Notebook No. 269 - Leverett

COUNTY

Cass: 1

Clinton: 9-10, 32-34, 36

Dickinson: 2-3

Gratiot: 34-36

Ingham: 3, 4

Kalamazoo: 1

Mackinac: 2

Menominee: 2, 3

Saginaw: 14-22, 22-31

Schoolcraft: 2, 3

Shiawassee: 4-9, 10-14, 15, 20-22, 30, 31-32

Van Buren: 1

I N D E X

T O

L E V E R E T T ' S N O T E B O O K

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LEVERETT'S NOTEBOOK

NO. 269

January 28, 1919 Notes on MC R.R. Between Kalamazoo and Niles, Michigan

On my way from Chicago to Ann Arbor on MC R.R., I noted that the drift is rather stony as well as sandy from Niles to the Dowagiac swamp at Glenwood, but has little morainic expression. This probably pertains to the Kalamazoo morainic system while the Alamo moraine is represented west of this swampy channel. It is very sandy and has only an occasional boulder and only gentle swells, but its relief above the swampy channel east of it is 20-30 ft. and rather abrupt. The full rise is usually made in $\frac{1}{4}$ mile $\pm$. There is NE of Decatur a slight presenation of a pitted plain standing about 15 feet above the swamp channel. The channel is swampy clear up to Lawton but seems to have a dry bed from Lawton northward.

There is a sandy plain along the railroad from Lawton to Mattawan but the edge of the Kalamazoo moraine is ____(?)____ southeast and in places crosses to the railroad.

Mattawan station is up on the slope 15-20' higher than the plain.

The Inner Kalamazoo moraine though very sandy here has boulders and cobble stones in it. There is very sandy land from where the railroad crosses the improved highway in SW corner of the Kalamazoo quadrangle eastward to Oshtemo station.

There are few boulders in low places around this station but the cuts show only gravel and cobble for about a mile further east or to where I have placed the west edge of the Outer Kalamazoo moraine.

About 1/3 mile west of Ceresco in west side of north tributary of Kalamazoo, there is a rather thin bedded sandstone exposed in the cuts on the north side of the railroad track up to 8-10' above the track level.

NOTES FROM ROMINGER'S GEOLOGY OF MICHIGAN

Vol. 1, Part III -- Page 18

Rominger noted that the forest vegetation furnishes a reliable clue to the character of underlying glacial and other superficial deposits. He seems, therefore, to have been an early ecologist as well as geologist. His report was published in 1873.

On page 32, Rominger states that most of Drummond Island is coated with boulder drift so that rock is at surface in only a small percent of the island. Marblehead at the NE end of the island stands about 100' above Lake Huron.

Rock outcrops on west shore of South Manistique Lake and at NW part of North Manistique Lake near its outlet--but heavy drift deposits form the principal part of the shore of each of these lakes.

Striae were noted by Rominger in Manistique--

There is limestone on east side Indian Lake in cliffs 10-15'. Indians were inhabiting the huge tract of beech-maple east of the lake and white men seem to have had a trading post there of which ruins of large log houses were noted.

On east side of Manistique River, a limestone ridge runs NE through T.42 & 43, R.14W. and terminates at west side of South Manistique Lake.

THICKNESS OF DRIFT ON EAST END OF NORTHERN PENINSULA

Russell -- Ann Rept for 1904, p. 67, estimates 20-30 feet from east shore of Drummond Island westward to north end of Lake Michigan. This is based on height of outcrops and on well records. On this Garden Peninsula east of Big Bay d Noc and south from the sandy area the drift is very thin and may not average over 10 feet. (p. 68) It is thin on the peninsula between Big Bay de Noc and Little Bay de Noc in much of area only 5 feet.

Even in Menominee County where drumlins 40' high occur, the average thickness of drift may not exceed 20 feet. Around Iron Mountain

and Metropolitan the drift is usually thin, 10-15' or less, through low lands have thicker deposits, Northern Michigan seems to be between a region of glacial abrasion in the north end of glacial deposition on the south with closer relation to the northern area.

Drumlins have in Menominee County a fine dust--like loamy sand 1-1½ feet of which 2/3 the material will pass through a 100 mesh sieve below which is a red sandy till with stones and boulders. The sandy material is largely quartz.

June 3, 1919

The Supt. of waterworks at Manistique, Michigan wrote that the head for the three dams between Indian Lake and Lake Michigan amounts to 33 feet as follows:

Manistique Pulp and Paper Co.	---	Head 25 feet
City Water Intake Dam 4 ft.	---	Head 3 feet
Brewery Dam	---	Head 5 feet

The ordinary level of Indian Lake seems therefore to be about 614' A.T. or possibly slightly more is the dams do not use all the fall.

The Supt. of Waterworks had no record of a survey from Lake Michigan to Indian Lake.

August 1, 1919 LANSING TO OWOSSO, MICHIGAN ON ELECTRIC R.R.

An esker crosses the railway in NNW to SSE course about a mile east of East Lansing. It is in a well defined swell and sag moraine. The knolls are sharper from this esker to Haslett Park than west from there and have basins and wet flats among them. The esker is 15-20 ft. high and has a rather winding course though running in a general SSE course. It is opened for gravel in several small pits near the railway--and seems to have considerable gravel of medium coarseness. There is a large amount of wet land east of Pine Lake for over a mile. The lake probably once covered it. Most of it is boggy.

Hill 75' above railway ½ mile S of MP 233 from Chicago (about 4 miles beyond Haslett Park)

It is morainic to and beyond Shaftsburg all the way from East Lansing. There is a short stretch of nearly level land about midway between Shaftsburg and Perry, which opens northward into a till plain the moraine being south. At Perry, there is a gentle swell and sag topography swells 10-15' or less--but rather numerous.

There is gently undulating till from Perry to Morrice.

The Electric turns away from the Grand Trunk R.R. at Morrice and runs north. There is a rolling topography and cuts 15'± deep just north of Morrice. Hills ½ mile east and 2-3-miles north from Morrice are 30-40' (they lie east from where the railway crosses a creek.) The surface is gently undulating to the north of this creek and probably to be classed as ground moraine. A small part of it is knolly enough to resemble terminal moraine. Some knolls are in chains from north to south.

August 2, 1919 - Owosso, Michigan

STUDY ALONG SHIAWASSEE VALLEY NORTH OF OWOSSO

I took north course on Washington Street across a flat with sandy soil for nearly ½ mile from the river and rose to higher ground at Oliver Street and a summit where Goodhue leads east. The flat is below 740' and this summit is above 755'. There is a narrow E-W ridge less than ¼ mile wide and about 3/4 mile long standing above 750' that may be classed as moraine. It is bouldery till. So, also, is the flat north of it below 750' contour.

