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STATE OF ILLINOIS
DEPARTMENT OF REGISTRATION AND EDUCATION
DIVISION OF THE
STATE GEOLOGICAL SURVEY
FRANK W. DE WOLF, Chief

BULLETIN No. 39

THE ENVIRONMENT OF CAMP GRANT

BY

ROLLIN D. SALISBURY and HARLAN H. BARROWS

PRINTED BY AUTHORITY OF THE STATE OF ILLINOIS

URBANA, ILLINOIS
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FRANK W. DEWOLF, *Chief*

Committee of the Board of Natural Resources and Conservation

FRANCIS W. SHEPARDSON, *Chairman*
Director of Registration and Education

DAVID KINLEY
Representing the President of the University of Illinois

THOMAS C. CHAMBERLIN
Geologist

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no. 39
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LETTER OF TRANSMITTAL

GEOLOGICAL SURVEY DIVISION,
MAY 6, 1918.

Francis W. Shepardson, Chairman, and Members of the Board of Natural Resources and Conservation,

GENTLEMEN:—I submit herewith a report on the Environment of Camp Grant and recommend that it be published as Bulletin No. 39. The purpose is to describe and interpret the topography and geology of the region in which men are being trained intensively for service abroad.

Modern armies find that the physical features of the earth are of great strategic importance, in spite of aviation, tractor engines, and improvements in artillery. Laymen do not appreciate at first that routes for movements of armies are still selected with reference to mountain and river barriers; that sharpness of slope controls the movement of artillery, cavalry, tractors, and of infantry; that swampy river-flats and dominant hills and cliffs are chosen for defensive lines; that the details of topography determine suitable landing places for airplanes, and in some cases the effectiveness of gas warfare; and finally, that the character and the depth of loose surface soil and subsoil make it possible or impossible to dig trenches quickly, and to maintain them effectively.

The report is accompanied by four topographic maps covering about 1,000 square miles, and by numerous illustrations which in other ways display the physical features and their significance.

The authors, Professors R. D. Salisbury and H. H. Barrows of the University of Chicago, do not pretend to be military men, but are geographers and geologists with broad experience. They point out the variety of natural features which may be utilized in training and maneuvering, and by explaining the origin of local features, assist in an understanding of those which will be seen abroad.

The report is one of several which were undertaken at various army camps at the suggestion of the Geology and Paleontology Committee of the National Research Council, after conferences with prominent military men.

Very respectfully,

FRANK W. DEWOLF, *Chief.*

CONTENTS

ILLUSTRATIONS

THE ENVIRONMENT OF CAMP GRANT

FOREWORD

This little volume gives a brief account of the region about Camp Grant, which may be of interest and value to those who are in training there. It is an interesting fact that at least one engagement of the Black Hawk War in 1832 (pp. 53-4), was within walking distance of the Camp where men are now being trained for a war of a very different character. The following pages contain brief accounts of the geography and geology of the region, suggest various sorts of problems connected with physical environment which armies must face wherever they find themselves, and give some account of the way in which man has adapted himself to the region, and the region to his own uses.

In Chapter II, on Points of Military Significance, the authors have suggested those things illustrated here which seem to them of importance from the soldier's point of view. The manner in which these topics are to be dealt with in training, if time permits their consideration, is of course left to the officers in charge.

In the section on the Geological History of the region, the attempt has been made to present the subject matter in such a way that general principles may be grasped, and perhaps applied in other regions where the geology is very unlike that of this place. In all regions, however different the details of formations, there are some things in common, and general principles are applicable everywhere.

It is hoped that the section on Nature and Man in the Rockford Region may be of interest both to those who are there temporarily, and to those who are permanent residents. There is a corresponding human side to every region, which cannot fail to be of interest to all thoughtful men who care to understand their environment.

Four maps accompany the volume. They are referred to repeatedly in the following pages, and are to be found in the pocket at the end of the volume. Each bears a name printed on its margin (Rockford, Belvidere, Kings, Kirkland), and is designated by name when referred to in the text. These maps should be spread out before the reader constantly, and every reference in the text to specified localities should be followed on the maps. Without their continuous use, Chapter I will have little meaning. The relations of the four maps to one another are shown in figure 1.

For the benefit of those not familiar with maps of this sort (*contour* maps), an explanation of the meaning of their various features is given on pages 73-5. This explanation should be read studiously by those who follow the text, unless they already are familiar with maps of this type. The explanation has been put in an appendix rather than in the body of the text, partly to avoid interruption of the narrative, and partly because many of those for whom the volume is written, are familiar with maps of this sort. Understanding of these maps, on the part of those not already acquainted with them, will be furthered by comparison of the maps with the block drawings, plates I and II, which represent the physical fea-

Fig. 1. Diagram showing the relative positions of the four maps accompanying this volume.

tures of selected areas in another way. Plate I (p. 12) represents the northeastern part of the area shown on the Kings map, and Plate II (p. 14) that part of the area of the Rockford map, which includes the remarkable Pecatonica flats. Plate I was drawn by Miss Barrett of the State Survey; and the shading on Plate II was kindly contributed by J. H. Renshawe through the courtesy of the Director and the Chief Geographer of the U. S. Geological Survey.

Attention may be called to the larger-scale map of a small area about the Camp prepared by the War Department. The scale of this map makes it possible to represent many details which are not shown on the maps accompanying this volume. These maps are perhaps more legible at a glance because of the use of colors; and because they cover a larger area will be more useful than the larger scale map in long marches. The larger area which they cover offers a greater range of problems involving reconnaisance, visibility, movement of artillery, horses and men, than the larger-scale map of the smaller area.

CHAPTER I—PHYSICAL FEATURES

Location and Topography

Camp Grant is in the midst of the great fertile tract which has been called *The Central Lowland Plains* of the United States.[1] These plains include the larger part of Illinois and adjacent states, and are characterized by an undulating surface which is not very rough, and which nowhere reaches mountainous heights.

The Camp is in the beautiful valley of Rock River, a valley prized highly by the Indians (p. 53) and attractive to white men as well, in the early days of settlement. The site of the Camp is little more than 720 feet above the sea. Its approximate flatness is shown by the wide spacing of the contours (the brown lines on the map, see p. 73) where the Camp stands. In contrast, the steep slope by which the nearly flat land falls off to the river, is represented by two contours close together. On the larger scale map of the Army Engineers (p. 8) a small contour interval is used, and several closely crowded contours represent this steep slope. In the other large valleys of the region, such as those of the Pecatonica (Rockford map), and the Kishwaukee and its South Branch (Belvidere and Kirkland maps), there are considerable tracts of about the same elevation as that about Camp. These are the lowlands of the region. The lowest point in the area covered by the four maps accompanying this report is the surface of Rock River at Byron, at the west edge of the area of the Kings map, where the river is less than 680 feet above the sea.

Outside the valleys, most of the surface in the vicinity of the Camp has an altitude ranging from 760 to 900 feet above the sea, but there are small areas which rise to greater heights, as in the northeastern part of the area covered by the Belvidere map, where several small areas, all of them less than 4 miles from the state line, have an altitude of more than 1000 feet. The total relief of the area shown on the maps therefore is a little more than 320 feet.

Most of the upland part of the area covered by the maps is well drained. On its surface there are neither ponds nor lakes, and most of it is free even from marshes. The northeastern part of the Belvidere map shows a number of upland marshes, and a few very small ones are shown on the Kings and Kirkland maps. Nor are there large areas of the upland where the surface is flat. There is a considerable tract in the southwestern part of the Kirkland area (Kirkland map), and the adjacent part

[1]Fenneman, N. M., Annals of the Association of American Geographers, Vol. VI, 1916.

of the Kings area (Kings map), where the slope of the surface is so slight that water from rain and melting snow does not run off readily. This approach to flatness is indicated on the maps by the wide spaces between the contour lines. In this nearly flat tract the natural drainage is so poor that there has been some ditching and tiling, to assist the run-off of surface waters.

Just as there are relatively few areas of upland which have poor drainage, so there are relatively few places where slopes are steep. Most of them are so gentle that they are tilled without difficulty. The only notable exceptions are (1) the slopes to Rock River below the mouth of the Kishwaukee (Kings map) two miles and more southwest of Camp, and (2) the slopes of the Kishwaukee Valley at the rifle range and east to the edge of the Kings area. The slopes of some of the small valleys tributary to the Rock and the Kishwaukee are less conspicuous examples of the same thing.

On the maps, steep slopes are represented by crowded contours. Where two contours are close together, the steep slope is at least 20 feet high, the vertical distance between contours on the maps being 20 feet. Where a number of contours are close together, the slope is higher,—20 feet for

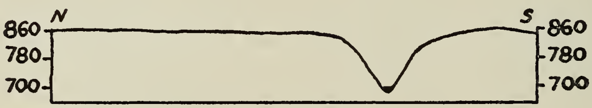


FIG. 2. Cross-section of the Kishwaukee Valley about 2½ miles above the New Milford Bridge. The numbers at the ends represent elevations above the sea. Length of section a little more than 3 miles. Vertical scale exaggerated about 8½ times.

each pair of lines. It will be seen (Kings map) that there are steep slopes more than 100 feet high along the Kishwaukee near the rifle range. Three miles or so above the bridge at New Milford the slopes are more than 140 feet high on each side of the river (Kings map, and fig. 2). There are equally steep slopes, but only half as high, along Rock River below the mouth of the Kishwaukee.

Here and there the streams have undercut their banks on one side or the other, developing very steep cliffs, as west of the north part of Camp; but the cliffs of this type are not very high, and are not continuous for great distances. From an agricultural point of view, the land of the area covered by the map lies so well that something like 85 per cent of it is improved.

The absence of steep slopes in most of the region is shown in another way. In most places, country roads have been laid out in straight lines without reference to unevenness of surface. Wagon roads are indicated on the maps by two parallel black lines close together, and an inspection of the map shows that most of them are straight, and have north-south or east-west courses. The few diagonal roads represent shorter routes between objective points of travel, and were established in early times, when travel was determined less than now by boundaries of farms which follow section or half-section lines.

There are, however, a few places where roads depart from straightness because the surface is rough. There are two such roads in the southwestern part of the Kings area, two or three in the northwestern part of the Belvidere area, and one about five miles northwest of Belvidere.

On the other hand, roads are absent from some regions because of the steepness of slopes. There are no roads across the Kishwaukee for some miles above New Milford, and there was no road across Rock River between Rockford and Byron until the autumn of 1917, when one was built near the Camp, for its accommodation. The lack of roads across these valleys may as well be said to be due to lack of bridges as to steepness of slopes; but the steepness of slopes is partly responsible for the absence of bridges. Rock River is bridged at several points above Rockford within the area of the Rockford map. The slopes of the valley here are not so steep as to the south, and the gentler slopes, the wider valley, the ease of making roads, and the favorable sites for settlement, have led to greater development within the valley. The construction of bridges has followed. The absence of such development below the mouth of the Kishwaukee where the valley is narrow, has made the demand for roads and bridges across the river much less than farther north.

The absence of extensive steep slopes is suggested further by the absence of considerable forests, which are shown in green on the maps. There are, it is true, "woodlots" on many farms, but most of them are small. They have been preserved, not because the land is unavailable for agriculture, but because it is the fashion in this region for the farms to have a patch of timber. The larger areas of timber are where slopes are too steep for convenient tillage, or where the soil is poor. To the former class belong the fringes of timber along some of the streams, notably the Rock below the Kishwaukee, the Kishwaukee where its slopes are steep, and rather large patches in the northwest part of the area covered by the Belvidere map, where the surface is made uneven by the many small and rather deep valleys which lead westward to Rock River. There are other considerable patches of timber in (1) the extreme southwestern part of the area covered by the Kings map, where the surface is, for this region, rough, and where the soil in spots is very sandy, though the slopes are not steep, and in (2) the northwestern part of the Rockford area where there is much dune sand.

It is not to be understood that all of the area was timbered, and that the absence of considerable forests is due wholly to the clearing of the land. Part of it was treeless (prairie) when the region was settled; but timber was found in most valleys, and on some of the uplands (p. 56).

Plate I is a general sketch showing the relief of an area about Camp somewhat as it would appear if seen from an elevation. It is meant to represent the surface somewhat as it would be seen from an air-plane, except that the color is wanting.

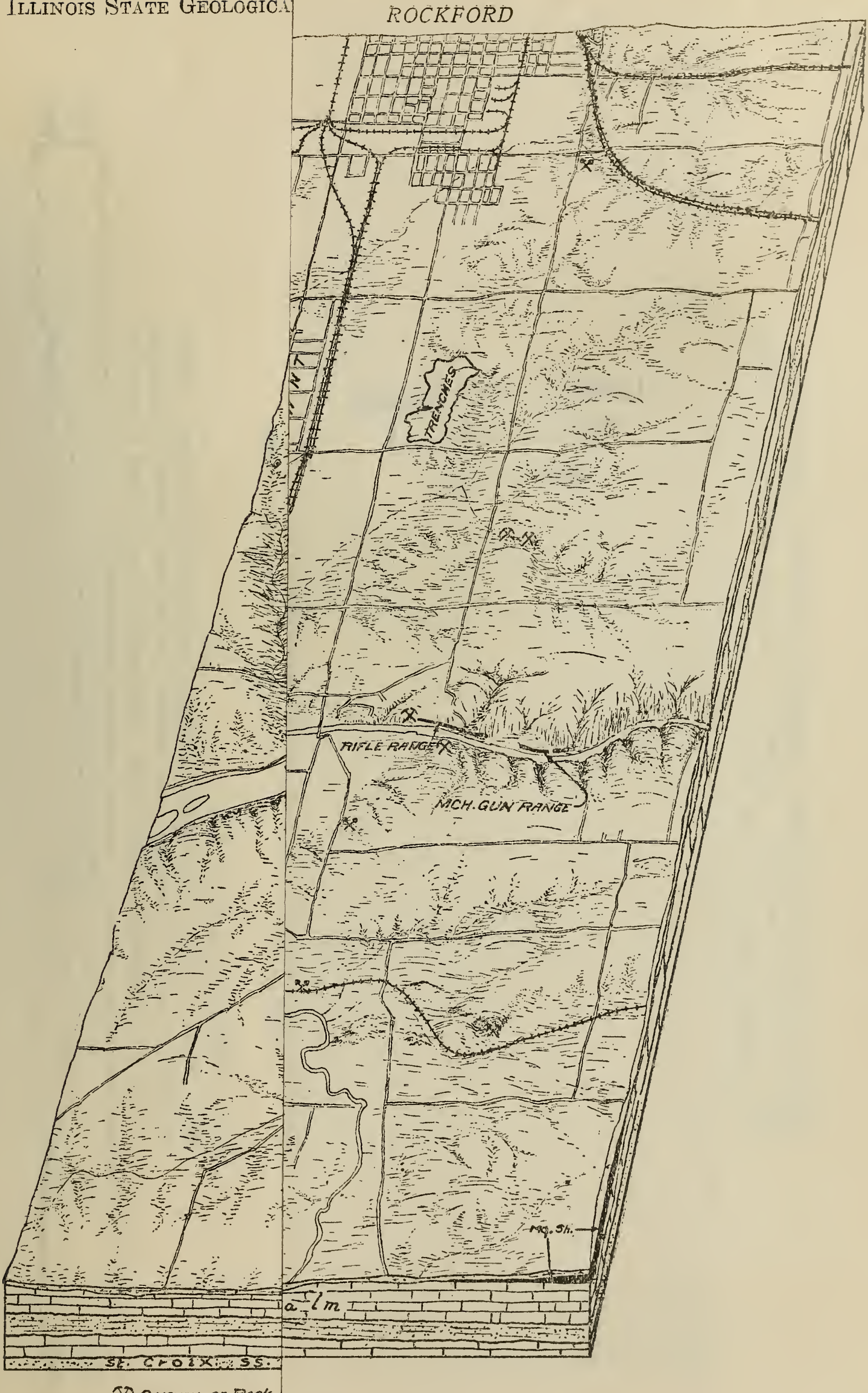
The Larger Valleys

ROCK RIVER VALLEY

Most depressions below the surface of the undulating upland are in the form of valleys, a few of which are large, and many small. Of the former, the valley of Rock River is largest. It is 2 to 5 miles wide north of Rockford, and has a depth of 100 to 200 feet below the upland on either side (fig. 3). Below the Kishwaukee, the valley is much narrower (fig. 4) and its slopes steeper. With something of an interruption at Rockford, there is a wide terrace of gravel and sand, in most places 40 to 50 feet above the river, on one or both sides of the channel, from the State line on the north most of the way to the Kishwaukee on the south. Camp Grant is on this terrace (fig. 5). While the terrace approaches planeness, as shown by the wide separation of the contours, it is not altogether flat. Its surface is affected by low mounds in some places, and small valleys cross it. Here and there short, steep-sided ravines lead down from it to the river, as in the vicinity of Camp, and are good illustrations of the beginnings of valleys. Below Camp, and for a few feet above the stream, there is a narrow flood plain, covered with water when the river is high. In places there is a low terrace, intermediate between the high terrace and the flood plain, but much nearer the level of the latter than of the former. In some places the low terrace is so low as to be flooded in extreme high water, thus constituting an upper flood plain, or "second bottoms." Much of this second flood plain below Camp and along the Kishwaukee south of Camp was flooded in March, 1918, when the water was abnormally high.

PECATONICA RIVER VALLEY

The second largest valley in the region is that of the Pecatonica River (Rockford map), and in some ways this valley is more remarkable than that of the Rock. It is not deeper, but it has an exceptionally wide (2 to 3 miles), low flat, or flood-plain (Plate II). The flat is, indeed, so low that it is drained but poorly, and during a large part of the year, is so wet as to make travel over it difficult or even impossible, except on roads which have been graded several feet above its level. The fineness of the surface



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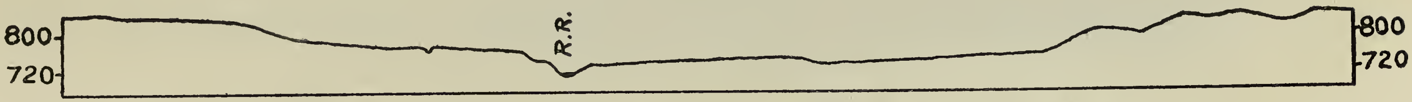

FIG. 3. Cross-section of Rock River Valley between 5 and 6 miles north of the uppermost bridge at Rockford. The numbers at the ends represent elevations above the sea. R. R. = Rock River. Length of section about 6½ miles. Vertical scale exaggerated about 8½ times.

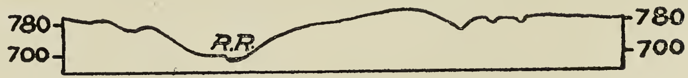

FIG. 4. Cross-section of Rock River Valley about 3 miles below the mouth of Kishwaukee River. The numbers at the ends represent elevation above the sea. R. R. = Rock River. Length of section a little more than 3 miles. Vertical scale exaggerated about 8½ times.

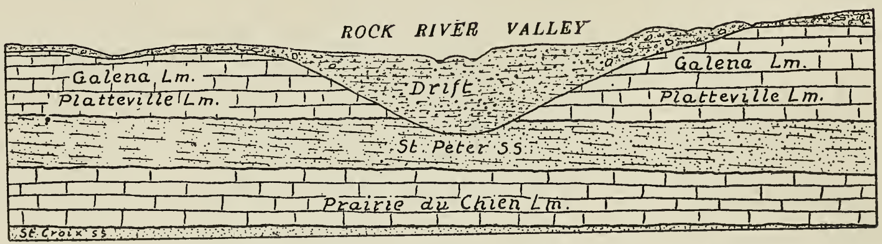

FIG. 5. Cross-section of Rock River Valley near the north edge of Camp Grant, showing beside the cross profile, the sub-structure. The bottom of the valley is in St. Peter sandstone. The bottom of the figure corresponds to sea-level. Length of section about 7½ miles. Vertical scale exaggerated about 8½ times.

material of this plain causes it to be very muddy when wet. This valley (fig. 6), is without well-developed terraces like those of the valley of the Rock. The map shows that dwellings are wanting on large areas of the Pecatonica bottoms, though present on some parts which are a few feet above their general level.

