DESCRIPTION OF CASSELTON AND FARGO QUADRANGLES.

By Charles M. Hall and Daniel E. Willard.

GEOGRAPHY.

Position and extent.—The Casselton and Fargo quadrangles lie between the meridians of 96° 30’ and 100° in the eastern part of North Dakota, and the center of trade for the Red River Valley, is located in the eastern part of the quadrangle, near the junction of the Pacific and Great Northern railways cross the Red River into North Dakota.

The area of special importance, as it represents a typical section across the mollusk valley of the Red River, lies outside the area of the quadrangles, as it is composed almost entirely of till and a narrow area from Big Stone Lake to the international boundary line.

RELIEF.

The Red River Valley.—The Red River Valley includes the greater part of the Casselton and Fargo quadrangles. During the last part of the Glacial epoch, it has been called the Red River Valley. The valley is a winding ridge from 15 to 25 feet high, and the present river flows on the top of this ridge, many feet above the level of the older river. After the ice retreated, the meltwater became the bottom of the Glacial Lake Agassiz. In the northern part of the Red River Valley, it is composed of Cretaceous shales and was formed by the erosion of the central part of the Red River Valley, with the valley bottoms their drainage and meandering courses are not unlike that of the Red River. They have been bent over in the streams, received to their present places by the recession of the lake.

DRAINAGE.

Red River.—The Cretaceous shales and the Red River in its tributaries—drainage into the east of the Red River, Shetland, and Maple on the west. The Red River is approximately in the center of the Red River Valley. It enters the valley at a point about 100 miles north of the mouth, at an altitude of 900 feet above tide, and it flows in a sinuous course of 24 miles in a direct line. It receives very little or no lateral drainage in its course. This stream is not subject to floods and does not seriously affect their present places by the recession of the lake.

Wild Rice River.—This stream has its source among the moraines near the southern boundary in which direction it flows more than 30 miles parallel with the Red River before finally joining the Red River. The Wild Rice River flows during the summer monsoon supplied with water by springs, but in winter the stream is a dry bed. It has very few tributaries, and in the delta plain rarely receives surface drainage from any point more than a mile from the low flat, but after the flood, during the spring, when all runcours are congested. It is not much affected by rains on account of the sandy soil and the lake region at its source, but it remains a fairly good flow during dry seasons, being flooded by rains start the flow again, but in winter the stream usually freezes to the bottom in many places.

Shetland River.—This stream flows in a serpentine course for nearly 40 miles before joining the main stream. Although it has a drainage area of about 40,000 square miles above its junction with the Maple, it is entirely without an outlet and the land along its lower course, for its area within the lowermost 15 miles is a large area to hold the water as it descends from the torrential channel of the upper valley. If this had not been so, the delta would have been cut.

When the Glacial Lake Agassiz had its greatest area, this river flowed from north to south, across the Red River Valley into Lake Agassiz, which is approximately the outer border of the delta—when the lake had been overflowed the water from the melting ice was diverted from the streams of the Shetland to other channels. In this way, the present stream was formed by the formation of the Minneota valley, which is approximately the eastern border of the lake region and a large area between the Shetland and James rivers.

Maple River.—Another stream resembling the Shetland in origin and history is the Maple River, but its drainage area is much smaller and its valley not so deep. Like the Shetland and the other tributaries of the Red River already mentioned, the Maple turns northward after it enters the Red River Valley. It unites with the Shetland 15 miles above the junction of the Shetland and the Red. During dry years the bed is usually almost dry, with very few tributaries.

Near the Maple River is a peculiar topographic feature the discussion of which, because of its apparent connection with this river, has been deferred to this point. Beginning at the east side of section 19, Maple River Township, near the point where Maple River debouches into the level valley, is a winding ridge from 15 to 25 feet high that follows the course of the Maple River. It can be studied for a distance of 30 miles. It runs almost in any way connected with a bench line of the trellising lake, for it assumes...
to be independent of the general topography and in a crescent 245 feet above tide at the southern end and is nowhere less than 25 feet above tide. In Maple River Township the ridge contains much sand, and several sand and gravel pits have been opened. In each case there is less than 5 feet of sand and gravel. Farther north, in Dunlin, Harri­ mony, and Boydson townships, other attractive sites for farm buildings, but in most bor­ riers for water quicksand is struck at a depth of 12 to 15 feet below the surface of the soil.

While the origin of this ridge is obscure, the suggestion is probably warranted that it was formed by the Maple River entering comparatively shallow water and dropping coarser materials first and the fine quicksand in the more gently moving current farther out from shore. It resembles in every respect an easterly or, worse, but what could confine a sand ridge in one course long enough to deposit such a prominent ridge is not clear.

