very abundant. Prof. D. P. Fowke, boys, consisting of part of a jaw, teeth, and parts of a few other bones, now in the collection of the Chicago Academy of Sciences, are said to have been found beneath 18 feet of sand. Whether these specimens are to be correlated with the beach deposits at this point can not be definitely determined, though they were said to occur on the soil corresponding to No. 6 of Dr. Marcy's section given above, overlying the peat horizon.

POST-GlacIAL Epoch.

Recent changes.—With the diversion of the water of the lakes from the Chicago Outlet to the northeastern one, the history of Lake Chicago may be considered as divided into two distinct epochs: the first, the history of Lake Michigan; the second, the history of Lake Chicago. They are, respectively, the oldest and the youngest stages of the post-glacial period. The formation of the basin now occupied by Lake Michigan is the result of the lowering of the lake level. The drift of Michigan mark the closing stages of the history of Lake Michigan and the establishment of Lake Chicago. As the result of this lake, the large island formed at the Calumet stage eventually drained out to the east and was unable to keep a clear channel and the bar was shifted southward by the extension of the bar eventually drained out to the east and was unable to keep a clear channel and the bar was shifted southward by the extension of the bar.

A new channel has been opened by dredging, to keep the harbors open. Before improvements had begun in 1854 on the present Chicago harbor, there was a bar across the outlet of Chicago River which shifted the bar southward nearly one-half mile from its present position to a point opposite the mouth of Michigan. The construction of the harbor inlet was formed by cutting through this bar and by constructing piers at either side of the cut. The north pier has extended from time to time as the sand accumulated on the north side. Successive positions of the shore line north of the south pier are shown in fig. 13. This figure shows the bar formed by the sand drifted to the end of the pier in 1851, when the shore line had filled out nearly to the end of the pier. It also shows the dimensions to which this bar had grown in 1846, as determined by Col. T. J. Cross, U. S. Engineers, in his survey of that year.

The course of Calumet River has been yet more curiously affected by the deposition of shore drift. At the Tolleston stage of the lake, Calumet River discharged its waters into the Sag outlet opposite Illinois Island (fig. 15) after having flowed 26 miles nearly due west to the lake and nearly 2 miles distant from it. When the lake level lowered and the western shore drained through the Sag outlet ceased, the waters of the Calumet occupied the channel between the River Island and Riverdale and reached the lake at the latter place (fig. 14). As the waters continued to subside the stream lengthened; but, instead of flowing northwestward directly to the lake, the continued shifting of the outlet by the shore drifts from the north carried the debris seaward to the most southerly point in the lake of Lake Michigan, its present position north of Miller's station, Indiana (fig. 14), nearly 14 miles from the

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said that this channel at Hegewisch was originally opened by the retreat of Elmhurst, a town of Illinois about ninety years ago; that they pushed their canoes in a line through the marshes until a channel was worn wide enough to allow water to flow freely.

Since the process of shore erosion, southward drift, and accumulation has evidently been going on ever since the first lake, which covered the region in ice, has been laid aside, it is evident that one might have a measure of the post-Glacial time if the rate of shore erosion, the rate of drift transportation southward, and the amount of filling all already accomplished, were known.

Some years ago Dr. Edmund Andrews undertook an investigation of this matter and published his results. The paper is now out of print, but the computations have been improved and supplemented by Mr. Leverett in his bulletin on the Pleistocene Features and Deposits of the Chicago Area, and in his monograph on The Illinois Glacial Lobe (pp. 456-459). While there are many unknown and variable factors in such a problem, the results, as Dr. Andrews remarked, useful in showing that it is impossible to allow, even on the most liberal estimates, any such duration of post-Glacial time as 100,000 years, which, at that time, had often been claimed.

The formation of sand dunes by the blowing away of fine sand from the beach into ridges and hills, has only occurred in the various stages of Lake Chicago, but the most striking results have been accomplished since the latest of these hills has approximated its present position. Small dunes illustrating the essential principles of dune formation may be seen at Windsor Park, near the foot of Seventy-sixth street, and at various points on the South Chicago beach (fig. 25). At Prairie Park and Miller's points, dunes are to be seen in all stages of development, from little drifts of sand, such as are shown in the great hills of blowing sand from 100 to 200 feet in height. An examination of these shows their mode of formation. As a brisk wind which is carrying sand passes an obstructing object, such as a tree, a shrub, or a tuft of grass, its current is interrupted, and in the quieter areas immediately in the lee of the obstruction some of the sand is blown and the dune ceases its travels; it becomes a fixed object, so far as the wind is concerned, and, unless it is removed by rain, snow, or other agencies, it remains a dune until it is blown or buried. The dunes which have occurred in the Chicago region are to be seen at various points about the head of the lake. In its migration a dune may reach upon the vegetation, and bury the trees. So long as the upper branches of the tree are uncovered by the sand the growth continues, but, once the sand has covered the tree it is usually killed. Since the highest part of the dune is close to its advancing front, and the migration of the glacial ice front from this region, it is evident that one might have a measure of the post-Glacial time if the rate of shore erosion, the rate of drift transportation southward, and the amount of filling all already accomplished, were known.

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Molding sand. — About 15 miles north of Lagrange is a pit from which molding and plastering sand has been taken. The molding sand is a dark-brown, partially compacted, coarse, clayey mass, without sphericity. The deposit is probably local and limited.

In a small ravine cut in the south side of the bog east of the above pit, a molding sand is found, which resembles closely the deposit which is light sand showing delicate cross bedding, as if also evidently a wind-blown deposit. The ravine is considerable in amount. It would seem well in a small ravine cut in the south side of the Purington station, on the Chicago, Rock Island and Pacific, to find deposits of a sort of clayey mud, which, when dry, can be easily pulverized to dust as fine as flour. This is a curious limestone pebbles varying in size from that of a sand. Mr. Purington, of the Purington-Kimball lead mine, reports that in the latter he says:

In the valley near Willow Springs and in the Sag, beds of peat have been exposed. These deposits afford gardening in close proximity to the city market. The occurrence of a bituminous peat in the county is also well shown in a small ravine cut in the south side of the valley and in the Sag. The occurrence of a bituminous peat in the county is also well shown in a small ravine cut in the south side of the valley and in the Sag. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below the National Park. The occurrence of a bituminous peat in the county is also well shown and in very fine pieces are found in the deposits in the valley below...