The low swell catching 750 at N. end of Washington Street has a thin veneer of sand on south slope, on till. Boulders are numerous on plain along line of Secs. 12 & 13 (North St.) and I note red, jasper conglomerate and a conglomerate with green pebbles, but mainly granite.

There is white oak and hickory timber here with a little pine close to the river in NW part of Sec. 12 and northward across Sec. 1.

At Goss School pine occurs with white oak and black oak, but on till with very patchy sandy veneer.

A till plain with very little expression extends from Owosso to this school. The only exception being knolls in south half of Sec. 12, Owosso and those in north part of the city above noted. It has a few boulders and a stiff clayey till.

GRAVEL BELOW TILL

A gravel pit on east bluff of Shiawassee River, east of center of Sec. 25, Ross twp., has gravel from river level 685' for 30' or to 715'. There is clayey till above the gravel to top of plain 735'. Some disturbance of gravel and incorporation in the base of the till occurs. The gravel beds dip southward or the reverse of the present drainage.

LIMITS OF LAKE SAGINAW 735

I cannot find andy trace of the highest Saginaw beach where the 735' contour occurs on Sec. 25, Rush. There is a stiff clayey till along the road past Five Points. North from Five Points 100 rods is a less clay ridge with house on it on west side of road which is a little below 730'. There is a slight sandy coating in places north from here and a low sandy ridge runs W-E across north part of NE¼ Sec. 24 and NW¼ Sec. 19 to a house about 50 rods south of Union School. There are a few pebbles in the sand and it looks to be a shore line. It is close to the 725' contour.

HIGHEST ARKONA BEACH 726-728'

I do not find this shore developed along the 725' contour in NE part Sec. 19, New Haven Twp. North of Six Mile Creek in west part of Sec. 17 near the quarter post the First Arkona Beach is developed and is above the 725' contour. The BM 726 at the quarter part is about 2 feet lower than the crest. The beach is not well defined on west part of NW¼ Sec. 17, but there

is some sandy gravel along and east of the line of Sec. 17 & 18 where it is above the 725' contour.

I came to the SW end of the highest Arkona beach in SE part of Sec. 7, New Haven Twp. A dwelling is on its crest about 40 rods south of the ¼ post of Sec. 7 & 8. The beach catches the 725' contour near here and is above it nearly all the way to Easton where it is 728'. It is gravelly ridge across Secs. 8 & 9, but in north part of Sec. 10, the gravel is banked along a slope part of the way and veneers a till ridge. It is spread over a width of 30-40 rods or more.

SECOND ARKONA 715'

I went to the second Arkona beach where it crosses the line of Secs. 3 & 4. It is fully as stony here as the Upper Arkona and has an inner border relief of 8-10', also gravelly. It is strong across Sec. 4 and SE part of Sec. 5, so that I can see it from the upper beach. It is weaker on NW part Sec. 8 and NE part of Sec. 7, New Haven. It is 715' or more from Sec. 5 eastward, but below that contour in Secs. 7 & 8. North of the second Arkona, there is only a little coating of gravel or sand in the till, so it is classed as heavy soil over a large area southeast of Chesaning. Between the First and Second Arkona beaches, there is a variety of soil, partly till, partly muck and partly sandy or gravelly. I went east through Sec. 3 and noted the double ridge of Second Arkona in this section and Sec. 2.

I then went south through Easton and crossed a low sandy gravel beach of Lake Saginaw near the ¼ part of Secs. 10 & 11, New Haven. A farmer living in SW part Sec. 11 says this ridge runs nearly continously across the central part of Sec. 11 to a house in west part of Sec. 12 just north of the quarter part of Sec. 11 and 12 that catches the 730' contour. The ridge catches the 730' contour in central part of Sec. 11, also.

FIRST SAGINAW 735+

A stronger shore line is found near south end of line of Secs. 10 and 11 which catches the 735' contour. It runs ENE a little beyond the N-S quarter line of Sec. 11 and then swings around to the south into Sec. 14 about 30-40 rods east of the ¼ post of Secs. 11 & 14. There are also two low gravelly bars further west crossing this section line. There is a thin veneer of sandy gravel between the bars, but boulders are visible here and there so till may be close to surface. This shore line is 3-5' high and 15 rods ± wide and seems to be stronger than the usual development of the highest Saginaw beach, perhaps because in an exposed situation. It seems to have been formed out in the lake on a tract that was just up to lake level. Lower land surrounds this area in Secs. 11 & 14. There is a heavy clay soil in nearly all of Sec. 14 except north half of NW½, and in all of Sec. 15 except along its north edge. It has only a few boulders but seems to be glacial rather than a lake clay.

WELL DATA

The drift in this vicinity as said by Mr. Matherton, who lives in south part of Sec. 10 to be about 100', some wells go into rock. Mr. Matherton's well on the Saginaw beach is only 12 feet. It is a crock well and he thinks there was gravel to that depth. The ridge here has a relief of about 5-6 ft., and catches the 735' contour.

INTERRUPTED SHORE

This sandy gravel ridge plays out at the west near a house at north side NW¼ Sec. 15 and there is no definite shore developed west from there across Sec. 16. There is a very faint ridge catching the 735' contour in east part Sec. 17, which is bouldery but has some pebbly material, also. It runs into west part of Sec. 16 but is there below 735'. Its relief is only

about 2' above very flat land each side. The same sort of a faint rise is traceable SW from a barn in a part of Sec. 16. Possibly this also nears limit of Lake Saginaw.

There is a flatter surface and boulders are less numerous below the 735' contour in Sec. 26 and 20 than above, though there are some in north part of SW¼ Sec. 21 along the road below 735'. The till also is more pebbly above 735', then below in the upper 1-2 ft, as if there had been some silt added by lake action to thelland below that contour. In Sec. 19, New Haven and 24, Rush Twp., the ordinary pebbly till extends nearly to the 730' contour and I think there was lake action but little about 730' in these sections. Differential uplift has brought up the shore south of Easton aboe 735'.

SMOOTH TILL PLAIN FOR 6 MILES NORTH OF OWOSSO

I returned to Owosso on road 1 mile from west side of New Haven amd Caledonia Twps. across a very smooth till plain until I reach Secs. 7 & 8, Caledonia. In these sections the land has scarcely any knolls but there are numerous saucer like depressions 5' or so below the dry land around them. In Sec. 17, the highest points have smooth gentle slopes like ground moraine, but in Sec. 18 there are knolls and basins of terminal moraine type and numerous boulders. The drift is clayey till so far as exposed on slopes and on road grading is this moraine as well as in the till plain.