**GENERAL GEOLOGY.**

At no place in the Casselton and Fargo quadrangles is there an exposure of the strata in the underlying the drift, and knowledge of these rocks is therefore derived entirely from borings. Deep wells have been drilled at various locations throughout the Casselton and Fargo quadrangles (see accompanying table of well locations). The deeper sands have been generally referred to the mississippiian rocks of the continental drift, in most places are exposed to the action of atmospheric agencies and may be independent of the general topography and in a crescent 245 feet above tide at the southern end and is nowhere less than 25 feet above tide. In Maple River Township the ridge contains much sand, and several sand and gravel pits have been opened. In each case there is less than 5 feet of sand and gravel. Farther north, in Dunlin, Harmony, and Boydson townships, other attractive sites for farm buildings, but in most bor­ riers for water quicksand is struck at a depth of 12 to 15 feet below the surface of the soil.

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The wall of ice which formed the northern shore. It was built down in perfectly stratified layers, the upper portion being black sand and mud, and the lower portion being accumulations of carunculous matter from the decomposition of plants and animals which found a habitat in the cold waters of the lake and in the shallow marshes which existed after the disappearance of the ice ages. The beach was accreted to the land in turn because dry marshes.

Beaches of Lake Agassiz.

In the northwest quarter of the Casselton quadrangle is a tract having the characteristic topography of a wave-shaded shore of a receding sea. It is about 6 miles in width and extends from the northern edge of the Sheyenne delta northwest beyond the quadrangle, and has an area of a little more than 100 square miles. The western limit of this tract is the highest level reached by the waters of Lake Agassiz. In the northern two-thirds of the tract, the 1100- and 1000-foot contours are about 3 miles apart, whereas the 9000-foot contour is about 40 miles to the east near the Red River. This slope between the 1000- and 1100-foot contours is the eastern face of the Minot depression.

The region was covered by the waters of Lake Agassiz during its highest stages, and was uncovered as the lake receded. Well-marked gravel and sandy ridges formed by the action of the waves and currents traverse the area in a general north-south direction. They are composed of whitish sands with a yellowish brown, and grayly clays are frequent. Sand for building purposes and gravel for road construction are obtained from these layers. The eastern slope, or front, of the beaches is usually steeper and higher than the western side, and a number of faults has caused a diluvial drainage to the lower levels to the east being prevented by the ridges. The area is one of reworked drift and lacustrine deposits, the latter being found in places where the configuration of the shore prevented the accumulation of sand and gravel.

The highest wave-marked ridge represents the level of the lake at its greatest extent, and is known as the Herman beach. The recession of the lake was not gradual but was by stages of intermittent recession and rise. The next lower beach was the Norcross, which is represented by a ridge about 4 miles in length along the boundary between Elkhorn and Waldburg townships, and another fragment about 2 miles in length in Waldburg Township. Fragments of beach ridges represent the lower levels of the lake. The lake was shallow, the water level fluctuating at intervals between the north edge of the Sheyenne delta and the northern limits of the Casselton quadrangle.

The most conspicuous beach of the Herman beach is the Beach of Lake Agassiz, which is marked by an escarpment developed within this area. It is represented by two fragments, not exceeding 1 mile each in length, in Waldburg and Hill townships. It is elsewhere a conspicuously developed ridge bearing sand and gravel. The escarpment is continued at depths of 200 feet. A prominent ridge parallel to Maple River and containing sand, gravel, and quicksand may possibly represent a lake beach, but its origin seems to be due to other causes, as is described under the heading "Dunes." The beachmark, representing the northern edge of the lake after its waters had been discharged through a northern outlet, is shown in a low sandy swell of an area of about 10 square miles near Winkley, Minn., having an area of about 9 square miles. These areas, represented on the map as modified beach ridges, are distinguished from the surrounding plain of the Sheyenne quadrangle and the frequent occurrence of gravel, as well as by their elevation.

The beaches just described are found on the eastern as well as western side of the lake. The beaches representing the higher stages of the lake after its waters had been discharged are the delta plains and the delta coastal plain. The lakeshore is marked by an escarpment eroded by the waves in the front of the delta. That the Tintah beach was of the Norcross, which is represented by the level of the lake at its greatest extent, and is

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distance from the streams. This material is the
fine overflow deposit from the rivers and is slightly
coarser than the lacustrine sediments. It is coarser
from the rivers and, while dry and suitable for
farming near the stream, is not infrequently too
deposits therefore would show a wedge in which the
character as the surficial soil from which they have
the melting snows and spring rains. It also peri­
ductive of the region. Their looseness renders
slow rising of the waters during dry seasons from
in this region, owing principally to two causes
active changes of heat and frost, this bowlder clay
age, and the levelness of the land, by reason of
the almost complete imperviousness of deeper sub­
porous to allow a very slow percolation, and the
deeper clay acts as a vast dish holding the water.

