

**Open File Report LII  
FIELD NOTES OF FRANK LEVERETT**

**Notebook No. 271 - Leverett**

- Bay
- Clinton
- Genesee
- Gratiot
- Midland
- Saginaw
- Shiawassee
- Tuscola

Notes on studies in quadrangles SW of Saginaw Bay having 5' contours, September 22 – October 29, 1919.

This notebook continues from No. 269 as notebook 270 deals with the Northern Peninsula work August 16 to September 17, 1919.

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**Notebook 271**

September 22, 1919, Middleton, Michigan.

With F. E. Jacobs, student from St. Johns, I drove south two miles across featureless till plain then turn east and cross fine Creek tributary of Maple River and, rise into a moraine.

**Thin Till Sheet Over Sandy Deposit**

There is a slight outwash deposit outside the moraine from Perrinton south east to here but below here the moraine extends to the border of the stream. We find that till has been laid down over a fine sandy gravel along east side of this stream and Mr. Jacobs takes a kodak view of an exposure on east side of N-S road near

south end of line of Secs. 20-21. The till is only 5-6' anywhere in this exposure and but 2' where view is taken. We passed another exposure on south part of Sec. 29 Fulton Twp. The moraine comes to the outlet in NE part of Sec. 32 and there is outwash on the strip of high lan running SW into west part Sec. 32 in a back of Pine Creek. It is partly above 725' contour. Lake Saginaw seemed likely to have stood this high for only 9 miles NE of here in Sec. 30 North Star Twp. This shore is 750'.

#### Tilting of Beach

In fact the highest Arkona should be nearly 725' for it is 735-740' a mile SW of North Star or 10 miles from here and the differential uplift is 15 to 20 inches per mile. Erosion and boulder concentration becomes conspicuous below 700' contour or just below the Second Arkona beach.

#### Grand River Outlet

Mr. Jacobs took a kodak view looking SE over the outlet from Sec. 32 Fulton Twp. to Sec. 4 Essex Twp (T. 8N., 3W.). We were high enough to look over tree tops to the moraine in Secs. 3 and 4 Essex Twp. There are stone piles in the foreground and slopes show the effect of the concentration of coarse material by removal of fine material in the outlet. The distance across the outlet here is over a mile so there will not be much relief shown in this view. It is a very impressive feature – a channel 80' deep and over a mile wide cutting right through the moraine and the till plain west of it. The till plain is almost 70' above the floor of the outlet on the west edge of the Perrinton quadrangle – and the island of till in the outlet is also 70' above it in Sec. 7 Essex Twp. and Sec. 12 Lebanon Twp.

We crossed the outlet at Maple Rapids and noted the filling in of material by Pine Creek so as to make a strip of dry land accross the outlet through the midst of which the creek is now flowing.

#### Features Near Maple Rapids

Maple Rapids is in a plain of sandy gravel which seems to have been deposited about at the time of Second Arkona, for it is almost at 700' AT. There is an interesting gravel bar running SW from this plain to the E-W¼ line road in Sec. 8 Essex near its west end. Mr. Jacobs took a kodak view of it looking NE to Maple Rapids. It is above 695' all its length and at NE end barely catches 700' contour. East of Maple Rapids is a higher plain 710 to 715' AT. The part that is 720-725' has a gravelly sand coating a few feet thick, but lower parts have till at surface. It seems likely erosion has removed this coating of gravelly sand in such places. There are slight ridges 3 feet or so high that catch the 725' contour. These look like stream bars and are likely to have been formed at an early part of the cutting of the outlet either by Lake Saginaw or the highest Arkona. The material may have been left as outwash from the moraine that

lies east of it, but if so there seems to have been subsequent modification by the stream issuing from Lake Saginaw.

#### Moraine In Essex Township

This moraine has strong expression in Secs. 3, 4, 9, 10, 15 Essex Twp. with a few points that use above 775'. Its outer border has morainic aspect down to about 725' in the sections just named or to the level at which stream action begins, or the level where sand and gravel were laid down by water action outside the moraine.

#### "The Island"

We went on the island west of Maple Rapids and followed it to the west edge of the map or to the line of Sec. 14 and 15 Lebanon Twp. It has on the top a rich clay loam soil. On its slopes and in the beds of the channels each side there are bouldery concentrates as in the channel east of Maple Rapids.

We went south across the south channel to the Session School at east side Sec. 22. This is fine till plains on which there are shallow basins. These seem to have been tile drained as they are dry.

#### Drainage Features

We went east 3 miles through Secs. 23 and 24 and 19 to Hayworth Creek valley. We are surprised at its small size for it looks no larger than the natural product of present drainage and not so large as one would expect for a channel fed from the Inlay Outlet waters.

Pects Creek which comes into Hayworth just above here and which is entirely outside the range of the Inlay Outlet has a valley about the same size as Hayworth Creek valley. It has hills of circumdenudation from remnants of the till plain. These streams seem to have started cutting at about 720' contour and on down to 673 at their junction - or only 45' depth of post glacial work.

The part of Essex Twp. between Hayworth Creek and the Cox drain channel and that channel as found later was covered with sandy gravel but this area was not reached in todays work. (See notes Sept. 30, 1919 for this area) ((From "as found later – is an over written insert. HMM))

We went south through till plain to corner of Secs. 29, 30, 31, and 32 Essex and then east 3½ miles to see the junction of South Swagert drain and Howorth Creek and the channels in Sec. 26 and 35. This valley has very indistinct bluffs on the north in Sec. 28 and low banks a south edge in Sec. 35 about 10-15' high. There is a gravel bar at corner of Secs. 26, 27, 34, and 35 that runs W-E and stands above 715 contour.

(See notes Sept. 23 for district east and the height of water action up to 725-730')

We went south on line of Secs. 34 and 35 Essex to the North Swagert Drain and find its west slope is clayey till, but the east is sandy.

We went west a mile along town line on a clayey tract that is low enough to have been covered by the drainage southwest through Swagert channel being largely below 720'. We went south on line of Sec. 3 and 6 Bengal Twp. to the drain.

On turning west we pass on what seems to have been an island in the old drainage, the lower limits of the island being at about 725' contour. It reaches 740'. West of it is a very flat tract standing between 720 and 725 whose banks are defined on the west by the 725 and 730 contours in Secs. 8 and 17. This flat west as well as the Swagert channel seems to have carried drainage southward across the St. Johns moraine to Stony Creek. (See sketch map in back of notebook 269)

#### Till Ridge

We went west across a low till ridge that runs N-S across Secs. 7 and 18 Bengal Twp. It may mark an ice border – and connects at south with St. Johns moraine. The main moraine, however, passes west and south of Fowler as indicated on map at back part of notebook 269, p 94, St. Johns moraine.

We went to Fowler and then south 2 miles to the crest of the St. Johns moraine (called by Taylor Fowler – MOA 53). There we turned east and mapped the moraine across Bengal Twp. (See note 269) and saw the place where Swagert channel connects with Stony Creek in Sec. 29. Its valley there is scarcely ½ mile wide but it has higher bluffs than to the north for it is cut into the moraine. The bed is 716.5 at the divide in south part of Sec. 20, so is low enough to have taken the water of the Imlay Outlet for that is 725-730' where it turns SW in the SE part of Essex Twp.

I went to Mr. Jacobs house in north part Sec. 36 Bengal Twp. It is at south edge of the Stony Creek channel. There is a till plain south of it and the St. Johns moraine north in Sec. 13 and 24 Bengal Twp. (See DeWitt topograph map). The moraine lies north and west of Basswood Creek a north tributary of Stony Creek. Mr. Jacobs says a low marshy and mushy tract extends eastward across south part of Bingham Twp. which is drained in- perfectly by Spaulding Creek. There are more sandy places in it. On its north side is a till plain that extends to the St. Johns moraine. This moraine has very feeble expressions east of St. Johns, but a sort of wavy surface with knolls 5-10' high runs eastward into the Elsie quadrangle along or near the Grand Trunk Railroad. Stronger expression is shown for 2 or 3 miles west of Shepherdsville and around that village. Mr. Jacobs has worked on this matter in some detail.

We returned to St. Johns from Mr. Jacobs house after dark so have no observations east of Secs. 25 and 26 Bengal. We, however, touched the St. Johns moraine near corner of Secs. 17, 18, 19 and 20 as it loops southward a little beyond these corners 40-50 wds. (See map in back part notebook 269, also DeWitt topograph map.

#### "The Prairie" Gravel Plain, Weak Moraine NW of St. Johns

September 23, 1919, St. Johns, Michigan.

I went north 2 miles then west 1 mile and north and NW across Sec. 31 Greenbush Twp. I find moraine crosses SW part Sec. 32 and the swamp around through north and west parts of Sec. 31 and runs south along range line to NE corner of Sec. 12 Bengal Twp. It has gravelly knolls and gravelly pockets in till knolls that furnish road materials for this region. This moraine is stronger in Sec. 31 where it makes the curve than elsewhere. It may find continuation in a gently undulating strip SE of Swagert basin in Secs. 1, 2, 3 and 10 Bengal Twp. and thus parallel to the St. Johns moraine. The ridge noted yesterday 2 miles east of Fowler may correlate with it.

I made an examination of the so called "prairie" in Secs. 25, 26, 35 and 36 Essex Twp. and find it over spread with a thin coating of sandy gravel in which river bars are developed. One crossing the line of Sec. 25 and 26 just south of ¼ post is above 730' and the general plain is 730-732' south from there in south part Sec. 25 NW of 36 and NE Sec. 35. It is evident that some of the waters of the Imlay Outlet here turned into the Swagert channel and made this deposit of sandy gravel. The gravelly bars swing around to the SW in Sec. 26 and 35 and descend toward the channel. The strips that stand above 725' mark them in Sec. 35. The sandy bars continue SW below 725' contour and reach about down to 720' contour in NW part Sec. 2 Bengal Twp. and in central part Sec. 35 Essex Twp.

#### Differential Uplift

From the NW part Sec. 2 southwestward along Swagert channel there is a blud silt reported to underlie the surface much which indicates rather slack current from there to Stony Creek valley Sec. 29 Bengal Twp. There has probably been as much differential uplift in this region as I found from Pompeii to North Star, 15 to 20 inches per mile. So this area of sandy gravel in SE Essex Twp. may now be relatively 8 to 12' higher above Stony Creek valley than when the outlet was in operation. The gravel bars in it at 730-732' are 14 to 16' above the level of the outlet in Sec. 20 Bengal. So when the bed was cut down to this level there might have been 4-7' descent in 7 miles. But at first the channel may have been started at as high altitude as this deposit had before the differential uplift took place – in which case there might have been ponded water up to where the bars of sandy gravel and the sheet of sandy gravel were laid down in Sec. 25, 26, 35, and 36 Essex Twp.

#### Drainage Features

It is probable there was no strong barrier in the line of the Grand River outlet that stood higher than the course taken by Swaggert channel and Stony Creek. Part of the flow of Imlay Outlet may have followed the

present drainage down Hayworth and Cox drains and the bordering sandy gravel plain to Maple River where the Grand River outlet had lowered a little it was able to take the entire discharge and thus cause the abandonment of Swagert drain outlet. The hills north of the Imlay outlet on the range line in SW part Sec. 19 Greenbush and SE of Sec. 24 Essex are gravelly with large pits opened in them. The channel each side of the hills have a mucky soil and are said to have clay subsoil as was found a mile NE where we were yesterday. It should perhaps be stated here that there seems to be no possibility for an ice barrier to prevent the Imlay channel from discharging to Maple River at the time it turned into Swagert channel. It is also not probable that a land barrier stood on the line of the Grand River outlet west of Maple Rapids. There probably was at first discharge in both directions and the Grand River finally took the whole flow.

I returned along line of Sec. 36 Essex and Sec. 1 Bengal and came onto till above the level of stream action just as I was at 730' contour. This contour seems to mark the limits at south edge of the Perrinton quadrangle in Sec. 16 and 17 Bengal Twp. The water surface was probably between 720 and 725 contour where it came to Stony Creek channel.

#### Features Near St. Johns

I traced the gravelly moraine south on the range line of Bengal and Bingham to NE part Sec. 12. It is gravelly westward to center of Sec. 1. But I am told there is very little further west on the undulating strip SE of the Swagert channel that may mark the continuation of this weak moraine. I went south on line of Secs. 17 and 18 Bingham and closed up the moraine loop near corner of Sec. 17, 18, 19 and 20.

On returning to St. Johns I got data from Mr. Lewis Green, the County Drain Commissioner, on the Swagert Drain (See p. 94 to 269).

#### Features Bordering Imlay Outlet Near Ovid

In the afternoon I walked through to Ovid from St. Johns and found features as stated by F. E. Jacobs – gentle swells for 2½ miles east from St. Johns and stronger expressions from there to Shepherdsville. Sand caps knolls in Sec. 12 Bingham Twp. and seems to give them their relief. Till ridges occur in NE part Sec. 13 and eastward in Ovid Twp. in Sec. 18, 17, 8 and 9 and south of Shepherdsville in Sec. 15 and 16.

The valley west of Ovid (Imlay Outlet) has gravelly bars but the flats are bouldery with till below. Gravel covers higher land north of this valley in Sec. 12 and the east part of Sec. 11 Ovid Twp. The gravel in Sec. 1 east of this moraine reaches the 775' contour and slopes down to about 755-760' at edge of the valley.

I took evening, train to Owosso and then to St. Charles.

September 19, 1919, St. Charles, Michigan.

I walked from St. Charles to Garfield Station on Michigan Central Railroad and found a general coating of sand above 590' contour and clay below that contour. The clay is sediment from floods. The sand seems to be a lake deposit. It has scarcely a pebble in it where level as well as in the ridges drifted up by wind.

I took train from Paires to Garfield. The clay runs to extend beyond the 590' contour in Sec. 16, 9 and 10 Swan Creek Twp. East of Swan Creek some sand between 595 and 600' is clayey but generally there is a thin coating of sand above 595 and dunes are 600' or more. In same area, however, the base of dunes is below 600' (See Sec. 1 and 12 and north part Sec. 6 Jones Twp.).

I followed south side of Tittabawassee River from Paines southeast 1½ miles to the highway bridge south of Vogt Corners. There are low sandy ridges and a thin sand coating above 595' contour. At Vogts Corners I rise above 595' and find a thin sandy coating as on opposite side of Tittabawassee River. As I go east past the Plate Glass works in east part of Sec. 33 sand ridges set in along the north bank of the river. They are only 5-6' high and catch 600' contour in places. There is a thin sand veneer eastward on quarter line road in Sec. 33 and 34 to where I take the street car at SW end of Michigan Avenue at center Sec. 34, T. 12N., R. 4E. This avenue runs along the river bank through Saginaw west side. On the east side the 610' contour scarcely covers within a mile of the river, its nearest point being in SE part of Sec. 25, T. 12, R. 9E. I went out Gratiot road on street car to near center Sec. 27 and then crossed over to Broadway Street 2 blocks north at place where it comes to 615' contour. There is a very thin deposit of pebbly sand here with till at depth of 2-3 feet. It may be a lake deposit of Elktonage (Lake Bundy).

#### Sand Ridges West of Saginaw

I went NW on Broadway and crossed a strip of low sand ridges probably wind formed, just west of the city limits. The highest points catch 620' contour. There is cobbly material south of this road at 1/8 mile west of city limits, and boulders appear near edge of the quadrangle 1/8 mile further west. One large granite is 4' in diameter. There are in SE part of Sec. 21, T. 12, R. 4. I come to a low ridge of pebbly sand south of center of Sec. 21 at 620'. This, however, does not make the ridges in west part of Sec. 21 that stand above 625' contour. They are dunes. The pebbly sand is in a ridge only 2-3' high above till surface SW of it and is flanking the dune strip on the SW in west part of Sec. 21 and NE Sec. 20. It may also flank it on the east side and run north through center of Sec. 21 into Sec. 16. This is probably the Elkton (Lake Lundy) beach. It is between 620 and 625' contour in Sec. 21 and 20.

I find no other shore line at lower level as I go west on line of Sec. 17 and 20. There is till near surface and some small stones up to 6-8 inches or more in diameter in fields. I saw no large ones in fields. The surface is very flat.

#### Features Along Tittabawassee Valley

In SE part of Sec. 18 low sandy ridges are present. It is one of these that crosses the protrusion of the 610' contour into SE $\frac{1}{4}$  Sec. 18. The sand has no pebbles in it and seems to be wind drifted. I followed east bank of Tittabawassee southward to Gratiot road in Sec. 30 and note that till is generally within 1-2' of surface so that it outcrops where there has been very slight erosion. It has a fine sand on it a few inches thick that rakes soil mellow and crops thrive on it. It can scarcely be classed as sandy land since roots can reach the clay.

There is very little sand on ridges in the east side Tittabawassee south from the White School. There are, however, some as shown on the topographic map which catch the 605' contour and also 610' in Secs. 28, 29, 32, 33, T. 12, R. 4E.

I crossed to west side at Shields Corners. There is a thick deposit of fine sand here and low sand ridges abound that were formed by wind action. I can see a prominent strip of sand ridges leading across Sec. 25 and touching west side of Sec. 36. It continues SW to Swan Creek  $\frac{1}{2}$  mile north of this station. This strip is largely in view from the Michigan Central Railroad between Paines and Swan Creek. There are scattered slight sand ridges east of this in NW part of Sec. 36 and parts of Sec. 25 and 31 bordering Sec. 36. The Tittabawassee River below Shields Corners has done its cutting at a level below 595' so its banks are only 10-20' high.

I took evening train from Paines to St. Charles.

#### Algonquin ? and Nipissing

September 25, 1919, St. Charles, Michigan.

I went NW across Sec. 31 Swan Creek and Sec. 36 Fremont on south side of Beaver Creek. The sand makes a nearly complete cover on flat tract as well as on ridges. It has scarcely a pebble in it in Sec. 31, but in Sec. 36 it becomes pebbly and pebble clay is exposed in shallow drains heading into Beaver Creek and along banks of the creek. The sand at 600' or less probably pertains to the Nipissing hole stage which had a water level of 596' at Port Huron and almost the same here.

This pebbly sand is above 600' and is likely to be the edge of Lake Algonquin.

I went north on line of Sec. 35 and 36 and found a very thin coating of sand over till 1-3 feet  $\pm$ . There is less sand at and above 610' contour than below it in Sec. 26. I continue north. There is a low sandy ridge along 610' contour where it crosses line of Sec. 23 and 24 that

looks like a weak shore line. The sand is, however, not pebbly. There are sandy spots at each of the residences on north half of line Sec. 23 and 24 with clay around them. Sec. 14 and west half Sec. 13 are nearly all clay land and I am told Sec. 15 is also. The east half of Sec. 13 is largely covered by sand and has dunes. The SE part of Sec. 11 and SW of Sec. 12 Fremont Twp. has heavy clay soil. It extends in Sec. 11 up to the base of the sand ridge that runs SW-NE across south half of the section.