ON RAILWAY - OWOSSO TO OVID, MICHIGAN

I took evening train to Ovid. The G. T. R.R. is on the edge of a glacial drainage channel about to the SW corner of the Chesaning sheet. The channel averages over ½ mile wide and is about 735-40'. There are only a few places where the till tract north of it rises above 780'. So it has rather slight relief above the outlet and is gently undulating more like ground moraine than terminal. Yet is seems to mark an ice border and held the glacial drainage to the course taken by the channel. This sort of topography

extends past Burton station. About 3/4 mile west of Burton is a group of gravelly knolls opened for gravel on north side the railway. There are easto of the long swamp that heads 4 miles NW of Owosso in Sec. 33, Rush Twp. but which drains partly to the north and east to Shiawassee River at Henderson and partly SW to the Maple River. The summit being near center of Sec. 7, Owosso Twp. at 743 feet. The railway is in bed of Imlay Outlet from this swamp into Ovid, about 3 miles.

August 3, 1919 - Ovid, Michigan

MORAINE NORTH OF OVID

I go north 1½ miles across a plain with thin veneer of outwash sand and gravel over till. Till exposed in the shallow ravines and draws. The outwash is present up to the 775 foot contour but moraine sets in at about 780' in Sec. 1, Ovid Twp., Clinton Co., and also at the east side of the outwash in Sec. 9, Middlebury Twp., Shiawassee County. There is a gentle slope to about 760' in the outwash in the northeast part of Ovid and also in northwest part. Below 760', there is still on the border of the Imlay Outlet.

The moraine of which this outwash is a dependency seems to cross the Imlay Outlet at Sheppardsville and to run in weak form to St. Johns where it again becomes prominent. It forks north of Ovid and the inner member runs NW to Duplain Village (or Rochester Colony on map.) This one may perhaps find continuation in one that runs west from Eurcka, but there is a gap 4 miles from Duplain to within a mile of Eurcka, but there is a gap 4 miles, from Duplain to within a mile of Eureka. Possibly the Eureka moraine continues toward Elsie*. (*see notes November 1919 on moraine correlation). Lake Saginaw covered this gap. The Imlay Outlet came into Lake Saginaw and formed a delta at 730-735 feet west of Duplain (Rochester Colony). It later cut down to 710'±. Its bed is 725 to 730 feet at Ovid. The business part of the village stands on the bed of the outlet.

FEATURES ALONG GLACIAL DRAINAGE CHANNEL

There is a good supply of water from drift in Ovid at about 40' but the waterworks supply is from well at about 200'.

I go east on Owosso highway through a gravelly plain to the swamp in NE part Sec. 21, Middlebury Twp. This swamp is ditched and till is cut into all along its course in SW part of Sec. 15 and NE of Sec. 21 where it is below 725' contour. The till surface is below 725 and 730 feet.

There is a gravelly plain along the E-W road in north part Sec. 22, whose highest part is between 750 and 755 feet where road turns south in west part of Sec. 23.

There is a till tract in north part of Sec. 23 and south part of SW$\frac{1}{4}$ Sec. 14 with flat top between 760-765' so it looks like ground moraine or till plain when one is on it.

East of this is a swampy channel leading north from Maple River (Imlay Outlet) to the swamp in Sec. 14. It is barely 740' at the divide between this swamp and the Imlay Outlet.

East of this channel is a morainic belt that follows the north side of a glacial drainage channel to Owosso. There is a sharp kame with gravel pit in SE part of Sec. 19, Owosso Twp., 25' high occupying only a few acres. A gravelly ridge with E-W trend lines $\frac{1}{2}$ - 3/4 mile further east in SE$\frac{1}{4}$ Sec. 20. It is about 20-25 feet high and about as sharp as an esker. After passing these sharp knolls there is very gently undulating till all the way to Owosso. The border is about $\frac{1}{4}$ mile south of the edge of the Chesaning topographic map in Sec. 21, 22 and 23, Owosso Twp., south of this is a glacial drainage channel with width of $\frac{1}{2}$ mile or more.

I crossed the Shiawassee River at the bend in east part of Sec. 14, Owosso Twp. There is a dam south of the bridge made of boulders holding water up 2$\frac{1}{2}$-3 ft. The river flat is narrow and is cut into till so boulders abound in the river bed. The river bluff east of the bend rises to 745' or 30-35' above the stream. There is till plain for 50-60 rods east below 750'. The

low till swell, noted yesterday, there sets in and runs 3/4 mile east. It is between 750 and 760'.

I take Electric car to Corunna--along the drainage channel. A moraine border is about 1/3 mile south of Court House in Corunna and rises abruptly 25'±. On the north there is no such rise but one passes into bouldery land with mixed soil, partly gravel, partly till about the center of Sec. 21, Caledonia Twp. The highest parts here 15'± rise above the bed of the channel. Near the north side of the section more clayey till with gentle undulation sets in.

FEATURES NEAR CORUNNA

I went east on the "Flint Highway" to corner of Sec. 13, 14, 23 & 24 through gently undulating till that seems like ground moraine rather than terminal moraine, and this sort of topography continues east to the SE corner of the Chesaning quadrangle.

I went NE over the prominence in Sec. 13. This has large clay pits opened in a very clayey till. This clay is used in a cement mill at Fenton, the clay being sufficiently uniform in composition to be mixed with the marl. This high area catches 780' contour but it does not look hummocky and seems to be a prominence in a ground moraine. On its east side, the water drains NE from beyond south edge of the quadrangle, but on its west side the drainage is SW, the waters from west part of Sec. 7, Venice Twp. being drained SW. There is mucky land along the swales north of this prominence, but it is now largely under cultivation. It may be on glacial drainage line. I went north on line of Venice and Caledonia Twps. a high hummocky area in NE part of Sec. 12, Caledonia.

WELL DATA

In SW corner of Sec. 1, Caledonia Twp., C. B. Young (?) Well 327', strikes rock at about 90' - head 16'. Alt. 764' - Draws 3 inch to 130' - water soft. From the hill near corner Secs. 1 & 12, Caledonia and Secs. 6 & 7, Venice Twp., I went west to the Kelley School, occurs a till plain on which there are scarcely a half dozen knolls in the $3\frac{1}{2}$ miles. One in NE part of Sec. 11 is 10-12' high but others on only 5-6' or less. There is a narrow crescent shaped ridge near the Kelley School lying mainly in south part of Sec. 4. It is of clayey till amd rises above 760 contour. It is nearly as narrow as a beach line but is of glacial material.

STUDIES NORTH OF CORUNNA

There is a large swale SE of the ridge in NW part Sec. 10 and east half of Sec. 9 which is below 750' and drains both north and south from the SE part of Sec. 9. This does not have coarse water-bedded material but is clayey where ditched to depth of 5-6 ft., so it may not be a line of glacial drainage but instead a low part of the till plain.

