THE PHYSIOGRAPHY OF THE REGION OF CHICAGO
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THE PHYSIOGRAPHY
OF THE
REGION OF CHICAGO
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By F. M. FRYXELL
DEPARTMENT OF GEOLOGY, AUGUSTANA COLLEGE
ROCK ISLAND, ILLINOIS

PREPARED BY
The University of Chicago Local Community Research Committee,
and the Chicago Commonwealth Club, for the
Committee on General Surveys of the
CHICAGO REGIONAL PLANNING ASSOCIATION

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INTRODUCTION

WHEN the Chicago Regional Planning Association started its work the officers immediately recognized the need for a correct base map of the region. For convenience of study they selected an area with approximately a fifty-mile radius, an area which included parts of three states, all parts of fifteen counties, and over two hundred and fifty cities and villages. Sections of the area had been carefully mapped, but for some parts there were no available maps, and on no one map was there the complete information needed. The first undertaking of the Association's Committee on General Surveys was the preparation of such a map, under the direction of Professor J. Paul Goode, of the University of Chicago.

To accompany the map, each department of the Regional Planning Association needs certain general information on the physical geography of the region, so that it may lay its plans carefully and on a correct foundation. Therefore the present study was undertaken which delineates in a broad way the outstanding natural features of the region and emphasizes especially such as have bearing upon regional planning.

The preparation of this work, as well as of the map, was made possible by the joint financial contribution of the Chicago Commonwealth Club and the Committee on Local Community Research of the University of Chicago. A grateful acknowledgment is accordingly made to both of these organizations.

In this report the area covered by the base map is designated as the "region of Chicago," or the "Chicago region," although the latter term has been used by other authors in a more restricted sense to refer only to the area covered by the Riverside, Chicago, Des Plaines, and Calumet topographic maps published by the United States Geological Survey. This region of Chicago lies at the head of Lake Michigan and embraces the northeastern corner of Illinois, the southeastern corner of Wisconsin, and the northwestern corner of Indiana. More specifically, it includes the counties of Lake, McHenry, Cook, Du Page, Kane, Kendall, Grundy, Will, and Kankakee in Illinois; the counties of Racine, Kenosha, and the eastern two-thirds of Walworth in Wisconsin; and the counties of Lake, Porter, and LaPorte in Indiana. Discussion is extended at times to outlying counties, notably Starke County and the northern part of Pulaski, Jasper, and Newton counties in Indiana; and the northeastern part of Livingston County in Illinois. The city of Chicago occupies a central position with reference to this region.

The inception of this study is due to Dr. J. Paul Goode, of the University of Chicago, the general plan developed in the report is essentially his, and he has given the work his constant personal attention. This invaluable supervision and the kindly interest which have accompanied it the writer takes the greatest pleasure in acknowledging.

To Professor J. H. Bretz, of the University of Chicago, who has shared with Dr. Goode the supervision of this study, the writer gratefully acknowledges his indebtedness for help and counsel. He also expresses his deep appreciation to Dr. M. M. Leighton, director of the Illinois Geological Survey, who not only placed at the disposal of the writer much unpublished data in the possession of the Survey, but also volunteered many suggestions which have been incorporated in this study.

Acknowledgments are also made to Dr. R. S. Smith and Dr. L. H. Smith, of the agronomy department of the University of Illinois, for access to unpublished soil data of the Agricultural Experiment Station, and for courtesies extended the author on the occasion of his visits to Urbana; to Professors D. J. Fisher, W. D. Jones, Paul MacCintock, George D. Fuller, and H. C. Gates, of the University of Chicago, and particularly to the officers of the Chicago Regional Planning Association, all of whom have generously assisted the writer on various occasions. Assistance is also acknowledged from the United States Geological Survey, the Bureau of Soils of the United States Department of Agriculture, the Indiana and Wisconsin Geological surveys, and the United States Lake Survey.

A complete statement of indebtedness to the great geological literature dealing with the region of Chicago is, of course, impossible; but in the text citations are made to the works from which most important data have been obtained, and a Selected Bibliography appears at the close of the report. The standard publications of Chamberlin, Leet, Taylor, Salisbury, Ader, Martin, and Goldscheild have constituted an invaluable mine of information.

F M Fryxell
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Chapter I

GENERAL PHYSIOGRAPHIC FEATURES
AND THEIR ORIGIN

The region of Chicago lies in what is known in a physiographic classification of the United States as the Central Lowland, an area embracing a large part of the vast basin which stretches from the Appalachian highlands on the east to the Rocky Mountains on the west.

Four features of the Central Lowland are of outstanding prominence: First, it is everywhere low and flat of surface. Illinois is the lowest of the states within its bounds, with a mean elevation above sea-level of only 600 feet; Indiana is 100 feet higher; and Wisconsin, notably higher than either Illinois or Indiana, has a mean elevation of 1,050 feet. Second, throughout the greater part of the Central Lowland the bed rock is deeply buried beneath a mantle of unconsolidated glacial deposits (see Fig. 7). Third, the province is drained by two extensive river systems, the St. Lawrence on the east and the Mississippi on the west. Fourth, the northeastern part of the province is a lake region, being occupied by thousands of small glacial lakes, and by the Great Lakes, the largest system of fresh-water bodies in the world.

In almost the exact geographic center of this lowland is the region of Chicago. The strategic importance of its location is due to at least four significant facts: (1) In the Central Lowland is probably the richest agricultural belt in the world, and in the center of it lies the region of Chicago. (2) The general flatness of the Central Lowland has facilitated the rapid extension of railroad and highway lines with the minimum of expense and difficulty. These railroads and highways concentrate on Chicago because east-and-west traffic is here compelled to turn southward around the head of Lake Michigan, thus meeting and crossing at this common, geographically determined focus. (3) Here is a direct point of contact between the lake region with its great water-transportation system and the agricultural region with its highly developed railroad system. (4) The Continental Divide between the Mississippi and the St. Lawrence drainage systems crosses the region of Chicago (see drainage map, Plate III). Therefore the region has the advantages of both systems, and proffits by whatever improvements are made in either with respect to inland waterway development.

NATURAL DIVISIONS OF THE REGION OF CHICAGO
AND THEIR ORIGIN

Alternating ridges, plains, and valleys enter the area at the north and, roughly paralleling the shore of Lake Michigan, swing southeastward around the head of the lake. The streams emphasize the alternate higher and lower land by flowing either parallel to the shore of the lake or at right angles to it. This same pattern is brought out in the distribution of soils (see generalized soil map, Plate IV); it is most strikingly shown, however, on the relief map (Plate II) and on the glacial map (Plate I).

Six such concentric belts or zones are recognized, and each is discussed in a separate chapter. They are as follows:

1. The Lake Plain
2. The Lake Border Upland
3. The Valparaiso Upland
4. The Manteno Plain
5. The Morris-Kankakee Basin
6. The Outer Upland

Lake Michigan is regarded as a special province, and its description follows the discussion of the land divisions.

How the natural divisions originated, and what has happened to them up to the present is an intensely fascinating story even to those who are not particularly interested in geology, because of the direct bearing which these divisions have upon what is happening in human affairs today.

ORIGIN AND CHARACTER OF RED ROCK

The existence in the Central Lowland of a series of strata of limestone, sandstone, and shale, containing marine fossils, indicates that this part of the continent was in ancient geologic times repeatedly depressed below sea-level so that seas stood over the area. For deposits to have accumulated at the bottom of these seas, as thick as those we now find the marine conditions must certainly have had a duration of millions of years.

Finally the sea bottom emerged to be inundated no more. Another vast interval of time elapsed, comparable in length to that during which the region was under the sea. Since the lifting of the sea bottom the central part of the continent has been subject to erosion. The uplifted surface was slowly dissected into valleys and hills; under atmospheric conditions soils accumulated; and a landscape of rugged rock valleys and ridges was developed not unlike that found at the present time in southwestern Wisconsin.

**ORIGIN OF THE GREAT LAKES**

This age-long process of erosion was interrupted in recent geological time by changes in climate which brought on the Glacial Period, a time of vast importance in the history of the region of Chicago. Great continental glaciers, nourished by persistent snowfall, spread outward for hundreds of miles from their centers in Canada, and it is now definitely established that the central part of the United States was invaded not once but repeatedly by ice sheets from the north, and that

In the Great Lakes region the rock strata do not lie flat but dip inward from all directions toward the center of the state of Michigan (see Fig. 5), in a saucer-like structure, around the rim of which one formation after another comes to the surface (see Fig. 6).

The hardness of the various formations in the Great Lakes region is not the same; for this reason, it is believed, valleys were developed by erosion in the softer rocks, such as the Devonian shales, and highlands were left on the harder rocks, such as the resistant Silurian (Niagara) limestone. In the Devonian outcrop, a northsouth strip underlying Lake Michigan, a large valley was developed, bordered on either side by highlands of Silurian and Mississippian strata. Similar valleys in the soft rocks, and highlands on the hard rocks, were developed throughout the Great Lakes region.

**Fig. 1.—Index map. Physiographic setting of the region of Chicago is indicated by the heavy outline. (After Fenneman)**

These invasions alternated with equally long intervals when the region was ice free. The most extensive ice sheet, the Kansan, reached as far south as northern Kansas and Missouri. Each successive readvance after the Kansan fell short of its predecessor, and more or less completely effaced the traces of earlier glaciations. Though the region of Chicago was probably glaciated repeatedly, it is the latest invasion of ice, the Wisconsin, which gave our area practically all of its present physiographic features (see Fig. 7). It occurred so recently, in terms of geologic time, that, were the covering of vegetation stripped from the area, the landscape would appear very much as it did when the late Wisconsin ice sheet receded, perhaps twenty-five thousand years ago. It is therefore possible to interpret with considerable accuracy the events of this glaciation.
Fig. 2. Natural divisions of the region of Chicago. Cross-sections are shown in Fig. 3 on following page.
PHYSIOGRAPHY OF THE REGION OF CHICAGO

Fig. 3.—Sections through natural divisions of the region of Chicago. Showing relief along lines A-A, B-B, and C-C in Fig. 2.

Fig. 4.—Rock formations in the Great Lakes region. Note, first, how the rocks dip inward to form a saucer-like structure; second, how the lake basins have been excavated largely from the outcropping edges of the soft rocks; and, third, how the resistance of the Niagara formation gives rise to an escarpment that separates Green Bay from Lake Michigan and Georgian Bay from Lake Huron. Similarly, it separates Lake Superior from Lake Michigan and Lake Erie from Lake Ontario.

Fig. 5.—Strata in the Great Lakes region. Block diagram indicates the basin character of the strata. The lakes lie chiefly in the Devonian and Ordovician strata, which are less resistant than the adjacent strata. Note the position of the Niagara escarpment, appearing as the peninsula cutting off Georgian Bay, as Grand Manitoulin I., and as the Door peninsula cutting off Green Bay.
The great ice sheets crept down from the north over a landscape of major valleys and divides, already developed by prolonged erosion of the bed-rock surface, and naturally the direction of flow of the ice was determined largely by these major valleys and divides. Concentration of the ice in the valleys caused the glacier to become distinctly lobate in character. Pushing through and beyond these great valleys, the lobes deployed widely, in some cases merging with adjacent lobes. The region of Chicago was largely covered by the deploying Lake Michigan lobe, but two other lobes impinged upon its northern margin in Wisconsin: the Green Bay and the small intermediate Delavan (see Fig. 8). Each of these lobes corresponded to a lowland which in turn corresponded to an outcrop of soft rock strata. Each lobe tended to deepen and broaden the valley it occupied, and the valley which now contains Lake Michigan is believed to have been deepened 500–900 feet. The material thus removed, as well as that obtained farther to the north, was carried to the margin of the ice and there deposited in the long, irregular ridges known as "terminal moraines." Thus the basins of the Great Lakes were formed by two processes: (1) the deepening by glacial erosion, and (2) the building up of their margins by glacial deposition (see Fig. 9).

The Great Lakes basins fall into two groups: (1) those excavated largely from the soft Devonian strata, and (2) those excavated largely from the soft Ordovician

---

*Fig. 6—Geologic map of the Great Lakes region. The region of Chicago is emphasized by a heavy line. A map of the geology of Wisconsin, from which a part of this map is based, is shown in Fig. 4. From geologic map of the U.S. Geological Survey.*
skiography of the Region of Chicago

strata. The basins of the groups are separated by the Niagara escarpment, a ridge of limestone which was too resistant for the ice to quarry away. This prominent ridge swings in a semicircle all the way from eastern Wisconsin to northern New York and strikingly emphasizes the great saucer of rock in which the Great Lakes lie (see Fig. 5). The Niagara escarpment separates Green Bay from Lake Michigan, Georgian Bay from Lake Huron, and Lake Ontario from Lake Erie.

lower land that encircles Lake Michigan and cross the region of Chicago.

At one stage of the retreat of the Wisconsin glacier, water issuing from the melting fronts of three adjacent lobes—the Lake Michigan, Saginaw, and Erie—escaped through the lowland now occupied by the Kankakee River. The escaping water entered the valley of the Illinois River in the vicinity of Morris, Illinois, and followed this drainage channel to the Mississippi. A termi-

In the region of Chicago, however, the Niagara limestone is deeply buried beneath glacial materials.

At its maximum extension the Lake Michigan lobe of the glacier reached as far south as Shellyville, Illinois. Its retreat was interrupted by repeated halts and readvances. Where it retreated steadily its deposits took the form of a ground moraine, or till plain, characterized by level or gently rolling surface. Where it halted or readvanced it piled up a ridge of debris under its edge, a terminal moraine. Because of the erratic character of its retreat, the lobe built up a series of plains and ridges, now recognizable in the concentric belts of higher and

nal moraine which crosses the Illinois Valley at right angles just west of the region of Chicago at Marseilles, known as the "Marseilles moraine," probably ponded the water for a time, forming a temporary lake in the Morris Basin known to geologists as Lake Morris. In the Indiana portion of the Kankakee Valley ponding also appears to have occurred, giving rise to shallow temporary lakes and marshes, many of which still exist or have been drained but recently. In both of these areas, extensive beds of sand were deposited. In the portion of the Kankakee Valley between the Illinois-Indiana state line and the mouth of the Kankakee River
the escaping water had sufficient gradient and volume to strip away much of the glacial moraine, in some cases down to bed rock. This glacial outflow has been called the "Kankakee torrent."

At last the ice retreated into the now greatly deepened Lake Michigan Basin. In the depression between the front of the ice and the group of abandoned terminal moraines that had been built around the head of the basin, there developed a lake which geologists have named "Lake Chicago." At one time this lake had a level about sixty feet higher than Lake Michigan. Unlike the present lake, Lake Chicago discharged southwestward to the Gulf of Mexico by way of the Des Plaines, Illinois, and Mississippi rivers. There must have been a low place in the moraine just west of Chicago through which the lake overflowed and so initiated this line of discharge. The lake was repeatedly lowered, probably through the cutting down of this outlet. Finally, as the ice retreated northward, the lake ceased discharging southwestward through the Chicago outlet, underwent a series of complex stages that need not be outlined here, attained its present level and place of discharge into the St. Lawrence drainage area, and so became Lake Michigan.

Fig. 8. Green Bay and Lake Michigan lobes of Wisconsin glacier. Between the two large lobes is the Delavan lobe, in the northwest corner of the region of Chicago, which is shown in the heavy line. (Modified from U.S. Geological Survey. Prof. Pap. 106.)

Fig. 9. A: Preglacial river valley; B: Lake Basin. The basin is due: first, to the deepening and widening of the preglacial river valley; and, second, to the heaping of moraine about its margins.

RECENT CHANGES IN THE REGION OF CHICAGO

Only a few noteworthy changes have occurred since the ice sheet completely left the region. (1) Prominent bluffs and ravines have been developed along the lake front between Winnetka and Waukegan by erosion of the shore line. (2) Extensive deposits of sand have been made along the shore at the head of Lake Michigan. (3) This sand-filling in northern Indiana has been built up into a magnificent assemblage of dunes. (4) Some of the larger streams have deepened their valleys to a minor extent. (5) The present soils have been formed upon the surface of the deposits left by the glacier.

VEGETATION OF THE REGION OF CHICAGO

Because the region of Chicago constitutes a meeting ground for the plants of many regions, the botanical


2 The following are valuable references dealing with the vegetation of the area: H. C. Cowles, "The Ecological relations of the Vegetation of the Sand Dunes of Lake Michigan," Botanical Gazette, XXVIII (1899), 167-202, 361-91, and The Plant Societies of Chicago and Vicinity, Geographical Society of Chicago, Bull. 2 (Chicago, 1904), and George D. Fuller, The Vegetation of the Chicago Region (Chicago, 1911).
features are of special interest. The natural vegetation of the area may be resolved chiefly into three components: (1) returned plant migrants from the southeastern part of the United States that had been driven out during the glaciation; (2) “hangovers” of northern species that have persisted locally since glacial times; and (3) a few migrants from the semiarid southwest.