This sand ridge continues across NW part Sec. 12 and then runs north through Sec. 1 into Sec. 36 Richland Twp. It is this ridge that I thought might mark the edge of Lake Algonquin, but I see no shore features along its east base and it is a wind drifted deposit. West of it there is a sand covered area nearly level. It is 620-625' in Secs. 1 and 2 Fremont.

There are very few pebbles in the sand and this is a low grade soil. It runs north almost to the Pere Marquette Railroad through west part Sec. 36 and through Sec. 33, Section 25 also is nearly all sand covered but sand is thin along the west edge. The sandy area runs east on north side the soil ridge in Sec. 30 Thomas Twp.

#### Flowing Wells

There are flowing wells in the vicinity of Orr one at Forest School is 96' and has a lead 3' above surface of 612 AT. A well in south part Sec. 31 on 610' contour is 300' deep and is into rock only a few feet. It barely flows, the lead being about 612'.

A well in SW corner Sec. 31 is 232' and is on ground 614'. Its lead is 4' and one across the road is SE corner Sec. 36 is of similar depth and does not flow. These two wells penetrate almost 200' clay or clayey till with only thin sand beds. There is then a fine sand which the wells obtain a supply from without reaching rock. Most of the flowing wells are less than 100' and some about 50'. I did not ascertain the extent of the area in which they can be obtained.

#### Wayne Beach and Other Features Near Hemlock

From Orr I went north  $2\frac{1}{2}$  miles to the Gratiot Road, and then west to Hemlock. There is clay with surface boulders in east part of Sec. 26, east of the dunes. There seems to be a very light coating of sand between the dune ridges west from there but enough to cover boulders.

At Hemlock there is a shore line with pebbly sand standing slightly above 650' contour, its highest point being 655'. There is a bar  $\frac{1}{2}$  mile west of Hemlock that is largely above 655'. It has pebbles, so is not wind drifted. There is another a mile west at edge of the St. Charles quadrangle. It is sandy here and has wind drifted material on it. But  $\frac{1}{2}$  mile north in SE corner Sec. 20 Richland just west of edge of quadrangle a gravel bar has been opened for road material. The elevation is nearly 660' for the road at its east base is 650'. There is

a strip of boulders strewn till between this and the bar ½ mile east but it extends south only to McClellan Run. The bar a mile west of Hemlock runs NW across NE part of Sec. 29. There is a large area of clay land (till) north and northeast of Hemlock covering much of Secs. 21, 22, 15 and 16 Richland Twp., but south of Hemlock there is sandy land with only small areas of clay in Secs. 27, 28, 33 and 34 Richland. There is said to be more clay land in Sec. 34 than Sec. 33 or 35.

I went east on Gratiot Road to Saginaw. I learn that the SE part Sec. 23 is largely clay as well as east half of Sec. 26. The east half of Sec. 24 also has much clay land south of McLellan Run and so has Sec. 19 (SW¼). Much of Secs. 17, 18, 19, and 20 Thomas Twp. has sandy soil. There is heavy clay (lake clay) east of the strip of dunes – Sec. 29. It is below 610' AT. West from here the clay land is till.

#### Flowing Wells

There are flowing wells in Sec. 29 on the low clay area. The clay land extends to east part of Sec. 28. There sandy land sets in which extends to the Tittabawassee River. East of Tittabawassee River as noted yesterday there are only a few sandy spots south of Gratiot Road.

#### Till in Saginaw

I went out to fair grounds in SE part of Saginaw and found that the area above 610' contour is till with large surface boulders, for a mile west of the fair grounds. There is a looser textured soil between the 605 and 610' contours in Sec. 25 and SW part Sec. 30 than above it in Sec. 36 and 31. This may indicate that Lake Algonquin was a little below 610'.

#### From Saginaw to Bridgeport

September 26, 1919, Saginaw, Michigan.

I took car south on Washington Avenue. This runs the length of an island that catches 600' contour lying between Lake Linton and Hoyt Park. It has some of the fine residences of the city. After crossing an old channel at south end of Hoyt Park another island standing between 595 and 600' in highest part is passed over. South Saginaw stands on it.

I continue from end of car line at Forest Lawn Cemetery southeastward on the old terminal road through a tract where the clay is pebbleless and probably a sediment from floods. There is a sandy bar north of a shallow drain in south part Sec. 1 Spaulding Twp. ? around it is fine silt. In NW part Sec. 7 Bridgeport a sandy area sets in that covers nearly half the section passing west and south of the center. It is mainly south of this road but at the Popp School extends 20-30 rods north of it. There is another sandy strip about ½ mile south of this one. It is south of a shallow ravine in Sec. 18 and runs east into north part Sec. 17 to the isolated 600' contour.

#### Sand

There is a continuous sandy strip along this road from the SW part of Sec. 8 to Bridgeport. The sand covers nearly all Sec. 9 and through part of Sec. 16 north of the Cass River bank. A low sandy strip runs SW from Bridgeport along north bank of river half way across Sec. 17. The marshy part of Sec. 9 is surrounded by sand and may have sand in the wet land.

#### Till Near Saginaw

I went north from Bridgeport along the electric line and was in sandy land nearly to King Road, about 40 rods south of this road I came onto a till area. Till is practically at surface all the way from here into Saginaw. Boulders are scattered over surface in Sec. 32 and northward past the fair ground.

#### Elkton Bar?

There is, however, a small gravelly bar (Elkton?) at the houses SE of south end of Fair ground in SW part of NW¼ Sec. 32 T. 12N., R. 5E. It is very nearly 615'. It seems to be slightly higher than crossroads 40 rods south with 614 BM. Possibly the topographers overlooked this and should have given it the 615' contour. It is highest at a house on west side the road. The pebbly and sandy deposit seems to be at least 3 feet thick at the west house.

#### Bar of Sandy Gravel

I went east on quarter line in Sec. 32 and 33 through a remarkably flat till tract with scarcely 3' variation in the 2 miles. There is very stiff clayey till at the top of which is an occasional boulder exposed in the deep ditch each side the road. The ditch is 3'± below the natural surface and 4' below the road at a house south of road 80 rods from east end of the quarter line road. The deposit here is scarcely a foot deep and is very thin for 80 rods south. There it becomes a definite ridge with relief of 3'± and catches the 620' contour. I followed it southeastward across NE corner of Sec. 4 Bridgeport to where sand ridge sets in in west part NW¼ Sec. 3 at 625' contour. The sand ridge gets up to 635' in Sec. 3.

#### Dunes

A sandy strip free from pebbles and probably entirely wind drifted sets in near north quarter post of Sec. 4 Bridgeport and runs to the SE corner of the section. It is almost ¼ wide and has clay (till) land each side. Sand along south edge of Sec. 4 causes the westward protrusion of 615' contour. There may have been some shore action here as water worn pebbles occur north of the sand ridge in pockets in the till at about 615. But sand free from pebbles gives the ridge, its slight relief of 2 or 3 ft. there is a double crest (each member trending WNW - ESE) and a very narrow swale between.

## Clay over Till

I went west on King Road to the angling road at SW corner Sec. 5, Bridgeport township. On descending below 605' contour near east end of line of Sec. 5 and 8 the ditches show a thin deposit of pebblelous clay or sediment over the till. They have till, however, at 2 ft. depth. This capping of sediment is very thin above the 605' contour in vicinity of Kind Road school. In Sec. 6 Bridgeport, below 600' contour there is 2 & 4' of nearly pebblelous clay but it is thinner in south part of Saginaw and the area between 600' and 605' contour. I notice an occasional boulder protruding above surface and the ditches along the road strike them.

## Features at St. Charles

When within ½ mile of Saginaw River the clay cover seems to be thicker at a level between 600' and 605' contours. I take evening train from Saginaw and St. Charles. I went east a mile from St. Charles to see the nature of the swamp. The swamp begins with ½ mile and the land is poorly drained immediately east of M.C.R.R. The village streets in St. Charles are on sandy land but within a block east of the easternmost street heavy clayey sediment sets in. There is a scrubby oak on the clay land east of St. Charles along south side of Bad River. South of this is a swamp with flags growing in it. From St. Charles this looks like a cornfield in NW part of Sec. 9 and south of Sec. 4. Much of Sec. 9 has tall timber along a small stream and there is some tall timber next to Bad River.

## Distribution of Sand and Clay SW of St. Charles

Sept. 27, 1919 – St. Charles, Mich. I find sand covers most of the land south of St. Charles from the north south quarter line road in Sec. 8 west to south fork of Bad River. There is clay along Bad River bottoms. Sec. 18 has a narrow strip of clay on south side but the rest is sandy. In Sec. 17 there is clay east and south of the easternmost strip of dunes, so about 1/3 of the section is clay. The SW¼ of Sec. 19 is mainly sandy but the remainder is clay land and so is all of Sec. 20. Share is a clay strip in west edge of Sec. 19 that extends west to sand ridges in Sec. 24. Brant Till comes to the surface and boulders are conspicuous east of center of Sec. 24 on the part above 610' contour. Below that contour lake clay covers the till. There is about 120 acres of clay land in SE part of Sec. 24 and 40 acres in NW part. Between these clay areas is a sandy belt covering 3/4 of Sec. 24 and the SE 1/3 of Sec. 23. Brant. There is till on the remainder of Sec. 33 and the part of Sec. 14 south of south fork of Bad River. The SW¼ Sec. is also till but the east half of Sec. 13 is poor sandy land. Bad River bottoms occupy much of the north half of Sec. 13 and have clay soil.

## Features near Brant

There is sandy land between north and south forks of Bad River for about 3 miles west of St. Charles. Farther

west small clay areas occur among sandy ridges. Clay is near enough to the surface around Brant Centre to make fair farm land but the sand forms a thin coating south of Potato Creek. As noted in my studies of Aug. 1919, there is clay land south of south fork of Bad River in Secs. 21 & 22, Brant township, but sandy land in these sections between Potato Creek and south fork of Bad River. A short section of a canal to come from Saginaw Bay to Grand River was constructed a mile east of Brant Centre many years ago. Trees 1½ ft. in diameter are growing in its bed and on its banks. I took auto bus back to St. Charles from this canal and train over M. C. St. Charles to Lansing at 11:00 A.M. and in afternoon continued to Ann Arbor.

## L. Saginaw Bar at Elsie 735'

Sept. 30, 1919 – Elsie, Mich. I came to Elsie the evening of Sept. 29 on T& AARR from Ann Arbor. Elsie stands on a gravel bar above 735' A.T. and hence too high for the Arkona beach but about right for L. Saginaw shore. The gravel in this bar extends down to 720' contour on the north and west below which till is at the surface and a moderate number of boulders. On the south sand extends lower and forms a coating on lowland along an east tributary of Maple River (Baker Creek).

## Bars southwest of Elsie at 725'

I went west two miles and there turned south to examine the areas that catch the 725' contour. They are sandy gravel areas but the deposit is thin usually less than five feet but in some places thicker. A farmer in west part Sec. 15 says tests show nine feet of gravel in a small 725' area. There is a gravelly bar which runs east into Sec. 15 and curves around to the south and south southwest crossing back into Sec. 16 near southeast corner and ending in northeast corner Sec. 21. There is a strip of sandy gravel running southwest through Sec. 16 passing near center. It has long strips about 725' contour. I presume these strips are highest Arkona. The one in west part SW¼ Sec. 15 may have been formed by water east of it but this main strip in Sec. 16 is likely to have been formed by water from the northwest. I find another strip formed by water on its northwest side, that runs across south part SW¼ Sec. 17 and NW corner Sec. 20 into edge of Sec. 19. This is not so definite a ridge as those in Sec. 15 and 16.

## Bouldery Strip an Ice Border?

Another very faint bar crosses the southward extension of 720' contour on line of Sec. 19 and 20. These strips are all on a divide between northwest drainage and SE or southward drainage to Maple River. This divide may be a waterhead moraine for boulders abound along it. It has no glacial knolls. This may be the line of continuation of the moraine that comes to Eureka from the west.

### Lake Action up to 735'

The boulders extend clear to the west edge of the Elsie quadrangle in Sec. 24, Greenbush township. There has been water action up to about 735 ft. in Sec. 23, Greenbush township with gravelly deposits at the upper limit. There are also gravelly deposits in Sec. 23 at about 725' marking highest Arkona beach. The highest deposits on the L. Saginaw or its forerunner for there was more or less ponding along the ice front while the Eureka moraine was forming.

### Moraine

I went west between Secs. 23 & 26, 22 & 27, 21 & 28. I crossed a hummocky tract that occupies part of Sec. 28 and extends a little into Sec. 21 (see map). I continued west past south side of the gravelly hills in SW part Sec. 19 and SE of Sec. 24 (Essex Twp.) They show in smoothing contours by water action up to about 730 ft. So also does the group of knolls west of this one in Sec. 24 east of the Cox Drain.

### Deposit by Imlay Outlet

SW of this drain is a tableland on which Low Church and school stand which is above 730 ft. and yet is covered with cobbly material. Its soil is a cobbly loam. This deposit seems to be thin for I see a few large granite boulders in slight depressions. It is like the area around the Prairie School in being the product of the waters of the Imlay outlet and is very nearly the same level, the highest points on each area, of which altitude appear on the topographic map, being 732 ft. There is another area of this sort, standing about 725 ft. between the Hayworth Drain and lower course of the south Swagert drain in Secs. 26 & 27, Essex. The pebbly deposit here is not so coarse as around the Lowe Church and school but more like that around Prairie School yet not so sandy.

### Deposits and Channels of Imlay Outlet

Mr. Ward who lives in north part Sec. 34 Essex, says there is a sandy ridge on which pines grew in the SE¼ Sec. 34 where the 720 contour runs furthest out to the ENE. The large area between the Hayworth and Cox Drains in Sec. 15, 16, 17, 18, 19, 20, 21, 22, 23, 27, 28, and 29, Essex Twp., has a coating of sandy gravel with more or less loam. The shallow draws that traverse it in some cases are cut through it and here till in thin beds. This area slopes gently westward and descends from 732' at east end to about 720' in Sec. 18 & 19, Essex Twp.

The distribution of this sandy deposit seems to indicate that water from the Imlay Outlet was passing into the Maple Valley in vicinity of Maple Rapids and draining through the Gd. River outlet as well as draining south through Swagert Channel to Stony Creek and that eventually all the water took the Maple River course and thus formed the shallow swales that ramify this region in Essex Twp. It appears also that channelling by the

Imlay Outlet waters reached nearly down to 700' on the Cox and Hayworth and a channel running SW occurs Sec. 26 Essex and the west flowing part of Swagert in line of Secs. 27 & 34.

### Maple Rapids and Eureka

Post glacial stream work in the line of these channels has been slight but on tributaries it is considerable far they had good fall while these channels that were occupied by large glacial striae were cut to a low gradient. After completing the mapping of these deposits made by Imlay Outlet waters I went north into the moraine east of Maple Rapids and took road that runs east from Maple Rapids to Eureka. There seems to be only fragmentary moraine development along the line I have been calling the Eureka moraine. The ice-border seems however, to have stood for a time at the bluff-like rise in the northern sections of Greenbush Twp. and Secs. 1 & 2 Essex Twp.

### Arizona Beach east of Eureka

Outside this strip on small hummocky areas one being near Grove School and others in north 12 Essex and Sec. 7, Greenbush Twp. From Eureka I went east 4½ mi. to Maple River. There is some sandy material on the plain below the Arkona beach in Secs. 1 & 12, Greenbush, SW part of Sec. 6 Duplain and NW of Sec. 7. But west from there boulder strewn still forms the surface with very little sand or lake deposit. There is no definite beach at 690 or 700' but the second Arkona gravel comes down to about 705' and its upper limit is about 715'. It is the Second Arkona beach.

### L. Saginaw Bars Near Elsie

October 1, 1919, Elsie, Mich. I go east and come to a gravelly shore line where the Ann Arbor RR crosses the line of Secs. 12 & 13. It runs NE across the county line and then turns around to the south with the 735' contour, occupying the area above that contour in Sec. 17. There is another bar running ESE on south side of the railroad in NE part of Sec. 13. I find that the prominent ridge in NE part of Sec. 24 and south part of Sec. 13 that stands 725' to 735' is a gravelly bar to depth of several feet. It runs southeast into Secs. 29 & 28.

### Submerged Area SE of Elsie and East

I went south on Meridian or county line road, to a ridge that stands above 730' and find it has a very light gravelly sand coating on till less than 2 ft. This probably was deposited by the lake waters on a lone glacial ridge. It is more than a mile further south to ridges that are high enough to have stood above the lake waters, in Secs. 4 & 5 Middlebury Twp., and Sec. 36 Duplain Twp. The gaps in this morainic strip are low enough to have let the waters connect with the Imlay Outlet near Ovid. The water here was high enough to catch the 740' contour in NE Fairfield and NW Rush Twp. so that ridges of that height in Sec. 12 Fairfield and Secs. 7 & 8 Rush, are

## Shore Lines near St. Louis & Breckenridge

shore or bars of gravelly material. The swamp in Secs. 17, 18, & 20 Rush seems to have been submerged land at this time and all the land north of it in the Elsie quadrangle as far west as the 740 contour in SW part of Sec. 12 and NW of Sec. 13 Fairfield Twp. It also covered the part of the Chesaning quadrangle north of the north state drain and seems to have reached 745' in the NE part of Sec. 8 Rush Twp. where I noted a gravelly bar in Aug. 1919. Differential uplift is likely to have made the level higher there than in districts to the southwest.

### Features east of Elsie in Fairfield & Rush Twps.

There is some undulating land in Secs. 14, 15, 16, 22 & 23 Fairfield Twp. but most of it is ordinary till plain. The most conspicuous area is in NW of Sec. 15 and NE of Sec. 16. This has looser textured drift than that border plain and is more bouldry. It rises about 750 ft. In NW of Sec. 23 and SE of Sec. 14 is a smooth ridge 760-770' that can be seen a mile or more away when viewed from the NW. The till plain on its borders is 750-760'. The coating of gravel is very thin in the areas above 740' contour in west part Sec. 4 Rush and NW of Sec. 12 and NE of Sec. 11 Fairfield so that farmers have put in tile to drain these areas and reach till of 1 – 2 ft. in some places. The gravelly ridge near center of Sec. 12 has 3 ft. or more of gravel. Southeast of Elsie I noted a good shore feature, east of the Munson school in in the NE corner of Sec. 28 a cobbly deposit at the SW end of a till ridge north of the swamp. The swamp has till soil and little or no peaty material and is strewn with boulders in Sec. 27 and SE part of Sec. 28.