I returned to Corunna from Kelley School. I am told fire clay has been obtained a mile east of Corunna. There is an old mine 2 miles ENE just south of the Flint Highway and just outside this quadrangle. It has a large dump and is said to have had a large amount of coal removed.

There is stiff clay in bed of the drainage channel where ditches are opened near east limit of Owosso along Electric line, and perhaps this is a common feature as the stream seems to have eroded rather than built up its bed. I find that in the east part of Owosso north of the river the flat low plain has clay soil. There is till from 740' contour up to crest of ridge in NE part of city. The river seems to be below 720' at Washington St. Bridge near R.R. depot--but the plain is nearly 740 feet.

August 4, 1919 - Owosso Junction, Michigan -- Altitude 743'

This junction has tracks about 3' above the natural surface of the bed of the channel that the MC R.R. runs in SW from Owosso Junction. There is a black soil 12-14 miles on a clayey bed in which lenses and thin beds of gravelly material occur, beds a few inches thick.

FIRST SAGINAW SHORE FEATURES NEAR HENDERSON

I take MC train north to Henderson.

There is a till plain all the way with very little undulation and only a few boulders in fields.

At the east edge of the village of Henderson, the till becomes coated with sand to depth of 1-1½' that extends to the river bluff. The upper limit is about at 730' contour.

In west part of Sec. 13, the strip standing above 730' contour is sand. There is less sand coating to the east below the 730' contour, so this seems to be a shore feature above that contour.

There are two gravelly beach ridges running from west part of NW¼ of Sec. 13, Rush Twp., WNW across NE part of Sec. 14 and SW part of Sec. 11. The two are distinct in Sec. 14 with a swale between but in Sec. 11 they are blended. The southern and higher one catches the 735' contour, the lower one is barely above the 730' contour. These are both Lake Saginaw Beaches. They are stronger than the neighboring part of the first Arkona beach. The latter seems to be represented in a faint sandy ridge in west part SW¼ Sec. 12 and another near center of Sec. 11 that is nearly up to 725 feet. The First Arkona does not become evident along or near the 725 contour in Sec. 13.

The Second Arkona is finely developed in east part of Sec. 2, SW part of Sec. 1 and north part of Sec. 12, Rush Twp. nearly at 710'. There is a very faint showing of gravelly material at about 710' on the range line between Sec. 12, Rush and Sec. 7, New Haven Twp.

ARKONA BEACH

I took train from Hender to Chesaning at 1 P.M. There is a slight sandy coating in Sec. 14, Rush, SW of the gravelly shore lines. These shore lines have gravel pits in them in Sec. 11 and seem to be largely of gravel for the stretch of 1½ miles above noted, where they are strongly developed. The first Arkona is sandy. The second Arkona is sandy gravel where I traced it on Secs. 1 & 12. The railway crosses a shore line (Second Lake Saginaw?) ½ mile SW of Oakley at about the 690' contour and it trends NW-SE with that contour. It is rather low sandy gravel ridge 2-3 ft. high and 15 rods ± wide.

LAKE WAYNE

The soil is not sandy for nearly a mile NE of Oakley. Sand is there entered which extends to Chesaning. A faint shore is covered in west part of Sec. 20 at about 660' contour, probably the Wayne beach. Possible it catches 665' contour.

From Chesaning, I go south on west bluff of Shiawassee River and find the coating of pebbly sand is thin, less than 10 feet. In the south part of Sec. 16, yellow till comes up to about 635 feet, A.T. There is till up to 645' where the 650' contour comes to the bluff in north part Sec. 21, Chesaning Twp. There is a till bank (cut into by wave action of Lake Wayne?) where the 660' contour comes to the river in south part Sec. 21. Back of this at 665' is a sandy surface. I went west on line Sec. 20 & 29 and could see a pretty definite beach along or near 660' contour marking Lake Wayne shore. There is a light yellow sand of poor quality south of this beach. To the north, there is more pebbly material and somewhat better soil. This poor soil covers about all of Sec. 29 and east half of Sec. 30. Noted as I went south on the line of these sections.

LAKE WARREN SHORE

I came into bouldery material where the road comes to the line of Sec. 30 & 31 about ½ mile east of Oakley. There is gravelly loam with the boulders from here into Oakley. In two places slight gravel ridges occur, one in north part of Sec. 31 - about ¼ mile from NE corner, the other on south edge of Sec. 30 west of middle of south line.

These are each at about 680' and seem to have been formed by Lake Warren. These ridges are only 2-3 feet high and a few rods wide and only 20-30 rods long. The sandy tract I have been examining seems to be between Deer Creek and the Shiawassee River from Oakley to Chesaning. West of Deer Creek is a heavier soil.

WELL DATA

Wells in vicinity of Oakley get water in rock at about 200-220 feet. A well 3/4 mile north in NE part Sec. 25 is 218 and has head 8'. The altitude is 675'. Water soft. Some dug wells were in use for many years that were 25 & 50 feet but they are not adequate for stock farms. The drift seems to be nearly continuous clayey till from top to bottom. This is the case over a large area in Saginaw and Shiawassee Counties.

THIN SAND COVER

I walked down the track 3/4 mile from Oakley and found soil a black sandy loam. The till seems not to come to surface in Sec. 30, but is present west of here and north.

The sand in this tract from Oakley to Chesaning seems to be a thin veneer (only 5-10 feet) over till. Where ditches are about 5 ft. ddep, they are liable to strike into till under the sand. I saw an exposure near middle of line of Secs. 20 & 29, Chesaning Twp.

August 5, 1919 - Chesaning, Michigan

I find a very thin coating of sand on till east of the river in this village so telephones poles are into till and boulders are visible. There may be less than 2 feet.

GROSSMAN SHORE

At this 635' contour in SE part of Chesaning and eastward toward center of Sec. 15 is a bank 3-5' high with till on its face but capped by sand 1-2'. This seems to be the Grassmere shore line.

There is also a low sandy bar at about 640' that runs ENE across line of Secs. 15 & 16. It is 1-3' high.

The strip of land above 645' runnins SSW from corner of Secs. 15, 16, 21 & 22 has till at surface. East of it is an old river channel below 640' that drains NE into Bear Creek. It may date from the time of the Grassmere beach. It has a flat bed 30-40 rods wide.

FAINT SHORE FEATURES

From this channel south 1 3/4 miles till is at surface and slopes are smooth with no sign of shore features at 660' where the Wayne beach should show up.

Nor is there a definite shore at 680'. There are patches of gravelly material, one being at a house in SW corner of Sec. 28 just below 680' contour.

