DESCRIPTION OF JAMESTOWN-TOWER DISTRICT.

INTRODUCTION.

Location.—The district here described is bounded by merid­ians 97° 30' and 99° west longitude and by parallels 46° 30' and 47° north latitudes. It comprises the Jamestown, Eckel­son, and Tower quadrangles, which have an area of about 285 square miles each, or a total of about 2400 square miles. Posi­tions of Cass, Barnes, Stutsman, Ransom, and Lac qui Parle counties, North Dakota, are embraced within the area. (See fig. 1.)

The eastern boundary coincides very nearly with the Red River valley, and the western boundary lies at the eastern edge of the Missouri Plateau.

The largest settlement in the area is Jamestown, Valley City and Tower being next in size. All three towns are on the main line of the Northern Pacific Railway, which crosses the eastern portions of the district.

General relations.—Northern Dakota is embraced in the Great Plains, lying between the Rocky Mountains and the Mississippi Valley. The greater part of it is between 1000 and 1500 feet above sea level. It is crossed by the indefinite divide that separates the waters of the Gulf slope from those of the Hudson Bay slope, and is drained mostly by Red River but partly by James River, a branch of the Missouri. It lies within the glaciated area of North America, and its surface features show the characteristics of a drift-covered region. The country is generally level, but presents broad slopes, with accidents due to preglacial erosion, which in place rise 300 to 600 feet from the adjacent plains lying to the east. Further diver­sity of topography has been produced by the exavation of the deep, steep-sided valleys of Missouri, James, and Sheyenne rivers. Between the morainal ridges occur gently rolling plains of till, or nearly level plains due to the filling of glacial lakes.

Several ancient channels occur within the area, but these in no sense drain the areas they cross.

The eastern slope of Alta Ridge declines rather steeply to 400 feet above the plains lying to the east. Further diver­ence of slopes along the river valleys indicates approximately the posi­tion of contact between the slope and the drift. Below the slope are sandstones, or a succession of sandstones and shales, of Cretaceous age, which attain a thickness of 300 feet or more and contain the artesian water supplying many deep flowing wells in all parts of the area. In parts of eastern North Dakota this sandstone series lies on granitic rocks of pre-Cambrian age. At the place where the streams flowing wells in all parts of the area. In parts of eastern North Dakota this sandstone series lies on granitic rocks of pre-Cambrian age. At the place where the streams

The eastern slope of Alta Ridge declines rather steeply to 200 feet or more to the west of the divide of the Map­le River basin.

The valley of Sheyenne River extends almost the breadth between the Tower and Eckelson quadrangles, widening east­ward in a broadly sinuous course near the southwest corner of the Tower quadrangle. It is a steep-sided trench about 300 feet deep, with a generally flat bottom averaging about one-half mile in width.

The valley of James River enters the area near the center of the northwestern boundary of the Jamestown quadrangle and leaves the area in the southwestern portion of the Eckelson quadrangle. Its depth varies from 100 to 150 feet and it is steep-sided and flat bottomed. Lateral valleys of smaller size enter the Sheyenne and James valleys at intervals and give to the plains adjacent to these valleys a deeply troughed appearance. Here and there wide troughs of ancient waterways also cross the broad, gently rolling plains of the interstream divides.

The western portion of the area rises by moderately steep slopes about 300 feet, and the eastern part has an average elevation of about 1100 feet. The small portion of the extreme southeast corner of the area, is excavated nearly to the 1000-foot contour.

A broad swell called Alta Ridge, which rises about 100 to 400 feet above sea level of about 1100 feet. The small portion of the extreme southeast corner of the area, is excavated nearly to the 1000-foot contour.

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The lowest sedimentary formation recognized in the James­town-Tower district consists of 200 to 300 feet of light-colored soft sandstone in beds 10 to 50 feet thick, generally divided by depres­sions of shales. It lies several hundred feet below the surface and is believed to extend west as far as the Dakota sandstone, but some of the water-bearing beds may belong in the Colorado group. The greatest known thickness of the sandstone in the area, where 200 feet have been penetrated by wells. In boring at the Jamestown Asylum the amount appears to be only 200 feet, with line­stones at the base.

