STATE GEOLOGICAL SURVEY OF KANSAS

RAYMOND C. MOORE
STATE GEOLOGIST

BULLETIN 4

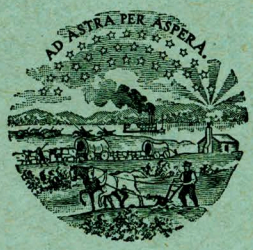
The Environment of Camp Funston

BY RAYMOND C. MOORE

WITH A CHAPTER ON

The Western Theater of War

BY MAJOR DOUGLAS W. JOHNSON



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STATE GEOLOGICAL SURVEY OF KANSAS.

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Chancellor of the University of Kansas, and
ex officio Director of the Survey.

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State Geologist.

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LETTER OF TRANSMITTAL.

Dr. Frank Strong, Chancellor of the University of Kansas, ex officio Director of the State Geological Survey:

SIR—I submit herewith a report on the environment of Camp Funston, the purpose of which is to describe and interpret the topography and geology of a portion of our state in which many thousands of the young men from Kansas and neighboring states are being trained intensively for service abroad. The intimate relation between military operations and the country in which they are laid is very well recognized. This report is intended to call specific attention to features of the terrain about Camp Funston which are of important military significance, and to compare them with conditions on the Western Front. It is believed that the comparisons made will be of considerable practical value and interest to the men in training at the camp.

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

This report will constitute Bulletin 4 of the Reports of the State Geological Survey of Kansas.

Respectfully submitted. RAYMOND C. MOORE,
State Geologist.

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FOREWORD.

THE armies engaged in the present Great War know that the physical features of the country in which they fight affect almost their every activity. Each campaign demontrates how large a rôle is played by the ground over which the armies move and fight. Military strategy is based on geography and topography as fundamentally as upon the fighting ability of armies. Mountains and rivers are barriers to the movement of armies; plains invite them forward. Steep slopes hinder or make impossible movements of artillery, cavalry, tanks, or infantry; gentle slopes are open to them. Defensive lines are placed where the advance of the enemy will be most difficult—along hills, steep cliffs, swamps, large rivers, covers of forest. Offensive movements are directed toward country easy to traverse. Details of topography determine the landing places of aëroplanes, and control to a greater or less degree the effectiveness of gas warfare; character of soils and underlying rocks determine whether trenches may be constructed quickly and maintained effectively. The study of these features broadly and in detail is absolutely essential to the proper direction of troops in the field and to a clear understanding of the movements of armies. Maps showing all the physical features of areas in which movement of troops is likely to occur are sought by the war departments of all countries, those of France and other European countries being almost astonishingly minute in detail. For Pershing's advance at St. Mihiel more than 100,000 maps of the area concerned were used.

In recognition of the vital relations which exist between an army and the country it occupies or traverses, the following brief description of the country about Camp Funston has been prepared for the soldiers in training there. Only the salient facts necessary to a proper appreciation of the topography and other features of military importance in the area are presented, points of academic or special technical interest being purposely omitted. Comparison is made with conditions in northern France, in order that notice of the physical features about Camp Funston may be related as closely as possible to the surroundings which the soldier will find in actual service on the West Front. While this description is primarily intended to aid in training men for most effective service in the present conflict, it is hoped that it may be of permanent interest and value to an established military organization like that at Fort Riley. Through the kindness of Major Douglas W. Johnson and the publishers of his "Topography and Strategy in the War," Henry Holt & Co., a most valuable and readable account of the chief physical features in the western theater of war, and the effect they have had on the campaigns of the war, taken from this work, is presented in Chapter I. It is very well worth the attention of every officer and soldier.

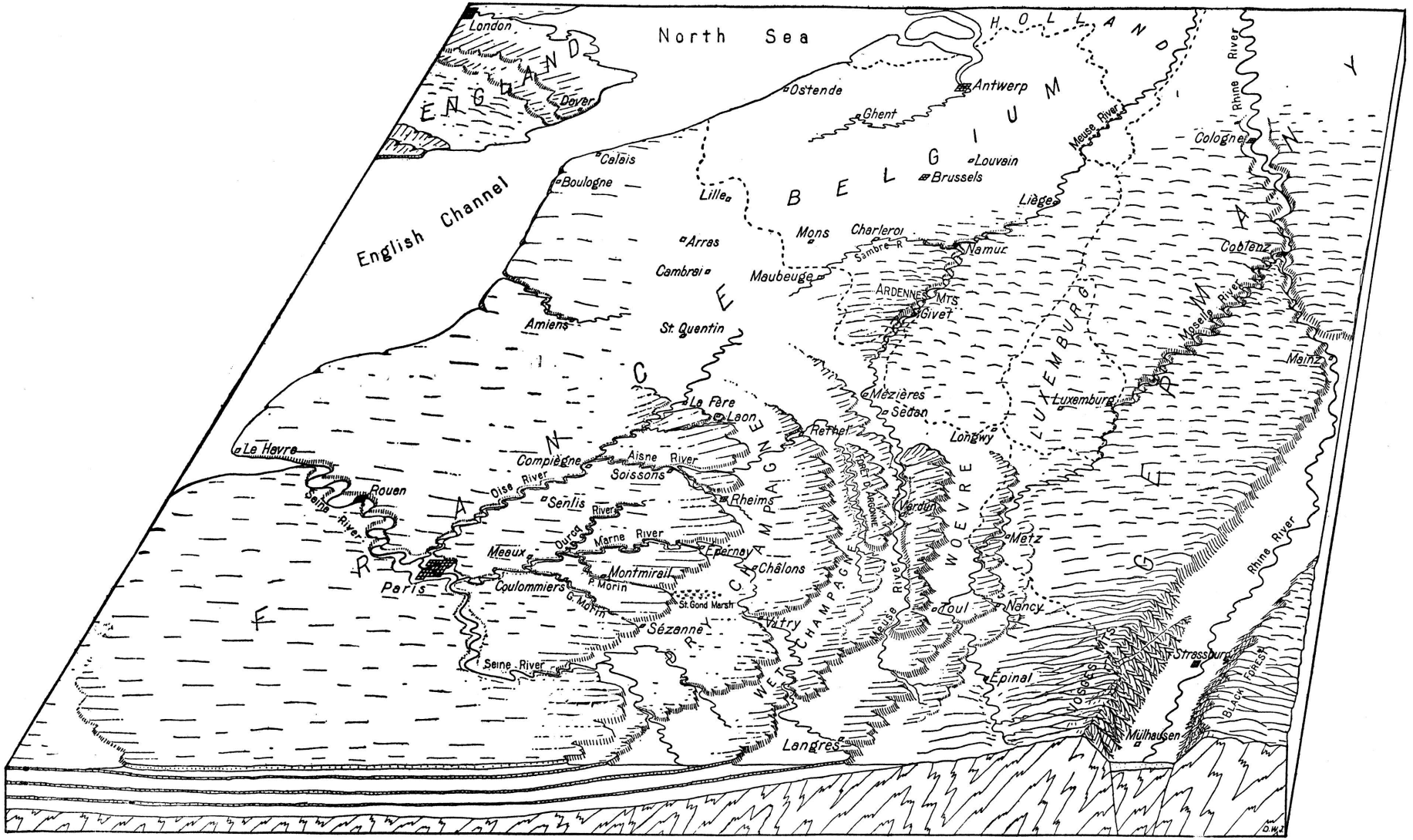


FIGURE 1. Diagrammatic view of the western theater of war, showing the principal plateaus and plains, mountains and lowlands, cliff scarps and river trenches which have influenced military operations. The underground rock structure is shown in the front edge of the block.

CHAPTER I.

THE WESTERN THEATER OF WAR.

By MAJOR DOUGLAS W. JOHNSON.[1]

GEOLOGICAL FEATURES.

THE violation of Belgian neutrality was predetermined by events which took place in western Europe several million years ago. Long ages before man appeared on the world stage Nature was fashioning the scenery which was not merely to serve as a setting for the European drama, but was, in fact, to guide the current of the play into blackest tragedy. Had the land of Belgium been raised a few hundred feet higher above the sea, or had the rock layers of northeastern France not been given their uniform downward slope toward the west, Germany would not have been tempted to commit one of the most revolting crimes of history and Belgium would not have been crucified by her barbarous enemy.

Influence of Terrain. For it was, in the last analysis, the geological features of western Europe which determined the general plan of campaign against France and the detailed movements of the invading armies. Military operations are controlled by a variety of factors, some of them economic, some strategic, others political in character. But many of these in turn have their ultimate basis in the physical features of the region involved, while the direct control of topography upon troop movements is profoundly important. Geological history had favored Belgium and northern France with valuable deposits of coal and iron which the ambitious Teuton coveted. At the same time it had so fashioned the topography of these two areas as to insure the invasion of France through Belgium by a power which placed "military necessity" above every consideration of morality and humanity. The surface configuration of western Europe is the key to events in this theater of war; and he who would understand the epoch-making happenings of the last few years cannot ignore the geography of the region in which those events transpired.

THE NATURAL DEFENSES OF PARIS.

The Paris Basin. What is now the country of northern France was in time long past a part of the sea. When the sea bottom deposits were upraised to form land, the horizontal layers were unequally elevated. Around the margins the uplift was greatest, thus giving to the region the form of a gigantic saucer or basin. Because Paris to-day occupies the center of this basin-like structure, it is known to geologists and geographers as "the Paris Basin."

1. This chapter is reprinted by permission of the author and publishers, Henry Holt & Co., from "Topography and Strategy in the War."

Since the basin was formed it has suffered extensive erosion from rain and rivers. In the central area where the rocks are flat, winding river trenches, like those of the Aisne, Marne, and Seine, are cut from three to five hundred feet below the flat upland surface. To the east and northeast the gently upturned margin of the basin exposes alternate layers of hard and soft rocks. As one would naturally expect, soft layers like shales have readily been eroded to form broad flat-floored lowlands, like the Woevre district east of Verdun. The harder limestone and chalk beds are not worn so low, and form parallel belts of plateaus, the "côtes" of the French. These plateau belts and the intervening parallel lowlands are best shown in bird's-eye view by a diagrammatic sketch of western Europe (Fig. 1). The diagram represents a block of the earth's crust, cut out so as to show in cross section the manner in which the hard rock layers have been eroded to form the plateau cliffs.

East-facing Scarps. The fact that the rock layers dip toward the center of the basin has one striking result of profound military importance. Every plateau belt is bordered on one side by a steep, irregular escarpment, representing the eroded edge of a hard rock layer; while the other side is a gentle slope having about the same inclination as the dip of the beds. As will be seen from the diagram, the steep face is uniformly toward Germany, the gentle back-slope toward Paris; and the crest of the steep scarp always overlooks one of the broad, flat lowlands to the eastward. The military consequences arising from this peculiar topography will readily appear. It is not difficult to understand why the plateau belts have long been called "the natural defenses of Paris."

Imagine yourself at Paris, and start on a tour of inspection eastward to the German border. First you traverse the central plateau of the Paris Basin, called the Isle of France, whose circular line of bordering cliffs were, according to an ancient theory, cut by the waves of the sea. Here and there, especially if you turn northward or southward in your journey, you will come suddenly upon the edge of a river valley trenching the plateau across which you are traveling. Descending the steep slopes of the valley wall, which are often clothed in forests, you reach the flat valley floor several hundred feet below, and make your way over the winding stream. Perhaps the season is wet, and you wade through marshes on both sides of the river until the dry land of the opposite valley wall is reached. Toiling painfully up the slope you at length come out again upon the flat upland of the plateau surface. Pausing to rest, you look back at the obstacle you have just traversed, and reflect that a number of such obstacles cross the plateau in parallel courses from east to west. You realize that they must prove serious barriers to the advance of armies moving southward or northward; and as you remember that two of these obstacles bear the names of the Marne and the Aisne, you have a fuller understanding of two notable chapters in recent military history.

As you journey onward you pass numerous quarries, some of them broad and deep. Cavern mouths tempt you to explore vast subterranean excavations where limestone or chalk in large quantities has been removed, leaving vast galleries and chambers which could easily house many thou-

sands of troops safe below reach of the heaviest shell explosions. An army intrenched behind the natural moat of one of the east-west river trenches, as for example the Aisne, and utilizing surface quarries and underground caverns for the protection of its men, might well consider itself impregnable against every assault of the enemy.

The First Escarpment. Musing thus, you continue eastward, until suddenly you arrive at the brink of the first line of east-facing escarpments. Behind you stretches the plateau whose features you have just been studying. In front of you, to the east, spread out below like a gigantic map, is the level surface of the Champagne lowland. As you look down upon it you see roads, like narrow white ribbons, bordered on both sides by green vineyards, while the steep slopes of the escarpment itself are often cleared of their trees and cultivated. At your feet, where the west-flowing Marne cuts its gateway through the escarpment, lies the town of Epernay, while to the north the towers of Rheims cathedral mark the similar gateway of a branch of the Aisne. Southward the marsh of St. Gond occupies a former river valley on the flat floor of the plain, its boggy surface a trap which captured many pieces of German artillery. Far out over chalky flats to the east lies the famous armed camp at Châlons. Nothing is hidden from view in that broad panorama of plain.

View from the Crest. What a position is yours from which to check a westward advance upon Paris! Every enemy movement would be open to observation from the crest of the scarp, and could be broken up by fire from artillery concealed in ravines back from the plateau face. Assaults on intrenched positions on the slopes and crest of the scarp would be made with every advantage on the side of the defending troops. The level plain below offers little opportunity for the offensive to secure concealed artillery positions from which to make preparation for the uphill infantry charges. It was reported in early dispatches of the war that during the Battle of the Marne the German center, stretching eastward from Sézanne at the base of the cliffs farther south, was subjected to a disastrous artillery fire from the crest of the scarp which broke up concentrations of reserves on the plain and prevented the reinforcement of the German line at critical moments.

The Plain of Champagne. Profoundly impressed with the strength of this natural defense line before Paris, you descend to the plain of Champagne and move eastward over its surface. For thirty-five or forty miles your course is over a dry chalky soil, a region comparatively unfruitful, where only scattered growths of trees relieve the semi-desert aspect. This is known as the "Dry Champagne," as the rain which falls on the porous chalk soon sinks to depths which the plants cannot reach. Farther east is the "Wet Champagne," where a narrower belt of impervious clay keeps more of the water on the surface, there to form numerous brooks and marshes, and to support a goodly forest growth.

The Second Escarpment. Before reaching the Wet Champagne, you make a gradual eastward ascent which does not end until you stand, a second time, at the crest of an east-facing scarp. The lowland now spread out below you to the east is traversed in the north by the winding upper Aisne, slightly intrenched in the floor of the plain; and the main river

gateways cutting through the escarpment are marked by the towns of Rethel and Vitry. Again you are impressed with the topographic advantages favoring the defenders of Paris from an attack from the east. The conditions are essentially those already noted from the crest of the first escarpment, save for the absence of the arid, chalky soil of the Dry Champagne.

The Third Escarpment. You push across the valley of the upper Aisne, on up the gentle back slope of the next plateau belt, until for a third time you stand at the crest of a steep east-facing escarpment, and look down upon a lowland spread out like a map at your feet. All about you the plateau is heavily forested, and cut here and there by the deep, wild gorges of numerous streams, which flow westward to the lowland just left behind, or eastward to the lowland at the base of the scarp. This wooded plateau belt is the Forêt d'Argonne, where more than one battle of France has been fought.

Verdun Escarpment. Descending the face of the Argonne scarp and crossing the valley of the Aire river, you continue eastward across a minor plateau strip and reach the winding trench of the Meuse. Past immortal Verdun and its outlying forts, you press on to the crest of the next great scarp. What a view here meets the eye! To the north and south stretches the long belt of plateau, cut into parallel ridges by east- and west-flowing streams—ridges like the Côte du Poivre, whose history is written in the blood of brave men. Below, to the east, lies the flat plain of the Woevre, whose impervious clay soil holds the water on the surface to form marshes and bogs without number. Here the hosts of Prussian militarism fairly tested the strength of the natural defenses of Paris, and suffered disastrous defeat. Moving westward under the hurricane of steel hurled upon them from above, their manœuvering in the marshes of the plain easily visible to the observant enemy on the crest, the invading armies assaulted the escarpment again and again in fruitless endeavors to capture the plateau. Only at the south where the plateau belt is narrower and the scarp broken down by erosion did the Germans secure a precarious foothold, thereby forming the St. Mihiel salient; while at the north, entering by the oblique gateway cut by the Meuse river, they pushed south on either side of the valley only to meet an equally disastrous check at the hands of the French intrenched on the east-and-west cross ridges. Viewing the battlefields from your vantage point on the plateau crest, you read a new meaning in the Battle of Verdun. You comprehend the full significance of the well-known fact that it was not the artificial fortifications which saved the city. It was the defenses erected by Nature against an enemy from the east, skillfully utilized by the heroic armies of France in making good their battle cry, "They shall not pass." The fortified cities of Verdun and Toul merely defend the two main gateways through this most important escarpment, the river gateway at Verdun being carved by the oblique course of the Meuse, while the famous "Gap of Toul" was cut by a former tributary of the upper Meuse, long ago deflected to join the Moselle. Other fortifications along the crest of the scarp add their measure of strength to the natural barrier.

The Metz Escarpment. Once more you resume your eastward progress, traverse the marshy and blood-soaked plain of the Woevre, ascend the gentle back slope of still another plateau belt, and stand at last on the crest of the fifth escarpment. Topographically this is the outermost line * of the natural defenses of Paris, and as such might be claimed on geological grounds as the property of France. But since the war of 1870 the northern part of this barrier has been in the hands of Germany, who purposed in 1914 to widen the breach already made in her neighbor's lines of defense. Metz guards a gateway cut obliquely into the scarp, and connects with the Woevre through the Rupt de Mad and other valleys.

Nancy Gateway. Farther south is Nancy, marking the entrance to a double gateway through the same scarp. Here in the first week of September, 1914, under the eyes of the Kaiser, the German armies, moving southward from Metz, where they were already in possession of the natural barrier, attempted to capture the Nancy gateways and the plateau crest to the north and south. Once again the natural strength of the position was better than the Kaiser's best. From the Grand Couronné, as the wooded crest of the escarpment is called, the missiles of death rained down upon the exposed positions of the assaulting legions. The Nancy gateway was saved, and more than three years from that date is still secure in the hands of the French. The test of bitter experience has fully demonstrated to the invading Germans that it was no idle fancy which named the east-facing scarps of northern France "the natural defenses of Paris."

River Gateways. It is but reasonable to expect that many of the rivers of northern France should flow down the dip of the rock layers and converge toward the center of the Paris Basin, where the beautiful city itself is located. A glance at a map, or at the diagram opposite page 4, will show that this expectation is fully realized. Most of the river gateways through the concentric lines of escarpments have been carved by these converging streams, or by streams which did so converge before they were deflected to other courses by drainage rearrangements resulting from the excavation of the parallel belts of broad lowlands. Of course these natural openings through the plateau barriers have great strategic value, and must figure prominently in any military operations in the Paris Basin. Some of them constitute the only feasible routes along which armies and their impedimenta may cross the barriers, as elsewhere steep grades and poor roads are the rule. At each of them a town of greater or less importance has sprung up, and both town and gateway are protected either by permanent forts or hastily constructed field fortifications. So great is the strategic value of the principal gateways, such as those near Toul and Verdun, that we find them marked by some of the most strongly fortified cities in the world. The fortifications dominate the roads, canals, and railway lines which pass through the openings, and must be reduced before the cities can be occupied and the transportation lines freely used. This explains the significance of the frequent mention, especially in the war dispatches of

* A discontinuous, low scarp farther east is not here considered.

the first year, of such towns as La Fère, Laon, Rheims, Epernay, and Sézanne guarding gateways in the first line of cliffs east of Paris; of Rethel and Vitry in the second line; of Bar-le-Duc at the south end of the third; of Verdun and Toul in the fourth; of Metz and Nancy in the fifth; to say nothing of other points in the same and lesser scarps not considered in this volume.

The importance of the strategic gateways will readily appear if we consider their relation to principal railway routes. No railway of eastern France can traverse the country from the German frontier to Paris without seeking out several of these fortified gateways in succession. Take, for example, the main through line from Strassburg to Paris. After crossing the German border it follows the valley of the Meurthe a short distance to reach one of the two Nancy gateways. Turning west through this opening in the Metz-Nancy escarpment, it makes straight for the famous Gap of Toul in the Verdun-Toul escarpment. Once through the Gap, the line bends north to find an opening in the low continuation of the Forêt d'Argonne scarp near the town of Bar-le-Duc. Westward from here the route crosses the Wet Champagne to Vitry, where there is a gateway through the Rethel-Vitry escarpment. At Vitry the line divides, one branch turning northwest to cut through the innermost line of cliffs at the Epernay gateway, the other continuing west to make use of the notch at Sézanne. Evidently there are along this one line at least five strategically important defiles through a corresponding number of military obstacles, all of which defiles must be controlled by the armies which would make free use of the Strassburg-Paris route.

The Sedan Lowland. Toward the northwest the several lines of plateau escarpments gradually descend, and ultimately merge with the undulating plain of northern France. The low land between these fading escarpments on the one hand and the rough country of the Ardennes mountains on the other, gives a roundabout but easy pathway along which one might reach Paris by swinging west beyond the ends of the scarps. Longwy, Montmédy, Sedan, and Mézières are the important points along this route, which is followed by a railway of much strategic value and which was quickly seized by the Germans after they had reduced the antiquated fortifications affording it a poor protection. As a route for an advance on Paris it is too circuitous to be of prime importance.

THE VOSGES MOUNTAINS AND RHINE VALLEY.

Beyond the limits of the natural fortifications of Paris are three outlying regions, each possessing a peculiar topography which has indelibly stamped its impress on the western campaigns. These regions are: to the east, the Vosges mountains and the valley of the Rhine; to the northeast, the mountains of western Germany and southern Belgium; to the north, the plain of northern France and Belgium. Let us examine these regions in the order named.

The Rhine "Graben." It will be seen from the diagram, Figure 1, that the folded rocks underlying the horizontal layers of the Paris Basin come to the surface at the east, forming rugged mountains from which the later beds have been completely eroded. Originally this eastern

rim of the Basin was a broad north-south arch, with a gently rounded summit; but a north-south block of rock extending along the crest, and bounded by two parallel fractures or rifts in the earth's crust, dropped down several thousand feet, giving the broad, flat-floored valley of the middle Rhine, or the Rhine Graben as it is known to the Germans. The river has spread a thick mantle of sand and silt over the surface of the down-dropped block, and now swings in a gracefully curving channel in its own deposits. The fertile plains of this valley floor constitute that part of the province of Alsace which the French are most anxious to recover from the Germans.

The Vosges Barrier. The two remaining limbs of the former arch, facing inward toward the down-dropped central strip, are known as the Vosges mountains on the west and the Black Forest on the east. Each of these ranges has a gentle slope away from the valley, and a steep face toward the valley representing the once nearly vertical fracture surface now eroded into sharp crested ridges and narrow ravines. Both slopes of each range are sufficiently rugged to make agriculture difficult and the building of roads and railroads expensive; hence the ranges are but little developed, and much forested land remains. But it is on the steeper slopes which lead abruptly downward to the flat floor of the Rhine valley that the ridges are most rugged and the forest most unbroken. Here the movement of large bodies of troops is particularly difficult, especially if the must ascend the slopes in the face of a determined enemy.