### Arkona Beach

I went today as far NE as corner of Secs. 6 & 7 Rush and 1 & 12 Fairfield and then took road west across Fairfield Twp. a mile south of the County line. The Arkona beach in south part Sec. 2 is a sandy ridge and the flat land South is sandy in NW¼ Sec. 11 and NE¼ Sec. 10, but further east boulders and clayey land occur. There are also a few boulders clay and south of the road in NW part of Sec. 10 in Sec. 9 sandy land covers the NW half. The shore line in SW of Sec. 4 is coarse gravelly material to depth of 8-10' and is so southward to the end of the bar.

### Features near Alma & Ithaca

From Elsie I took train to Alma and found that lake action is evident clear to Ithaca. A moraine runs thru Ithaca that forms the west limit of the lake. Ithaca is 747' at depot and this is near level of old shore. This moraine lies mainly east of the Ann Arbor RR from Ithaca north but a spur is crossed 2 or 3 miles south of Alma. There is a very narrow strip of sandy outwash between this moraine and a swamp west of it for 3 or 4 miles north of Ithaca. The railway runs in this outwash strip.

Alma, Mich. Oct. 2. Altitude 730 ft. A.T. (Gannett)

I take train on Pere Marquette R.R. to Saginaw. Till plain from Alma nearly to St. Louis. Morain in and west of St. Louis. Gravel beach just east of Pere Marquette depot in St. Louis at practically the same altitude as depot 740 ft. Till with a few boulders and very little sand for 2 – 3 miles east, soil pebbly and some fields surface flat as far north and south as I can get a view (2 miles) to within 2 miles of Breckenridge. Low ridges there occur north of the track 5 – 6' high, Otherwise plain clear to Breckenridge. A gravel beach runs across railway in NNW – SSE course of west edge of Breckenridge about ½ mile west of Depot.

### Wayne Beach

Another gravelly beach ½ mile east of depot. Boulder strewn plain east of this beach as far north and south as I can get a view clear to Wheeler. Boulder strewn clay land east from Wheeler for a mile or more than flat sandy strip ½ mile – followed by strips of alternating clay and sand with flat surface all the way to Merrill. Till and boulders east of Merrill for a mile. Shallow valley in next mile leads ENE and has sandy strips each side alternating bouldery and sandy strips surfaces plain to within a mile of Hemlock. Shore line of L. Wayne there as noted a few days ago. No dunes of any note from St. Louis to here. But they occur from Wayne shore eastward to below 660' A.T. (See notes taken last week for 3-4 miles east of Hemlock)

### Algonquin

At the cross roads one mile west of Graham Station there is a deposit of pebbly sand at 608' A.T. that may mark the Algonquin shore. There is sand from Graham eastward to west part of Sec. 35 Thomas Twp. Then a clay strip is crossed that occupies the central and SW parts of that Section. There is then sand nearly to Paines.

### No Development of Algonquin Beach East of Saginaw

From Saginaw I took the "Stone road" east through Secs. 29, 28, 27, 27, & 25 Buena Vista Twp. which is about 605 – 610' altitude hoping to find traces of the Algonquin shore but I am unable to detect any. It is a featureless till plain with a few boulders and with a gummey clay with a few pebbles down to 2 – 3 ft. when ordinary till full of pebbles and stones of all sizes sets in. Ditches expose it well. In places there is a slightly loamy and sandy appearance to depth of a few inches but generally the soil and subsoil are clay and clay loam.

### Elkton and Grassmere Beaches

I went south ½ mile on range line between Buena Vista and Blumfield Twps. and then east through Frankentrost across a featureless till plain until I cross Blumfield

Creek on line of Secs. 28 & 33. I, however, could see a shore line to the south in east part of Sec. 32 and I came to it near east end of line of Secs. 28 & 33 at 625' contour. A stronger gravel ridge to the east catches the 630' contour. This curves around in the SW $\frac{1}{4}$  SW $\frac{1}{4}$  sec. 27 running SW into east part of Sec. 33 and SE into north part of Sec. 34 Blumfield Twp. The 625' shore makes a sweep around this running north  $\frac{1}{2}$  mile through east part SE $\frac{1}{4}$  Sec. 28 then east 40 – 50 rods just south of E-W quarter line of Sec. 27 then southward into Sec. 34 just east of the limit of the Saginaw quadrangle, perhaps 20 – 30 rods. It seems to run eastward in north part of Sec. 34 and then make a turn NE into SE corner of Sec. 27 about as shown in the Saginaw soil may by "MS" area.

After working out the series of ridges in Sec. 27 & 28 & 34, I worked SW across Sec. 33 and found till spots as well as sandy strips in the NW quarter of the section and not definite beach ridges. There are ridges along west side of SW $\frac{1}{4}$  Sec. 33 and east side of the SE $\frac{1}{4}$  of Sec. 32 at 625 and at 630'. The 635' contour in SE part of Sec. 32 is a sand ridge blown up by wind. The pebbly material rises very little above 630' contour. There is more or less sand coating on till between the 620' and 625' contours in Sec. 33 Blumfield.

#### Elkton Beach

There are sandy patches with nearly level surface standing about 625' in north part of Sec. 5 Frankenmuth Twp. between which are till strips below 625' contour. There is a shore at 630' in west part of Sec. 5 with bars at east end that cover the projections of that contour. There is more or less pebbly sand down to and a little below the 625' contour in north half of Sec. 6 but it does not extend down to the 620' contour. There is clayey till along and below the 620 contour in Sec. 6 Frankenmuth and in Sec. 1 and NE $\frac{1}{4}$  Sec. 2 Bridgeport Twp. There is a beach of sandy gravel along or near 625' contour in Secs. 1 & 2 Bridgeport. It shows plainly from the road on south line of these sections as it stands a little above the clay land south of it in these sections. There is not a definite shore or a sandy deposit along or near the 630 contour in Secs. 1, 2, 11, & 12 Bridgeport Twp but there seems to be in Sec. 6 Frankenmuth and there are some strips of thin sandy deposits 1 – 2' thick cut through by the ditches along line of Sec. 6 and Sec. 1 between the 625 and 630' contour. The gravelly 625' shore connects in Sec. 3 with the shore I traced last week to the end of the gravelly deposit in SE $\frac{1}{4}$  Sec. 33 Buena Vista Twp.

#### Dunes

South of this gravelly beach in Sec. 3 Bridgeport is a sandy area and it continues over Sec. 10 and 9 to Bridgeport. It also crosses the SW part of Sec. 11 and Secs. 14 & 15 Bridgeport. It is drifted by wind into low dunes as indicated by contours of these sections in Saginaw map. From Bridgeport I took electric car into Saginaw through a strip previously sapped.

#### Dunes

October 3, 1919 – I go by electric car past Frankenmuth Jc, 2 miles to Maple Street Station (Wicks on map), and find a sandy tract east from Bridgeport to within  $\frac{1}{4}$  mile of the Maple Street Station or nearly to east side of Sec. 19 Frankenmuth Twp. As indicated on topographic map it has a few low dune ridges. There is very little pebbly material in this sandy tract. It is largely wind deposited and drifted material. The sand covers about  $\frac{3}{4}$  of Sec. 19 Frankenmuth but this is the only section north of the Cass River in this township that is sandy except a narrow strip on the immediate north bank of Cass River.

#### Grassmere Beach

For a mile north from the electric railway on line of Secs. 19 & 20 Frankenmuth Twp. there is a loamy material with a few pebbles, covering the till to a depth of several feet. But at about the 635' contour this seems to stop and till is at surface above that contour. I find there is very little waterwashed material on the till in this part of Frankenmuth Twp. Gravel about 2 feet in depth was obtained for road use in central part of Sec. 18 but it is not in a well defined ridge. There is a better defined ridge of gravelly material in north part of Sec. 13 and SW part of Sec. 12 Bridgeport Twp. that curves around to the east and runs to center of Sec. 12. It catches the 640' contour in much of its course. It is only 2 – 3 feet as a rule above border till tracts and gravel pits in it are only about 3' deep before reaching till. There is a little sandy gravel catching 640' contour and spreading west of it to the range line in SW part Sec. 7 and NW of Sec. 18 Frankenmuth Twp. But the amount of shore material is very slight at the 640' level. This seems to be the Grassmere level.

I went east on line Secs. 6 & 7, 5 & 8, 4 & 9, Frankenmuth, without finding any definite shore features except those noted yesterday in west part Sec. 5. A ridge there catches the 630' contour. It dies out to the SW in SE $\frac{1}{4}$  Sec. 6, and there in only thin patchy deposits of sandy or gravelly material above the 625' shore in Sec. 6. In Sec. 4 there is some gravelly material in north part but the south half seems to have none.

I turned south between Secs. 9 & 10 and rose gradually making 10 ft. ascent in the mile and 10 ft. more or to 654' in the next mile to corner Secs. 15, 16, 21 & 22. In these sections there are slight deposits of sandy gravel at about 650 ft. or a little above the contour. There is not a definite shore feature, however, not enough so one can be certain of the trend of the strips that are gravelly. The deposits are scarcely 2 ft. thick. I turned east at corner Secs. 21, 22, 27 & 28 and went into Frankenmuth for dinner.

#### Features SW from Frankenmuth

The river bluff by the mill in south part of Frankenmuth Twp. has blue till up to 18 – 20' above stream and yellow loamy clay and yellowish brown till 9-10' thick above it.

This is south bluff. On the plain south of the river there is a loamy slightly pebbly clay above the till several feet thick as on north side 3 miles west of Frankenmuth as noted this morning. This tract is higher than a plain south of it along Dead Creek, but it is no higher than the north side of Cass River. At the south edge there is a steep slope taking 2 or 3 five foot contours. The plain being below 625' and this higher strip 635 to 640 feet. This lower plain has a thin and somewhat patchy coating of fine sand and pebbly sand over a clay or over till - the subsoil being variable as well as the soil. It looks to be a deposit made by a stream rather than lake as if Cass River might once have flowed through here. It is now in a narrow winding valley cut in higher land, its valley is 30' deep while the inner channel of Dead Creek is scarcely 10' below the plain.

#### Near Birch Run

Along the road that leads south between Secs. 3 & 4, 9 & 10 Birch Run Twp., there is considerable laminated clay covered in places by sand. This was noted about as far south as center of Sec. 10. From there south to Moon Drain in Secs. 15 & 16 there is sand on dry land and peat over sand in the wet land, from Moon Drain south in Secs. 15 & 16, 21 & 22 Birch Run there is boulding till, coated in places by thin sand, and also with a few wind drifted sand ridges (see topographic map). The NW quarter of Sec. 21 is largely sand covered and so is Sec. 20 except south of Runnels Drain and a narrow clay strip on north side of the section. Section 19 seems to be sand covered except in south part.

#### Well Data

The till tract extends south beyond the limits of the quadrangle in Secs. 30, 29, & 28 Birch Run Twp. I found a driller at a well he has just completed 2 miles N of Birch Run in NW part Sec. 17. It penetrated sand 10 ft and was then in stony till most of the way to rock at 104 ft. The well is 286' and has head only 2 ft. below surface. He has run a tile from it to lower ground south and got a discharge there. The water is brackish. This is the case in nearly all the wells near Birch Run that are into rock. I took electric car to Saginaw from McKenna station 2 miles north of Birch Run. There seems to be a continuous sand coating along this electric line from ¼ mile N of Birch Run northward to Cass River and also north of the river from Frankenmuth Jc. past Bridgeport.

#### Features NW in Frankenmuth Twp.

October 4, 1919 – Saginaw, Mich. I take electric car to Streeter in Frankenmuth Twp. I note a narrow strip of loamy silty soil on north side of Cass River from Frankenmuth Jc. east a mile. I am told by a farmer on the car that this kind of soil is found in Sec. 30 southward from an E – W road south of this one the electric line is on. There is sand between the two roads but in places it is very thin, and this loamy silt underlies it. There is some of this loamy silt at Streeter and south

to Cass River. There is pebbly clayey till under it at about 5 ft.

I cross the river at the ford south of Streeter and find the loamy silt southward to a shallow drain a few rods south of corner of Secs. 38 & 29, 32 & 33. This is first-class farm land.

South of this drain I pass through a white pine forest that occupies about 100 acres and is about as good pine as one can find now, trees tall and 12 - 18 inches in diameter. The soil is a mine sand. South of Dead Creek in SE part of Sec. 32 and SW of Sec. 33 there is a lighter sand yellowish color, that is rather poor farm land. This follows down the south side the creek, I am told, to Cass River. The southwest part of Sec. 32 has about 100 acres of good farm land with loamy clay soil. This is part of an area of about a square mile of good farm land around corners of Secs. 31, 32, Frankenmuth and Secs. 5 & 6 Birch Run Twp. It is a water deposited clay or loam with till subsoil. In Sec. 31 it occupies only 80 acres but there is more in each of the other sections.

#### Sand in Birch Run Twp.

In the NW part of Sec. 6 there is an area with very thin coating of sand and with mucky spots. It is not so good farm land as the area east of it. There is about 40 acres of good clay land in SW corner of sec. 6.

In Sec. 7 there is clay with spots of sand in south part of SE¼ but the remainder is nearly all sandy and Sec. 8 is all sandy. In Sec. 18 there is clay with thin coating of patches of sand. In NE¼ and also in SE corner but the rest is sandy or swampy. Sec. 17 is nearly all sandy. I went into Birch Run for dinner. I then went west along south boundary of the quadrangle to Flint River. There is considerable till in Secs. 19 and 24 with sandy ridges along the section line and southwest of center of Sec. 19. The south part of sec. 24 is a little more sandy than the central part.

#### Gravelly Loam Delta Flint River

In Sec. 23 there is a light sand with a few pebbles scattered through it and this extends into the west edge of Sec. 24 and the east part of Sec. 22. There is then a strip of gravelly loam with flat surface that borders Flint River and extends about a mile east of it in Secs. 22, 21, 15, and 16, Taymouth Twp. The deposit seems to be only 3 or 4 feet in average depth and rests on till. It probably was laid down by Flint River. Pine River valley traverses it in Secs. 22 & 16. The stream, however, has been diverted by a short cut into Flint River near the south edge of the quadrangle. This was done to get logs into the river. It has damaged the farms for the abandoned channel has no stream near to carry the water brought in by ditches and tile drains. The channel was cut to a low grade by the large stream that excavated it. Silver Creek is along the NE edge of this tract of gravelly loam in Secs. 15 & 16. North of Silver Creek in these sections there is a rather inferior sand slightly pebbly. This sandy strip extends over the space

between Silver Creek and Birch Run in secs. 9, 10, 11, 12, 13, 14, 15, & 16 and in Secs. 3, 4, 8, and 9, Taymouth Twp. and is less pebbly as one passes toward Birch Run than near Silver Creek. There is a very thin coating of sand and rather patchy in SE part of Sec. 13, Taymouth Twp. and till is at surface in SW part Sec. 18 and north part Sec. 19 adjacent to this area.

#### Laminated Clay

There is a little laminated clay exposed along the banks of Birch Run at Blackmar and clay is near surface for 1½ miles north of Blackmar, with some small areas with no sandy coating. In the SW of Sec. 36 and SE of Sec. 35, Bridgeport Twp., is a wet tract with very little sand over the mucky clay. It is surrounded by sand several ft. thick.

#### Sand in Southern Bridgeport Twp.

For about ½ mile south of Cass River in Secs. 25 & 26, Bridgeport Twp., a nearly pebbleless clay is at surface or has very slight sandy cover. There is sand along and south of the electric line in Sec. 25 down to about 605' contour but to the west in SW part of Sec. 25 and SE of Sec. 26 there is very little sand below the 615' contour. There is sand on north bluff west of Frankenmuth Junction almost to 605' contour but east there is clay or loamy silt up to 620 -25' and further east near Streeter up to 635' as noted this morning. I took car at Frankenmuth Jc. to Saginaw.

#### Saginaw & Bay City

Oct. 5, 1919 – Saginaw, Mich. I made a short trip into NW part of Saginaw to see if I could find any definite shore line at about 610'. There is a light coating of sandy loam 2 feet over a stiff clayey till. The soil here is black. I went east in Sec. 23 and on descending to the 605' contour I came into a strip of yellow sand with a few pebbles in it. This contour has a northward projection here but near the north end of the projection there is less sand than at the south. Perhaps this is a river deposit. In the afternoon I went by electric railway to Bay City. There is a mucky slippery clay outside the marshes as far north as south edge of the Bay City quadrangle on west side the Saginaw River that is likely to be recent flood material. In Bay City there is a pebbly loamy sand in places over the till.

#### The Prairie Farm Project

Oct. 6, 1919 – Saginaw, Mich. I took train south on Grand Trunk RR to Verne Station near south side of Saginaw quadrangle. There is sandy land from the south bluff of Cass River near Orrville southward to Flint River bluff. Some loamy land is along river bottoms but to the south of Flint River there is a continuous sheet of sand to Verne. There are only a few small pebbles in it around Verne. But as I go east toward Flint River the pebbles become more numerous. This pebbly sand covers the NW part of Sec. 21 about 610' contour and

the north half of Sec. 20, Taymouth. But there is till at surface in south part of Sec. 20 and SW¼ Sec. 21. A narrow strip of sand in SE part of Sec. 21 lies between this till area and Flint River terrace. On this terrace which is about 610' there is till and a coating of gravelly material 2 – 3' in places. Boulders are rather numerous on this terrace. The till area covers the NW¼ Sec. 28 but I am told the section is sandy and so is nearly all of Sec. 29. The NE part of Sec. 19 is sandy and a low dune ridge traverses the SW part and contacts 625' contour. But on the borders of this ridge both north and south till is at the surface. The sand ridge runs WSW into SE part of Sec. 24, Albee Twp. and dies out there. In the road west on line of Secs. 24 & 25 Albee Twp. about 1/3 mile from west and there is a distinct change in slope, the descent to west becoming greater just below 620' contour and coming down to 610' at corner of Secs. 23, 24, 25 & 26. I there find some pebbly loam suggesting shore action but not a distinct beach line. West from this corner there is some nearly pebbleless clay 2 – 3' thick over the till. In the SW part of Sec. 23 NW of Sec. 26, NE of Sec. 27 and east part of Sec. 22 there is sand which is drifted into dunes to slight degree. West of this is a clay area along south edge of the Saginaw quadrangle to the SW corner. I went north on line of Secs. 22 & 23 and 14 & 15 to the Gd. Trunk spur that runs to Alicia and follow it west to Alicia. There is some fine sand in east part of Sec. 15 and west part of Sec. 16 near Gd. Trunk spur which I presume was brought in from the east by a small drainage line that here enters the great swamp. There are small patches of sand in SW¼ Sec. 14 but most of the land is clayey. Along the ditches on Prairie Farm for 2 miles east of Alicia there is about a foot of black peaty material. Below this is a deposit largely organic material 1 – 2 ft. thick. Under this is a pale clay most of which is free from pebbles as deep as the ditches go into it which is about 2 ft. in a few places pebbles are exposed in the bottom of the ditches. The overseer says the north part of this, farm has a more clayey soil with less peaty cover than where I crossed, I return by auto to Barnum School at corner Secs. 13, 14, 23 & 24 Albee Twp. This school is near the border between sandy and clayey land. It is on a sandy ridge and the road south crosses a sand ridge 60 - 80 rods from corners that rims about 80 rods west into NE¼ Sec. 23. It also runs east halfway across Sec. 24. There is bouldery till in central and east parts of Sec. 24. It extends down nearly to 605' contour. Below that the clay has few pebbles at surface.