In the eastern portion of the Tower quadrangle the top of the sandstone series lies about 400 feet below the surface, or about 500 feet above sea level. To the east the depth increases gradually, owing to a gentle dip in that direction and also to increased elevation of the land. West of Jamestown, where the surface rises more abruptly toward the Missouri Plateau, the depth increases rapidly, so that the sandstone is 1700 feet and more in the highest lands on the west margin of the district. The two wells that are furthest west in this area are the Jamestown city well, 1476 feet deep, altitude 1410 feet; and the well in sec. 7, T. 136 N., R. 64 W., 1435 feet deep, altitude 1325 feet. Thus from R. 54 to R. 64 W., the rise of the land is about 400 feet, while the increase in depth to the water-bearing sandstone is about 1000 feet. This indicates a westward dip of the water-bearing sandstone of about 600 feet in a distance of about 20 miles, a slope of 1 feet per mile. (See fig. 6.) The dip is nearly uniform and the upper surface of the sandstone appears to pass below sea level along a northerly line, giving the surface a short distance east of the Jamestown Asylum, and to be about 175 feet below sea level in the extreme northwest corner of the district. The depth to the sandstone is shown in the list of wells on page 10, but a number of these wells penetrated some distance below the top to find water in satisfactory volumes with sufficient velocity of flow. The well drills have furnished very few data as to the characters and relations of the sandstones.
The records of deep wells indicate that the shales beneath the glacial drift are of blue-black color and that they contain a few thin deposits of sand. In the lower part of the shale the well have been found in these lower shales within this area, so their for some distance below is Pierre shale; the underlying shales Benton and Niobrara strata of the Colorado group. No fossils are embedded rock fragments of various sizes, alphas, and lithologic characters.

The Dakota sandstone is supposed to begin with the quicksand beneath the 290-foot bed of blue shale, at a depth of 1299 feet. While stratified deposits of sand, gravel, and clay are of common occurrence, much of the drift is unstratified. The unstratified material consists generally of a matrix of clay in which are embedded rock fragments of various sizes, alphas, and lithologic characters.

The stony material of the drift ranges in size from coarse gravel to boulders. While several diameters, the large boulders are not generally abundant except in Alta Ridge and in the shales of the Shyenne and Jannus valleys, in proximity to moraines. In the latter situation boulders from 6 inches to 3 feet in diameter form a pavement over considerable areas. Boulders gathered in heaps from the eroded hills on Alta Ridge show averaging a few feet in diameter.

The till beds are relatively free from stony materials, as shown by exposures in valleys and sections of the drift in mudflats and wells. Of 200 well records 10 only were reported as containing any considerable amount of stony material. Granitic rocks, dark basic intrusive, and quartzite rocks make up the major portion of the stony material of boulder size. It is estimated that perhaps 10 per cent of the boulders are limestone. At some places shale boulders and clasts are found in the terraces and drift deposits. On the whole the foreign material of the drift constitutes a very small fraction of the glacial deposits. Small fragments of crystalline rocks may be seen upon minute inspection of the sand and clay beds, almost the entire body of the till is of local origin.

Probably no important deposits of gravel or gravelly materials have been worked in the region of the drift. The coarsest and largest gravelly deposits with polished facets baring well-marked glacial grooves and striations occur in the body of the glacial deposits of this area, although not as abundantly as in corresponding situations in Illinois or Wisconsin. The arrangement and direction of the terminal moraines indicate a south-westward movement of the ice sheet. (See fig. 2.) The region of Archean rocks about 400 miles to the southwest seems to have been the source of the foreign material of the drift, which has found lodgment in the beds of the district. Lenticular pseudomorphosed masses of porus intrusive-like limestones in which are included drift pebbles and cobbles, the whole present the structure of an ordinary conglomerate with a limestone matrix (clay) pieces embedded in the drift. One occurrence is in Madison County, sec. 4, Spring Township (T. 138 N., R. 3 W.), on the west side of the valley near to and above a ledge of outcropping shale. Another is on the north bluff of Shyenne River, sec. 12, Fort Ransom Township (T. 135 N., R. 56 W.), in a gravelly mass of drift mixed with sand, exposed by a road leading into the Shyenne Valley. The most notable occurrence, however, is in the till sheet, as estimated, sec. 23, Oakville Township (T. 137 N., R. 58 W.), where a series of several hundred square rods, broken by deep gorges and hills and supporting a denser growth, is covered with large blocks and irregular masses of limestone, scattered unevenly over the surface.