Invasion of Alsace. It was not political expediency alone which led the French to invade southern Alsace at the beginning of the war. The international boundary line follows the crest of the southern Vosges, and it was much easier for the French to move up the gentle west slope of the Vosges, capture the passes, and then sweep down the steep eastern face upon the flat plains about Mülhausen, than it was for them to cross the boundary farther northwest, where no such advantage was furnished by the topography. A French soldier, writing home from the battle line in the Vosges, described the influence of topography upon the fighting in that district in the following words: "Our task has been much easier in the southern Vosges than farther north. In the south it is all downhill after we cross the border; but in the north we must fight uphill against the Germans after we have entered their territory, as there the boundary line lies west of the mountain crest."

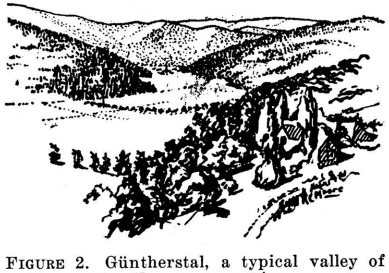


FIGURE 2. Güntherstal, a typical valley of the Vosges mountains.

It has been stated in press reports that a commander of German forces at Mülhausen, ordered to lead his men across the Vosges mountains into France, made three futile attempts to carry the heights of the range in the face of French artillery. Then came an urgent message from the Kaiser: "The crest of the Vosges must be carried at any cost." A fourth

desperate assault by the intrepid commander ended in his defeat. Retiring to his quarters the unhappy general, according to the story, committed suicide, first sending to his Kaiser this message: "The Vosges cannot be crossed. Come and try it yourself." I would not care to vouch for the truth of the story, but it serves to illustrate the peculiar surface features of the Vosges which render their ascent comparatively easy from the French side of the border but very difficult from the German side. This is the key to the significant fact that after three years of desperate offensives the only place where the German troops have been unable to expel the French from German soil is on the steep eastern face of the Vosges mountains.

In this connection it is interesting to note that should the French succeed in pushing the Germans back to the east side of the Rhine, their further eastward advance in southern Germany would then be opposed by precisely the same topographic difficulties which have long retarded the westward movement of the Germans in southern Alsace. The Black Forest will replace the Vosges in immediate importance, and while the Germans hold the crest and more gentle eastward slope of this range the French will find assaults against the steep west-facing scarp both costly and difficult.

The Belfort Gateway. Not far south of Mülhausen, but beyond the limits of the drawing, Figure 1, the Vosges mountains descend to a low pass which connects the Rhine valley with the valley of the Saône in eastern France. In this pass, guarding the strategic gateway from one valley to the other, stands the mighty fortress of Belfort, the southernmost of the great fortifications erected against a German invasion. Entrance to France by this route is easy, so far as the natural physical features alone are concerned; and in the commercial intercourse between the two nations the gateway has played an important rôle. But the opening is narrow enough to be effectively defended by the fortress in its center and to permit the concentration of troops in such numbers as to render its passage by an invader extremely difficult. Whether the fortress which withstood the attacks of the Germans in 1870 can defy the guns which reduced Liége, Namur, Maubeuge, and Antwerp will be determined only in case the Germans can push the French field army back far enough to bring their heavy siege artillery within range of the walls of Belfort.

THE MOUNTAINS OF WESTERN GERMANY AND SOUTHERN BELGIUM.

The Mountainous Upland. North and west of the Vosges mountains the older series of folded rocks, exposed at the surface around the margin of the Paris Basin, have not been raised so high as in the Vosges. Instead they form an upland of moderate elevation, which was once a nearly level erosion plane; but which, since the uplift, has been cut into hills and valleys by many branching streams. This hilly country is known as the Slate mountains, the Haardt, the Eifel, and by other names in Germany, and as the Ardennes in southern Belgium. Although usually described as mountainous, the most striking feature of the area is the remarkably even sky-line which appears in every distant landscape view, and which is proof that the much folded rocks were once worn down to a surface

of faint relief, after which warping raised the surface to its present position and permitted its dissection by river erosion. The upland is now so badly cut up by streams that cross-country travel is difficult, and transportation lines tend to follow the valleys.

Valley Defiles. Two main rivers cut deep trenches across this upland from southwest to northeast—the Moselle and the Meuse; while the lower Rhine transects it from southeast to northwest. Despite its excessively meandering course the Moselle gorge has been, from time immemorial, one of the chief pathways through the broad mountain barrier, and the strongly fortified city at its junction with the Rhine bears a name, Coblenz, which reminds us of the fact that in Roman times this was recognized as an important "confluence." In the present war the Moselle has served as

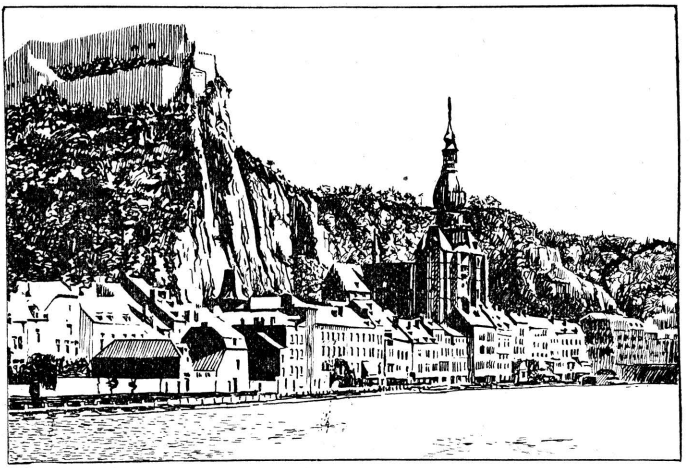


FIGURE 3. The gorge of the Meuse river at Dinant, showing steep, rocky sides of the gorge and the old fortress of Dinant. The Meuse river is a natural barrier of greatest importance in military operations.

the chief line of communication for one of the German armies of invasion, but if the Allies succeed in driving the invaders out of Belgium and back toward the Rhine, the great natural moat of the Moselle trench would change its rôle, and become a military barrier of the first importance, behind which the Germans might hope to check the Allied advance.

The gorge of the Meuse is the second great natural highway through the upland barrier, and cleaves its way through the heart of the Ardennes mountains. Less winding than the Moselle, it is scarcely less important, especially if we include the branch gorge of the Sambre, which joins the main trench at Namur. For the Sambre leads one southwestward to a low divide whence the headwaters of the Oise may be entered and followed directly to Paris. The combined Meuse-Sambre-Oise valley route is followed by a through railway line from Berlin to Paris, and for this reason was heavily guarded by the fortifications of Liége, Huy, Namur, and

Maubeuge. Commanding the main gorge of the Meuse southward from Namur were the forts at Dinant and Givet.

Both the Meuse and the Sambre trenches, now serving as principal lines of communication and supply for the German armies, were utilized by the Allied armies in August, 1914, as protective barriers behind which they waited to receive the first great shock of the German onslaught. The main Allied front faced north, and between Namur and Charleroi was protected by the lesser gorge of the Sambre; while the right flank enjoyed the admirable protection of the deep, steep-sided canyon of the Meuse. Those familiar with the steep, rocky walls of this larger trench will readily appreciate what a high defensive value it must have possessed. The causes of its ultimate abandonment by the Allied forces are touched upon in another chapter.

Gorge of the Rhine. The famous gorge of the Rhine, with its precipitous walls from which ruined castles look down upon the swift current of the great river, is better known to the world than the valleys of the Moselle and Meuse. From the earliest times it has been one of the chief routes of transportation and communication in western Europe, and today five important transport lines thread the narrow defile—two railways, one on either side of the river; two auto roads, one on either side; and the steamboat route on the river itself. In few places in the world can one find such a striking contrast as when, standing on the upper rim of the gorge, he looks out over the quiet farms and sleepy villages on the upland surface, then down upon the busy thoroughfare where trains, autos, wagons, and steamboats form a constant stream of hurrying traffic.

The two ends of the Rhine trench are guarded by Mainz and Cologne, two of the strongest fortified cities in Germany; while near the middle stands the strong fortress of Coblenz. Here then is a natural moat of impressive dimensions, carrying a swift, deep river, and heavily fortified at its most accessible points. German armies retreating from Belgium in the north could hope to check, along this trench, the most vigorous assaults of a pursuing enemy. Thus far, however, we are concerned with the Rhine trench as a line of communication connecting central Germany with military bases in the west from which attacks on France could most conveniently be launched. It is evident that two armies with headquarters at Coblenz and Cologne, and supplied by the railways, auto roads, and steamer routes which pass through the Rhine gorge, could attack France simultaneously if one ascended the Moselle to Luxemburg and the other passed from Cologne westward around the north side of the hilly country to the Meuse, and then followed southward up that valley. Hence it was that in the early weeks of the war we heard much of the "army of the Moselle" and the "army of the Meuse"; and the capture of Liège, Huy, Namur, Dinant, and Givet marked the progress of the latter army along the best pathway through the Ardennes.

THE PLAIN OF NORTHERN FRANCE AND BELGIUM.

The Undulating Plain. Northward from Paris, and west of the fading belts of plateaus and scarps which characterize the eastern and northeastern sectors of the Paris Basin, stretches the undulating plain of Normandy, Picardie, and Artois. The underlying rock layers are prac-

tically horizontal and are exposed in picturesque manner along the coast where the waves of the sea have cliffed the margins of the land. Branching streams of moderate size have dissected the surface of the plain into a complex system of low hills with gently rounded slopes, those sufficiently large to be called rivers having eroded shallow valleys whose flat floors are not infrequently, as in the case of the Somme, covered with ponds and marshes. Above the valley bottoms the uplands are dry, and crossed by a network of excellent roads and railways. Even where valleys interrupt the surface the slopes are gentle, and in all this region there is not a single military barrier of the first magnitude. Marshy valleys of small streams, hill slopes, and occasional low ridges would figure in intensive fighting where opposing armies were deadlocked; but striking topographic barriers do not exist.

In Belgium the plain continues, but takes on a double aspect. From the margin of the hilly Ardennes northwestward toward the sea the surface is much like that described above, except that it is in general more gently undulating, even monotonously level over broad areas. Roads and railways make a dense network affording excellent communications in every direction. Nearer the coast, however, the land slopes down beneath the level of high tide, and becomes an absolutely flat, treeless plain. Belts of sand dunes along the shore and artificial dikes alone prevent the waters of the sea from flooding the land when the tide is high. Rivers crossing this belt must themselves be diked to prevent the indefinite spreading of their waters. Thus it happens that they are practically converted into canals, and like the lower Yser are called indifferently "canals" or "rivers." A close-set network of smaller canals helps to drain the flat, marshy surface, but forms an endless system of obstacles to free movement through the region. The level of permanent ground water is at or near the surface, and trenches dug in the marshy soil can scarcely be effectively drained. Trench life here is at its worst, and omnipresent mud adds its miseries to field life on the Flanders plain.

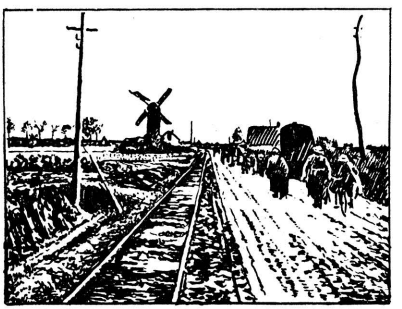


FIGURE 4. A typical scene on the flat plain of Flanders.

The higher parts of the plain, both in France and in Belgium, are covered with deposits of fine-grained loess and loam which afford a fertile soil easily cultivated. As a result the population is dense, and agriculture flourishes. Forests have been largely removed to permit the intensive farming of every available acre. It will be evident, therefore, that both the richness of the country and its favorable topography combine to make this plain a natural pathway from eastern and central Europe into France. It has, indeed, been called the gateway to northern France, and forms part of the greater plain belt over which one may travel by rail from northeastern Russia to the Pyrenees without passing through a

single tunnel and without rising 600 feet above the level of the sea. From the military standpoint it presents four prime advantages: it is interrupted by no topographic barrier of serious importance; it is supplied with numerous parallel roads and railways by means of which to advance simultaneously different columns of troops; it is productive enough to supply food for the sustenance of large armies for long periods of time; and it passes close to important coal and iron deposits in the borders of the Ardennes, and has, indeed, important coal fields lying immediately below its level surface.

The Liége Gateway. In concluding our examination of the plain, let us note one peculiar feature of its position in eastern Belgium. Here the rugged country of the Ardennes reaches north to the vicinity of Liége, while Holland sends far southward a great peninsula of her territory in the form of the province of Limburg. The Belgium portion of the plain is thus narrowed to a neck of land only a few miles in width. German troops desiring to enter the Belgium plain would thus find themselves confined between the hill country on the south and Dutch territory on the north. Across the narrow gateway cuts the valley of the Meuse river, and blocking passage of both river and gateway stood the forts of Liége. Manifestly free access to the broader plain beyond would not be possible until the forts had been reduced and their guns silenced.

FIGURE 5. The level plain of Belgium across which the main German advance on Paris was launched. Note the intensive cultivation of the plain. In the distance is the smoke of a burning town, set on fire by artillery.

Summary. We have completed our survey of the surface features of the western theater of war, and have found that the Vosges mountains, the mountains of western Germany and the Ardennes in Belgium, constitute a broad outer zone of comparatively difficult country, within which concentric belts of plateaus with east-facing scarps defend the most direct approaches to Paris. Only through Belgium into northern France is there a level pathway, free from obstacles, of great breadth most of the way, and provided with every facility for the rapid movement and prolonged sustenance of large armies. In the following pages we will see how profoundly these physical features affected the general plan of the German campaign and the detailed movements of the opposing armies.

THE PLAN OF CAMPAIGN.

First Route of Invasion. If the reader will turn back to the diagram, Figure 1, he will see at a glance that four principal routes of invasion were open to Germany in her campaign against France. She could, for example, concentrate her main armies in the valley of the Rhine with bases at Strassburg and Mülhausen, and in the country about Metz to enter by the so-called Lorraine gateway. An advance westward from between Strassburg and Mülhausen would encounter the steep east-

facing scarp of the Vosges mountains, a topographic feature which, as we have already seen, imposes practically impossible conditions upon a German offensive. On the other hand, the main advance from this region might be made by turning either end of the mountain barrier, passing through the Belfort gateway between the Jura mountains and the southern end of the Vosges; or between the north end of the range and Luxemburg, through the gateway of Lorraine. In the first instance the ring fortifications of Belfort block the way, and since they effectively command every transportation line through the pass, their complete reduction would be necessary before an advance would be possible. From the southern foothills of the Vosges to the neutral territory of Switzerland in the Jura foothills the distance is but ten or fifteen miles, and the narrowness of the gap would favor the defense and prevent satisfactory manœuvering of the attacking forces. Firmly intrenched in the gateway, their left flank secure against the difficult Vosges and their right flank protected by the neutral Swiss hills, supported by one of the four strongest fortified camps of France and supplied by adequate rail connections with the rear, the French armies could render an advance into their country by this route at best a slow and costly undertaking.

In order to understand the German plan of campaign we must remember that rapidity of action was of its very essence. German strategists have long maintained, and German statesmen at the outbreak of the war frankly asserted, that to win the war the German armies must drive swiftly to the heart of France and bring that country to her knees before Russia should have time to mobilize and become a pressing danger on the east. In the German plan no route of invasion was practicable which would impose on the advance any appreciable delay. German and Austrian heavy artillery might account for the permanent fortifications of Belfort within reasonable time once they were fairly under fire; but the topography favored a long and obstinate defense from field works, which would perhaps prevent the big guns from coming within effective range of their objectives. The Belfort gateway might become the scene of important subsidiary operations, but German necessities required a topographically more favorable route for the main invasion.

The Lorraine Gateway. The Lorraine gateway is broad and, since the war of 1870, largely in German territory. Metz is an admirable fortified base and is connected with Strassburg by excellent rail communications. It was by this route that the Prussian armies passed in the former war, whereas at the gate of Belfort they knocked in vain. West of Metz the German border is closer to Paris than any other point. Here, then, would seem to be an appropriate point from which to launch the main attack upon the French capital.

But to reach this conclusion is to forget the surface configuration of the Paris Basin. Just over the French border is the broad, marshy plain of the Woevre. Dominating it on the west is the steep escarpment crowned at short intervals by permanent fortifications from Verdun to Toul, and offering exceptionally advantageous positions for temporary field works commanding the plain below. At the two points mentioned the only practicable gateways through the barrier are heavily fortified.

Beyond, to the west, the same unfavorable topography is repeated again and again; always a steep scarp toward Germany, commanding a plain over which the invading troops must advance; always a gentle back slope down which the defending armies might retreat to the next scarp if too heavily pressed, while rear guards on the formerly occupied crest held the invaders temporarily at bay. If victorious along one plateau scarp, the invading armies would be checked at the next and compelled to fight the battle anew. Delays at the fortified gateways must be expected even if the forts were invested and the main armies pressed on to the barrier next west. Narrow and few in number, the gateways afford insufficient lines of communication for vast armies advancing and fighting, while the construction of new roads suitable for heavy traffic up the escarpments and over the plateaus would be an engineering feat involving an enormous expense in labor and time.

Clearly the route from the middle Rhine country westward into France must be eliminated as the main path of invasion in a campaign demanding rapidity of action as its chief object. The failure of the Crown Prince's army to break through the gateway at Verdun, the failure to capture the plateau crest west of the Woevre, and the failure to secure the Nancy gateways and reach the Gap of Toul are sufficient vindication, from the military standpoint, of the German staff's determination to avoid the difficult terrain of northeastern France and the delays it would inevitably impose on military operations. The belt of fortifications alone would probably have weighed but little in the Teuton plans. Their confidence in their heavy artillery was supreme, and was fully justified by the speedy fall of every fort coming effectively under its fire. But the defenses of Nature can not be blasted away by the devices of man, and it was these defenses and not the permanent forts which saved Nancy, Toul, and Verdun.

Second Route of Invasion. A second route of invasion is from the northeast, following the course of the Moselle trench to Luxemburg and thence into France by way of Longwy or Metz. Such an advance could base on Coblenz and Trier, and would in the one instance involve the violation of neutral Luxemburg, and in the other bring the armies to the same advanced base (Metz) used by the troops moving west from the middle Rhine. In either case the further progress of the armies would encounter the same difficult terrain of the Paris Basin which rendered impracticable the first route, as described above. Large armies must undoubtedly push through the Lorraine gateway, capture the important iron deposits within easy reach of Metz, and forestall any attempt of the French to invade Germany by this route. But the main striking arm of the German military machine must operate along some other path.

Third Route of Invasion. To a lesser degree the route from Cologne, around the north side of the Ardennes, past Aix-la-Chapelle, and so to the trench of the Meuse through the mountains, is open to the same objections. Once the invaders were in French territory the plateau scarps could be crossed near their western extremities, where they constitute less formidable obstacles. Nevertheless the terrain is far from favoring a speedy advance on Paris. The scarps are sufficiently pronounced to

give commanding artillery positions and to restrict free movement to a limited number of gateways. The innermost line of cliffs is especially forbidding, and its gateways are guarded by the fortifications of La Fère, Laon, Rheims, and Soissons. Moreover, to conduct the main offensive with its principal line of communications a single railway running back through a narrow mountain gorge in hostile territory would be inadvisable if more favorable conditions could be found a short distance to the west. The "army of the Meuse" was, therefore, destined to play a subsidiary rôle in the invasion.

Fourth Route of Invasion. There remains the fourth route, by way of the Belgian plain. Entering, as before, by the Liège gateway, invading armies could spread westward around the northern side of the Ardennes, through Louvain and Brussels, swinging gradually southwest past Mons and Charleroi, Cambrai and Le Cateau, on past St. Quentin, and so down to Paris. The left flank could profit by the Sambre-Oise valley route, while the right flank could swing as far out over the plain as circumstances required. The pathway here is broad and level and no topographic obstacle bars the way. It is a route which enables an invader to take in the flank the entire series of plateau barriers farther east. Roads and railways are excellent and numerous, permitting the rapid simultaneous advance of different columns of troops. The country is fertile and highly productive, providing sustenance for large armies. With the occupation of this route would go the conquest of deposits of coal and iron of immense importance to the invaders. Back of the armies operating in France would be a broad network of first-class lines of communication and supply. Assuredly of the four possible routes of invasion this is the one incomparably the best so far as its physical characteristics are concerned.

There existed, however, some serious objections to an advance on Paris by way of the Belgian plain. The distance from the nearest point on the Franco-German boundary, near Metz, to Paris is about 170 miles as the aëroplane flies. From the German-Belgian border to Paris, via the Belgian plain, the distance is approximately 250 miles. The latter route is, therefore, nearly fifty percent longer than the legitimate route directly from German territory into France. Not only this. The longer route involved the violation of Belgian neutrality, and if Belgium and England were faithful to their treaty obligations and true to their national honor, must inevitably bring the Belgian army and the British army and navy into the field against the invader. Yet this was precisely the route over which the great mass of the German armies were hurled. The smooth Belgian plain was to serve as the slot along which the German bolt should reach the heart of France.

Military Necessity. Surely the choice of an invasion through Belgium must have been dictated by some very compelling reason to justify it in the minds of the German general staff. That reason is to be found in the topographic features of western Europe, which rendered a swift advance on Paris impossible from the east, but comparatively simple from the north over the broad pathway of the Belgian plain. "He who is menaced as we are can only consider the one and best way to strike," said the

German chancellor. "Belgian neutrality had to be violated by Germany on strategic grounds," cabled the Kaiser to President Wilson. Military Necessity, the one true god of the Prussian autocracy, demanded the speedy death of France; and to gain the one secure route to the heart of the victim, German honor and Belgian peace were sacrificed on the altar of Prussian militarism.

THE INVASION OF FRANCE.

THE ADVANCE.

Attack on the Liége Gate. On the afternoon of the 4th of August, 1914, there appeared at the mouth of the Liège gateway small bodies of German troops. The first important operation of the great war was to shatter the defenses of this narrow pass and gain admittance to the Belgian plain. The gateway is only a dozen miles in breadth, and the forts of Liége effectively command the railway lines which converge to pass through it before spreading out again on the plain beyond. Evidently the gathering hosts of the Kaiser could not fling themselves over the plain upon France until the advance guard had opened the gate.

A few days later the city was entered, but most of the forts held out. A cavalry screen pushed through the gateway and advanced westward over the plain; but lacking proper support it was forced on the 13th to make a partial retreat before the brave little Belgian army. The battle for the possession of the pass was not yet decided, and in the meantime troops and supplies were congested at the entrance awaiting free passage before the real invasion could seriously commence. The delay was becoming dangerous, for the advantages to be reaped from a sudden sweep over the plain might be lost through failure to gain prompt admission to its level surface. Finally on August 14th or 15th, eleven days after the struggle for the gateway began, the westernmost fort, Loncin, with General Leman, the heroic defender of Liége, fell into German hands and the sweep toward Paris began.

Meanwhile, the French and British were taking advantage of the delay imposed by geographic conditions at the entrance to the plain, in order to prepare for the shock which would quickly follow the debouching of the main German armies through the gateway. Instead of setting themselves athwart the course of the main German advance over the plain, they selected a topographically more favorable position in the northern foothills of the Ardennes. This position possessed at least three notable geographic advantages: it occupied and, therefore, completely blocked the Meuse and Sambre passageways through the Ardennes; it was defended in front by the gorge of the Sambre from Namur to Charleroi, and on the right flank, the flank next the advancing Germans, by the deeper gorge and larger stream of the Meuse; and it flanked the course of the German advance, compelling the invaders to turn and fight on a line selected by the defense, since they could not continue over the plain with their flank constantly exposed to an Allied attack from the hills.