Back in the period of glaciation, when arctic conditions prevailed over the northern part of the United States, the refrigeration resulted in a great southward exodus of plant and animal life. The colder temperature conditions enabled the plants of the far north to migrate south to the central part of the United States, where they replaced the former vegetation that had been driven into the southeastern part of the United States. After a great lapse of time the climate moderated, the ice began its withdrawal, and there was again initiated a great migration of flora—this time, however, northward. Unable to endure the warmer climate, the northern vegetation retreated again to high latitudes; and the vegetation native to the middle latitudes made its way back again to the region whence it had been expelled. At the present time these returned migrants dominate the region of Chicago. They include such well-known species as the white oak (Quercus alba), the red oak (Quercus rubra), the red maple (Acer rubrum), the shag-

Prickly Pear (Opuntia rafinesquii), a native of the Arid Southwest, is found in the Sand-Dune Area of Indiana, a melting pot of vegetation in the region.

Yellow Lady’s Slipper (Cypripedium acaule) is still found in the Sand-Dune Area.

bark hickory (Carya ovata), and a host of others. In certain restricted localities, however, of which the sand dunes region of northern Indiana affords the best example, a number of species of plants from the far north still linger by virtue of a favorable environment. Of this class excellent examples are the jack pine (Pinus Banksiana) and several other conifers, the bearberry (Arctostaphylos Uva-Ursi), the dwarf birch (Betula pumila), and the cranberry (Vaccinium macrocarpon). Of the third strain which enters into the floral composition of the area, the migrants from the semiarid southwest, the prickly pear cactus (Opuntia Raffinesquii) and
the western reed grass (*Calamorhiza longifolia*), are good examples.

The cosmopolitanism of the vegetation in the area is best displayed in the sand-dune region of northern Indiana, which Professor H. C. Cowles, eminent authority on that region, has aptly termed "a veritable floral melting pot." Professor Cowles's description is a vivid picture of the unusual conditions that there occur.

There are few places on our continent where so many species of plants are found in so small compass. This is in part because of the wide diversity of conditions prevailing there. Within a stone's throw of almost any spot one may find plants of the desert and plants of rich woodlands, plants of the pine woods, and plants of swamps, plants of oak woods and plants of the prairies. Species of the most diverse natural regions are piled here together in such abundance as to make the region a natural botanical preserve, not only of the plants that are characteristic of northern Indiana, but also of the plants of remote outlying regions. Here one may find the prickly pear cactus of the southwestern desert hobnobbing with the heather of the arctic and alpine regions. The commonest pine of the dunes, the jack pine, is far out of its main range, reaching here its farthest south. One is almost startled at the number of plants of the far north, many of which, like the jack pine, are not found to the southward of our dunes.

Among such plants of the Canadian forest and tundra are the twin flower, the glandular willow, the poverty grass, and the northern rose. Northern plants are particularly characteristic of the dune swamps, and embrace such interesting species as the larch, bunchberry, dwarf birch, sage willow, numerous orchids, cranberry leaf, and many more. Many of these species are found nowhere for many miles outside of the dune region.1

CLIMATE2

The climate of the region of Chicago is excellently adapted for human comfort and activities. This is due to its position at the center of the Great Lakes system, which provides a moderating influence on the climate. The region is characterized by a mild winter and a warm summer, with moderate precipitation throughout the year. The climate is influenced by the proximity to the Great Lakes, which help to regulate temperatures and humidity. The region experiences a transition climate, with influences from both the humid continental climate and the oceanic climate. The forest and tundra plants mentioned earlier are well adapted to the climate, which provides a diverse and thriving ecosystem.

### TABLE I

**Weather Conditions at Chicago**

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<td>NE, NE</td>
<td>NE, SW, SW</td>
<td>NE, SW, SW</td>
<td>NE, SW, SW</td>
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<td>NE, SW, SW</td>
<td>NE, SW, SW</td>
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<tr>
<td>Maximum wind velocity, M.P.H</td>
<td>16</td>
<td>16</td>
<td>17</td>
<td>16</td>
<td>15</td>
<td>13</td>
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<td>12</td>
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<td>13</td>
<td>16</td>
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<tr>
<td>Mean precipitation, inches</td>
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<td>2.07</td>
<td>2.61</td>
<td>2.78</td>
<td>3.35</td>
<td>3.53</td>
<td>3.36</td>
<td>3.41</td>
<td>3.09</td>
<td>3.58</td>
<td>3.34</td>
<td>2.07</td>
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</table>

* From Annual Meteoric Summary of U.S. Weather Bureau, 1924.

### TABLE II

**Fog-Signal Operations in the Region of Chicago**

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<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
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<td>20</td>
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<td>108</td>
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<tr>
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<td>Indiana Harbor</td>
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<tr>
<td>Michigan City</td>
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<td>3</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

* Averages shown for Indiana Harbor are for the two-year period. Where space is blank the harbor was closed to navigation. Smoke and prevailing winds are accountable for the prolonged period of operation necessary in the stations opposite the city of Chicago.

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region of Chicago, amounting on an average to over 30 inches per year. From the standpoint of agricultural requirements this rainfall is fairly well distributed, about

10 inches ordinarily falling during the growing season for crops—May, June, and July. Drought sometimes occurs, thereby preventing maximum crop production; but complete crop failures, such as frequently befall some parts of the country, are here unknown.

Chicago is widely known as the "Windy City," but the winds thus advertised are not more vigorous at Chicago than at other points along the lakes. During spring and summer the winds from the lake are most prevalent, and these bring in to the land a constant supply of cool, pure air. The dominant winds are from the southwest, the "Prevailing Westerlies," and from the northeast (see wind rose, Fig. 10). The longest periods of sunshine come in the autumn, and Indian summer may be seen at its best in this area.

Probably the most distinctive characteristic of the climate of the region of Chicago is its changeableness. This is due to the location of the area in a belt that is traversed by an endless succession of atmospheric disturbances—cyclonic storms, or "lows" they are commonly called—that sweep across the continent. It is the passage of these storms at intervals of a few days that gives to the weather its changing aspects of heat and cold, rain and snow, sunshine and cloud. These "spells" of weather, whatever their character, are rarely of long duration.

It is not generally realized that a climate characterized by frequent and sudden changes of weather of this sort is healthful and stimulating to a high degree, and is to be regarded as a most desirable asset to a community. Undoubtedly the vigor and activity which stamp the people of this area are in an important measure attributable to climatic conditions.
Chapter II

THE LAKE PLAIN, A GREAT INDUSTRIAL AREA

The Lake Plain (see Fig. 2) includes the low belt of land once covered by the waters of the extinct Lake Chicago. On it are located the sites of Chicago, Gary, Michigan City, Waukegan, Kenosha, Racine, and many other cities. Originally a continuous province encircling the lower end of Lake Michigan, this plain has been cut away for a 20-mile stretch between Winnetka and Waukegan by the ceaseless erosion of the waves. Thus separated into two parts, the Lake Plain now consists of (1) a narrow strip extending from Waukegan northward to a point 5 miles beyond Racine, and (2) a broad, crescent-shaped tract extending from Winnetka southward around the head of the lake into Michigan. The northern area is 33 miles long and has a maximum width, just north of Racine, of about 3 miles. The southern and much larger area is often referred to as the Chicago Plain because upon this section the city of Chicago is located. It has a width of from 10 to 15 miles through most of its course in Illinois, but narrows rapidly across Indiana, being only about a mile wide where it crosses the Indiana-Michigan state line.

Although to the eye the Lake Plain appears very flat, its surface rises imperceptibly from the lake to its contact with the rolling uplands, the total rise amounting to about 60 feet. This remarkable flatness, best shown in the vicinity of Chicago, is the most striking feature of the Lake Plain. Probably the building of no other large city has been attended by such freedom from grading problems as has that of Chicago. This situation, however, has not been an unmitigated blessing, for it has introduced serious drainage and sanitation problems. Much of the Lake Plain was formerly swamp and had to be drained artificially for habitation. An early geographer wrote, "The country around the extreme south bay of Lake Michigan has the appearance of the sea marshes of Louisiana."

The general flatness of the Lake Plain is varied by a few interruptions, described in the following paragraphs.

Sand dunes. In northern Indiana one of the greatest dune areas known has been developed by action of wind upon sand deposits either left on the plain by Lake Chicago or brought in to the present beach by Lake Michigan. Some of these sand dunes near Michigan City are 200 feet high. Other dunes less imposing occur on the west edge of Blue Island Ridge, from Beverly Hills to Blue Island, and along the shore north of Waukegan.

Blue Island Ridge, the most prominent topographic feature on the Lake Plain in the vicinity of Chicago, is an isolated ridge 7 miles west of the lake, in the latitude of South Chicago. It is elliptical in form, about 6 miles long, north and south, and about 1 mile wide. It rises, island like, about 50-80 feet above the otherwise nearly featureless plain; and at one time it was an island, its summit rising 10-35 feet above the surface of Lake Chicago at its highest stage. Well borings show that the bed rock is no higher under Blue Island Ridge than under other parts of the plain. Its existence is apparently due to a thicker deposit of the glacial drift here. The city of Blue Island is located at its southern end. Morgan Park is on its crest, and the residential section known as Beverly Hills is near its northern end.

Stony Island, just west of South Chicago, is an outcrop of Niagara limestone that rises about 20 feet above the surrounding marshy Lake Plain. It trends east and west, is 1 1/2 miles long, and 1/2 mile wide. Stony Island is one of the most interesting geologic features in the region of Chicago. It is a dome of limestone, the strata of which are steeply inclined, dipping outward in all directions. On its sides the grooves and scratches made by the overriding glacier may still be seen. Because of
these and other similarly interesting features, the Geographic Society of Chicago has urged the preservation of Stony Island as a park.

Beach ridges and bars constitute important features of the Lake Plain. There are three main groups of long, low ridges that traverse the plain, rising in some cases as much as 20 or 30 feet above its surface and traceable for many miles. These are the ancient beaches of extinct Lake Chicago. They are approximately 60, 40, and 20 feet above the surface of Lake Michigan and record the

Drainage of the Lake Plain

The Lake Plain north of Waukegan is drained by short rivers all of which head a few miles back in the Lake Border Upland. Kenosha and Racine are located at the mouths of two such streams, the Pike and Root

three main stages of Lake Chicago. They have been named from towns where their character is well shown: the Glenwood, Calumet, and Tolleston stages, respectively. Where the ridges pass through city sites they have in part been obscured by grading or utilized for their gravel; but some of them are still prominent enough to be recognized. The great Rose Hill Bar that passes southward through Evanston is followed by Ridge Avenue. It has furnished a site for some of the finest residences in this part of the city. Outside of the cities, the bars may usually be identified by the oak groves that mark their courses. The glacial map shows the positions of the most prominent beach ridges and bars. North of Waukegan and in northern Indiana they

1 At many places in the Lake Plain there are “Ridge” roads and avenues, it having been necessary in early days for vehicles to follow these slight ridges which offered the only dry and firm routes available.

South of Winnetka the most important streams on the Lake Plain are the Chicago, Calumet, and Des Plaines rivers.

The only natural drainage lines on the northern part of the Chicago Plain are afforded by the sluggish Chicago River with its north and south branches. Originally the north branch had its source about 4 miles west of Highland Park, and flowed south-eastward 27 miles, while the south branch had its source northeast of Summit and flowed northeastward through the present city of Chicago, uniting with the north branch a mile from the lake. The combined streams flowed eastward to the lake through the present downtown district. This original drainage of the Chicago River and its branches has been greatly modified by the building of the Chicago Drainage Canal.

By repeated dredgings Chicago River and its branches have been enlarged to form a river harbor.

Before the improvements had begun in 1833 on the present Chicago harbor, there was a bar across the outlet of Chicago River which shifted the outlet southward from its present position to a point opposite the foot of Madison Street. The present harbor inlet was formed by cutting through this bar and by constructing piers on either side of the cut. The north pier has been extended from time to time as the sand accumulated on the north side.

1 William C. Alden, Chicago Folio (U.S. Geol. Survey.), p. 4.

2 Ibid., p. 44.
Fig. 11.—Four stages in the history of the Calumet River. (Various intermediate stages in the foregoing series are not shown.) The westward flow through the Sag and the exit at Burns's ditch have been artificially produced.
The Calumet River is a curious and interesting stream which drains the part of the Lake Plain south of Chicago and in northern Indiana. Its remarkable history is illustrated in Figure 11. At one time this river entered Lake Michigan near Riverdale. Throughout the 45-mile stretch between its source in Laporte County and Riverdale it flowed parallel to the lake shore and only a few miles from it. Two well-developed parallel beach ridges held it to this very unusual course. But the constant wave action kept building up sand bars from the north across the mouth of the river, steadily shifting the mouth southeastward. At times of high water the river would break across the bar obstructing its mouth, but a new bar would again form at the mouth of the river, and the whole process would be repeated. Thus there developed a series of alternating sand bars and lagoons, the lagoons representing channels formerly occupied by the river. Eventually the mouth of the Calumet River had shifted eastward a distance of 14 miles to a point north of Miller, Indiana. Such was the situation when white settlement began. The upper and lower parts of the river then flowed parallel to each other but in opposite directions, separated by a narrow barrier only 2 or 3 miles wide consisting of alternating sand ridges and lagoons. Frequently the mouth of the river, north of Miller, was nearly closed by sand drift.

Man changed the course of this river, like that of the Chicago River, to suit his purposes. The mouth north of Miller was blocked, and an artificial channel was dug from the Calumet River near Hegewisch to Lake Michigan at South Chicago. This reversed the flow of the lower part of the Calumet River, compelling it to flow westward like the upper part. The artificial channel at South Chicago was kept dredged, and small steamers were able to ply between Chicago and Hammond.

Recently the course of the Calumet River was again altered. The Sag Channel was dug from the Calumet River near Riverdale to the Chicago Drainage Canal at Sag. As a consequence, the Calumet River theoretically no longer discharges into Lake Michigan but turns due westward at Riverdale, crosses the old Continental Divide through the Sag Channel, and so passes into the drainage of the Mississippi River by way of the Chicago Drainage Canal. The actual condition, however, is that part of the time the surface water is discharged into Lake Michigan. This is because of occasional floods or because of temporarily lowered lake level.

The completion of the Burns ditch just east of the Porter-Lake County line allows the excess flow of the upper reaches of the Calumet River to discharge directly into Lake Michigan east of Gary, at time of flood, but normally it does not affect the current of the stream.

Like the branches of the Chicago River, those of the Calumet have low gradients; consequently they are sluggish of current and subject to overflow. This condition, together with the absence of any valleys, gives them the appearance of canals, which indeed they practically are as a result of the many changes they have undergone.

Lake Calumet, Wolf Lake, and Lake George (the latter now practically non-existent) occupy very shallow basins between sand ridges deposited by the shore drift of Lake Michigan. The basins of these lakes probably resulted from the damming of a former bay at this point. Lake Calumet, the largest of the lakes, has an area of about 3 square miles. A channel links Calumet and Wolf lakes with Calumet River. It has been proposed that Lake Calumet be deepened and converted into a harbor.
Chapter III

The Lake Border Upland, a Residential and Recreational Area

Western of the Lake Plain lie the Lake Border Upland, the Valparaiso Upland, and the Outer Upland, each consisting of a series of terminal moraines successively deposited mainly by the Lake Michigan lobe of the Wisconsin glacier. These three provinces are distinct from one another in the central part of the region of Chicago, but when traced northward they merge into a continuous upland (see Fig. 2).

The Lake Border Upland is an elongated province five to fifteen miles wide whose main body extends from the cities of Des Plaines and Winnetka northward beyond the limit of the region of Chicago and has a long, flat extension to the south reaching as far as Oak Park. From Winnetka to Waukegan the province is bounded on the east by conspicuous lake bluffs, 100 feet high in places, that rise abruptly from the present shore of Lake Michigan. Hence the name Lake Border Upland. North of Waukegan these bluffs are absent and a narrow strip of the Lake Plain separates the upland from Lake Michigan. Three-fourths of the western margin of the province lies along the valley of the Des Plaines River and that of its tributary, Mill Creek.

The surface of the Lake Border Upland varies from 60 to over 200 feet above Lake Michigan. Its topography is characterized by a series of parallel north-south ridges, terminal moraines, separated by narrow strips of ground moraine (see glacial map). The alternation of these ridges and flats produces a gently rolling surface that contributes greatly to the scenic charm of this region. Though usually very distinct, the ridges at places coalesce or divide so that the total number is not everywhere the same. Usually three may be recognized in Illinois and four in Wisconsin. The ridges vary greatly in width and height, those farthest from the lake being the wider and higher. The crests of the ridges rise and fall in low swells, and the western slopes are usually narrower and consequently steeper than the eastern. The ridge next the lake is from one to four miles wide, its crest rising from 110 to 140 feet above lake level and 35 to 60 feet above the valley west of it.