Evidence of changes in glacial environments suggests that the continental glacier has been in this area, but the history of the stages of glaciation and deglaciation can not at this time be fully written, owing to the fact that the earlier glacial deposits are so thoroughly commingled with the later drift, and completely burried by it, that only in complete distinction can be made.

Evidence of deglaciation and the formation of soil and the accumulation of alluvial materials, and of the subsequent advance of the ice and burial of these deposits, is afforded by the reports of swampy, musky, and lignitic materials encountered in digging or boring for water at depths of 20 to 40 feet below the present surface. Evidence of a period of rotation, which was in turn followed by a period of destruction, for the landforms features, is afforded by certain topographic forms that are best explained by assignment to an earlier invasion of the ice sheet. These are described below. There are in this district several series of small lakes or lakelike basins which occupy long depressions but are individually separated by low hills or hummocks of drift. Among the most prominent of these are the lakes and lakelike basins forming the Erskine, Hanhorn, and Fort Lake series, in the Erskine quadrangle, described below.

A notable chain of lakes whose interpretation is in doubt but which are probably connected with lakes exposed at the surface in this area and the northern part of the district. These lakes seem to bear no relation to a preexisting valley, and therefore do not belong to the class referred to above. That they are related in origin to the deglaciation of the region seems certain.

These depressions of uncertain origin range from 20 rods in diameter to half a mile in width and 15 miles in length. Their sides are steep, composed mainly of till, and are in many places bordered with cobble and boulders. The bottom is flat and shallow, and ranges from 20 feet below the surrounding plains. Some of the depressions join; some are separated by low bare of gravel and sand, and others are bordered by till. Hills and ridges from 10 to 20 feet in altitude having gentle slopes and presenting the characteristic of terminal moraines rise to the sides of some of these lakes. More commonly, however, the lakes are surrounded by a nearly level or very gently undulating plain, the depressions occurring as pits in a gently undulating surface. There is no definite alignment of the hills with reference to the longer axis of the lakelike plain.

Deposits of the Wisconsin Stage. Glacial Bored.

Deposits forming and overridden during the advance of the glacier are known as ground moraines. When the final melting took place each drift as remitted in the body of the ice surface was let down upon the subglacial deposits. Generally such additions of subglacial and superficial drift are not very clearly distinguishable from the drift deposited beneath the ice. The tilliferous terminal moraines formed during the deglaciation of the area, scattered marginal deposits also occur in many places within the ground-moraine mass. Many of the ground and terminal moraines merge into each other that the two can not be sharply distinguished. Generally undulating till plains occur among hills of terminal moraine character. Many isolated symmetrical hills rise with glacial plains from 10 to 25 feet above the nearly level surface of the ground moraine. These are characterized by a core of ordinary unstratified till surrounding and overlain by irregularly stratified and rather definitely assorted gravel and sand beds. The gravel is clastic and calcareous in composition, and the individual pebbles of this moraine series are generally considered as gravel-capped hills. Ravines in their slopes reveal their structure and their availability as a source of excellent road material, as well as of sand and gravel for other constructive purposes. The great body of the ground moraine is made of fine-grained compact aluminum clay, with which are intermingled grains of quartz, particles of silt, and angular fragments of crystalline rocks. Widely scattered throughout this clay matrix are pebbles, cobbles, and boulders of various lithologic characters not unlike those of the terminal moraines of this area, elsewhere described. The whole is unstratified as compared with the definite assortment of water-deposited material, yet where some are remarkable, thicknesses are exposed of irregular and crude bedding may be distinguished. Beds of varying thickness and attitude consisting of distinctly stratified sand and gravel, which are intercalated with the more massive and heterogeneous body of the till. The clay matrix is dark clay gray in color and is generally known as the blue clay of the region.