Through this extensive clay-covered flat, the river winds back and forth, much as the Mississippi winds through its low flat toward the Gulf of Mexico. Not only are there great bends (meanders) in the stream, but there are numerous ox-bow lakes, which represent the cut-offs of former meanders. These lakes are in all ways similar to those along the lower Mississippi, or to those of the flood plains of other streams which have wide flats but little above their own level. Such lakes, as well as meandering channels, are characteristic of sluggish streams. In times of flood, most of this great flat along the Pecatonica becomes virtually a lake, though there is always a current to the northeast. This wide flood-plain

FIG. 6. Cross-section of the Pecatonica Valley a little less than 4 miles west of the Rock River at Rockton. The numbers at the ends represent elevations above the sea. P. R. = Pecatonica River. There are other channels at essentially the same level at various points in the flat. Length of section nearly 4 miles. Vertical scale exaggerated about 8½ times.

is in sharp contrast with the narrow flood-plain of the larger river to which the Pecatonica flows. The cause of the difference will be explained on later pages.

The lower end of the valley of Sugar River, tributary to the Pecatonica from the northwest, partakes of the nature of the valley of the Pecatonica itself.

THE KISHWAUKEE VALLEYS

The third largest valley in the region is that of the Kishwaukee River. Its North and South branches come together about 7 miles above Camp Grant, and just east of the area covered by the Kings map. Down to their junction, the two branches of the river flow in wide, shallow valleys (fig. 7) whose slopes are gentle, and tilled in most places; but below their junction, the valley is narrow (fig. 2) and its slopes are steep down almost to New Milford, a mile or so above the south part of the Camp. The valleys of the North and South branches of the Kishwaukee have terraces similar to those of Rock River Valley, though lower. The narrow part of the Kishwaukee Valley, below the union of its branches, has no distinct terraces. In this respect, the narrow part of this valley is like the narrow part of the valley of the Rock.

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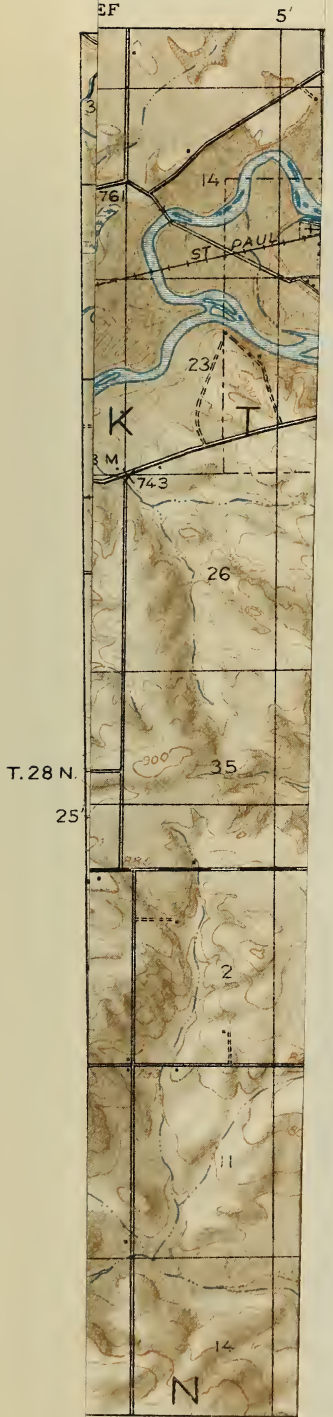

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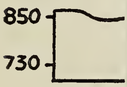

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Fig. 7. Cross-section of the valley of the North Branch of Kishwaukee River at Cherry Valley. The numbers at the ends represent elevations above the sea. K. R. = North Branch of the Kishwaukee River. Length of section about 7½ miles. Vertical scale exaggerated about 8½ times.

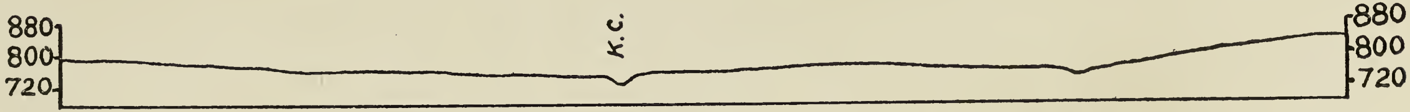

Fig. 8. Cross-section of Killbuck Creek Valley a mile below Lindenwood. The numbers at the ends represent elevations above the sea. K. C. = Killbuck Creek. Length of section a little more than 8 miles. Vertical scale exaggerated about 8½ times.

Peculiarities of the Larger Valleys

As a rule, large streams have large valleys, and small streams have small valleys. Furthermore, the valleys of most streams increase in width down stream. Within this region there are a number of rather striking exceptions to these general rules. Among them may be noted (1) the wide valley of Rock River above the Kishwaukee (except for a short distance at Rockford), succeeded by a much narrower valley below (compare figs. 3 and 4); (2) the wide, capacious valleys of the two branches of the Kishwaukee, and the narrower and smaller valley of the joint stream which carries their united waters for 4 miles before it reaches the large valley of the Rock just above Camp (compare fig. 7 with fig. 2); and (3) the valleys of some of the creeks, which are so large as to be out of harmony with the streams which flow through them. Thus Stillman Creek, some 8 miles southwest of Camp Grant (Kings area), has a wide, capacious valley, quite out of keeping with the volume of water. The same is true of the valley 2 or 3 miles farther west. South of the Kishwaukee River, south of Camp, there is a broad, capacious valley through which a very small creek flows with very slight fall. So poor was the natural drainage here that for some miles the creek has been provided with a channel by ditching. The valleys of Piscasaw Creek (southeastern part of Belvidere area), Coon Creek (northeastern corner of Kirkland area), and Killbuck Creek (eastern part of Kings area, fig. 8), all are large for the creeks which flow through them. Such valleys are not normal. Their explanation is connected with the history of the development of the surface of this area, which will be sketched later.

Minor Valleys

In contrast with the valleys just mentioned, most of the many tributaries to the larger streams flow in valleys harmonious in size with the

Fig. 9. Cross-section of a small tributary valley nearly 3 miles due west of the Camp Grant Bridge. Numbers at the ends represent elevations above the sea. Length of section about 2 miles. Vertical scale exaggerated about 8½ times.

creeks themselves. There are many little valleys or ravines which have no streams except in wet weather. The relation of most of the small streams and valleys is such as to make it clear that the streams have made their valleys, in relatively recent times. These valleys are being made larger all the time, and their size is not such as to call for their inception far back in geological history. Most of the valleys leading to the Rock River are of this sort (fig. 9).

Streams

The water of the larger streams is turbid all the time. Formerly the Rock was a clear stream. Its Indian name, Sinissippi, is said to signify "rocky river," referring perhaps to the fact that its bottom was stony when the region first was settled. Whether this has reference to the gravel at the bottom, or to the fact that the channel was on limestone in some places, is not known. A "rocky" bottom implies a clear stream. Early settlers in the valley have left it on record that in the '40's the water of the river was clear enough at Rockford, except in times of flood, so that fish could be seen at the bottom. This condition of things ceased long ago. The numerous factories along the river pollute its waters, and the cultivation of the land permits the surface water flowing to the river to gather more mud than formerly. The result is that the water is never clear. The early settlers in the region had high hopes of the navigability of the river (p. 63), but these hopes were doomed to disappointment.

The Pecatonica is a sluggish, muddy stream, and is said to have been in contrast with the Rock, even in early days. This is because the bed of the stream is muddy, in contrast with the original bed of the Rock. An early writer[2] speaks of the "turbid waters" of the Pecatonica, mingling with the "bright flashing current of the Rock River." The Indian name, Pecatonica, means "muddy water" or "crooked stream," according to the same writer.

The Kishwaukee River is less turbid than the larger streams, and during much of the year its waters are relatively clear. So also are the waters of the Sugar River, in the northwestern part of the area, above the Pecatonica flats. Like Sinissippi and Pecatonica, Kishwaukee is an Indian name, said to mean "clear water."

The waters of the larger streams are so turbid that they are not suitable for domestic use. While the waters of many of the smaller streams are less objectionable to the eye, their use is to be discouraged, for most of them flow through areas which are settled so closely as to make pollution possible or even probable. The stock of the pastures through which most of them flow has free access to them, and drainage from many farm-yards finds its way into them. The only surface waters of the region which are wholly palatable and safe are the waters of springs, of which there are few. One of the most notable is Blackhawk Spring, south-southwest of the village of Cherry Valley.

Ground-Water

Generally speaking, the cracks and pores in the rock, clay, gravel, and sand, are full of water up to a certain level. This level up to which

[2] Shaw, James, Ill. Geol. Survey, Vol. V, 1873.

the earth is full of water, is known as the *ground-water surface,* or the *water-table.* When wells are sunk below the water-table, water seeps into them from the surrounding material, whether gravel, sand, clay, or rock. The ground-water which supplies wells is rain water which has sunk into the soil and into the material beneath it.

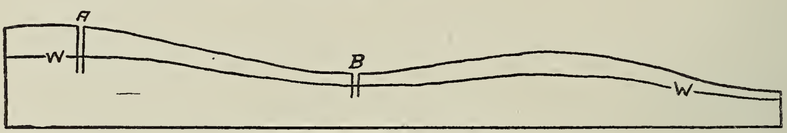

FIG. 10. Diagram to show the relation of the water-table, W W, to the surface. The water-table is farther below the surface where the land is high than where it is low.

In general, the water-table is higher under high lands, and lower under low lands; but wells must be sunk deeper in high land than in low, to get water. This is illustrated by fig. 10. The well at *A* will need to be deeper than the one at *B*, but its bottom is at a higher level. In the region here under consideration, an adequate supply of well-water is to be had in most parts of the upland, at depths of 40 to 60 feet; in the valleys, at depths half as great. Many wells in the uplands are much deeper than 40 to 60 feet, some of them more than 100 feet. In many cases this is not because water is not to be had at lesser depths, but because the deeper wells yield purer water or more water. On a later page, some account is given of the ways in which a supply of pure water may be secured.

CLIMATE[3]

The soldier's interest in the climate of the region about Camp Grant centers chiefly in two items: (1) how it affects his comfort and activities, and (2) how it compares with the climate on the Western Front.

Camp Grant is about as hot in summer and as cold in winter as most other places in the upper Mississippi basin. At Rockford, July, which is a little warmer than June and August, has an average temperature of 73° F. (about 23° C.), with maximum temperatures ranging up to 100° F. (nearly 38° C.) or more. The highest on record is about 110° F. (about 43° C.). Such extreme heat, however, is fortunately rare. January, with an average temperature of about 21° F. (about –6° C.) is the coldest month. The lowest recorded temperature is –26° F. (about –32° C.). Such extremely low temperatures are as rare as the very hot days of summer. The changes in temperature from month to month are shown in figure 11, where the big average difference, 53° F. (about 29.4° C.) between summer and winter, also appears.

Rainfall (including the water of melted snow) is not very heavy about

3The paragraphs on climate were prepared, for the most part, by Professor Walter S. Tower.

Camp Grant, averaging approximately 35 inches or about 89 cm. (10 to 12 inches of snow being counted as 1 inch of rain) a year, with 90 to 100 days each year when rain or snow falls. Figure 12 shows, graphically, the distribution of rain through the year at Winnebago, 10 miles west of Camp. The warmer months, April to September inclusive, have about 65 per cent of the total rainfall. Most of the summer rainfall comes in showers—rarely heavy downpours—of short duration, though gentle rains of longer

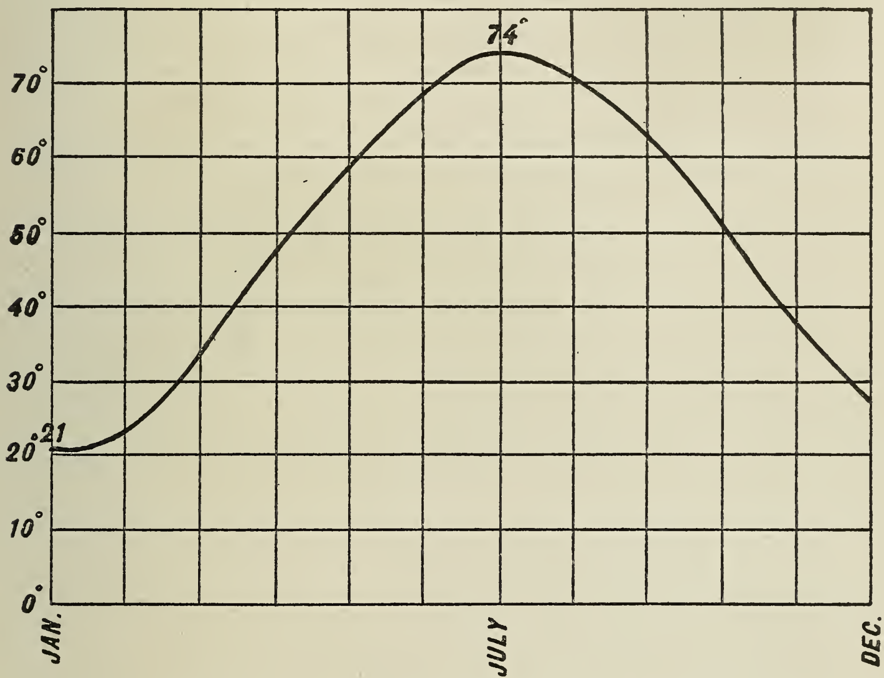

Fig. 11. Graph showing the temperature curve for Rockford. The numbers at the left indicate temperatures in degrees Fahrenheit. The vertical lines represent average temperatures for the several months. The highest average monthly temperature is that for July, 74° F. (= 23.3° C.). The lowest temperature is for the month of January, 21° F. (= nearly —6° C.). The average temperature for any other month can be determined by reference to the numbers at the left. The mean annual range of temperature is 53° F. (= 29.4° C.) and the mean temperature for the year, 47° F. (= 8.3° C.).

duration may come at any season. Sudden showers are likely to make roads heavy, and parade grounds and trenches muddy. In winter, snow is more abundant than rain, the average amount being about 42 inches (about 4 inches or 10 cm., of rain). Most of the snow falls between the beginning of December and the end of March. In few years is there enough to interfere seriously with camp routine. The winter of 1917-18 was exceptional in this respect.

Climatically, Camp Grant is one of the most desirable cantonments in which to train for the Western Front, because the differences between the two places are all to the advantage of the Camp Grant man, as compared with the men from most other cantonments. The Camp Grant man will find a milder climate on the Western Front in winter, and a cooler climate in summer.

Temperature conditions on the Western Front are illustrated by the data for Lille, near the Belgian frontier. Figure 13 shows the change from month to month, which is notably less than for Camp Grant. July

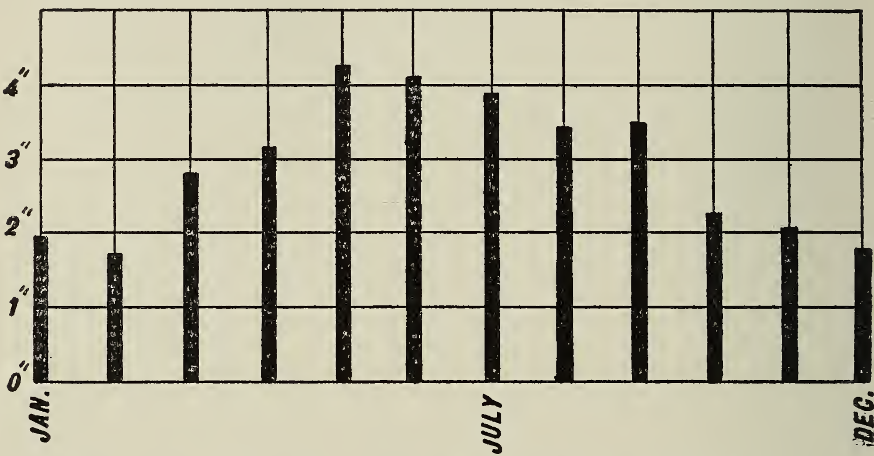

FIG. 12. Graph showing the precipitation (rainfall) at Winnebago, Ill., about 10 miles west-northwest of Camp. The numbers at the left indicate inches of water. The several vertical lines represent the average rainfall for the several months, that at the left being January and that at the right being December. It will be seen that the greatest monthly precipitation is in May, when the amount is something more than 4 inches (about 10 cm.), and that the rainfall is much heavier during the spring and summer months than during the rest of the year. The average for the year is 35 inches (about 88.8 cm.). The average amount of snow is 42 inches, or about 4 inches (10 cm.) of water.

is 10° F. (5° to 6° C.) cooler there than at Camp Grant, and January 16° F. (about 9° C.) warmer. Farther east, however, in the low tablelands near the German frontier, the winter temperature is only about 10° F. (5° to 6° C.) above that of Camp Grant. These higher temperatures in winter help materially to lessen the discomforts of that season. In every respect the Camp Grant man has experienced in his training much more rigorous weather than he is likely to find on the French Front.

The scene of war in northern France (spring, 1918) is more than 500 miles farther north than Camp Grant. Its latitude is a little higher than that of the northern boundary of the western part of the United

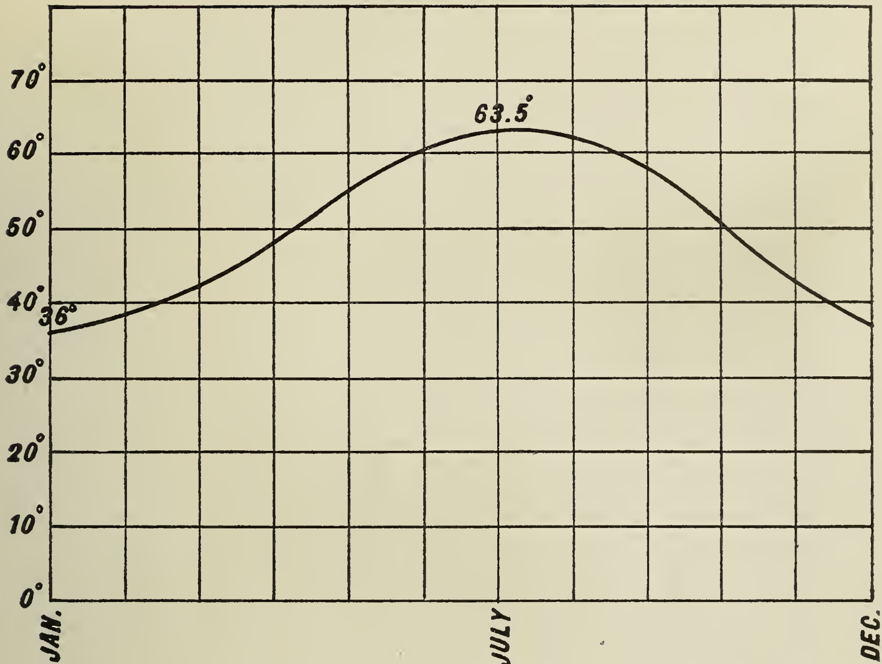

FIG. 13.—Graph showing monthly temperatures at Lille, France. The numbers at the left show temperatures in degrees Fahrenheit. The 12 vertical lines represent average monthly temperatures, commencing with January at the left. The highest monthly average temperature is that of July, 63.5° F. (= 17.5° C.). The mean annual range is 27.5° F. (= 15.3° C.). The mean temperature for the year is 49.46° F. (= 9.7° C.). The mean maximum is 90° F. (= 32.2° C.) and the mean minimum, 8° F. (= —13.3° C.).