The southern end of this ridge, at Winnetka, has been cut off by the lake.

It has apparently had its entire east slope and a portion of the crest removed by the lake, there being a descent immediately from the bluff on the lake to the slough, which lies west of the ridge. Following the ridge north to Highland Park the crest and east slope appear.

A series of steep ravines, most of which are less than a mile long, extend back into the moraine between Winnetka and Waukegan. Until recently bluff and ravines were in a state of active erosion, but this condition has been largely stopped by landowners who have developed fine home grounds along the shore.

A moraine in northern Indiana which belongs to this upland extends from a point near Dune Park eastward and northestward into Michigan. The city of Chesterton lies just south of its western end, and Michigan City lies between it and the lake. Although its average width is scarcely a mile and it is inconspicuous through much of its course, it divides the drainage district of the Calumet River from that of Trail Creek and causes the two streams to flow parallel to the shore of Lake Michigan for some miles (see drainage map).

The streams of the Lake Border Upland lie in the troughs between the ridges, and thus parallel one another except at points where they turn at right angles and flow through gaps they have cut in the moraines. This province is drained chiefly by the headwaters of the Root, Pike, and Des Plaines rivers, and by the north branch of the Chicago River.

The glacier left drainage conditions very much disturbed, and not nearly all of the many depressions occurring on the Lake Border Upland have yet been drained, either naturally or artificially. Consequently there are a few lakes and ponds and great areas of marsh occupying elongated tracts between the moraines. One of the most typical and extensive of these is a marsh known as the Skokie, which lies about ½ miles west of the lake shore between Winnetka and Highland Park.

USES OF THE UPLAND

Much of the upland is a rich farm-and-dairy country. In recent years it has become a favorite residential and recreational section. Areas have been set aside by the Forest Preserve Commissioners of Cook and adjacent counties for the preservation of the growth of native trees which is exceptionally rich over the upland, and which was being rapidly destroyed until the forest preserve districts began their acquisition of land. The last few years have witnessed a remarkable development of the strip of bluff and ravine country along the lake from Winnetka to Waukegan. Residential towns are almost continuous to the Wisconsin line, and thousands of Chicago commuters, served by the electric and steam railroads, now have their homes in such residential towns as Winnetka, Glencoe, Highland Park, Highlandwood, Fort Sheridan, Lake Forest, Lake Bluff, North Chicago, and Waukegan, most of which municipalities are 60 to 100 feet higher than the Lake Plain at Chicago. Picturesque bluffs, trenched by ravines, and the high rolling upland with its wealth of trees make this section almost ideal for home sites.
Chapter IV

THE CHICAGO OUTLET, THE GREAT PASS TO THE MISSISSIPPI VALLEY

The Chicago outlet (see Fig. 2) leaves the Lake Plain by two branches, separated by the triangular-shaped elevation known as Mount Forest Island. These branches unite at Sag into a single valley which cuts southwestward, bisecting into north and south parts the Valparaiso Upland, the Manteno Plain, the Morris Basin, and the Outer Upland. The cities of Joliet and Morris are located in the outlet.

The branch of the outlet that lies south of Mount Forest Island is known as the Sag, and is smaller than the other branch. At one stage during which the Sag carried water from Lake Chicago, it was itself divided at its eastern end by Lane’s Island, an elevation on which the village of Worth is now located.

The main channel of the outlet lies to the north of Mount Forest Island. From Summit to Joliet it is a steep-sided, flat-bottomed valley, from 1/2 to 1 1/2 miles wide, and 20-70 feet deep. In places the limestone bluffs are vertical or overhanging. Along most of this stretch the glacial drift is stripped away and the outlet is cut down to the bed rock or even into it. Below Joliet the outlet loses its valley character as it widens into the flat Morris Basin. In this lower stretch, which is as much as 5 miles in width, the removal of glacial material was less complete, and little erosion of bed rock took place. In the Morris Basin the northern margin of the outlet is marked by the prominent bluff now followed by another “Ridge road” (now State Highway No. 7), but its southern margin is ill defined and must be arbitrarily drawn.

Where the Chicago outlet leaves the Lake Plain near Summit it is only 15 feet above the level of Lake Michigan. Between the divide at Summit and the town of Lemont the slope is so slight that this stretch is known as the “12-mile level.” From Lemont southwestward, however, the descent is more abrupt, there being a 90-foot drop in the 23 miles between Lemont and the head of the Illinois River, thus bringing the bottom of the outlet about 75 feet below the level of Lake Michigan. Most of this fall occurs in the “rapids section” of less than ten miles between Romeo and Joliet.

The Outlet River found the preglacial valley which it adopted partly filled with outwash gravels deposited during the retreat of the ice. This gravel filling it largely cut away, but remnants persist as terraces extending along the border of the valley from Romeo southward. In the upper part of the valley some of the crests of these terraces are as much as 100 feet above the river, but in the lower part their elevation is about half as great. Between Joliet and the head of the Illinois occur several island-like mounds, remnants of this former filling.

The Chicago outlet is now occupied by the lower part of the Des Plaines River and the upper part of the Illinois River. It is also traversed by two canals: the Illinois-Michigan Canal and the Chicago Drainage Canal. Tributary to the latter is the Calumet-Sag Channel, so called because it connects the Calumet River with the main drainage canal through the Sag branch of the outlet.

Des Plaines River

“The Des Plaines issues from a flat swamp or slough near the boundary of Racine and Kenosha Counties, Wisconsin, where drainage is so imperfect that in wet weather part of the marsh discharges northward to Root River.” From its head it trends southward between two moraines of the Lake Border Upland and drains a long, narrow basin 90 miles long and rarely more than 15 miles wide. Its most important tributaries are Salt Creek and Du Page River, both of which flow parallel to each other and to the Des Plaines itself for a long distance.

North of Maywood the Des Plaines River emerges upon the Lake Plain. “Extending its mouth out on the flat plain south of Riverside . . . . the Des Plaines seems to have had a free choice between a course to the Mississippi or to the St. Lawrence.”

“So flat is the plain at this point,” remarks Goldthwait, “that the escape of the Des Plaines from the lake plain westward through the deep notch in the moraine seems highly accidental.” In fact, a well defined slough, formerly known as Mud Lake, leads castward to the south branch of the Chicago River. It marks

1 Illinois Geological Survey, Bull. 11, p. 4. 2 Ibid., p. 56.
a line of escape which has been used time and time again by the Des Plaines during floods. Here was the old Indian per-
tage, where Marquette and other early explorers, at the time of a spring freshet, could paddle their canoes from Lake Michigan to the headwaters of the Illinois. It is not at all
improbable that at one time the Des Plaines River discharged
wholly through this slough, into Lake Michigan. If so, its
southwestward course is a very recent one.1

At Summit the Des Plaines turns westward and now confined in an artificial channel, crosses the "12-
mile level" through the Chicago outlet. The discrep-
ancy between the magnitude of this valley and the small
size of the stream which now enters it is one of the most
interesting physiographic features in this part of the
country. Goldthwait pictures vividly the situation
which resulted after the disappearance of the Outlet
River; "In place of the great river whose volume was
perhaps comparable to that of the St. Clair River today
was left the little Des Plaines, a stranger in the district,
which struggled into the great valley as if by accident."2

At Romeo the river reaches the upper end of a
series of rapids which lower it 50 feet in the 10 miles be-
tween this point and "Lake Joliet." Through the west
side of Joliet the river is artificially confined, but im-
mediately below the city, at Brandon's Bridge, it ex-
pands to fill Lake Joliet, a depression probably formed
by the Outlet River at the point where it crossed from
the resistant Niagara limestone to the softer and more
easily eroded Richmond formation. Lake Joliet is 5
miles long, about 10 feet deep, and lies 75 feet below
Lake Michigan. At Clamahon the Des Plaines is joined
by the Du Page, and immediately below their junction
there occurs another expansion, "Lake Du Page." Half
a mile farther downstream it joins the Kankakee.
The point of confluence of these rivers is taken as the
head of the Illinois River.

**ILLINOIS RIVER**

The Illinois is the master-stream of the region of
Chicago, receiving the waters of all of the important
rivers with the exception of the few that drain east-
ward into Lake Michigan. It is commonly divided into
two sections, the upper Illinois and the lower Illinois,
the point of division being the great bend near Hennepin,
where the river abruptly turns southward. The
two sections are radically different. The upper Illinois,
63 miles in length, has a steep gradient, flows largely
over bed rock, and (except in the flat Morris Basin) occupies a valley that has steep rock bluffs averaging
1/2 miles apart. This is a postglacial course along which
the river is still busily excavating a channel. The lower
Illinois, about 200 miles long, has a very low gradient,
is not excavating in bed rock, and wanders aimlessly
over a flood plain 2.5 miles wide—a preglacial course
much older than the course of the upper Illinois.

Only a 20-mile stretch at the head of the Illinois
lies in the region of Chicago, but according to L. E.
Cooley, of the Drainage and Water Supply Commission
of Chicago (the organization which preceded the Sanitary
District of Chicago), its major tributaries have
part or all of their drainage basins in the region of
Chicago, and these contribute over a third of the total
area of 25,914 square miles in the basin of the Illinois.

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1 Ibid., p. 83.
2 Ibid., p. 36.
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**The drainage basins of these tributaries have the following areas:**

<table>
<thead>
<tr>
<th>Basin</th>
<th>Square Miles</th>
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</thead>
<tbody>
<tr>
<td>Des Plaines River (including the Du Page)</td>
<td>1,392</td>
</tr>
<tr>
<td>Kankakee River</td>
<td>5,146</td>
</tr>
<tr>
<td>Aux Sable Creek</td>
<td>218</td>
</tr>
<tr>
<td>Mazon Creek</td>
<td>549</td>
</tr>
<tr>
<td>Fox River</td>
<td>2,020</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9,996</strong></td>
</tr>
</tbody>
</table>

Owing to a reversal of flow through the canals of the Sanitary District of Chicago, all of the drainage
from the Chicago River watershed of 236 square miles is tributary to the Illinois River. A portion of the run-
off (up to 2,400 cu. ft. per second in storms but ordi-
arily 700 cu. ft. per second) from the Calumet water-
shed of 680 square miles also reaches the Illinois.

Despite the general narrowness of the upper Illinois
Valley most of its course across the region of Chicago
is broad and flat. At its head, the confluence of the
Kankakee and Des Plaines rivers, there rises a steep
bluff 120 feet high on the north side known as Dresden
Heights: this is the southern tip of the Minooka moraine, a section of the Outer Upland.

**Canals**

The Illinois-Michigan Canal, built between 1836 and 1848, extends from the south branch of the Chicago River southwestward through the outlet a distance of nearly 100 miles, entering the Illinois River at La Salle. Originally it was 6 feet deep, 60 feet wide at the surface, and 36 feet wide at the bottom in earth, and 48 feet wide in rock. At the divide its summit level was 8 feet above the low water level of Lake Michigan, and at its termination it was 150 feet lower. Four locks, two at Lockport and two at Joliet, were necessitated by the steep gradient along this section. In time this canal fell into disuse largely as a result of railroad competition, and now along much of its length it is little more than a ditch.


The Chicago Drainage Canal was made to meet the needs of the growing city of Chicago, as a means of sewage disposal. This dual-purpose sanitary and ship canal reversing the flow of the sewage-laden Chicago River into the Illinois watershed, begun in 1892 and completed in 1900, was excavated through the Chicago outlet between the old canal and the Des Plaines River.

Its length from the west fork of the Chicago River at Robey Street to the controlling works at Lockport was twenty-eight miles. Of this a little more than half (the fifteen miles between Willow Springs and Lockport) was cut through rock. Above Willow Springs the channel was sunk wholly in unconsolidated beds, mainly glacial drift. The depth of the canal is 24 feet, its bottom width, where in earth, 202 feet, and where in rock, 160 feet.¹

The declivity is 1 foot in 40,000 feet in the section above Willow Springs, and 1 foot in 20,000 feet below, giving a total fall from the head of Robey Street to the controlling works at Lockport of about 3½ feet.
The Calumet-Sag Channel, a feeder for the foregoing, was dug along the line of the old feeder for the Illinois-Michigan Canal. It was begun in 1911, completed in 1922, and extends from the Calumet River near Riverdale through the Sag Valley to the main drainage canal at Sag.

**GEOGRAPHIC SIGNIFICANCE OF THE CHICAGO OUTLET**

Through this channel, carved thousands of years ago by a river now extinct, there passes a full and ceaseless stream of human activity. Providing as it does a natural route connecting the Great Lakes region with the Mississippi Valley, this valley is one of the greatest natural passes in our country. One more admirably adapted for man's purposes could hardly have been designed by man himself. Its industrial significance lies in the fact that the Continental Divide along this valley is only 15 feet above the surface of Lake Michigan, whereas the next lowest point on the divide is at Fort Wayne, Indiana, and is fully 190 feet above the lake. "No wonder that the idea of an artificial channel near Chicago, to join the lakes with the Mississippi, was conceived by Louis Joliet, one of the first [white] men to cross the divide."1 Long a favorite route with the Indians and early explorers, the outlet came to a fuller utilization with the settlement of the interior and the growth of Chicago. The Illinois-Michigan Canal, the Chicago Drainage Canal, the Chicago and Alton Railroad, the Atchison, Topeka & Santa Fe Railroad, and an arterial highway all chose a route southwestward from Chicago through the outlet. The railroads and highway thus avoid the grades otherwise necessitated in passing over the Valparaiso Upland. Where the outlet widens below Joliet, other highways and railroads pass through or across it. Along the outlet cities have grown up that are largely dependent on these lines of transportation.

Despite this great development it is obvious that the fullest utilization of the Chicago outlet is still far from being realized. Plans are under way for a navigable waterway which will enable barges to pass from Lake Michigan to the Mississippi River.

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Chapter V

THE VALPARAISO UPLAND, A CONTINENTAL DIVIDE

The Valparaiso Upland is a broad, elevated belt of land which, to borrow the descriptive figure employed by Dr. T. C. Chamberlin almost a half-century ago, “may be likened to an immense U, embracing the great lake between its arms” (see Fig. 2). It is designated by the name Valparaiso after the city of Valparaiso, Indiana, located on a prominent part of it, and because geologists have long applied this name to the moraine which forms its greater bulk. The Wisconsin section of the upland includes part of the moraines deposited by the small Delavan lobe and a very small part of those deposited by the Green Bay lobe (see Fig. 8), but the greater part, that trending through Illinois and Indiana, was deposited by the Lake Michigan lobe, and is the most prominent of the moraines attributed to this lobe.

On its lakeward side this province is bordered by the Lake Border Upland, except in the middle where it is in direct contact with the Lake Plain. On its outer margin it is bounded (1) by the Morris-Kankakee Basin from near the Illinois-Indiana line east; (2) by the Manteno Plain from the state line northward to the vicinity of Elgin; and (3) by the Outer Upland from Elgin northwestward into Wisconsin. South of Elgin its outer margin is fairly distinct because of its contact with two lowlands; but north of Elgin the boundary between the two uplands must be somewhat arbitrarily drawn, as in the case of the Valparaiso Upland-Lake Border Upland contact.

West of Chicago the Valparaiso Upland is crossed by the Chicago outlet and literally cut in two. Mount Forest Island, which is isolated by the branches of the outlet, is part of the upland; and at this point the eastern margin of the upland is farthest from Lake Michigan, being 13 miles away in a line directly through Chicago. The upland is widest in the northern portion, being 25 miles in width through the middle of Valparaiso County. Southward in Illinois it narrows to the Chicago outlet; and throughout the 80-mile course from the outlet southeastward to Valparaiso it has a uniform width of from 12 to 15 miles. At Valparaiso it narrows abruptly to less than half this width, and north of Laporte, Indiana, it is only 4 miles across.

The relief of this province is great, amounting to fully 450 feet. In general, the outer margin is higher than the inner, although this relation is reversed east of Valparaiso. The northern portion is much the highest, most of it being over 800 feet above tide, two points in northwestern Cook County and large areas in McHenry County being over 900 feet. In Walworth County, Wisconsin, is found the highest point in the region of Chicago, a hill 3 miles north of Williams Bay that reaches an elevation of 1,140 feet above sea-level, about 560 feet above Lake Michigan. The middle portion of the upland is fairly uniform in height, its crest varying from 700 to 750 feet above tide and reaching 800 feet only in eastern Will County, at the village of Monee on the Illinois Central Railroad. The narrow portion east of Valparaiso is notably higher, its crest reaching an altitude of 885 feet above tide in Laporte County.

Like the other two uplands this province is a system of narrow, more or less parallel ridges separated by lower tracts. On the glacial map (see Plate I) the differentiation of the upland into its moraines and intermorainal tracts has been indicated as fully as geologists have carried this analysis to date. In areas where such detailed study has not yet been made, the moraines have been mapped as “undifferentiated Valparaiso.” Eventually, with the progress of detailed mapping, it will be possible to locate and name all of the small moraines.