Oxidation has changed the upper 5 to 20 feet to a light-gray yellow color. The thickness of the blue clays, as taken from well records, varies from 100 feet to a fraction of an inch. Of the body of the till more than 90 per cent, of both the ground-moraine and the terminal moraine, seems to have been derived from the subglacial portion of the ice sheet. This material was supplied to the glacier from the underlying Ordovician shales at no great distance from their present place of lodgment.
The very small number of bowldery scattered over the ground moraine would seem to indicate that the superficial and englacial load of the glacier at the time of the recession was relatively small. Almost all the bowldery are rounded masses of the more refractory fragments of the granite and other crystalline formations which are found in place 400 miles distant in the Ouimet district to the northwest. Bowldery whose characteristics indicate a Paleozoic origin are found, but their number is comparatively small.

**Terminal Moraines**

**Distribution.** The moraine is traversed in a generally north-south direction by several well-defined moraines. The extreme southeast corner of the district includes a small tract of the Second or Gray moraine, mapped by Todd, and the extreme eastern portion is traversed by the east side of the loop of the Eighth or Fergus Falls moraine, as mapped by Upham. In contrast, the eastern portion of the district includes a large area of the Second or Gray moraine, as mapped by Todd, and the extreme eastern portion is traversed by the east side of the loop of the Eighth or Fergus Falls moraine, as mapped by Upham.

**Antelope Moraine.** The outer or eastern face of the moraine is well-defined throughout the district. The inner or western face of the moraine is defined at points along the northwestern boundary of the district by hills of sand and gravel that mark the inner or eastern face of the moraine. The moraine is also defined by the presence of a small morainic tract that extends from the moraine to the west, north of the James Valley, and coincides with the inner or eastern face of the moraine. The moraine is also defined by the presence of a small morainic tract that extends from the moraine to the west, north of the James Valley, and coincides with the inner or eastern face of the moraine.
presents a roughly rolling surface, the closely aggregated hills rising to an altitude of 10 to 50 feet and being generally moraine.

This morainic tract in southeastern Otisco, eastern Springvale, and northeastern Binghamton townships, although closely continuous with Allis Ridge, is to be correlated with a terminal morainic belt extending from eastern Otiscans outwards through eastern Springvale, Clinton, and Pontiac, to southern Liberty Township. In the southeastern half of this moraine, where it is continued from Allis Ridge to the southeast, the hills and ridges of drift have a relief of 15 to 30 feet, are closely aggregated, and assume with the intervening undrained depressions a distinct north-south and south-southwest trend.

A drainage channel from the front of this part of the moraine originating at the village of Otisco, continues southwards through secs. 33, 34, and 35, Springvale Township, and enters a branch of Maple River in sec. 5, Raritan Township. The southeastern half of the moraine, that portion in Binghamton, Clinton, and Pontiac townships, presents a much less regularly type of terminal topography. The valleys and ridges rise with gentle slopes to a maximum of about 30 to 35 feet. Prominent hills with rounded contours and elongated gentle slopes to an altitude of 20 feet above the inner border of the moraine in R. 58 W., and broadens out 20 miles south of the district into the gently undulating plain representing the bottom of an ancient lake in Susquehanna County known as glacial Lake Sargent.

Another terrace is crossed by a channel running from sec. 12, Bear Creek Township, through secs. 18 and 19, Preston Township. The bottom of this channel is below the 1300-foot contour, and therefore 20 feet below the channel just described. It is probably represented further north by traces on the valley slope in sec. 36, Oakville Township, and by a slightly higher terrace in sec. 25 of the same township.

Two remnants of terraces border the valley at intervals over considerable distances. One of these in the northeast corner and passes southward through the eastern edge of Sheyenne Township, by which it is connected with the present Sheyenne Valley, 186 feet above the present stream.

The valley of Sheyenne River is marked by a distinct narrow lobe of the ancient glacier, while the moraine in R. 58 W., and broadens out 20 miles south of the district into the gently undulating plain representing the bottom of an ancient lake in Susquehanna County known as glacial Lake Sargent.
The village of Ebeltoft is built upon a gravelly plain which is about 15 feet higher than the bottoms, or alluvial flat, along the present channel of the river. About 10 feet higher than the plain on the other well-defined gravel terrace, and the sides of the valley show pockets and shoulders of stratified sand and gravel 30 feet above the terrace.

In sec. 31, Highland Township, and sec. 1, Liberty Township, Maple River branches its valley in a breadth of half a mile as it reaches the large stream on its right side. The highest or Herman shore of Lake Agassiz was probably the western limit of the ancient valley. Though no beach is now traceable, here till is exposed in the side of the valley, the channel having been eroded below the lake deposits, but not far as to reach the subjacent strata, gravel and sand.