#### Features near Verne

I crossed Sec. 24 through fields going past the center. I there turned north and after crossing a small stream draining WNW I found patches of thin veneer of sand over till as far as the store in NW Corner Sec. 19, Taymouth (formerly Verne P.O.). The storekeeper says there are clay or till spots in south part of Sec. 18 nearly to SE corner of Section but continuous sand cover elsewhere in Sec. 18. There are also patches of till exposed across north part of Sec. 19 but most of the

land has a slight sandy coating. I went west across Sec. 13 along the Gd. Trunk spur and found no clay exposed, the sand being several ft. thick. But in Sec. 14 most of the sand is in the NE¼ and the remainder has only strips and patches of sand of slight depth. The underlying clay is only slightly pebbly and is not till. It is likely to be a deposit in the waters that have covered this area. I go north on line of Secs. 13 & 14, 11 & 12 and find sand covers the east half of Sec. 11, all of 12, the SE part of Sec. 2 and south part of Sec. 1, Albee Twp. It extends slightly below 595' contour. There is a heavy soil below this level. Flint River has probably brought in silt to about 595' contour is Secs. 1 & 2, Albee and Secs. 35 & 36 Spaulding Twp.

#### Features S. of Saginaw

North of Flint River there are strips and patches of sand in NE part of Sec. 35, north half of Sec. 36, SE part of Sec. 26 and south part of Sec. 25 but the land is fair to good farm land. The north half of Sec. 25 and SE part of Sec. 24 is in lighter soil with sand several ft. thick. This thins out to the north & west between the 600 & 595' contours. Below the 595' contour there is heavy soil extending west to the mucky swampy land that overflows. North of Cass River there is mucky land to a ravine that crosses Sec. 2 near E – W¼ line to Saginaw River. North of this there is fine sand about to north side of Sec. 2. There coarse pebbles set in and there seems to be till soil and subsoil. This is little south of Forest Lawn Cemetery and probably marks the edge of the Port Huron (Saginaw) moraine.

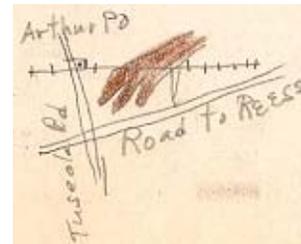
#### Elkton Beach near Arthur

October 7, 1919. – Saginaw, Mich. I take Pere Marquette train to Arthur Station at east edge of Saginaw quadrangle. I pass low sandy ridges in east part Sec. 17 and west part SW¼ Sec. 16 that are in one case 600' but in others below that contour. With this exception there is till at or near surface clear to the little stream west of Arthur. The soil map of the Saginaw area shows muck as far south as this railway in Sec. 18, Blumfield but gravelly. The border is a little to the north.

#### Beaches near Arthur

There is a gravel beach east of Arthur at an altitude 620'±. It terminates in Sec. 15 a short distance south of the railroad. There are three bars that run a few rods south of the railroad and there die out as indicated on the topographic map by brown color and in this sketch. There is a slight deposit of gravelly material less than 2 ft. thick at Arthur. The soil map gives its extension westward to Cheboyganing Creek but it nearly disappears at Arthur. The extent of this gravel beach northeastward as shown on the map by U. S. Bureau of Soils seems to be about 2 miles. A lower tract there sets in. This is, therefore, a bar on a prominent part of the till tract. There is a prominent tract SW of Arthur in north part of Sec. 21 which catches the 615' contour and rises nearly to 620 ft. Its highest part in south part of NW¼

Sec. 21 has a gravelly coating 2 – 3 feet thick and a slight ridging. There is a pebbly surface from there NNE into Sec. 16 as indicated by brown shading over blue on topographic map. It is traceable nearly to the Pere Marquette RR in SE part of Sec. 16. The deposit is only a few inches thick and follows the crest of a flat till ridge. At the south this pebbly deposit seems to end about 40 rds. NW of the center of Sec. 21 and to curve to the east there as if formed by water action from the west. I think the land to the south is not quite so high here as though standing above the 615' contour. It is only 616 at the SE and the SW corners of Sec. 21 and may be no more than that anywhere in the SW¼ of the section. This gravelly deposit in Sec. 21 and the bar east of Arthur are likely to be of the same age as this beach 2 miles south of Arthur that catches the 625' contour and for a short distance the 630' contour. It seems to range from just below 620' up to fully 630' in accord with exposures and strength development. The lake level is likely to have been between 620 and 625 ft. so the pebbly deposits below 620 were a little below the lake level while these above were thrown up by strong wave action above the ordinary lake level. The level of this lake then as now may have fluctuated about 5 ft. between its highest and lowest stages.



#### Features East of Saginaw

There is a slight coating of pebbly sand a foot or so thick at about 605' on east side of Cheboyganing Creek in SW part of Sec. 10 Blumfield Twp. It is very faint compared with this strong bar east of Arthur. Is this likely to be the Algonquin.

On my return to Saginaw I took the E – W quarter line road from Sec. 21 Blumfield Clera to the city. I saw no shore features of clear import yet in places there is a slight ridging like that that catches 600' contour north of center of Sec. 24 Buena Vista in which the soil is a little more pebbly than ordinary. This condition is found in SW or NW of Sec. 21 above 600' contour. There is, however, scarcely a foot depth of pebbly coating. There is also a slight sign of cutting in a low bank 1 – 2 ft. of less crossed by the road in east part of Sec. 21. It runs parallel with the 600 and 605' contours ENE – WSW and about halfway between them. It seems likely to rise from 602 to 604' and indicate a lake level of 602'. A faint sort of bank like this runs parallel with the 600' contour in Sec. 30 and about 60 rds. south of it. This runs into the business part of Saginaw passing near the post office.

## Rock Study South of Bridgeport

In the afternoon I took electric car to Bridgeport and then made a trip through the sandy district between Bridgeport and Fosters and Blackmar. Clay is at slight depth along south bluff of Cass River in NW¼ Sec. 21 and NE¼ Sec. 20 Bridgeport Twp. Yet the flat areas have thin coating of fine sand and there are low sandy ridges on brow of bluff. There is a heavier deposit of sand in south half of Secs. 19, 20 & 21 so the ditches 3' deep along roadside do not reach the bottom. This sand has remarkably few pebbles in it anywhere between Cass River and Birch Run. I noted an occasional one ½ inch or less in diameter. In places where the sand is very fine and apparently about down to clay the ditches show an occasional nodule of lime or iron oxide – but even these are rare. Where the land is very flat and lower than the general level there is a rather dark colored sandy muck or black sandy loam, due probably to the organic material that fails to decay while in well drained areas it all decays.

I am told that rock is struck in the vicinity of Bridgeport at 70 to 90 ft. or at a little above 500 A.T. There seems to be more brackish water north of Bridgeport than that across Cass River. A farmer in north part of Sec. 21 has excellent drinking water in a well 90' deep that is into rock near bottom and he has had a bed 285' made in his farm and the water it is brick (?). This farmer tells me that today the water in Cass River at Bridgeport is 20 inches higher than it was when a north wind started up yesterday. That has driven Saginaw Bay water into the river and caused this rise. In the past 40 years he says the water 3 times has been nearly up to the 600 foot contour at Bridgeport. He says that when the Saginaw Bay is quiet and water not driven into Saginaw River the low water fall from Bridgeport to the Bay is about 2½ ft, the level being about 583 – 584 at Bridgeport. I noted a red laminated clay over the till in exposures along Birch Run near corner Secs. 2 3, 10 & 11 Taymouth and on line of Secs. 4 & 5. The bed of this stream barely gets down to till in these sections. There is sand over the red clay except in the immediate valley of Birch Creek (Birch Run), I returned from Bridgeport to Saginaw on electric.

## Wayne Beach at Freeland

October 8, 1919 – Saginaw, Mich. I take train on Pere Marquette RR to Freeland. It runs near crest of the Port Huron moraine from Linndale to Freeland. The crest is a little east of the railroad for 2 miles SE of Freeland and is well defined and seems to have a beach on it, probably Wayne. (See notes Oct. 9) I went across the Tittabawassee River at Freeland and spent the day in study of the north part of St. Charles quadrangle west of the river. I enter the quadrangle in south part Sec. 29 Tittabawassee Twp. From the river bank west of Freeland to here there has been very little sandy land. Till is exposed on a terrace of the river in Sec. 20. The plain has a fine silt loam easy to cultivate. There is in places a thin coating of fine pebblelus sand. This pebblelus clay extends west to Swan Creek valley on the

north edge of the St. Charles quadrangle and is 5' thick on the creek bluff at the county line ¼ mile inside the quadrangle. There is very little pebbly material in the soil east of LaPorte. But within ½ mile west pebbles become numerous, and worn boulders and till occur. They were noted about when I rose above the 625' contour in Sec. 26 Ingersoll Twp.

## Mapping Extent of Sandy & Clay Land In NW part of St. Charles Map

I find light sandy land in much of Secs. 33 & 34 Ingersoll and south half of Sec. 35. The north side of Sec. 34 and NE corner of Sec. 33 have till at surface and good soil. There is good soil in SE and SW parts of Sec. 28 but sand in most of the sections inside this quadrangle. The sand covers much of Secs. 2, 3, & 4 Richland Twp. and west side of Sec. 1 and NW¼ sec. 12 and north side of Sec. 10. There are scattered ridges in Sec. 11 but much of this section has good soil. The south part of Sec. 4 has rich soil with till near surface and a few boulders. This is the north edge of good farming area that extends nearly to Hemlock.

This sandy area lies mainly between 625 & 460' contour or near the level at which I found shore features east of Saginaw but I am not able to trace a shore line here.

I found good soil in much of Sec. 1 and NE part Sec. 12 and strips of good soil alternating with sand in south half of Sec. 12, Richland Twp. and NW part of Sec. 13.

In Sec. 6, Thomas Twp. there are a few sand ridges but otherwise a good soil. There is good soil in west part of Sec. 7 but more than half of Secs. 7 & 8 is light sandy land. The SE part of Sec. 8 has good soil. There is good soil in Sec. 5 but it becomes sandy in south part. There is pebbly clay east of Swan Creek in Sec. 5 as far as the Hatch Drain and in SW part of Sec. 32 Tittabawassee Twp. so till is near surface this far east or fully 2 miles farther east than in the road a mile north.

Swan Creek bluff in NW part Sec. 5, Thomas Twp., has exposures of dark blue till up to 5 – 10' above the bed of the stream or half way to top of bluff and oxidized till to top of bluff. The till is rather hard to dig with trowel, is very thickly set with small pebbles, and looks like ordinary land-laid till. It has not weathered like pre-Wisconsin till and seems likely to be Wisconsin. I took a small sample of the blue till.

## Laminated Clay

East of Hatch Drain near corner of Sec. 32, 33, Tittabawassee and Secs. 4 & 5 Thomas Twp. I enter a plain with thin coating of fine sand over pebblelus clay. There are a few places where the sand is drifted into dunes. It seems to be pebblelus or nearly so – It covers much of the area between Swan Creek and Tittabawassee River in Thomas Twp. It is labeled Cf or Clyde fine sandy loam on the map by Bureau of Soils. It is a better class of sandy land than the areas of sand in Richland Twp. and southern Ingersoll for it has some

humus and darker color. The ridges here in this area of fine sandy loam are labeled Mfs or Miami fine sand. They seem to have had their derivation from the Clyde Fine sandy loam and are merely wind drifted parts of it. They naturally contain less humus than the flat areas.

The sand in northern Richland Twp. is white and ashy looking in places and seems to be washed sand. This may be because it is only an old shore line. The sand in Thomas Twp. may have been brought down into Lake Algonquin by the Tittabawassee River. A large part of it is below 615' contour. The clay under the sand along west bluff of Tittabawassee is of a pinkish tinge, is laminated and contains some lime nodules. It and the sand form a large part of the bluff in Thomas Twp. Till is exposed only to 8 or 10' above the river level.

#### Elkton Beach?

October 9, 1919, Saginaw, Mich. I turn north from Court Street at end of its street car line at line of Secs. 22 & 23 and go through a till tract with very little sandy coating as far as the Pere Marquette RR. I turn west on line of Sec. 10 & 15 Saginaw Twp., and am in a till tract for about a mile with no signs of a beach. Just west of the corner of Secs. 9, 10, 15 & 16 I cross a low ridge of pebbly sand at nearly 620 ft., the section corner bench mark being 618'. There is a strip of till from here west to the 620 contour 60 rods ± wide.

There a pebbly sand slightly ridged sets in and extends to the ¼ post of Secs. 9 & 16 from there west to the 625' contour till is near surface and is only lightly cohered as far west as corner Secs. 8, 9, 16 & 17. From there at Town Hall west ¾ mile to the McMann school there is sand with few pebbles. It is drifted into low ridges 4 – 5' high that in some cases catch 635' contour.

#### Relief of Port Huron Moraine

There is a strip of till out from the McMann School for a mile. This runs NW and SE and is above 610 ft. and reaches to about 625'. I turned north on line of Secs. 7 & 8 and came to sandy land near middle of Section line. It has few if any pebbles yet is about at the level where gravelly beach is developed east of Saginaw being 625 – 630 ft. and barely 635'. About ¾ mile south of Lawndale the sandy land ends and there is till at surface there northward past Lawndale. There is sand to the west in Sec. 1 that extends NW across Sec. 35, Tittabawassee Twp., and west edge of Sec. 36. This is wind blown sand in low ridges. The Port Huron Moraine has perceptible relief above the country west of it from Sec. 36, Tittabawassee Twp. northwest and past Freeland. Its base is about 620 ft. and its crest 660 ft. in Secs. 27 & 26 Tittabawassee Twp. On the slope till is generally within 1 – 2 ft. of surface there being only a thin veneer of washed material over it. There is a strip of gravelly material along its crest above 660' contour from east part SE ¼ Sec. 26 NW beyond Freeland. I traced it to the road that runs north from near Freeland Station. It is a strip about 30 – 40 rods wide and has 1 to 3 ft. or

more of pebbly beach material, with only a slight sandy admixture.

#### Pebbly Coating

It is flat as if washed down, and as it is the Wayne beach such is likely to have been the case. From its SE end sandy bars run eastward into Sec. 25 past the N - S quarter line or entirely across the SW ¼ of the section, and there is sand farther southeast to the corner of Secs. 25 & 36 Tittabawassee and Secs. 30 & 31 Kochville Twp. I found a little pebbly material in this sand at about 640 ft. in south part of Sec. 25 and at 645 ft. in NE part of Sec. 35. The sand is also slightly pebbly at about 630 ft. in SW part of Sec. 26. I am not able, however, to trace a definite shore line far at any of these levels. The west slope of the moraine in Secs. 26 & 27 and 22 Tittabawassee, has slight irregularities in the till surface but till usually is within a foot of surface on prominent parts of the slope. The sandy material is thicker in the depressions on the slope.

#### Features in NE part of St. Charles quadrangle

I examined the east slope of the moraine for shore features to the north and east of Lawndale but found only faint and patchy deposits. About 120 rods east of Lawndale is a deposit of sandy gravel 3 ft. thick which catches 635' contour at a house in south part SW ¼ Sec. 32. This protrusion of the 630' contour at a house in north part NW ¼ sec. 32, is at a place where a deposit 1 – 2 ft. thick of pebbly sandy material rests on the till. There are similar light deposits along or near line of Secs. 32 & 33 Kochville Twp. for about ¼ mile north from corner Secs. 32 & 33 and Secs. 4 & 5 (Saginaw). There is a short bar of sandy gravel north of the P.M. railway ½ mile WNW of Lawndale Station that is above 635 contour. This deposit is 2 – 3 ft. thick, 8 – 10 rods wide, and 30 – 40 rods long (E – W). Along the line of Secs. 30 & 31 – mile north of Lawndale the part standing above 635' contour is somewhat more sandy than lower land to the north but is not definitely ridged. I had dinner today at a farmhouse in NE part of Sec. 27 Tittabawassee Twp., altitude 640'. The well now in use is 175' deep and has fresh water. An old well 10 ft. from it was drilled to the rock at about 300 ft. and had water so salt that cattle didn't like to drink it. P.M. I took the train to Saginaw from Lawndale at 5:33 P.M. I passed across a strip of sandy gravel a few rods wide, a little east of centre of Sec. 5 about at the 630' contour. There is also a slight coating of sandy material in NE part of Sec. 9, Saginaw Twp. at and above the 620 foot contour. But gravelly till is near enough the surface in these sections for boulders and cobble stones to be seen in fields. There is some sandy coating near the Y where the Pere Marquette ran south to the west Saginaw station (but which is not in use now). This sand is low down near 605' contour. The soil map seems to show its extent fairly well in the north part of Saginaw so far as I have examined.

On the road, along east side of Tittabawassee River south from Freeland there is deep grading and the cuts show a clay that is laminated but it contains not a few small pebbles up to an inch or more in diameter. It is of pink tinge. As this has on the border of the Port Huron moraine it may be the fading out of its deposits where the moraine was waterlaid - and laid down perhaps a little beyond the ice border. The material of this clay is close textured and not a loose textured silt loam like that west of the river.

#### In Saginaw Twp. E. of Tittabawassee River

October 10, 1919, Saginaw, Mich. I follow Mackinaw Street NW to the city limits at line of Secs. 15 & 16 Saginaw Twp. and find till within 1 - 2' of surface all the way. The distinctions made in the map by the Bureau of Soils I am unable to see. I go west through center of Sec. 16 into the St. Charles quadrangle. There is a slight gravel coating in N-S strips a few rods wide and only 2-3' depth. With till between practically at the surface. The best defined and highest one is just west of line of Secs. 16 & 17. There is scarcely any sand on this road such as I noted in road ½ mile north and in the two roads farther south. I went north to the McMann school and then west 1¼ miles to a sandy strip that runs NW across Sec. 12. The buildings of the county infirmary stand on it. There is bouldery till north and east of this sandy strip but a silty and sandy cover and slightly pebbly sand W of it.