As compared with the adjacent Lake Border Upland, the Valparaiso Upland exhibits, on the whole, a surface of far more diversity. This is because the moraines which it bears show a wide variety of outline, arrangement, and contour, being usually less symmetrical and regular than those on the Lake Border Upland.

The northern portion is exceptionally rugged and irregular, and exhibits better than any other part of the region of Chicago that peculiarity of morainal deposits, “knob and kettle topography,” a surface characterized by rounded hills and intermediate undrained depressions. These depressions are of great interest and have originated in several different ways: through (1) the damming of stream valleys; (2) the irregular piling up of glacial drift by the ice, giving rise to hills and depressions; and (3) the melting of isolated blocks of ice that had been surrounded or buried by glacial deposits.
Many of these depressions are now occupied by lakes and marshes and others were formerly so occupied, having been filled or drained. This is pre-eminently the case in the lake region of Illinois and southern Wisconsin, the total number of lakes in Walworth, Racine, Kenosha, McHenry, and Lake counties running into the dozens. In southeastern Wisconsin from 12 to 15 per cent of the land area is covered with lakes, marshes, or land formerly covered with lakes and marshes.\(^1\) Among the better-known lakes are the Oconomowoc lakes, Lake Delavan, Lake Como, Lake Geneva, Wind Lake, Lake Elizabeth, and Silver Lake in Wisconsin; and Lake Marie, Grays Lake, Fox Lake, Pistakee Lake, Long Lake, and Lake Zurich in Illinois. Of these Lake Geneva is the largest, having a length of 8 miles, a maximum width of 2 miles, and a depth of 142 feet. Most of the other lakes are less than 15 feet in depth. All of them having become or are becoming busy summer resorts, and many permanent, year-round residences are being built on their shores.

As the glacial map indicates, the morainal ridges north of the Wisconsin line are peculiarly arranged in two sets: (1) those in the eastern part of the upland, trending north and south; (2) a group of curving moraines that branch off southwestward from the first set and almost at right angles to them. Their courses form a marked contrast with the prevailing trend. These moraines are those of the small Delavan lobe that formed between the Lake Michigan lobe and the Green Bay lobe (see Fig. 8) probably in response to a pre-existing lowland at this point. Thrown across pre-glacial valleys, they constituted dams which produced Lakes Geneva, Delavan, and Como, the finest in southeastern Wisconsin.

In northern Illinois the moraines form a composite mass, or "morainal complex," extremely difficult to analyze; nevertheless, a pronounced north-south tendency may be recognized in the arrangement of the ridges.

In the middle portion of the Valparaiso Upland the topography is far more subdued than in the northern, being gently rolling in character. Locally, at West Chicago, the "knob and kettle" topography does occur, but for the most part the knobs and depressions are not prominent. The morainal ridges are generally low and not infrequently ill-defined. Swamps and ponds are common but lakes are rare.

On Mount Forest Island the surface is very rough, the knobs and hollows having a range of over 50 feet. Ponds are abundant. Much of this area is now in the Cook County Forest Preserve of Padas Park, and the features are thus preserved in their natural state. From the Indiana-Illinois line eastward to Valparaiso three crests are recognizable, the most southerly of these being weaker than the other two and disappearing entirely at Valparaiso. Five miles southeast of Crown Point is Cedar Lake, over a square mile in area, the only lake of any consequence in this part of the upland.

Near Valparaiso the elevation increases and there is a corresponding increase in ruggedness. A striking feature of this interesting portion is the fact that the crest of the upland is near the northern edge; the northern slope is abrupt, there being a rise of 150 feet in the 2 miles from the Lake Plain, while the southern slope is broad and gentle (see Fig. 3). Another peculiarity is that from Valparaiso eastward the moraine is composed largely of sand and gravel instead of the typical "boulder clay" characteristic of moraines. There are prominent knobs in this part of the upland, and in the basins between them are inclosed shallow lakes. This is the western part of the lake region of Indiana, Hudson Lake in northeastern Laporte County and Pine Lake northwest of the city of Laporte are the larger of the lakes in this region.

**DRAINAGE OF THE VALPARAISO UPLAND**

That section of the Valparaiso Upland north of the Chicago outlet is drained southward by the Des Plaines and the Fox rivers. South of the outlet the upland forms the Continental Divide, drainage to the north entering Lake Michigan. The diversion of the Calumet River through the Sag Channel left only an insignificant amount draining into the lake, that carried by Calumet and Trail creeks in the vicinity of Michigan City, but the new Burns ditch helps restore the natural drainage of the area (see Fig. 11). Water from the north by the Fox and the Des Plaines and much of that from the south and east by the Calumet and Kankakee is eventu-

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\(^1\) Wisconsin Geological and Natural History Survey, Bull. 38, p. 16.
ally received by the Illinois and carried westward and southward to the Mississippi and Gulf.

**Geographic Features of the Valparaiso Upland**

Like the Lake Border Upland, the Valparaiso Upland is an exceedingly rich farm-and-dairy region. The northern lake section is a part of the famous dairy section that has placed Wisconsin foremost among the dairy states of the country. The Indiana part is hardly less important as regards dairying, Lake County being known as "the Denmark of Indiana." The production of stock and grain is important in all parts of the province, especially in the middle, or Illinois, portion.

Being primarily an agricultural region, this province has a great predominance of small country towns, the larger ones being established along the major streams or along the margin of the Lake Plain. In most cases the communities in this upland are located on the crests or sides of moraines (see glacial map, Plate I).

Approaching the city of Chicago one finds that villages become increasingly numerous. These are served by a close net of railroad lines that converge on Chicago and offer excellent passenger and freight transportation. Many of the towns, Wheaton and Downers Grove for example, even though located some distance out on the upland, contain a large percentage of people who have their occupation in Chicago. Other communities are built on the edge of the rolling upland bordering the Lake Plain, thus combining the advantages of accessibility to the large city with those of suburban location. Glenview, Park Ridge, Franklin Park, La Grange, Palos Park, Homewood, and Chicago Heights are in this group. This chain of marginal towns on the more habitable upland is rapidly becoming continuous.

On the uplands railroad lines are not quite so direct as in most parts of the region, their courses being determined by the uneven topography. Highways, also, find it impossible to follow section lines so faithfully as they do on the more level parts of the region. Streets may, and usually do, depart from the gridiron pattern to follow the topography so as to give home sites the benefit of elevations. Thus drainage is usually easily obtained for storm and sanitary sewerage. On the uplands, also, are found the best sites for forest preserves and parks, country clubs, golf courses, and riding clubs. Large areas, particularly near the more congested part of the region, have already been acquired by private capital and by public funds for these purposes. By the middle of 1926 the Cook County Forest Preserve Commissioners had acquired 31,000 acres of forest-preserve lands, approaching the first objective of 35,000 acres. In Du Page County over 1,300 acres had been taken over for forest preserves, and Kane County is just embarking on its program of acquisition of forest preserves. These areas are being selected very wisely so as to include all the natural features of the region and hence all types of flora and fauna; they include upland forests and prairies, flood plains, ravines, swamps, rivers, ponds, lakes, and springs, with a corresponding variety of vegetation.

Mention should also be made of the great many summer resorts in the lake region. So numerous are these resorts, and so highly coveted are choice locations in them, that in certain instances desirable home sites on the lakes command prices higher than those in the better residential sections of Chicago.

Many of the summer resorts have become permanent villages, and are made up of beautiful, substantial homes. The rounded and usually wooded knolls of the lake country and the clear blue lakes they inclose constitute what is undoubtedly one of the most picturesque parts of the interior plain.

Possibilities for further utilization of this beautiful province for recreational purposes are practically unlimited.
Chapter VI

THE MANTENO PLAIN

The Manteno Plain takes its name\(^1\) from the town of Manteno, Illinois, located at a point where this province is widest and where it is typically developed. It is a crescent-shaped tract (see Fig. 2) lying wholly west of the old Continental Divide; its inner margin faces northeast and faithfully parallels the shore of Lake Michigan. Its widest and most southerly part is north of Kankakee, whence it pinches out both to the north, where it ends in a sharp point south of Elgin, and to the east where it crosses the Illinois-Indiana state line and ends in a blunt point near Lowell. The length of the plain, along its midline, is 80 miles; its average width is 12 miles; and its maximum width is 17 miles, just north of Kankakee.

On the inside the crescent is bounded by the outer front of the Valparaiso Upland. On the outside it is bounded from Elgin southward to the Chicago outlet by the Minooka moraine, a part of the Outer Upland; from the outlet to its eastern tip it is set off from the Morris-Kankakee Basin by the bluffs of the Kankakee River. The Chicago outlet crosses the plain at Joliet and divides it into north and south portions, the latter being the larger of the two. In its course across the Manteno Plain the Chicago outlet is at first deep and narrow, but below Joliet it becomes broad and shallow and widens into the low Morris-Kankakee Basin.

The surface of the plain descends from 720 feet above sea-level south of Elgin to 650 feet at the eastern end. East of Wilmington, where the Wabash Railway crosses, the border of the plain is lowest, with an elevation of 600 feet. In the northern portion the slope is inward from both sides, giving rise to a basin about 366 square miles in area and drained by the southward-flowing Du Page River. In the southern portion the slope is generally southwestward from the Valparaiso Upland toward the Kankakee River. Consequently, the streams which are tributary to the Kankakee River have approximately parallel courses and bring out strikingly the slope of this portion of the Manteno Plain.

The plain character of this province is varied by the presence of two moraines that represent brief pauses of the ice front as it retreated across this area. They are the Rockdale\(^2\) and the Manhattan moraines (see glacial map), both characterized by gentle swells and shallow, undrained depressions. Three large abandoned valleys, now sloughs, cross the Rockdale moraine in a general east-west direction north of Joliet. During the period of glacial retreat they were occupied by good-sized rivers. In the extreme southern part, near Kankakee, the Rockdale moraine and the surface of the plain are crossed by shallow channels which were formed by the torrential glacial waters escaping through the Kankakee Valley while the great ice lobe still occupied the Lake Michigan Basin and Plain.

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\(^1\) Name proposed by Dr. M. M. Leighton.
Chapter VII

THE MORRIS-KANKAKEE BASIN, A POTENTIAL RECREATIONAL BELT

M O S T extensive of the lowlands in the region of Chicago is the Morris-Kankakee Basin, a broad belt across the entire southern part of the region (see Fig. 2). A compound province as is suggested by its name, it consists of (1) the Morris Basin, a flat, saucer-shaped depression at the west end; and (2) the Kankakee Basin, the broad valley of the Kankakee River that enters the Morris Basin from the east. Because there is no physiographic break between the two basins, and because they have many features in common, they are here regarded as one province. On all sides this basin is bounded by higher land: on the northwest, west, and south by the Outer Upland; and on the north by the Manteno Plain and the Valparaiso Upland. Near its western end it, too, is crossed by the Chicago outlet. It is from fifteen to twenty-five miles wide through most of its course, but near Kankakee it is constricted to a width of 4 miles.

In general the basin slopes from east to west, the westward flow of the Kankakee River expressing this slope. The higher elevations, about 750 feet above tide, are in eastern Indiana; and the lowest part, an elevation of 550 feet, is the center of the Morris Basin. The descent from the sides of the basin toward the river is in places imperceptible.

THE MORRIS BASIN

Were it not for the gap in the western edge (outside the region of Chicago) through which the Illinois River flows, this basin would contain a large lake, as it undoubtedly did at the time of glacial retreat. Much of its surface is lower than the surface of Lake Michigan, as is shown on the relief map (Plate II). Because the Morris Basin is a saucer-shaped depression, the drainage has a radial pattern, that is, the streams flow inward toward the center of the basin.

THE KANKAKEE SAND PLAIN

In Indiana the entire breadth of the Morris-Kankakee Basin is a plain covered with sand or very sandy soil, and is therefore frequently called the “sand plain.” This great expanse of sand represents the deposits made during the glacial period chiefly as outwash from nearby ice lobes.

Throughout most of its course this province is a monotonous lowland without any interruptions other than the numerous sand dunes and occasional shallow bars that rise from its surface. In parts of Indiana sand ridges, probably built up by the wind, are fairly conspicuous. In the Morris-Basin a prominent gravel ridge forms the northern margin of the Chicago outlet; and south of the outlet clearly marked shore lines record the levels of the lake that once occupied the basin.

The master-stream of the Morris-Kankakee Basin is the Kankakee River. Though it receives many tributaries, all, except the Iroquois River, are relatively small. In the Morris Basin the largest streams are the multibranched Aux Sable and Mazon creeks.

Originally most of the sand plain and parts of the bordering areas were in a swampy condition. Old settlers recall that areas were under water so deep that it was necessary to swim horses across. In 1899 Leverett wrote of this lowland:

The Kankakee marsh embraces probably 1,000 square miles or about one-fifth of the watershed. In addition to this, about 3,000 square miles have very poor drainage. . . . The head of the Kankakee marsh near South Bend, Indiana, stands about 140 feet above Lake Michigan, or 720 feet above tide. From this point to Momence, Illinois, a distance of 82 miles by direct line, there is a continuous marsh. The amount of water above the junction with Yellow River is insufficient to from a well-defined channel, but below that point there is quite a definite open channel. The small tributaries are usually lost in the marsh before reaching the main stream. The Kankakee Valley Drainage Company has estimated that 645 square miles may be directly reclaimed and 1,000 square miles benefited by systematic ditching.1

In the 100 miles through which the Kankakee River flows in Indiana it originally meandered so that its length was 300 miles and its average fall 4 inches per mile.2

During the last twenty years conditions in the marsh belt have been changed greatly. The Kankakee and many of its tributaries have been straightened and deepened so as to increase both their gradient and

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2 Handbook of Indiana Geology, p. 72.
capacity. Much drowned land still remains, however, all the way from Kankakee County eastward to Starke and Laporte counties, especially close to the Kankakee River. Even where ditching has been resorted to, maintenance of good drainage presents a difficult problem because at times of high water the streams and ditches bring in water beyond the capacity of the Kankakee Channel. These floods have had important bearing on town locations. Morris, for example, is located on a terrace well beyond the reach of the overflows that frequently occur in the Morris Basin, and there are practically no communities of any size on the Kankakee east of Momence.

Where the sandy soil of the lowland is drained it is usually suitable for farming, corn and hay being commonly grown on it. From marsh areas not yet drained, "wild hay" is often cut. A strip of practically unchanged lowland in places several miles wide extends from Kankakee County eastward along the Kankakee. Much of it is still in forest, the native growth of trees including maple, ash, elm, birch, and oak. In open glades cat-tails and rushes grow luxuriantly. Some farmers own wood lots in this area and during the winter go into the woods on the ice to cut and haul out an annual supply of firewood. On dry sections hunting and fishing camps have been located. Attempts have been made to reclaim parts of this undrained belt, but the returns have not justified the high expense. For this reason the area should prove ideal for forest preserve and should be maintained in its wild state, so that the plant, bird, and animal life still abundant there may be cared for. The area is adapted by nature for this type of recreational use and is of little value for any other purpose.

\(^1\) Soil Survey of Porter County, Indiana (U.S. Dept. of Agriculture), p. 41.


Chapter VIII

THE OUTER UPLAND, AN AGRICULTURAL AREA

This province is the third and outermost of the three concentric uplands that occur in the area. Like the others it encircles the lower end of Lake Michigan and trends parallel with the shore of the lake (see Fig. 2). Only extensions from its inner margin come within the region of Chicago, the main part of the upland lying outside of it. Here is the front along which the edge of the ice stood stationary for a long time in the course of its northward retreat. Though not so pronounced as the Valparaiso, this upland is very prominent through much of its course. It will be considered under three sections: (1) a northern portion, extending in a broad belt from the Wisconsin line southward to the north end of the Morris-Kankakee Basin; (2) a middle portion, extending from the southwest corner of the region of Chicago eastward nearly to the Indiana line; and (3) an eastern portion, in Indiana, occupying the southeast corner of the region of Chicago.

The northern portion, like the Valparaiso Upland, has an unusually great relief for the region of Chicago, its altitudes ranging from little more than 600 feet above tide at the southern end to altitudes of 1,000 and 1,050 feet in the northern portion west of Elgin and at the Wisconsin-Illinois state line. The northern half, north of the town of Elburn, is distinctly higher than the southern, most of it being more than 800 feet above sea-level and large tracts being over 900 feet.

The surface of this highland shows well-marked terminal moraines. Two of these, the Minooka and Marengo moraines (see Plate I), trend north and south and are very long. The Minooka moraine extends south to the Chicago outlet, 16 miles beyond the main part of the upland, thus forming the eastern rim of the Morris Basin. The Illinois River has cut into the southern tip of this moraine and developed a sharp bluff 120 feet high, called Dresden Heights. Here the Minooka moraine is fairly conspicuous, but in general it is not prominent, being characterized by Leverett as "a single smooth ridge on whose crests and slopes there are few swells exceeding 10 feet in height."