Jones River.—The Jones Valley resembles the Sheyenne Valley in general character, but it is less wide and less deep, through its sides are marked by well-defined gravel terraces. The valley is about 100 feet deep, and the bottom is through a deposit of sand and gravel of late glacial age, overlain in the lower portion by alluvium of the postglacial stream. The drainage is the result in large part of the deposition of materials translocated by the broad stream in its earliest stage.

Sleet or snow sheets may have an area of several square miles of good expanse from the other side. In modern drainage systems streams tend to cut through the terminal moraine.

In sec. 30 and 31, T. 141 N., R. 63 W., well-defined terraces occur on either side of the valley. From this point southward to the point where the valley is joined by that of the Pipestem at Jamestown the river valley extends fully 2 miles upon the east side of the valley bottom at about the same altitude as all the lower terraces described. In sec. 15, T. 140 N., R. 64 W., and sec. 31, T. 141 N., R. 63 W., 6 miles south of Jamestown, occurs the most extensive exposure of shale observed in this area—a long high bench with the surface nearly parallel with the course of the stream. Shale outcrops also high on the valley side opposite. In sec. 20 and 21, T. 141 N., R. 63 W., well-defined terraces occurs on either side of the valley. This point southward to the point where the valley is joined by that of the Pipestem at Jamestown the river valley extends fully 2 miles upon the east side of the valley bottom at about the same altitude as all the lower terraces described.

The Sheyenne River Delta.—A tract of about 25 square miles of the deposits of Glacial Lake Agassiz occupies the southeastern part of this region been inundated by the waters of Lake Agassiz. The shore line of Lake Agassiz enters the Tower quadrangle in sec. 4, Highland Township, passing thence westward to the mouth of the valley. The delta deposits are sand and silt.

The delta deposits are sand and silt. The surface of the delta is flat. The remaining delta portion of the Sheyenne River Delta, except where deeply trenched by Sheetfood and Maple rivers, the top of the delta is largely covered or unduly undulating. Slight ridges of dune sand occur in secs. 17 and 20, Sheldon Township.

The Sheyenne River Delta deposits vary in thickness from a few inches to 90 feet. In the southeast corner of the district the Sheyenne Valley, here one-hundred foot wide and about 30 feet deep, is the result of the deltaic deposit of sand and silt. The valley is filled to a depth of 10 feet with an alluvium of gravel and sand.

In Shefford and the adjoining parts of Casey, Liberty, and Sheldon townships glacial drift is exposed in many places at the surface. The delta deposits snout filled depressions between morainic hills. The topography and structure of this part of the Sheyenne River Delta is markedly different from that to the north in Highland and Sheldon townships. The elevations are rounded and knobs with boulder till exposed on the crest and flanks of the valley. The surface of the Sheyenne Delta has many knobs and ridges with bowldery till exposed on the crests and sides of the knobs. The topography and structure of this part of the delta is flat. The delta deposits are sand and silt.

From these appearances it seems reasonable to conclude that a portion of a moraine provisionally correlated with the deposits of the delta extends continuously northward throughout the succeeding deposits. This tract of 25 square miles is bounded by the delta plain on the west side opposite. In modern drainage systems streams tend to cut through the terminal moraine.

In sec. 6, 7, 8, 11, 12, and 13, T. 140 N., R. 63 W., are large gravelly terraces that are much lower in relation to the river than the delta deposits. These terraces are eroded by the lateral streams that enter the main valley from the south. The delta plain at this point is accompanied by stream terraces, which are composed largely of gravel and sand.

The village of Jamestown is built upon a gravelly plain which is about 15 feet higher than the bottoms, or alluvial flat, along the present channel of the river. About 10 feet higher than the plain on the other well-defined gravel terrace, and the sides of the valley show pockets and shoulders of stratified sand and gravel 30 feet above the terrace.

In sec. 31, Highland Township, and sec. 1, Liberty Township, Maple River branches its valley in a breadth of half a mile as it reaches the large stream on its right side. The highest or Herman shore of Lake Agassiz was probably the western limit of the ancient valley. Though no beach is now traceable, here till is exposed in the side of the valley, the channel having been eroded below the lake deposits, but not far as to reach the subjacent strata, gravel and sand.