Terrain of the Battle of Mons-Charleroi-Namur. Let us look more closely at this first strategic position of the Allied armies. The main front faced north, and from Mons to Charleroi was constituted by the British Expeditionary Force, while the French Fifth army continued the line from Charleroi to Namur. Unfortunately the British had in front of them no protective topographic barrier of importance; but for all or most of its length the French Fifth army lay behind the gorge of the Sambre. In this portion of its course the Sambre is a strongly meandering river, which follows a winding trench cut 300 feet or more below the upland surface. The flat floor of the trench is 500 or 600 yards in breadth, and covered with open meadows. As a rule the southern wall of the trench is steep and forested. An enemy advancing from the north would find it difficult to cross the exposed meadows, bridge the river, and dislodge the defenders from the wooded heights beyond.

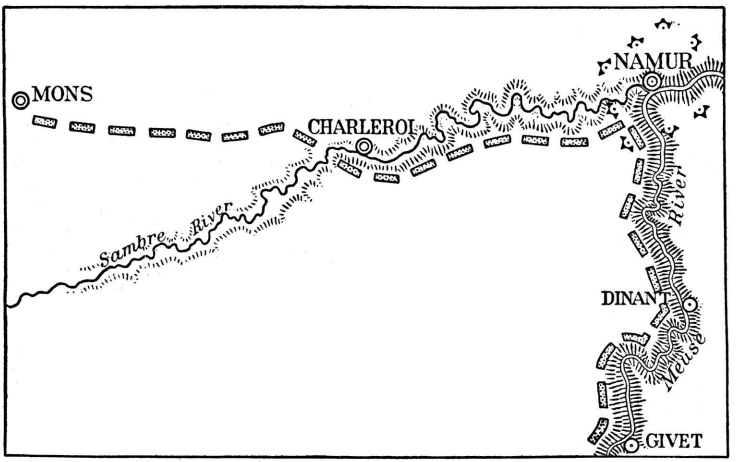


FIGURE 6. Main defensive position of the Allied armies at the Battle of Mons-Charleroi-Namur.

With the Allied front facing north along the line of the Sambre, there was, of course, danger of a flank attack by German troops advancing from the east. Fortunately as a protection against this danger the main gorge of the Meuse was admirably located, and behind this natural moat lay the French Fourth army extending from Namur southward past Dinant to the fortress of Givet. This stretch includes the most formidable part of the Meuse trench. Less strongly winding than the Sambre, it is cut deeper below the Ardennes upland and has steeper walls. The river is deeper and broader, and practically fills the bottom of the trench. Precipitous cliffs of bare rock rise in places several hundred feet from the water's edge. Where the slope is less steep the walls are heavily forested. Without question this is the most formidable obstacle in the Ardennes district.

It will be seen that the combined Allied fronts formed a salient with

both sides protected by topographic barriers of imposing magnitude, but with the apex thrust far out toward the advancing Germans. This apex being the junction of two principal natural pathways through the mountains, it was the locus not only of an important town, but also of the most valuable crossings over the two rivers. The strategic value of Namur was thus very great, and for its protection there had been constructed a ring of modern forts. Located at the junction of the north-facing and east-facing Allied armies, and guarding passages across the rivers, which, if captured by the enemy, would enable him to breach both topographic barriers and flank both armies out of their positions, it is clear that fortified Namur was the key to the Allied defense. The fortress was, moreover, the solid support upon which the right of the main Allied front rested in supposed security.

On the 20th of August the German artillery opened fire on the forts of Namur. At the same time the German infantry had wheeled south from the plain to attack the main Allied front behind the Sambre, while the French Fourth army behind the Meuse was also feeling the enemy pressure. It now developed that the Allies had made some fatal miscalculations. In the first place, they had woefully underestimated the enormous strength of the German invasion by the way of the plain. Overwhelming masses of the best Prussian troops were hurled against the Sambre barrier, while the heaviest attacks of all were concentrated on the more remote but topographically unprotected western end of the line. At the eastern end the forts of Namur melted away with incredible rapidity under the German fire. Less than twenty-four hours after they opened fire German troops entered the city, and the next day controlled the vital passages over the Meuse and Sambre. On August 22 the defensive line of the Meuse-Sambre trench was abandoned, and there began the retreat which was not to end till the stage was set for the Battle of the Marne.

The phenomenal sweep of the German armies across the Belgian plain into northern France now proceeded apace. Von Kluck's great army swung far to the west and south, through Tournai, Arras and Amiens, overlapping the western end of the Allied line and constantly threatening to envelop it. The infantry advancing by parallel columns on different roads, and supplied by an efficient motor transport service, moved swiftly over the smooth surface. Ceaselessly pressed by the extreme rapidity of the German advance, the British army withdrew southwestward into France, along the margin of the plain just west of the Oise valley, turning to face more and more toward the northwest in order to defeat Von Kluck's efforts at envelopment. In time this brought the British contingent into a position parallel to the Oise valley, and the heart-breaking retreat was first checked when the exhausted expeditionary force put this important barrier between itself and the pursuing Germans on a line from Noyon to La Fère. Not before this had the plain offered an obstacle sufficiently serious to check the pursuit and afford the pursued a real breathing space. Here was a fairly large river meandering excessively through a series of marshes on the flat floor of a broad valley, with the wooded hills of Noyon protecting the left end of the line and the

fortress of La Fère at the right. Although not a defensive barrier of the first importance, it offered temporary security. Meanwhile the French were falling back toward a concave line running from Paris to Verdun, in preparation for the offensive which was to bear the name of the Battle of the Marne.

Thus far the assault through the plain of Belgium had succeeded beyond measure. Germany had moved an incredible number of men at an incredibly swift pace across the low, level pathway into France. The Allied armies were in peril from the swift swing around the western end of their line, and it was believed Paris would soon fall before the heavy guns moving rapidly southward over the plain. Fate seemed about ready to set the final seal of approval upon Germany's choice of the topographically most favorable route into the enemy's country.

THE BATTLE OF THE MARNE.

The Plan of Battle. In its simplest terms the Battle of the Marne consisted on the part of the Germans, in an attempt to swing round the western end of the Allied line and envelop it from that direction, at the same time breaking through the Allied center far to the east and forcing the remainder of the western half of the line back on Paris, thereby completing the process of envelopment and creating a second Sedan on a grand scale. On the part of the French the intention was similar: a flanking movement around the west end of the German line, and a break through their center, which should split the invading forces, thus insuring the complete envelopment or precipitate retreat of the western half. It is notable that of these four movements the two flank attacks were begun on the plain north of Paris, while the two attempts to break the enemy's center were staged on the low plain of Champagne. Only subsidiary movements consequent upon the main efforts were assigned to the troops operating over the more difficult topography of the intervening plateau with its deep-cut river trenches.

Let us follow, in outline, the chief events in this most important battle of the war, noting as we go the rôle played by the surface features of the country over which two vast army groups were contending for a victory which should, in all likelihood, determine the course of world history for many centuries to come. Although called the Battle of the Marne, the trench of this important river cannot properly be said to have played a determining rôle in the issue of the struggle. Only once, in fact, were the opposing armies aligned on opposite sides of this natural barrier for any great part of its length, and then only for a brief space of time. It was the battle of the plateau of the Marne and of the Marne river and its tributaries, including especially the Ourcq, Petit Morin and Grand Morin; and the final issue was in fact determined on the low plain of Champagne farther east. Maps of the battle line at critical stages in the engagement usually fail to show that striking parallelism between army positions and topographic features which most readily gives one an appreciation of the influence of land forms on military operations. But it would be a serious mistake to draw from this the conclusion that such influence was any the less real.

Joffre's Strategic Retreat to Favorable Terrain. The Battle of Liége gave the Allied armies time to assemble in the triangle guarded by the Sambre and Meuse gorges. The Battle of Mons-Charleroi-Namur, in its turn, was not expected by the Allies to accomplish the impossible task of crushing the German armies, but was designed to afford time for troops to assemble farther south, where the final struggle might take place under conditions more likely to bring decisive victory to the Allied arms. Joffre's strategic retreat not only lengthened out the enemy's lines of communication through many miles of hostile territory, but compelled the German generals to leave behind them enormous forces to guard stragetic passes over or through topographic obstacles, to mask fortresses which, like Maubeuge, guarded valley routes into France, and to rebuild bridges over marshes and river trenches. The retreat brought the enemy into the plateau country of the Isle of France, where the east-west gorges would impede the advance, and where the final struggle would take place with these obstacles in the enemy's rear, hampering his supply system and threatening his retreat in case of disaster.

Von Kluck's Enveloping Movement. Swinging west through Belgium and south into France, Von Kluck, with the main striking arm of the German forces, had, by the first week in September, traversed the level plain almost to the gates of Paris. The time had now come, in the opinion of the German high command, for Von Kluck to ignore the small French forces to the west and the exhausted British expeditionary force in front of him, and to strike boldly southeast, get in behind the Allied line east of Paris, and envelop it by a flank attack. The Allied center was already bent in dangerously, and might be broken at any moment. There followed that spectacular sweep of Von Kluck's army from the northern gates of Paris east and south across the Marne, a movement which surprised and puzzled those who looked for no check until the city itself was in German hands. But the destruction of the French army, not the mere occupation of the French capital, was the logical goal of the German general staff; and this goal could only be reached by the envelopment of the enemy's line. This enveloping action was now fully under way.

The French Countermove. The moment had arrived for the French to strike their blow. Within the circle of the Paris forts, and to the west and south of the city, a new French army, the Sixth army, had secretly been assembled. Waiting until Von Kluck had crossed over to the south side of the formidable Marne trench, still patiently waiting until he had also placed the trench of the Grand Morin in his rear, the French Sixth army at length fell on the thin screen of troops he had left west of the Ourcq to protect his flank, and began the process of cutting the lines of communication in his rear. Under pressure the German screen fell back slowly toward the trench of the Ourcq, where they might hope to find protection for a stand against French forces. The army which was seeking to envelop the Allied line was itself in grave danger of being enveloped.

At this point the Germans showed marked skill in turning the obstacles, which might have hampered their retreat, into defensive barriers against

the Allied pursuit. How far this was due to failure of the British to press Von Kluck with unrelenting vigor cannot now be stated, but the fact remains that he was able to withdraw his forces north of the Grand Morin, leaving a rear guard of troops along that trench to hold the pursuers at bay, while he sent the bulk of his forces back north across the Marne to retrieve the disaster threatening his exposed right flank. Facing west and southwest against the French Sixth army, Von Kluck began to drive them back. In this new position his left flank was exposed to the British, with only the thin rear guard along the Grand Morin to serve as a

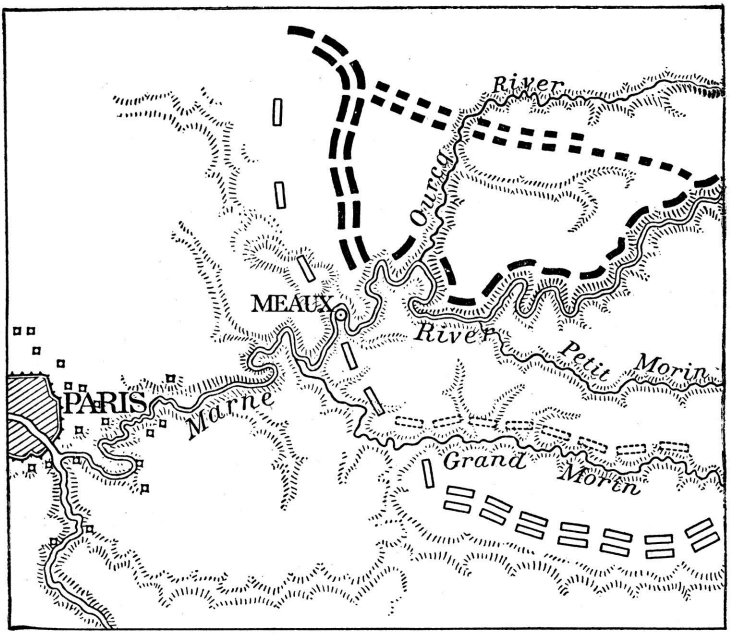


FIGURE 7. Approximate German positions at the battle of the Marne. Solid line open rectangles: Mass of German armies south of Grand Morin, thin screen of troops facing west to protect right flank, at beginning of battle. Broken-line open rectangles: Rear guard defending passage of the Grand Morin while bulk of troops are being shifted north to meet French attack on flank. Black rectangles: Main army facing west and seeking to envelop north end of French line, while screen of troops defends crossings of the Marne trench. Black dots: German armies withdrawing up the valley of the Ourcq.

protection. For precious hours the Germans tenaciously kept this steep-sided, flat-floored trench between themselves and their foe, while Von Kluck was redressing the balance farther north in favor of the invaders.

The Battle for the Marne Trench. At length the British forced the crossings of the Grand Morin and the German rear guard fell back to the Petit Morin and then to the main great trench of the Marne. For a short time this trench now became the most important factor in the struggle. If the German rear guard could hold it some hours longer Von Kluck would be left unmolested to destroy the French Sixth army with

his superior forces, the Allied line would be turned, and the war won by the efficiency of a militaristic autocracy. If the British forces could cross the trench without delay they could roll up Von Kluck's left flank and decide the battle, perhaps the war, in favor of the Allied democracies. Great issues hung in the balance along that natural moat on the afternoon of September 9.

Nature gave a clean decision to neither contestant. The obstacle was not sufficient to hold the British in check long enough for Von Kluck to complete the destruction of the French Sixth army. On the other hand, the British found it impossible to cross the barrier at once and involve Von Kluck's flank in disaster. According to reports they negotiated the obstacle first toward its eastern end where it is of smaller dimensions, and only later crossed its western reaches. The delay gave Von Kluck opportunity to swing his forces back toward the Ourcq and withdraw them up that valley, so as to face more nearly south toward the oncoming British.

At this moment there was in progress farther east a phase of the Battle of the Marne in which natural topographic barriers were playing no less important a rôle than in the operations just described. If the reader will turn again to the diagrammatic sketch, Figure 1, he will see that the Petit Morin rises in the long east-west belt of the St. Gond marsh, and flows directly west through its gorge in the Marne plateau. We thus have an east-west barrier of no mean importance consisting of a marsh at one end and a river gorge at the other. It was along this barrier that the Battle of the Marne, and hence the issue of the war, was finally decided.

Deadlock at the St. Gond Marsh. While the British were struggling to cross the trenches of the Grand Morin and Marne farther west and assault Von Kluck's flank, the French and German forces faced each other across the St. Gond marsh and the Petit Morin gorge. By September 8 or 9 the French had been able to dislodge the Germans from the north side of the gorge, west of the plateau scarp, and drive them northward in hurried retreat. At the Marne the German armies paused, expecting to check their pursuers with the aid of the imposing river trench; but the impetuous French assaults carried them beyond the northern wall before German reinforcements could be brought up to hold the advantageous position. Farther east, however, the battle line curved southward, and at the east end of the Petit Morin gorge and along the marsh the opposing forces were, for a time, deadlocked. French efforts to push northward across the gorge and occupy the heights beyond were checked, while the marsh remained practically impassable for both armies.

Then began the final German attempt to smash through the French center. The assault progressed successfully across the dry ground beyond the east end of the St. Gond marsh, but back of the marsh and Petit Morin gorge the French line held firm. To increase the force of the blow farther east the German armies north of the marsh were seriously depleted. At the same time the German line in this vicinity may have been stripped of men to assist Von Kluck out of his troubles farther west. The difficult nature of the marsh was relied upon to protect the weakened German line. The French commander, General Foch, saw his oppor-

tunity. A thin screen of German troops behind the marshy barrier might, indeed, hold that part of their line secure. But Foch could strike with effect close to the east end of the marsh, where a strong German army connected with the thin line back of the obstacle. This junction was a point of weakness, especially when southward progress of the German offensive left an opening here which the depleted forces north of the marsh were unable to close. Here Foch struck with all the fury of the proverbial offensive power of the French army. To get the men for the stroke he withdrew an army corps from behind the Petit Morin gorge, near the edge of the plateau, where the difficult nature of the topography made the withdrawal comparatively safe. The stroke was a brilliant success. The French armies smashed through the gap. The German center was broken, and the German retreat to the Aisne began.

THE BATTLE OF THE AISNE.

The great trench of the river Marne is the most imposing topographic barrier in the plateau of the Isle of France. We should expect that behind its protection the German armies in retreat would make a desperate effort to halt their pursuers. Such, indeed, was the case. But the Marne trench was too close to the field of battle; it was, in fact, as we have seen, involved in one of the principal actions at the west. There was no space to manœuver, no opportunity so to order the retreat that the retiring forces would arrive at the barrier in such dispositions as would enable them to align themselves along the northern bank without confusion before the pursuers could break across at one or more points and flank them out. The British forced a crossing east of the mouth of the Petit Morin and the French broke through farther east, at a time when the Germans had retired north of the Marne near Meaux, and were still far south of it in the direction of Epernay. The German line crossed and recrossed the barrier, instead of paralleling it on its northern side. Desperate efforts were made to hold the trench in different sections, but here the French or British broke over with an impetuous assault, there the secure positions were outflanked by crossings made elsewhere. The retreat continued, and the whole valley of the Marne passed into French hands.

Terrain of the Aisne Valley. Northward there is not a single continuous trench from east to west until the valley of the Aisne is reached. Here, however, is a military obstacle of capital importance. Entering the plateau by a gateway near Rheims, the river flows directly west to join the Oise at Compiègne. For forty miles the great straight trench cleaves the plateau, its steep walls leading abruptly down to a flat floor several hundred feet below, over which the narrow but deep river pursues its meandering course through grassy meadows. In the edge of the plateau above are extensive quarries and vast subterranean galleries and chambers, left by the excavation of a limestone much used for building purposes. Patches of forest clothe the valley walls and are scattered over the upland surface. It was a foregone conclusion that the Germans would make every effort to stop their retreat along this natural defensive barrier.

About the 12th or 13th of September the main German armies arrived at the line of the Aisne, closely pressed by the French and British. Cross-

ing to the north side the Germans destroyed the bridges behind them, and turned to pour a hurricane of steel into the valley. From trenches along the valley walls and on the plateau crest, from open quarry and cavern mouth, from every bit of woodland cover, machine guns and artillery rained death upon the meadows below, where in exposed positions the French and British pursuers worked feverishly to build pontoon bridges and rafts with which to cross the unfordable river. Heavy rains had been falling and the flood waters made the task doubly difficult and dangerous. Every advantage of nature lay with the invader. If he could not stop the pursuit here and hold the rest of northern France in his grip, he could hardly hope to pause again till the hills of the Ardennes had been reached.

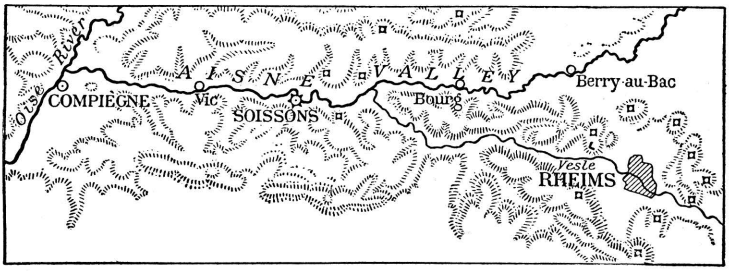


FIGURE 8. Trench of the Aisne river.

From Soissons west to the Oise valley the French crashed against the barrier with an impetuous assault which carried them through the hail of steel and over the flooded Aisne. At the foot of the northern valley wall they paused to regain their breath. East of Soissons to Berry-au-Bac, the British met with less success. Baffled at first by the combined defensive of nature and man, they at length made a few precarious crossings. The morning of September 14 found the French over the stream and ready for an attack upon the steep northern wall of the trench, while the British had attained the northern bank only in places. The situation was not ideal for a further offensive, but time was precious; the odds were becoming greater every hour as the Teutons dug in more and more firmly along their naturally strong position.

An immediate assault on the plateau was ordered. Up the steep valley walls, and out over the plateau to the north swept the invincible Frenchmen. Night found the trench of the Aisne behind them, although the highest crests on the plateau were yet in the hands of the Germans. Farther east the British were still held at bay south of the trench for several-mile stretches east of Soissons and again east of Bourg. The French, unsupported by a corresponding British advance on their right, and with their lines of communication imperiled by a flooded river in their rear, were unable to hold their gains. In a day or two they were pushed back to the river, and the Battle of the Aisne was decided in favor of the Germans. The great moat, made formidable by nature and skillfully fortified by man, had proven too much for the offensive power of the Allied armies. The mobile war in the west was ended, and the war of the trenches had begun.

THE DEADLOCK.

THE BATTLE OF NANCY.

Terrain of the "Grand Couronné." While the sweeping movements involved in the Battle of the Marne were in progress in the west, the war of fixed positions was beginning farther east. The Germans massed in the Lorraine gateway were making their first great attempt to smash the outer line of the natural defenses of Paris. As can be seen from the sketch, Figure 1, Nancy guards a double gateway through the easternmost plateau scarp. The crest of the escarpment, a line of heights overlooking the lowland to the east, is known to French military writers as "le Grand Couronné." Along this crest the main positions of the French armies, under General Castelnau, were located, taking skillful advantage of a topography extremely unfavorable to the Germans. To defeat the French armies and capture the first plateau belt with the Nancy gateways, was the object of the Battle of the Grand Couronné, or as it is popularly known, the Battle of Nancy.

Not far from 400,000 highly trained German troops were massed on the lower land in the course of the battle, and hurled against the wooded plateau scarp. French infantry in greatly inferior numbers intrenched along the higher levels, and French artillery concealed in folds of the undulating upland ground, in ravines cut back into the escarpment face, and in patches of woodland, poured their combined fire upon the assaulting columns below. In front of the main scarp are outlying mesas and buttes, erosion remnants which, like the positions on the main crest, command a wide field of fire. Wave after wave of the gray-clad invaders in mass formation swept up the lower slopes of the Grand Couronné, withered away under the merciless hail of steel from the heights above, ebbed back to the lowland again in weakened currents, leaving a gray mark on the plateau face to mark the highest reach of each impotent wave.

The Impregnable Barrier. Day after day the slaughter went on throughout all the first third of September. The myth of German invincibility died hard; the impregnability of Nature's best fortifications, when manned by Frenchmen, was a hard lesson to learn. Forty thousand German corpses at the base of the scarp, one-fourth of the attacking forces on the casualty lists; such were the results of the Kaiser's introductory study of the natural defenses of Paris. Not, however, until he had pondered the bloody chapters of Verdun did he fully realize that the topographic barriers, which he well knew to be difficult, were, as a matter of fact, impregnable.

THE BATTLES OF VERDUN.

First Assault on the Verdun-Toul Scarp. On the 20th of September the German armies made their first serious attempt to break through the Verdun-Toul escarpment. The French line, pivoting on Verdun, swung far to the south on either side. If the eastern limb of the salient, along the plateau scarp, could be broken, the troops defending the western limb would be taken in the rear and Verdun isolated. The eastern limb was

held by a comparatively thin line of French troops who depended upon the strength of the topographic barrier to maintain their positions. Occasional permanent forts along the crest added their measure of strength, although the known weakness of such fixed points had led the French to transfer many of the big guns to outlying field fortifications located with regard to the favorable configuration of the terrain.