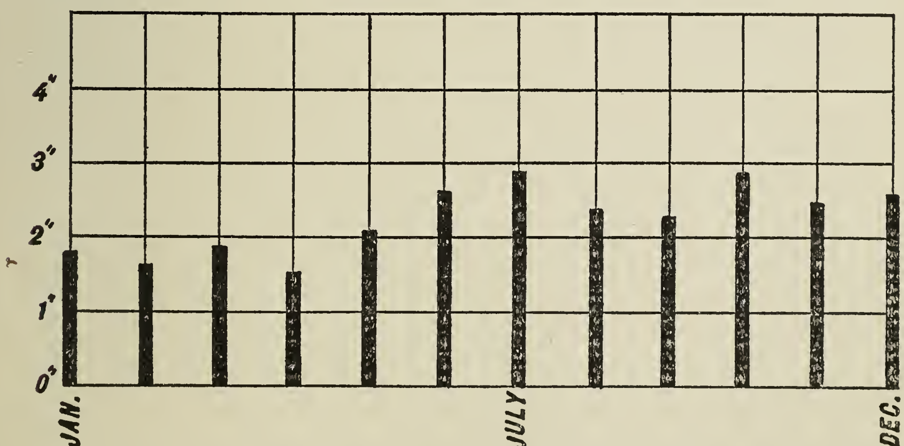

FIG. 14.—Graph showing the rainfall by months at Douai, France. The figures at the left indicate inches of precipitation. The several vertical lines represent the precipitation by months, commencing with January at the left. The average annual precipitation is 27.2 inches (nearly 70 cm.).

States. The temperature of the coastal portion of northern France is not unlike that of Seattle. The absence of such extremes of temperature as are experienced at Camp Grant is due, as in the case of Seattle, to proximity to the sea. The sea is warmer than the land in winter, and cooler in summer. The prevailing winds are from the west, and the air which drifts over the land in winter tempers the cold, and that carried over in summer reduces the heat, making extremes much less than they otherwise would be. Farther east, the influence of the sea is less, and extremes of temperature are greater, for the same reason that they are greater in central Washington than at Seattle.

Rainfall conditions in northern France vary greatly, most places having as much rain as Camp Grant, and some parts much more (fig. 14). Toward the west, there is rather more in winter than in summer, but toward the east the reverse is the case. On the average there are about 140 days a year when rain falls in northern France, 40 more than in northern Illinois. More of the rain in France comes in "drizzles" or "heavy mists." Sudden downpours, like the summer showers of Camp Grant, are infrequent. From the standpoint of trench life and military operations, short, heavier showers probably are preferable to protracted rains. In winter many of the protracted rains are accompanied by chilling winds.

CHAPTER II—POINTS OF MILITARY SIGNIFICANCE

If the area is looked upon from the point of view of military operations, there are some significant features, though none of a commanding character.

Barriers

There are few natural obstacles to movement of troops or artillery in any direction. There are no mountain ranges to oppose movement or to offer protection, and there are no commanding ridges or hills. The most significant barriers are (a) the larger streams, and (b) certain low tracts, notably the flood plain of the Pecatonica, which are subject to floods, and which are wet and muddy for weeks or even months at a time. Such tracts would not be obstacles when the ground is frozen or in dry times in warm weather. Of lesser significance as barriers are (c) a few steep slopes which would make rapid movement of troops difficult; but there are none of considerable extent, which are prohibitive.

It is to be noted that barriers are as real to one of two contending armies as to the other, and that the obstacle which blocks the progress of one army may serve a defensive purpose against its adversary.

The Rock, the Pecatonica, the Kishwaukee, and the Sugar rivers all are large enough to interfere with the crossing of men or wheels, except where they are bridged. Between Byron and Rockford, some 15 to 20 miles as the river flows, there was no bridge, prior to the establishment of the Camp. There are five bridges in Rockford, and three between that city and the northern edge of the area covered by the Rockford map. The Pecatonica River has but one bridge within the area of the Rockford map, though there is another but a short distance west of the western border of the area of the map. Elsewhere the wide separation of the bridges leaves long stretches without practicable crossings. Furthermore, bridges are destroyed easily, so that problems of stream crossings are serious, as the Austrians found in their early attempts (1914) to cross the Save and the Danube, into Serbia. The Rock, though a small stream as compared with some of those which have played an important part in the European conflict, is too large in most places to be forded at any time. The other rivers, and many of the creeks, are too large to be forded when in flood. The periods when the creeks cannot be forded are short, ranging from a few hours to a few days. The periods of high water in the rivers are longer. The channel of the Pecatonica is muddy, and the muddy bottom would make fording difficult or impossible, even when the water is not too deep.

The valleys of some of the larger rivers of western France, as the Somme, have low flood plains which offer problems similar to those of the Pecatonica.

Some of the smaller valleys offer problems akin to those of the Pecatonica. A number of them, like those south and southwest of the village of Stillman Valley, the valley of Killbuck Creek and the valleys of some of its tributaries (Kings map), and the valleys of Piscasaw and Beaver creeks (Belvidere area), are wide and basin-like, and their bottoms may be boggy. The high water in times of flood, and the muddiness which persists after floods, would be serious obstacles to troops and heavy guns, as serious for hostile as for friendly armies. The maps hint at this condition of things along some of these valleys, by the wide separation of roads across them. Thus there is, in one place, a stretch of 3 miles where no road crosses the Piscasaw.

The Kishwaukee and Rock rivers afford opportunity for the study of problems in crossing streams where bridges are wanting, but where the bottom is firm. The Rock has islands near Camp and below, and the problems which such islands offer, in the crossing of streams, might be studied here. Islands were of great service to the Austrians when they finally effected a crossing of the Danube into Serbia, late in 1915.

The valley of the Pecatonica offers excellent opportunity for the study of the many problems which armies might encounter in the field, in crossing wet, marshy, and flooded tracts, and in crossing streams with soft, muddy bottoms. The conditions along the Pecatonica have some resemblance to those along the Save River on the north border of Serbia. The marshy lands along this river played a significant part in the early attempts of the Austrians to invade Serbia.

The problem of flooding such an area as the Pecatonica bottoms, might be worthy of attention.

Ridges and Slopes

There are minor ridges and hills at one point and another of which military use could be made under some circumstances, and many slopes of which experts in warfare would know how to take advantage. A ridge of the type referred to lies about 4 miles south-southwest of the bridge across the Kishwaukee just above its junction with the Rock. Under some circumstances, such a ridge might be of great service in warfare, and the ways of utilizing it might be studied here. There is a group of hills of possibly similar significance, 3 or 4 miles southeast of Camp, east of the junction of Killbuck Creek with the Kishwaukee River.

The utilization of steep slopes can be studied to good advantage along the Kishwaukee above Camp, and along the Rock below the Kishwaukee. In both these situations, solid rock (limestone) comes close to the surface.

Gentler slopes, of clayey or gravelly material, are available for the study of such problems as they afford, all along the east edge of the terrace on which Camp Grant is located.

Slopes of various angles within easy reach of Camp, afford good opportunity for the study of the positions on slopes which offer protection against fire from various positions on the uplands above, and also for the study of problems involved in the movement of infantry, cavalry, and artillery.

Roads and Road Metal

There are numerous roads, and more could be built almost anywhere, in almost any direction, if needed. The steep slopes of the Kishwaukee Valley for a few miles above Camp, and of the valley of the Rock most of the way below the Kishwaukee, are unfavorable for their construction, but there is hardly a slope in the whole area along which a road could not be made, if it were important.

Many of the roads of the region have been graveled, or treated with crushed stone. In some cases this has been done so well and so recently, that the roads are in good condition. In other cases, the roads, once good, have not been properly cared for and are now in bad condition. The main valley-road north from Rockford on the east side of the river, is an example. Generally speaking, the better roads, that is those which are in good condition at all times, radiate from the cities of Rockford and Belvidere. In one place, 5 miles or so north-northeast of Belvidere, there is a stretch of cement road. Many of the roads of the region are ''dirt'' roads. While they are good for light traffic in dry weather, they are not satisfactory for traffic of any sort in wet weather, or for heavy traffic at any time.

If this region were the scene of such conflict as northern France, one of the great and immediate problems would be the construction of roads,—roads which would be serviceable in all sorts of weather, for all sorts of traffic. Fortunately material for the betterment of the roads is at hand. Limestone underlies most of the region, and limestone, crushed and properly applied, makes excellent road metal. There are quarries in many places (Pl. I), and limestone comes to the surface and might be quarried in many others. Most of the large quarries are west of the river, in or near Rockford, but there is a considerable quarry a mile or so west-southwest of Belvidere, and small quarries are distributed widely. Limestone is to be seen at numerous points along the bluffs on both sides of the Kishwaukee River where the bluffs are steep (Rockford map), and on both sides of Rock River Valley below the Kishwaukee. In these situations most of the tributary valleys and ravines which descend from the upland to the main streams, reveal the rock. It is seen also in some of the small valleys both east and west of Rock River north of Rockford, along roadways at many points, especially west of Rock River, and at numerous points in the uneven tract in the southwest corner of the Kings area. Quarries are possible in all these places. In all of them the overburden is thin, and the thickness of weathered rock above the unweathered is slight. Sites for quarries should be selected with reference to accessibility, and proximity to the places where the stone is to be used.

Road materials in this region are not confined to limestone, though crushed rock is the best local material available. There is gravel in great quantities at various points throughout the area covered by the four maps. The deep filling of Rock River Valley is the largest single source, and a very extensive pit has been opened in the terrace along the railway about 3 miles northeast of Rockton. Much of the filling of this valley is, however, too sandy to be of excellent quality for road-making. The excess of sand could be removed by screening, though this takes time and involves some expense. The filling is, on the whole, more sandy to the south than to the north. The quality of the material near Camp can be seen in the terrace bluff facing the river.

Gravel of better quality for road purposes is found in some of the gravel hills in various parts of the region. There is a group of such hills (called *kames*) 3 to 5 miles southeast of Camp, the west end of the group being north of Killbuck Creek, just above its junction with the Kiskwaukee.

A ridge (or line of hills) of similar composition extends southwestward from a point about 5 miles southwest of Camp (about 3 miles northeast of the village of Stillman Valley). There is still another group of gravel hills (kames) 4 miles southeast of Belvidere, east of the railway. There is much gravel also south of the junction of the two branches of the Kishwaukee, quantities of it in the valley of the North Branch of the Kishwaukee, and along the east bluff of Rock River Valley above the terrace, north of Camp. There are many smaller, but considerable sources of supply, widely distributed throughout the area. In some of these places, screening would improve the quality of the material for road purposes. In these various places there are scores of gravel pits, some large and some small, and many more could be opened in case of need.

The condition of various roads within easy walking distance of Camp is such as to suggest problems of various sorts to those interested in their improvement. Questions of (a) road bed, (b) drainage, and (c) grade, all may be studied to advantage, and the principles illustrated here are applicable elsewhere.

A geologist might be of material service with every considerable army unit, by helping to locate quickly suitable sites for road beds, road metal, and materials suitable for other sorts of construction. The Germans have successfully used experts for such purposes who furnish advice in advance even as to what tools shall be brought for working the material available.

Problems of Trenching and Tunneling

Over the limestone in most places lies a very considerable thickness of gravel, sand, and clay, or a mixture of these materials. Collectively they are known as *drift.* They constitute the *mantle rock* of the region, mantle rock being surface material which is not hardened, and not popularly known as rock. Trenches could be made in some of the mantle rock easily and in some of it only with more or less difficulty. Trenches in some sorts of material would drain readily, while in some drainage would need to be provided with much care. Trench walls would stand much better in some sorts of material than in others. Problems involving these elements can be studied to good advantage close to Camp.

The sandy and gravelly parts of the drift can be dug into easily, as in the nearly level area at Camp. The tougher, clayey drift, of the sort seen in the railway cut just south of Camp, and on the higher part of the land in the trench area, is much harder to excavate, but can be dug into with pick and shovel. Trenching in areas underlain by these two phases of drift is less unlike than might be anticipated, because both are covered in many places by loam 2 to 5 feet deep, which is less diverse in character than the material below. The difficulty of digging in the clayey drift is illustrated in the deeper excavations on the higher land in the trench area east of Camp. The trenches lower on the slope, and those on the flat west of Camp, illustrate the effect of sandiness on the ease of trenching.

Fig. 15.—Diagram to show how, in some situations, it may be possible to drain a trench downward. T = trench. The sub-stratum (Gr.) is porous sand and gravel, which comes to the surface in the valley to the left. If a hole be made from the bottom of the trench in the clayey matter at the top (Cl.), down into the gravel below, water from the trench would escape.

Trenches in gravelly drift would drain somewhat readily, because the gravel is porous enough to let the water sink through it when the ground is not frozen; but trenches in the clayey drift would not allow the water to sink so readily, and in such material, the problems of drainage demand special attention. Either (1) the bottoms of the trenches should have slope enough to let the water run out, or (2) ditches should be dug so as to divert surface drainage from them, or (3) under-drainage should be provided, by boring down to a porous under-stratum. The last device is practicable in some places where there is a porous bed of material, as of gravel, beneath a clayey cover, especially if the porous stratum comes to the surface on some near-by slope (fig. 15). This latter plan would be practicable at some points east of Rock River terrace, where the clayey upper part of the drift is underlain by gravel. Special study of any particular locality probably would show whether this method of drainage is practicable.

In the northern part of the area covered by the Rockford map, north of the Pecatonica and east of the Sugar River, there is much dune sand. Dunes constitute distinct hillocks over parts of several square miles some 3 miles north-northwest of Shirland. Most of them are covered with a poor growth of timber. If dune sand offers problems of interest to officers, they may be studied in the region mentioned. Dune sand is excavated easily, and ridges of it could easily be built up along the trenches for their protection. Dune sand affords good drainage, and does not become muddy in wet weather. In dry times, the roads in sandy regions are bad, unless a good road bed has been made by the use of gravel or crushed stone. In the areas of dune sand, most of the roads are poor. They are ''dirt'' roads, but the dirt is heavy in dry weather instead of wet, as in areas of clay. Dune sand comparable to that of this area is found along the coast of northern France.

The upper part of the limestone, where it comes close to the surface, is much *weathered,* that is, it has been broken into small pieces by freezing and thawing and by the roots of trees, and has been softened and disintegrated by the dissolving action of rain water which has sunk through it. In most places, therefore, it would be possible to make excavations in the limestone to the depth of trenches, without great difficulty. If the underlying rock were of some harder variety, such as granite, it would not be practicable to make trenches in it. In this event the thickness of the mantle rock would determine the positions in which trenching is practicable. In regions where there is no drift, the mantle rock is thinner than in most parts of this area, and it is thinner, as a rule, on slopes than on level lands, as illustrated at many points in this region. In general, solid rock is likely to be nearer the surface on steep slopes than elsewhere.

The walls of trenches in the broken limestone would stand with little or no support. Trench walls in the drift above the limestone would need revetment, if the trenches were to be more than temporary. This was illustrated by the slumping in the trenches at Camp Grant during the winter and spring of 1917-18. The methods of revetment in the clayey parts of the drift would be somewhat different from those in the gravelly and sandy parts.

The various problems connected with trenching find ample illustration in the vicinity of Camp. In no part of the upland area near Camp, would trenches of ordinary depth reach the ground-water surface (water-table, pp. 17-8). On the flood plains of streams even shallow trenches might reach the water-table, especially in wet seasons. In such places as the Pecatonica flats (Plate II, and Rockford map), where the water-table is close to the surface, dry trenches would be impossible most of the year. Sample trenches there would illustrate quickly the difficulties of trenching in such positions. The flood-plains of other streams would illustrate the same difficulties, though less pointedly.

While flood-plains like that of the Pecatonica are places where it would be impossible for an army to dig itself in and remain in comfort for any considerable period, they might, under some circumstances, be good places in which to force an enemy to dig himself in. A heavy rain would make his position virtually untenable. In cases where the "elements" can be utilized against the enemy, the opportunity should not be neglected. Conditions similar to those of the Pecatonica bottoms are found in the bottoms of some of the larger valleys of northern France, and on the low plain near the coast of Flanders.

Tunneling and mining have been important in some places in the European battle-fields, both in Italy and France, and while the variety of rock near Camp Grant available for studies of this sort is not great, the limestone in the steep slopes of the Kishwaukee, above Camp, and in the steep slopes of the Rock below the Kishwaukee, afford opportunity for practice in tunneling in rock which is excavated rather easily. Problems in the timbering of tunnels or other excavations also could be studied. Tunneling in the mantle rock would be much easier than in the limestone, but the problems of support would be much more serious. Expert advice as to the formation which was suitable for tunneling proved to be of decisive importance to the Allies in at least one critical juncture of the war.

On the Western Front, sunken roads and covered railways are said to have been made in some places. Where such roads are to be made, it is manifestly of importance to know the location of materials which can be easily excavated, and their ability to stand under varying conditions of moisture.

The study of problems such as those suggested above, in advance of actual field operations, can hardly fail to be of critical value. Studies of this sort are not being overlooked by the Germans. On the contrary, they are being carried out systematically and in great detail. Geologists, or engineers who understand geology, give advice as to the location of trenches, taking into account ease of excavation, possibilities of drainage, and ability of material to stand both when wet and when dry. As in the case of road-making, they even advise in advance what tools men should bring with them when they enter new territory. That the Germans have used geologists extensively and intensively, is one of the many evidences of their thorough understanding of the physical problems of warfare.

Water Supply

Since the water of the streams of this region is unsuitable for drinking, and springs are too few to serve as an important source of supply, the chief reliance must be on wells, and it is important that the sources of well water and the possibilities of its contamination, be well understood. Failure on this point has produced disastrous results in more than one military campaign of the past.

It has been stated already that well water is rain water which has entered the ground. In some cases, it has moved long distances from its place of entrance before it is drawn from wells for use. In regions of dense population, as in large villages and cities, or even in thickly settled farming communities, shallow wells are unsafe, unless properly located, properly made, and properly protected, for in such regions sources of contamination are numerous.

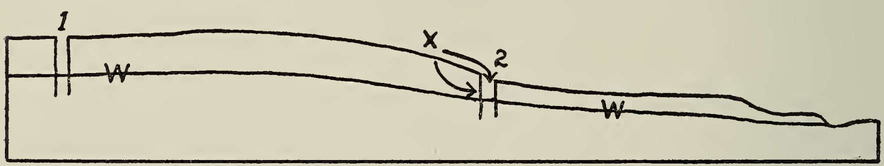

Fig. 16.—Shows how a well, at 2, might be contaminated by drainage from a stable or other farm building at x. The water might run down over the surface into the well unless the mouth of the well is protected against it, or water from the stable might sink into the ground and flow down the water surface, WW, into the well if the well is not cased so as to exclude it.