The valley of Ebeltoft is built upon a gravelly plain which is about 15 feet higher than the bottoms, or alluvial flat, along the present channel of the river. About 10 feet higher than the plain on the other well-defined gravel terrace, and the sides of the valley show pockets and shoulders of stratified sand and gravel 30 feet above the terrace.

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material. Very little drift exists along the bottom or sides of
several miles beyond the north line of this district as a slough
and Binghamton townships, as a flat till plain interrupted by
sees. 30 and 31, Raritan Township, and sees. 25 and 36, Thor-
hills of morainal type. Thence it continues northward through
depression contains several lakelike basins with intervening
chainlike series of lakes or basins, and also of such large valleys
retreat of the glacier. The most obvious explanation of such
incursion of the sea over this area was due to the relative sink-
erosion, had been blocked or partly filled by drift deposits
covered what is now the region of the Great Plains and the
region, some inferences may be drawn from other areas. In
of the earliest geologic events are very meager. However, as
the shales and sandstones of the Cretaceous system, the records
formed by these great glaciers shows that the glaciation of
its forward movement. The great amount of material in these-
marginal deposit within the area indicating a halt in the prog-
attendant waters, and especially to the deposition of the drift,
just south of the boundary. The Cretaceous system, a region
in the ridged, humpy, and pitted surface characteristic of these
of great masses of ice from the disintegrating glacier, resulted
constituting more or less definitely ridged terminal moraines.
The opening of the Quaternary period was marked by a
chance in the climate and climate that during the colder
summer is the upper Becker in the east entirely across the Jamestown quadrangle from its north-
preparation for the advent of civilized man.
on the whole the glaciation of this region was an advantageous
for Pleistocene glaciation. The opening of the Quaternary period was marked by a
margins of the Lake Superior lobe of the Wisconsin glacier, which as the ice sheet approached the
the Minnesota lobe, so that the retreating ice front approached the present area from a west-southeastern
the Minnesota and Iowa, was marked by the deposition of the
in its history during that time was one of erosion. Doubtless the advance of the glaciers of the Wisconsin stage was attended by many interesting events, but the record is imperfect, and in the northwestern part of the district, known as the Second or Gary moraine. The
of the largest glacial lake basins, which are also the largest glacial lake basins, are the Lake of the Woods, the Lake of the Woods, and the Lake of the Woods, the Lake of the Woods, and the Lake of the Woods.

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WISCONSIN GLACIATION.

The extent of the ice sheets in this region during the Wicposin glaciation is shown on the map, in which the
northeastern Minnesota was covered by the Lake Superior lobe of the Wisconsin ice sheet. Sweeping southwestward and south-
confluence, and the glacial lake in Tps. 138 and 139 N., R. 64 W., covered the lower Pipestem. It is probable that the upper Becker was connected with this
of the Deep Sinews. The other lobe, known as the Dakota Glacier, moved down the James Valley on the west side of the
was drained by the glacial Lake Agassiz. The most prominent feature of the Wisconsin period is theIce age, during which time the earth was covered with

Figure 4—Map of area covered by the North American ice sheet of the Pleistocene epoch, showing the

This at stage all that part of North and South Dakota lying east of Missouri River was covered by the ice sheet, which was probably hundreds and perhaps thousands of feet in thickness.

As has already been indicated, the study of the deposits formed by these great glaciers has revealed that the glaciation of northern North America was not confined to a single stage of growth and decline of the ice sheet. It appears that stages when the climatic conditions were favorable to the development of such continental glaciers alternated with milder intervals when the ice sheet was stationary or even retreated, with advances and retreats, and the whole in a new deposit of drift.

when the ice sheet was stationary or even retreated, with advances and retreats, and the whole in a new deposit of drift.

Figure 5—Map of the Wisconsin glacial map, showing the location of the various marginal drift deposits, and the terminal moraines.

This map shows the Wisconsin glacial map, which is an important tool for understanding the history of glaciation in the region.
Sheyenne at Valley City, the one from sec. 9, Skandia Township—found from one depression to another and a channel ultimately escaping to the lower places and ponding until escape was possible from a point near its southeast corner to its northwest corner. The valleys and the river had been cut away by the melting ice plain. The drainage to it from the northwest-flowing system and the head of the Sheyenne is so clearly discernible as to be easily mistaken. The modern drainage from the upper channel to the west of the moraine, in secs. 31, 30, and 29, passes west from 31 and 32 by a small channel that lies close to the north side of the Northern Pacific Railway track, the ancient channel being nearly blocked by the remarkably eroded.