#### Features NW of Saginaw

This bouldery land lies between sandy strips in NE of Sec. 12 and SW of Sec. 1. There seems to be a shore at about 625' at corner Secs. 1, 12, 6 & 7 with pebbly sand ridge and this corresponds to what I saw yesterday in NW part of Sec. 35 and with the shore on the east slope of the moraine. It also occurs a mile east from here in SE part of Sec. 6, Saginaw Twp. at 625 ft. Most of this sand in Sec. 6 is in the SW part. It extends only a short distance north of the SE corner. I find a slight ridge with gravelly material at 635' just west of Middle of line of Secs. 5 & 6 Saginaw Twp. It bears east of south and drops below the contour but is traceable 40 - 50 rods south, the ridge on west side of the quarter line road in Sec. 8 is sandy but is likely to correlate with this. I find only very thin and patchy deposits of pebbly material near the 625' contour east from here. They are between 630 & 625 contour.

There is a very slight coating of pebbly sandy material crossing line of Secs. 4 & 9 near east edge of the St. Charles quadrangle, scarcely enough to make a traceable ridge, nor is there definite ridging in the gravelly material between 625 & 630' contour. I continued east of corner Secs. 2, 3, 10 & 11 without seeing any definite shore features, though descending 13 ft. on line of Sec. 3 & 10. There is till with occasional stones up to a foot or more. I went south on line of Secs. 10 & 11, 14 & 15, 21 & 22 to Court St. in Saginaw. I made some examination near Marshon of the tract

marked as sandy on the soil map but find pebbly clay at only 1 foot or less over much of this area.

#### On Electric Car Saginaw to Flint

I took 2:10 P.M. car to Flint. South from Birch Run - first mile flat with slight sandy coating. Sand is pebbly near south side of section. Second mile, sandy plain, the only boulders seen are near south side along P.M.R.R. Third mile, flat sandy soil, email pebbles and cobbles in shapes of dunes no boulders. Fourth Mile, sandy in north half and level south half rone undulating and with a few boulders in fields, soil looks sandy, Fifth mile, numerous cobblestones north of valley opposite Clio which is at Fifth mile at south side of a stream. A shore line runs SW from this village.

First mile S. of Clio along a valley.

Second mile, boulder strewn plain. At 2¼ - 2½ a prominent moraine with boulder pits on slope on west sidetrack but plain on east side. This undulating moraine seems to continue south and west side of track for a mile. The railway crosses it at Mt. Morris or rises onto it. The crest is east of track south from Mt. Morris (see notes in previous years as to features south from Mt. Morris).

#### Features near Bay City

October 13 - I returned to Bay City to continue field work. From Saginaw I went by the electric line east of the river known as the "Third Rail Route". This was in land that had pebbles in soil about to the Crow Island School in NE part Sec. 8 Buena Vista Twp. From there north there is swamp west and mucky land east of the railroad to edge of Bay City quadrangle. The wet land there extends east past Cheboyganing Creek and the railway is in wet land to north part Sec. 15 Portsmouth Twp., Bay Co. I note boulders in clay soil ½ mile farther north in west part of Sec. 10. There is a rise of 10-15' in the next half mile and sandy soil in a summit in SW part Sec. 3 that catches 600' contour. In NW part of Sec. 3 at nearly as high altitude pebbly clay shows in fields and continues NW into Bay City in Sec. 33.

#### Study NW of Bay City

From Bay City I went west on the Midland Road. There is sand over gravel on west bluff of Saginaw River just north of Midland Ave. where some trenches are open. The altitude seems to be above 595' contour. There is an abrupt rise of about 10 ft. to this sand and gravel strip from the low land along the river. This sandy land only extends west ¼ mile or so to the channel that runs parallel with Saginaw River past the Gd. Trunk depot and in which this Salzburg drain is located.

West of this channel I find till with scarcely a foot of washed material covering it. Its highest part is above 605' contour. I crossed this in Sec. 19 Bangor Twp. At the town line of Bangor and Monitor Twps. I turned north and was in a similar till area for over a mile. At the south

house on west side NW¼ Sec. 18 I pass a light sandy strip that crosses a slight rise in the road perhaps 1 ft.. It seems likely to be a weak shore feature. It is just below 600' contour, not more than 1 – 2' so may be Nipissing shore. North of it the land is lower than south and has some mucky clay over the till 1-3' exposed well in the roadside ditches. About 60 – 80 rods north of corner Secs. 12 & 13 Monitor and Secs. 7 & 18 Bangor, the road crosses another slight rise which is cobbly and pebbly as if till had been wave-washed and this stony material left as a concentrate. This strip runs ENE – WSW. It is above the 595' contour and may be nearly 600'. There are a few boulders in this strip and also in lower land much of it down to 595' contour.

In the NW part of Sec. 7 is a gravelly bar almost 600' A.T. It is higher than the B.M. at corner marked 598'. This is developed for 50-60 rods in NW part of Sec. 7 and trends SE – NW. It crosses into the NE corner of Sec. 12 Monitor and there swings SW and soon dies out. The protrusion of the 595 ft. contour in the north part of Sec. 12 so far westward is not due to gravel or sand deposits but is a prominence in the till. It has boulders and pebbles and clayey soil from the end of the gravelly bar just noted, westward to Millpond Drain

#### Dunes

There are sandy ridges along line of Secs.6 & 7 Bangor Twp. that catch the 600' contour but they have been sorted by wind action.

#### Nipissing Beach

I go north on line of Secs. 6 and 1 over sandy land with scarcely and pebbles until I pass a swale that is below 595' contour. North of this is pebbly sand extending to Kawkawlin River. It may be a delta deposit of the river. I find it in Kawkawlin Village on the prominent land between the Millpond Drain and the river, and it here barely catches 600' contour. There are dunes east of here that rise above 600' contour, but the pebbly material is at or below this contour. This seems to be a Nipissing feature. I go west from Kawkawlin and find the North Branch has a very small channel here and is bordered by till on both banks in Sec. 35, Kawkawlin Twp.

#### Nipissing

There is a thin sandy coating south of here in the bend of the river but it scarcely reaches north of the Monitor Twp. line. The sandy gravel strip seems to curve in from the north along an old shore line instead of being deposited by the stream. It comes into the east edge of Sec. 35 but lies mainly in Sec. 36, Kawkawlin Twp. The till plain covers Secs. 27, 28, 33 & 34 in the Bay City quadrangle. There are small patches of sand of slight depth which I noted from road on line of Secs. 27 & 28. There are similar slight sandy deposits in Secs. 21 & 22 south of North Branch. What sand there is does not

have much pebbly material in it, and may be largely wind drifted especially when it stands above the general level.

#### Dunes

North of North Branch in Secs. 15 & 16 Kawkawlin, there are more pronounced ridges of sand and much of the surface has a thin sandy coating, but till is exposed in ditches only 2-3 ft. deep.

#### Nipissing Beach

North from these sections there is a generally coating of sand clear to the limits of the Bay City quadrangle east of Linwood though clay spots occur in Secs. 3, 4, & 9. I went no farther north today than Secs. 15 & 16 but turned east to examine the shore line that is followed by the highway in Secs. 14, 23, 26 & 36 Kawkawlin. This shore was occupied by Lake Nipissing for the base of the sandy deposits on its east slope is down to about 590 ft. or 6 ft. lower than the Nipissing beach at the south end of Lake Huron. It is bordered on the west in Secs. 15, 22 & 23 by a strip of peaty muck that is below 600' contour. But in the beach there is pebbly material as high as that contour. This pebbly material is better displayed on the outer border of the beach in south part of Sec. 23 and in Sec. 26 than in Sec. 14. I went west on quarter line road in Sec. 26 and found the west limit of pebbly sand at two houses 60 rods from west end of the road. Clayey till is at surface farther west. The sand lies over north part and east of a wet strip south of center of Sec. 26 so there is very little sandy land in SW¼ of Sec. 26. In Sec. 35 there is perhaps 80 acres of sandy land in the NE part. The SW half of Sec. 36 is occupied by a belt of sandy ridges for the shore line which farther north occupies a width of only 30 – 40 rods, here is split up and spread out to a width of over ¼ mile. Its east limit is below the 595' contour. On the west the sand is present down to about the 595' contour but is very thin and patchy below that contour. There is sandy land both sides of the M6RR from Kawkawlin to Winona but SE from Winona in Sec. 8, Bangor Twp., it lies entirely east of the railway. I went south on line of Secs. 7 & 8, 17 & 18 through a till plain well exposed by deep roadside ditches. There is a slight ridge causing the projection of 600' contour north in Sec. 18 which I had not time to examine but I came to a faint shore at about 600' near south end of line of Secs. 17 & 18 and there is a distinct cut bank a short distance east of the corner of Sec. 17, 18, 19 & 20, Bangor Twp. These faint shore features may have been formed before the strong bar was built farther east in Sec. 8 and NE part of Sec. 17 and SW of Sec. 17, Bangor Twp.

#### Slight Ridges of Pebbly Sand 600'±

October 14, 1919. I go into West Bay City and southwest to corner Secs. 19, 20, 29 & 30 where the 600' contour makes a projection SW into Sec. 30. There is a slight coating of gravelly material in SE part Sec. 19 and a relief here of 2 or 3 ft. above lower land each side. This low ridge crosses the road into Sec. 30. To the

southwest there is a faint ridge that is below 600' contour but was washed pebbly material along it. It extends into SE of NE¼ Sec. 25. South of this 80 – 100 rds. is another similar ridge that catches 600' contour. It is pebbly but a sandy strip runs SW from it 30 – 40 rds. There is a light patch of sand near south end of line of Secs. 25 & 30 also a short sandy ridge in north part of Sec. 36 between 595 & 600'. But most of the land is free from sand coating in this vicinity. The 600' contour south of center of Sec. 25 has ordinary till without pebble concentration in it. The area in NW part of Sec. 25 and SW of Sec. 24 is similar, these being clayey till except a few square rods where a slight sandy coating occurs.

#### Features in Monitor Twp. NW of Bay City

I went north on line of Secs. 25 & 24, 13 & 14 Monitor, crossing areas on line of Secs. 13 & 14 that catch 600' contour but they do not show pebbly concentrates. There is an area above 600' contour in SE part of Sec. 11 that has several acres of pebbly concentrates and the whole area above the contour is a little more sandy than bordering lower ground. There is a slight riding in SW part of Sec. 12 with a little pebbly material. This is nearly up to 600' contour. The area above 600' in SE part Sec. 7, Bangor Twp., has clayey till only a foot below surface but carries a coating of pebbly gravelly material. It is a very weak shore feature but seems to be one and to continue south into Bay City along or near 600' contour.

#### Zigzag Sand Ridges

In the afternoon I took street car to Salzburg and then went west 3 miles to a strip of sandy land that is near 600' contour but when heaped up by wind is 605 or 610' or more. The contour map brings out its irregularities well. It runs ESE across Secs. 28 & 27 to SW corner Sec. 26, Monitor Twp. Its course is then southwestward into south part of Sec. 34 then ESE to center of Sec. 2, Frankenlust. Then SW into SE corner Sec. 3 then SE across Sec. 11 & NE part of Sec. 14. Its general width is about ¼ mile but in Sec. 28, Monitor, it is scarcely half that width. There is a little pebbly sand in patches but generally it is pebbleless wind-blown material and very poor quality compared with the bordering till areas.

#### Features of NE in Frankenlust Twp.

In my afternoon trip I went north from Corner Secs. 26, 27, 34 & 35 to the Midland Road, then west a mile, then south 4½ miles then NE along road east of Frankenlust drain, then north through Sec. 2, then east to Saginaw River at Brooks and back to Bay City on car line on east side of river – Aside from the sandy strip just noted I was in a till tract in all this circuit. There are very few boulders, but cobble stones are common and stones 6 – 8 inches in diameter. The boulders seem to be largely gneiss and granite and some are weathered to form freak boulders with strong ribs at indurated places. On the borders of the sandy strip some mucky land occurs and forms a clayey or gummy deposit 1 – 3 ft. thick over

the till. It is in places black and somewhat peaty but usually is a pale clay.

The Dutch Creek drainage in NE part of Frankenlust Twp. is almost a dead stream as far up as Sec. 2. The lower course of the Salzburg drain is through a marsh with about 2 ft. of water at present low stage.

#### Features near Salzburg

October 15, 1919 – Bay City, Mich. I take street car to Salzburg. There is considerable sandy and pebbly soil on the strip of land on which this car line runs that lies between Saginaw River and a channel west of this car line. At the end of the car line it is a pebbly sand. This strip catches the 595' contour. The channel west is down to 585'. There is a narrow strip of sandy soil on the slope west of the Salzburg Drain in Sec. 31 that extends a little above 595' contour. The sandiness, however, does not extend to SW corner of Sec. 31.

#### Study in SW part of Bay City quadrangle

I go SW in Sec. 1, Frankenlust Twp., and find laminated clay exposed in SW part of the section to depth of several ft. It extends south on line of Secs. 11 & 12 about ¼ mile. Till is then within a foot of surface and boulders are exposed along the roadside ditches. There are a few acres of sandy land in SW corner of Sec. 12. A considerable part of west half of Sec. 13 is sandy and the sand extends a little beyond the center. There is a strip of pebbly clay along the NE edge of this sand but at middle of line of Secs. 12 & 13 there is laminated clay. The sand lies in the laminated clay in the line of Secs. 13 & 24 showing that it is younger than the clay there. I went west on line of Secs. 13 & 24, 14 & 23 and find sand about to middle of line of 14 & 23. Its border bears east of south toward the SE corner of Sec. 23 but sand is present on both sides the marshy land in north part of Sec. 23. I go south on line Secs. 22 & 23 but see very little evidence of a shore line here though I am near the 600' contour. The projection of 600 contour in SE part of Sec. 22 has a slight deposit of pebbly sand. I find fully as much ½ mile west on the projection of the 605' contour. Neither place can be considered a definite shore feature. I went west to corner Secs. 21, 22, 27 & 28 but saw no shore features near the 610 or the 615 contour. The latter crosses the line of Secs. 21 & 28 less than ¼ mile west of the corner and the surface there is ill drained and clayey. I went south into Saginaw quadrangle on line of Secs. 27 & 28 Kochville Twp. rising to 617.7' at corner Secs. 27, 28, 33, 34. The soil here is very stiff clay.

#### Study in NW part of Saginaw Quadrangle

I go east on line Secs. 27 & 34 and note a thin sandy deposit south of road near 610' contour. I come to sandy strips in Sec. 26 & 35 between the 595 & 600' contour. The sand has a few pebbles in it. It is in strips and seems to be a thin deposit, with places where till outcrops with cobblestones in it. There is laminated clay

around corner of Secs. 25, 26, 35, & 36 but sand occurs to the northwest in Sec. 25 and to the SE in Sec. 36, and it occurs also the west half of Sec. 1, Saginaw Twp. There is a strip of heavy clay east of this sandy strip extending nearly to Saginaw River. There is, however, a strip of pebbly sandy & loamy material along the west side of the river from Zilwaukee past Carrollton to edge of Saginaw. It is  $\frac{1}{4}$  -  $\frac{1}{2}$  mile wide. It is likely to be due to stream work but the sandy strip west of it seems to be a shore feature of Lake Nipissing. The limits of Lake Nipissing were probably as far west as the sandy pebbly strips in Secs. 26 & 35 Kochville and Secs. 2 & 11, Saginaw Twp. The angling road that runs NNW-SSE crosses Sec. 11 is on a small ridge of pebbly sand. Two places on it have 598' as altitude. So it is about the right height for Nipissing beach. There is sandy land down to 595' contour on its east border. Study in North part of Saginaw City. There is a strip of sand running ENE-WSW across NE $\frac{1}{4}$ , Sec. 14 that is windblown. Its highest points catch the 605' contour. There is mucky clay south of it along the old Pere Marquette track in SE $\frac{1}{4}$  of Sec. 14. It is well exposed now by the numerous trenches for sewers and water pipes in the building operations that are going on here. There is a slight deposit of sand in west part of Sec. 13 that seems to be a southward extension of the Nipissing shore. There is a swale with mucky clay soil between this strip and the one along the river in Carrollton and southwest from there into Saginaw. I made examinations of soil on east side of Saginaw River along the north edge of the city of Saginaw as far east as the Michigan Electric RR (third rail). There is a mucky clay 2 - 3' thick over the till in north part of Sec. 17, Buena Vista Twp. There is a patch of sandy land in NE $\frac{1}{4}$  Sec. 18 at about 590'. This mucky land extends a little above the 590' contour. There are sandy strips in east part of Sec. 17 and south part that I noted a few days ago from the Pere Marquette train as I went east to Arthur Station. These sandy strips are more recent than the mucky deposit. I went back to Bay City from Carrollton. Till sets in on this line near the south limits of Bay City in the NW part of Sec. 4, Portsmouth Twp.

#### Study near Linwood

October 16, 1919 - Bay City, Mich.

I take train to Linwood on MCRR. There is a bouldery till east of the strong shore line. It extends clear out to the bay for 2 miles SE of Linwood or about to Linwood Park. Farther south sand ridges and marsh extend back a mile or so from the edge of the bay and till occurs, or is exposed only in a narrow strip, next to the Nipissing shore. The surface of the till has been washed and a pebble concentrate is quite widely developed on it. This concentrate material is several inches thick in some cases so as to look like a pure? bed. I went west from Linwood across the Nipissing shore to corner of Secs. 33 & 34, Frazer Twp., and Secs. 3 & 4 Kawkawlin Twp. There is a sandy coating over the till west of the shore

line as far as this corner but it ends within 80 rods south. So quite an area of till as exposed in west part of Sec. 3 and in Sec. 4. There is scarcely any till exposed in Sec. 10 except in NW and NE corners. The soil map shows much of the west half of Sec. 9 to be Clyde loam and this generally is till of clayey nature.

#### Features North of Bay City

After examining this north end of the Bay City area I went to Linwood Park and took train south to the Belt Line. I noted along the present shore near Linwood Park gravelly material just below present water level. But nothing except sand and shells above this level. There are a few boulders in the edge of the water. North of Saginaw River opposite Bay City there is a till tract with very little sandy coating in much of the area east of the Nipissing shore and between Saginaw and Kawkawlin Rivers. Mr. Cooper's map seems to outline its extent better than the soil map by U.S. Bureau of Soils. Its east edge is near the D & MRR there being sand and marsh between this railroad and the present shore of Saginaw Bay. For two or three miles north of Kawkawlin River there seems to be a continuous cover of sand and many little ridges 2 - 5' high or formed in it as shown by the topographic map.