From the low plain of the Woevre the waves of German troops were hurled westward against the escarpment. The slaughter was terrible, but for a moment German hopes ran high. Some miles south of Verdun the scarp is broken down by erosion, and through several low passes one may quickly reach the Meuse river. Here the Germans secured a foothold on the eroded plateau, and brought their heavy artillery within range of several of the southern forts. Fort Camp des Romains quickly crumbled to ruins under the rain of heavy explosive shells. The Germans established themselves in St. Mihiel, and threw some forces across the river. A general assault on the long escarpment had succeeded at the point topographically most favorable to the attacking troops, but had failed elsewhere. There resulted the famous "St. Mihiel salient," which was to persist through several years of strenuous warfare. The partial success of the German armies could not be pushed to victory so long as the more formidable positions of the plateau scarp remained in the hands of the French.

The struggle which will go down in history as "the Battle of Verdun" was not to begin until some months later, when the opposing armies had been long deadlocked in the war of the trenches. Struggles, which in previous wars would have counted as important battles, had shown that Verdun could not be taken except by military operations conducted on a colossal scale. On such a scale Germany prepared for her greatest effort of the war. The accumulations of munitions and the massing of men and guns exceeded anything previously dreamed of. The main attacks were made from the north. Entering the escarpment by the broad open gateway cut obliquely through it by the Meuse river north of the city, the German armies had already spread out on both sides of the valley, occupying cross ridges between some of the east-and-west trending branch ravines. An advance southward across these successive ridges was deemed more feasible than an attack from the east against the main scarp, although operations from that direction should accompany the major movement.

It is not necessary to repeat the history of the great German disaster: the surprise attack from the north with much ground gained the first day; the slower advance of the days that followed and the eventual capture of a few northern forts; then the deadlock with week after week of incessant slaughter of the attacking waves, first on one side of the river then on the other; the withdrawal of the French to the base of the scarp when German guns on the heights farther north dominated their positions in the Woevre plain; the failure of the Germans to ascend the steep scarp; finally the smashing French counter offensive, in the form of sledgehammer blows at long intervals, each blow sending the invaders reeling back to the north; half a million of Germany's finest

troops sacrificed in the fruitless endeavor to capture the Verdun gateway and conquer the second easternmost belt of the natural defenses of Paris.

Natural Defenses of Verdun. The French victory at Verdun was not won by the permanent fortifications. These had been stripped of their great guns in order to enable the French to hold the favorable topographic positions farther out from the city. The plateau scarp is of

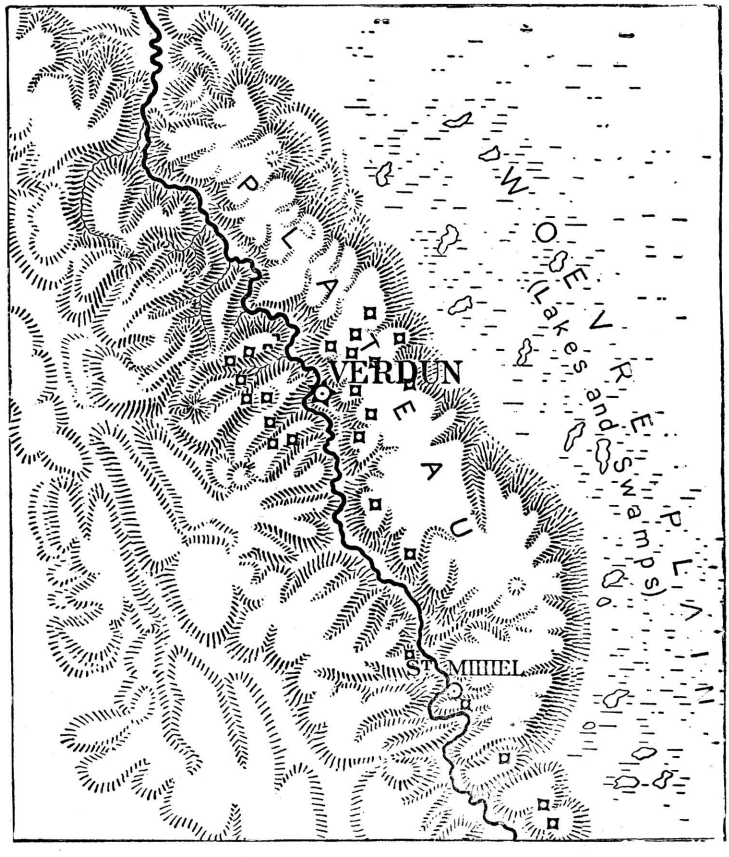


FIGURE 9. Terrain of the Verdun district.

limestone, and quarry openings and caverns played their part in the defensive scheme. But most important of all were the east-facing escarpment, and the endless series of east-west ridges with their intervening parallel ravines, draining toward the Woevre plain on the east or into the Meuse river on the west. Dead Man Hill and Pepper Ridge, Hill 304 and the Côte de Talou, now historic points on the map of France, were formerly unimportant ridges, lost in the maze of similar crests which characterize the dissected plateau belt. Their defensive

value lay in the fact that each crest dominated a ravine next north, across which the Germans must advance in their assaults toward the south, and in the further fact that in the maze of ridges artillery positions could be found which commanded practically every avenue of German approach.

The Meuse Barrier. Another topographic element of great importance in the defense of Verdun consists in the peculiar character of the Meuse valley. The trench of the river is broad and flat-floored, and in wet seasons interposed a marshy and muddy barrier between the two wings of the attacking Germans. The shifting of troops from one side of the river to the other was not an easy manœuver, and attacks made from one side of the barrier could not always be effectively supported from the opposite side.

The Meuse river, moreover, occupies what is known to the geographer as an intrenched meandering valley. From the upland spurs projecting into each curve French guns could dominate the crossings of the river in three directions, and pour their fire upon the German positions on the upland beyond. The successive swings of the valley north of Verdun cause the river to form a valuable defensive screen which the Germans would have to cross at repeated intervals, unless they chose to avoid the obstacle by concentrating their movements east and west of the river zone, thereby presenting better targets for the French artillery. German troops once in possession of the meander spurs have sometimes found themselves in a natural trap. On more than one occasion a swift French counter stroke has been so planned as to sweep across the neck of the meander spur, thus imprisoning large bodies of German troops on a peninsula surrounded on three sides by an unfordable stream. It was by this manœuver that the French made their largest captures of German prisoners.

Marshy Plain of the Woevre. Attacks on Verdun from the plain of the Woevre were, as already noted, of importance during the main great battle. Determined assaults from this direction would have been highly important, had the nature of the terrain offered any hope of success. But the Battle of Nancy and the first attacks from the Woevre had demonstrated the formidable character of the great plateau scarp. Furthermore, the plain of the Woevre in winter and early spring, the time when the great struggle was at its height, is practically impassable for large bodies of troops. The soil is a stiff clay which when wet turns minor roads and fields into bogs, while the water resting on its impervious surface forms marshes and ponds without number. Troops and artillery confined to the few good roads of the district would be at the mercy of the French guns, and could not manœuver into positions offering any hope of a successful offensive. The plain of the Woevre and its dominating plateau scarp by forcing the Germans to attack from the north, and the ridges and valleys of the plateau by offering defensive barriers which the Germans could not overcome, saved Verdun to the French.

THE BATTLES OF FLANDERS.

German Failure to Reach the Channel Ports. Why the German general staff should elect to make several of its main efforts to break the Allied line on the low plain of Flanders is a question which cannot be answered with assurance until after the war. Perhaps it was believed that the weakness of the Belgian forces defending this line would more than offset the difficult nature of the terrain; that the Allies might count too much on the protection of nature, and insufficiently support the line. However that may be, in the early months of the war the world was treated to the spectacle of enormous masses of German troops being sacrificed in the hopeless endeavor to break through this line to the channel ports beyond.

We have seen that the plain of Flanders is low and wet; so low that the waters of the sea must be diked out at high tide, and so wet that an endless system of ditches must be constructed to drain the marshy soil. Rivers must have their waters confined by artificial levees, and canals of formidable depth and width add their defensive strength to the naturally difficult terrain.

Against such a barrier the German troops were thrown in great numbers. Fully exposed on the nearly treeless surface of the plain and checked at every step by water and marsh, the waves of German infantry worked painfully forward, to melt under the Allied fire. Thousands were drowned in the rivers and canals, while tens of thousands perished on the marshy plain. Still the assaults continued, and forced the defenders to yield, bit by bit, the difficult ground. When nothing else would stop the invaders, the dikes were opened and the whole lower course of the Yser turned into an impassable lake. So ended the Kaiser's best efforts to plant his guns on the edge of the strait of Dover. The marshes of Flanders were as impregnable as the plateau scarps of the east.

Summary. It is not possible within the limits of this volume to trace in detail the influence of land forms upon all the battles of the great war. That is a task which would require several volumes of the present size. The writer's effort has been rather to show how far such an influence still persists under modern conditions of warfare, and to give, in addition to some special examples of this influence in particular battles, such a general picture of the terrain in the chief theaters of operations as will serve as a basis for more detailed studies of other engagements. For this reason we must forego, for the present, any analysis of the important rôle performed by the marshy valley of the meandering Somme in the battle to which that stream has given its name; of the nature of the topographic obstacles known as Vimy ridge and Messines ridge, and the part they played in two great British victories; or of the chalk ridges of the Champagne plain, and many other topographic features which have given a special character to different contests.

CHAPTER II.

THE REGION ABOUT CAMP FUNSTON.

CAMP FUNSTON is located almost at the exact geographic center of the United States. Indeed this median point is said to fall within the Fort Riley military reservation about four miles southwest of Camp Funston, where it is marked by a monument erected to Major E. A. Logan, who first located the present fort and called it Camp Center, "it being very near the geographical center of the United States."[1] The camp is in the midst of a great prairie country which slopes gently eastward from the Front Range of the Rocky Mountains to the Mississippi, reaching

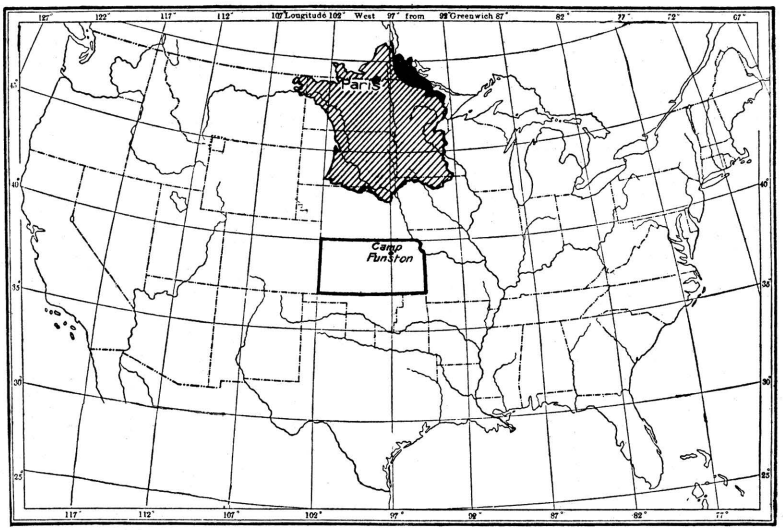


FIGURE 10. Map showing location of Camp Funston and relation in latitude to France. The battle area of northern France is nearly 700 miles farther north than Camp Funston. This map also shows relative size of Kansas and France.

north into Canada and south to the Gulf of Mexico. The region is well named the Great Plains, for there are few places in the world where so vast an expanse of unbroken plains country may be found. The west portion of the plains, from the Rockies east to western Kansas and Nebraska, is remarkably featureless, in places absolutely flat so far as the eye can

1. Circular issued by the United States Surgeon General's office, 1875, cited by Blackmar, Frank W., Kansas, A Cyclopedia of State History, vol. I, pp. 668, 671; 1912.

determine. This belt, often spoken of as the High Plains, gets relatively little rainfall because of its position in the lee of the high mountains, and it is not thickly settled. The east portion of the Great Plains is marked by a succession of low east-facing escarpments or steps, readily traceable for long distances from north to south. These Scarped Plains, as they are called, are better watered, and therefore much more thickly settled, than the High Plains farther west.

Camp Funston is in the west portion of the Scarped Plains, where the country, while broadly a plain, is yet marked by hills and escarpments which rise more than 300 feet above the level of the valley bottoms. It is situated on Kansas river, about 140 miles west of Kansas City, and nearly midway between Manhattan, at the mouth of Blue river, and Junction City, where Smoky Hill and Republican rivers unite to form the Kansas. Like the original Fort Riley, the camp is in an important strategic position, controlling as it does the main lines of easy passage along the river plain to the east, southwest and northwest. In early days Fort Riley was a strong frontier post in the warfare with the Indians.

In the landscape about Camp Funston the features of primary interest to the soldier are (1) the bottom lands of the large streams, (2) the bluffs which border the river plains, and (3) the rolling upland, deeply cut by the ravines tributary to the main river valleys. These portions of the landscape may be considered briefly in turn.

BOTTOM LANDS.

The camp is built entirely on the broad bottom land of Kansas river in the east part of the Fort Riley military reservation. The view of the camp and bottom land from almost any point on the high bluffs at either side of the river is most interesting and shows to advantage the peculiar characters of the river land. The bottoms appear perfectly flat,[2] as indicated in the names Smoky Hill flats and Republican flats, and they extend without break, except where the winding river has cut its channel, from bluff to bluff and as far up and down the river as the eye can reach. The bottom lands are really a long narrow plain which stretches like a ribbon along the general course of the river, including within its limits all the curves and irregularities of the river. It extends eastward, very sharply defined and without interruption, as far as Kansas City, where it joins the similar river plain of Missouri river. It is itself joined by many smaller river plains, where tributary streams flow into the Kansas. Such are the mile-wide bottom lands of Big Blue river which extend for many miles north of Manhattan, the plain of Vermillion river east of Manhattan, and, on the Fort Riley military reservation, the bottom lands of Three Mile and Forsythe creeks. West of Camp Funston the plain of the Kansas divides at Junction City, one branch going to the northwest with Republican river, the other to the southwest and west with Smoky Hill river. Perhaps the river plain of the Kansas should be said to end opposite Fort Riley, since by a geographic freak the name Kansas river is applied only to the waters be-

2. This is shown on the map, Plate I, by the very wide spacing of contours. See Appendix.

low the confluence of the Republican and Smoky Hill; but the plains are continuous each with the other. The plains of Three Mile and Forsythe creeks, the only streams in the military reservation having well-developed bottom lands, reach back about three and two miles, respectively, from the edge of the Kansas river plain.

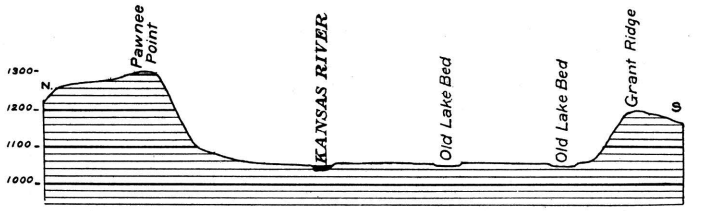


FIGURE 11. Profile across the Kansas river valley at Pawnee Point, showing flood plain and bluffs. Elevation above sea level is shown at the left.

The width of the Kansas bottom lands is rather uniformly about two miles, but at some points, as near Junction City, they are nearly three miles wide, while at others, as at Manhattan, they are hardly a mile

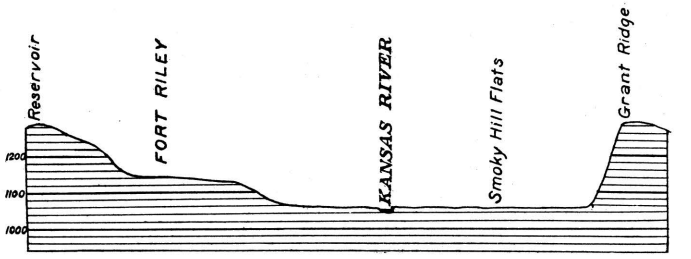


FIGURE 12. Profile across the Kansas river valley at Fort Riley, showing the flood plain of the river (Smoky Hill flats), the bench on which Fort Riley is situated, and the bluffs to the north and south.

across. The plains of the tributary streams are much narrower than that of the Kansas. The flats of Three Mile and Forsythe creeks are but a quarter of a mile wide, and those in Pumphouse canyon and along Four Mile creek, west of Fort Riley, have a width of less than 100 yards.

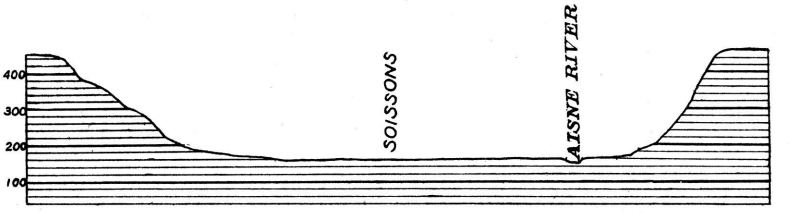


FIGURE 13. Profile across the Aisne river valley at Soissons, showing flood plain of the river and bluffs. Comparison with Figures 11 and 12 shows the similarity of the Aisne valley to that of the Kansas. The same is true for other French rivers.

Big Blue river north of Manhattan has a plain a mile to a mile and a half wide.

River plains appear to be about the same height everywhere above the water in the streams which flow through them, and since streams have an inclination in the direction of their flow, it follows that the bottom lands must also slope in the same direction. This is proven by measurements of the elevation above sea level of points along the plain, as in the case of the Kansas plain, Lawrence 828 feet, Topeka 880 feet, Manhattan 1,012 feet, and Junction City 1,078 feet.[3]

So intimate are the relations of the valley and plain of a river to the river that it is clear they have been formed by the river, and this is true

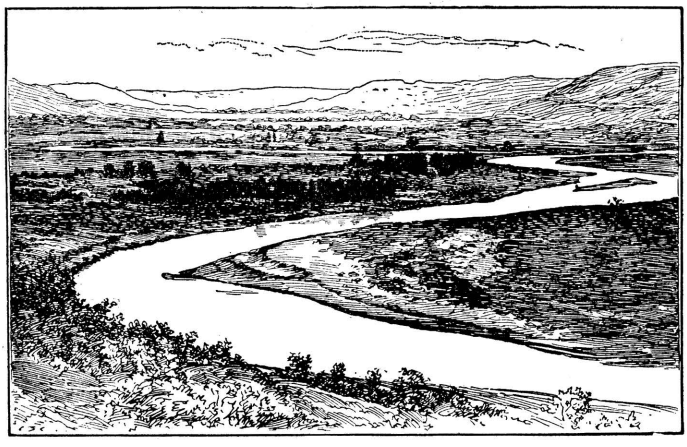


FIGURE 14. Meandering stream with wide flood plain and high bordering bluffs, showing topography typical of many of the rivers of France.

for the Kansas and its tributaries. The carving of the Kansas valley has been going on for thousands of years, the stream having cut downward as much as the very slight slope to the Mississippi and Gulf permits (1,050 feet in 1,200 miles, *i. e.* about 1.14 feet per mile), and sideward against either bluff to the bounds of the river's swinging curves. Downward cutting has virtually ceased, but erosion sideward is still active wherever the river turns to the side of its valley. The smooth, slightly curved outline of the bluffs at Sherman Heights, north of Junction City, of Grant Ridge, opposite Fort Riley, and the bluff northeast of the cavalry camp are the marks of recent side cutting by the river. The projecting rock ledge on which Fort Riley stands is being attacked now where the river swings against it on the southwest. Forsythe creek is very actively widening its valley, cutting here on one side, there on the opposite side of its flat. (See map, Plate VI.)

There is a constant small, almost indeterminable shifting of the channel of a stream on its plain, which results in more or less regular swing-

3. Gannett, Henry, A Gazeteer of Kansas, U. S. Geological Survey, Bull. 154, 1898.

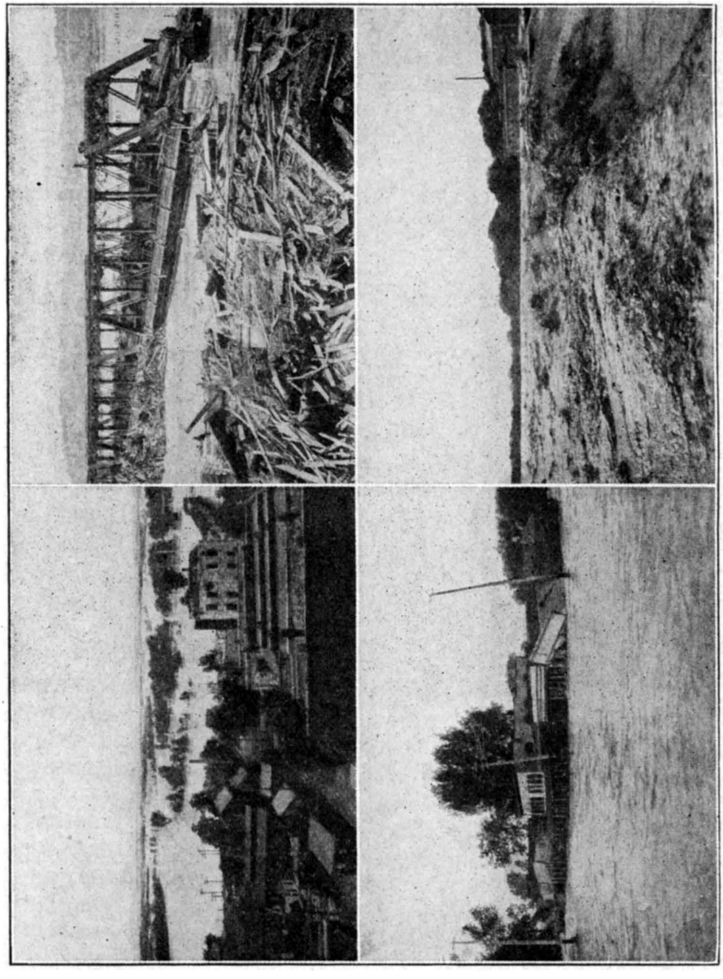


PLATE II. Kansas river in flood, 1903.

ing curves, called meanders. Such meanders are well shown in the course of the Kansas near Camp Funston, but are even more evident in the Smoky Hill south of Junction City. (Plate X.) They are characteristic of most of the rivers of France. Occasionally the opposite sides of a swinging curve come together, and a more or less pronounced change in the course of the stream results. The abandoned portion of the river's channel forms a horseshoe-shaped lake, but eventually it is filled up with mud and plant growth. Thus Whiskey lake, east of Fort Riley, represents a former position of the Kansas river channel when it cut against Grant ridge. This old course was abandoned when one side of the bend

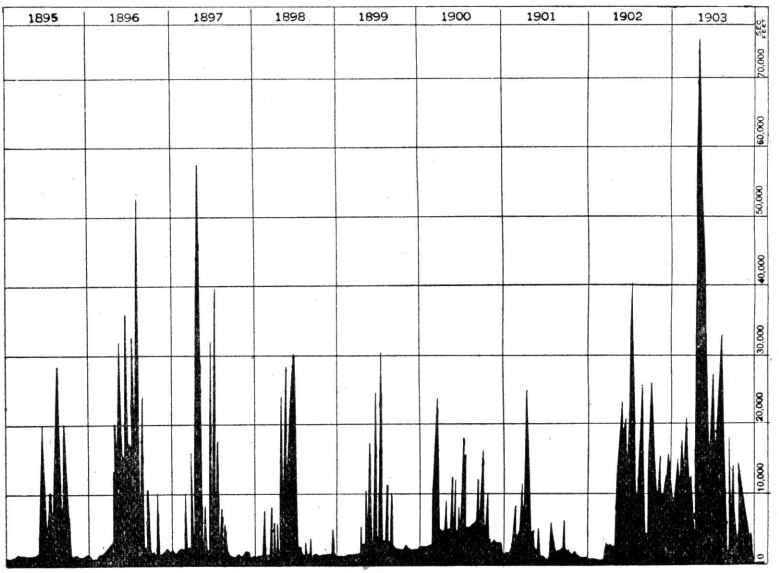


FIGURE 15. Chart showing yearly high water and flood stages in Kansas river at Lawrence, 1895-1903. Note that time of high water is chiefly in the summer months, and that it occurs somewhat regularly. The high peak in 1903 marks the great flood of that year.

cut into the opposite side in front of the fort. Most of the old river meander is filled up, which accounts for the present small size of Whiskey lake. A slight amount of erosion by the current of Smoky Hill river as it swings against its north bank near the junction with the Republican would shift the mouth of the Smoky Hill to a point due south of Fort Riley more than a mile east of the present confluence. To prevent this the bank of the Smoky Hill has been heavily reinforced with stone revetment. It has been necessary to protect in a similar fashion the river bank at the east edge of Camp Funston.