Underground water moves down slope, just as surface water does. If a stable is situated at x (fig. 16), not only may surface drainage from it reach a well at 2, unless the top of the well is protected against it, but drainage from the stable may sink beneath the surface, and find its way into the well, unless the well is so constructed as to exclude it. Before reaching the well, the water has been filtered in passing through the earth, but inadequate filtering would not destroy harmful elements in it. If the well is cased so as to prevent the entrance of water above a level which is considerably below the water-table, WW, contamination from the surface is likely to be prevented. The modern method of drilling wells from the surface and casing them down some distance below the water-table, accomplishes this result. The old-fashioned "dug" well, open at the top and not cased, was subject to contamination unless its site was so chosen as to prevent surface or sub-surface drainage into it. The curbing of the open well does not prevent the entrance of contaminated water. If such a well were cased from a level above the highest stand of water in the well, down to a level considerably below the water-table of dry seasons, its water probably would be safe.

The six wells which supply Camp Grant with water are on the flood-plain of the river, west of the northern part of Camp, where the elevation of the surface is about 693 feet. In depth the wells range from 153 feet to 185 feet. All are in drift, none reaching the rock beneath (fig. 5). The lower parts of the wells are in coarse sand which carries abundant water. Not only is surface water excluded, but the wells are cased so that water enters them only at depths of 140 feet or more. At the bottoms of the wells, strainers are inserted to keep out the sand which might otherwise come up with the water in the vigorous pumping necessary to supply the Camp. The topographic position of the wells is shown in figure 17. The

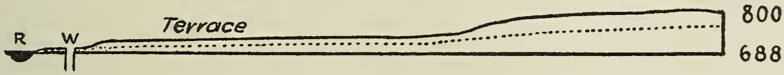

Fig. 17.—Diagram showing the general position of the Camp Grant wells. R = the river, W, the site of the wells on the flood-plain just above the river. The broken line represents the ground-water surface, which is scarcely below the surface of the flood-plain. The figures at the right represent approximate elevations above sea-level. Length of section about 2 miles.

water-level was found to be only 6 to 8 feet below the surface, and but little above the level of the river at the time (summer) when the wells were drilled. In wet times, the surface of the ground-water would have been higher, probably at all times a little above the stream.

The water which enters the wells from depths of 140 feet or more, has been filtered through sand for a long time, and in the process any harmful elements it may have contained when it sank beneath the surface, have been removed, or their injurious qualities destroyed.

The great volume of water in the drift is evidenced by the fact that the wells have supplied more than 2,000,000 gallons of water per day, when so much was needed, and could supply much more if occasion demanded. There is in fact a volume of water in the drift of the drift-filled valley (fig. 5) far in excess of that in the river itself. The pumping of the water from the wells draws down the water-surface immediately about them, and this causes the continuous flow of water toward the wells from all sides.

In permanent camps, it is possible to secure an adequate supply of good water if camp sites are intelligently chosen. But in actual warfare, when the scene of operations changes frequently, a safe and reliable source of supply is not always at hand, and the thirsty soldier must be on his guard against wells or other sources of supply which are likely to be contaminated, either by the enemy or in any other way. As to poisoned wells, the geologist has no source of information beyond that of other men; but he may have some basis for judgment as to the probable safety of water from other wells, and from springs.

The conditions affecting ground-water and well-water in the region about Camp Grant are not unlike those found in many other regions, and illustrate general principles which are applicable widely. Most of the shallow wells are in the gravel, sand, or clayey material which overlies the limestone, and in the terraces and on the flood-plains abundant water can be had at shallow depths. The sand and gravel are porous, and surface water, descending, circulates freely through them. This free circulation facilitates the contamination of the upper portion of the ground-water, so that the location, construction and protection of the wells is doubly important. But even under these conditions, well sites may, in some cases, be so chosen as to insure relatively pure water. Thus a well at A (fig. 18) is not likely to be contaminated by surface or sub-surface drainage, for the slope both of

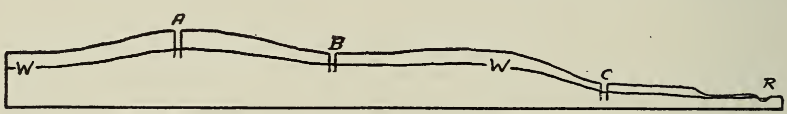

FIG. 18.—Diagram to show various relations of wells to the surface. A well at A would not be likely to be contaminated by surface or sub-surface drainage. The well at B or C might be contaminated by surface drainage from above. If the mouths of the wells at B and C were protected against surface drainage, and if the wells were cased down to a level considerably below the water-table, WW, the water in them probably would be safe.

the surface, and of the surface of ground-water, WW, are such as to divert surface drainage from it. Wells at B and C, on the other hand, would be subject to contamination both from surface and under-ground drainage if there are farm buildings on the slope above, unless surface drainage is diverted from their tops, or the wells cased from the top down to a level considerably below the water-table. If there is such a casing, any polluted waters which might sink below the surface would go down to the water-table, WW, and flow over this surface to the river, R.

In the vicinity of cities, or in other regions which are closely settled, the danger of contamination is greater than elsewhere, and shallow wells are to be suspected. But even in such situations, water from deep wells is safe if surface waters are shut out (fig. 19).

Protection against local contamination does not insure against contamination at the place where the water now in the well entered the ground. The best the geologist can do in such a case, is to indicate probabilities of purity. In many cases this can be done by determining where the water comes from, and its course before it reaches the well, determinations which, in many cases, are easily made, if the geology of the region is understood. In doubtful cases, water should be avoided if possible, until tests are made by a sanitary expert. If it is impracticable to await his verdict, the water should be boiled before drinking.

In many regions where mantle rock is thin, wells must be sunk into solid rock. This is the case, for example, in most of the area of this region west of Rock River. In such situations, knowledge of the underlying rock

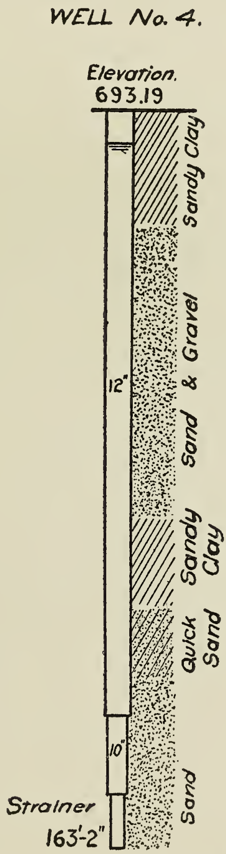

FIG. 19.—The log of one of the Rockford wells, showing depth (163 feet), the size of the bore, the position of the strainer at the bottom, and the material encountered in drilling. The water surface was only about 6 feet below the land surface at the well site. (Alvord and Burdick.)

and of the depth of the water-table may be of great help in determining sites where the desired quantity of water can be had, and what its quality is likely to be. In Rockford and Belvidere, for example, there are deep wells, some of them nearly 2000 feet deep, which go down to a thick formation of porous sandstone (the St. Croix sandstone, fig. 5), which comes to the surface and receives its water in a sparsely populated region more than a hundred miles to the north. The existence of this sandstone and its approximate depth were known before the wells were put down. The water from these wells stands little chance of pollution, if protected, as they are, against local surface drainage.

The water of the region about Camp Grant is "hard"; that is it contains much lime (lime carbonate). This makes it somewhat objectionable for boiler use, but is not prohibitive. Water from wells which are in limestone, or in surface earths (mantle rock) which contain much limestone, as about Camp Grant, are sure to be hard. This does not injure them for cement work, and is not especially harmful to man.

It may happen in some places that the supply of uncontaminated water is scanty, while other waters are abundant. In such cases, it is worth remembering that waters which are not suitable for drinking may be serviceable for boiler use, or for cement work.

The promptness with which water can be secured is in some cases a matter of great importance. A case in the present war is cited where, under geologic advice, a well sunk 15 feet gave an aedquate supply of water, when the alternative was piping it 10 kilometers (between 6 and 7 miles).

Gas Problems

Many of the very small valleys which are narrow and relatively deep, such as those just east of Camp, many of those east of Rock River north of Camp (west border of Belvidere area), and many of the ravines leading to the Rock below the Kishwaukee, offer opportunity for the study of the effect of topography on the behavior of gases. The tiny ravines just west of Camp, if not too small, might serve the same purpose. Into such ravines, noxious gases heavier than air might settle to such an extent as to make them dangerous, even when the ridges between are safe. Studies in problems of this sort, in advance of service at the front, might prove to be of value.

Timber

It already has been noted that there are few large areas of timber (shown in green on the maps) in the region. The trees of most of the forest patches are young and small, the older and larger ones having been cut. Most of the timbered areas are pastured, so that dense underbrush is wanting in most places. In spite of the meagerness of forests, the stands of timber are such in one part or another of the area accessible to Camp, as to offer opportunity for the study of military problems in which scant forests play a part.

Summary

The several topics which have been discussed briefly in the preceding paragraphs, suggest some of the ways in which geologic knowledge may be of value to an army in active service. The points which have been mentioned are those which find illustration in the region about Camp Grant, but most of them can be applied widely. In many regions, too, a knowledge of geology may help in other ways. It may be of great importance to know (1) the strength of various sorts of rock in a region where foundations for heavy structural work are to be placed, (2) the relative strength of the various sorts of rock available for building, (3) the ease with which they can be worked, and (4) their behavior under shell fire, as for example their tendency to splinter. In mountain regions, it is important to know in advance localities where slumping, land-sliding, and snow-sliding are likely to take place, either in the course of nature, or under the unnatural disturbances of shell fire. There are many localities, too, where the earthy matter of slopes creeps when wet, and possibilities of this sort should be taken into account when roads, railroads, trenches, or structural work of any sort, are located. In one case it is said that von Hindenburg's army was able to make its way through certain marshes by choosing routes where the bottom was solid, as shown by the plants which grew there, while the Russians, unable to distinguish between safe and treacherous bottoms, were defeated. The Germans' knowledge of botany as well as geology was turned to good account here.

Most of the considerations mentioned in the preceding paragraphs have possibilities of utilization in two ways. Not only may the army which is in a position to choose take advantage of geologic conditions, but it may be able to force its opponent to accept positions and conditions which are disadvantageous. A thorough knowledge of topography and geology cannot fail to be useful in many ways and at many junctures, and possibilities of this sort should not be overlooked. Since geologists can hardly be at hand at all times at every place where war activities are in progress, it is desirable that as many men as possible in each army unit know something of the subject and its possibilities.

Reference already has been made to the effective use which the enemy has made of the expert knowledge of geologists, and to some of the ways in which their advice is utilized. It is said that 170 experienced men of this class are attached to the staffs of the German-Austrian armies. In addition to their advice concerning road construction, water supply, trenching, and tunneling for their own armies, their knowledge of the ground occupied by those opposed to them has been turned to their own advantage more than once.

CHAPTER III—THE HISTORY OF THE LAND

The history of the area about Camp Grant is somewhat different from the history of the area about any other cantonment. If the age of a particular land area is dated from the time when it finally became land, the area about Camp Grant is neither one of the older nor one of the younger parts of North America. There are older lands (i. e. lands whose uppermost rock formations are of greater age) to the north, and younger lands to the south. The land is still extending itself southward into the Gulf of Mexico, as may be seen at the mouth of the Mississippi, where the mud carried down by the river is being built into new land along the shore of the Gulf.

It would be interesting to know how old the earth is; but that is beyond present knowledge. It is known, however, that its history is a remarkable one, and though all its details have not been determined, enough is known so that its general outline can be stated with much confidence.

The Bed Rock

The known geologic history of the region about Camp Grant goes back to a distant time, many millions of years ago, when a shallow sea covered northern Illinois. It probably connected freely with the ocean to the south, where the Gulf of Mexico now is, and perhaps with ocean waters which occupied the sites of the Arctic and Atlantic oceans on the north and east. This sea was only a few scores, or at most a very few hundreds of feet deep. On its bottom were deposited the materials which later became the limestone which lies beneath the area about the Camp, and which may be seen in a number of quarries within 5 miles of Camp, at many points on both slopes to the Kishwaukee River above Camp, and at many places along the Rock River below Camp. Small quarries which are readily accessible for examination may be found near the west end of the rifle range, both north and south of the river, in the western part of Section 18, 2 miles east-southeast of Camp Grant railway station, in the low swell which is indicated by the 720-foot contour in Section 21, a mile southwest of Camp, and on the west side of the Kishwaukee, in the same section. There are much larger quarries in Rockford (S. ½ of sec. 15). The limestone contains many shells and other hard parts of animals which lived in the shallow sea,—is, indeed, made of the shells and other secretions of sea life. The area must have been beneath the sea for a very long period of time, in order to allow the accumulation of shells, coral, etc., in quantities sufficient to make the 300 to 400 feet of limestone which underlies the upland of the region. Its accumulation may have been at some such rate as a foot a century, though the rate is not known. Under favorable conditions limestone now is accumulating at about this rate.

The limestone in sight at most of the quarries and along the slopes about Camp is known to geologists as *Galena limestone* or *Galena dolomite.* Limestone is composed chiefly of calcium carbonate. Dolomite differs from limestone in containing a considerable amount of magnesium. In other words it is the carbonate of calcium and magnesium. Popularly, dolomite frequently is called limestone. The Galena dolomite got its name from the city of Galena, in the northwestern corner of the state, where the same formation is found. About the city of Galena, the limestone contains an ore of lead, called *galena,* and this mineral gave its name to the mining district settlement which later became the city of that name.

Immediately beneath the Galena limestone lies other limestone known variously as Trenton limestone, Platteville limestone, and Beloit limestone. The first of these names has been in use longest, but *Platteville* is now preferred. The name is taken from the city of Platteville in southwestern Wisconsin where the formation comes to the surface.

Both the Galena and Platteville limestones are in layers. The layers or beds are nearly horizontal, but they decline (dip) a little to the south and east. As a result of this slight dip, which amounts to only a few feet in a mile, older formations come to the surface from beneath the limestone toward the northwest, and younger ones come in over it to the southeast (fig. 5).

The oldest formation which comes to the surface in the region is sandstone *(St. Peter sandstone).* It comes up from beneath the Platteville limestone (1) near the northwest corner of the area of the Rockford map, and (2) in the southwest corner of the area of the Kings map. In the former place it is seen in the valley of Sugar River, where the northernmost road shown on this map crosses the river. In the southwestern corner of the Kings area it is seen at various places in the slopes, and here and there forms distinct though low cliffs, some of which are bare and rather picturesque. The material of the St. Peter sandstone was deposited as sand. Its change to sandstone came later, by cementation; but the sandstone is not very firm, and crumbles to sand readily. The name is taken from a locality in Minnesota.

The youngest formation of bedded rock which has considerable extent in the region is shale *(Maquoketa shale,* named from a river in Iowa), which overlies the Galena limestone, some miles southeast of Camp Grant. It is exposed in the bank of the South Branch of the Kishwaukee River, 1½ miles west-northwest of Kingston, about 18 miles southeast of the Camp. Like the limestone below it, the shale contains shells of sea animals, and like the limestone, the material of which it is composed was deposited on the bottom of a shallow sea. When deposited the material of the shale was mud. Later the mud was consolidated into rock (shale) by cementation and by pressure. The cementing material was precipitated from the sea water, or possibly from waters which percolated through the mud after the area became land. The shale, however, is not very hard. In places it contains so much lime carbonate, as to be earthy limestone, rather than shale.

This shale formation, now restricted to the southeastern part of the area covered by the Belvidere map, and the eastern part of the area of the Kirkland map, probably once covered all the area shown on the four accompanying maps.

Another formation of limestone probably comes in over the shale near the extreme southeastern corner of the Kirkland area, southeast of Kingston. Its existence in this area is inferred rather than known, for it is not known to appear at the surface. This formation (*Niagara limestone,* named from Niagara Falls), like the shale, probably extended over the whole area at one time. Its absence now is the result of erosion which has worn it away.

A remnant of a formation intermediate between the Maquoketa shale and the Niagara limestone is known in the hill-top quarry 4 miles south-southwest of Belvidere, but it is not of great importance in this connection.

Of the history of the region prior to the deposition of the formations which can be seen, we know something. Drillings for deep wells have made known what lies beneath the formations which can be seen (fig. 5). Furthermore, these lower formations come to the surface farther to the north and northwest, in Wisconsin.

A Long Period of Erosion

After the deposition of the formations mentioned above (the St. Peter sandstone, Platteville and Galena limestone, Maquoketa shale and Niagara limestone), this area, with considerable tracts about it, emerged from the sea. Either the area was crowded up from beneath the water, as many other areas of sea bottom have been at various times in the earth's history, or the great basins which held the sea water sank, becoming deeper and more capacious, and drawing off the shallow water from much of what is now the continental area.

When the area of this region became land, the rains fell upon it much as now, and the water, running off, began to wear away the surface material, even as the run-off from every shower and from every melting snow, now carries away a little of the soil, as mud, sand, etc. It is the material thus washed away which makes the streams muddy after every heavy rain, and during the rapid melting of every snow. All the mud washed from the surface of this region, is started toward the Gulf of Mexico. It goes down the creeks and small rivers to the Rock, is carried by that stream to the Mississippi, and by the Mississippi to the Gulf. Some of the mud stops on the way, being deposited on the flood plains of the valleys through which it is carried. But all sediment thus dropped in one flood, is likely to be taken up and carried on at some later time. When it finally reaches the Gulf much of it comes to rest, and after being buried, makes new deposits of shale. This, in turn, may become land at some future time.

During the long ages following the conversion of the area about Camp Grant from shallow sea-bottom to land, considerable but unknown thicknesses of rock were worn away. If the Maquoketa shale, the Niagara limestone, and a still younger formation which perhaps once overlay the region could be put back, they would raise the surface at Camp Grant from its present level, about 730 feet above the sea, some hundreds of feet (probably 500 to 1000). Not only have great thicknesses of rock been removed from the surface, but at the end of this long period of erosion, the surface was affected by many valleys, much as now. There was at least one trunk valley, two or more large tributary valleys, and minor tributaries both to the main valley and to its principal tributaries, the whole making a ramifying system, somewhat similar to the valley system of the present, though much deeper. These valleys in the surface of the bed rock did not altogether correspond in position with those of the present surface.

The Glacial Period and the Drift

Long ages after this area became land, and after hundreds of feet of rock had been worn away from its surface, came one of the most remarkable chapters in the earth's history. This region, together with a vast area about it, was covered with a great sheet of ice, similar to that which now covers most of Greenland.

The ice-sheet of Greenland was developed from snow. In modern times more snow has fallen on the island than has melted. The result is a great area in which the snow persists from year to year. Snow always is transformed into ice if it lies long on the ground in quantity. The last remnants of great snow-banks, like those of February and March, 1918, in this region, illustrate the point.

When by long accumulation the ice formed from snow becomes very thick, it begins to spread. The ice-cover of Greenland is creeping slowly out from the central part of the island where the ice is thickest, toward the borders where it is thin. Similarly, the ice-sheet which formerly covered some millions of square miles in the northeastern part of North

America (fig. 20), moved slowly out from certain centers where it was thickest, toward its edges where it was thin. This period of the earth's history, known as *the Glacial Period,* was relatively recent compared with the time when the limestone of the region was being deposited on the sea bottom; but in terms of human history it was long ago.

One of the strange things about the glacial period is the fact that there were several great ice-sheets, one after another, separated by periods when the climate was relatively mild. During at least one of these interglacial epochs, we know that the climate was warmer than now.

Fig. 20.—Map showing the extent of glaciation in North America. Professional Paper 106, U. S. Geological Survey.