The other moraine, the Marengo, lies to the west of the Minooka and extends from a point 5 miles west of Batavia northward beyond the Wisconsin line. This

2 Ibid., pp. 291-92.
Anne, Illinois. There is an interruption in the moraine near its eastern end, where the Iroquois River crosses it. The crest of the moraine lies south of the region of Chicago, and therefore the elevations in our region are low, ranging from 700 feet at the west end to 650 at the east. The moraine slopes northward, thus determining the flow of the tributaries of Mazon Creek and Kankakee River. The relief is not great, but swells 20 feet high occur on the moraine. Near St. Anne is the eminence called Mount Langham that rises 75–100 feet above the plain to the north of it.\(^1\)

The eastern part of the Outer Upland, the Indiana portion, is an upland only in a relative sense as contrasted with the lowlands that surround it. It consists of a few narrow hummocky moraines, probably continuations of the Marseilles moraine, that rise to over 700 feet above tide, and are separated by areas of sand and sandy ground moraine.

The Fox River,\(^2\) the only important stream in the Outer Upland, has its source in southern Wisconsin, follows the eastern and southern margins of the Aurora Plain, and after passing out of the region of Chicago enters the Illinois River 33 miles below the mouth of the Des Plaines.

For a distance of nearly 75 miles from its source the Fox River drains only a narrow strip among the morainic ridges of the composite belt previously described. In this portion of its course its fall amounts to but a few inches to the mile, but it expands at frequent intervals into lakes and marshes, between which are short spaces having a narrow and well-defined channel. . . . Above Elgin, Illinois, the river begins a rapid descent to the low plain that lies on the outer border of the Marseilles moraine, and follows this plain to its mouth. The stream has no valley until it begins the descent to this plain, where for a few miles it has cut to a depth of nearly 100 feet, but in the passage through the plain its bed is sunk to a depth of only 40 or 50 feet. . . . The valley is also narrow throughout its entire length, and presents a conspicuous contrast to the broad valley of the upper Illinois. Its channel even in the lower 75 miles has a breadth of only about one-eighth mile and a depth scarcely half as great as that of the neighboring portion of the Illinois.

A peculiarity of the Fox River is that all its important tributaries lie on the west side, there being but a narrow strip of watershed on the east side.

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\(^1\) Ibid., p. 280.  
\(^2\) Ibid., pp. 309–10.
Chapter IX
LAKE MICHIGAN AND ITS SHORE LINE

Lake Michigan, a complete barrier to east-west land traffic, is a principal cause for the development of the great metropolitan area at the point where all traffic lanes—water, rail, and highway—intersect and come to a focus.

The lake1 is about 300 miles long and has a maximum width, at Racine, of 80 miles. At Chicago the width in a due east-west line is a trifle over 50 miles. The area of the lake is 22,400 square miles.

In cross-sections based upon soundings, the lake has the profile typical of an ice-eroded basin rather than of a river-cut valley, in that it is broad, flat bottomed, and has somewhat abrupt sides. The longitudinal profile bears out the same view, for it shows the existence of broad, inclosed basins separated by swells. The character of the bottom in the part of the lake lying north of Racine is very different from that lying south of that city. In the northern portion the bottom is irregular, due to the presence of what are apparently a series of westward-facing escarpments protruding into the basin; in the southern portion the bottom is smooth and rounded. It is suggested that the condition in the southern end of the lake is due to a veneer of glacial drift covering the bottom and hiding irregularities which are probably present on the surface of the bed rock.

Along a line from Milwaukee to Grand Haven, the lake nowhere exceeds 348 feet in depth (see Fig. 12). This relatively shallow stretch marks a submerged divide which separates Lake Michigan into two major basins. The northern of these is considerably the deeper of the two, reaching a maximum depth southeast of Sturgeon Bay of about 870 feet, or about 290 feet below sea-level. The southern basin reaches its maximum depth in the middle of the lake, opposite the city of Racine, where the bottom is 582 feet below the surface, or approximately at sea-level. From this point southward to the head of the lake the bottom rises gradually. The deepest part of the lake between Chicago and Benton Harbor lies at a midway point where the water is 252 feet deep. The rate at which the lake deepens off the Chicago shore line is indicated by Table III.

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<tr>
<th>Distance from Shore in Miles</th>
<th>Depth in Feet</th>
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<tr>
<td>1</td>
<td>12-25</td>
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<td>5</td>
<td>30-45</td>
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<td>30</td>
<td>245</td>
</tr>
<tr>
<td>34</td>
<td>252</td>
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A striking feature of the southern two-thirds of Lake Michigan is the absence of natural islands. Submerged reefs are found, however, though fortunately for lake navigation they are few. One of these, the Racine reef,2 occurs within the region of Chicago. Its inner edge lies over a mile offshore from the city of Racine; on its shallower part it is 6½-11 feet beneath the surface of the lake, and it is surrounded by depths of 25-30 feet. In extent it is a half-mile broad by a mile and a quarter long. There is a lighthouse near its eastern border. The constitution and origin of this reef have not been determined.

Changes in level of lake Michigan
Seiches.—This is a tidelike rise and fall of the water level set up in response to varying atmospheric pressures and rarely amounting to as much as a foot.

Tides.—Lunar tides having a range of about 3 inches occur on Lake Michigan.

Seasonal variations.—The range in level between low water in January and high water in July or August amounts to 18 inches or less. This variation is due to fluctuations in precipitation, spring melting, and evaporation.

Longer-term fluctuations.—There are groups of years during which the lake level is rising and others during which it is falling. The variations between high and low level do not exceed 1½ feet. The years during which high and low levels have been reached are shown in Table IV.

1 Data drawn chiefly from the lake-survey charts furnished by the United States Lake Survey Office, Detroit, Mich.
Recent changes in level.—Since about 1920 there has been a steady lowering of the Great Lakes that has caused some alarm and that threatens seriously to interfere with the use of the lakes for navigation, sanitary purposes, and the generation of power in hydroelectric plants. Lake Michigan had a level of 382 feet above sea-level in 1918; but in January, 1926, it had fallen to 577.37 feet—the lowest level ever recorded for the lake. By August, 1926, the level had risen to 578.59, showing the usual seasonal fluctuation. This lowering of the water level has been attributed to the diversion of water at Chicago from Lake Michigan into the Chicago Drainage Canal, but an exhaustive investigation by the Engineering Board of Review of the Sanitary District of Chicago has led to the distribution of the causes as shown in Table V. Thus diversion at Chicago is seen to be neither the sole nor the greatest factor involved. Abnormal weather conditions of recent years appear to play the leading part.

The most favored remedy for this condition is the construction of movable dams at the outlets of the lakes, by means of which the outflow and hence the level of each lake may be regulated. Such control has been successfully exercised at the outlet of Lake Superior for eight years and also by the Canadian government at the outlet of Lake Ontario, where it has resulted in the raising of the water level about 6 inches.

THE SHORE LINE

In the region of Chicago the shore line of Lake Michigan presents a smooth curve that is remarkably free from irregularities. This situation has not always existed. For scores of centuries the waves have been cutting away protruding headlands and filling up bays to produce the present regularity.

Three processes—erosion, transportation, and deposition—are constantly modifying the shore line; and the fact that in this region they have to deal only with unconsolidated bowlder clay, gravel, and sand facilitates most of their work. The winds from the northeast, so frequent near Chicago (see wind rose for Chicago, Fig. 10), have a long sweep across the lake, develop great velocities, and form great waves, often 20 feet high.

TABLE IV

<table>
<thead>
<tr>
<th>Year</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>1880</td>
<td>578.9</td>
<td>571.1</td>
</tr>
<tr>
<td>1881</td>
<td>578.9</td>
<td>571.1</td>
</tr>
<tr>
<td>1882</td>
<td>578.9</td>
<td>571.1</td>
</tr>
<tr>
<td>1883</td>
<td>578.9</td>
<td>571.1</td>
</tr>
</tbody>
</table>

* No record from 1845 to 1855.
* Lowest to date.

TABLE V

<table>
<thead>
<tr>
<th>Factor</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excessive evaporation and subnormal precipitation</td>
<td>13</td>
</tr>
<tr>
<td>Increased flow by the enlarged St. Clair River</td>
<td>8</td>
</tr>
<tr>
<td>Diversion at Chicago</td>
<td>5</td>
</tr>
<tr>
<td>Storage and retention in Lake Superior</td>
<td>3</td>
</tr>
<tr>
<td>Backwater effect by diversion and lowering in Lake Erie</td>
<td>2</td>
</tr>
</tbody>
</table>

Total below normal level | 31 |

which break over the beaches on the west shore and advance to the very base of the bluffs, undercutting them so that large masses of bowlder clay slump down into the lake carrying shrubs and trees with them.

Most of the time waves encounter the shore obliquely, not at right angles; the backflow, however, is at right angles. The result is that any material such as sand or driftwood which the waves may be carrying is shifted steadily along the shoreline in a zigzag course (see Fig. 13). Probably a single storm accomplishes more of this “shore drift” than is otherwise performed in the course of a year of ordinary weather conditions. It is apparent that the shore drift is not a current as is often maintained, but simply a matter of wave action. By means of the drift, material from the bluffs north of Evanston is shifted southward to the head of the lake.

At the same time that the material is being transported it is also being sorted. The larger and heavier stones in the bowlder clay are left on the shore, forming so-called “cobble beaches,” where they are gradually worn down; while the very fine material, the clay, is carried in suspension far out into the lake before being deposited. It is chiefly the material of intermediate size, the sand, that is carried along by the shore drift.

There are two sections of the shore line to be noted in the region: (1) the erosional portion north of Evanston, and (2) the depositional portion south of Evanston.

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**Fig. 13.—How material is carried southward.** With a northeast wind the wave carries the sand diagonally across the beach. The receding water or undertow flows directly down across the beach, the result being a zigzag path to southward. The major part of translation during the year is done in a few heavy storms.

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**Lake Michigan’s Shore Line near Lake Bluff, Looking North; the Lake Is Actively Eroding the Shore Line.**

**THE EROSIONAL SHORE LINE**

Between Evanston and Racine the Lake Plain is being cut away—in fact, it has long since disappeared from the 20-mile stretch between Evanston and Waukegan, where the lake has cut far into the Lake Border Upland. At Pike River, near Kenosha, and at various points north of Racine, the bluffs retreated 1–6 feet a year between 1836 and 1874. At exposed points the recession has been even faster, as at Racine where it averaged nearly 10 feet a year for the twenty-four years following 1840.¹ Efforts to stop this erosion by the use of piers have proved only partially successful, and

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¹ Wisconsin Geological and Natural History Survey, Bull. 36, p. 289.
erosion is still going on. Farther south, at Glencoe, vegetation has obtained a good foothold on the bluffs, since the erosion has been stopped and the undercutting and subsequent landslides prevented. Although erosion is the dominant process in operation along the lake shore north of Evanston, much sand is accumulated along the north sides of piers and across the mouth of streams. It is deposition of this sort that hampers the maintenance of open harbors at Racine and Kenosha.

Between Waukegan and Evanston the high bluffs have been gashed with a remarkable series of deep, V-shaped ravines that have become widely known among geologists as excellent examples of very young valleys. These ravines usually head a mile or less back in the upland, and do not contain streams except after rains. Formerly the headward erosion of these ravines went actively on, keeping pace with the recession of the lake bluffs; but here, as in so many other instances, man interfered and has in most cases artificially prevented further erosion at the ravine heads. It is along the crests of the bluffs and between the ravines that the many residential towns of this section have grown.

In 1897 Leverett wrote as follows:

The rate at which the lake bluff is being encroached upon by wave action has become a matter of much concern to the residents. It is estimated by old settlers that from Waukegan to Evanston there has been, during the thirty years from 1860 to 1890, a strip about 150 feet in width, undermined and carried into the lake. This amounts to about 300 acres, representing at present valuation nearly one million dollars' worth of property.1

Another observer has noted:

In 1845 and for about ten years following there was a village located in the southeast corner of what is now the Fort Sheridan grounds. This village was known as St. John, . . . . Reports differ as to the amount of land that has been cut away at this point, but all agree that it was more than 100 feet. Some old settlers insist that 300 to 400 feet have been removed, and that the wearing away of the land caused the site to be abandoned. The orchard trees at the edge of the cliff and even overhanging are reported by some to have been in the yard to the west of the westernmost house in the village. If this is true, the entire site of the village of St. John is east of the present shore line.2

The moving of roads and sidewalks has been necessitated in places by the cutting back of the bluffs. In Rogers Park some of the concrete sidewalks extended farther east than they now do.

Through Wilmette the government road was unfortunately near the lake cliff and was frequently washed away by the waves. At the foot of Lake Avenue, Wilmette, as reported by C. P. Westerfield, a surveyor at Waukegan, Illinois, the present shore line is nearly 200 feet west of where it was in 1837. The original location of the old government road at this place is more than 200 feet east of the present shore line.3

North of Winnetka the Green Bay road turns westward to avoid crossing the numerous ravines and to take advantage of the rolling upland. The railroad and electric lines take the same route, crossing the heads of the larger ravines by means of culverts.

THE DEPOSITIONAL SHORE LINE

Much of the present site of Chicago has been produced through deposition by the shore drift. In the northern part of the city as far south as Lincoln Park this filling originally took the form of closely set sand and gravel ridges 10-15 feet high, now largely obscured by grading. Southward from Thirty-fifth Street similar

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4 Ibid., p. 89.
deposits cover a considerable area. Northeast and east of Washington Park a series of ten to twelve of these low ridges could be recognized before grading took place. They ran roughly parallel to one another and were from 1 to 6 miles in length, their southern ends being as a rule turned slightly to the west, giving them the form of shallow hooks. The longest and most prominent ridge passed through the campus of the University of Chicago; it continued southward through the western part of Oakwoods Cemetery, terminating a mile north of Burnside.¹

South of Lakes Calumet and Wolf and north of the nearest beach ridge is a remarkable series of low parallel sand ridges which range from 3 to 10 feet in height and are separated in many cases by narrow, marshy belts. From the present One Hundred and Thirty-eighth Street in Hammond to the Grand Calumet River ninety of these ridges were once counted before grading had destroyed them. Similar ridges, approximately parallel to the lake shore, may be traced all the way to Gary and Miller in eastern Lake County.

Lake Calumet, Wolf Lake, and former Lake George occupy a shallow depression or sand plain between the mass of ridges in Chicago and those in northwestern Indiana. This depression may once have been an open bay that was partially closed off as a result of filling.²

The deposition of sand along the lake shore is still actively going on, and has given rise to the great sand areas that have become famous for their marvelous development of dunes.

THE DUNES

It is not so well known as it should be that the dunes of Lake Michigan are much the grandest in the entire world. Not necessarily the highest, though some of them reach up 400 feet and more above the lake, but more than any other anywhere, our dunes show magnificent and contrasting types of plant life, everything from the bare dunes to magnificent prairie forests. No other dunes than ours show such bewildering displays of dune movement and struggle for existence, such labyrinths of motion, form, and life, . . . . They are without a parallel.³—Henry Chandler Cowles.

The Lake Michigan dune region⁴ lies in a belt along the shore from Gary, Indiana, eastward and northward practically the full length of the east shore. Originally the dunes extended as far west as Chicago, but excavation for sand has destroyed them between Chicago and Gary, as it has at so many other points. Throughout much of its length the dune belt is not over a mile in width, but locally it is fully 25 miles wide. In the Indiana portion the finest stretch is that extending from Miller to Michigan City; here the largest dunes are about 200 feet high. In Michigan, however, the dunes reach their fullest development, especially at the deltas of rivers flowing into Lake Michigan where supplies of sand have been furnished not only by the lake but by the rivers. At Sawyer, Ludington, and Glen Haven occur the most imposing dunes, some being over 400 feet high. A few small dune areas occur along the west shore of the lake also, between Waukegan and Kenosha, but here they are relatively inconspicuous.

The dunes have been formed as a result of winds blowing from the lake across areas of sand that have been freshly deposited along the shore. We have considered how this sand is obtained through the erosion of the west shore north of Evanston, and how it is carried around to the head of the lake by “shore drift.” Thus is explained the existence of great dune areas along the Indiana and Michigan portions of the shore line and the pandemic of dunes along the Illinois and Wisconsin portions. The dunes are best developed where the winds from the lake have passed over broad

¹ Geographical Society of Chicago, Bull. 1, p. 46.
² Twenty-second Annual Report (Dept. of Geology and Natural Resources, Ind.), p. 37.