I went west on line of Secs. 28 & 33 and could see no wave cut bank in Sec. 33 at or near the 680' contour. There is till at surface the whole length of this section line and south and north. I find a thin sandy coating 2-3 feet over till for about 1/8 mile east from the brow of Shiawassee River bluff at Parshallburg. There is a mill using water power here. There is also a water power and mill at Chesaning. The Warren shore is finely developed

with a sandy gravel ridge 5-6' high and 15 rods ± wide from center of Sec. 32 westward to Shiawassee River bluff along or near the 680' contour. There is sand several feet deep north of it in central part of Sec. 32 west of the ravine but in the NW part of Sec. 32 till is at surface, also in NE part of Sec. 31 north of Warren shore.

STUDIES NEAR CHESANING

South of this shore the soil is gravelly for a short distance, a black gravelly loam. Till then covers to the surface and boulders are numerous, some very large granites. There is a shore line in NW part of Sec. 5 and NE of Sec. 6, New Haven, at 695' and above this a till ridge with gravelly beach on it at 700-705'. This is well developed eastward to the center of Sec. 5 and westward to Shiawassee River near center of Sec. 6. There is a very bouldery strip along the county line and for ½ mile or more both north and south of it from the Shiawassee River eastward several miles. Some fields are full of cobble and boulders that are piled in large heaps. There are also numerous large granite boulders. I do not find well defined shore features in Secs. 4 & 3 either at 695 or 700-705 feet, but the very cobbly patches are probably near washed areas. This stony strip lies just north of the second Arkona beach and 10-20 feet lower level.

WELL DATA

Oscar Hunt in west part Sec. 36, Chesaning Twp. has a flow that comes up into cellar. It is into rock. A. F. Smithgall in east part has well 142 ft. that entered rock at about 50'. Head 13' Altitude 690'. Hunts is 695+.

In SW corner Sec. 34, Mr. Terry has a well 240'. The head is more than 20' below surface. Altitude above 695 feet.

FAINT SHORE FEATURES

I find a very faint Warren shore crossing this line of Sec. 26 & 27, Chesaning about on the 680' contour. A gravelly deposit, 2 feet thick, is dug into at the roadside.

I can see no trace of the Wayne shore on line of Secs. 22 & 23 where the 660' contour crosses. Boulders and a smooth till slope everywhere. There is a slight gravelly sand deposit around and east of corners Secs. 14, 15, 22 & 23 at about 650' contour. This looks to be a shore line and contours loop around on surface 13' as if there is a shore at 650-655 feet.

I find clay soil north past middle of line of Secs. 14 & 15, Chesaning and west past center of Sec. 15. There is an immense granite boulder fully 15 feet in diameter and standing about 5 ft. above ground in a field about 60 rods NW of center of Sec. 15. It is below 635' contour.

The sandy gravel deposit I noted this morning near west ¼ post of Sec. 15 as a probable Grassmere beach extends east to within about 40 rods of the center of Sec. 15 and there curves around to the south.

WELL DATA

A flowing well a few rods east of center of Sec. 15 (?) between 625 and 630 feet is 185 feet deep and gets water in rock. It flows a very weak stream, a mere trickle. From Chesaning, I went west across a sandy plain nearly to corner of Sec. 7, 8, 17 & 18 Chesaning. There is a little clay in SW corner of Sec. 8 and along west side of Sec. 17 for 60-80 rods from west line. The border between clay and sand runs nearly N-S across the west part of Sec. 17.

LAKE WAYNE BEACH

In Sec. 18 there are scattered and disjointed sandy ridges and low sandy swells on the till. In the south part is a ridge above 660' contour running E-W. North from this the highest lands has boulder piles

on it. There seems to be some gravelly loam however with the boulders that may be due to action of Lake Wayne.

SHORE AT 690' BOULDERS

Boulders are numerous along the line of Brady and Chesaning Twps. to within ½ mile of Oakley. There is a stony loam probably connected with Lake Warren sets in and conceals the boulders. There is no well defined Warren beach in Oakley Village. West of the village on south side Mickles Creek past the cemetery there is clayey till and it extends along south side of the creek as far back as the shore line along the 7690 contour noted yesterday. This shore line has a sandy gravel deposit several feet thick. I returned by MC R.R. from Oakley to Chesaning.

August 6, 1919 - Chesaning, Michigan

BEACH AT 650 - 655

I drove east on line of Sec. 15 & 22, 14 & 23, Chesaning Twp. and traced a beach that is nearly on the 650 contour in Sec. 22, but reaches the 655 foot contour in SE¼ Sec. 14 and eastward nearly across Sec. 13. It is a low ridge of sandy gravel about 3' high and 15 rods ± wide, in Secs. 22 & 14, but seems to be broader in Sec. 13, filling much of the area in the central part above 655 contour.

LAKE WARREN BEACH 680±

I go south between Secs. 23 & 24, 25 & 26.

There is a faint gravelly strip at about the 680' contour that runs NE from near middle of line of Secs. 25 & 26 and crosses into Sec. 24 near south ¼ post. In Sec. 26 it runs westward to where I crossed it yesterday, keeping near 680' contour. But in Sec. 25, it is a little below that contour though above 675'.

There is a more gravelly soil at about the 690' contour and above it in Secs. 35 & 36 than below, but I do not detect a definite ridge of gravel.

ARKONA BEACHES

The Second Arkona Beach is very gravelly and strong in Secs. 1 & 2 with relief of 10'± in north and width of 30 rods ±.

There is a little ridge south of it about 40 rods that seems to run only a short distance into Sec. 1 and scarcely any into Sec. 2.

Between the first and second Arkona beaches, boulders are at surface and there is very little lake deposit.

South of the First Arkona beach in north part Secs. 11 & 12, there is a lake deposit of sandy material of slight depth but enough to conceal nearly all the boulders.

SAGINAW BEACH 735'

A faint ridge of sandy gravel catches 730' contour north of the ¼ post. It bears ESE into Sec. 12 to a drain south of center of Section. In Sec. 11 it moves westward to middle of line of Secs. 10 & 11 where I crossed it August 2.

The first Saginaw beach in Sec. 11 has a bar farther east that I noted Aug. 2 that nearly follows the 735' contour around to line of Secs. 11 & 14.

LAKE SAGINAW FEATURES

There is wave cutting on a knoll on line Secs. 13 & 14 about 80 rods from South end of line in north face of the knoll. The top of knoll catches 735' contour. The tract in Sec. 13 standing above 735' has a sandy soil and slight admixture of pebbles. There is a low ridge apparently a lake bar on south side E-W road from near center of Sec. 13 eastward 60-80 rods. It is about 2' above the flat land east side. On the west side of

this tract there is a rise of 3-4 ft. from the clay into the sandy tract near the 735' contour.