All the ice-sheets were not equally extensive, and no two of them covered exactly the same area. The region about Camp Grant was overspread by at least two of them, and perhaps by more. That more than

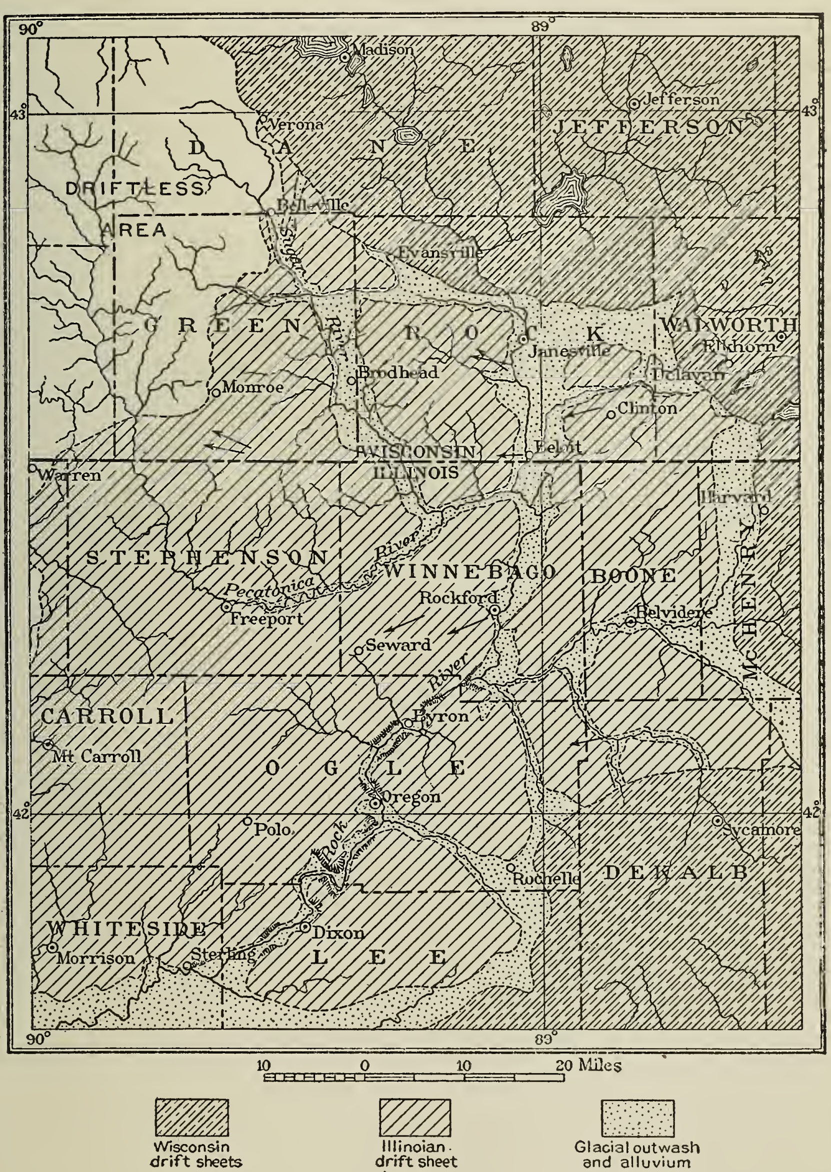

FIG. 21.—Sketch map showing the position of the edge of the Wisconsin ice-sheet in the vicinity of Camp Grant. Professional Paper 106, U. S. Geological Survey.

one ice-sheet covered the region is known in various ways, but perhaps the simplest proof is the fact that borings for wells in the south part of the area shown on the Kirkland map, have shown an old soil beneath one sheet of drift, and above another.[1] This means that after the lower sheet of drift was deposited, a soil developed on it, in which vegetation grew. Later, another ice-sheet buried the soil beneath another sheet of drift. In most places, the old soil doubtless was worn away and destroyed past recognition by the later ice; but it was preserved in some places. As a rule, this old soil is seen only when excavations are being made, and then only in some places. The old soils which have become known in this region, were beneath 20 to 60 or more feet of drift. The latest ice-sheet which covered this area is known to geologists as the *Illinoian* ice-sheet.

The latest of the four or five ice-sheets of the Glacial Period (known as the *Wisconsin* ice-sheet) came within a few miles of this region but did not reach the site of the Camp. Its edge was but a few miles east of the area of the Belvidere and Kirkland maps (fig. 21), and but a few miles

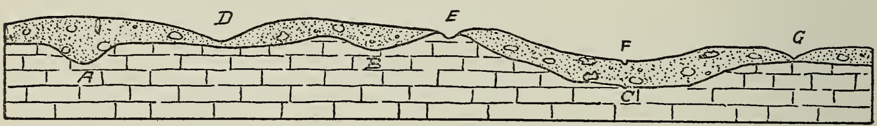

Fig. 22.—Diagram showing the way in which a surface may be altered by the deposition of drift. The upper portion of the figure is drift, and the lower part rock. It will be seen that some of the valleys in the present surface do not correspond in position with the valleys in the surface of the rock beneath the drift.

north of the area of the Rockford and Belvidere maps. On the south, this ice-sheet probably touched the southern border of the Kirkland area.

The latest ice-sheet is believed to have disappeared some 25,000 years (more or less) ago. The older ice-sheets, including those which covered the area under consideration, were much more ancient.

The ice-sheets moved over the surface very slowly, the rate probably not exceeding a few feet a day. The ice was hundreds of feet thick, at a maximum perhaps even more than 1000, and such a body of ice, even with a slow rate of movement, effectively eroded the surface over which it passed. This surface was somewhat uneven, the result of the earlier stream erosion which had made valleys similar to those of the present surface, but deeper. It probably was covered with soil and decayed rock. As the ice moved forward over this uneven surface, its bottom became filled with debris worn from its bed. The ice which reached northern Illinois had much debris which it had brought from Wisconsin, and

[1] Leverett, Frank, U. S. Geological Survey, Mono. XXXVIII, 1899.

the ice in Wisconsin had much which it had brought from northern Michigan and Canada.

When an ice-sheet melts away, all the debris which it carried is left on the surface, and is known as *drift*. These deposits of drift, if thick, leave the surface strangely altered (fig. 22).

The drift within 20 miles of Camp Grant is in some places very thick. On the upland to the northeast, it is as much as 100 feet thick in many places, as is known by the records of the many deep wells on the upland north of Belvidere. Drift 100 feet thick may conceal many small valleys in the surface of the rock beneath. Other wells, on the other hand, reach the limestone beneath the drift at depths of 40 to 60 feet, and in still other places the limestone comes almost or quite to the surface.

In the valley at Rockford, one of the deep city wells went down through 248 feet of drift (gravel and sand) before reaching rock. A well at the Rockford Malleable Iron Works, went through 285 feet of drift, and there is no knowledge that this well-site is over the deepest part of the valley as it existed before the glacial period. The surface of this well is on the terrace 40 feet or so above Rock River. These records show that the valley in the rock below the drift was more than 250 feet below the bed of the present stream, and less than 450 feet above sea level[2] before it was partly filled with drift.

The valley of the Pecatonica River and the valleys of Sugar River and of Coon Creek, tributary to the Pecatonica from the north, have drift fillings probably 200 feet deep.

The records of well drillings therefore show that the surface of the *rock* beneath the drift is very uneven, and that it is affected by valleys much deeper than any of those in the present surface. Some of the old valleys, indeed, are completely filled with drift, while others are but partly filled (fig. 22). Of the former no trace remains at the surface, and their existence and position are known only by deep borings. Probably none but small valleys were completely obliterated by the deposition of the drift.

If all the drift were removed, the total relief of the surface would be increased 250 feet at least, and probably somewhat more. The drift, therefore, serves to even up the surface, especially by partly filling the valleys in the surface of the rock beneath.

The general direction of movement of the ice in this area was west-southwest (S. 75° W.). This is shown by the course of the scratches (striæ) made by the moving ice on the surface of the limestone. Such striæ are seen on the limestone only where its surface has been uncovered recently by the removal of the overlying drift. The surface of limestone soon weathers, and the striæ disappear in the course of a few years, where

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2Alden, W. C., U. S. Geological Survey, Professional Paper 106, p. 114.

not protected. Striæ have been seen on the surface of the limestone at the quarry southwest of Belvidere, where their course is a few degrees north of west, and near Rockford and Winnebago, where they have the direction cited at the beginning of this paragraph.

It has been thought that the general direction of ice movement is suggested by the topography shown on the southwestern part of the Belvidere map, six or eight miles northwest of Belvidere, where there are drift hills with a northeast-southwest trend. This direction however does not correspond with that of the known striæ.

The area of the western front, as it now (Spring, 1918) stands, was not affected by an ice sheet during the glacial epoch, though an ice sheet from the north invaded northern Belgium. There were valley glaciers in the Vosges Mountains, especially in the valleys of their western slope. These valley glaciers left considerable thicknesses of drift locally; and gravel, analogous to the gravel and sand of Rock River valley, was carried far beyond the glaciers down the valleys leading westward from the mountains.

The Development of Existing Valleys

When the last ice-sheet which covered this region (the *Illinoian* ice-sheet) melted away, rain waters and waters from melting snows flowed off by the lowest courses open to them, and surface drainage was re-established.

The valleys of the region fall into three classes:

1. Some of the old valleys were not filled by drift, and such valleys were followed by the new streams after the ice melted. The valley of the Pecatonica is an example. So also are the large valleys occupied by small streams, already referred to (p. 16). In these cases, the present creeks probably are much smaller than the pre-glacial streams which flowed through the same valleys.

2. Some of the old valleys were filled completely. Not only this, but in some places the surface of the drift over their former sites is actually higher than the surface of adjacent lands. In such cases the new streams did not follow the courses of their predecessors. Many of the valleys of the small creeks of the area appear to have no definite relation to valleys in the limestone beneath the drift.

3. Some of the valleys were filled in some places, and not in others. In these cases, the new drainage followed the old valleys where they were not filled, and departed from them where they were filled. The valleys of the Rock and Kishwaukee rivers are examples of this type.

ROCK RIVER VALLEY

The history of Rock River valley in this region is both complicated and interesting, and illustrates certain types of changes in drainage which glaciation brings about. The history falls into four chapters.

1. The last ice-sheet which is known to have covered this region is known as the Illinoian ice sheet. Before its advent, and perhaps before the coming of any of its predecessors, there was a deep valley along the course of the present stream from the Wisconsin line down to a point somewhat south of the site of Camp Grant. Its bottom was more than 250 feet below the channel of the present river. Below Camp Grant, or more exactly, below the Kishwaukee, the continuation of this old valley was to the south-southeast, instead of southwestward as now (fig. 23).

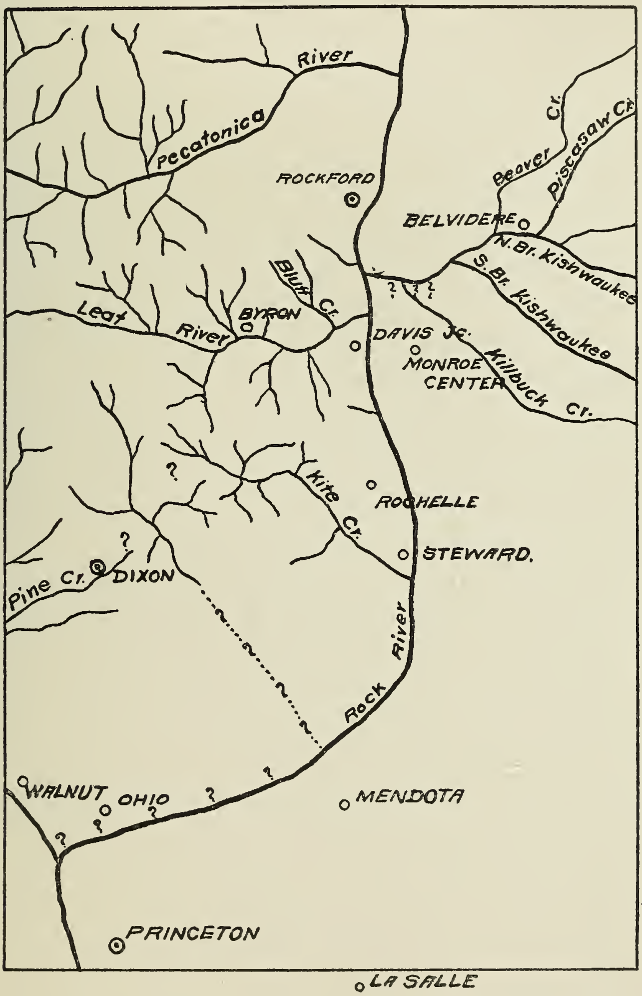

FIG. 23.—The old course of Rock River, before the Illinoian glacial epoch. The course of the river and its tributaries from the west is taken from Leverett's map in U. S. Geological Survey Monograph XXXVIII.

North of the Kishwaukee thick deposits of drift were made in the valley by the Illinoian ice-sheet, or its predecessors, or both; but these deposits nowhere filled the valley completely. At Rockford, where the map shows the valley to be narrow, a thick body of drift had been left in the valley, almost choking it. The drift filling at this point seems to have been pushed in from the east, and crowded the river over to the west side of its former valley, where the drift was shallow. Later when the channel was lowered by erosion, the stream uncovered, for a short distance, the limestone beneath the drift. This rock bed of the stream became the site of a ford, and from this ford on rock came the name Rockford. South of this point, the retreat of the ice left the valley wide, down to the Kishwaukee. Farther south, the old valley was filled with drift and obliterated. Its general position is suggested by the great depths of drift known at a few points. Leverett thinks it passed between Lindenwood and Monroe,[3] some 10 miles south-southeast of Camp Grant. Its further course to the southeast probably was through the southwestern corner of the Kirkland area, and it probably led to what is now the Illinois valley, in the vicinity of the big bend of that river in Bureau County.

2. When drainage re-established itself after the melting of the Illinoian ice-sheet, the river followed the unfilled part of the old valley down to the Kishwaukee. Down to the site of Rockford the valley was wide; at Rockford the river found its way through the constriction noted above,[4] but farther south it found itself in the wide valley where the Camp stands. Since the old valley southeast of the Kishwaukee had been filled with drift, the new stream left the course of its predecessor a little below the site of Camp, and took its present course to the southwest. This course was chosen because it was the lowest line of escape for the waters in the valley above. Since this new course was chosen, the stream has deepened and widened this part of its valley, but has not had time to make it so large as the older part farther north. This is why the wider, older part of the valley above the mouth of the Kishwaukee, is succeeded by a narrower and younger part below.

The older part of the valley to the north probably was not deepened much during the time of erosion which followed the melting of the Illinoian ice-sheet, because the river in the old part of its valley could not cut below the level of the channel in the new part, farther down the stream; but the narrow part of the valley at Rockford has been widened notably by the wear of the stream, since the disappearance of the Illinoian ice-sheet.

3. The third chapter in the history of this valley came much later,

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[3]Leverett, Frank, U. S. Geological Survey Monograph XXXVIII, 1899.

[4]There are some complicated details connected with the re-establishment of the course of the river through the narrow part of the valley at Rockford, which are purposely omitted.

and in this chapter which helps to explain the extraordinary flood plain of the Pecatonica.

It has been stated (p. 42) that in the last (the Wisconsin) glacial epoch an ice-sheet approached this area from the east and north (fig. 21), but did not reach it except at the south edge of the area shown on the Kirkland map. The front of the Wisconsin ice-sheet crossed Rock River about 16 miles north of the State line, and a large volume of water from it flowed down the valley. This swollen river carried quantities of gravel and sand which were deposited south of the edge of the ice. These deposits built up the bottom of the valley to the level of the terrace on which Camp Grant stands. This valley plain of gravel and sand, the former flood plain of the river, is higher to the north and lower to the south, as the plain of a southward flowing river should be. The thickness of the gravel and sand which the stream deposited at this time is not known, but it was no more than a small part of the deep drift filling of the valley, probably not so much as 50 feet.

4. Since the ice of the Wisconsin glacial epoch disappeared, the stream has cut its present narrow and shallow valley below the level of the plain described in the last paragraph. The portions of that plain which remain, constitute the terraces. A few feet above the normal level of the river, a flood plain has been developed, which is covered with water when the stream is in flood. At some places there are low terraces, intermediate between the high terrace and the flood plain. Such terraces were developed by the river as it lowered its channel after the disappearance of the Wisconsin ice-sheet.

THE VALLEY OF THE PECATONICA

One effect of the filling in the valley of the Rock referred to under (3) above, was to obstruct (dam back) every tributary. The largest of these tributaries was the Pecatonica, which joins the Rock some 20 miles above Camp. If the drift of the Illinoian ice-sheet filled this valley to the level of the filling in the valley of the Rock, the relations of the two valleys after the melting of this ice-sheet may have been much as now. But the latest filling of the larger valley had a pronounced effect on its large tributary from the west. If in the last glacial epoch the Pecatonica had been as well supplied with gravel and sand as the Rock, it would have filled up its valley as the Rock did; but the Pecatonica River heads off to the northwest, and did not receive water from the melting ice-sheet, except by way of the Sugar River. The Pecatonica therefore brought down much less sediment than the Rock, and did not fill its valley to the same level. Obstructed by the filling in the valley to which it led, the lower part of the valley of the Pecatonica became a lake, in which was deposited mud brought in by the river and its tributaries.

Similar conditions existed in the lower part of the valley of Sugar River, though this stream received water from the edge of the ice to the north, and carried much sand.

Since the Wisconsin ice-sheet melted, Rock River has deepened its channel 35 to 50 feet below the level of its old flood plain (the present terrace). This deepening has been enough to draw off the water of the lake which once covered the Pecatonica flats, but not enough to drain its former bottom thoroughly. The result is that most of the great flat which represents the old lake bottom is covered with water when the river is in flood, and remains wet and muddy long after the floods recede. Through this flat, the river has a very low gradient and a very sluggish current. Except in times of flood, the current is so slow that it can carry no sediment coarser than mud. As already noted, the stream, the muddy channel, and the wide valley flat which is impassable in times of flood, are serious obstacles to travel, except along roads which are graded up several feet above the plain.

THE VALLEY OF THE KISHWAUKEE

The history of the valley of the Kishwaukee and its two branches is similar to the history of the Rock. The North and South branches of this river follow valleys which antedated the Wisconsin glacial epoch. These valleys, like the valley of the Rock above Camp, were not completely filled with the drift of the Illinoian ice-sheet,—the last which covered them. A well in Belvidere, in the valley of the Kishwaukee, showed 122 feet of drift. The valley therefore was much deeper than now before the deposition of the drift, and doubtless was nearly as low as that of the Rock, to which probably it was tributary. Drift is known to be 98 feet deep at one point in the valley of the South Branch at Kingston. The former continuation of these valleys below their junction is not known, for beyond that point the old valley was filled. It doubtless led to the old, drift-filled valley of the Rock somewhere to the southwest, and its position probably was south of the present Kishwaukee River, below the junction of its two branches.

When the Illinoian ice-sheet disappeared, the waters which followed the valleys of the two branches of the Kishwaukee found themselves without a well-defined valley below the point where they join. They chose the lowest course open to them, which was down the present course of the river to the valley of the Rock just below Camp. From the junction of the two branches down nearly to Camp, the valley of the Kishwaukee is like the valley of the Rock below the mouth of the Kishwaukee; that is, it is a valley which was not occupied by a large stream before the drift was deposited. It is a youthful valley, as shown by its narrowness and its steep slopes.

Like the valley of the Rock, the valleys of the North and South branches of the Kishwaukee carried waters from the Wisconsin ice-sheet, the edge of which was just east of the area of the Belvidere and Kirkland maps (fig. 21). Like the valley of the Rock, both these valleys were filled to some extent by gravel and sand which the streams from the ice carried. It is probable that only a small part of the 122 feet of drift known to exist in the valley at Belvidere, was deposited at this time. Most of it is older.