Photo by George D. Fuller

AT THE SOUTH END OF LAKE MICHIGAN THE BEACH IS BEING WIDENED BY DEPOSITION OF SAND FROM THE ERODING SHORE NORTH OF CHICAGO.
expanses of lake, and as a consequence have developed high velocity. Such winds, especially, are those from the southwest and northwest (see wind rose, Fig. 9). There is hardly a time when at some point along the sandy shores winds from the lake are not carrying the sand inland, building up dunes into the vegetation of the land.

It will prove instructive to review the stages of a typical dune. Winds blowing from the lake over the beach pick up particles of sand and carry them inland. Where some obstacle is encountered, the velocity of the wind is checked and the sand is dropped. So dunes may originate about clumps of grass, shrubs, etc. The embryonic dune itself becomes an obstacle, and rapid growth takes place. Meanwhile, the dune moves inland as a result of the rolling of sand up its gentle, windward slope and over the crest to its steep, leeward slope. Along Lake Michigan it has been found that dunes may move as rapidly as 10 or 15 feet per year. In its inland journey, the dune may encounter shrubs, trees, even whole forests, and engulf them. Only those forms of vegetation can then survive that have the power of putting forth new roots and growing upward as the sand piles around their base; in the case of the largest dunes, nothing survives. Later, dead tree trunks are exhumed when the dune has passed completely by. Eventually the "wandering" dune slows up as a result of the cutting off of its sand supply by new dunes that have formed between it and the shore. Vegetation then gains foothold on it, thus contributing to stabilization. With time the dune will probably become "fixed," though not infrequently dunes that are apparently fixed become rejuvenated and move on again, only to slow up and stop as before.

Life of the dunes.—The plant life of the dunes, and in fact the dunes themselves, have become celebrated as a result of the classic studies of Professor Henry C. Cowles. A résumé of the botanical features is given on pages 7–9.

The bird and animal life are also extremely interesting. Concerning the former, Mr. O. M. Schantz, of the Audubon Society, says:

The list of birds regularly visiting the area comprising the dunes and the adjacent regions is a very large one—well over 300 varieties; and the list is often swollen by wandering visitors who are attracted by the wonderful food supply, and the favorable climatic conditions.1

Professor Elliot R. Downing states that the region is exceedingly interesting to the animal lover because it is an extensive stretch of wild country with plenty of cover in which the small animals find shelter; it is consequently also the haunt of some of the larger predacious animals now nearly extinct elsewhere hereabouts. In the last five years I have found the gray timber wolf there once, foxes several times, racoons, porcupines, rattlesnakes, and nearly every year the bald eagle has been seen nesting somewhere in the region. . . . Just as the flora of the dunes is a curious mixture of southern and northern species, like the cactus and arbutus, that grow side by side, so there are found animals there as neighbors that represent the desert conditions of the Southwest and the pine barrens of the North. Such representatives of usually widely separate faunas are the six-lined lizard that runs to cover with such celerity and the ruffed grouse that as a rule only nests in the pine forests several hundred miles

farther north. Yet both these animals are quite common in the dunes. . . . You also find a group of animals naturally foreign to this latitude but brought here by plants they inhabit. The varying hare, porcupine, and chipmunk are here; such birds as the wood pewee and red eyed vireo nest in the mixed evergreen and birch thickets; the Pickering tree frog peeps his love song; and numerous woodboring beetles and bark tunnelers that infest only the conifers are found abundantly. . . . Because of the congenial cover afforded by the evergreen thickets and the abundant food, many birds are found during the spring and fall migrations, staying days and weeks in the dunes, that would not loiter at all in the Chicago region were it not for the attractions of this particular section. Such are the raven, cross-bills, kinglets, black-throated green and pine warblers. So too the many lakes and swamps of the region, lying in the depressions between the sand ridges, are ideal shelters for the waterfowl on their way to or from the extensive marshes that lie near to the south. Wild geese, ducks of all sorts, loons, coots, gallinules, rails and a variety of snipes are all annual visitors and some of them regular residents.¹

CONSERVATION OF THE DUNES

At numerous points large areas of sand dunes have been excavated by steam shovels and hauled away to be used for construction purposes. While a reasonable amount of such excavation may perhaps be justified, the destruction of some of the very finest dune area—as at Dune Park—is nothing short of tragic. It is a source of gratification that a large area, already nearing 2,000 acres, has been acquired by the Indiana Department of Conservation as a state park. Michigan, also, has taken steps to protect some of the most valuable areas by creating state parks, and the total destruction of the beautiful dunes is thus not likely to occur. It is sincerely to be hoped that further protective measures will be taken either by the state or federal governments.

¹ Ibid., pp. 93-94.
Chapter X

THE BED ROCK AND ITS SURFACE, A BURIED LANDSCAPE

SEVERAL formations are represented in the bed rock of the region of Chicago. These are composed of limestone, sandstone, shale, and coal, limestone being by far the most common rock type, coal the least so. Fossils found in the rocks indicate that the various formations were in great part laid down at the bottom of seas which time after time over-spread the central part of the continent.

The fossils also enable geologists to determine at what time in the course of geologic history these rocks were formed; and by their use it has been found that in the region of Chicago formations representing the following geologic periods occur: Ordovician, Silurian, Devonian, and Pennsylvanian. All of these periods date far back into geologic time. Thus the rocks of the region of Chicago are extremely ancient, their age being measured in terms of millions of years.

Originally nearly horizontal, the strata of the region have been slightly deformed so that their general dip is toward the east. Ordinarily this dip is so slight as to be imperceptible. Because of this structure, shown in Figures 4 and 5, the younger formations, those of the Devonian period, are at the surface in the eastern part of the region of Chicago and older rocks successively come to the surface as one goes westward. In the southwestern corner of the area, however, these older rocks are overlapped by the younger formations of the Coal Measures. The latter are continuous southward and are part of an area known as the "Eastern Interior Coal Basin" that comprises most of the state of Illinois.

DESCRIPTION OF FORMATIONS

The following are generalized descriptions of the formations occurring in the region of Chicago. They are given in the order of their age from oldest to youngest, and are located in Figure 14.

ORDOVICIAN

The St. Peter formation occupies a small area in the southern part of Kendall County. It consists of a sandstone of unusual purity that is usually snow white where freshly exposed. As a rule the sand grains that compose it are well rounded and but slightly cemented; consequently the rock is soft and easily eroded. It is chiefly in this soft sandstone that Starved Rock and the many neighboring scenic features have been eroded. Because of its high purity and softness this formation is an important source of sand for molding and glass-making, and due to its high qualities "Ottawa sand" has been adopted by the American Society for Testing Materials as a standard for the fine aggregate in concrete.

The Galena-Platteville formation is a limestone and magnesian limestone (dolomite) formation that occupies two areas: one in the northwestern corner of the region, in Wisconsin, and one along the middle portion of the western margin of the region, from central Kane County south to northern Grundy County. It is a hard, gray, or buff limestone that appears massive in fresh exposures but thin beded and "shabby" where weathered.

The Richmond formation extends in a narrow belt through the western part of the region from the northern boundary as far south as the Illinois River between Joliet and Morris. An isolated patch occurs along the Kankakee River near Wilmington. It consists of a grayish, bluish, or greenish shale in which occur layers of limestone that vary from fine to coarse textures. Where freshly exposed the limestone is gray, but it weathers to a brown color. Because of the shale it contains, the formation is relatively non-resistant to erosion.

SILURIAN

The Alexandrian series comprises two thin limestone formations, the Edgewood and the Kankakee, at the bottom of the Silurian system. They do not differ greatly from the much thicker and more extensive overlying formation, the Niagaran, and are therefore not differentiated from the latter on the geologic map.

The Niagaran formation is the most well-known formation in the region, because of the prominence of its outcrops, as at Joliet, and because of the limestone industries to which it has given rise. It is a hard dolomite, blue or gray on fresh surfaces and yellow where long exposed. It occurs in well-developed layers showing a wide range in thickness from less than an inch to 2 or 3 feet. Its distribution, as shown on the geologic map, covers more than two-thirds of the Chicago area.
GEOLOGIC MAP
OF THE
REGION OF CHICAGO

DATA FURNISHED BY U.S. GEOLOGICAL SURVEY
AND ILLINOIS GEOLOGICAL SURVEY

KEY

- PENNSYLVANIAN
  Formations not differentiated

- DEVONIAN
  Formations not differentiated

- SILURIAN
  Niagara formation and Alleghanian Series not differentiated

ORDOVICIAN
- Richmond formation
  - Galena-Platteville formation
  - St Peter formation

Fig. 14.—Geologic map of the region of Chicago. (Data furnished by the U.S. Geological Survey and the Ill. Geological Survey.)
DEVONIAN

In the eastern part of the region of Chicago in Illinois the rocks encountered in deep wells have been found to be Devonian in age. They include a shale formation (New Albany), a limestone (Corniferous), and a sandstone (Pendleton).

PENNSYLVANIAN

The formations of the Pennsylvanian, together constituting the Coal Measures, lie in the southwestern corner of the region, their distribution corresponding roughly to the Morris Basin. The three formations that are recognized—the Pottsville, Carbondale, and McLeansboro (named from bottom to top in a vertical section)—exhibit greater diversity than do the other formations that have been described, consisting of alternating beds of sandstone, limestone, shale, and coal. The coal occurs in layers up to 3 feet thick, that is, in workable layers. This is the nearest occurrence of coal to Chicago.

SURFACE OF THE BED ROCK

Though the surface of the bed rock is largely hidden beneath the great accumulations of glacial deposits left by repeated glacial advances, conclusions relative to its character may be drawn from data obtained in drilling wells, digging foundations, etc. These data indicate clearly that the surface of the bed rock is not flat but is diversified by the presence of ridges, hills, and valleys in much the same fashion as is our present landscape. Indeed, we are here actually concerned with a buried landscape, that which existed prior to glaciation. Its major features are unchanged, though it is known that the overriding glaciers in some cases rounded off the hills and scoured out the valleys that trended in the direction of the ice flow.

While data are not yet numerous enough to make possible the construction of a map of the entire region of Chicago showing the features of the buried preglacial surface, several such maps have been made for parts of the area that have been studied in detail. Dr. William C. Alden, of the United States Geological Survey, has prepared a map for southeastern Wisconsin, and Professor D. J. Fisher one for the Joliet region. These maps are of great interest, and indicate that the preglacial topography was very similar to that of the present surface, though as a rule more rugged; and that the elevations and lowlands of the present surface do not usually correspond to elevations and lowlands in the bed rock beneath. For example, the Chicago Plain is nearly flat, yet the underlying Niagara limestone has an extremely uneven surface. On the plain the drift must be thin over the bed-rock hills, and thick over the bed-rock lowlands. Such lack of correspondence between the bed-rock topography and the surface topography is the rule throughout the region of Chicago, though exceptions occur, as in the case of the Lake Geneva Basin, which corresponds to a preglacial valley of considerable size.

The character of the bed-rock surface involves important practical considerations. It is often desirable, for example, to be able to predict the depth to which wells and foundations must be sunk before they will reach the bed rock; but the nature of the bed-rock surface is such that often predictions can be made only within wide limits. At one point the bed rock may be quickly reached because a buried hill or divide is encountered; whereas at a point only, a few hundred feet away it may be necessary to proceed 50 or 100 feet deeper because of a buried valley. Attempts to map in detail the buried bed-rock topography underlying the downtown section of Chicago have been made, but to date with no great success, due to the lack of sufficient recorded information. Could such a map be prepared with accuracy it would be of great value. The slope of the surface, the solidity of the rock, and the character of the material resting on the bed rock are of importance in connection with the laying of foundations for high buildings. Caisson-workers find it necessary to continue their holes for some distance after striking rock in order that they may feel fully assured that they have reached solid bed rock and not some loose and insecure ledge. Fortunately, the glaciers in most cases stripped off most of the decayed portions of the bed rock and left a clean, firm surface.

DEPTH OF THE BED-ROCK SURFACE

The depths at which bed rock now lies are indicated in part by the soil map (Plate IV) which shows the areas where soils rest directly on bed rock (usually less than 3 ft.) and in part by Figure 15 which shows in generalized form the relation of the bed rock to the present surface.

Leverett makes the following statement about the area:

The thickness of the drift is so great in the northeastern fourth of Illinois as to convey a false idea of the altitude of the rock surface in that region. Were the drift coating entirely removed, the average elevation would probably be as low as the surface of Lake Michigan, and possibly it would not exceed 500 feet above tide. This low altitude extends eastward some distance into Indiana. The low altitude of this district, as well as that of the Lake Michigan basin, probably influenced the ice flow and invited its great southward extension in the State of Illinois.

1 Published in United States Geological Survey, Profess. Pap. 106.
2 Published in Illinois Geological Survey, Bull. 31.

3 Proceedings, Western Society of Engineers, June, 1911, p. 399.
On the Lake Plain in the vicinity of Chicago, the bed rock lies from 0 to 130 feet below the surface with an estimated average of 50 feet. A map prepared by Samuel G. Artingstall, a former city engineer of Chicago, showed a valley with a floor 100-125 feet below the level of the lake crossing the north-central part of Chicago and entering the lake south of Lincoln Park.

On the Lake Border Upland the bed rock is deeply buried under glacial drift. The following depths to bed rock are reported by Leverett:

- Lake Forest: 160 feet
- Highland Park: 160-75 feet
- Winnetka: 150 feet
- Near Northbrook: 147 feet

At Racine the thickness of deposits on bed rock varies from 100 to 125 feet; at Union Grove a thickness of 195 feet was found, the maximum for Racine County.

No outcrops of consequence occur in the Illinois portion of the province. In Wisconsin outcrops that deserve mention occur at Ives and along the lower part of Root River, in Racine County. On the Valparaiso Upland the bed rock lies far below the surface. In Kenosha County the drift is generally from 50 to 100 feet thick and in many instances 100-290 feet thick. At Burlington, in Racine County, the drift is 50 or 60 feet thick. The usual range for this county is reported as being from 25 to 100 feet. In Walworth County thicknesses up to 329 feet are known.

From the Illinois and Indiana portions of this upland Leverett reports the following depths at which bed rock was encountered:

- At Ivanhoe, Ill., on crest: 290 feet
- Near Lake Zurich, on crest: 267 feet
- Crest east of Wauconda: 230 feet
- Crest south of Barrington: 315 feet

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1 Geographic Society of Chicago, Bull. 1, p. 3.
4 Ibid., p. 385.
5 Wisconsin Geological and Natural History Survey, Bull. 35, p. 324.
6 Ibid., Bull. 34, p. 133.
7 Ibid., Bull. 45, p. 393.
East of Elgin, near crest 220
Palatine and vicinity 40
Near Schaumberg, along crest 100
Arlington Heights, about 150 feet below crest
Crest south of Bloomingdale 125
Itasca 125
Bensenville
Elmhurst
Crest of Naperville, east 125
Downers Grove 125
Crest northwest of Lemont 150
Crest of moraine east of Lockport 115
Monee, on crest...
Beecher...
Chicago Heights
Crown Point, Ind...
Hebron...
Valparaiso...
Laporte...
Two miles north of Wheeler
Near Coburg
Woodville

feet along the Minooka moraine to 20 or 30 feet next
the Valparaiso Upland. The portion south of the outlet
has an average depth to bed rock of 30-40 feet, and in
places as at Manteno rock ridges rise to the surface of
the plain and outcrops.

In the *Morris-Kankakee Basin* bed rock is at or
near the surface throughout the Illinois portion. Re-
garding the Morris Basin, Leverett states as follows:

The drift along the border of the Marseilles moraine has
generally a thickness of 100 feet or more, but upon descend-
ing the slope toward the head of the Illinois the thickness de-
creases, and there are extensive areas in eastern Grundy,
southwestern Will, and northern Kankakee counties, where
rock is encountered at very slight depth, so that the shallow
ravines and shallow wells and even the cellar bottoms reach it.¹

As shown on the soil map, there are large tracts west
of Kankakee and south of Momence where the sand
rests directly on bed rock and a number of outcrops
occur.

In the *Outer Upland* the bed rock throughout the
northern portion (except over the Aurora Plain) is deep-
ly buried; Leverett² reports thicknesses of glacial drift
ranging from less than 100-360 feet. In the southern
part of the Aurora Plain the bed rock lies within 20-40
feet of the surface³ and some outcrops occur along the
Fox River. The depth of the bed rock over the middle
portion of the Outer Upland ranges from over 100 feet
at the western end to about 60 feet in the vicinity of
St. Anne. In the Indiana portion of the Outer Upland
the drift is probably everywhere over 100 feet thick
except south of Medlarville in Pulaski County, where
the drift begins to thin toward the south.

¹ Wisconsin Geological and Natural History Survey, Bull. 45, p. 74.
Chapter XI

THE SURFACE MATERIALS, BASIS OF OUR AGRICULTURAL WEALTH

Since the thickness of the materials overlying bed rock ranges from 0 to 350 feet in different parts of the region and for the most part exceeds 75 feet, it is evident that the surface materials and not the bed rock constitute the major factor in determining the geographic development of the region.