Subsoils.—The subsoils have the same general
character as the surficial soil which they have
been derived by the action of the atmospheric
agencies and the addition of organic matter. The
subsoils, however, show a better development of
deposition from water, being in definite strata or
layers. Many of these layers are of fine-grained
clay loam, approaching clay in character, but are
not so heavy that they are not penetrated by water.
The sands which occur in the near of the surface
water to percolate slowly to lower depths and to
allow underground water to rise by capillary
action. This quality is favored by the atmospheric
and organic agencies which produce soil, and is of
great importance in determining the value of the
lands for agricultural purposes, as it renders natu­
ral and underdrainage possible and permits the
slow rising of the waters during dry seasons from
the water table below. These stratified subsoils
differ from the unstratified till in the regularity of
the layers, and also from the till underlying the stratified deposits, chiefly in the
assorted and stratified character of the ma­
terial.
The deeper till consists of pre-Glacial soil and
the broken and pulverized rock shoveled along the
bottom and carried in the ice. It also per­
meates, it consists of clay, bowlder, gravel, and
sand. The gravel and sand often occur in locally
stratified layers or beds. The clay is in deeper
portions is a dark blue, becoming brown nearer the
surface, where it is upon the subsoil. At a depth
which it is not penetrated by vegetable roots
and burrowing animals, and is beyond the ac­
tually exposed horizon of plant roots. This clay
in some cases such clay has been found to
flow, and has a porous nature. In some cases such
flow has ceased to flow entirely, and has been
pumped. It is likely that in many cases the
connection has been due to faulty construction in
the well tubbing or to infiltration of sand, and not
to any real loss of pressure due to any appreciable
extent even with the use of a windmill or steam
pump. Sometimes the water can be lowered appro­
priately, but in general it is difficult to lower it,
with difficulty that the well driller is able to avoid
being drowned before he can be lifted out of
the well. The supply of water is practically inex­
haustible, it often being impossible to lower it
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indicates that a distinct reservoir supplies the water to each well. The marked variation in the depths of the water beds in tabular wells where the water rises to within a few feet of the surface but does not flow is similarly explained. Four wells in sec. 34, Elvas Township, are 90, 110, 117, and 294 feet in depth, and the water rises respectively to about 4, 10, and 16 feet of the surface. Similar diversity in depth characterizes the whole quadrangle.

It has frequently been observed that in boring a well within a few rods, or even a few feet, of a well which had furnished an abundant supply of water but which had choked with sand or otherwise become clogged, a thinner gravel or sand bed was encountered at about the same depth as the water-bearing bed in the first well, but no water, or but a scanty supply, was obtained. Sometimes no trace of the bed that yielded the water in the first well was found in the second boring. It seems probable, therefore, that the gravel or sand beds are not continuous over large areas, but thin out rapidly. It would, however, be an abundant supply of water and the strong head in most of the tabular wells, and the Quaternary artesian wells, that the beds extend for considerable distances in some directions.

The higher lands outside the Red River Valley, where frequent sand and gravel occur, and where the surface drift is often loose and porous, are tracts of gravel and sand may have been so placed as to afford conduits or underground channels that the water in these wells is generally salt and hard, as shown in fig. 5. In sec. 8, T. 137 N., R. 48 W., water was obtained first at 262 feet, but insufficient in amount, and another flow in the same boring was struck at 485 feet. In sec. 32, Amenia Township, two flow wells one on the first sand and in other cases the second sand layer is penetrated; but insufficiently to meet the needs of the local population. The pressure of the water-reach in the wells is generally salt and hard, as shown in fig. 5. In sec. 8, T. 137 N., R. 48 W., water was obtained first at 262 feet, but insufficient in amount. In sec. 7, T. 137 N., R. 48 W., water was obtained at 216 feet, water being pumped and boiled away in kettles to be delivered about the city. As much as 500 barrels per day are expected to be have been boiled away in the town of Fargo.

One of the most remarkable feats of drilling recorded in this region is the Moorhead well, T. 139 N., R. 48 W., deep well, drilled in 1898 and shown in fig. 6. According to the log kept by Mr. Andrew Holes, a citizen of Moorhead, and from samples secured by him is shown in fig. 4. The water is derived from gravel at a depth of 147 feet, and sand and stone occurring below this to a depth of 104 feet. No record has been obtained of the rock penetrated from 10 to 147 feet, but it may be presumed that it was heterogeneous silt and till, and that the bottom of the water supply is at the depth of the drift or the upper layers of the Cretaceous limestones.