There is reason to think that the valley of Killbuck Creek which, like the branches of the Kishwaukee, carried water from the ice-sheet, was filled no more than 15 to 20 feet at this time. If so, the valleys of the North and South branches of the Kishwaukee probably were filled to some comparable extent. Since the close of the glacial period, these streams have lowered their channels a few feet, leaving remnants of the earlier valley plain as terraces. They are lower than the corresponding terraces along the Rock, because these streams have deepened their channels less since the last glacial epoch.

Valleys tributary to the branches of the Kishwaukee, such as those of Piscasaw and Coon creeks, were obstructed by the filling in the valley to which they led. These tributary valleys therefore were affected somewhat as the Pecatonica was by the filling in the valley of the Rock. This is at least one reason for the bogginess in several of the valleys tributary to the North and South branches of the Kishwaukee.

MINOR VALLEYS

The history of the valleys of some of the smaller streams, such as those of Killbuck and Stillman creeks, is similar to the history of the valleys of the branches of the Kishwaukee. The streams occupy valleys left when the ice melted. The valleys of this class are large, compared with the size of their streams.

Most of the small streams tributary to the Rock are in small valleys. These valleys have been developed in the surface of the drift since the retreat of the ice. The surface water in any place took the lowest course open to it, and the flow began a valley. The little valleys begun in this way have been growing ever since by the wear of the water flowing through them. Many of the tributary valleys east of the Rock are cut wholly in drift, nowhere reaching rock. Others have been cut down through the drift into the rock beneath.

Minor Changes of Post-Glacial Times

Stream erosion since the ice disappeared has been considered in connection with the history of the valleys but one special effect remains to be noted.

DRAINING OF BASINS

In many places, drift deposited by glacier ice has a very uneven surface, and one of its distinctive marks is the presence of depressions without outlets. These depressions give rise to lakes, ponds and marshes. No features of this sort are found on the upland drift near Camp, though there are a few marshes in the northeastern part of the Belvidere area which are relics of former ponds not yet completely drained. The reason for the absence of such features elsewhere is that the time since the deposition of the drift has been so long that any upland lakes and ponds there may have been when the ice melted, have been drained out through the valleys which have been developed since that time by running water.

The drift to the east of the Belvidere and Kirkland areas has lakes, ponds, and undrained depressions in considerable numbers. This drift, deposited by the Wisconsin ice-sheet, is much younger (p. 42) than that of the area about Camp. In time its lakes and ponds will disappear.

WIND WORK

In relatively recent times, the surface has been modified in a few places by the blowing of sand and dust. Within the limits of Camp there are several low mounds and ridges of sand which are small dunes. These are not brought out on the 20-foot contour map, but several of them are shown on the large-scale map of the Army Engineers, with its 2-meter contours. Illustrations can be found west of the Kishwaukee road, in the southwestern part of Camp, shown on the large-scale map referred to, by closed contours. There are several others farther north, all low and inconspicuous. Most of them are represented on the large-scale map by a single closed contour. Farther south there is a dune half a mile north of the mouth of Stillman Creek. There is a little wind-blown sand at numerous points on the southeast side of Rock River Valley below the Kishwaukeee, but most of it is not in the form of distinct dunes. There is sand of similar origin, but no distinct dunes, at various points on the slope above the terrace on the east side of Rock River Valley north of Camp. In all these places the sand has been blown up to its present position from lower levels.

The greatest development of dune sand in the region is north of the Pecatonica River, west of the Rock. Dunes are here numerous in an area a few square miles in extent, some three miles northwest of Shirland. The sand here appears to have been blown up from the valley of Sugar River to the west. There are some low dunes on the terrace west of the Rock north of Rockton, near the State line. The sand of these dunes probably came from the terrace itself.

Wind-blown dust is not aggregated into dunes, and where its amount is small, it is not readily identified. But just south of Rockton, south of the

River and north of the road leading west-southwest, there are some pits where ''molding sand'' is dug. This material, so fine as to be called loam quite as properly as sand, is composed of dust and very fine sand blown up from the valley bottom. It is the material known as *loess.* This is the only good exposure of typical loess (and this is rather coarse) known in the region.

In some parts of the area covered by these maps there is, on the upland, a thin body of earthy stoneless matter over the body of the drift. It is thick enough in much of the region to conceal the stony character of the great body of the drift, where cuts are absent. This surface earth is more clayey and compact than loess, though it is sometimes called by that name. Some have regarded it as wind-blown dust, and doubtless it is, in part. It is probable that it is due in part to earth-worms and burrowing insects, which bring up earthy matter from below, but do not bring up pebbles or larger stones. In so far as this is true, it is a modified part of the drift, derived from that beneath. It makes an excellent soil.

The surface covering of stoneless or nearly stoneless loam, sandy in some places and clayey in others, is well seen in the trenches near Camp. It is thinner on slopes, and thicker where the surface is nearly flat. In the trenches there is 2 to 5 or 6 feet of this surface material, and an average of these figures is about its average thickness for the whole region. It is, as a rule, more sandy where the underlying drift is sandy, and more clayey where the underlying drift is compact.

LEACHING

Much of the material of the drift was derived from limestone, and limestone is dissolved slowly by water percolating through it. Down to depths of something like 4 feet, on the average, the calcareous matter of the drift has been leached out. The leached part is reddish-brown or buff in color, while the unleached part below, where the drift is clayey, has a grayish or bluish or in places a pinkish tone, quite unlike the part above. This distinction can be seen in most fresh cuts. It is well seen, for example, in some of the terrace cuts close to Camp. A dark line marks the base of the leached zone in a ravine exposure near the headquarters of the Officers' Training School.

SUMMARY OF RECENT CHANGES

Since the ice melted, the greatest change in the surface has been brought about by the erosion of running water, which has deepened the valleys which the ice did not fill, has developed many new valleys of small size, and has drained out all depressions without outlets which the ice left. The wind has been but a minor factor—almost negligible except in a few places. In very recent times, man himself has become an important factor in the geological processes now in operation. By cutting the timber and plowing the land, he has greatly facilitated erosion, both by water and by wind, and it is safe to say that erosion has been many times as rapid since the region was tilled, as before. Cultivation of the land, too, has facilitated the passage of water through the soil, and ditching, tiling, and the drilling of many wells, have helped to lower the level of ground water.

CHAPTER IV—NATURE AND MAN IN THE ROCKFORD REGION

The Black Hawk War

During the first century of the history of the United States (1776-1876), the country experienced one year of actual war for every three years of peace. This was due largely to the numerous Indian wars of the period, one of the more important of which, called the Black Hawk War after the leader of the hostile Indians, was staged (1832) partly in the Rock Valley.

The beautiful lands along Rock River were valued highly by the Indians. The streams abounded in fish; woodland and prairie game was abundant. There were, for example, many deer, otter, muskrats, squirrels, wild geese, ducks, prairie chickens, and quail. The sites of Belvidere and Rockford appear to have been favorite resorts of the Indians. At Belvidere there was a large burial place for their dead, and in Rockford there are several large Indian mounds.

In 1804 the Sacs and Foxes ceded their lands along Rock River and elsewhere east of the Mississippi to the United States, with the understanding that they could live and hunt on them until they were sold by the government. Before the lands were sold, however, settlers invaded the southern part of the region and their presence caused trouble on more than one occasion. Finally in the autumn of 1830, while most of the Indians were on a hunting trip, some whites occupied their ancient village near the mouth of Rock River, and expelled the old men and women left there. Finding the village in possession of the whites on returning in the spring of 1831, the Sacs under Black Hawk attacked it, destroyed houses and corn, drove off stock, and threatened the settlers with death if they remained in the region. Regulars and militia were sent to the seat of the trouble, the overawed Indians crossed the Mississippi, and Black Hawk and other chiefs made a treaty in which they agreed never to cross to the east side of the Mississippi without permission from the President of the United States or the Governor of Illinois. In the spring of 1832, however, the Black Hawk band and some of their allies (800 to 1,000, all told) returned to the Rock River country to attack the frontier settlements.

Illinois volunteers and later United States regulars took the field to repel the Indians.[1] The volunteers gathered at Dixon's Ferry on Rock

[1]Nearly 6000 troops were employed in the war (regulars, 1341; volunteers, 4638). Abraham Lincoln was one of the first to volunteer. Others who served were Jefferson Davis; Zachary Taylor, who commanded the American forces in northern Mexico in the Mexican War and later was President; Winfield Scott, who served in the War of 1812, the Mexican War (crushing the Mexican armies in a series of brilliant battles in 1847), and the Civil War; and Albert Sidney Johnston, one of the leading generals of the Confederate army.

River (site of city of Dixon), whence Major Stillman was sent up the east side of Rock River with some 275 mounted volunteers to Old Man's Creek (now Stillman Creek; Kings map), "where it is supposed the hostile Sac Indians are assembled, for the purpose of taking all cautious measures to coerce said Indians into submission." Stillman encamped at nightfall (May 14) in the timber on the north side of the creek, close to the site of the village of Stillman Valley (Kings map). Soon three Indians appeared in his camp bearing a white flag, while five others were discovered on a neighboring hill where they might watch and report how the flag of truce was received. Despite the efforts of several officers to restrain them, a number of the rangers mounted their horses and started in pursuit of the Indians on the hill, who fled toward Black Hawk's camp, situated between three and four miles away, northeast of the mouth of Stillman Creek. Black Hawk, with the 40 or 50 of his followers at hand, attacked with spirit the first of the pursuing whites to reach the vicinity of his camp. These reckless rangers, fearing that they now were opposed by the 800 or more warriors known to belong to Black Hawk's command, turned and fled to their own camp, pursued in turn by the Indians. With few exceptions, Stillman's entire command now became panic stricken, and fled at once across the creek and on toward Dixon's Ferry. With a view to covering the retreat of the fugitives, Captain Adams and a small party made a stand on a hillside south of the creek and fought till all were killed.

In the eastern part of the village of Stillman Valley there is a monument where these soldiers were buried by members of a relief party from Dixon's Ferry. The lesson of "Stillman's Defeat," as of various battles in the history of the country, such as Bladensburg and Bull Run, is the great danger involved in using untrained troops in military operations.

Following Stillman's Defeat, the Indians scoured the country, massacring men, women, and children wherever found. In June United States regulars arrived, and Black Hawk was defeated in a pitched battle at Kellogg's Grove (Southwestern Stephenson County). He then withdrew his warriors into the swamps of the region, and for a time engaged in raids against various settlements. The war closed with battles in Wisconsin on the banks of the Wisconsin and Mississippi rivers (July 21 and Aug. 2). The Indians were defeated and dispersed.[3]

The Settlement of the Region

The Black Hawk War freed Rock Valley from all danger of Indian attack, and directed the attention of Eastern people to it. Books, pamphlets, and many newspaper articles were written on "the newly discovered paradise." The scenery along the river, the fertile soils, and the favor-

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[3]As a result of experiences in the Black Hawk War, Congress created (1833) as a part of the regular army a regiment of dragoons, thereby completing the three arms of the service.

able climate all were described with enthusiasm, and in 1834-5 the settlement of the Rockford district began.

SOURCES OF SETTLERS; EMIGRANT TRAVEL

Most of the early settlers of the area came from New England and New York,[4] whence a large emigration was in progress. Less numerous elements in the early population represented various other states and other parts of Illinois. There were some early settlers of foreign birth. Argyle, for example, was settled by Scotch.

Some of the Rock River pioneers came all the way from the East by land. Most of them crossed New York State on the Erie Canal, and at Buffalo took passage by sailing vessel or steamer for Chicago, the "gateway" of the Rock Valley and of Northern Illinois in general. The overland journey from Chicago commonly was made in cloth-covered wagons called "prairie schooners" from their fancied resemblance, when viewed from afar, to vessels at sea. A State road was located in 1836 between Chicago and Galena;[5] it crossed the North Branch of the Kishwaukee at Belvidere and Rock River at Rockford.[6] It became the leading emigrants' route from Chicago to Rockford and vicinity, and the most traveled stage road across the northern part of the State. Rockford was connected with Chicago by railroad in 1852, and the next year the last railroad link was finished between Chicago and New York City. The railroad promptly caused the disappearance of the prairie schooner and stage coach, and has been all-important in the later life of the Rockford area.

GROWTH OF POPULATION; FACTORS INFLUENCING RATE OF SETTLEMENT

By 1840 the combined population of Winnebago and Boone counties, largely within the area covered by this report, was a little more than 6300. In 1850, it was more than 19,000, which was nearly half the population of the entire Rock River country.

For some years the following conditions tended to retard settlement: (1) Though the land of Winnebago and Boone counties was surveyed in 1836-7, it was not offered for sale till 1839, settlers meanwhile occupying it as "squatters." Trouble over claims resulted, due in part to the presence of "land sharks" and "claim jumpers." (2) A band of outlaws known as "Prairie Pirates" operated in the Rock Valley, particularly in Ogle County and southward. They robbed cabins, bought moveable property

[4]Of 871 of the early settlers of Rockford, 470 were from New York and 237 from New England. The birth places of 102 of the early settlers of Rockton are known; more than half were New Englanders. As a rule the pioneers from the northeastern states were characterized by energy, thrift, and ingenuity, traits induced in no small degree through generations by the geographic conditions of the New England-New York area, and from the outset they impressed the stamp of their institutions and ideals on the life of the new community.

[5]Galena, near the northwestern corner of the state, was the metropolis of the Illinois lead-mining district and a place of much importance, having a large river trade with St. Louis and the South.

[6]State Street, in Rockford, takes its name from the old road, of which it was a part.

with counterfeit money, and stole horses. The band was said to have members scattered from Wisconsin to St. Louis by way of Rock Valley, and stolen property was passed from one "station" to another until it reached some distant market where it could be sold. In a number of counties members of the band held office and prevented the punishment of their companions by process of law. At last a company of "regulators" took the law into its own hands and executed two of the "pirates" in Ogle County in 1841. This stopped the operations of the desperadoes in the Rockford region, and reassured the settlers. (3) The local markets for surplus farm produce were totally inadequate (for a time there was almost no opportunity to sell, save to incoming settlers), and it was difficult and expensive to haul it to Galena or Savanna on the Mississippi or to Chicago, particularly if the roads chanced to be wet.

After 1842 settlement proceeded more rapidly. The people of Rockford and vicinity took a leading part in pushing the plan for a Chicago-Rockford-Galena railroad, which would solve the problem of transporting the products of the region to a satisfactory market. Several sawmills and grist mills had been built. They met a pressing need of the settlers, and helped to stimulate immigration. Rockford, by 1850 the "metropolis of the northern prairies," attracted many people, and formed the best local market in the entire valley. The earlier settlers sent glowing reports of the region to friends and relatives in the East, many travelers and writers praised it, and, thus advertised, the Rock River country became known more and more widely for its attractiveness and its remarkable fertility.

The following statements concerning the region are typical: "Rockford on the Rock River was a beautiful spot, and the whole country in the neighborhood so far as we could see presented [1845] great temptations to the emigrant."

"ROCK RIVER COUNTRY. No portion of the West is remarked [1852] with more favor and admiration than this and it holds about the same relation that the Genesee country does to the East."

DISTRIBUTION OF EARLY POPULATION

In locating their land claims the pioneer farmers of the Rockford region were influenced chiefly by (1) the character of the land and its vegetation, (2) the location of towns or the sites of proposed towns, and (3) highways.

(1) Other things equal, timbered lands or tracts containing both woodland and prairie were preferred to treeless areas. Timber was needed for buildings, fences, and fuel, and afforded some protection against the bitter winds which in winter sweep across the open prairies. Moreover, to settlers from the northeastern states, which originally were forested throughout, the prairies with their tough sod and matted roots presented unknown problems in tillage. Most of the native timber was restricted to

the vicinity of the streams, where there was some protection against droughts and prairie fires, but there were sizable belts and groves of trees some distance from water courses, as, for example, west of Rockton, and east and southeast of Rockford. Some of the wooded lands were too wet to be tilled without expensive drainage (e. g. along the Pecatonica), and some were infertile (e. g. in the sand-hill district in the northwestern part of the area). Such tracts were avoided for the most part. Since much of the area was treeless, the settlers of necessity shortly undertook the conquest of the prairies.

In the end, the settlement and cultivation of the area were facilitated by the preponderance of prairie. The prairie farmer was saved the arduous labor of felling the forest, and the flattish prairie land, unencumbered with the stumps and roots of trees, was from the outset adapted to the use of labor-saving machinery. A writer of vision said in 1837: "The greatest objection made to the Rock river country is the alleged scarcity of timber * * * but the time will come, and the day is not far distant, when emigrants will rush to the large prairies with almost as much eagerness as they now avoid them." Ten years later (1847) another writer said: "A prejudice formerly existed against prairie, but it has worn away. The prairie is now universally preferred for purposes of cultivation, to the timbered lands."

The terraces of Rock River, though for the most part without timber, appear to have been settled relatively early.

(2) Proximity to a town or the site of a proposed town was highly desirable, since as they grew the towns would afford markets for farm produce, the advantages of schools and churches, and would increase land values in the vicinity.

(3) Land along the early roads (especially the State road) and near the line of the proposed Chicago-Galena railroad was in demand for obvious reasons.

In connection with the influence of towns and highways it is noteworthy that in 1840 the agricultural population of Rockford Township was considerably more than two-fifths the total population of Winnebago County, outside the village of Rockford.

In general, the wet lands, the distinctly infertile lands, and the lands most remote from towns and railroads, were settled last.

EARLY ROCKFORD

Rockford, begun in 1834, became the largest city in the region (indeed, in the entire Rock Valley) largely because of its geographic advantages. Here, as already noted, the State road (1836) and later the first railroad in northern Illinois crossed Rock River, then considered navigable. Rockford was roughly midway between the termini of the great land route,[7]

[7]Consequently it was called "Midway" for a time, the much happier name, Rockford, replacing it not later than 1837.

Chicago to Galena, in the midst of a region of pronounced fertility. Thus it became a way-station and transfer point on the through-routes, and a collecting and distributing point for the surrounding farming country, its tributary area steadily expanding as agricultural settlement proceeded and its leadership among the early rival towns increased. In early days the river could be forded at Rockford by persons on horseback or in lightly loaded wagons;[8] provision was made for a ferry by the County Commissioners in 1836; and a low, wooden bridge was opened for travel July 4, 1845—"a time of great rejoicing."

Another major factor in the growth of Rockford since the middle 1840's has been the water power made available by the rapids in the river. The first dam built to utilize the power was completed in 1845. Parts of it were carried away by the river in 1846 and 1847, and in 1851 the entire dam went out. Two years later a more substantial dam (replaced by the present concrete dam in 1910) was completed on the line of the old ford, where the solid limestone formed an excellent foundation. This improvement and the coming of the railroads were leading influences in the making of the modern city, discussed in later pages.

The terrace flat afforded an excellent site for a city. Drainage was good, excavation was easy, good building stone was readily available (quarries were opened at an early date), and there was enough timber in the vicinity to supply for a time the demand for lumber.

The first to locate land claims on the site of Rockford were Germanicus Kent and Thatcher Blake, two natives of New England who, in 1834, left Galena in search of a desirable place for settlement. Kent proposed to build a sawmill, and so sought a place where water-power and timber were available. Descending the Pecatonica and Rock rivers in a canoe, they landed near the mouth of a creek afterward named Kent Creek (Rockford map), where both located claims. In 1835, Kent, as planned, built a dam and a sawmill on the creek. From the outset, therefore, Rockford was a manufacturing center.