Glacial drift, often called “boulder clay” or “till,” constitutes the great bulk of the surface material over the region of Chicago particularly on the uplands and plains. It was either heaped up under the edge of the glacier in the form of terminal moraines or left under the body of the glacier to form the more level deposits known as ground moraines or “till plains.” Ordinarily the drift is composed of a matrix of blue or buff clay in which are imbedded stones of various sizes and kinds. Glacial drift has aptly been characterized as “homogeneous in its heterogeneity,” and its lack of assortment affords a ready means of identification. While the stones generally range in size from small pebbles to moderately sized boulders, they are occasionally found as large as 12-15 feet in diameter.

In the region of Chicago most of the stones are of limestone; there is, however, a fairly high percentage of granitic rocks and other types foreign to the immediate vicinity but known to occur in the country over which the glacier moved, that is, north and northeast of the Great Lakes region. It is to be noted that the larger boulders are ordinarily of these foreign-rock types for the reason that they are more resistant than the limestone. The stones tend to be angular in shape and flat faced, very unlike the pebbles modeled by water on shores and beaches. Scratches may sometimes be found on the rock faces, indicative of glacial origin. The clay in which the stones occur consists of pulverized rock in which limestone is again the most important constituent of the various kinds represented. The upper 2- or 3-foot zone in a deposit of glacial drift is often buff instead of blue, as a result of oxidation at the surface; and in this portion the limestone is more or less leached out.

The loess is a fine, wind-blown material, usually light buff in color, that in many parts of the region mantles the surface in a layer varying in thickness from a few inches to several feet. It is believed that the loess was derived from finely ground rock originally spread out in the stream valleys and bottom lands flooded by water from the melting glacier. This light, flourlike stuff was subsequently whipped up from the outwash flats by the wind and carried out over the uplands. The loess differs strikingly from the glacial drift upon which it usually rests in being free from pebbles and boulders. No doubt it was formerly more widespread than is now the case, having been stripped away from many localities by erosion. Though poorly developed in the region of Chicago as compared with the great thicknesses in which it occurs in the nearby Mississippi Valley, the loess is nevertheless of very great importance, for it is largely from it that our present soils have been developed.

Gravel occurs in large deposits in the northwestern part of the region of Chicago (see glacial and soil maps), chiefly along present or former drainage lines. The deposits take the form of gravel hills or of broad plains according to manner of deposition. The outwash plains are the most common and extensive form of deposit, though frequently, as near Joliet, they have been dissected by streams so that they are now no longer continuous plains but terraces instead. The gravels were deposited by water flowing out from the melting glacier, and have the characteristics of water-laid materials in that (1) they are stratified, (2) they are roughly sorted according to size, and (3) the materials of which they are composed are more or less rounded. The extremes of size that characterize glacial till are here absent.

Sand occurs along with gravel as an outwash deposit; frequently the gravels are sandy or are interstratified with beds of sand, and some entire outwash deposits consist of material no coarser than sand. In the Morris-Kankakee Basin sand makes up the bulk of the surface deposits, gravel being present in insignificant quantities.

Lake deposits.—While it may seem surprising that lacustrine clays should be practically absent over the Lake Plain since it was so long under the surface of Lake Chicago, nevertheless this is the case. Possibly the
finer materials suspended in the lake water were carried away by the vigorous current that flowed toward and through the Chicago outlet; or, if any deposits did form the lowering of the water level during successive lake stages may have enabled the waves to cut into and remove them.

There are extensive sand deposits over the surface of the Lake Plain, some of which were derived from the re-working of glacial drift on the bottom of Lake Chicago and some of which are the result of deposition by Lake Michigan. For the greater part these deposits are underlaid by glacial drift.

The bench ridges of the Chicago Plain (see glacial map) are composed of gravel, frequently quite sandy and containing small, well-rounded pebbles.

Various sand, clay, and silt deposits occur in the Morris Basin, and are believed to represent deposits laid down on the bottom of the temporary lake that occupied this area for a time after the withdrawal of the ice from the region.

**SOILS**

The present soils are the product of certain alterations which have taken place in a zone extending down 2 or 3 feet below the surface into the various deposits that cover the region. Most of the soils have been developed from the mantle of loess, though some are derived from the other materials. Immediately after their deposition, these materials began to undergo gradual changes which have continued to the present time and are still in progress. Much of the lime was dissolved out by waters percolating through these materials from the surface. The fresh rock particles, more or less pulverized by the glacier, were decomposed and broken up by weathering. Plants spread over the barren landscape and by their decay contributed organic matter to the minerals already in the ground. The action of their roots and of alternate freezing and thawing during the changing seasons served to loosen the ground and make it still better adapted for plants. These processes, operating jointly upon different original materials and to different degrees in various localities, have given rise to the diverse soils of the area.

Soil types in large number have been differentiated by the Soil Survey of the University of Illinois Agricultural Experiment Station, in the various counties which it has studied and mapped. In 1916 sixty-two soil types had been recognized in the state. The latest report published for northeastern Illinois is that on Grundy County issued in 1924, and it recognized in that county no less than thirty-nine soil types. The surveys conducted by the Wisconsin Soil Survey and the Bureau of Soils, United States Department of Agriculture, follow a different nomenclature but are based upon similar principles of classification. The classification and nomenclature of the Illinois Soil Survey are followed in this discussion. In establishing soil types, the Survey takes into account the following factors:

**Horizon.** A layer or stratum of soil which differs discernibly from those adjacent in color, texture, structure, chemical composition, or a combination of these characteristics, is called an horizon.

**Depth and Thickness.** The horizons or layers which make up the soil profile vary in depth and thickness. These variations are distinguishing features in the separation of soils into types.

**Physical Composition.** The physical composition, sometimes referred to as “texture,” is a most important feature in characterizing a soil. The texture depends upon the relative proportions of the following physical constituents: clay, silt, fine sand, sand, gravel, stones, and organic material.

**Structure.** The term “structure” has reference to the aggregation of particles within the soil mass and carries such qualifying terms as open, granular, compact.

**Organic Matter Content.** The organic matter of soil is derived mainly from plant tissue and it exists in a more or less advanced stage of decomposition. Organic matter constitutes the predominating constituent in certain soils of swampy formation.

**Color.** Color is determined to a large extent by the proportion of organic matter, but at the same time it is modified by the mineral constituents, especially by iron compounds.

**Reaction.** The term “reaction” refers to the chemical state of the soil with respect to acid or alkaline condition. It also involves the idea of degree as strongly acid or strongly alkaline.

**Carbonate Content.** The carbonate content has reference to the calcium carbonate (limestone) present, which in some cases may be associated with magnesium or other carbonates. The depth at which carbonates are found may become a very important factor in determining the soil type.

**Topography.** Topography has reference to the lay of the land, as level, rolling, hilly, etc.

**Native Vegetation.** The vegetation or plant growth before being disturbed by man, as prairie grasses and forest trees, is a feature frequently recognized in determining soil types.

**Geological Origin.** Geological origin involves the idea of character of rock materials composing the soil as well as the method of formation of the soil.

On the basis of the foregoing factors, the Survey had mapped the following soil types as occurring in Grundy County. The list is selected as typical for the region of Chicago.

a) Upland Prairie Soils
   - Brown Silt Loam
   - Black Clay Loam
   - Brown Sandy Loam
   - Brown Silt Loam on Tight Clay

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2. Ibid., Soil Rep. 26, p. 36.
3. Ibid., pp. 6-7.
Brown-Gray Silt Loam on Tight Clay
Brown-Gray Sandy Loam on Tight Clay
Brown-Gray Clay Loam on Tight Clay
Brown-Sandy Loam on Gravel

b) Upland Timber Soils
Yellow-Gray Silt Loam
Yellow Silt Loam
Yellow-Gray Sandy Loam
Dune Sand


c) Terrace Soils
Brown Silt Loam
Black Clay Loam
Brown Sandy Loam
Yellow-Gray Silt Loam
Yellow-Gray Sandy Loam
Brown-Gray Silt Loam on Tight Clay
Brown-Gray Sandy Loam on Tight Clay
Dune Sand
Black Sandy Loam
Brown Sandy Loam on Rock
Brown Silt Loam on Rock
Brown Sandy Loam over Gravel
Yellow-Gray Sandy Loam on Gravel
Brown Sandy Loam on Gravel

d) Swamp and Bottom-Land Soils
Deep Brown Silt Loam
Mixed Loam
Black Clay Loam
Brown Sandy Loam
Black Mixed Loam
Peaty Loam on Clay
Medium Peat on Clay
Deep Peat
Muck on Clay
Muck on Marl

c) Residual Soils
Brown-Sandy Loam on Rock
Yellow-Gray Sandy Loam on Rock
Rock Outcrop

The composition of these soil types is indicated by the following table of standards used by the Survey:

Peats—Consisting of 35 percent or more of organic matter, sometimes mixed with more or less sand or silt.

Peaty loams—Soils with 15 to 35 percent of organic matter mixed with much sand. Some silt and a little clay may be present.

Mucks—Soils with 15 to 35 percent of partly decomposed organic matter mixed with much clay and silt.

Clays—Soils with more than 25 percent of clay, usually mixed with much silt.

Clay loams—Soils with from 15 to 25 percent of clay, usually mixed with much silt and some sand.

Silt loams—Soils with more than 50 percent of silt and less than 15 percent of clay, mixed with some sand.

Loams—Soils with from 30 to 50 percent of sand mixed with much silt and a little clay.

Sandy loams—Soils with from 50 to 75 percent of sand.

Fine sandy loams—Soils with from 50 to 75 percent of fine sand mixed with much silt and a little clay.

Sands—Soils with more than 75 percent of sand.

Gravelly loams—Soils with 25 to 50 percent of gravel with much sand and some silt.

Gravels—Soils with more than 50 percent of gravel and much sand.

Stony loams—Soils containing a considerable number of stones over one inch in diameter.

Rock outcrop—Usually ledges of rock having no direct agricultural value.

While a detailed consideration of all the soil types occurring in the region of Chicago lies beyond the scope of this report, the characteristics and distribution of the main groups may be briefly outlined.

Upland Prairie Soils

Owing to the accumulation of organic matter, derived very largely from the roots of the prairie grasses that once covered the land, the soils of this group are dark in color, varying from dark brown to black. The network of comparatively thick roots of these grasses was protected from complete decomposition by imperfect aeration resulting from the covering of fine, moist, soil material. The flat prairie contains a higher amount of organic matter than the more rolling land because the grasses grew more luxuriantly there and the higher moisture content retarded the decay of their roots. The material resulting from this partial decomposition is a black substance of varying chemical composition. Some of it has probably been in the soil for many thousands of years and has reached a stage similar to coal. It is almost wholly resistant to decay. This old organic matter, as well as that more recently formed, gives a dark color to the soil.

This group has much the widest distribution of any in the region of Chicago. It reaches its most extensive development on the uplands, particularly south of the Chicago outlet. In the rougher portions of the uplands, in Indiana, northern Illinois, and Wisconsin, this group of soils is confined to the higher parts of the moraines.

Upland Timber Soils

The Upland timber soils occur as irregular zones along streams and on or near somewhat steep morainal ridges. They are characterized by a yellowish grey color, due to their low organic-matter content. The deficiency of organic matter has been caused by the long-continued growth of forest trees. After the forest invaded the prairies two effects were produced: first, the shade from the trees prevented the growth of prairie grasses, the roots of which are mainly responsible for the large organic-matter content in prairie soils; second, the trees themselves added very little organic matter to the soil, for the leaves and branches either decayed completely or were burned by forest fires. Furthermore, the organic matter that had been produced by the prairie grasses became gradually dissipated during the occupation of the land by the trees. As a result, the organic-matter content of the upland timber soils has
been reduced until it is decidedly lower than that of the adjacent prairie land. Several generations of trees were necessary to produce the present condition of the soil.\footnote{\textit{Ibid.}, p. 24.}

In addition to the belts of these soils that usually occur along the courses of streams and on the slopes of steep moraines, there are broad areas from northern Du Page and Kane counties northward into Wisconsin. It is a dominant soil group in McHenry, Lake, Waukegan, Kenosha, and Racine counties. Where it occurs along with the upland prairie soils, it usually occupies the valleys and slopes of the moraines, whereas the latter occupy the crests.

**TERRACE SOILS**

Terrace soils are formed on terraces or old fills in valleys. The terraces owe their formation generally to the deposition of material from overloaded streams which became greatly enlarged and which flooded the valleys during the melting of the glaciers. Sometimes these valleys were filled almost to the height of the upland. Later the streams cut down thru the fills and developed new bottom lands, or flood plains, at lower levels, leaving part of the old fills as terraces. The lowest and most recently formed bottom land is called first bottom. The higher land no longer flooded (or very rarely, at most) is generally designated as second bottom. Finer material later deposited on the sand and gravel of the fill constitutes the mineral portion of the soil. Along some of the streams the fill seems to have been made almost entirely of fine, silty material.\footnote{\textit{Ibid.}, p. 34.}

In addition to the foregoing terrace soils the Soil Survey recognizes the water-deposited materials on the Lake Plain, and these it designates as the "Lake Michigan Terrace." The latter are in part sandy and silty.

By far the largest tracts of terrace soils are those covering the Lake Plain and the greater part of the Morris-Kankakee Basin (see generalized soil map). Other areas occur along the Des Plaines, Fox, and Illinois rivers; and over broad outwash tracts in Kane, McHenry, and Walworth counties, and in western Racine and Kenosha counties.

**LATE MARSH AND BOTTOM-LAND SOILS**

In this group are included "the bottom lands or flood plains along streams, the swamps, the poorly drained lowlands, and also all peats and mucks, whether on upland or terrace. Much of the soil is of alluvial formation, and the land is largely subject to overflow."\footnote{\textit{Ibid.}, p. 39.}

The largest tracts of soils belonging to this group occur in the central part of the Morris-Kankakee Basin along the Kankakee River, particularly in Indiana. Other extensive areas lie on the Lake Plain, especially from Lake Calumet eastward around the head of Lake Michigan. A broad stretch of bottom land lies along the Illinois River in its course through the Morris Basin; and lesser strips are found along most of the streams. Wherever the glacial moraines are hummocky in character, these soils are found in the depressions. As shown in the generalized soil map, the largest areas occur chiefly in the elevated uplands north of the Illinois River.

**RESIDUAL SOILS**

These are "the residue left in place by the weathering of rock and the accumulation of organic matter."\footnote{\textit{Ibid.}, p. 34.} The residual soils have very limited distribution, the most extensive occurrences being patches in the Chicago outlet. Smaller areas are found along the Morris-Kankakee Basin and along the Fox River.

**GENERALIZED SOIL MAP**

**SOIL GROUPS**

The generalized soil map (Plate IV) is based on state and federal soil maps and other sources. Five main soil groups are differentiated, chiefly on the basis of their physical character rather than according to their mode of origin or agricultural significance. These five groups are the following: (1) fine soils (loams and clays); (2) sandy soils (including some gravelly and stony soils); (3) dune sand; (4) bottom-land soils (chiefly alluvial); (5) peat and muck. The map also indicates by means of symbols the areas where the soils rest on bed rock and on gravel (usually less than 3 ft. below the surface); where no symbol appears the soil rests on glacial drift or, very rarely, on lake clays.

The lines between these groups are not sharply defined. In Lake and Porter counties, Indiana, for example, the loams grade into sandy soil so gradually that no exact line between the two groups can be drawn. In many places, as on the Valparaiso Upland in Indiana, the loam is derived directly from glacial drift and hence is somewhat bowldery or gravelly. The deposits in the Kankakee Basin, particularly east of Kankakee County, are sandy soils; but because of the fact that they are poorly drained and the area which they occupy is subject to frequent floods, they have some of the characteristics of alluvial or peaty soils, being frequently silty and high in organic content. The same is true of the sandy deposits on the Lake Plain. These soils have been put in the sandy group inasmuch as their high sand content is their most distinctive feature and the one likely to be of most significance in connection with road building, excavation, etc. The line between the sandy soils and the dune sand is necessarily arbitrary. Not all of the dunes have been mapped, particularly in the southern portion of the Indiana portion.
A few outstanding features shown on the generalized soil map may be pointed out in connection with each soil type.

*Fine soils* constitute the most widespread type, occurring over the greater part of the Lake Border Upland, the Valparaiso Upland, the Outer Upland, the Manteno Plain, and over large areas of the Lake Plain and Morris-Kankakee Basin. Their distribution corresponds closely to the distribution of the glacial drift.

*Sandy soils* are found chiefly over areas where water has been the agent of deposition, though often the sand deposits have subsequently been affected by wind action. They cover much of the Lake Plain and the Morris-Kankakee Basin, a part of the Valparaiso Upland in Laporte County, Indiana, where a peculiar sandy phase of the glacial drift occurs, and various outwash areas in the northern part of the region, especially in McHenry and Walworth counties.