#### Studies near Essexville

After dinner I went by electric car to Essexville. There is a shore line starting in Essexville and running SE across SE $\frac{1}{4}$ , Sec. 14 and SW corner of Sec. 13, T.14N., R.5E. Much of it is above 590' contour but its NW end is a little below the contour. This dies out in south part of Sec. 13. South of it in south part SW $\frac{1}{4}$ , Sec. 13 is a very cobbly area with stones 3 - 6 inches in diameter so numerous as to be very conspicuous. It runs 30 - 40 rods along south edge of the section. It has very little relief, only a foot or so above less pebbly tracts around it. Boulders are present in these clayey tracts. The soil has many small pebbles in SE part Sec. 13 and NW of Sec. 19 in a flat area. But the pebbles indicate river wash. A more definite shore leads eastward from center of Sec. 23 through Sec. 24 and SW part of Sec. 19 and NE part of Sec. 30 Hampton Twp. This catches 600' contour in a few places where sandy and heaped up by wind action. But the pebbly material in it is a little below 600' probably 598'. There is a pebbly area outside the sandy ridge in SW corner of Sec. 19 and north part of Sec. 30 and this is 597 ft. at the corner of Secs. 19 & 30, 24 & 25. This definite shore ends abruptly at the end of the loop of the 595' contour in east part of Sec. 30. Till is at surface immediately south as well as east and west of this shore.

#### Studies East of Bay City

A somewhat sandy strip runs SE across Sec. 29 from near Raby to the SE corner of the section. It has white sand in spots but generally is dark color. This sandy strip is marked by three different soil patterns on the soil map: Clyde sand, Clyde sandy loam and Saginaw

sandy loam. Probably Clyde sand has less loam than the others but the change from one to the others is liable to occur in almost any acre, and I think there are not definite limits such as the soil map shows. There is a large area of flat black sand slightly pebbly in Secs. 21, 22 & 27 north and west of Farleigh. It has a clay subsoil at 2 – 5 ft. and in places at less than 2 ft. The clay seems to be silty and with few pebbles – and I do not see large stones on it in the ditches such as occur outside this area. North of it is a string of weak beach lines at about 587 – 588 ft. and these are on till that has a notable number of granite and gneiss boulders up to 4 or 5' in diameter. The sandy pebbly strip just noted may be an outwash deposit when the ice was covering the area that is boulder strewn. The water must, however, have been ponded here to as high a level as the outlet at time of the second Lake Saginaw of 690 – 700 ft. Another shore just above the present one runs past Oak Grove. It is a sandy strip and much of this material is sand in the next string of beaches to the south. I saw small shells in this shore line along line of Secs. 12 & 13, Hampton Twp. (T.14N., R.5E.) I took car into Bay City from Essexville.

#### Studies in SE part of Bay City Quadrangle

October 17, 1919. South Bay City, Cass Ave. I went east to the crest of a beach of sandy gravel that catches the 600' contour in south part of Sec. 33 and north and east parts of Sec. 4 (Portsmouth Twp.) The main ridge does not extend but ¼ mile north into Sec. 33 and it dies out at SE end a few rods east of the Mich. Electric RR in west part of Sec. 3. There are weak curved bars running east and swinging to NE from this bar in NE part of Sec. 4 and west of Sec. 3. Another bar sets in in south part of Sec. 3 on the angling road and follows it to the center of Sec. 11. This spreads out in NW part of Sec. 11 to 40 rods width but generally is only about 15 rods wide. It stands about 5 ft. above the plain south of it and was formed by water on that side. There is a strip of flat black pebbly sand along line of Secs. 10 & 11 extending down to 590' or less. This bar catches 600' contour where strongest and is pebbly at highest part. This bar is weak in SE part of Sec. 11 but is traceable to the SE corner. Another bar sets in about 40 – 50 rods south of this area near center of Sec. 11 and runs SE through south part of Sec. 11 into the north edge of Sec. 14 where it seems to end. It is pebbly sand and is only 2 – 3' high. Another bar sets in near center of NW¼ sec. 13 and runs ESE across the section. It catches 600 ft. for a short distance but is mainly a little below that contour. Weak curving bars branch off from it in the east and run into Sec. 18 as shown on the map (contour). There is weak shore development on west side of Tuscola Road in east part of Sec. 19 above 595 contour. It curves around and crosses this road and runs NE into the edge of Sec. 20 north of the west quarter post. East from here is a low strip below 595 contour, that extends to a shore line formed by water in the Saginaw basin NE of it. That shore line runs NNW – SSE across east half of Sec. 20 passing ½ mile west of Munger. There is a sandy &

pebbly deposit not definitely ridged covering the east part of NE¼, Sec. 30 and extending a little into Sec. 29 which is probably due to wave work in shallow water. It is 598' or less. About ½ mile farther southeast there is a cut bank formed by Nipissing waters at west side of a till island that stands above 600' contour. At the south end of this 600' area the cut bank changes to a bar of sandy gravel that turns east a little north of center of Sec. 32. This is nearly 600'. To the southwest there is a lower one barely 595' that curves around to the west and south of center of Sec. 32 with that contour line.

#### Studies SE of Bay City

There is a lower shore feature farther west that I noted near the Watcher Mine. A cut bank or water? strip slope passing below the 590' contour. In the SE part of Sec. 31 I noted a pebbly black sandy deposit at about 590' contour. There is also a black sandy deposit west from there at 588' at the SW corner of Merritt Twp., Bay County. The surface is flat in both places. I was told by a farmer that in sinking an air shaft for the mine in south part Sec. 6, Buena Vista Twp., several ft. of coarse gravel was found under a bed of mucky clay 5 or 6 ft. thick. This at about 588 ft. This farmer says the land marked CL on the soil map in Secs. 1, 2, 10, 11 & 12 and which stands a little below 590' contour is a heavy clay and not a black muck. Boulders are struck in it in tile drains and road ditches so it is likely to be glacial material. It is little if any higher than the areas of black musk east and west of it. After examining the flat area just noted I returned to the higher land and traced the Nipissing beach around the curve from the bay south of the Bay City moraine across the moraine to the NE slope facing Saginaw Bay. It crosses in Sec. 33 southeast of center of section and is just below the 600' contour. In the north part of Sec. 33 and in SW part of Sec. 28, Merritt Twp. it catches 600' contour. The area above 600' in Sec. 33 is mainly a till area. In places there is a showing of cobblestones and pebbles as if it had been wave washed but there is not a definite beach on the highest part.

I traced the shore that was formed by Saginaw Basin waters northward past Munger to the parochial school in west part Sec. 8, Merritt Twp. It there curves around to the SW to the MCRR and dies out. A continuation is found in a sandy ridge that runs north across east side of SE¼, Sec. 6. The crest of the Bay City moraine west from here is above 600' and in places 605' but it seems to have no shore features. It is a stiff clayey till within a few inches of the surface and the soil is such as usually forms on till with remarkably little sandy or gravelly material in it. I followed the Tuscola Road into Bay City from NE part Sec. 13, Buena Vista Twp. and saw no shore features until I reached the cemetery near city limits in NW part of Sec. 27. There is a ridge of sandy gravel here that catches the 600' contour. There is a peculiar trench around the center of Sec. 27 that is below 595'. The land enclosed by it is clayey though scarcely as high as the beach at the cemetery a few rods northwest in NW¼ Sec. 27. This is near the west

end of a bar of sandy gravel that runs eastward through central part of Sec. 26 and SE across SW part of Sec. 25 to center of NE $\frac{1}{4}$  Sec. 36 and is exceptionally well defined all this distance, and was mapped by the soil survey as Mfs. There is a light sandy coating for  $\frac{1}{2}$  mile or more west from the west end of the definite bar as far as the NE corner of Sec. 28 or to within a mile of Saginaw River. There is a strip of till  $\frac{1}{2}$  mile or so in width between this shore line and a later one that I traced yesterday westward into Sec. 23 and which catches 600' contour where best developed which is true also of this earlier one. The two are practically identical in altitude, the difference being less than 5 ft.

#### Studies SE of Bay City

October 18, 1919. Bay City, Michigan. I examined the sandy strip that runs west from the bar that I traced to Sec. 23 on Oct. 16. It has nearly flat surface in Sec. 22 and is only 2 – 4 ft. thick. It becomes thicker in NW part of Sec. 23. A ditch runs across it from south to north in the west part of NW $\frac{1}{4}$  sec. 23. It shows 4 – 5' of sand with numerous shells on its lower part, clams, etc. There is a slight ridge at south edge of this sand deposit running across Sec. 23 about 60 – 80 rods from its south line. It is 3 – 4 ft. above the till tract south of it. It dies out in SE part of Sec. 23 but in SW part of Sec. 24 it is developed for a short distance and catches 600' contour. This is south of the main ridge that I traced Oct. 17 into Sec. 23. I went south through Sec. 25 to the outer Nipissing shore and found it well defined SE to center of NE $\frac{1}{4}$  Sec. 36. For nearly a mile SE from this place there is very faint shore development, low sandy strips with relief of only 1 – 2 ft. I cross two of these on line of Secs. 36 & 31 within 80 – 100 rods of north end. There is another weak sandy strip running ESE across north part of SW $\frac{1}{4}$  Sec. 31. A well defined ridge of sandy gravel sets in about 80 rods of center of Sec. 31 that is continuous for fully 1 $\frac{1}{2}$  miles in a SSE course across east part of Sec. 6 into NE corner Sec. 7 Portsmouth Twp. where it dies out abruptly. There is a gap of  $\frac{1}{2}$  mile between its south end and the north end of the bar in west part of Sec. 8 near the Parochial School. This bar in Sec. 31 & Sec. 6 is narrow 6 – 10 rods wide and comprised of sandy pebbly material. Its relief is only 3 – 5 ft. I examine the swells in central part of Sec. 6 that catch 600' contour and find them to be till swells with less than a foot depth of washed material on them. I then went across the swells in sec. 36 that traverses the SE $\frac{1}{4}$  of the section and find it has almost no washed material on it. For a short distance east of center of Sec. 36 there is pebbly sandy material, a few inches in depth, less than 2 ft. An isolated swell northwest of center of Sec. 36 also has a slight deposit of this sort. The swell between this and the larger ones to the south has a stiff clay with boulders at surface. There are a good many boulders near surface along ditches in Secs. 1, 6, 31 & 36 as this is the inner slope of the Bay City waterlaid moraine. The Tuscola Road is along the crest and boulders are somewhat plentiful there as noted last night. The swell that catches 600' contour in south part

of Sec. 26 and is cut through by the MCRR has little or no washed material on it.

I followed the outer Nipissing beach westward from where the MCRR crosses it to Park Ave. and found it very irregular owing to development of hooks as it was extended westward. These double back to the south. I went north on Park Ave. to the MCRR and find it very little sandy coating here and west along the railroad to the depot.

#### On MCRR Bay City to Detroit

I took noon train from Bay City on MCRR to Detroit. The sandy gravel along the railroad north of Salzburg has a depth of several ft. and it is a nearly continuous deposit over the width of the strip that lies between the river and the old bayou west of it. This seems likely to be river deposit. There is a fine silty sand on the low tract south of Brooks bordering the swamp. East from Saginaw there is a till plain to edge of the Saginaw quadrangle. There a beach is cut through in Sec. 26, Blumfield Twp. whose course from there NE is shown on the map by U.S. Bureau of Soils partly is MS and partly Mg color. The flat sandy soil bordering it seems to have color C. There is then till plain to within about a mile of Vassar when a strong beach is crossed that is marked Mg on the soil map. The crest of the Port Huron moraine lies between this shore line and Cass river at Vassar. South of Cass River from Vassar to Millington there is sandy land with wind drifted ridges. Millington is at the shore of Lake Saginaw. There is a moraine south of the village with numerous low hummocks of bouldery loose textured till.

Features from here to Detroit have been noted in detailed studies in earlier years. There is a gravel pit at top of North Bluff of Clinton River east of Rochester at altitude fully 50' above the stream above dam in east part of the village. The bluffs expose till below it for 30 – 40' above river level.

#### At Davison with Sadler Topographer

Oct. 20. I took evening train Ann Arbor to Durand and eastward on Gd. Trunk RR to Davison to Meet Mr. C. L. Sadler, Topographer, who has surveyed the Burt quadrangle lying east of the Chesaning. I find by his maps a steep rise from about 690 to 605-710' as if to a waterlaid moraine in north part Sec. 2 Flushing and east of streams in Sec. 1, also northward from there along east side Sec. 36, Montrose at the west part of Sec. 30 Vienna Twp. It is this strip that shows as a till area north of Clio but it is sandy in Flushing Twp. The Arkona beach in Sec. 27, Vienna and SE part of Sec. 28 catches 735' contour. It is easily traceable by protrusions of the 735' contour in north part Sec. 33 and east part Sec. 32, also near corner Secs. 31 & 32, Vienna and Secs. 5 & 6, Mt. Morris Twp.

## Studies Near Mt. Morris

Oct. 21, 1919 – Davison, Mich. I went north from Davison with one of the topographers (Mr. Richardson), for 2 miles across undulating till. There is stronger undulations farther north in Sec. 28 and in Ne part of Sec. 29 with suggestion of moraine. The SE part of Sec. 20 is also of this sort. We went west 2 miles and then turned north on line Secs. 29 & 30 crossing the channel that leads SW from Flint River past corner of Secs. 17, 18, 19, 20, Richfield Twp. and the east end of the island that laid north of this channel and occupied a square mile  $\pm$  in Secs. 18 & 19 and SE of Sec. 13 and Ne of Sec. 24 (Genesee). It has till and the channel south is cut in till but has a little sand and gravel coating – on its bed and banks and delta to the west. North of this island along Flint River is a gravel plain that is being extensively drawn on for road ballast. A delta of Imlay outlet in head of Kersley Lake. (See Monograph 53) There is undulating till in places east of the well defined moraine that runs through Mt. Morris but most of this district is flat surfaced but the drift here is very loose-textured.

From Mt. Morris I went a mile north along railroad and then west along township line road. There is a morainic surface with strong expression in Sec. 35 and west edge of Sec. 36, Vienna which runs SE into Mt. Morris. South of it in NW part of Sec. 2, Mt. Morris to south edge of Sec. 35, Vienna is a sandy plain that is slightly above Lake Saginaw level being 760'. A weak till ridge runs WSW from west part of Sec. 35 into Sec. 34 that has sand deposits on its north slope to within 5 ft. of level of the crest or to 760'. It may drop below the lake level in Sec. 34 near west side of Section. I went north between Secs. 34 & 35 & west a mile through lake till (Lake Saginaw) with boulders and slight sandy deposits on till. I went south on line Secs. 33 & 34 Vienna and found Lake material of sandy character south of the small stream as far up as 740' – 745' but not to the 750' contour. I went west on township line and seem to be above Lake Saginaw level until near middle of line of Secs. 5 & 32. There I enter sandy gravel which runs westward on the town line to the town corners. There is also a strip of sandy gravel on south slope of a till ridge in north part of Sec. 5, Mt. Morris nearly across the section. It is likely to be Lake Saginaw deposits or else outwash into water ponded south of the till ridge. I do not find any well defined beach in Secs. 4, 8, & 9 but there is a deposit of sandy pebbly material in east part of Sec. 8. Shore features are indefinite in Secs. 17 & 18, but I come to a deposit of sandy pebbly material on line of Secs. 18 & 19 near middle. There is gravelly undulating till in SE part of Secs. 17 & 20 and in south part of Sec. 20 that contrasts with the flatter land of the northwest and suggests that the flatter land is lake bed – I went north on line of Mt. Morris and Flushing Twps. From corner Secs. 18 & 19, 13 & 24. There is a prominent gravel bar that has its SW end on the bluff of a stream in NE part Sec. 13. It is largely above 730' and some of it is 735 ft. It is opened for gravel and has 3 – 4' of sandy loam over gravel. The loam is pebbly. The bar

does not extend more than 3/4 mile north but is prominent for about that distance or to middle of line Secs. 12 & 7. There is till plain around its east and north borders. There is sandy land west from it to Flint River on line of Secs. 12 & 13, 11 & 14, I am told. Till extends west on line of Secs. 1 & 12 to a creek but west of this creek there is sandy land to Flint River – of poor quality. I took road east on line Sec. 6 & 7 Mt. Morris and continued to the village of Mt. Morris.

East of a creek 3 miles west of Mt. Morris there is a thin deposit of clayey till 3 – 4' thick over sandy material. This is exposed for 20 rods  $\pm$  on north side of the road. It shows readvance of ice sheet. There is a sandy ridge in NW part of Sec. 10 that reaches 765' contour and its lower limit on the north is at 750' contour. It is too high for Lake Saginaw and is above the level of the till that caps sand west of it as just noted. It seems more like a lake deposit than glacial feature and there may have been local ponding to 760 – 765'. Features a mile north noted this? warping(?) suggest this. The Lake Saginaw wave action seems to reach to about 745' in south part of Sec. 3, Mt. Morris. The surface below this level seems to be more thoroughly wave washed than between 745' and 760 ft. yet ponding may have reached 760'. There is a sandy strip in west part of Mr. Morris at the cemetery that is about 770'. It is at the southeast end of a morainic strip noted this morning. West of this is a low plain barely 755' that has a thin sandy coating. It is crossed 1/2 – 1 mile west of Mt. Morris.

I returned from Mr. Morris to Davison with the topographers. Mr. Mafit is working north of Mr. Morris and he gave me altitudes along shore lines in that district. One at town line 2 miles east of Clio is 749'. A lower beach at the county line and town corners 3 miles northeast of Clio is 723'. There are two places on this beach between Clio and the county line that rise above 725', one being near center of sec. 11 and the other in southwest corner of sec. 1, Vienna. The 700' contour crosses the electric railway one and one-quarter miles north of Clio in south part of sec. 10, the 680 contour a mile farther in south part of sec. 3 and the 660 contour in south part of sec. 33 about 2 miles southeast of Birch Run. The soil map of Genesee County has a sandy soil about up to 700' contour on the electric line marked Cs. – Clyde fine sandy loam. There is some land marked C – Clyde loam that has less sandiness. I find the patch of pebbly sandy land in east part of Sec. 8 Mt. Morris catches 745'. A ridge in west part of SW $\frac{1}{4}$  sec. 8 has 730' contour and is a projection of a shore to the northwest.

The pebbly sand I saw near middle of line of secs. 18 & 19 Mt. Morris is 730' at east limit.

### Studies near Mt. Morris Rock Surface 525'

The prominent bar near north end of line of secs. 18, Mt. Morris and sec. 13, Flushing, catches 730 contour and its highest elevation is about 735'. The low plain south of the end of this bar is only 715 – 720'. From Hazelton Twp., Shiawassee County, a 735' bar crosses into

Genesee County near north end of line of sec. 24. There is a ridge in sec. 19, Flushing, that catches 740. The second Arkona beach in secs. 18 & 20, Flushing, is 715' and also in sec. 13 & 12, Hazelton Twp., but drops below 715' in sec. 14. There is a 715 bar in northwest of sec. 9, Hazelton, and one that catches 710' runs southeast across northeast part of sec. 9 from sec. 4. This is the 2nd Arkona beach. I got a record of distance to rock on the McArthur farm 5 1/4 miles west of Mt. Morris at altitude about 725' – rock was struck at 200' – the head is 6'. There are flowing wells northwest of here in Montrose twp. on ground between 680 and 700'. I traced contours for 660, 680, and 700' on the Genesee County soil map across Burt Quadrangle from the field sheets of Mr. C. L. Sadler and the 700' contour in the part of Hazelton Twp. in Burt Quadrangle. It seems from today's observations that the Lake Saginaw extends to about 745 in Mt. Morris Twp. and the highest Arkona is about 730 – 733'. Mr. Sadler says the sag 3 – 3 1/2 miles east of Flushing is 726' natural surface at the water parting. The ditch that drains south from south part of sec. 29 has a water level 720' at line of secs. 29 and 32.