The greater part of Sec. 18, Hazelton Twp. is stiff clay but there is a faint sandy gravel ridge east of Porter Creek running ESE past the Tintop School house to a drain in NW part of Sec. 20. It is 731-732'. So is a bar of the First Saginaw shore. There was probably shallow water covering most of Sec. 19 at this time and also much of Sec. 30. The SW part of 19 and SE of Sec. 20 rose above the lake level.

ARKONA BEACHES

The first Arkona beach splits into several weak lines in Sec. 8, Hazelton Twp. The outer one runs south into Sec. 17 near middle of line Secs. 8 and 17 and continues to Porter Creek, east of center of Sec. 17, but I do not find it continuing south of the creek.

Another weak ridge crosses the line of Sec. 8 & 7 about 60 rods from east end.

Another runs SE from near center of Sec. 8 to the SE corner.

Another sets in east part SE $\frac{1}{4}$ Sec. 8 and runs east across south part of Sec. 9 being near 720'. The others are about 725 feet.

There is a beach at about 720' in south part of Sec. 6 and north part of NW$\frac{1}{4}$, Sec. 8. The houses just south of corner Secs. 5, 6, 7, & 8 are on it. It seems to be fragmentary generally but is nearly a mile long in Sec. 6. It probably is closely related to the First Arkona beach.

There is another $\frac{1}{2}$ mile north of it and 5' lower that catches 715' contour and seems to be an outer bar of the Second Arkona Beach.

WELLDATA

A well 201' on 715 beach, Head -20' or 695' A.T. This well is on west side Sec. 5. The well owner says this beach or bar is found faint form in the SE$\frac{1}{4}$ Sec. 5 and it crosses into SW corner of Sec. 4, coarsing the

projection of the 715' contour.

ARKONA BEACHES

The main ridge of the Second Arkona is much stronger being 30 rods ± wide and 8-10 ft. above the plain north of it and 4-5 above that south. It continous SE from edge of this quadrangle across NE part of Sec. 9 into Sec. 10, Hazelton Twp.

SECOND SAGINAW AND THIRD ARKONA

There is a much more bouldery tract north of this Second Arkona tract than south and it is said to cover the south half of the Maple Grove Twp., Saginaw County.

FIRST WARREN SHORE

There is a faintly developed shore line at about 700 feet in Secs. 31, 32, & 33, Maple Grove with bars north of it that catches the 700' contour, one being NE of center of Sec. 32 and one in SW part of Sec. 33. This beach is a low cobbly strip and there are boulders with the cobble and gravel. They relief is only 2 or 3 feet and that may be the depth of beach material.

There is scarcely a trace of the Lake Warren beach where I went north on line of Secs. 20 & 21, Maple Grove Twp. There seemed to be a little more pebbly material in the soil at about the 680 contour but no ridge.

LAKE WAYNE FEATURES

At the level for the Lake Wayne shore there is a strip of sand dunes about 660' running across south part of Sec. 9, NW corner of Sec. 16 and north half Sec. 17. The continue with slight interruption nearly to center of Sec. 18. Westward from there the beach is present at about 655' and consists of sandy gravel. Between these dunes and another strip in NE of Sec. 8 and NW corner Sec. 9, there is very stony till as in the district

to the south.

WELL DATA

L. H. Conklin, SW corner Sec. 12, Chesaning Twp., flowing well nearly 300' deep - Alt. 633'.

FEATURES EAST OF CHESANING

There is stony till in south part of SW¼, Sec. 4 and in SE half (transcribed as written) of Sec. 8 and in east and south part of Sec. 18, Maple Grove Twp. above 640 contour in Sec. 4, and 635 contour in Sec. 8. Below this there is some wet sandy land with clay subsoil and some land with a gummy clay soil. The sand coating is present in much of Sec. 7 and north part of Sec. 18 and below 625 & 635' contours in Sec. 8 except near north side where it is lacking. The part of Secs. 7 & 8 below 625' contour seem to be nearly free from sandy coating. The clay is of the sort to rut badly in roads and is cloddy. It seems to be a lake deposit rather than glacial.

The stony till occupies the greater part of SE¼ Sec. 12 and south edge of Sec. 11, Chesaning Twp. and all of Secs. 13 & 14 except in the NE corner of Sec. 13 and NW corner of Sec. 14 where gummy clay is present.

Another low strip of sand dunes runs WSW from North part of Sec. 12 across south half of Sec. 11 and along part of Secs. 10 & 15 to within ½ mile of Shiawassee River bluff. There is a thin coating of slightly pebbly sand over till from here to the river at Chesaning.

WELL DATA

The village of Chesaning has a water supply from five wells drilled into the rock to depth of about 200 feet. The rock is struck at about 50 feet in this vicinity on ground 625-635 feet A.T.

August 7, 1919 - Chesaning, Michigan

Features North of Chesaning

I drive north 2 miles through a sandy plain a slightly pebbly sand water deposited. The sand is only a few feet thick for clay forms the bed of shallow swales.

West of Deer Creek in Sec. 5 and west side of NW¼, Sec. 4 there are occasional low dune sand ridges, seldom 10' high. They occupy only a small part of the land. The remainder is a stiff clay with few boulders or pebbles within two feet of surface. It seems to be lake deposit rather than glacial.

I stopped in Sec. 5 to see Fred Cornair (?) who is interested in soil classes and seeding. He says that in Sec. 6 the SW part is more stony than the rest, that below 635' being gummy clay except in dunes.

In Secs. 30 & 31, 29 & 32, St. Charles Twp. small dune sand strips are scattered over the clay land but cover less than 10% of the area.

Below the 610' contour there is very little sand in Secs., 19, 20 and 29, St. Charles Twp. This seems likely to be below Lake Algonquin level. The sand is lined up in straight course where the 610 contour cross ESE in NE¼ Sec. 29 and looks to be a shore. There is an occasional pebble in it. Bars each side the road on line of Secs. 20 & 29 west of ¼ post may also belong to the lake. There is very heavy clay to the north of this supposed shore.

TO ALGONQUIN SHORE 610'

The Algonquin Shore seems to cross SW part of Sec. 28 and runs south toward center of Sec. 33, St. Charles Twp., catching the 610' contour. The sand in it is slightly pebbly. Fine sand with a few pebbles in it extends north through Sec. 28 along the road and for about ½ mile west of it. East of the road is till along Deer Creek with boulders. East of the creek in east part Sec. 28 and west of Sec. 27 is a clay tract clear to the Shiawassee River.