River plains are always subject to overflow by the rivers in time of flood, and on this account they are often called flood plains. Floods leave a deposit of fine, extremely fertile alluvium over the plain, and thus add to the richness of the land, but in general they do much more harm than

good. Not only may unharvested crops on the river flat be ruined during flood, but almost everything in the path of the water may be destroyed or washed away, for the erosive power of a stream in flood is many times greater than under ordinary conditions. Bridges, roads, railroads, houses and towns may be severely damaged, and in not a few cases thousands of human lives lost. Therefore, unless provision is made to protect the works and habitations of man by the selection for them of suitable sites, by well-chosen methods of construction, or by systems of flood control, danger may be anticipated at some time from flood. In some streams floods are of much greater frequency than in others, a fact depending on a number of factors. Kansas river is subject to partial flooding almost annually (Fig. 15), but bad floods are of rather infrequent occurrence, the last important ones having occurred in 1903 and 1904. In the flood of 1903 much damage was done to roads, railroads and towns along the

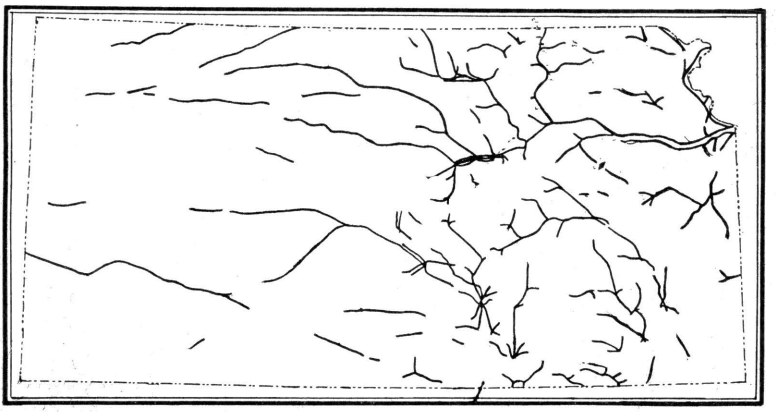
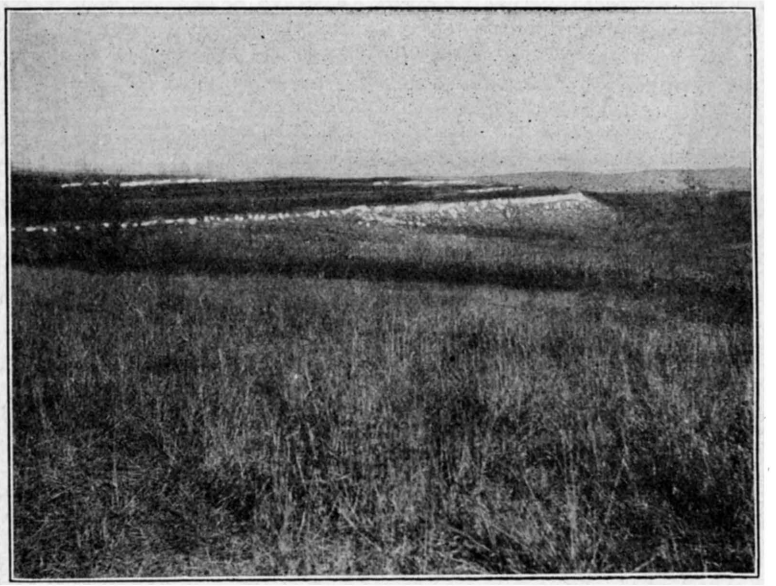


FIGURE 16. Map showing the railroads in Kansas which are laid in river valleys. River valleys are natural highways, which even in plains country like Kansas control largely the position of railroads and the location of cities.

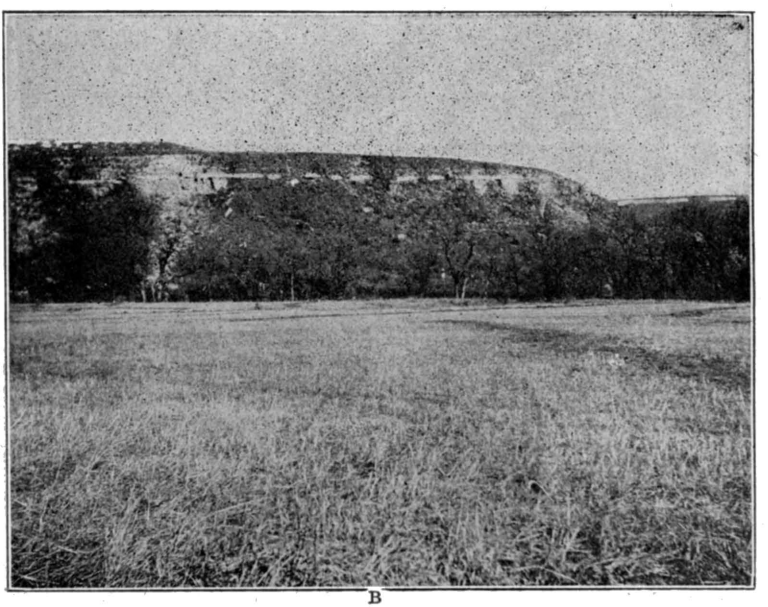
river. Crops were ruined and traffic was impossible for days. Camp Funston is less favorably situated than Fort Riley with respect to danger from floods, for the fort is on a projecting bench, fully thirty feet above the flood plain of the river (Fig. 12), while the camp is on the flood plain itself. This means that any protracted spell of wet weather makes the land around the camp very muddy and necessitates elaborate arrangements for drainage. No flood has occurred since the organization of Camp Funston.

River plains are of great value to man because of their fertility and because they constitute easy and natural routes for travel. Not only is the alluvial soil of the river plain richer than ordinary soil, but the land is flat, and there is a never-failing water supply at hand. Consequently some of the most intensively cultivated areas of the globe are the flood plains of large streams, as, for example, the Nile, the Ganges and the Hoangho. The river plains of the Kansas and its tributaries are inten-

STATE GEOLOGICAL SURVEY OF KANSAS. PLATE III.



A



B

PLATE III. *A*. Escarpments of Fort Riley limestone overlooking Kansas river near Fort Riley. *B*. River bluffs near Four Mile creek, showing flat bottom and and upland limestone benches.

sively farmed above and below Camp Funston, but in the military reservation the flats are used only for rifle ranges, polo grounds and manœuvers, a considerable area near Fort Riley being left with forest cover. The river bottom north and northwest of Junction City is very sandy and contains many low mounds of wind-blown sand, which may correctly be regarded as dunes. Most of these are now covered with vegetation, which holds them stationary. Such sandy areas are, of course, not so well adapted for farming.

In mountainous or roughly hilly country stream valleys afford the only practicable means of transportation, and along them lie the main roads and railroads, villages and towns. The same is true to an important degree in a plains region of moderate relief, like north central Kansas, as may be seen by reference to Figure 16, showing the portions of railroad lines in Kansas which are laid in stream valleys. In the vicinity of Camp Funston the bottom lands of Kansas river and of its two branches to the west, the Republican and Smoky Hill, are the chief arteries of travel. The valley of the Kansas is occupied near the military reservation by the main line of the Union Pacific railroad, an electric interurban line which runs from Junction City to Manhattan, and important wagon and automobile roads, including a county road on the south and the Golden Belt highway, a portion of one of the main transcontinental trails, on the north. At Junction City the Union Pacific divides, the main line proceeding up the valley of Smoky Hill river and a branch following the plain of the Republican to the northwest. The important strategic position of Camp Funston, Fort Riley and Junction City, at the intersection of the natural river-plain highways leading east, northwest, southwest and west, is therefore evident.

RIVER BLUFFS.

Rising steeply, almost precipitously, on both sides of the bottom lands of the Kansas and its two main tributaries, are lines of bluffs, straight or slightly curved, which mark the edge of the upland plains. These bluffs are much the most imposing feature of the topography to a traveler coming into the region. In places, as along (1) Grant ridge, south of Smoky Hill flats, (2) Macomb hill, west of Fort Riley and north of Republican river, (3) between Pawnee and Sheridan points, and (4) Summit hill, just back of Camp Funston, the bluffs, 150 to 200 feet high, present a nearly unbroken front to the river. In other places the bordering bluffs are breached by the entrances of the small streams which are tributaries to the main rivers. With the exception of the gap at Three Mile creek, however, most of the valleys cut into the bluffs are very narrow, so that the border line between the uplands and the bottom lands of the river appears very sharp indeed. This is very clearly shown on the large map of the military reservation (Plate I).[4] The bluffs which confine the

4. On the map 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 the contours, or contour interval, being 20 feet. Where a number of contours are close together, as along the edges of the river plain, the slope is higher, 20 feet for each space between the contour lines. Thus Pawnee Point, above the cavalry camp, between Camp Funston and Fort Riley, is shown to be 200 feet high.

river flats and mark out the path of the roads and railroads, with their busy traffic, are a most difficult obstacle to travel in a direction across them. Thus, while a heavily loaded motor lorry proceeding along the river road below the bluffs would find easy progress everywhere, one crossing from the upland south of the river to north of the military reservation would have to descend the bluffs south of the river, cross the river, and climb the bluffs on the north. The only possible way to accomplish the task would be to find a road leading down some tributary stream to the level of the river flat, cross the river at a bridge, and ascend to the north upland by means of a road through one of the gaps in the bluffs, as at Three Mile creek or Magazine canyon. There are excellent roads along the river plain, but, excepting that at Junction City, almost none across the Kansas valley, due both to the steepness of the bluffs on either side and to the absence of bridges. A river valley with steep bluffs and a wide, deep river is a most troublesome barrier to travel, and it becomes an almost insurmountable obstacle in time of heavy flood.

UPLANDS.

Above the bluffs and back from the river the country is very different, indeed, from the flat plain on which Camp Funston is situated. It is a region of narrow, flat-topped divides, and deep, steep-sided ravines, almost entirely up and down. Indeed, there are few areas of flat land above the camp large enough to drill any considerable number of men, and it is necessary to scatter the troops in rather small training units over a large area. A glance at the relief map of the reservation (Plate I) shows how thoroughly the upland country has been dissected. The divides, in most cases, have been reduced to little more than narrow, irregular lines. The valleys are narrow, steep-sided and deep, as evidenced in the name canyon given to many of them—Breakneck canyon, Pumphouse canyon, Rock Spring canyon, Magazine canyon, etc.

Along the sides of the valleys, and especially at their rims, are outcropping beds of thick limestone, which in many cases form an almost unsurmountable rampart at the tops of the valley slopes. Below the outcrops large and small limestone fragments which have been broken from the outcropping beds are strewn. The roughness of the country is reflected in the position of all the roads which either follow the divides (Saddleback road above the engineers' camp, Rodney Hill and Sumner Hill roads, above Camp Funston), or ascend the valleys (Forsythe drive along Forsythe creek, roads ascending Magazine canyon, Pumphouse canyon, and other streams). (See map, Plate I.)

Much the most striking feature of the upland plain about Camp Funston, as viewed from a point on the river bluffs or from one of the narrow divides, is not, however, the rough, broken topography which one observes in ascending the valley roads to the uplands, but the evenness of the sky line, except where, here and there, a very slight descent marks the change from one general level to another. In the near vicinity the common height of the divides impresses the observer. Looking either north or south from the bluffs behind Camp Funston the country seems not unlike a series of

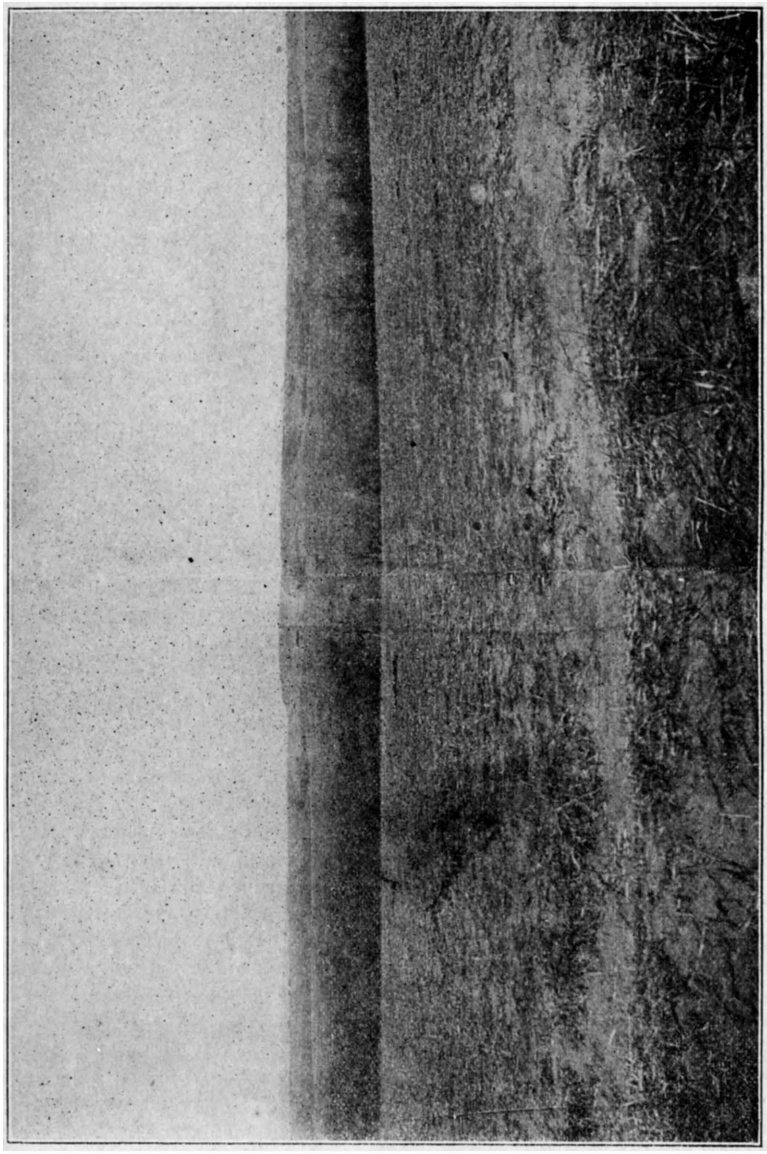


PLATE IV. Upland above Camp Funston, looking north.

STATE GEOLOGICAL SURVEY OF KANSAS. PLATE V.

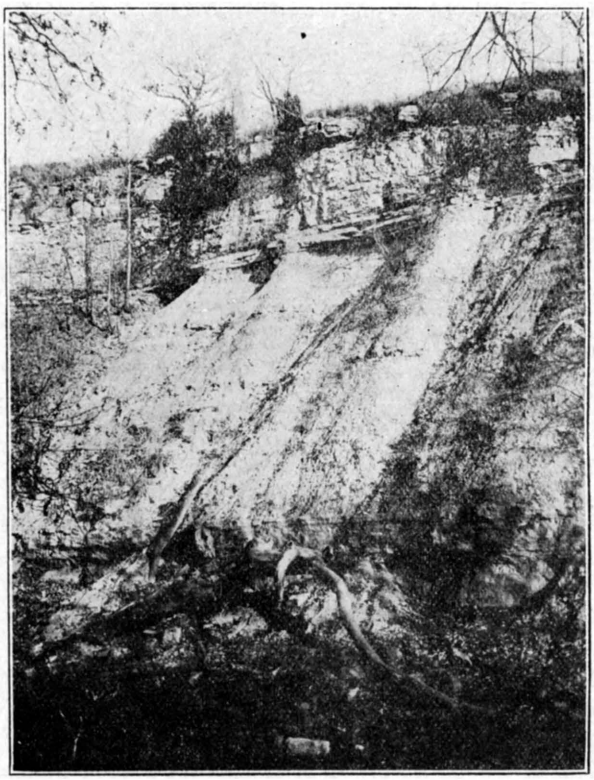


PLATE V. Typical exposure of limestone and shale which compose the upland north of Camp Funston. Four Mile creek.

immensely wide, flat stairs, with the low risers facing the east and long treads extending miles from east to west. The steps are, it is true, cut deeply in many directions by streams, large and small, which cross them, and more than merely casual observation is necessary to make them apparent. This succession of low stairs, or escarpments, is a characteristic feature of the plains of eastern Kansas, and is closely related to the structure of the rocks of which the plains are composed. (Fig. 17.) It is a fact of special interest to the soldier, because, as shown in foregoing chapter, a great portion of the region in France which has become the battle ground of the present war is precisely similar in its major structural and topographic characters to the country about Camp Funston.

To understand the dependence of the upland plains topography on the rock structure it is merely necessary to point out that the level of the various divides almost invariably marks the position of a resistant bed of

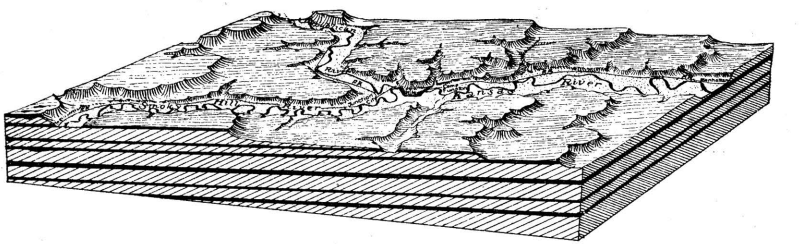


FIGURE 17. Block diagram showing rock structure and topography in the vicinity of Camp Funston. The hard rock layers (in black) dip gently to the west. The position of their outcrop is marked by east-facing escarpments. The large streams have cut valleys through the hard layers.

hard limestone. The rocks of the Camp Funston region consist of alternating beds of limestone and shale,[5] the average thickness and position of which are shown in Figure 18. The beds are almost horizontal, having an inclination (dip) to the west amounting to only a few feet in a mile. Exposures of the hard limestone beds are very numerous about Camp Funston, and some of them are definitely continuous for miles. The soft shale beds, however, weather very quickly to form a soil which supports a thick cover of vegetation, and there are consequently few shale exposures. The limestone, because of its resistance to erosion, stands up in abrupt, steep slopes, and in most cases controls the position of the divides and of projecting benches in the topography. The parallelism between the height and shape of the hills and the position of the hard rock layers is evident at a glance. The shale, because it goes to pieces easily, forms long, gentle slopes.

The outcrops of the alternating limestones and shales (Plate VI) are very irregular, owing to the irregular courses of the streams which have cut into them. The block diagram, Figure 17, shows the structure of the rocks and their relation to surface topography. The bluff just north of Camp Funston is formed by the resistant Wreford limestone, which protects from erosion the softer underlying Garrison shale. The higher land

5. These rocks belong to the Permian division of geologists.

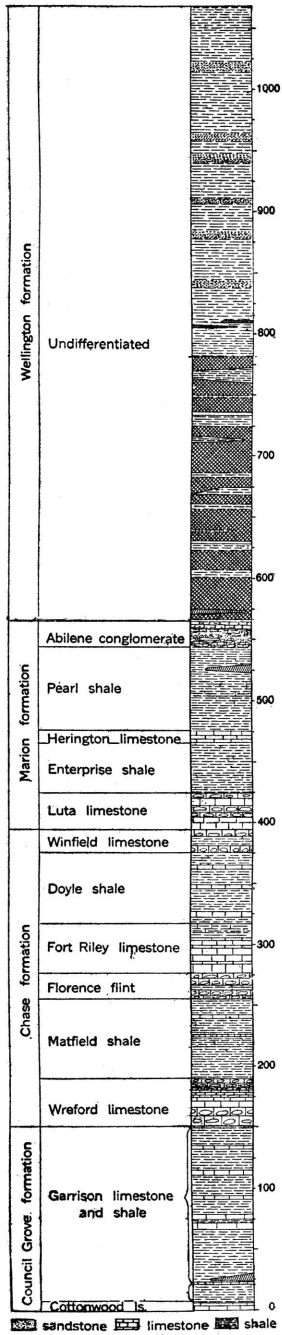
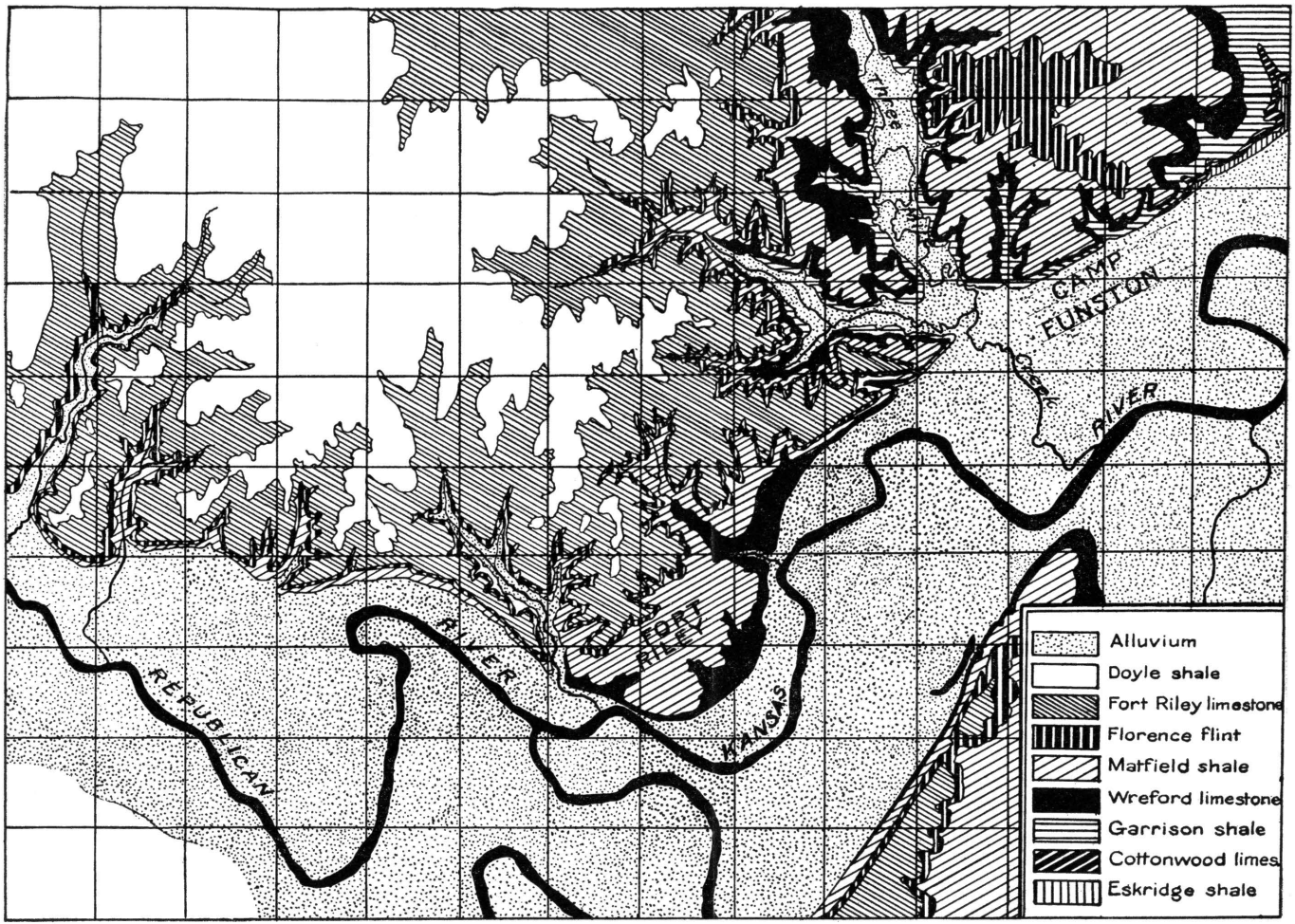