The railroad crossing a mile southwest of Rogersville on line of secs. 1 and 12, Genesee Twp. is nearly at the level of the plain that was covered by a glacial lake and is 745.6'. The cross roads south of Rogersville is probably fully up to the level of this lake and is 752'.

#### Studies near Clio

Oct. 22, 1919, Clio, Michigan. I take road south a mile and cross a shore line at the cemetery 1/4 mile from south end of line of secs. 22 and 23 in the area  on soil map. This beach is represented to run southwest into east part of sec. 28, Vienna Twp. It is 740 and 1st Arkona. I went east on line of secs. 23 and 26 and came to a higher beach about 1/4 mile east of the railroad tracks altitude about 750 – 752' and this runs near corner of secs. 23, 24, 25, and 26, and has similar altitude to this corner 752 – but from this corner east northeast to the angling road, "Dixie Highway", in sec. 24 there is a till ridge nucleus with lake deposit over part of its length but the highest part on or close to this angling road is above the lake action several feet – 15'+ - and is not coated with washed material. From the angling road eastward there is a shore that crosses the E-W quarter line road in sec. 24 near center of the section and stands 750' at that place. It drops a little below the 750 contour east of center of sec. 24. There is a nucleus of till capped by beach material in a ridge in northeast part of sec. 24 that is 749 at the corner of the section. There is a strip of low land in northwest part of sec. 24 south of the 750' beach. This beach probably has a till ridge as nucleus or as part of its relief. The northeast quarter of sec. 26 may have been covered by water while the 750' beach was forming as an off shore bar – and so also was the northwest part of sec. 25, and east of sec. 24 and northwest part of sec. 19, Thetford Twp. This puts the mainland border in central part of sec. 25 and southeast part sec. 24 and central part of sec. 19,

Thetford Twp. and sec. 18 as noted p 79-80. The border runs north through central part of sec. 17 and sec. 8 and SW 1/4 sec. 5 and there turns east through north part of this section to a small stream. The edge of the lake action is at about 750' from sec. 23, Vienna, northeastward.

#### Studies in North Part of Flint Quadrangle

I went south from east side sec. 19 to the corner of secs. 19, 20, 29, and 30, Thetford, descending from a till ridge about 775 – 780' to a plain 760'. This plain has considerable flat black sand or sandy loam which is colored for symbol C – Clyde loam light phase. A considerable part of secs. 29 and 30 has nearly plane surface but it seems to range from heavy clay to light sandy loam. The east edge of sec. 29 and the east half of sec. 20 are strongly morainic being in the Mt. Morris moraine. The moraine is largely loose-textured drift with some very sandy spots and it rises to about 800'. There are some sharp ridges somewhat like eskers in secs. 5, 8, and 17, along west edge of the moraine.

I went east to this moraine on line of secs. 20 and 29 and then north in it for two and one-half miles. The main moraine turns eastward and its inner border is in sec. 9 and along line of secs. 3 and 4 to north end. The border there turns southeast and runs south of Buell Lake into sec. 11 and 12, Thetford Twp. There is a strong ridge somewhat like an esker in west half of sec. 5 and north of sec. 8 which is only 1/8 – 1/4 mile wide and has points 60 – 75' above the border plains. From its north end a gravelly undulating till ridge runs east across north half of sec. 5, south of which is a strip of wind blown dune ridges. The SE 1/4 sec. 5 and south and central parts of sec. 4 have some flat till that seems likely to have been covered by Saginaw waters at highest stage. I think the water extended southeast into sec. 10 but it was shut in between long morainic ridges and it lies back of a strong but narrow moraine that runs east northeast from northwest part sec. 32, Arabella Twp., Tuscola County, through south part sec. 28 and north part of sec. 27, Arabella Twp. It is less than 1/4 mile wide but has an abrupt inner border relief of 50' or more and an outer border relief of 30'±.

It runs beyond the limits of the Flint quadrangle in southeast part of sec. 22, Arabella Twp. Its crest is 750 – 775' A.T. The inner border is down to about 715 – 720' and the outer about 740'.

I come to a U. S. Geological Survey bench mark 708' at corner secs. 21, 22, 27, and 28, Arabella Twp. An Arkona beach lies a few rods south and is 715 – 720'. The moraine is wave washed up to about 750' or the limit of Lake Saginaw. The drift in it is loose-textured and largely sand but has stones on surface as well as in the drift. The cut on line of secs. 27 and 28 shows crumpled sand and pockets of stony material and till all in a disturbed condition as if shoved into by the ice sheet.

I went west along north boundary of the Flint quadrangle for two miles to corner secs. 19, 20, 29, and 30. The plain slopes 20' in that direction in two miles, or to 688'. It reaches 680' at the county line 3/4 mile farther west and 647' at corner of Saginaw quadrangle 3 miles farther west. I went south on line secs. 29 and 30 and found bridge elevation at stream to be 694'. The stream is 690'. There is an Arkona beach 717 – 718' about 60 rods from south end of line of secs. 29 and 30. It is faintly developed east of the creek to the base of this morainic ridge (above noted) and follows north base of ridge east northeast to edge of the quadrangle in sec. 27, Arabella Twp. The corner of secs. 29, 30, 31, and 32 is 711'. A beach 50 rods south at a school house is about 20' above this or 730'± A.T. There is a dune ridge crossing it.

#### Studies in north part of Flint Quadrangle

There is a belt of dunes in secs. 31 and 32, Arabella Twp. and secs. 5, 6, and 7, Thetford Twp., but the flats among the dune ridges are covered with pebbly sand that seems to be a lake deposit and shore feature. There is a U. S. Geological Survey mark at county line 732' and a mile south (at corner secs. 5, 6, 7, & 8), is 743'. There is gravelly material and some wave action on slopes up to 750 – 755' contour all around this bench mark. I cross the gravelly area west of the corner and used hand level both to the east and south to get at the level to which wave action reached. I went west through dune belt to a strong Arkona beach that runs into Clio along the angling road in secs. 1, 11, & 14. It is 725' on highest points but generally is between 720 and 723'. It is gravelly at the top and not capped by dune sand. The sand sets in jus teats of it in secs. 1 and 12, Vienna Twp. I went to Mt. Morris on electric car to see Mr. Mofit, topographer, who is mapping the northwest part of the Flint quadrangle. He found the shore line that is marked "Dg" on the soil map north of Pine Run in secs. 13 and 14 is all above 740' and one point at a house in west part sec. 13 is 745'. This seems to be the highest or First Arkona beach. The one noted this morning 3/4 mile south of Clio may also be First Arkona while the one that catches 750' is about 10' higher is likely to be the Saginaw beach. Mr. Mofit finds the cross roads two miles south of Clio to be 742' so the First Arkona should appear near there as well as in the bar 3/4 of a mile south of Clio. I traced 660 and 680' contours across the northwest corner of the Flint quadrangle from the field sheet made by Mr. Mofit.

#### Pebbleless Clay

Oct. 23, 1919, Clio, Michigan. There is a large pit opened in a pebbleless clay in the valley of Pine Run in south part of Clio. It is below the level of the Arkona shore and seems to fill a depression outside it. The beach on north side of Pine Run has till under it the gravel being only 5 – 6' deep. The till becomes a blue gray color at 8 – 10' depth and is well exposed to 20' depth.

#### Rock Surface 620'±

Flowing wells occur in southeast part of Saginaw County in secs. 23, 26, and 35 between the 660 & 680' contour and perhaps to a little above 680' contour. Depth slopes from 75 to 150' or more – Henry Thompson's well in west part sec. 30, Arabella Twp. strikes rock at 71' and is 86½' – head 14'. Altitude 690'. Mr. Will Loomis in southeast of sec. 30 on Arkona beach 725' has well 150', that is only a few feet in rock – head is 40'.

#### Studies east from Clio

Oct. 23, 1919, Clio, Mich. I go east a mile and cross the highest Arkona beach about 3/4 mile east of Clio. It seems to be about up to 740' contour here as it is on these two roads farther NE that cross it. It dies out at an east branch of Pine Run. It seems to be faintly developed near center of sec. 23 but is scarcely 5' above border plain in secs. 13 and 14. It is 10 – 15' and is composed of gravelly material with some cobblestones and boulders on slopes. There is a faint ridge north of it in east part NE¼ sec. 14 that runs across NW corner of sec. 13 and dies out on a plain in SW part of sec. 12. It is only 5 – 6' wide and 3 – 5' high. It is probably 738 – 740'. It has gravel under a sandy capping 2 – 3' thick. So the sand gives about half the relief. From Pine Run I went east 2 miles to corner secs. 17, 18, 19, and 20, Thetford Twp. The road rises above Lake Saginaw level near west end of line of secs. 19 and 20, Thetford Twp. There are sandy gravel spots in a till ridge that reach about 770 – 75'. The altitude at corner sec. 17 and 18, 19 and 20, is 765' and is 5 – 10' below the highest points in south part of sec. 18.

#### Studies east of Clio

I go north descending to 748.5 at quarter post of secs. 17 & 18. This low strip runs west and also NE and was covered by Lake Saginaw. There is a gravelly knoll 10 – 15' high in SW of NE¼ sec. 18 and was above Lake Saginaw. There are other knolls still higher in SE part of sec. 7 extending into SW of sec. 8, Thetford twp. The sec. corners of 7, 8, 17, 18, on about the Lake Saginaw level 752.8'. These knolls rise to 770 – 775'. They are glacial and not due to lake action. Lake Saginaw washed the west, north, and east slopes of this group of gravelly glacial knolls. It probably extended into the center of sec. 8 and covered sec. 7 except about 40 acres in SE corner. In sec. 18 it covered the west edge and extended east among the knolls. In sec. 19 it seems to have covered only the NW part as noted yesterday.

After tracing the limits of Lake Saginaw I went west on line secs. 12, and 13, Vienna, and noted the small beach NW of the large Arkona in secs. 12, 13, and 14. The large first Arkona dies out at the NE at the place indicated on soil map by change from Dg to C. The area C is largely a pebbly loam with an occasional boulder and probably with till at slight depth. The area Mf west of it is very similar and has more boulders in sight. On the coarse phase of Mf in sec. 14, there are low gravelly

ridges 1 – 3' above intervening till strips. The trend is NE – SW and this sort of land extends to the large second Arkona beach in sec. 14. West of this Arkona beach along the Dixie Highway angling NW in sec. 24, there is a stony pebbly and sandy washed material 2 – 4' thick on the till. It has quite a number of boulders and coarse stones left as a concentrate. It should not be labeled sand as is done on the soil map.

#### Studies north from Clio

There is a small beach of sandy gravel not far from 700' altitude that curves around eastward into NW¼ sec. 11. It then runs NE in south part of sec. 2. It dies out south of a wind drifted sand ridge that lies east of center of sec. 2. I found a faint separate ridge NE of here in SE corner of NE¼ sec. 2. To the east and north from here is flat till to the county line. There dune sand sets in that follows the county line east to the Arkona beach. Some boulders are mixed in the sand for 1/2 mile west of this beach in sec. 36 and in sec. 31 (Arabella). This is likely to be the washed down continuation of the narrow strip moraine that I traced yesterday to NW corner of sec. 32, Arbella. Dune sand strips run westward across this boulding – one into east and NE part of sec. 36, Birch Run Twp. I am unable to trace any lower Arkona beach in secs. 36 & 31 than the Second Arkona which stands 720 – 725'. This has dune sand heaped on it raising its altitude perhaps to 735' or more.

I went north to limit of Flint quadrangle at corner secs. 24 & 25, 19 & 20 (Arbella). This is 681.7' and there are strips of pebbly sand north and west of this corner that stand 1 – 2' above till surface. These seem to be all there is here of Lake Warren shore line. Dune sand strips are present around here and rise 5 – 10' above the till surface. They are much more conspicuous than the gravelly sand strips or shore features. I find the gravelly sand strips west from here a little below 688'. West from the quarter post of secs. 24 & 25, Birch Run Twp., there is till at surface.

#### Flowing Wells

I go south on line of secs. 25 & 26 and note strips of pebbly sand near the 660' contour in east part of NE¼ sec. 26. Boulding areas are predominating over sandy patches in secs. 26 & 25 and 36 & 35. There is (as noted on p. 79) an artesian well area in these sections. I did not try to work out its limits, but was told that most of the wells flow in secs. 26, 27, 34, & 35, Birch Run Twp. I went west on line of secs. 26 & 35 passing low strips of pebbly sand 1 – 3' higher than the till areas. I find these strips have a NNE-SSW trend about with the contour and they are not far from 680'.

#### Studies SE of Birch Run

I went north on line secs. 26 & 27 and pass these strips at intervals clear to the north end of the Sutton line. The corner secs. 22, 23, 26, & 27 is 659'. A low ridge of pebbly sand crosses the line a few rods west that is

about this altitude. There are strips of this sort westward on line of secs. 22, 27, about of quarter post. Here the altitude is 653' on the westernmost one. The NW¼ sec. 27 is till with little or no sandy coating. The NW corner is 647'. The till as noted a few days ago in trip south from Frankenmuth extends down to the 640 contour in secs. 21 & 22. Below that contour sand is conspicuous and drifted into dunes.

#### Studies SE from Birch Run

I went south on line of secs. 27 & 28 and found sandy strips only near south end, till being at surface and within 80 rods of the section corners of 27, 28, 33 & 34. This is close to 660'.

Along the Dixie Highway (the road leading SSE through secs. 34, Birch Run and sec. 3, Vienna) I found a pebbleless clay for the whole distance across sec. 34. The ditches expose it about 3'. There are strips of sand on it that also are pebbleless. The altitude rises gradually southward in this clay area being 664' near quarter line (E-W) of sec. 34 and 671' at the county line south side sec. 34.

There is pebbly sand and are occasional boulders south from here setting in at about 675'. This seems to be Lake Warren shore material. I cross a low ridge of sandy gravel with clear gravel exposed at base in a pit at side of road near center of sec. 3 opposite a house east of the road. This, I think, is about 680' contour. There is another about 100 rods farther on south that is a little stronger. This is likely to be fully 685' and perhaps 690'. A stream cuts it west of this highway but it sets in west of the stream and crosses line of secs. 3 & 10 near middle. It is faint here. I find the altitude at Pere Marquette RR on line secs. 3 & 10 is 685.3. This is in a pebbly sandy area with very few boulders. The corner of secs. 3, 4, 9 & 10, Vienna twp., is 684.4. The 680' contour is near by so the rise of this deposit may mark Warren shore. There is not a definite ridge, however, but a gentle southward rise.

#### Features near Clio

There is 13' rise southward in line of sec. 9 & 10 and in this mile I saw nothing but pebbly sand, not a boulder in sight. There is 5' rise in the half mile to the quarter post of secs. 15 & 16 or to 702'. The area on soil map marked Dg is like the Cs area crossed on line of secs. 9 & 10. The Mf is also similar – a pebbly flat sandy area. I see only pebbly sand where the road cut down to Pine Run Valley on line of secs. 15 & 16. The valley here is not more than half as deep as at Clio for the bluffs are 20' lower here. The altitude is 706.6' a mile west of Clio at cross roads. There is a rise of about 15' both east and south in about 1/2 mile to the Second Arkona beach which is 720'±. I did not go south on line of secs. 21 & 22 but could see the shore from north end of the line. I crossed it at west edge of village of Clio. It is more sandy here than NE from Clio but has pebbly material clear to surface.

I need to get altitude of the shore line where it crosses line of secs. 21 & 22 (it is 718') and secs. 15 & 23. Also of a higher one in line secs. 27 & 28. Near quarter post (above 735') I took car to Saginaw from Clio in order to do work needed to complete the St. Charles quadrangle, and NE part of Elsie quadrangle. There are very few boulders from Clio to Birch Run and the sandy gravel coating extends from Pine Run Bluff in Clio to within a mile of Birch Run Village. The surface of this sheet of sandy gravel is not ridged definitely at the levels for Warren and Wayne shore lines. The Grassmere and Elkton are in dune areas and not clear as to course or position in this district south of Cass River. Probably the Elkton beach is the one found at 620 – 25' on north side.

#### Studies near Brant and Marion Springs

Oct. 24, 1919 – Saginaw, Mich. I take morning train on MCRR to St. Charles, Mich. And auto bus to Brant Center (see notes). When on earlier trip between St. Charles and Brant I went west 2 miles through a plain with fine sand as a thin cover over till. The land is fair agricultural land. There is a strip of bare till just east of a prominent sand ridge in the NW part of sec. 20 Brant Twp. There is very sandy land west of this ridge in NW corner sec. 20 and adjacent parts of 17, 18, 19. The east half of sec. 18 is sandier than the west half which has some till in a strip running north into SW¼ sec. 7

I go south into the Elsie quadrangle on line of secs. 19 & 20, Brant Twp. and find some till but sand is heavy a short distance west in sec. 19. Sec. 30 is very sandy except in SE corner but sec. 29 which is traversed by south Fork of Bad River has good farm land as noted in August and so have secs. 31 & 32. I went west on line of secs. 19 & 30 in sandy land all the way except in part of a swamp which has clay under it. From the line of Brant and Marion westward to Marion Springs, there is scarcely any land without sandy coating. There are small spots in which boulders are to be seen but the soil around these stones is loose textured. I am told this sandy area extends west from Marion Springs 4 miles and it extends about the same distance north and south or from the south Fork of Bad River across to the north Fork. There are spots of clay south of the south Fork in secs. 14 & 15, Chapin, north of a prominent chain of sandy ridges that crosses the north part of secs. 22 & 23 and forms the south edge of the sandy country. It is probable that all these spots of clay in Marion Twp., if put together, would make less than a square mile. It is more generally coated with sand than other twps. in this region.

#### Studies near Brant

I went north from Marion Springs and found a small area of clay in NE part of sec. 22 and NW of sec. 23, Marion, probably 40 acres. Farther north there is a heavier sand deposit. Potato Creek cuts through the sand and has till for a few feet above creek level.