*Dune sand* in the greatest quantities occurs on the Lake Plain, in northern Indiana, and on the Kankakee sand plain. A few stretches of dune are mapped along the strip of Lake Plain between Waukegan and Kenosha.

*Bottom-land soils* form narrow strips along the streams, particularly those subject to overflow, and irregular-shaped patches occupying lowlands. They are important in the rougher morainal areas, where depressions are numerous and drainage is poor.

*Peat* is confined to poorly drained depressions in the glacial moraines and to swampy lowlands along the streams and on the Lake Plain. Often the peat deposits assume the form of roughly circular patches, more or less completely surrounded by bottom-land soils.
Chapter XII

THE GEOLOGICAL RESOURCES OF THE REGION

LIMESTONE. 1—The main outcrops that have furnished limestone for commercial use in the region of Chicago are located (1) in the Chicago outlet along the bluffs of the Des Plaines-Illinois Valley; (2) in the bluffs of the Fox River Valley in Kane County, south of Elgin; and (3) in the Morris-Kankakee Basin west of the Indiana-Illinois state line. Areas of lesser importance are (1) Thornton, in Cook County; (2) Elmhurst, in Du Page County; (3) Ives, in Racine County. The most important area in the region of Chicago is the section of the Chicago outlet between Summit and Joliet.

The quarries of the region have furnished rock material for road metal, concrete, railroad ballast, flux in the iron industries, cement, building stone, flagstone, “riprap,” and “agricultural limestone” (lime for fertilizer).

Regarding the quarries of Cook County, the report of the Illinois Geological Survey has the following to say:

Large quarries either have been or are located at almost every outcrop of limestone of any consequence in the county. Most of these quarries operate on a large scale and are equipped to crush rock to any size. The market for the crushed stone is to a great extent local, that is, in Chicago and its environs, but considerable shipping is done to the south, to make use of the empty coal cars returning to the mines over the Illinois Central Railroad. 2

The quarries of Cook County are located at Thornton, Lemont, Summit, McCook, Lyons, Chicago, Hodgkins, La Grange, and Bellwood. In most of these the output is used for concrete, road material, railroad ballast, and agricultural limestone. In a few lime is produced. Chicago is one of the three leading limestone-producing cities of Illinois, the other two being Quincy and Alton. The quarries of Cook County having the largest production of crushed limestone are those at Bellwood, Hodgkins, Thornton, and McCook, with daily outputs ranging from 2,000 to 4,000 tons. The total annual output ranges from 5,000,000 to 6,000,000 tons.

The rock excavated in digging the Chicago Drainage Canal was piled up in the form of “spoil banks” along the side, forming a long ridge varying from 10 to 50 feet high. This ridge offers a large supply of readily obtained rock some of which is used for filling cribs and breakwaters along Chicago’s lake front. 3

Joliet was once the center of a very important stone industry and formerly furnished much building stone, as is witnessed by the numerous imposing structures in Joliet and neighboring cities built of Niagara limestone. But in recent years the output has greatly diminished. At present neither building stone nor flagstone is being produced in the Joliet region. The present output of rock is used for concrete, agricultural limestone, road material, and ballast, and is confined to two quarries and the State Penitentiary. Regarding the future of the rock output in the Joliet region, Professor D. J. Fisher states:

Undoubtedly the amount of good dimension stone available is limited, and with the present tendency towards the use of brick and artificial stone, it seems fairly certain that the dimension stone industry of this area is not a growing industry. On the other hand the great abundance of dolomite suit-

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1 The reader is referred to the following excellent discussion of this subject: F. Krey and J. E. Lamar, *Limestone Resources of Illinois* Illinois Geological Survey, Bull. 56 (Champaign, 1925); pp. 392.

2 Ibid., pp. 98-99.

3 Ibid., p. 140.
able for road metal, concrete aggregate, or for agricultural purposes, combined with its ready accessibility and the good transportation conditions, points to an increase for these purposes.1

The quarry at Elmhurst, in Du Page County, has a daily output of 1,000 tons, which is utilized for agricultural limestone, road material, concrete, and ballast.

The Illinois State Geological Survey reports as follows concerning Kankakee County:

The overlying glacial drift is thinner on the average than in adjoining counties and rock is available at many places with only a thin cover of overburden. In the latter part of the 19th century large quantities of rock were quarried in the county for use as building stone, but the use of concrete for construction purposes and the popularity of the Bedford stone are responsible for the abandonment of the building-stone industry in this county. Most of the abandoned quarries are found in the vicinity of Momence and Kankakee.2

The only quarries of any importance in the Wisconsin part of the region of Chicago are located (1) at Whitewater in Walworth County, (2) northwest of Racine, (3) west of Burlington, and (4) at Ives in Racine County. The quarries of the last-mentioned town are by far the most important. A report issued by the Wisconsin Geological Survey (1914) states that here the supply of limestone is, "for practical purposes, unlimited." The quarry is equipped with a crusher with a capacity of about 2,000 cubic yards per day, in 1912, making it one of the leading crushed-stone producers in the state.3 The stone quarried at Whitewater is from the Galena-Trenton formation; though soft and earthy it is suitable for road material.

Sand and gravel are abundant in the region of Chicago and in recent years have become of great economic importance in connection with building activities in Chicago and other cities and in connection with the building of the state and county systems of hard roads. In Waukegan fine gravels have been used in the manufacture of roofing material.

The greatest source of sand is the dune area of northern Indiana, from which whole trainloads are daily hauled away. Sand for local use is obtained from many other points on the Lake Plain, where the sand is frequently very pure; and from the few localities on the Kankakee sand plain where the sand is of good quality. Sand is also obtained in a number of places, as at Plainfield, through the screening of gravel, which may be as high as 75 per cent sand.

The sources of gravel are chiefly two: (1) the beach ridges of the Lake Plain, and (2) the outwash areas along the Illinois River and in the region to the north of that river. The beach ridges have been drawn on to a considerable extent chiefly for local use. From the outwash areas the output of gravel has long been maintained on an important commercial scale; and vast reserves are available for the future. Most of the workings up to the present time have been along the streams and rivers, where water for washing the gravel is easily obtained. The gravel deposits occur chiefly along the Illinois, Des Plaines, Du Page, and Fox rivers, and in outwash areas scattered through Kane, McHenry, Walworth,Kenosha, and Racine counties, often removed from any present-day streams. The glacial map and the generalized soil map show most of the larger gravel areas; but there are innumerable small gravel pockets that are of considerable local importance. Such deposits occur in depressions on the moraine throughout the region, but are most abundant in the counties mentioned above. Joliet and Plainfield are important shipping centers for gravel.

Clay.—By far the most of the clay products used in the region of Chicago are of local manufacture. The material used is chiefly the common glacial drift or "bowlder clay," which is obtained from selected areas where the content of pebbles and bowlders is low. With such a vast market for the finished products and such an inexhaustible supply of raw material, the region of Chicago has become a great center for the manufacture of clay products. Cook County ranks as the foremost brick-producing county in the United States, furnishing annually over half of the total output of the state of Illinois, which for many years has stood third among the states of the country in point of clay products, being exceeded only by Pennsylvania and Ohio. In northern Indiana there are available excellent lake clays in addition to the bowlder clay; both kinds have long been utilized at Hobart, Porter, Chesterton, and other cities. Morris has for many years produced brick and tile made from lake clays occurring in the Morris Basin. In addition to these clays, certain shales occur in the Pennsylvania formations near Morris that are suitable for brick manufacture. In eastern Racine and Kenosha counties there are lake clays that at one time formed the basis for a very important brick, tile, and pottery industry, though today the output is relatively small.4

Peat occurs in large quantities in various parts of the region, as is shown on the generalized soil map (Plate IV), but principally in McHenry and Lake counties, Illinois, and in the three Wisconsin counties. The Wisconsin Geological Survey has made an exhaustive study of the peat resources of the state5 and has reached the conclusion that little use will be found for peat until other fuel materials become scarce and expensive. The chief obstacle to the use of peat for fuel or gas is the high

water content, for less than 10 per cent usable material can be recovered, and a large part of this is ash. The dried product is from eight to sixteen times as bulky as coal and has about one-half its heating value. The peat areas, at present largely unused marshes, are therefore more likely to be drained and reclaimed for agricultural purposes than used for their potential fuel value.

Coal.—The Wilmington coal field extends into the southwest corner of the region of Chicago. While this field was formerly a principal source of bituminous coal for Chicago, the larger part of the production is now shipped to points north and west. This is due to the high cost of operation in this field, as a result of which it is cheaper to ship coal into Chicago from Williamson County, 300 miles distant, than it is to ship it in from Grundy County, only 55 miles distant.

This coal occurs in what is known as "seam No. 2," which is here a very widespread bed of uniform thickness and character and has been mined in scores of openings. It varies in thickness from 20 to 72 inches, but shows much greater uniformity than these figures indicate, a variation of less than 5 inches throughout an entire mine being common. It is overlaid by a gray shaly sandstone 40 feet thick, and is underlaid by fire clay. Other coal seams, much thinner and but little worked, occur in the field.

Bowlders of glacial origin are frequently made use of for ornamental purposes: fireplaces, porches, stone walls, pedestals, and occasionally even for whole buildings. Because of the variety of colors and patterns available in these bowlders, most of which are granites, very artistic and pleasing effects are produced.

WATER RESOURCES

Springs having a permanent flow are few, but there are numerous intermittent springs. Both types are usually small and of local importance only. In Walworth County, Wisconsin, springs are abundant along the outcrop of the Richmond shale, there being many springs in the vicinity of Whitewater. The city water supply of Delavan is obtained from springs, and a well-known mineral spring, the Sheridan Mineral Spring, is located near Lake Geneva.

Drift wells constitute the most common type of well and serve most of the farms and small towns. The depth to which such wells must be dug in order to obtain a constant water supply varies with the thickness and character of the material penetrated. Usually these wells are continued until they reach a stratum of sand or gravel; this will usually provide sufficient flow. Often it is found necessary to penetrate to the surface of the underlying limestone, or even into it, in which case the porous rock will usually afford an adequate supply of water. In general, wells of this shallow type are most successful on or adjacent to terminal moraines, and in areas where sand and gravel are abundant. They are commonly from 3 to 5 feet in diameter though some of the small towns have wells that are up to 20 feet in diameter. The majority do not exceed 20 30 feet in depth, but wells 100 feet or more deep are not uncommon, especially in villages and on stock farms where a constant water supply is imperative. In the areas of deep drift, as in McHenry and Lake counties, wells are dug 200 feet in the drift.

Shallow wells have two serious disadvantages: (1) they are subject to contamination and have frequently been found to be the cause of typhoid fever and other serious epidemics; and (2) they are not absolutely reliable, sometimes going dry or nearly so during periods of drought. For that reason deep wells of small bore that are drilled into water-bearing strata are much to be preferred.

2 Ibid., Bull. 41, pp. 188-189.
3 Much of the data for this section is taken from the following excellent treatise: Carl H. Anderson, The Artesian Waters of the North-eastern Illinois, ibid., Bull. 31 Urbana, 1919, Pp. 336.
Drilled wells less than 500 feet in depth obtain their water chiefly from the uppermost rock strata, in most cases the Niagara limestone. They range from 200 to 500 feet in depth, average 350 feet, and are usually drilled when only a comparatively small amount of water is required, and like the drift wells furnish water that is relatively soft, that is, free from lime. Because the limestone in this region is usually more or less fissured and sometimes porous, wells of this type ordinarily afford a dependable supply of water.

Wells deeper than 500 feet obtain their water chiefly from the St. Peter and the Potsdam sandstones. These formations are at the surface in Wisconsin, as indicated in Figure 16, and from that region they dip gently eastward and southward so that in the region of Chicago they lie hundreds of feet beneath the surface. Rain which falls in Wisconsin on the outcrops of these porous formations is in part absorbed and, moving very slowly, descends through them toward the east and southeast to gradually increasing depths (see Fig. 17). Subjected to the weight of the stream of water behind and confined between strata that are relatively impervious, the water comes under greater and greater hydrostatic pressure or “head” as it is commonly called. When a stratum thus saturated with water under high pressure is tapped by a deep well, artesian conditions result; the water rises in the well to a height determined by the amount of head. Though this head may not be strong enough to make the well flow, it least will be sufficient to make pumping easy.

The amount of head has not remained constant in all parts of the region, but is in some places gradually decreasing. In 1864 a well was drilled in Chicago to a depth of 711 feet, a relatively shallow depth, and enough head was encountered to make the water rise to a height 80 feet above the surface. This particular well is now abandoned, but the other wells in its vicinity today penetrate to much greater depths, yet have such low head that the water rises only to within 150 feet of the surface. Thus the artesian water level here has dropped 230 feet. This is the result of the drilling of hundreds of deep wells which have partially exhausted the resources of the water-bearing strata. In outlying parts of the region of Chicago where fewer deep wells have been drilled, the level has dropped to a less extent or not at all.

The depth to which artesian wells must be drilled varies with localities. In general, the necessary depth increases to the east on account of the eastward dip of the strata. C. B. Anderson, of the Illinois Geological Survey, reports that in northeastern Illinois wells range in depth from 500 to 2,700 feet. The average depth amounts to between 1,600 and 1,800 feet for this portion of the state, being influenced by the large number of wells in Chicago and vicinity which are about 1,600 feet in depth. In the Stockyards at Chicago a number of wells have been drilled to depths greater than 2,200 feet and possibly over 2,500 feet; the deepest well, however, is at Aurora and has a depth of 2,759 feet. As the water level lowers, it becomes increasingly necessary to drill wells to the lowest strata. In Chicago, in recent years, the St. Peter sandstone has proved inadequate to furnish a sufficiently large flow of water, and wells have been continued to the Potsdam sandstone. The St. Peter is encountered at an average depth of 894 feet at Chicago; the Potsdam, at 1,400 feet.

The water in the St. Peter and Potsdam formations is under pressure and hence is better able to dissolve mineral substances than is the water occurring in the Niagara limestone and the drift. Consequently the water from the artesian wells is usually highly mineralized and hard. When the lowest part of the Potsdam is tapped, the water obtained is frequently too salty for use. Wells in the Morris Basin that penetrate the Pennsylvania strata (Coal Measures) are sulphurous; this is also sometimes the case with water from the St. Peter. Such waters may have an offensive taste but are desirable for their medicinal properties.
SELECTED BIBLIOGRAPHY

BElOW are listed publications that are of outstanding importance in connection with the region of Chicago and that are readily accessible in private and public libraries. Most of these are governmental or state publications and, so far as they are still in print, may be secured from the sources indicated for a nominal fee covering the cost of printing. A few are available for free distribution. The majority of the publications listed are written in a style as free from technicalities as possible, and so are of service to all classes of readers. Through reference to these works the reader may in many cases obtain detailed information concerning particular localities or topics which especially interest him.

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Ridgley, D. C. The Geography of Illinois, Chicago, 1921.


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Report

9. Lake County 1915
13. Kankakee County 1916
16. DuPage County 1917
17. Kane County 1917
21. McHenry County 1921
25. Livingston County 1923
26. Grundy County 1924

Will County (map only to date).

Also see Summary of Illinois Soil Investigations, University of Illinois Agricultural Experiment Station, Bull. 193. Urbana, 1916.

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County soil reports and maps (issued for Indiana by the Bureau of Soils, U.S. Dept. of Agriculture, Washington):

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County soil reports and maps (issued by the Wisconsin Geological and Natural History Survey, Madison):

*Bull. 56B*, "Soil Series No. 29". Racine and Kenosha counties

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GLACIAL MAP OF THE REGION OF CHICAGO

KEY:
- Beach ridges
- Land area formerly covered by Lake Chicago
- Early Wisconsin ground moraine
- Early Wisconsin terminal moraine
- Late Wisconsin ground moraine
- Late Wisconsin terminal moraine
- Early Wisconsin terminal moraine

SYMBOLS OF TERMINAL MORAINES:
- Huntley Moraine
- Genoa Moraine
- Palatine Moraine
- Zurich Moraine
- Elkhorn Moraine
- Garden Moraine
- Miscoa Moraine
- Cary Moraine
- Saunders Moraine
- Aurora Heights Moraine
- Marcellus Moraine
- Lake Border Moraine
- Rockdale Moraine
- West Chicago Moraine
- Fox Lake Moraine
- Manhattan Moraine
- Marengo Moraine
- Outer Bloomington Moraine
- Middle Bloomington Moraine
- Kettle Interlobate Moraine
- Inner Bloomington Moraine
- Valparaiso Moraine

Survey and map of the region of Chicago by F. M. Fryxell

Based on the reports of the U.S. Geological Survey and of the Illinois and Indiana Geological surveys; also on much unpublished data obtained through the courtesy of the Illinois Geological Survey.