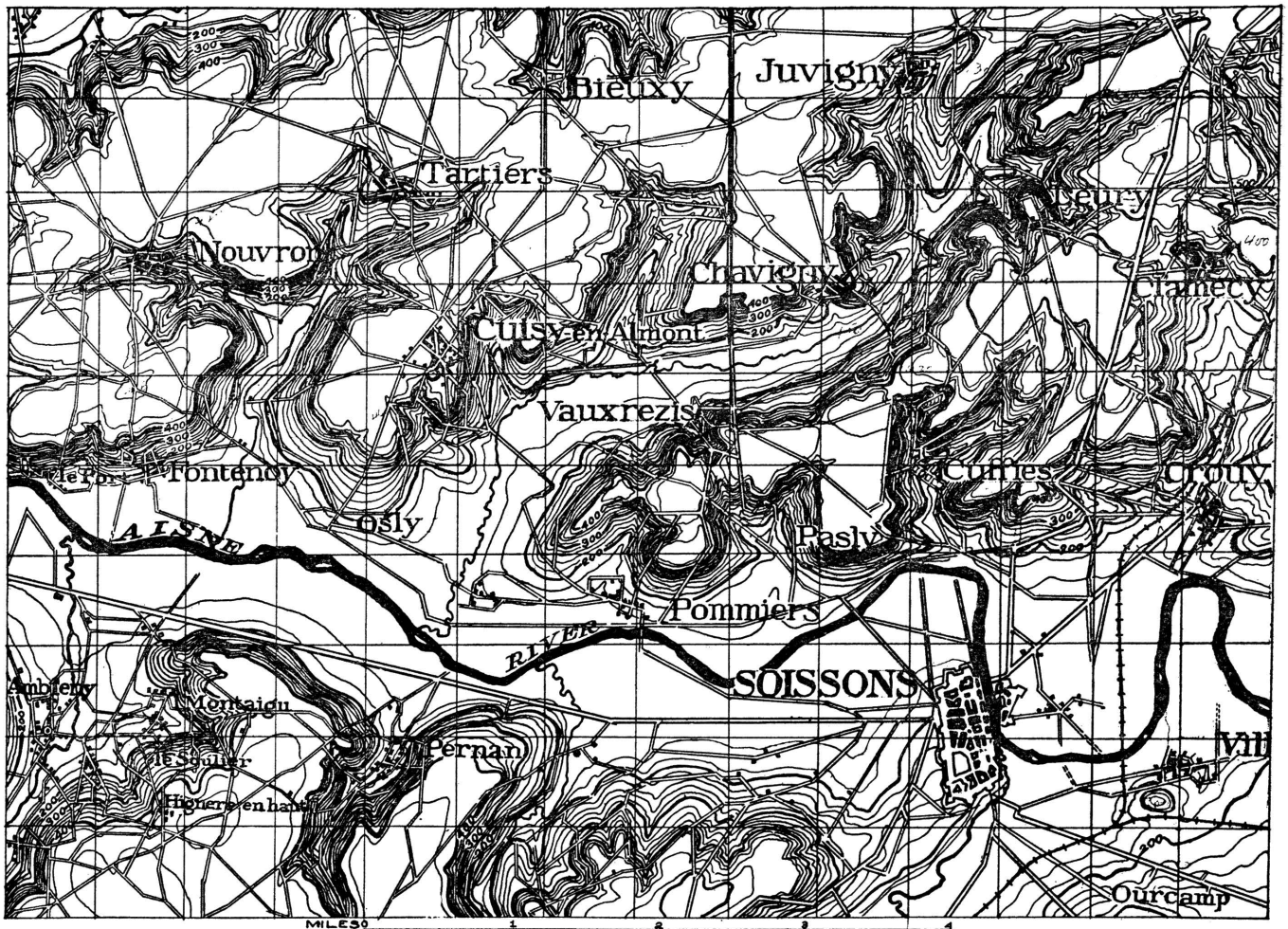
FIGURE 18. Generalized section of the rocks exposed in the vicinity of Camp Funston, showing formation names used by geologists. All of the rocks belong to the Permian system.

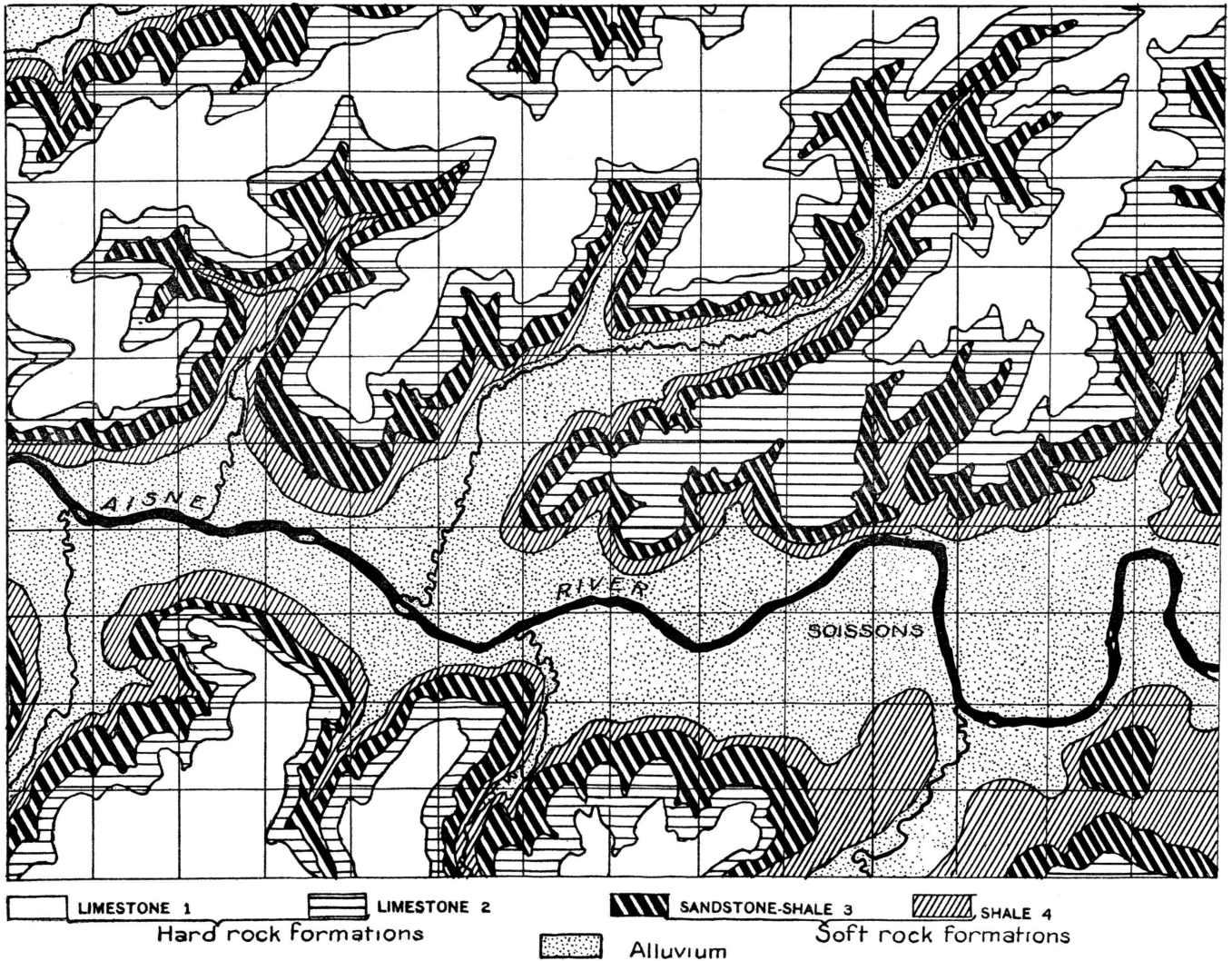
farther north is capped by Florence flint. To the west the ledge of Wreford limestone descends to a lower and lower position until at Fort Riley it is only a slight distance above the level of the Kansas river flood plain. (Plate VI.) It forms a broad bench, on which the fort itself is built. (Fig. 12.) The high bluffs north and northeast of Fort Riley are capped by the hard Florence flint and Fort Riley limestone. The latter formation, named from the exposures in the Fort Riley military reservation, is the massive limestone which is most commonly observed in the bluffs and along the streams. It has been traced from Nebraska, the entire distance across Kansas to Oklahoma, and is everywhere known by the same name. It will be noted that in the west part of the reservation the Florence flint and Fort Riley limestone have come to within a short distance of the Republican river flood plain. This is due in part to the westward inclination of the rocks, in part to the westward rise of the flood plain.

The Wreford limestone, Florence flint and Fort Riley limestone are all valuable for road construction. The quarry at Packer's hill, near the engineer's camp on Three Mile creek, and numerous quarries near Fort Riley have been used for this purpose. The Fort Riley limestone contains beds which are excellent for building purposes, and almost all of the permanent buildings of Fort Riley have been constructed from this rock.

The soil of the upland plain is in general rather thin, and it is due to this that the rocks outcrop in so many places. At many points on the divides there is hardly any soil at all and the bare rocks appear over large areas. On shale outcrops, such as that of the Doyle shale, which covers most of the northwest part of the reservation (Plate VI), soil is formed readily and the country is much better suited for farming. The soil of the upland supports a thick growth of prairie grass, but except for the rows of trees planted artificially along the divides it is treeless. Trees are very abundant, however, in all the draws, as shown in Plate I. The natural growth of trees in the ravines and draws is due to the larger amount of moisture in the ground there. The close dependence of tree growth on moisture supply and its relation to topography is of special interest because of the precisely similar distribution of forests in certain portions of France, where the conditions of rainfall are like those of the Camp Funston area.


CAMP FUNSTON
FORT RILEY
REPUBLICAN RIVER
KANSAS RIVER
Alluvium
Doyle shale
Fort Riley limestone
Florence flint
Matfield shale
Wreford limestone
Garrison shale
Cottonwood limes.
Eskridge shale


Bieuxy
Juvigny
Tartiers
Leury
Nouvron
Chavigny
Cramecy
Cutsy-en-Almont
Vauxrezis
Fontenoy
Cuffies
Crouy
Osly
Pasly
AISNE
RIVER
Pommiers
SOISSONS
Ambleny
Montaigu
Pernant
Ourcamp
MILES
Contour interval 20 ft.
Grid interval 1 Km.


AISNE
RIVER
SOISSONS
LIMESTONE 1
LIMESTONE 2
Hard rock formations
SANDSTONE-SHALE 3
SHALE 4
Soft rock formations
Alluvium

GROUND WATER.

Water suitable for drinking purposes is available a short distance from the surface in wells drilled almost any place, for the cracks and pores in the rock, clay, gravel and sand are, in general, full of water up to a certain level, this level being known as the ground-water surface or water table. (Fig. 33.) The ground water which supplies wells is

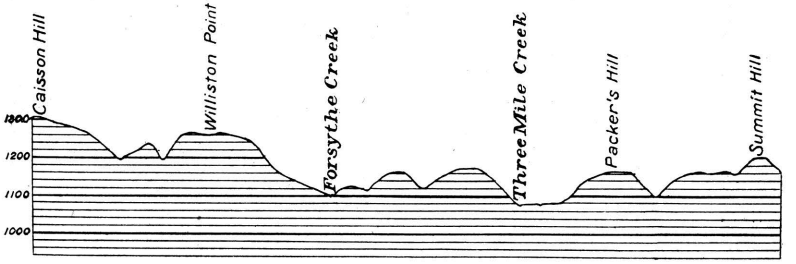


FIGURE 19. Profile across typical portion of upland northwest of Camp Funston. The elevation above sea level is shown at the left of the diagram.

rain water which has soaked into the soil and the material beneath it. When wells are sunk below the ground-water surface, water seeps into them from the surrounding rock, clay, sand or gravel. In general, in a region like the uplands above Camp Funston there is much more water in the cracks of the limestone than in the almost impervious shale beds

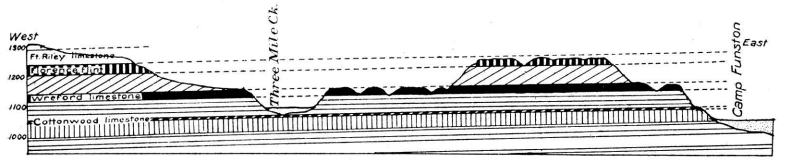


FIGURE 20. Geologic section of a portion of the upland north of Camp Funston, showing relation of hard limestone formations to topography. The formations are indicated as in Plate VI.

between. The quantity of water in the soil and underlying rocks of the upland in north central Kansas is not as large as in regions of more abundant rainfall, and wells drilled here would not yield enough water to supply the needs of Camp Funston and Fort Riley. However, there

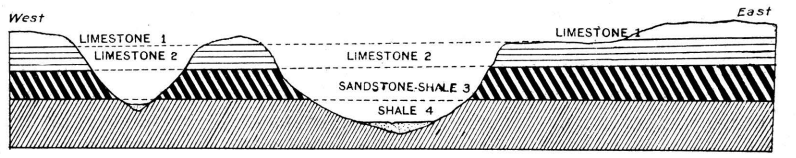


FIGURE 21. Geologic section across portion of the upland north of Soissons, France, showing the flat upland topography and steep bluffs produced by the hard limestone beds. Compare with Figure 20. The formations are indicated as in Plate VIII.

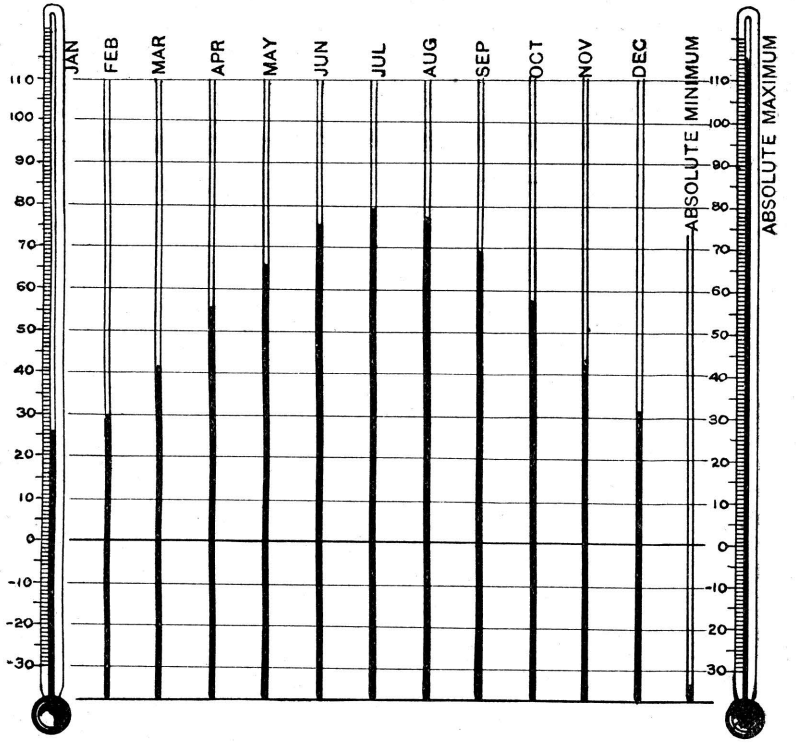


FIGURE 22. Diagram showing average monthly temperatures at Manhattan in degrees Fahrenheit. The highest average monthly temperature is in July, 79°, the lowest in January, 26°, a difference of 53°. The coldest temperature recorded is minus 32°, the hottest 115°, an extreme range of 147°. Warm summers and cold winters are characteristic of inland regions.

is an entirely adequate quantity in the water which fills the spaces between the grains of sand and gravel in the valleys of Kansas, Republican and Smoky Hill rivers. This water is rain water which has sunk into the flood plain and water which has been brought down the river valleys and their tributary streams beneath the surface of the ground. The water in the open river or almost any stream is impure because of organic matter which is in it. The water beneath the river plain, however, filters very slowly through the sand and gravel, and is suitable for use in the camp. Its quantity is great enough for almost any requirements, as there is a continual new supply which is independent of local rainfall.

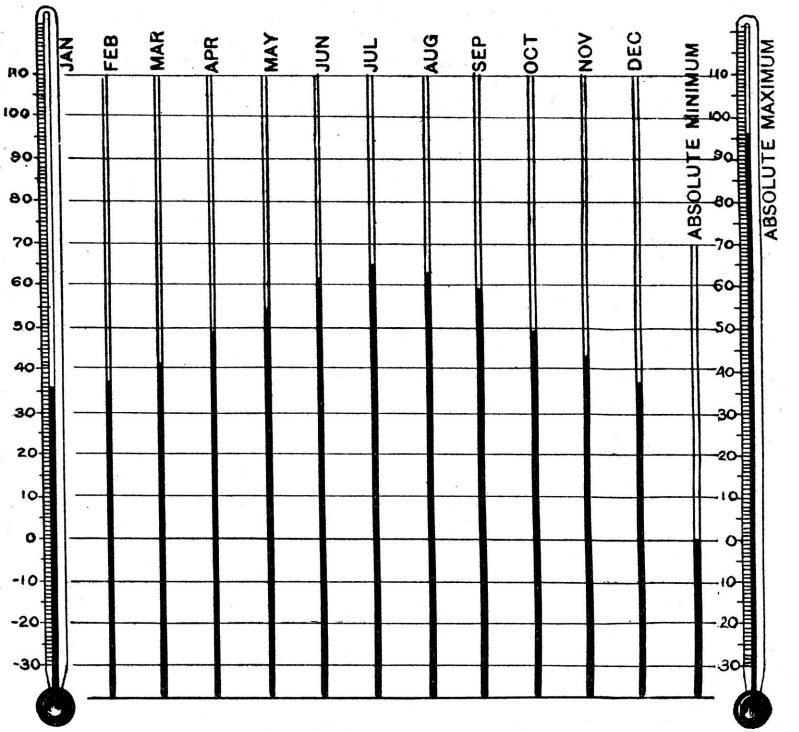


FIGURE 23. Diagram showing average monthly temperatures at Lille, France, in degrees Fahrenheit. The warmest month, July, has an average temperature of 65°, the coldest, January, 36°, a mean annual range of only 29°. The summers of northern France are much cooler than those of Camp Funston. The lowest temperature recorded at Lille is minus 2°, the highest 96°.

CLIMATE.

The soldier's interest in the climate of the region about Camp Funston lies chiefly in its effect on his comfort and activity, and how it compares with the climate he will find on the Western Front.

Like most other inland points in the great Mississippi valley, Camp Funston has a hot summer and a cold winter. The hottest month, July, has an average temperature of 78.7° F. (25.9° C.), only slightly warmer than June and August. Some days at the camp are as hot as 100° to 105° F., the highest recorded temperature being 115° F. (46° C.). Such extreme temperatures fortunately are rare, but on account of the dryness of the air they are not so oppressive as they otherwise would be.