The outlet drainage channel in this region extended southeastward from the central part of T. 140 N., R. 66 W., crossed the present low divide in sec. 6, T. 140 N., R. 66 W., and continued in the northwest to be the present channel of the upper Sheyenne.

From T. 138 N., R. 64 W., southeast of the outlet drainage channel just below the inner edge of the terminal moraine in T. 140 N., R. 64 W., and continuing by Brookhead Creek to James River. This composite ancient drainage system, together with the terminal moraines in Tp. 138 and N. 128 N., R. 64 W., and T. 139 N., R. 64 W., and the low moraine or hummocks, indicates that the edge of the great ice sheet lay in a generally north-northwest and south-southeast direction across the central part of the district. The ancient drainage channel, known as Hobart Lake and the lakes to the west of it were never reopened, because the ice was not melted from the line of the Sheyenne until the ice front had retreated in a direction to the northwest from that part of the moraine in Bear Creek and Fort Ransom Township, north of that part of the moraine which remains. As has been shown, the ancient drainage channels, large in the form of disconnected hills and ridges of stratified drift, are scattered over the whole area of the ground moraine east of the main moraine and beyond the bounds of the district. Continuing southeastward along the east side of the moraine for 20 miles, the stream mingled its waters with those of Great Lake Sargent. About 3 miles above Fort Ransom, in sec. 36, Bear Creek Township, southward across Fort Ransom Township, and beyond the bounds of the district. Continuing southeastward along the east side of the moraine for 20 miles, the stream mingled its waters with those of Great Lake Sargent.
Such a condition would have been sufficient to determine the course of the river along the line of the ice front. The trend generally south-southeasterly direction.

Gleic Lake Agassiz-The name given to the body of water which flooded the entire basin of Red River as the northernmost glacial lake melted northward. As the ice front retreated the area of ponded water was extended until it encompassed the southeastern part of the district (Tower quadrangle) in the townships of Highland, Sibley, Sherdon, and Cassy. Where recognizable in Highland Township the elevation of the highest or nearest shore line of this glacial lake is approximately 1965 feet above the sea as, so that the part of the Sheyenne River valley within the Tower quadrangle may have been eroded in its present depth while yet the stream discharged its waters into the lake. The material derived from this area of the south beyond the present area is in a district.

The trend generally south-southeasterly direction of the moraines to the south beyond the present area is in a district.

The Sheyenne River while the glacier extended west of the present course of the river along the line of the ice front. As the deepening of the valleys continued the coulees and possibly directly from the drift at the melting area northward. As the ice front retreated the stream which flooded the broad basin of Red River as the Minnesota River; much of it is fine level meadow, the divide being imperceptible.

20 feet, but many of these wells yield water of good quality. In some wells the water contains a large amount of iron and manganese; in others the water is considered to be of superior quality, owing to the presence of mineral matter derived from the soil through which the water has percolated. There are noteworthy exceptions, however, as, for instance, the usually pure water which the shallows of Sand Prairie yield in the vicinity of the village of Sand Prairie. The shallows of the Sheyenne Delta also furnish water of superior quality. Many dug wells which penetrate gravel yield good water and plenty of it, but where the water is closely associated with shale or clay it is likely to be inferior. The explanation of these differences is probably in the water table which is influenced by the soil in which the wells occur. In Sand Prairie the surface soil is underlain by water-bearing sand and gravel, which were removed and the surface of the Sheyenne River. Relatively few wells have penetrated beyond this sand and gravel stratum, partly because plenty of water is obtained in it and partly because of the presence of much quicksand. The underlying material is either cinder or clay, or shale, which restrains the water from percolating downward, while the slight gradient of the soil permits a slow lateral movement. To this underground flow is attributed the purity of the shallows of water. The purity of the water from the shallows is sufficient to prevent the concentration of salts. At Lake Minnetonka, however, a well about 15 feet deep furnishes water in abundance, but of very poor quality. This is because the shallows of water are muddy, the topography is such that surface water can not easily escape except by evaporation or percolation into the soil, and the structure of the plain is such as to afford ready lateral underdrainage. On the east side of Alpine there is considerable variety in the quality of the water, due to the varying conditions of the drift. Where the gravel beds are considerable the water is generally of good yield, but where the gravel and sand layers are thin, or where there is much blue clay associated, the water is alkaline.
base on the Cretaceous shale; but in some places it is a porous layer in the shale. Ordinarily the water-bearing bed is over- lain by compact blue clay which serves as a cap to hold the water under considerable pressure. When this clay is pierced by the drill or auger the water rises, often with considerable force, as the pressure in the underlying stratum is released. The water-bearing bed is so porous that the water readily passes through it for great distances.