South from here in Sec. 33 is a clay strip just west of the river and also along Deer Creek, but between these is a strip of pebbly sand. There is a narrow sandy strip west of Deer Creek, but clay sets in within ¼ mile. This is true of Sec. 4 & 5, Chesaning also.

I crossed to east side of Shiawassee River on the line of Chesaning and St. Charles Twps. There is a very thin sand coating over till for ½ mile east of the river. But much of Sec. 3 and west half of Sec. 2 Chesaning, have a pebbly sand several feet thick and this extends north into Secs. 35 & 34, St. Charles, as far as the 610 foot contour. Below that contour in north part of Sec. 34, it is thin and clay comes to the surface in spots.

PEBBLY SAND

The SE quarter of Sec. 27 has a thin sandy coating and so has the part of Sec. 26, southwest of Bear Creek. There is a tract of heavy clay north of this stream in Sec. 26 and northward into the St. Charles quadrangle.

LAKE ALGONQUIN

There is a little sand in Secs. 25 & 36 but clay comes to the surface in many spots. The south part of Sec. 36 near the 610' contour has a thicker deposit of sand that is slightly pebbly and seems to be like a delta at edge of Lake Algonquin. The pebbly sand continues south with a gentle rise but becomes thin and less pebbly before reaching 615' on line of Secs. 1 & 2, Chesaning Twp. The main deposit brought down Shiawassee Valley covers the tract between Bear Creek and the river in Secs. 2, 3, 9, 10 & 11, Chesaning, but strips of rather pebbly sand radiate to the NE from Bear Creek into Secs. 11 & 12, Chesaning, as far out as the strip of dunes in Secs. 11 & 12 and south part of Sec. 1, Chesaning. Narrow sandy strips continue further northeast along west side of Fairchild Creek across Sec. 31, Alber Twp. There are strips of bare clay in this section running SW to NE between the sandy strips. The sand in Sec. 31 has few if any pebbles and may have been caused by wind

action. From present data it appears that the pebbly sand does not extend much below the 610' contour. This lower limit was probably due to Lake Algonquin whose static water prevented river or current action going beyond this shore at or near 610' perhaps slightly above 610'.

DUNES IN ALBER TWP.

There is an extensive tract of wind blown sand east of Fairchild Creek in Secs. 28, 29, 31, 32 and 33, Alber Twps. and continuing, I am told to Burt Village 5 or 6 miles beyond the limits of the Chesaning quadrangle. This poor sand area has its effect on residents. There are abandoned houses, in some cases log houses, and those occupied are cheap unpainted shacks in most cases.

The area of pebbly water laid sand to the west between Bear Creek and Shiawassee River has a prosperous community and good dwellings. This poor sand covers the north part of Secs. 5 & 6, Maple Grove but in the north part of Sec. 4, Maple Grove and south part of Sec. 33, Alber, there is a pebbly sand that seems to be productive. This pebbly sand is mainly above the 615' contour and it is possible the Algonquin Shore is nearly up to that contour. It may be difficult to fix its exact altitude but it seems likely to be fully 610' and may approach 615' where wave action was strong.

FLOWING WELLS

There are shallow flowing wells 60 to 95 ft. deep in Secs. 4 & 5, Maple Grove and Sec. 33, Alber Twp. near base of the bouldery (morainic) strip. They are on ground 615 to 625 feet. There are wells of greater depth 200 to 300 feet on ground of similar altitude in northeast part of Chesaning Twp. along line of Sec. 3 and 10, 2 & 11, 1 & 12. There are also flows farther north. I passed one at the Luce Store in the SE corner Sec. 25, St. Charles Twp. The wells after penetrating a little sand or lake deposit are in a yellow till to the rock. In some cases rock is struck at 30 feet but usually

at greater depth. Some wells pass through one or even two coal beds and some fine clay as well as sandstone and shale.

August 8, 1919 - Chesaning, Michigan

WAYNE ? BEACH 650+

I find a beach line on south part of Sec. 7, Chesaning that is just above 650 contour which runs north from the line of Secs. 7 & 18 about 60 rods and then cruves around to the west. Another bar of sandy gravel runs WNW across the SW part of Sec. 7, Chesaning, and continues to center of Sec. 12, Trady Twp. It is between 650 & 655 feet most of the way but in south part Sec. 7 it rises above 655' and is above 655' in NW part of Sec. 18. This is likely to be the Wayne beach. It is mixed up with sand ridges in Sec. 12 from center west. In Sec. 11, Brady Twp., some gravel has been obtained from it on farm of H. Thiel.

GRASSMERE

I find a shore line just above 640' contour in NW part of Sec. 7 and SE of Sec. 1 (Brady Twp.) that is likely to be Grassmere beach. It is a low ridge of pebbly sand. This is lost in the dunes further west in Sec. 1, Brady, but may form the low ridge that runs west to line of Secs. 1 and 2 about 120 rods from south end.

WAYNE BEACH

I went south from this place to corner Secs. 11, 12, 13 & 14, Brady, and there west. There is a low ridge of sandy and pebbly material along south edge of Sec. 11, that seems to be the Wayne beach. It is just above 655' contour. There is another ridge more sandy that runs from center of Sec. 11 WSW to a coal mine in west part of SW$\frac{1}{4}$ of Sec. 11, which is between 650 & 655 feet and probably alos pertains to the Wayne shore.

I go north to corner Secs. 26, 27, 34 & 35, Brant, over several sandy strips with only narrow clay strips between. In fact, most of Secs. 26 and 27, the NW part of Sec. 25, and much of Secs. 23 & 24 are sandy and in great part poor land.

DUNES AND CLAY AREAS IN BRANT TWP.

The north edge of Sec. 27 NW corner Sec. 26, the west part of Sec. 23 and southeast part of Sec. 22 have mostly clay soil. In Sec. 21, the clay has a very thin coating of sand. The road along line of Sec. 21 & 28 is graded and ditches and seems very clayey because of material thrown from the ditches. The soil is sandy. This land is considered as good as any in the township. In Sec. 28, there is considerably heavy clay soil but in places low sandy strips cover it.

I am told by Mr. Whaley, who lives in Sec. 28, that there is considerable clay land in south part of Sec. 29 below Lamb Creek and Bad River also in north part of Sec. 32. There is a low sandy ridge running west from near center of Sec. 32 to west line. South of it the clay has usually a thin sandy coating.

There is a small clay tract northwest of Bad River in Sec. 29 and a strip of clay runs north and east along a drain in south part of Sec. 20. Otherwise Sec. 20 is sandy. Most of Secs. 19 & 30 are sandy but some clay land occurs in SE quarter Sec. 30.

SANDY AREAS IN NORTHERN BRADY TWP.

The SE part of Sec. 31 has clay near surface, but west of Bad River are some sandy strips interrupting the clay tracts.