I turned east on line of secs. 10, 11, 14, & 15, and traversed a sandy country to the town line. It is a flowing well district. Some flows are obtained at 35 or 40', but the wells generally are 80 – 100' and in some cases 150'. They enter rock at 80 – 100'±. The water is strong in iron wherever I sampled it. The altitude is 640 to 650'. Rock surface is about 550'. I got dinner in south part sec. 7, Brant Twp., at a farmhouse on the clay area above noted that extends north into sec. 7 across west half of sec. 18. This farmer has a flowing well 90' deep which he thinks is on the rock at bottom. I find sand rather heavy and land poor east from quarter post of secs. 7 & 18, Brant, nearly to the west edge of the St. Charles quadrangle. There good farm land sets in. It has patches of sand but they usually are thin so the subsoil of till is within reach of plants. This kind of land extends east into north part of sec. 15 and south of sec. 10, Brant Twp.

#### Features west of St. Charles

There is sand on much of secs. 9 & 10 except their south edge. It is so thick where the heavy grading for sand is being made on line of secs. 9 & 10 and of secs. 3 & 4 south of Bad River, that clay is seldom reached at depth of 3 – 3½'. The sand in places is pebbly and is more productive than the pebbleless wind driven sand in the district to the west. There is good farm land south of Bad River in SW¼ sec. 4 and it extends west into sec. 5. There is till at or near surface in this area. This pebbly sand is found at a level that corresponds with the Elkton beach from a little below 620' up to 625' or higher but I do not find a definite shore line or ridge developed. The ridges that are mapable are of wind blown sand. An isolated 625' strip in SW part of sec. 27, Fremont, has pebbly sand without wind deposit over it. The same is true of a 625' area on south bank of Beaver Creek, north of center of sec. 27. Those in east part of sec. 27 are more sandy and raised by wind action. Except a few sandy ridges, secs. 27, 28, 33 & 34, Fremont, have good farm land with till at or very near surface. North of Nelson in secs. 15, 16, 21 & 22, there is excellent farm land with scarcely any sand cover on the till. From there sections northward to Hemlock, till areas are small and sand predominates as soil. Only a small part, however, is drifted into ridges as may be seen by the contours on the topographic map. The first mile west of Cleveland School is less sandy and a better class of farm land, I am told, than 2 miles west where heavy sand occurs.

From Nelson I went across north part sec. 27 and then turned south. There is sandy land on east side SE¼ sec. 27 except a few acres of mucky clay in SE corner, east of a sharp sand ridge. This muck land extends east into sec. 26 and into NW part of sec. 35 covering 400 acres ±. In secs. 34, 35, 36 there is a change from good land at the west to poor sandy & swampy land at the east that is gradual – till becoming less and sand more. The north part of sec. 2 has strips of sand wind driven between which till is at surface or but thinly coated with

sand. From this section east into St. Charles the land is so poor it is largely of brush. There is clay only along Bad River bottoms.

North from Durand across Venice Twp. in Hazelton Twp.

Returned Oct. 24 to Ann Arbor and went to Durand Oct. 28.

Oct. 28, Durand, Mich. I took road leading north across the Imlay Outlet and the Flint moraine. The outlet is about 765' and the highest points crossed north of it are scarcely 800'. Webb Creek channel also is 765' on this road. A till plain is entered a mile from north edge of the Durand quadrangle near corner of secs. 21, 22, 27 & 27, Venice Twp., at an altitude of about 776' that being the survey elevation at this corner. In the next mile there is a descent to 747'. This is on a bridge of a small stream corner secs. 15, 16, 21, 22 within 5' of the altitude of the border plain. At the next crossing of this stream nearly 1½ miles north the bridge is 739' and the plain here is perhaps 740'. The survey altitude 1/2 mile north at corner of secs. 3, 4, 9 & 10 is 741'. North from here past the angling road near middle of line secs. 3 & 4 there is a wavy till surface that seems not to have been covered by Lake Saginaw. A flatter tract is entered near north end of line of secs. 3 & 4 which seems likely to be below Lake Saginaw level. It is below 740'. There is no altitude mark in sight at the line of Venice and Hazelton Twps. at south edge of this flat land. But a mile north the survey shows 728'. This is 35' lower than a knoll crossed by line of secs. 25 & 36 about 2½ miles east. This corner is called Judds Corners but there is no village here. I went a mile west to determine the extent of Lake Saginaw and find very flat surface to the section corner secs. 28, 29, 32, 33, Hazelton Twp. altitude 746'. But a few rods west and south there is a slight rise and what seems to be a cut bank that is perhaps the shore of Lake Saginaw. It seems to be too high for lake action and more likely is a glacial feature. This is a dividing ridge, there being drainage westward from near this section corner. The land looks flat, however, as far west as can see distinctly, probably a mile. I went north on line secs. 28 & 29 and noted some pebbly ground near a dwelling on west side of road near middle of sec. line and this is slightly higher (1 – 2') than flat land east of it and is about 746' contour. So sec. line may be near the Lake Saginaw limits. My study of the Chesaning quadrangle last August left the line near the corner of secs. 20 & 21, 28 & 29, Hazelton Twp. I went east on line of secs. 21 & 28 and descent to 723' at corner secs. 21, 22, 27, 28. I passed a strip of pebbly sand forming a thin coating on the till a short distance west of this section corner at altitude of about 725'. This is about at the level I should expect to find the highest Arkona beach. So it is likely to be represented here only by this strip of flat pebbly sand with no ridge or relief above border till tracts. I went north on line of secs. 21 & 22, 15 & 16, and noted similar pebbly sand strips in east part of SE¼ sec. 16 and along part of the section line just north of the quarter post. There probably was a narrow bay of Lake Arkona extending south over secs. 22 & 23,

and east part of 21 into secs. 26, 27, 28, Hazelton Twp. There is higher land to the east so that its limits seem to have been on line of secs. 13 & 18 at the county line (sec. 13, Hazelton Twp. and sec. 18, Flushing Twp.)

#### Limits of Lake Arkona

Lake Saginaw only extended on the county line a little south of corner of secs. 13 & 24, Hazelton and secs. 18 & 19, Flushing. Lake Arkona probably covered much of sec. 16 and NE part of sec. 17, Hazelton as noted last August. A bar of Lake Arkona runs east across south part of sec. 9 that is slightly lower than the First Arkona beach but is higher than the second Arkona being about 720'. The Second Arkona runs across NE part of sec. 9 and dies out in west part of sec. 10 at a stream that runs NE past New Lothrop.

#### Features near New Lothrop

It is very weak and interrupted by wide gaps in south part of sec. 10 and in NE part sec. 15 and NW of sec. 14, Hazelton Twp. but becomes strong in NE part of sec. 14 and north part sec. 13 and SE of sec. 12 being up to 715' much of its course in secs. 13 & 12. It is not quite up to 715' in secs. 4, 9, 10, 15, 14. The lowest Arkona or perhaps second Lake Saginaw is represented by weak bars of pebbly sand west of New Lothrop in south part of sec. 3 and north of sec. 10, one bar being below and the other barely above 700' contour. The section corner 1/3 mile west of the outer of these two bars is only 704'. I could not find this lowest Arkona on line of secs. 3 & 4 near 700' contour but in NE corner of sec. 4 a bar sets in that is a little below 700' and this is traceable NW into sec. 33, T 9, R 4 E in Saginaw County (Maple Grove Twp.).

#### Shore Lines in Maple Grove Twp.

I went north on line of secs. 33 & 34 and cross bar after bar of pebbly sand. One at corner of secs. 27, 28, 33 & 34, at a school house is 690'. It runs ESE into sec. 34. There are two other within 1/2 mile south and two more with about the same distance north of this school house all with similar trend. They are all low and weak compared with the Arkona shore but consist of wave washed pebbly material in low ridges 1 – 2' high and several rods wide. The lowest one is not far from 680' for the altitude is 678' at corner of secs. 21, 22, 27 & 28, Maple Grove Twp. I went west on line of secs. 28 & 33 and traced one of these bars from NE part of sec. 33 into SW of sec. 28 and then NW into NE of sec. 29, Maple Grove or into the edge of the Chesaning quadrangle. This bar seems to be near 690' altitude.

#### Features near New Lothrop

I went east on line secs. 21 & 28 descending past a 680' shore to 678' at corner secs. 21, 22, 27 & 27. I then went south to the school house at 690' contour SW corner sec. 27. I then went a mile east and could see the gravelly 690' bar as far east as N – S quarter line

about 1/4 mile south of the road. Farther east I was on a plain on which I saw no trace of shore features. I turned south on line of secs. 34 & 35 and saw no trace of shore features. I turned south on line of secs. 34 & 35 and saw no shore features there nor in the next mile south to New Lothrop. There is a flat till bordering the valley at New Lothrop. The bars near 700' contour just west of this village are mentioned above. I continued south for a mile from New Lothrop through a greatly eroded strip but noted a faint bar of sandy gravel south of quarter post of secs. 10 & 11, Hazelton, just before descending into a valley that crosses SE part of sec. 10. South of this valley at area marked Mg in SE part of sec. 10 and SW of sec. 11 there is very little shore material. It is flat and has some cobble and a mere trace of pebbly sand. Continuing south on the line of secs. 14 & 15 I cross two faint low ridges of pebbly sand a few rods wide and 1 – 3' high – one being near quarter post and the others 60 rods north of it. These are what were mentioned above as weak parts of the second Arkona beach.

#### Lake Saginaw 735 – 740'

I turned east at Hazelton (corners 14, 15, 22, 23) and crossed a much eroded plain. I noted a deposit of pebbly sandy material near east end of this section line, altitude 715'. SE of here a low ridge runs NE across NW part of sec. 24. It is Arkona at the highest stage being about 725'. Its continuation is likely to be in or near the stripe marked Mf on Owosso soil map in south part of sec. 13, Hazelton Twp., but it does not extend into sec. 14. SE from here there is a rapid rise to a morainic area with numerous boulders and with till swells up to 10 or 15' high. Lake Saginaw seems to have washed this slope up to 735 – 740' and to have left a thin coating of pebbly sand on much of its border. The major relief, however, is that of the glacial features rather than lake features.

#### Moraine west of Flushing

I followed this moraine to Flushing through secs. 19, 20 (SW part), 29 (central), 32 & 33, Flushing Twp. There is a rapid descent NE from it to a very smooth lake plain in E part sec. 29 and in sec. 28, Flushing Twp. I went three miles south from Flushing to see the areas marked MF on soil map. They have nearly plane surface and the sand is of fine texture so far as examined and is a very thin deposit 2'±. There are irregularities of valley width of the small streams in the locality, as if the streams had cut through basin rims and crossed basins in their path. The north part of sec. 3 is rather prominent and may fall within the moraine that I traced SE sec. 33, Flushing. But the country south is plain as far as I could see from quarter post of secs. 10 & 15, Clayton Twp. I went west from here 3/4 mile and then north. I was in a clayey till in sec. 9 and found a change to veneer of fine sand in north part of the section. This runs eastward with slight interruptions across north part of sec. 10. This does not seem to be outwash from the moraine north of it but is a veneer over an uneven surface such as might be a deposit by wind. Boulders are not so

numerous on the plain south of Flushing as on the morainic strip leading into sec. 33, Flushing, from the northwest. I stopped overnight at Flushing (Hotel Mundy).

#### Delta of Flint River in Lake Arkona

Oct. 29, 1919, Flushing, Mich. I took road NW across sec. 27 through a gravelly plain below the Arkona beaches. I come to the beach or part of the delta of Flint River in NW corner of sec. 27 and it runs NW from there into sec. 21 about 1/4 mile and then doubles back to the south and comes to south line about 1/4 mile west of corner of sec. 21. It is above the 720' contour. It runs only a short distance north and runs SSE into NE 1/4 of sec. 28. It may be the highest Arkona. West of this beach line or bars there is a low plain with black mucky soil and a few boulders that is drained by Brent Creek. An Arkona beach appears to the west in sec. 20 at altitude above 715' on an area marked M1 on soil map, and traverses it from ESE – WNW. A lower strip south of it marked C on soil map has till and clayey soil. This runs to the SW into the moraine noted last night in sec. 29.

#### Shore of Lake Saginaw

The slope as noted last night was wave washed nearly up to 740' contour by Lake Saginaw. The limits are in places well defined but generally rather obscure. There was a bay extending into NW 1/4 sec. 29 and in this the shore is very ill defined but in NE 1/4 sec. 29 it is plainly marked.

#### Till Plain

I went south on line of secs. 29 & 30 and found a light coating of sandy loam over boulding till near the quarter post at an altitude that seems to be above Lake Saginaw about 745' contour. South from this the land is clayey and flatter but rises gently southward to 755' at township line. I went west on line of secs. 30 & 31 across flat till but on continuing into Shiawassee Co. on line of secs. 25 & 36 I cross a high tract of undulating till very clayey that catches 760' contour. It drops off abruptly at the west to about 740' and has a slight sandy coating on the slope.

#### Lake Saginaw

In the NE part of sec. 35 and SE of sec. 26, Hazelton Twp. an area marked Mf seems to be a Lake Saginaw deposit of fine sand at 740'. It has a slight ridge where crossed by the section line road 2'± above the plain east of it. This probably represents the depth of this deposit. There is a marked rise eastward from west part of sec. 26 to the central part but the slope is very smooth. The Saginaw shore appears on this tract in the NE part of sec. 26 as a definite ridge above 740' of sandy pebbly material 2 – 5' high trending SW-NE. It is cut off by a valley in the NW corner of sec. 25. But about 120 rods NNE from the sec. corners of 23, 24, 25, 26, it sets in

and runs northeastward through the north part of sec. 24 and continues into sec. 19, Flushing. It catches the 735' contour in most of its course in sec. 24 and NW part sec. 19. It is developed on a morainic ridge and it is nearly on its crest in sec. 24 and sec. 19.

#### Features near New Lothrop

I went north on line secs. 26 & 27 and east on line s3 & 26, then north 3 miles and west 1 mile to New Lothrop. The first Arkona is poorly developed in secs. 23 & 24 and 13 as well as in secs. 26 & 27 and I shall need a contour map to show its position. It is close to 725' contour in this vicinity. The second Arkona was crossed on line of secs. 13 & 14. It is rather weak in sec. 14 but is very strong in sec. 13 and SE part of sec. 12 with relief of 12 – 15' in its inner (NW) borders. The plain north of it is flat and clayey with a few boulders. This condition extends north into Saginaw county. From New Lothrop I went north to county line over a flat clay tract then east along the line for two miles to NE corner of Shiawassee Co. This road is along or near a valley part of the way which has steep bluffs 25'± high. The plain bordering the valley is till and very flat. The stream runs north in sec. 36, Maple Grove Twp. and I noted a short section of the Lake Warren shore east of it in SE¼ sec. 36.

#### Lake Warren Shore

It dies out near the line of 36 & 31. Its relief is 3 – 5' above the plain south of it so it can be seen 1/4 mile or more away. Another shore feature south marks the limit of Lake Warren in NE part of sec. 1, Hazelton Twp., Shiawassee Co., and across north half of sec. 6 into NW¼ sec. 5, Flushing Twp., Genesee Co. An area marked C on soil map lies north of it and is flat till with a few boulders. There is an abrupt rise of several feet at this shore to a level above the 680 contour and perhaps 685'. The base of this bank is above 680' in NE part of sec. 6 and NW of sec. 5, Flushing Twp. At the east of this flat till area is a sandy plain with fine pebbles in the sand. The same also covers the north part of sec. 31, Montrose. In fact the west half of Montrose Twp. is nearly all covered with this pebbly sand. The only important exceptions on the area just noted in south part sec. 31 and SW of sec. 31 which has flat till, and an area of pebbleless clay west of Montrose in secs. 18 & 19 and south part of sec. 7.

#### Delta of Flint River in Lakes Wayne and Warren.

This sandy area is about 680' in south part of the township and descends very gradually northward. It is 675' at Montrose. The clay plain west of Montrose in sec. 19 is barely 660' and is lower to the north. I can see no clearly outlined shore features but there is a rather rapid descent of a few feet northward about where the 660' contour runs in south part of sec. 18. There is also a rapid rise from 660 and 665' along the Gd.T.RR in passing south into sec. 17 and 10' more to Montrose. A slight bank is traceable ESE from the railway just south

of line of secs. 8 & 17 that is about 660' at top and the base is perhaps 657'.

#### Limits of Lake Wayne Indefinite

From sec. 17 northward 3 miles to Burt the plain of pebbly sand has a very flat surface and very gentle northward descent. It is 650' at line secs. 5 & 8, 645' at county line of Genesee and Saginaw and 637' at Burt Station. The bench mark there is 638.7' but is about 1.7' above level of ground at depot in Burt. I went west from Montrose to Laytons Corners and found a change from Pebbleless clay to boulding till a mile west of the county line and a gradual westward rise to 666' at Laytons Corners. I did not see any trace of the Wayne shore east of Laytons Corners but it may be where the change to till was noted 2 miles east. The 660' contour runs across north part of secs. 23 & 24. On going north from Laytons Corners, I found a pebbly washed material setting in 1/2 mile north that may be Lake Wayne beach washed down. I also noted a faint ridge of this material running N-S from south part SW¼ sec. 10 into sec. 15, Maple Grove Twp., 1/4 mile east of corner secs. 9, 10, 15, 16. A strip of dune sand comes into the Burt quadrangle near corner secs. 8, 9, 16 & 17 and runs eastward and northward in south and east part of sec. 9 and SE corner of sec. 4. It is continued in faint form to the stream in sec. 3. North from this strip of dunes I enter a pebbly sand area in line of secs. 3 & 4 and it continues to the north edge of the Burt quadrangle. It is 622' at line of Albee and Maple Grove Twp. where road turns north into sec. 34, Albee.

#### Delta of Flint River at Elkton stage

Boulders are embedded in this sand and exposed in ditches at roadside. This may be the Elkton beach as it has a sort of bank leading NE from south part of sec. 34 across NW part of section 35 into sec. 26. The top of this rise is about 630' and the base 620' or less. The plain NW of it drops below 610' at cross roads on line secs. 27 & 34, about 80 rods from west end of sec. line. From the top of this rise there is a flat sandy tract extending east past Burt. There are but few pebbles in the sand for 3 – 4' from top but in the deep ditches 5 – 6' deep considerable pebbly material is cut into. The plain is 630.5 at south quarter post sec. 26 and 633.7 in SE corner sec. 26. It is 636' at bridge on line secs. 25 & 36 near quarter post, and is also 636' at SE corner of sec. 36. It is 638' at corner 29, 30, 31 & 32, Taymouth and 637' at Burt in south part sec. 29, Taymouth. This sandy tract gives place to clay about at the border of the Burt & Saginaw quadrangles, as noted a few days ago (Notes Oct. 6). I followed the railway track from Burt to Montrose to get altitudes put there by U. S. Geol. Surv. this year. The data given above show what I found. I took evening train from Montrose to Flushing. Distance covered by auto afternoon of Oct. 28, 45 miles. Distance covered on foot and catching auto rides Oct. 29, 36 miles. (from 6:15 A.M. to 5:30 P.M.)