Before the close of 1835, some 27 people had gathered in the infant settlement, some of whom had built their homes on the east side of the river.[9] In 1839, when the population was 235, Rockford was incorporated as a town and was chosen as the county seat—events which helped to stimulate further growth. In 1841 the population was 800; in 1845, 1278; and in 1850, 2093. Rockford had outstripped all rivals, and enjoyed undisputed leadership among all the towns along Rock River.

[8]The rock-bottom ford from which the city is named was ruined in 1845 when an attempt was made to improve the navigation of the river at Rockford. It has been stated that the Indians used the ford, and that they called it the "rock-ford." The river also was forded at times opposite Auburn Street.

[9]For years there is said to have been keen rivalry between East Rockford and West Rockford. The former scored heavily when it secured the postoffice, but this triumph was offset when the first railroad located its depot on the west side.

OTHER EARLY TOWNS

Belvidere, the seat of Boone County, dates from 1835. It grew very little till after 1840, and in 1850 had a population (1003) less than half that of Rockford. Its importance in early days was due largely to its location at a water-power site on the North Branch of Kishwaukee River, where the latter was crossed by the State road. Little power was available, however; the river was not navigable; Boone County was little more than half as large as Winnebago County, and was settled less rapidly. These things largely account for the slower growth in early years of Belvidere, as compared with Rockford.

Rockton, in the northern part of the area, and Byron, in the extreme southwest (both dating from 1835), are the only survivors of an interesting group of river towns—would-be rivals of Rockford. Rockton was a response to the water-power there available. In early days its mills attracted trade from a large area. As Rockford, with superior advantages, forged ahead, it from time to time drew people from Rockton, and at the last census (1910) the population of Rockton was less than it had been fifty years before. Byron, also a mere village, is on a terrace at a big bend of the river, where in early days a busy ferry served the needs of trade and travel between Rockford and towns toward the south. Among the river towns which have disappeared were Winnebago and Kishwaukee,[10] both "boomed" as rivals of Rockford. Winnebago, situated a short distance north of Rockford on land now within the limits of the latter, aspired to be the county seat, and began to decay as soon as Rockford was chosen (1839) for that purpose. Kishwaukee, at the junction of the Kishwaukee and Rock rivers, also died in its infancy, though two or more stores, a blacksmith shop, a large building begun for a seminary, and a number of dwellings had led its friends to believe it would survive. It is strange that these early town-builders failed to see that the combination of the water-power and the ford across the river at Rockford made successful competition with that place impossible.

Most of the villages of the area not mentioned in the foregoing paragraphs came into existence as local shipping points following the advent of the railroads.

Conditions of Pioneer Life

EARLY PRIVATIONS

Isolation subjected the earlier pioneers of the region to many privations, and limited severely their household and personal effects. Many homes were rough log houses, some of which contained only one room. Prairie homes in some cases were built of saplings, and thatched with

[10]These should not be confused with the existing towns of the same names, neither of which is on the river.

straw or prairie grass. Not a few homes contained for a time no furniture save that made by the pioneers themselves. Springs were not numerous, and until wells were dug many settlers found it difficult to get an adequate supply of good water.

The older settlements in which supplies could be purchased were remote, roads throughout Northern Illinois were poor, and most streams were unbridged. The prices in the Rockford district of commodities wagoned from these outside markets therefore were high. For a time, even the foodstuffs soon produced in abundance around Rockford were scarce and expensive. Thus flour is said to have sold for twenty dollars a barrel, and pork for thirty. Sugar was twenty-five cents a pound. Salt from Chicago sold at Byron for fifteen dollars a barrel. Moreover, most of the pioneers had little money and many of them were scarcely able to purchase absolute necessities. Fortunately, wild game supplied an abundance of meat.

At first there were no roads and little intercourse took place between the scattered settlements, especially in winter. News from the outside world was received at infrequent intervals. As late as 1837 mail from Chicago was received at Rockford only once a week. The monotony of the broad stretches of unbroken prairie, the uncomfortable houses, the coarse food, the lack of society, and the absence of the comforts and conveniences to which most of the settlers had been accustomed in the East, all contributed to the irksomeness and loneliness of pioneer life. Some of the older settlers, completely discouraged, returned to the East.

PIONEER FARMING

Almost from the first the enterprising farmers of the Rockford region used the woodland as a base for the conquest of the prairie. The first plowing of the heavy prairie sod was a slow and laborious task, particularly since the plows introduced by the first settlers were not suited to the work. If the later comer hired a professional "sod breaker" to plow his land, the cost ($1.50 to $2.50 or more an acre) exceeded the cost of the land itself, if purchased from the government ($1.25 an acre). The best time to "break" the prairie was late spring or early summer, and thereafter little could be grown until the sod had rotted. The first season, therefore, most settlers planted only a little "sod corn" and some garden vegetables. The second year the land was fit for tillage, though in many cases full crops were not obtained until the third season. Prairie sod broken in the autumn, after the grass was ripe, remained tough and troublesome for several years.

The stock of the pioneers was grazed in summer on the unbroken prairie, and this necessitated fences for the protection of the crops. For the farmers without woodland, the fencing problem remained for years a serious one. It finally was solved when wire fencing, introduced about 1850, became cheap enough to be generally available.

Corn and wheat were the staple crops of the pioneer farmer. Corn was easy to cultivate, commonly returned large yields, and had a long harvest season—an important consideration in the early days, when labor was scarce. It was stored easily, readily prepared for food, and was highly nourishing for animals and man. Corn was raised largely or wholly for consumption on the farm; it was too cheap, in proportion to weight and bulk, for transportation to distant markets. Wheat, on the other hand, was grown more and more extensively for sale. Oats were raised much less than wheat in early days.

In 1849, the farmers of Winnebago and Boone counties raised more than 564,000 bushels of wheat, more than 440,000 bushels of corn, and about 330,000 bushels of oats. These figures are impressive when it is remembered that no land was cultivated in either county before 1835, and that the region still was without railroads.

MARKETS

The inadequacy in early days of local markets, and the expense and difficulty of wagon trade with the Mississippi River towns and Chicago have been noted (pp. 56 and 60). The trip to the river with a load of grain took a week or more, and that to the lake at least twice as long. Wheat often brought only 25 to 37½ cents a bushel, and sometimes less, delivered at Chicago. Nevertheless, produce appears generally to have been higher and merchandise lower in Chicago than at the towns on the Mississippi. This probably was due to the superior connection of Chicago with the East by way of the Great Lakes and the Erie canal, as against the roundabout eastern connections of Galena and Savanna, through Pittsburgh or New Orleans, by rivers whose navigation was uncertain. Each autumn after harvest, when the roads were best, many farmers from the vicinity of Rockford made the tiresome journey to Chicago with 35 or 40 bushels of grain to a load. At that season people living along the State road between Rockford and Chicago not infrequently saw two hundred eastbound wagons pass in a single day, all loaded with grain. The most difficult part of the road was that through the low, usually wet prairie near Chicago. ''Farmers of the Rock River * * * having hauled their wheat * * * to this Slough of Despond, frequently could get it no farther.'' The farmer who reached Chicago did not actually realize for his wheat even the low prices indicated above, because of the expense of the trip, and the value of the time of team and driver. Indeed, as a writer familiar with the wagon trade put it, the farmer in many cases found ''he was not much further along than if he had remained quietly at home.'' Another said, ''It is a fact well known, and frequently adverted to, that a farmer near Rock river expends as much in getting his wheat to market as all other expenses of ploughing, sowing, harvesting and threshing.'' The early merchants of the Rockford region of course experienced similar difficulty and expense in hauling goods from Chicago.

MILLS; EARLY MANUFACTURES

The high cost of transportation induced the early building of mills for the manufacture of prime necessities for which the raw material was available. Lumber was in great demand for flooring, doors, frame buildings, and other uses, and sawmills were erected at various water-power sites to manufacture lumber from such timber as was available in the vicinity. Kent's sawmill, built on Kent Creek at Rockford in 1835 (p. 58), was the first in the region. Three sawmills were built in Rockford following the completion (1845) of the first dam in the river. Belvidere built its first sawmill in 1836; Roscoe and Byron, in 1837; and Rockton, in 1838.

It was unsatisfactory and laborious to pound grain on a hominy block, or to grind it in hand mills. The long tiresome trip to a grist mill on the lower Fox River or at Ottawa (on the upper Illinois River) was equally objectionable. Accordingly grist mills were, next to sawmills, the first manufacturing plants established. Indeed, the first lumber turned out by the sawmill at Belvidere was used to complete a gristmill already begun, to which settlers came from far and near in such numbers that frequently they had to wait an entire day, and sometimes two days, to be served. The original mill at Belvidere was replaced by a larger one in 1845, and a third was built the same year. Byron (in 1838), Rockton (1839), and Rockford (1846) presently followed the lead of Belvidere in establishing grist mills.

Almost every blacksmith doubtless made a few plows, and perhaps other implements. A small plow factory was opened at Belvidere in 1840. At Rockford a carding and fulling mill and an iron foundry were established in the 1840's. The pioneer period, however, witnessed only the beginning of industrial development, and that along only a few, simple lines which required relatively little capital and met a heavy local demand.

Improvement of Travel and Transportation

THE ROAD SYSTEM OF THE AREA

The narrow trails of the Indians were of little or no value to the first settlers, who followed the shortest practicable lines across country to their objectives. Some of these tracks, especially those which focused on the early villages, were followed by wagons till roads were worn along them. Such roads must have been poor even under the best weather conditions, and some of the unbridged streams and sloughs presented serious obstacles. The surveying of the area and the settlement and fencing of more and more of the land caused the abandonment of most of the earlier roads. In response to the flattish topography of most of the area, the modern road system conforms almost everywhere to the rectangular pattern of the land survey (pp. 10-11). For years little was done to improve the dirt roads within the area. The energies of the people were directed rather toward facilitating trade and travel between the area and outside markets by other means.

It may be noted in passing that in and about Rockford the direction of many streets and roads is influenced by the course of the river. In the older parts of the city, on both sides of the river, the streets are parallel to the river or at right angles to it, without regard to the points of the compass.[11] When in later subdivisions streets were laid out along north-south and east-west lines, they joined the older streets at awkward angles.

IMPORTANCE OF IMPROVED TRANSPORTATION TO OUTSIDE MARKETS

Clearly the greatest need of the Rockford region from the beginning of settlement had been adequate and cheap transportation facilities connecting it with outside markets. The prices of farm produce would be low and those of merchandise from outside markets would be high until faster and cheaper transportation was provided. Without improved transportation, manufacturing on a large scale was impossible. The early settlers, realizing keenly that satisfactory transportation facilities alone could solve their economic difficulties and assure to the region prosperity and rapid development, supported every scheme for internal improvement that seemed likely to afford them easier access to the markets of the outside world.

The Mississippi River towns, Chicago, and Milwaukee also were interested greatly in the improvement of transportation for the upper Rock River country, since they were competitors for the trade of the region.[12] Though Chicago merchants enjoyed most of the wagon trade with the people of the Rockford district, as already noted, improvements in transportation might divert the trade to rival markets. For years it was uncertain in what direction finally the bulk of the rapidly increasing surplus produce of the Rockford country would move.

ROCK RIVER AS A HIGHWAY

For years before the settlement of the area began (since 1818 at the latest) Rock River had been listed among the navigable rivers of Illinois.

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[11]That the streets at right angles to the river on one side are not opposite the corresponding streets on the other side appears to be due to the early jealousy between West Rockford and East Rockford (foot note 9, p. 58), as a result of which the surveyor was not allowed to alter his original plat on the west side (though it is said no building improvements would have been affected) with a view to bringing the streets into alignment.

[12]Milwaukee was concerned most with the trade of the Beloit-Janesville section of Rock Valley.

Some of the early writers declared it was navigable for three hundred miles, though the basis for their statements is not apparent.[13] As a result of such published statements, many people may have settled along Rock River in the belief that it would become an important commercial highway. Experience soon showed them, however, that except at flood stages its navigation would be impeded seriously, if not rendered wholly impracticable, by several rapids. At the rapids near the mouth of the river, the water was said to be "not often more than eighteen inches deep."

In the spring of 1838 a light draft steamboat, aided by high waters, managed with difficulty to ascend the river from the Mississippi as far as the mouth of the Pecatonica. Intense interest was aroused by the trip, and the hope was renewed that the river might be navigated regularly.

A resident of Kishwaukee wrote to the editor of a Chicago paper as follows concerning the coming of the steamboat: "Much anxiety has been felt for some time past by the people on Rock river on this subject, and thus at length their trembling hopes have been realized, and the fact established that this beautiful river can now and will hereafter be navigated by steamboats * * * as she [the steamboat] gallantly plowed her way up this clear and noble stream, [she] was hailed with acclamations of applause by the crowd of enterprising inhabitants who thronged our shores."

In 1839 a steamboat purchased for the Rock River trade was unable to pass the rapids near the mouth of the river, and was forced to engage in trade on the Mississippi. These events of 1838 and 1839 served at least to stimulate agitation for the improvement of the river. A river-improvement convention was held at Rockford early in 1840, and Congress was petitioned for a grant of public lands along Rock River, the proceeds of their sale to be used in improving the stream. Nothing came of the petition.

The arrival of another steamboat at Rockford in 1844 renewed interest in the navigation of the river. Another meeting was held at Rockford, followed by a convention at Sterling. This time State aid was sought, and in 1845 an act was approved for the improvement of the river with funds to be obtained by a special tax levied in certain counties along the river. Work was undertaken at Rockford (foot note 8, p. 58), among other places, but nothing of value was accomplished.

Again in 1846 a convention was held at Rockford, which sought the aid of Congress in opening a waterway for large boats from Lake Michigan to the Mississippi, by way of Rock River. The scheme involved a canal from the lake to Rock River, and the canalization of the latter.

A strong demand for a canal to connect Milwaukee with the upper Rock River, 50 miles or so to the west, had developed in Southern Wisconsin more than

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[13]The possibility of navigating the middle and lower river, at least at times, was demonstrated in 1830, when lead, apparently from mines in southwestern Wisconsin, was taken down the river. John Dixon, founder of the town on Rock River named from him, wrote the editor of the *Miner's Journal* at Galena as follows on June 24, 1830: "The first flat boat built on the Pickatolica [Pecatonica] passed here this day, bound to St. Louis with one thousand pigs of lead (70,000 lbs.) for Col. William S. Hamilton."

a decade before this. A land grant had been made in aid of the enterprise, the line of the canal had been surveyed, and about a mile of it had been dug. There, for various reasons, work stopped, and the project had come into more or less widespread disfavor before the Rockford convention of 1846 advocated a Lake Michigan-Rock River canal. In December, 1844, the *Madison Argus* said: "A Canal * * * is a fine affair where it is really needed. But because a canal connecting navigable waters like Lake Erie and the Atlantic ocean has paid for itself, and brought the state a large revenue, it by no means follows that a canal connecting Lake Michigan and Rock River would be equally productive in proportion to cost. A canal is to be made from Milwaukee to the Rock River and there it stops. It connects at the east end with an extensive lake coast, and so far it is very well; but what is there at Rock River? Neither an ocean, nor a lake, nor even a navigable river. There are neither steam-boats nor flat-boats running on Rock River anywhere in the neighborhood of the proposed termination of the canal, and the river will not admit of this kind of navigation to any advantage. * * * The business of the territory naturally extends east and west, and any attempt to turn it north and south into the channels of our shallow river must be an up-stream undertaking."

Early in January, 1845, the following appeared in the *Chicago Daily Journal*: "The project for constructing the Milwaukee and Rock River Canal, appears to be dead. At a recent meeting of the citizens of Granville [Wisconsin] it was resolved that a petition be presented to the Legislature, praying for a forfeiture of the charter, and a reduction of the price of the Canal Lands to $1.25 per acre, with pre-emption rights to actual settlers."

As in 1840, Congress in 1846 failed to undertake the improvement of the river. Two years later a railroad to connect Chicago and Rockford was begun, and with railroad transportation assured, the question of improving Rock River became relatively unimportant. Nevertheless, the project has been revived from time to time, notably in 1865 and 1899.

Some of the schemes for the improvement by the Government of Rock River were impracticable, but Congress has spent vast sums on many projects much less promising. The occasion for regret is not its restraint in the case of Rock River but its lack of restraint in the case of many others. Had the river been improved in pre-railroad days, it would have been for a time the great commercial outlet of the region. Most of the surplus produce would have gone by flatboat or steamboat to St. Louis and the South, rather than by wagon to Chicago. Navigation doubtless would have declined to small proportions, however, after railroads from Chicago reached the river. Chicago was the natural market for the region (in part for reasons given on p. 61). Railroad transportation was in various ways as superior to transportation by river steamer, as the latter was to transportation by wagon. The later history of traffic on the rivers of the Interior (even the Mississippi) is a record of the triumph of the locomotive over the steamboat.

In later years certain sections of the river between obstructing dams have been navigated to slight extent by a few small boats engaged in local trade.

ROCKFORD STAGE LINES

The opening of the State road (p. 55) from Chicago, through Elgin and Belvidere, to Rockford, and westward to Freeport and Galena, prepared the way for the advent of the stage coach. The State road, moreover, continued to be by far the most important stage route of the region until in the early 1850's the railroad drove its coaches out of business. The minor stage routes opened in the region will not be considered here.

Regular ''runs'' between Chicago and Rockford were begun not later than January 1, 1838. ''On that day the arrival of the stage coach in Rockford attracted the attention of the people of the village, and large numbers came from the surrounding country to witness the spectacle.'' Small wonder they were greatly interested: the establishment of stage-coach service was a long step toward overcoming the isolation of the Rockford region, so far as travel was concerned. In 1840 the stage coach company advertised a twenty-four hour schedule for the Chicago-Rockford service, which was tri-weekly. The fare was $5. The heavy coaches were drawn by four horses, changed at intervals of about fifteen miles. A year later there was daily service each way.

A man who traveled by stage from Galena to Chicago over the old State road in the autumn of 1841, said "The means of traveling had by this time so much improved, that instead of the jolting, hard-seated, two-horse wagon, we had a regular Frink & Walker daily stage line, with comfortable coaches." Apparently, however, the coaches were comfortable only in comparison with the wagon, for he added: "The coaches had three inside seats, calculated to hold three passengers each. The back seats were the most comfortable, as you had something to lean against—the others were seats of torture during a long journey. The stages did not stop at night, but drove right along. When morning came, the passengers, if they had been able to sleep at all, would wake up stiff, chilled through, and tired; and after an indifferent breakfast would have to endure another day and night of torture. My recollection is it took us three days and two nights to reach Chicago [from Galena]."

Neither the roads nor the coaches were much improved as time passed. Said one who journeyed to Chicago in May, 1844: "My journey to Chicago was most unpleasant, by reason of the late heavy rains, which still continued. These so softened the rich soil, that the public coach was detained in a slough during a whole night; the weather cold and our feet wet, and our person chilled. Next morning, at eight, we were drawn out of our distressing condition, by four yoke of oxen." In 1852 a traveler who had come by train to Cherry Valley, the end of the pioneer railroad in process of construction from Chicago to Rockford, expressed the following opinion of "staging": "At Cherry Valley private vehicles and coaches were in readiness to convey travellers to their destination; those bound to Galena were consigned to the latter, and were soon jolting over roads, respecting which they were assured every few miles that they were 'just passing over the worst.' It will be a joyful era in civilization when those heavy, lumbering, leathery horrors are banished from the traveller's knowledge."