The western two-thirds of the Casselton quadrangle lies within the Cretaceous artesian basin. Here the water rises nearly to the surface, and its estimated yield is 8000 barrels per day. This well is one from which water is supplied to city reservoirs for domestic use, the water being pumped and boiled away in kettles to be delivered about the city. As much as 500 barrels per day are expected to have been boiled away in the town of Fargo.

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Boring penetrated more than 1500 feet of granite.

The water-bearing gravel stratum at the depth of about 800 feet, or more than 400 feet below the top of the granite, is bed containing soft water, and another at about 300 feet contains the so-called "green chalky shale or clay," which may represent the soft-borne water. At 950 feet, also furnishing soft water, which would have been a water-borne sand or gravel was struck in the well.

In sec. 29, T. 138 N., R. 43 W., five holes have been drilled, and no water obtained in any. A whitish clay at about 250 feet in thickness was struck at 162 feet, which is described by the log as "green chalky shale or clay," which may represent the Benton, and granite at 286 feet. The generalized log of the five wells, as nearly as can be ascertained, is as follows:

- First well, at 150 feet, a well-drilled to a depth of 286 feet below the surface, water from the bed was piped into the largest holding, and water was used from both tanks, separately. The two tanks now yield 300 barrels per day. The water is heated readily, soft, and excellent water. The temperature is reported to be constant at 60°F.
- In sec. 10, T. 138 N., R. 51 W., a well was drilled to a depth of 430 feet below the surface, and at 396 feet, water was struck. A small flow was obtained at 436 feet, and below this thin layer of water, hard rock was penetrated. At 514 feet the drill rock was passed from 350 to 514 feet. One well in this farm was struck at 332 feet. Driller reports penetrating "100 feet of hard rock, thought to be granite, was penetrated at 490 feet. Above the hard granite was a layer, 40 feet, of what was thought to be granitic, since as at 430 to 450 feet at Addison, elsewhere."
- A well in sec. 10, T. 138 N., R. 51 W., was drilled to a depth of 480 feet, but did not get flow. Hardpan and a little water were struck at 480 feet. Driller reports penetrating "100 feet of hardpan but no water at 350 feet. Sand and gravel, 434 feet, and the well abandoned."
- On the Trott farm, sec. 10, T. 138 N., R. 51 W., a well was drilled to a depth of 418 feet, and below this thin layer of water, hard rock was penetrated. At 514 feet the drill rock was passed from 350 to 514 feet. Water is small quantity was struck at 418 feet. In a boring at Chaffee, sec. 11, T. 138 N., R. 51 W., a well was drilled to a depth of 420 feet, and flows were obtained at about 150 feet, 250 feet, and 400 feet. Hardpan is reported from 50 to 80 feet, and again from 140 to 200 feet. A small flow was obtained at 260 feet, from 4 to 5 feet of sand. A dark layer with licks of brown clay is reported below the 450 feet flow, with sand in the main flow at 400 feet. In one, T. 138 N., R. 51 W., a well was struck at about 432 feet, and within the 400 feet flow, with sand in the main flow.
- In sec. 15, T. 138 N., R. 18 W., a well was drilled to a depth of 430 feet, and at 394 feet, water was struck. A small flow was obtained at 432 feet, yielding 100 barrels per day. The same-layer layer is reported above the water-bearing sand in the Chaffee well, as shown in the last paragraph. A well in sec. 15, T. 138 N., R. 18 W., is said to yield 90 barrels of clear water per day. Three are reported at 394, 476, and 478 feet. A well on the Averill farm, sec. 15, T. 138 N., R. 18 W., was struck at about 250 feet in diameter 40 barrels per day. Material not reported.

This well has proved a very unfortunate exception to the success of the property. It has emptied quicksand till an area of 70 to 80 acres has been buried in sand. The bore was 20 feet deep, and the core of the sand was examined, and while repeated efforts have been made to "plug" it, by having old men. It cracked and tumbled, and the sand was used for building. The success of the wells, however, has been encouraging. The gravel bed is a foot of dirty gravel at 362 feet. At 405 feet, a well was struck which yielded 300 barrels per day. The water from this bed was piped into the largest holding, and water was used from both tanks, separately. The two tanks now yield 300 barrels per day. Water is clear, and excellent water. The temperature is reported to be constant at 60°F.

In one, T. 138 N., R. 18 W., a well was drilled to a depth of 430 feet, and at 394 feet, water was struck. A small flow was obtained at 432 feet, yielding 100 barrels per day. Material not reported.

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