Water from tubular wells is usually palatable and wholesome, especially when they are frequently pumped, but if allowed to stand long in the well it often becomes brackish and saline. A diagnostically good water, and it is universally recognized that it is unfit for domestic use. This undesirable effect probably results from the motion of the water, which generally contains some alkaline or other salts, upon the clay in which the well has been bored. Also, at many wells where the water is allowed to stand in reservoirs or cisterns excavated about the mouth of the well, or where the well is partly dug and partly bored, the water is stored. This is generally overcome by the use of windmills, which by constant pumping keep the water in circulation.

Many tubular wells possess the shale which underlies the drift, though the exact line between the blue clay of the unconsolidated drift and the blue clay shale below is not easy to ascertain. The water from these wells is usually the same as the shale below the drift. In some localities good water is obtained from layers in the sandstone or shale, but in others it is claimed that if there is water it is before the sandstone is reached, because none of the wells yet reach that formation. The region along the crest of Alta Ridge is one in which few wells have been drilled, but a capacity and quality have been obtained. The underground structure is not extensive, and thick deposits of water-bearing sand or gravel may rest on the blue clay. In either case the water can be obtained from the sand or gravel, but often only from the blue clay.

The ridge itself is a steep hill, probably of Pierre shale, with a crest 300 feet higher and the plains 10 miles to the east, so that water must first be flown over 300 feet of water in the porous rocks before it can be obtained from the shale, and often only from the blue clay. The water from these rocks is usually the same as the shale below the drift. In some localities good water is obtained from the sandstone or shale, but in others it is claimed that if there is water it is before the sandstone is reached, because none of the wells yet reach that formation. The region along the crest of Alta Ridge is one in which few wells have been drilled, but a capacity and quality have been obtained. The underground structure is not extensive, and thick deposits of water-bearing sand or gravel may rest on the blue clay. In either case the water can be obtained from the sand or gravel, but often only from the blue clay.

All parts of the region the head increases with the depth, that is, lower flows have progressively greater pressures. This is clearly illustrated in the figure, which shows how the head of water in many upper wells is only 1350 feet high, while in others it is 1500 feet.

From these it is clear that the water-bearing sands and shales are not always the same. The sandstone does not yield a flow of satisfactory volume and the water is allowed to stand in reservoirs or cisterns excavated about the mouth of the well, or where the well is partly dug and partly bored, the water is stored. This is generally overcome by the use of windmills, which by constant pumping keep the water in circulation.

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Representative soils in James-town proper district.

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### Summary

The soils of James-town are generally characterized by their clayey loam texture, with varying organic matter content. The area is mostly flat, with some gentle undulations.

### Soil Types

- **Clayey Loam**: Predominantly found throughout the district, varying in organic matter content.
- **Clayey Silt Loam**: Occurs in smaller areas, typically near wetlands or streams.

### Geologic Relations

The soils of James-town are formed from glacial till deposits, which are a combination of the glacial drift and the underlying bedrock. The till is rich in organic matter, which contributes to its high fertility.

### Agricultural Uses

- **Crops**: Most suitable for a wide range of crops, including corn, soybeans, and small grains.
- **Fruit and Orchard crops**: Good for apples, peaches, and other tree fruits.
- **Pasture and Grazing**: Suitable for both beef and dairy operations.
- **Vegetable gardens**: Ideal for a variety of vegetable crops.

### References

For more detailed information, refer to the United States Department of Agriculture soil surveys. These surveys provide comprehensive data on soil types, properties, and suitability for various crops and land uses.