THE RAILROADS

Early in 1836 a charter was granted to the Galena and Chicago Union Railroad Company, to build a railroad from Chicago to Galena. The project was thought to be justified by the existing and prospective commerce of the Great Lakes and the upper Mississippi River, which the road would connect. Particularly it would provide a shorter, better outlet for the lead of the Galena region, then for the most part sent by river to New

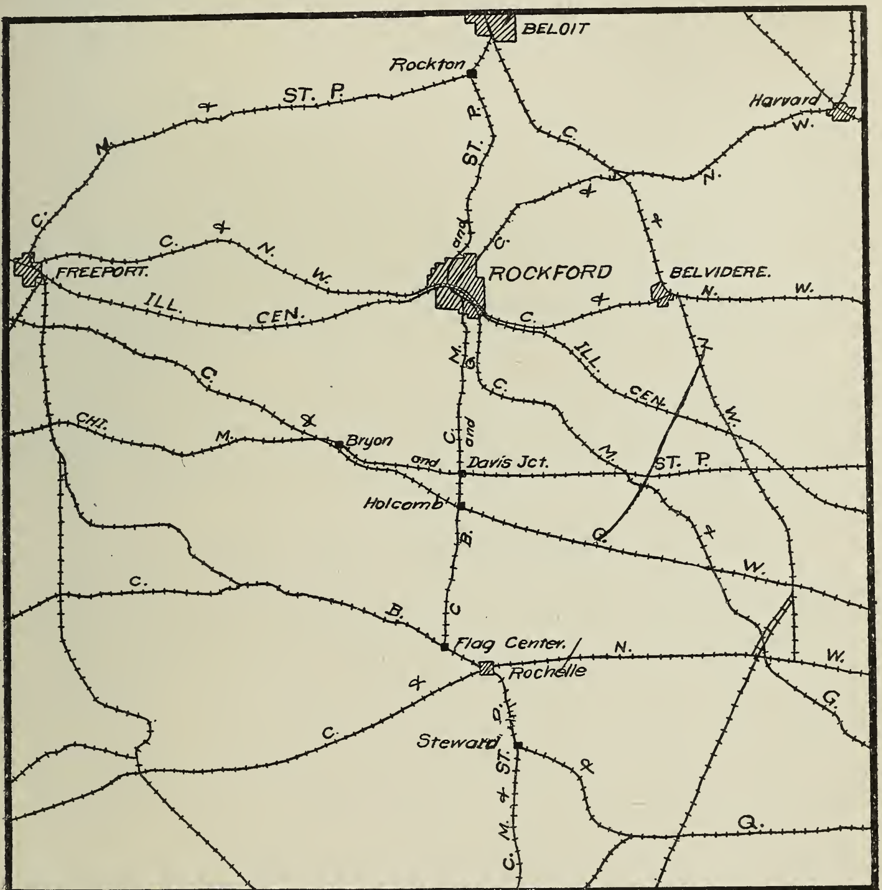

FIG. 24.—Sketch map showing the railroads of Rockford and the surrounding region.

Orleans for export—a difficult matter when the water was low at the rapids of the Mississippi (at Rock Island and Keokuk).[14] The road also

[14]So unsatisfactory was the river route that some lead had been wagoned to Chicago, the first in 1829. It is interesting to note that the *Galena Advertiser,* in announcing the initial trip to Chicago, found it desirable to explain where the latter was: "Mr. Soulard's wagon and mule team returned, a few days since, from Chicago, near the southernmost bend of Lake Michigan; to which place it had been taken across the country, with a load of lead. This is the first wagon that has ever passed from the Mississippi river to Chicago."

would provide an outlet for the infant settlements of the country traversed (including those of the Rockford region), would stimulate further settlement, and would enhance land values. After some work had been done on the road in and near Chicago the undertaking temporarily was abandoned.

The people of the Rockford region took a leading part in the campaign to revive the railroad project,[15] and at last the construction of the road was undertaken in 1848, under conditions assuring success. The Galena and Chicago Union not only was the first railroad of the Rockford region, but the first Chicago railroad and the first one of importance in Illinois. It reached the Des Plaines Valley in 1848, Elgin in 1850, Belvidere in the spring of 1852, and East Rockford the following summer. "On Monday, August 2, 1852, a train on the Galena & Chicago Union railroad arrived in East Rockford. Its advent was signalized by the ringing of bells and the firing of cannon." The following year the road was extended to West Rockford (upon the completion of the bridge across the river) and on to Freeport (fig. 24; the Galena and Chicago Union is the Chicago and Northwestern). An arrangement having been made to connect with the Galena Branch of the Illinois Central at Freeport, the road was not built, as originally planned, to Galena. As a result the road through Rockford became a branch of the main line of the Galena and Chicago Union, which extended almost due west from Chicago to the Mississippi River at Fulton (reached in 1855). The Galena and Chicago Union Company and the Chicago and Northwestern Company were consolidated in 1864 under the latter name.

It will not be practicable to consider here in detail the later railroads of the Rockford region. The road from Belvidere to Beloit (fig. 24) was built in 1853 as a branch of the Galena and Chicago Union, with a view to securing the trade of the Beloit region, and to connecting with a proposed Beloit-Madison railroad. In 1859 a road was completed from Rockford to Harvard (as part of a Rockford-Kenosha line), whence there was connection with Chicago by way of the Chicago and Northwestern, which, from the outset, managed the Rockford-Harvard road (fig. 24). For five years Rockford interests benefited greatly from the sharp competition between the rival roads leading to Chicago. Then, as already noted, the Galena and Chicago Union was consolidated with the Chicago and Northwestern. As early as 1855 an attempt was made to secure a north-south railroad through Rockford from Beloit to Mendota (some fifty miles to the south of Rockford, on the Illinois Central). Through its northern connections this road would afford Rockford access to the lumber of Wisconsin, and through its southern connections access to Illinois coal

[15]A meeting in aid of the proposed road was held at Belvidere in the winter of 1840-41, and several were held at Rockford, chief among them the "railroad convention" of 1846, attended by more than three hundred delegates.

fields. This enterprise failed, however, and not till 1875 was a road built toward the south. It connected Rockford and Rochelle (fig. 24). This line (now owned by the Chicago, Burlington, and Quincy), also is used by the Chicago, Milwaukee, and St. Paul as far as Davis Junction, where it crosses the main line of the "St. Paul" from Chicago to Omaha. At Holcomb it crosses the Chicago Great Western. At Flag Center (fig. 24) it connects with the main line of the "Burlington" from Chicago to Minneapolis, and at Rochelle the latter crosses the main line of the "Northwestern" from Chicago to Omaha. Direct rail connection between Rockford and the coal mining district south of Mendota, which the railroad promoters of 1855 sought to provide, is completed by a "St. Paul" line which extends south from Steward (fig. 24) on the "Burlington." The "St. Paul" road which extends north from Rockford meets at Rockton an important line of that system extending from Milwaukee to Kansas City. The Illinois Central (fig. 24), though it came to Rockford relatively late (1888), has the shortest line between Rockford and Chicago; it also connects Rockford and Omaha. The Chicago, Milwaukee, and Gary (fig. 24) is an outer-belt freight line, extending from Rockford southeast to Momence (near the Indiana line) across numerous roads which focus on Chicago.

The interurban electric lines connecting Rockford with Beloit, Freeport, Belvidere, and points eastward doubtless form only the nucleus of the interurban system which in the future will center at Rockford.

Progress Since the Advent of Railroads

THE RAILROADS AND THE NEW ERA

The advent of the railroad solved at last the transportation problem of the Rockford region, and inaugurated a new era of remarkable development.

(1) The railroads freed the farmers of the area from the time-consuming and expensive haul to outside markets. Other things equal, they therefore realized a larger profit on their surplus produce, while at the same time the cost of merchandise from without was lowered materially. Particularly noteworthy is the fact that the railroads made available high-grade pine lumber at reasonable prices, for lumber, as already noted (p. 62), was one of the great needs of settlers on the prairies.

(2) The unoccupied lands of the area suited to farming were settled rapidly. Largely as a result, the total population of Winnebago and Boone counties increased from about 19,000 in 1850 (p. 55) to more than 36,000 in 1860, the greatest gain of any census decade in their history. Essentially all the desirable farm lands of the area had been occupied by

1860, and since then the rural population has changed but little in numbers.[16]

(3) The railroads brought new life and energy to the towns through which they passed, and gave a new impetus to almost every branch of business. Rockford profited most, because its natural advantages were greatest and its railroad facilities best. It was incorporated as a city in 1852. This event, doubtless a consequence in part of the increased activity which the pioneer railroad had induced, itself contributed to the growth of the following years. The population of Rockford increased more than three-fold between 1850 and 1860 (1850, 2093; 1860, 6979). Belvidere more than doubled its population in the same time (1850, 1003; 1860, 2446). Until 1852 Belvidere had been confined to the north side of the river, but when the Galena and Chicago Union railroad was located some distance south of the river, building began in the vicinity of the station, and in time the business section was transferred largely to that side of the stream. On the advent of the railroads several villages were founded as shipping points for grain and stock. Winnebago, platted in 1853 on the completion of the pioneer road through the area, is an example. Located on sites without natural advantages, these places remain mere farm villages, serving as collecting and distributing points for the surrounding country.

(4) In agriculture the first great effect of railroad transportation was the increased production of grain. The amount produced in 1859 was almost twice that produced in 1849 (p. 61). The unfenced area used for grazing stock decreased as the area devoted to grain increased, and soon "open-range" grazing ceased. Railroad facilities tended to restrict the raising of swine whenever the price of corn was high in the East. There appears to have been a considerable decrease in the number of swine in the middle fifties, when, because of the Crimean War, corn as well as wheat was high. Later, the railroads became an important factor in the development of the dairy industry of the region, by making possible daily shipments of milk to Chicago. Without railroads, the industry could have been developed only with a view to supplying local markets.

(5) The railroads increased greatly the value of land and of other property. According to a statement made in 1854, the "valuation" of Winnebago and Boone counties virtually doubled between 1850 and 1853, the year in which, as already noted (p. 68), the first railroad was completed across the counties.

(6) The railroads made practicable the use of coal and steam power in manufacturing, the assembling of widely scattered raw materials, and

[16]The large gain in the aggregate population of Winnebago County since 1860 has been due to the rapid growth of Rockford, while the moderate increase in Boone County has been due to the leisurely growth of Belvidere (7253 in 1910).

the extensive distribution of manufactured products, and so have been fundamental factors in the industrial development of later years.

(7) The railroads have influenced in large measure the higher life of the people of the area, for they have been a chief factor in the material development on which notable progress in social, educational, and other lines has been based.

AGRICULTURE

Little need be added to what already has been said concerning agriculture. Next to railroads, improved farm machinery was the most important factor in facilitating the remarkable agricultural development which began in the early 1850's. Drills, mowing machines, reapers, threshing machines, and other labor-saving machines then were coming into general use, and they increased notably the acreage which could be tilled.

As already noted (p. 61), wheat was the great money crop of early days. During the 1870's the amount produced decreased greatly, and in later years little has been grown. Reduced yields due to exploitive farming, the ravages of the chinch bug, and inability to compete with the then new wheat lands of the Northwest, were leading reasons for the decline of the wheat industry of the area. As the wheat crop diminished, the production of oats and corn increased enormously, and they remain the great crops. Corn, it is interesting to note, has been a staple crop throughout the history of the region. Hay is an important crop. Truck farming is important near Rockford.

Relatively little attention in this area had been given to raising sheep until the Civil War, by creating a heavy demand for wool to be used in manufacturing clothing for troops, brought high prices and made the business very profitable. Soon after the war, sheep raising for various reasons declined in the Rockford region. In later years the industry again has assumed greater importance, at least in the rougher parts of the area. The raising of swine has been an important phase of farming in the area, especially since the 1870's. The number of swine has varied greatly from time to time, however, partly in response to variations in the corn crop. One of the more significant things of later years in connection with the raising of cattle in the area has been the increase in the number of milch cows, due to the development of dairy farming (p. 70). Most of the scattered woodlots of the area are used for pasturing stock. From the standpoint of farm forestry, this practice is unfortunate, since it interferes with the growth of a full stand of timber.

MODERN ROCKFORD

The growth of Rockford has been traced to 1860 (pp. 57 and 70). Between 1860 and 1916 its population increased eight fold, being estimated by the Bureau of the Census at more than 55,000 in the latter year. The growth of the last sixteen years of the period equaled that of the preceding forty years. Rockford in 1916 was the fifth city in point of size in the State. Since 1916, and particularly since the location of Camp Grant in the vicinity, the city has grown with remarkable rapidity, and its population is said now (1918) to be about 75,000. Apart from its capable and progressive population and the recent influence of the Camp, the reasons for its substantial growth are its railroad facilities, its efficiently developed and cheap water power, its highly productive tributary area, and its rapidly-developing manufacturing industries (largely dependent on the other factors enumerated). The railroads, the water power, and the nature of the tributary area have been discussed in earlier connections. It remains only to note briefly the extent and character of its industries.

Rockford, according to its Chamber of Commerce, has more than 250 manufacturing establishments, representing an investment of more than $40,000,000, which together employ about 15,000 people and manufacture products to the value of approximately $35,000,000 yearly. In 1899 the number of establishments was 159; in 1904, 180; and in 1909 (the last year for which census data are available), 205. The values of products in these years were in round numbers $11,000,000, $15,000,000, and $22,000,000. These figures reflect a rapid and consistent growth in manufacturing. The relative gain in value of products between 1904 and 1909 (45.8%) was the greatest for the leading four manufacturing cities of the State. While Rockford has a great diversity of manufactures, the furniture factories, knitting mills, agricultural implement plants, and foundries and machine shops are the more important groups. The malleable iron works and the plant for the manufacture of saddlery also are especially noteworthy. Its great manufactories constitute perhaps the distinctive feature of modern Rockford, and they insure the city continued growth and prosperity.

APPENDIX

EXPLANATION OF MAPS

The features shown on these maps may be classed in four groups: (1) *water,* including rivers, creeks, and swamps; (2) *relief,* including ridges, hills, valleys, and other elevations and depressions; (3) *culture* (works of man), such as cities, towns, roads, railroads, and boundaries, as between townships and counties; and (4) *areas of timber.*

(1) All water features are printed in *blue,* the smaller streams and ditches in full blue lines, and the larger streams in blue water-lining. Intermittent streams—those whose beds are dry at least three months in the year—are shown by lines of blue dots and dashes. Marshes, of which there are few in this region, are shown by the blue shading. Most of the marshes are in valley bottoms. They are most numerous and largest in the northeastern part of the Belvidere area, but nearer Camp there are some in the valley of Killbuck Creek.

(2) Relief is shown by contour lines in *brown.* On the ground, a contour passes through points that have the same altitude. One who follows a contour will go neither uphill nor downhill, but on a level. The contour lines on the map show not only the shapes of the hills, ridges, and valleys, but also their elevations above sea-level. The line of the sea coast itself is the contour 0, mean sea-level being the datum from which elevations are measured. The numbers on the contours shown on the map therefore represent elevations above sea-level. The contour 20 feet above sea-level would be the shore line if the sea were to rise or the land to sink 20 feet. On a gentle slope it is near the coast. Where successive contour lines are close together they represent a steep slope; and where they run together in one line they indicate a cliff. Basins without outlets are few, and are shown by contours with short hachures inside. An illustration of such a depression contour may be seen on the Kings map, 3 to 4 miles east of the north end of Camp. Other illustrations appear along the railways, as near Holcomb and west of Stillman Valley (Kings map), 2 or 3 miles west of Kirkland (Kirkland map), and at several points along the Chicago Great Western Railway, near the south edge of the same map. The basin-like depressions in these situations are due to the railway embankments across shallow depressions which formerly had outlets.

The manner in which contour lines express altitude, form, and grade is shown in figure 25. The sketch represents a river valley between two hills. In the foreground is the sea, with a bay that is partly inclosed by a hooked sand bar. On each side of the valley is a terrace into which small streams have cut narrow gullies. The hill on the right has a rounded summit and gently sloping spurs separated by ravines. The spurs are truncated at their lower ends by a sea cliff. The hill on the left terminates abruptly at the valley in a steep scarp. Its surface slopes down gradually on the side away from the scarp, forming an inclined table-land, which is traversed by a few shallow gullies. On the map each of these features is indicated, directly beneath its position in the sketch, by contour lines.

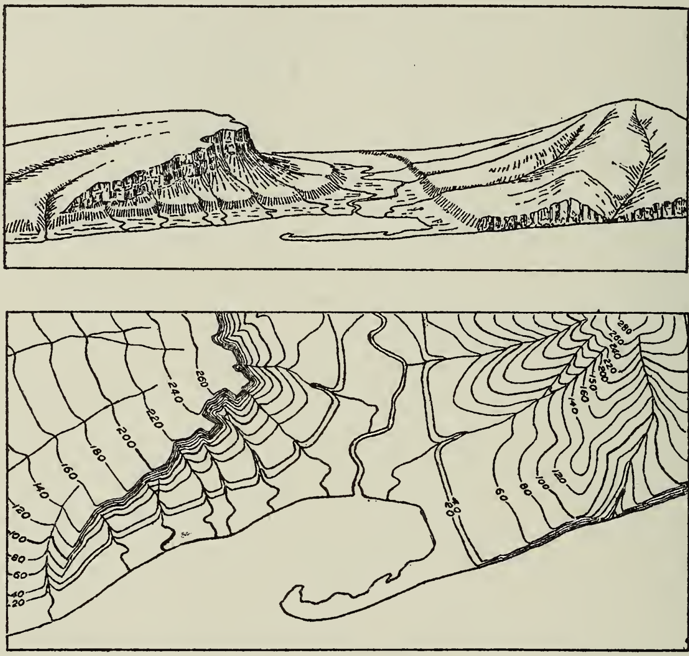

FIG. 25.—Diagram showing the relation between topography as indicated by hachures and by contours, as explained in the text. (U. S. Geol. Survey.)

The contour interval or the vertical distance in feet between one contour and the next on these maps is 20 feet. Every fifth contour is heavier than the others, and such contours are accompanied by figures stating the elevation above sea-level which they represent. The heights of many points, such as road corners, summits, surfaces of lakes, and bench marks (marked B. M., as e. g. ¾ of a mile east of the north edge of Camp), are also given on the map in figures, which express the elevations to the nearest foot only. The horizontal scale of a contour map, as well as its contour interval, should be noted. The scale of these maps, noted at the bottom of each, is 1-62,500; that is, the map is 1-62,500 the size of the area represented. This is approximately one mile to the inch. Some maps published by geological surveys, national and state, have scales 1-125,000 or even 1-250,000. Many of the maps on the smaller scales, have larger contour intervals.

Maps prepared expressly for army purposes have other scales, and other contour intervals. Thus army maps in the United States on a scale of 1 mile to the inch, have a contour interval of 60 feet; those on a scale of three inches to the mile have a contour interval of 20 feet; and those on a scale of 12 inches to the mile, a contour interval of 5 feet. The special map of this region prepared by the War Department has a 2-meter contour interval, doubtless for the purpose of accustoming the men in training to the metric system in use on the Western Front. Its scale is 1-10,000, or more than 6 inches to the mile.

(3) The works of man are shown in *black,* in which color all lettering also is printed. Boundaries, such as those of a state, county, city, land grant, township, or reservation, are shown by continuous or broken lines of different kinds and weights. Public and through roads are shown by two fine parallel lines close together, and private and poor roads by corresponding dashed lines. In villages and cities, the roads are close together. Railroads are shown by single lines with short cross-bars at short intervals. Houses are shown by small black squares. Most of them are near roads.

(4) Areas of timber are colored *green* on the maps.

The topographic maps were made by the U. S. Geological Survey in cooperation with the War Department and with the State Geological Survey Division. The special edition for this volume was published by the State through the courtesy of the U. S. Geological Survey.

4 maps