The coldest month, January, has an average temperature of about 25.9° F., only a few degrees below freezing, but there are many winter days in which the mercury drops for a time below zero. The lowest recorded temperature near Camp Funston (Manhattan) is 32° below zero, but such extremely cold days are as rare as the very hot days of summer. The changes in average temperature from month to month at Manhattan are shown in Figure 22, where the great difference between average summer

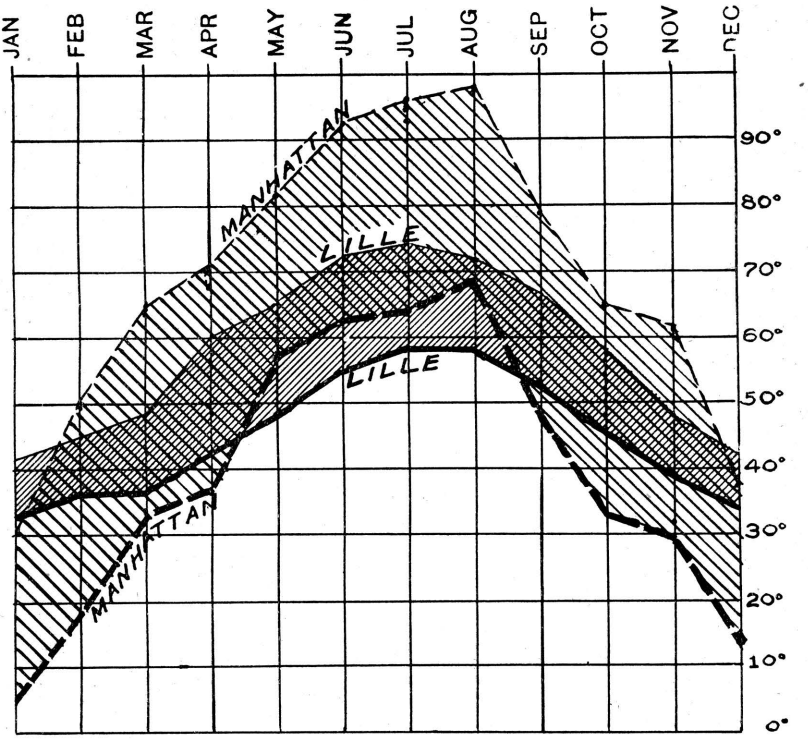
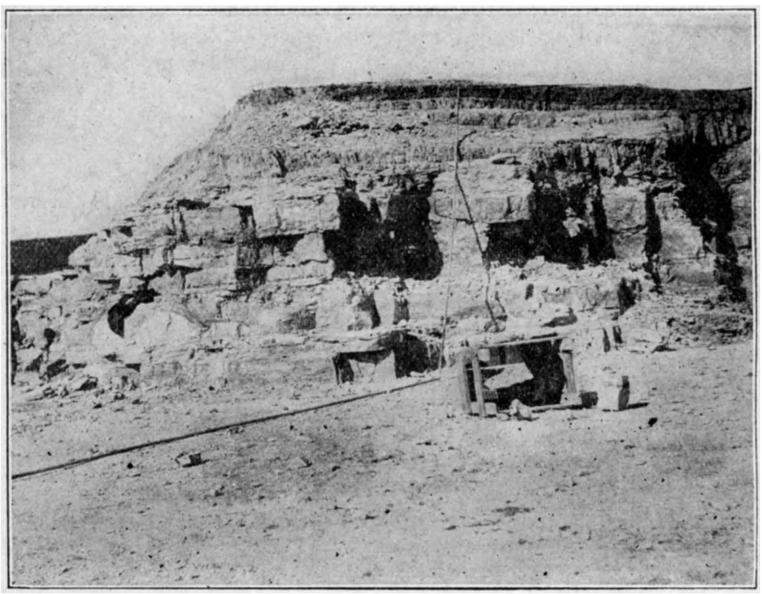


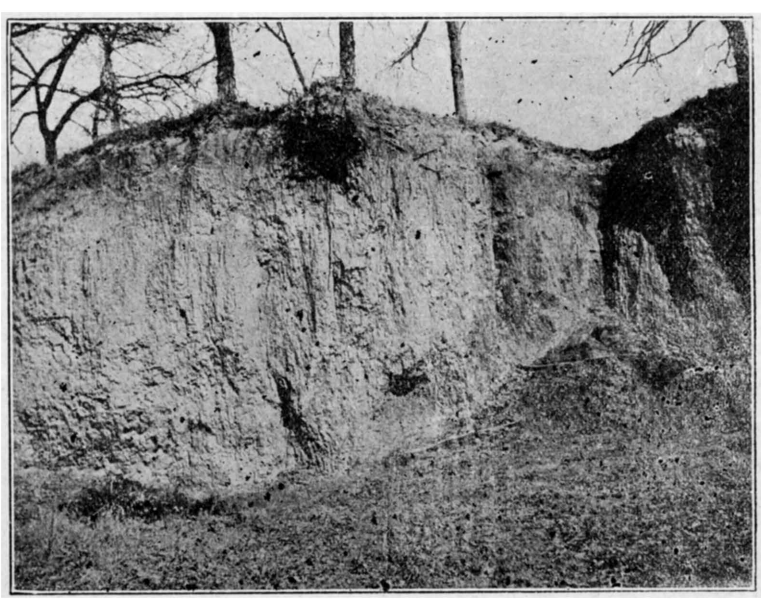
FIGURE 24. Diagram showing average daily range of temperatures at Manhattan, Kan., and Lille, France. The average maximum temperatures each day recorded at Lille in July are only 15° above the average minimum, while the average daily range at Manhattan in the same month is nearly 30°.

and winter temperatures, 52.8° F. (29.3° C.), is indicated. The average monthly temperatures at Lille, France, are shown in Figure 23. There is a difference in the average temperature of summer and winter of but 27° F, (15° C.) at Lille. At Camp Funston there is a considerable daily temperature range throughout the year; that is, it is hot or warm in the day, cool or cold at night. The mercury rises each day during July to an average of 93°, and falls to 63°, a range of 30°. In northern France and Belgium, because these countries are close to the sea, the temperatures are much more equal, and the warmest part of the day is rarely more that 10° or 15° above the coolest. January at Brussels has an average

STATE GEOLOGICAL SURVEY OF KANSAS. PLATE IX.



A



B

PLATE IX. *A*. Quarry in Wreford limestone near Fort Riley. *B*. Stream cut in alluvium on One Mile creek, near Republican river.

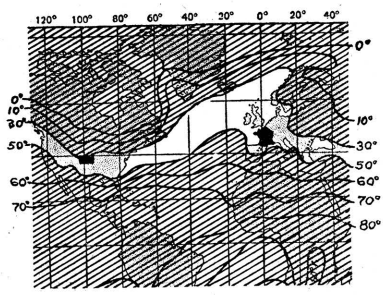


FIGURE 25. Map showing belts of equal temperature for January. Note that in winter Kansas and France have approximately the same temperature.

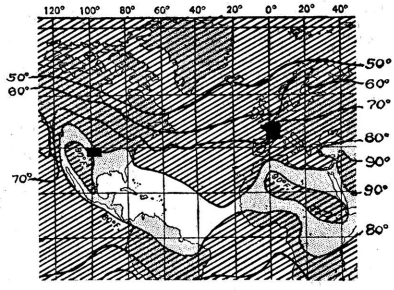


FIGURE 26. Map showing belts of equal temperature for July. Note that the temperature belt which includes Kansas is far south of France, where the summer temperatures are most like those of northern Canada.

temperature of 41° F. during the warm part of the days, but the coolest of the night is only 33° F., 8° cooler. These relations are shown in Figure 24.

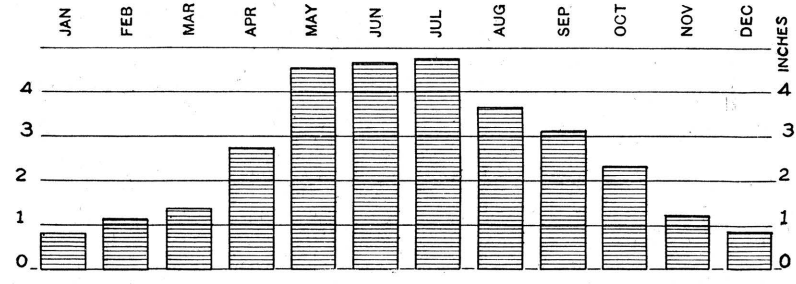


FIGURE 27. Diagram showing average monthly rainfall at Manhattan, Kan. Most of the rain of north central Kansas falls in the summer months. The winters are relatively dry.

Rainfall, including the water of melted snow, has an average yearly total at Camp Funston of about 31 inches—less than in the country farther east, but greater than western Kansas and eastern Colorado. (Fig. 29.) About sixty-five days out of the year at Camp Funston are rainy. Much the greatest portion of the rain (Fig. 27) comes in the warm

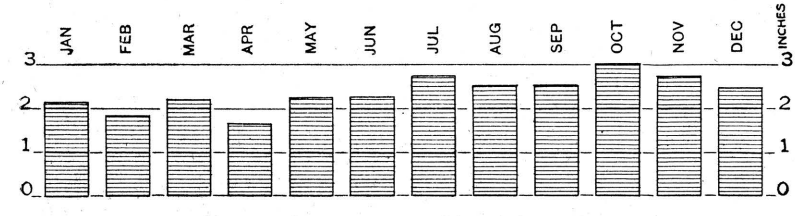


FIGURE 28. Diagram showing average monthly rainfall at Lille, France. While the total annual rainfall is approximately the same as that of Camp Funston, note that the rainfall is approximately equally distributed through the year. The winters of northern France are wet.

summer months as short, heavy showers, which make roads heavy and parade grounds and trenches muddy. Belgium and northern France have about the same amount of rain in a year as the region near Camp Funston, but unlike north central Kansas, the rains there are spread very evenly through the year. (Figure 28.) In winter there is much more snow than rain at Camp Funston, the average thickness for the season being about 16 inches (equal to about 1.6 inches of rain). The prevailing winds, which are sometimes very hard, are uniformly from the southwest or south.

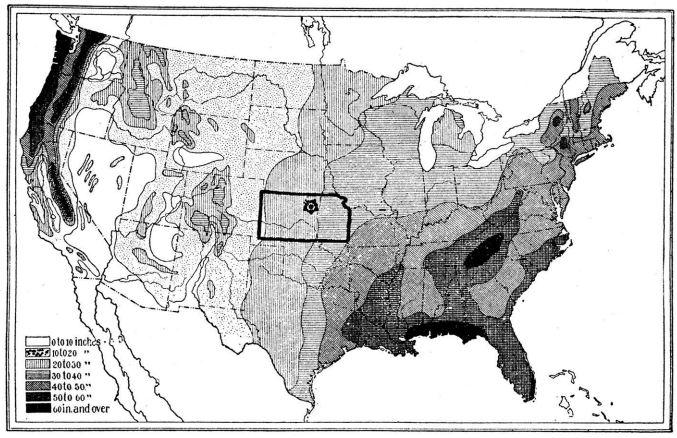


FIGURE 29. Map showing distribution of annual rainfall in the United States. In the open plains country of the Mississippi valley rainfall is much the same over great areas.

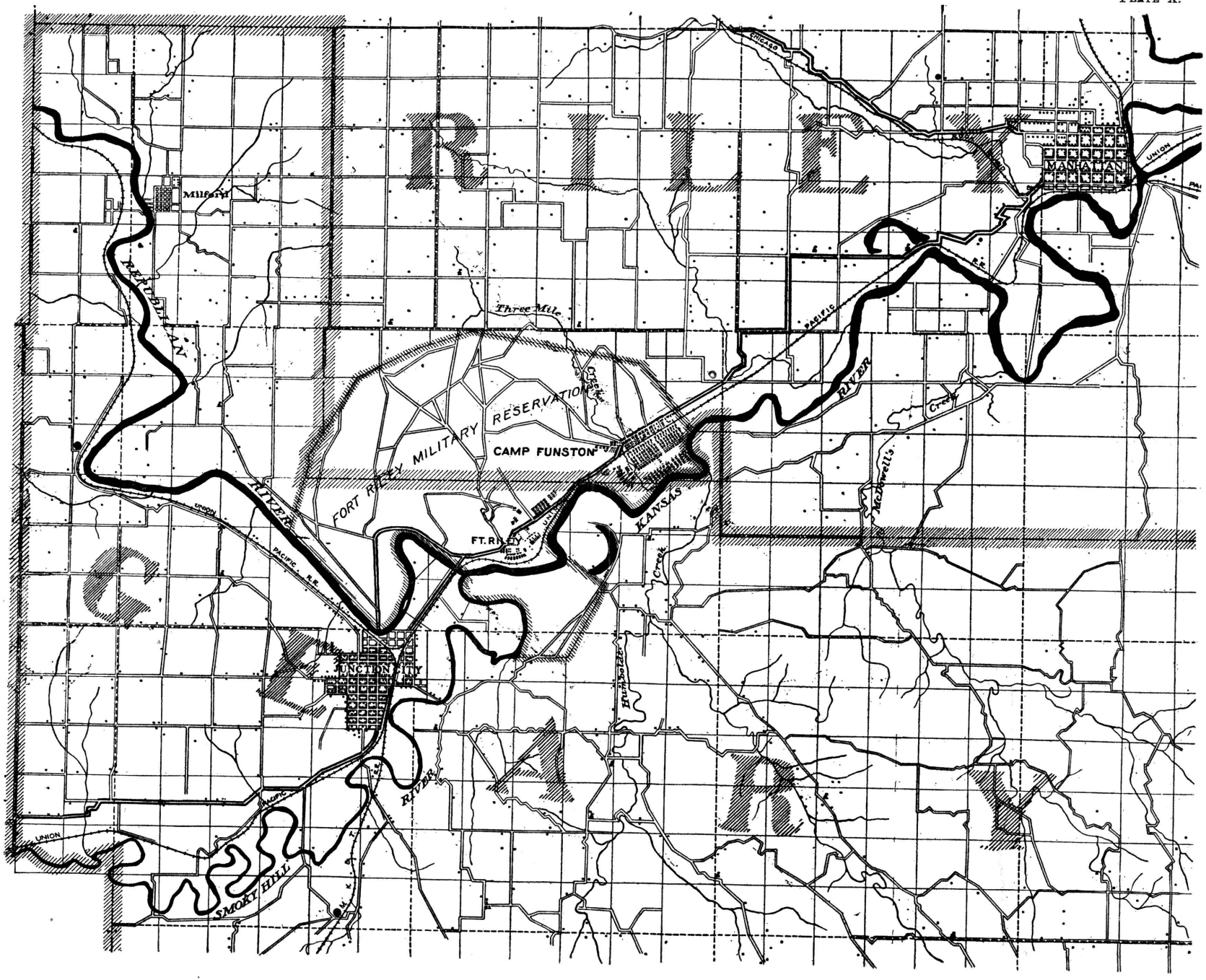
France and Belgium are much farther north than Kansas. The battle area is almost entirely north of the northernmost limits of the United States (excluding Alaksa). (Fig. 10.) Paris is nearly 700 miles farther north than Camp Funston and Brussels nearly 50 miles north of Winnipeg, Canada. The difference in longitude is such that noon at Paris is 6 o'clock in the morning at Camp Funston.

Because of the nearness of France to the ocean, which serves as a climatic equalizer, the winters of the battle area, despite the distance north, are milder than those of Kansas, and the summers much cooler than the summers of Camp Funston. The following paragraphs are an excellent summary of the weather conditions the soldier will meet in service on the Western Front.[6]

From the standpoint of bodily comfort, the climate of northern France and Belgium may be thus briefly summarized:

The winter weather is rather rigorous and unpleasant, due to the persistence of comparatively low temperatures, much cloudiness and frequent rain and snow. The winds blow mostly from the west or southwest and are frequently damp and chilly, the relative humidity being rather high. The winter nights are long and the days correspondingly short.

6. Day, Preston C., Notes on the Climate of France and Belgium, U. S. Dept. of Agriculture, Monthly Weather Review, vol. 45, p. 493; October, 1917.


Milford
REPUBLICAN
RIVER
Three Mile
Creek
FORT RILEY MILITARY RESERVATION
CAMP FUNSTON
FT. RILEY
U. S. RESERVATION
UNION
PACIFIC R.R.
CHICAGO
R.I.
MANHATTAN
UNION
PACIFIC
RIVER
Creek
KANSAS
Mathewall's
Creek
JUNCTION CITY
Republican
RIVER
Humboldt
Creek
UNION
SMOKY HILL
M. K. & T. R.R.

In the extreme northern portion of France, near the present battle line, the sun sets during the latter half of December a few minutes before 4 p. m. and rises about 8 a. m., making the nights, sunset to sunrise, about 16 hours long.

With the transition from winter to spring, the rapid warming up familiar to residents in most sections of the United States is not so noticeable in France and Belgium, the average temperature for March being only 2° to 4° F. higher than in February. April and May are moderately cool and not unpleasant, the length of the day increases much more

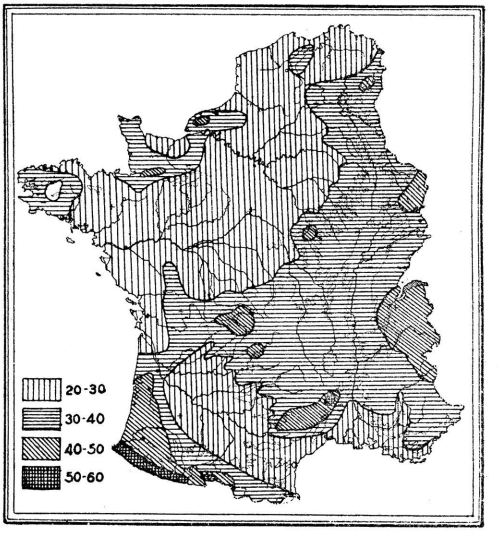


FIGURE 30. Map showing distribution of annual rainfall in France. The distribution of rainfall in Europe is very irregular. Even in a small country like France there is a rapid change from very wet to semiarid conditions.

rapidly than in most sections of the United States, and there is correspondingly large increase in the amount of sunshine, while rainfall is comparatively light, although occurring rather frequently.

The summers are pleasant as compared with much of the United States, the day temperatures being mostly moderate and the nights cool. Occasionally hot weather is experienced, but the heat is not excessive and the periods are usually of short duration. During the latter part of June the days in northern France and Belgium are more than 16 hours long, the sun rising a little earlier than 4 a. m. and setting after 8 p. m.

Fall also is usually pleasant, especially during September and October, the temperature during these months being, as a rule, considerably higher than for the corresponding spring months. With the advent of fall the rainfall usually becomes heavier, resulting more from greater intensity of falls than from increased frequency. This usually is the season of maximum rainfall.

CHAPTER III.

FEATURES OF MILITARY SIGNIFICANCE.

THE armies of the Great War know that the physical features of the country in which they fight affect almost their every activity. Each campaign demonstrates how large a rôle is played by the ground over which the armies move and fight. Military strategy is based on geography and topography as fundamentally as upon the fighting ability of armies. Mountains and rivers are barriers to the movement of armies; plains invite them forward. Steep slopes hinder or make impossible movements of artillery, cavalry, tanks, or infantry; gentle slopes are open to them. Defensive lines are placed where the advance of the enemy will be most difficult—along hills, high cliffs, swamps, large rivers, covers of forest. Offensive movements are directed toward country easy to traverse. Details of topography determine the landing places of aëroplanes, and control to a greater or less degree the effectiveness of gas warfare. Character of soils and underlying rocks determine whether trenches may be constructed quickly and maintained effectively. The study of these features broadly and in detail is absolutely essential to the proper direction of troops in the field and to a clear understanding of the movements of armies.

The following paragraphs present briefly points of military significance in the country around Camp Funston: first, those of a general nature affecting the strategy of a military campaign as a whole; second, features in the immediate vicinity of Camp Funston of importance in military tactics.

PROBLEMS OF MILITARY STRATEGY.

Military strategy involves the conception, or plan, of army locations and movements in campaigns. It is based upon a broad knowledge of the nature of the country to be traversed by the armies in the field, the strength and disposition of the opposing forces, problems of food and munition supplies, transportation, and the condition of army morale. The violation of Belgium in August, 1914, due to "military necessity," was a part of the German strategy to avoid the difficult country west of Metz on the direct and short line to Paris. The rapid retreat of the Allies and the sudden furious stand against the Germans, which won the first great battle of the war at the Marne, was in accordance with the strategic plan of Joffre. Similarly, the invulnerable defense of Verdun, the battles of Flanders and Picardy, and in the summer of 1918 the swift blow of Foch at Soissons, which began the great German evacuation of northern France and Belgium, are parts of broad strategic plans. Military strategy is the guide which controls all the work of fighting forces in the field—the plan which chooses times and places for attacks, retreats, and for unyielding defense.

It will be observed at once that the relation of any specific area, such as that about Camp Funston, to the large problems of military strategy in a campaign depends wholly on where the armies are located and what the direction of their movements. The general terms of the problems—food supply, munitions production, transportation, and protection of natural resources—would vary materially in case the supposed enemy were advancing north, east, south or west across north central Kansas. Moreover, the great, open, central plain of the United States is so unlike the battle ground of western Europe that it is difficult to draw any parallel to the conditions of military strategy in the present war. Even the far-flung battle lines of the Union and Confederate forces of the Civil War may not be compared to those in the present conflict. Nevertheless, the distribution of fertile fields, the position of great manufacturing and munitions centers, the location of iron ore, coal and petroleum deposits, the number and directions of railroads and highways, and especially the general nature of the topography in the central United States, would play a prominent part in outlining the movements of an army across north central Kansas. Most of the materials needed for war are east of Camp Funston, and it would be advantageous to defend eastern Kansas, Oklahoma, the Mississippi valley and eastern states with their well-watered fields, great cities, many railroads, and immense natural resources of coal, iron and petroleum, against an enemy advancing from the west, while it would be difficult to make attack from the arid west across the mountains of Colorado. On the other hand, the character of the terrain in north central Kansas, with its east-facing escarpments, like those of northern France, would favor defense against an enemy approaching from the east.

PROBLEMS OF MILITARY TACTICS.

Military tactics has to do with the successful and effective carrying out of the details in a strategic plan. It controls in detail the positions and movements of troops in the field, the location of trenches, gun emplacements, camps and billets, construction of roads and railroads for transport, and the choice of immediate objectives in attack. It touches every phase of the everyday work of an army in the field and depends upon features with which every soldier and officer should be familiar. From the standpoint of military tactics, there are many features in the region about Camp Funston which may be of very practical value in the training of the soldier, and they are of added interest at this time because in so many ways they duplicate conditions to be found in northern France, Belgium and western Germany. These features will be discussed briefly under their appropriate headings.

BARRIERS.

The ease or difficulty with which country can be traversed by troops in the field—infantry, cavalry, artillery, tanks and transports—governs to a very large degree the nature of military operations.

In a flat plain, like Flanders and northern Belgium, movements may be executed with utmost ease except when prolonged wet weather makes the plain a morass. The same may be said for river plains like the Aisne, the

Somme, or the Kansas, except for crossing the rivers themselves or in time of floods. In Flanders defenses are located with reference to any natural barriers available—rivers, canals, and low hills; or artificial barriers are constructed—barbed-wire entanglements, trench systems, and other fortifications. In such country even low ridges (Messines ridge, Mont Kemmel, Paschendaele ridge) become of greatest possible tactical importance because they dominate the surrounding lowlands. Some of the bitterest fighting of the war has been waged for their possession.

In hilly country, even a plains region with moderate relief, like Kansas or a large portion of northern France, any dominating feature of the topography assumes great tactical importance. The series of ridges and east-facing escarpments which form the natural defenses of Paris (Chapter I) have been in every campaign the keys to success for the opposing forces. The escarpment at Verdun is the barrier at which the German crown prince lost half a million of his best troops in unavailing efforts to capture "the gateway to Paris." The long, narrow ridge east of Soissons, along which runs the famous Chemin des Dames, is the barrier which dominates the valleys of the Aillette and the Aisne, and the lowland country toward Laon. It has been the ground fought over in the terrific Champagne battles. The larger streams are also important military barriers, not only because of the difficulty in crossing them under normal conditions, but because under fire of an enemy intrenched on the bluffs beyond it becomes an exceedingly serious problem to effect a crossing in force. Artillery must be brought up to silence as far as possible the hostile fire, bridgeheads must be established, and the crossing is at best a very difficult and dangerous manœuver. The Austrians were thus delayed in their early attempts to cross the Save and the Danube into Serbia. After the strategic retreat of Joffre and the defeat of the Germans at the Marne in 1914 the Allies pursued the invaders to the Aisne; but all attempts to effect a crossing of this barrier failed. Similarly, the Italians were able to defend the barrier of the Piave river after Cadorna's disaster before Trieste, and in the Austrian offensive of the spring of 1918 to capture thousands of the enemy troops caught behind the flooded and impassable river. Forests have served in the same way to block the advance of armies, both because they are easily made more impassable by means of wire entanglements and because they screen the movements of troops. The bitter fighting of the Americans for the Bois de Belleau (renamed Bois des Americains) and in the Argonne forest, and the long time required to expel the Germans from St. Gobain forest near Laon, the bulwark of the Hindenburg line, sufficiently show the part played by forest barriers. Swamps and lakes are barriers which proved the ruin of the great Russian offensive in east Prussia when Hindenburg brought disaster to the invading Russian armies. The marsh of St. Gond was a decisive factor in the victory at the first Battle of the Marne. In short, any feature of the terrain which makes the movements of an army difficult—in other words, a barrier—is an important object of study in military tactics.

In the vicinity of Camp Funston there are a number of military barriers. The topography of north central Kansas is quite like that of a large portion of the European battle area, and there is opportunity for

much valuable topographic study. The chief natural barriers are (1) the large streams, and (2) steep slopes, including (*a*) the river bluffs and (*b*) the upland ravines.

Kansas river and its two main tributaries, Republican and Smoky Hill rivers, are all sufficiently large to impede seriously the crossing of men, artillery, tanks and motor transports, except where they are bridged. Republican river is crossed near its junction with the Smoky Hill at the head of the Kansas by bridges of the Union Pacific, the interurban, and a road bridge, and again by the Golden Belt highway just north of Junction City. These passageways connecting Camp Funston and Junction City are the only crossings of the Republican and Kansas rivers between Manhattan, eighteen miles northeast of Junction City, and the small town of Milford, twelve miles northwest, or a total distance, as the river flows, of forty-four miles. The wide separation of the bridges along the Kansas and Republican leaves very long stretches which are without practicable crossings. Bridges are easily destroyed, so that the problem of stream crossing here under conditions of actual warfare would be a serious one. The river would become an almost impassable barrier in floods. There are four bridges across Smoky Hill river within six miles south of Junction City. The problem here, especially as the Smoky Hill can at certain places be forded in low water, is not so serious, but farther west there is a considerable stretch without bridges.

The high river bluffs which line either side of the Kansas, Republican and Smoky Hill are of very great military importance, commanding as they do the bottom lands for many miles up and down the river. Forces strongly intrenched along the bluffs, with guns properly emplaced, would make attempts by a hostile force to cross the stream and climb the bluffs to attack extremely hazardous. In defending the line of bluffs it would be necessary to give special attention to the gaps where tributary streams, such as Three Mile creek, flow down from the upland. The continuity of defending trenches on the higher land is broken here, and this is the easiest point of attack for enemy troops. The Germans advancing west from Metz in 1914 were unable to take the line of bluffs east of Verdun; but ascending breaks in the bluffs caused by east-flowing streams, they were able to capture St. Mihiel. This they held uninterruptedly until Pershing's attack in 1918 obliterated the threatening salient. Similarly, the importance of Rheims, Laon and Toul are largely due to the positions which they occupy at the breaks in escarpments.

The country back of the bluffs, due to its extreme roughness, is difficult both for defending and attacking troops. The relations of slopes of various angles in the stream valleys of this portion of the reservation to movements of infantry, cavalry, tanks and artillery, and to protection against fire from various positions on the uplands, is of some little interest. Problems of trench location with reference to the defense of the uplands may be studied to advantage.

The east-facing escarpments produced by the outcrops of hard limestone beds are the most important military barriers in the country back from the large streams. (Fig. 17.) From the top of the escarpment the region below may be observed clearly for many miles, and it could be dominated easily by gun fire. The Camp Funston region is at the north

end of one of the most prominent escarpment lines in Kansas, that of the so-called "Flint Hills." To the south of Funston it is higher and less broken by stream valleys, and it forms here a barrier in almost every respect a counterpart of the defenses of Paris. There are excellent opportunities along the escarpments near Camp Funston for study of military tactics with reference to this type of barrier.

ROADS.

Of very first importance to an army is the position, number and character of all means of transportation, railroads, roads, harbors, rivers and canals. Like all armies, the modern army "travels on its stomach," and, to a degree hitherto undreamed of, depends on an uninterrupted supply of the materials with which it wages war. Without food and ammunition and without means for bringing reserves when needed an army is helpless. One of the foremost considerations of an army commander, therefore, is to provide and protect adequate means of communication between his armies and bases of supplies. The shorter and easier the conditions of transport for men, food and munitions, the greater the advantage, and conversely. The British disaster at Kut-el-Amara, Mesopotamia, in 1915, was due to overlong lines of communication and their inadequate protection. The rapid retreat of the Germans from the Marne in July, 1918, was caused by the threat to the German lines of communication from the successful Franco-American attack on their flank at Soissons. The short distance of the German supply centers from both eastern and western fronts in the first years of the war made it possible for them to supply easily the armies in the field and to shift reserves quickly from one front to another. Germany was on the inside of a circle, with excellent means of transportation, the Allies on the outside, with means of intercommunication very difficult. The same advantage of transportation conditions has been with the Germans on the Western Front, where, until Foch begun to press the enemy on all sectors of the line, it was possible to shift reserves and materials from one part of outward bent line to another. The selection of important lines of defenses, as the Hindenburg line, the Valenciennes-Mezieres-Metz line, has been made in no small part with reference to lines of easy communication parallel to the front and back of the German lines. The remarkable system of roads in France has been of almost incalculable service to the Allies, and since the beginning of the war many new roads and railroads have been constructed. One of the first calls on America's entrance into the war was for regiments of railroad and highway engineers.

Near Camp Funston the main avenue of transportation is the big valley of the Kansas river. Here lies the main line of an important transcontinental railroad, and electric interurban, and excellent automobile highways. A short distance west of Camp Funston, between Salina and Abilene, the Smoky Hill valley is occupied by three independent railroads. The Golden Belt highway, from Kansas City and Topeka to Denver, is surfaced with limestone in the vicinity of Camp Funston and is an excellent road even in wet weather. The electric

interurban runs only from Manhattan to Junction City. Communication in an east-and-west direction is very easy. Transportation either north or south across the upland, however, is more difficult. There are no railroads except the line of the M. K. & T. railway south from Junction City, and branches of the Union Pacific in the valleys of Republican river to the northwest and Blue river at Manhattan, north. Wagon roads to the north and south are of the ordinary "dirt" type. Main roads are very good in dry weather, but are almost impassable after protracted rains. There is abundant material of very satisfactory character for road surfacing in the vicinity of the camp, in the hard limestone and flint beds which are exposed along the bluffs and in the stream valleys of the uplands. Quarries have been opened at a number of points near Fort Riley and Camp Funston and road work has been active. Streets in the camp, at Fort Riley, and a number of the roads

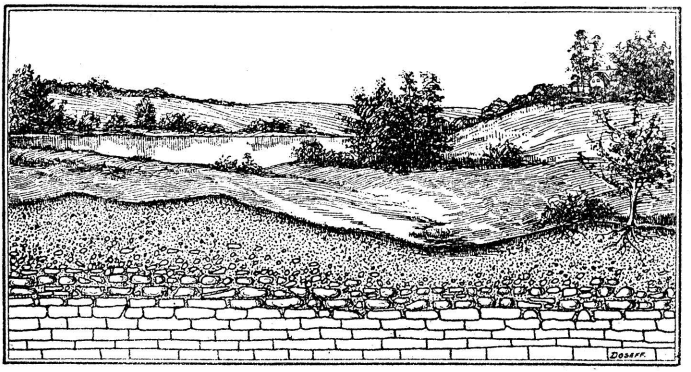
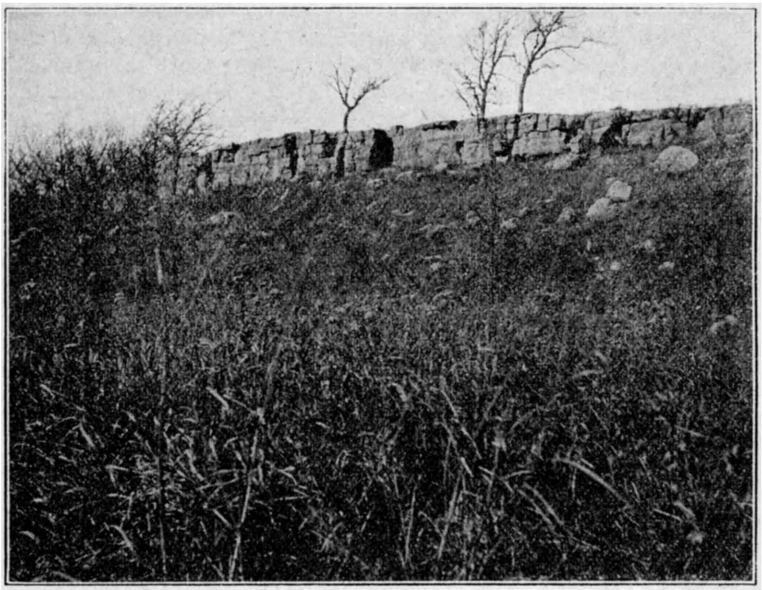


FIGURE 31. Diagram showing typical relation of soil to underlying rocks. In many places soil is extremely thin, and if the rock beneath is a hard formation, trench construction is slow and difficult.

in the reservation are now surfaced, all-weather roads. In general, however, the roads of north central Kansas have not been improved. For economic reasons, if not for military purposes, it is strongly to be hoped that highway construction and improvement may be undertaken vigorously.

TRENCHING AND TUNNELING.

The present conflict has developed, to a degree previously unknown in warfare, the art of temporary and permanent defense systems of trenches, tunnels and dugouts. Some of the trenches of the opposing forces on the Western Front, especially those of the Hindenburg line and supporting defenses, are exceedingly elaborate works. All soldiers in active service are equipped with trenching tools for use either in constructing temporary individual "funk" holes or in excavating complete trench systems. The nature of the ground in which ditches or trenches are to be excavated is of prime interest and importance to any body of troops in the field. Successful operations in actual warfare often depend



A

B

PLATE XI. *A*. Exposure of Fort Riley limestone at top of valley slope. Uplands northwest of Camp Funston. *B*. Wall of Fort Riley limestone and broken fragments from its weathering, near head of Forsythe creek.

upon the quickness with which trench protection can be constructed and the effectiveness with which it can be defended.

The thickness and constitution of the soil, the nature of the underlying rocks and the problem of drainage are all features which should enter into the selection of trench locations, particularly of those which are to serve as more or less permanent lines of defense. In a soft, loamy soil with underlying shale formation, as on the upland in the northwest part of the reservation, trenches may be constructed quickly and easily. However, on many of the lower divides and on steep slopes where the bedrock is near the surface, limestone beds will probably be encountered in trenching operations. Where the limestone has been broken into small pieces by freezing and thawing, and disintegrated by the dissolving action of rain water—in other words, where the rock is much weathered—it may be possible to construct trenches to depths necessary without great difficulty. Where hard rock is close to the surface and relatively unweathered it is, of course, very difficult to excavate a trench, and in a thin-soiled region of hard rocks, like granite, for example, it is almost impossible to construct trenches without blasting.

The problem of drainage in trenches is a very important one and deserves careful study. Facility of drainage depends upon the topographic position of the trench system and upon the material in which the trench is excavated. It is impossible to drain a trench in a water-soaked lowland, such as a river plain during wet season, and on some river plains trenches would be more or less filled with water most of the year. In case of flood, trenches on river flats would, of course, become absolutely untenable. Much of the discomfort and danger of river-plain trenches have been experienced by the troops in the low wet plains of Flanders. It is impossible to construct dugouts in a water-soaked plain. Trenches in higher ground may be drained (1) by making the bottoms of the trenches slope enough for the water to run out, (2) by digging ditches near the trenches so as to divert surface drainage from them, and (3) in some cases by underdraining through a boring into a porous lower stratum. Rocky or sandy material is, in general, sufficiently porous to drain readily without much trouble. Trenches constructed in areas of dune sand, such as on the coast of northern France, therefore, are generally dry even in wet weather. Trenches in clayey material tend to hold their moisture and drainage is difficult.

The walls of trenches in rock will stand without support, but in ordinary soil, sand or clay, revetment of some sort is needed if the trenches are to be more than temporary. This is illustrated by the slumping in of some of the trenches constructed near Camp Funston a year ago. Method of revetment depends upon the nature of the material in which the trenches are excavated.

Tunneling has been important in the battle fields of Europe both for offensive and defensive purposes; in offense for mine-laying and listening operations, in defense for dugout and bombproof shelter construction. As in trenching, the problem of tunneling depends very greatly upon the nature of the material to be penetrated. Tunneling in a hard, massive,

rock formation is a slow, difficult process, but underground rooms constructed in solid rock are thoroughly bombproof and of permanent value.

In the uplands behind Camp Funston conditions are excellent for practice tunneling. Tunnels and dugouts may be excavated very quickly in the shale formations here, and if they are located just below the limestone beds the limestone will form a natural strong roof. The roof of any large tunnel or room underground should, however, be adequately supported by strong pillars. At some places on the western front and in Italy natural underground passageways, made by the action of ground water, like Mammoth cave and the many caverns of Kentucky, Virginia, Missouri and other states, have been used very effectively by both fighting forces. Great underground rooms (dolines), some of them large enough to hold whole battalions and great quantities of supplies, were employed by the Austrians defending Trieste as shelters for troops, gun emplacements and as natural fortresses. The Italians found it almost impossible to dislodge their opponents from these natural strongholds. Underground tunnels and caves in the thick limestone bluffs around Verdun were similarly utilized by the French for the protection of their troops and as emplacements for their guns, contributing in no small degree to the decisive defeat of the German assaults. Very successfully and systematically the Germans have employed trained geologic engineers for advice as to location of trenches, tunnels and other excavations. Taking into account ease of excavation, possibilities of drainage, and the ability of materials to stand both when wet and dry, their assistance in this sort of engineering work, as well as in road construction, water supply and many other problems of an army in the field, has been invaluable.

WATER SUPPLY.

The problem of water supply is a fundamental one to an army. More than one military campaign in the past has proved costly or disastrous because of failure to recognize adequately the fact. In a well-watered region with heavy rainfall there may be springs with large flow, but this rarely affords a sufficient supply for a large number of men. The most important problems of water supply are, first, to obtain pure water; secondly, to obtain it in sufficient quantities at the places where it is needed.

Since the water in streams is generally entirely unsuitable for drinking, and especially so under war conditions, chief dependence must be placed in wells. Well water is rain water which has entered the ground, in some cases having moved long distances from its place of entrance before reaching a well, in others only a short distance. The purity of well water depends wholly on the sources of the water and the cleanness of the well. The possibilities of well contamination, therefore, should be thoroughly understood. Underground water moves down slopes just as surface water does. If a stable or other source of contamination is located near and above a well (Fig. 33), not only may surface drainage from it reach the well, but impurities will be carried by the water sinking into the ground and will find their way into the well, unless the well is specially constructed so as to exclude it. Modern drilled wells are

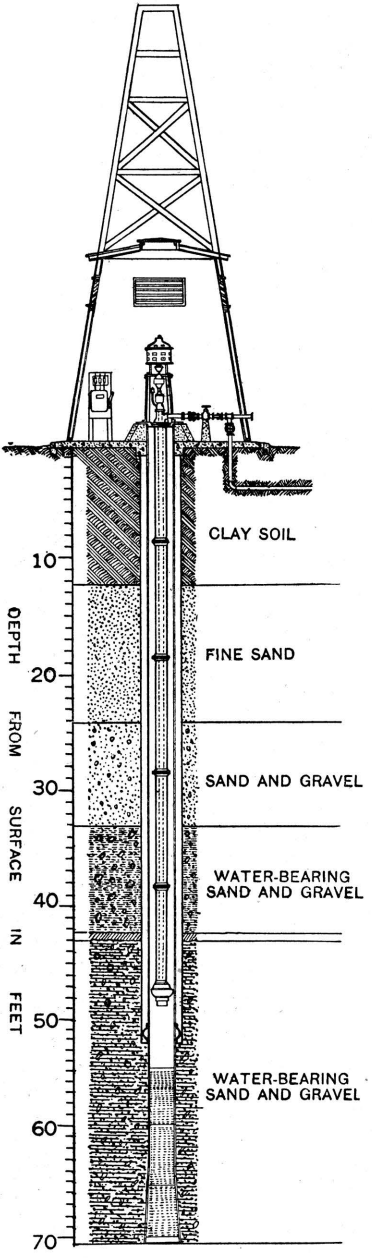


FIGURE 32. Section of water well on the Kansas river plain, one of eight which supply Camp Funston. The water, obtained in coarse sand and gravel, is part of the underflow of Kansas river.

generally cased to a point some distance below the ground-water level, which stops the entrance of contaminating surface and near surface drainage. The water in such well is very much safer than in the old-fashioned "dug" well, open at the top and uncased. In every case a well should be located so as to avoid as much as possible any likely source of contamination. In regions of dense population, as in villages and cities, or even in thickly settled farming communities, shallow wells are very unsafe unless properly located and constructed. In the present war, according to press dispatches, difficulty in securing pure water has been aggravated in certain places on account of intentional contamination and poisoning of well waters by the enemy.

In many places to obtain drinking water in sufficient quantities for a large number of men is a serious problem. The largest and most permanent sources are the underflow of large streams, such as the Kansas, the water of certain porous underground strata, and bodies of surface water, such as lakes, which are sufficiently large and pure. In moist climates all of these sources are likely to be larger than in dry regions. Geologic information is always desirable in seeking supplies of drinking water for military camps.

The water supply of Camp Funston[1] is obtained from eight wells drilled on the flood plain of Kansas river at the south and west edges of the camp. The first wells, drilled during the early construction of the camp, are located south of the camp near the river, and are relatively shallow (40 to 58 feet). Their individual capacities range from 115 to 315 gallons per minute, their combined capacity being about 940 gallons per minute. In November, 1917, three wells were drilled on the west side of the camp to a depth of about 71 feet, penetrating in their

1. Information concerning the water supply of Camp Funston was kindly furnished by Major W. L. Benham, officer in charge of camp utilities.

lower portion (Fig. 32) thick deposits of coarse water-bearing sand and gravel, the water being part of the underflow of Kansas river. The capacities of these wells—875, 1,100, and 1,200 gallons per minute—is very much larger than any of the shallow wells, and the total available daily water supply for the camp (approximately 4,320,000 gallons per day of 24 hours) is entirely adequate for the requirements of the camp.

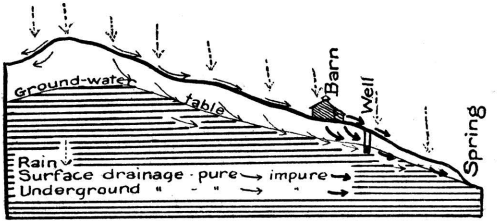


FIGURE 33. Diagram showing relation of ground-water table to the surface, and sources of possible well and spring contamination. Surface drainage and underground seepage from barn may enter well or spring below.

The water is pumped from the wells to a collecting reservoir, and from this reservoir is lifted to four wooden tanks of 200,000 gallons capacity each, located on the bluffs north of the camp.

The water from the wells is extremely hard, containing approximately 6 grains of solid matter per gallon, or about 400 parts per million. On account of the deposits of iron and other solids and the growth of Crenothrix, a low form of plant life, with consequent damage to water tanks, boilers and water backs, a new 3,000,000-gallon per day iron-removal reservoir and rapid sand mechanical filter plant is being constructed. The water will also be softened by a soda and lime treatment, which will remove all encrustating solids.

The water supply of Fort Riley is obtained from wells located about a mile west of the fort on the flood plain of Republican river. The water is pumped to the large reservoir on the hill behind the fort by the pumping station in Pumphouse canyon.

APPENDIX.

EXPLANATION OF MAPS.

A MAP is a representation, to scale, of a portion of the earth's surface. There is an almost endless variety of maps, depending upon the purpose for which the map is intended—land maps, railroad maps, geologic maps, etc. Almost any good map is of some value for military purposes. However, special maps, commonly designated military maps, are used by all armies in the field. A military map is one which shows

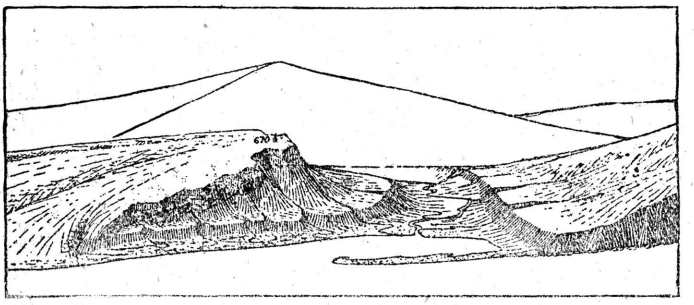


FIGURE 34. Ideal landscape with gentle and steep slope.

accurately all the features of the country which are of military significance. Besides towns, villages, rivers, railroads, and such features as are commonly shown on a good map, the military map must show the character of the ground, hills, valleys, and plains.

On American military maps the surface features are shown by means of lines, called contours. On the ground a contour is an imaginary line

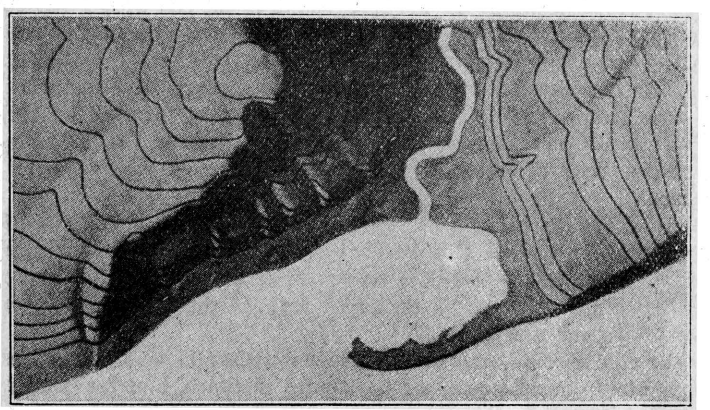


FIGURE 35. Model of the ideal landscape shown in Figure 34.

which passes through points that have the same altitude above sea level. Therefore, one who follows a contour goes neither up hill nor down, but always on a level. The contour lines on a military map, as in Plate I, show not only the shapes of the hills, bluffs, and valleys, but also their elevation above sea level. The line of the seacoast itself is contour 0. The contour 20 feet above sea level would be the shore line if the sea were to rise 20 feet. Where contour lines are far apart, as on the bottom lands of Kansas river, or the tops of the upland divides, they show that the land is nearly flat, for it is necessary to go a considerable horizontal distance to move 20 feet vertically. Where contour lines are

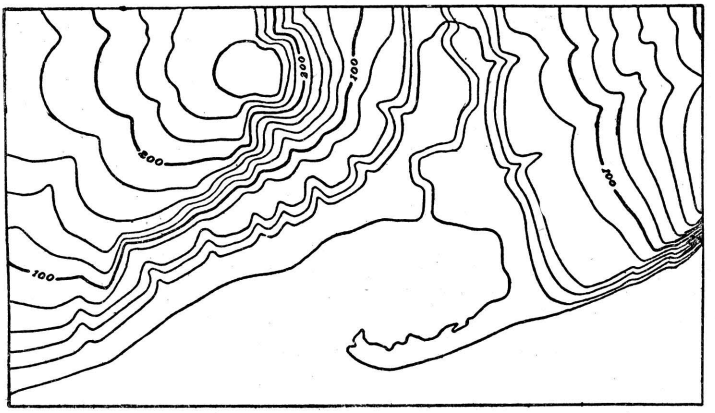


FIGURE 36. Contour map of area shown in Figure 34. The contours are widely spaced on gentle slopes and close-crowded on steep slopes.

crowded close together, as along the river bluffs (Plate I and Plate VII), they represent a steep slope.

The manner in which contour lines express altitude, form and slope, is shown in Figures 34 to 36. The sketch, Figure 34, represents a river valley between two hills. In the foreground is the sea with a bay that is partly enclosed by a hooked sandbar. On each side of the valley is a terrace into which small streams have cut narrow gullies. 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 tableland, which is traversed by a few shallow gullies. On the map each of these features is indicated beneath its position on the sketch by contour lines.

Official maps of the French military staff, *Carte de France de l'Etat-major*, represent surface features by down-slope lines or hachures, which are drawn short, heavy and close-set for steep slopes; long, fine and open-spaced for gentle slopes. A hachured map of the landscape shown in Figure 34 is given in Figure 37.

On the map of the Camp Funston region (Plate I) one inch represents approximately one kilometer of horizontal distance, and the map is divided by cross-ruled squares into quadrangles one kilometer each way.

The scale of the map, 1:40,000, shows that one unit on the map equals 40,000 horizontal units on the ground, as, one inch on the map equals 40,000 inches on the ground.

FIGURE 37. Hachure map of area shown in Figure 34. The direction of slope is indicated by the direction of the lines, the steepness of slope by the weight and crowding of the lines. Hachure maps are employed by the French general staff.

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