A considerable part of Secs. 5 & 6, Brady Twp. has clay soil or very thin coating of sand, and there is some clay in north part of Secs. 7, 8, 17 & 18, but sand predominates in Secs. 7, 8, 17 and 18, Brady Twp. It also covers most of Secs. 3, 4, 9 & 10. But the west and south part of Sec. 9 and

east and south parts of Sec. 10 have clay exposed. In Sec. 3, the most clay is in the north part. In Sec. 4, it is in patches among sandy ridges in both north and south parts, the main sand is in E-W belt through center. There are slight patches of dune sand in Secs. 13, 14, 15 & 16, Brady. But till forms the soil over much of these sections. It is not so gummy a clay as that to the north among the dunes.

Five displays of shore lines in southern Brady Twp. The southern part of Brady Twp. has a fine development of shore lines from the Warren up to the Highest Saginaw. The Warren has some bars between 675 and 680', but its most definite and continuous shore development is at about 685 feet such as the height in an exceptionally well developed gravelly beach in NE part of Sec. 23 and west part of Sec. 24. It also catches 685 contour near north end of line of Secs. 27 & 28 and in s uth part Sec. 22. There are faint gravelly beaches at 690' or slightly higher in Secs. 27, 28 & 29.

The lowest Arkona, or perhaps a beach at second Lake Saginaw, seems to be at about 700-705' in a gravel beach that is exceptionally strong from SE part of Sec. 29 eastward across Secs. 28, 27 & 26. It reaches its northern-west position near line of Secs. 26 & 27 and is very strong for $\frac{1}{2}$ mile SE in the NW$\frac{1}{4}$, Sec. 26. A beach 5' lower than 700 contour cruves up to its northern-most point just east of corner of Secs. 22, 23, 26 & 27 and fits around the inner border of the 3rd Arkona in NW corner Sec. 26. The Second Arkona controls the 715' contour from west border of Chesaning Quadrangle in NE part Sec. 32, Brady, eastward. Outside the main ridge are weak ones of same altitude.

I did not go to the First Arkona or the Saginaw Beach, but could see the First Arkona from line of Secs. 28 & 33 running east through center of Sec.33.

WATERLAID MORAINE

On my return I crossed the MC R.R. On line of Secs. 17 & 20, Chesaning and found clay nearly at surface east from the railway for most of the distance to the Shiawassee River. There seems to be only 1-2' of sand.

Boulders are very numerous and many of large size 4-5 feet in diameter in Sec. 23, 22, 24, 25, 26 & 27, Brady Twp. and rather numerous in Secs. 13, 14, 15, 16, 21 & 28. This take in a reentrant in the moraine. While Shiawassee Valley is at a salient. There is another reentrant in west part of the Chesaning quadrangle in Maple Grove Twp. and boulders are very numerious there and as far south as the Second Arkona Beach.

August 9, 1919 - Chesaning, Michigan

FINE DISPLAY OF SHORE LINES WEST OF OAKLEY

I took M.C. train to Oakley and went west from there to complete study of shore lines. There is a faint shore action just below 695' contour in SW part Sec. 25 & NW of Sec. 36, Brady Twp., a slight gravelly deposit with relief of a foot or so. The 3rd Arkona, or perhaps beach of 2nd Lake Saginaw, is not developed along or near 700' contour in Sec. 36 and SE part of Sec. 26. The 2nd Arkona is well developed across Sec. 35, Brady Twp.

In SE part Sec. 35, Brady and NE of Sec. 2, Rush Twp. dune sand is heaped up to 10 feet or more above the beach level and there is level sand for about $\frac{1}{4}$ mile west of the beach along the county line. The beach is well developed southward through east part Sec. 2 to where I examined it August 4.

The first Arkona is well developed where the shore trends westward from NW part of Sec. 2 and NE of Sec. 3, Rush Twp., But where it trends southward in west part of Sec. 2, it is scarcely traceable and it is weak from there to the Shiawassee River.

There is some wind-drifted sand in NW part Sec. 3, Rush Twp. in low ridges 5-6' high that are between the first Arkona and the Saginaw beach.

LAKE SAGINAW SHORE

I came to the Saginaw Shore across Secs. 3 & 4, Rush and 33 & 34, Brady Twp. Shore is a double bar, one runs WSW into NE part of Sec. 4, Rush,

the other runs through south part of Sec. 33 for nearly 3/4 mile. It there turns south into Sec. 4 and dies out near a drainage line. West of this it sets in and runs west beyond the limits of the Chesaning quadrangle in north part of Sec. 5, Rush Twp. and south edge of Sec. 32, Brady. It is a ridge of sandy gravel about as strong as the usual strength of the First Arkona. It stands above 730'. The First Arkona is below 725 to 730 feet.

I went south a mile on line of Secs. 4 & 5, Rush Twp. across a level till tract with a moderate number of boulders. It them rise slightly to a tract above 740 feet that has some gravelly material over the till. In one place a sharp gravel ridge (in NE corner Sec. 8) rises 4-5' above the surrounding land. It looks like a shore feature but I know of no other place where shore action reaches 745' in this quadrangle. (Later study in Elsie quadrangle shows a beach at 740 to 745 feet. See notes Book 271).

I find a knoll in NE part Sec. 9 standing above 735', has a weak gravelly bar on it trending west to east.

There is a sandy gravel bar running ENE from SE¼ Sec. 9 into SW¼ Sec. 10 that is above 735' and seems to be Lake Saginaw shore. It lines up well with the shore I traced August 4 into southeast part of Sec. 10 from west side of Sec. 13, Rush Twp.

SWAMP WEST OF HENDERSON

There are other places further south where low ridges of sandy gravel occur above 735' contour. One crosses near north end of line of Secs. 14 & 15, south of a place marked swamp but which now has a rich field of clover all over it. Another lies only ½ mile NW of Henderson in SW¼ Sec. 14. It is 4-5' high and has a slightly pebbly yellow sand. It runs from west line of Sec. 14 eastward ¼ mile or more. The swamp that sets in 2 miles west of Henderson and runs west into the Elsie quadrangle is below the level of the Lake Saginaw shore and there is no land barrier to prevent the lake from discharging westward through it. This swamp is drained eastward into the

Shiawassee River. This outlet has recently been dredged and cuts into a soft blue till just west of Henderson. I took the noon train from Henderson to Lansing. This follows an old watercourse from Owosso southwest to Maple River. Then the features seem to be well shown on the Glacial Map published by Michigan Geological Survey in 1911. From Lansing I returned to Ann Arbor and completed the map of north peninsula (except Menominee Co. and Drummond Island) On August 16, I started for the Northern Peninsula to study Menominee County with Ralph W. Peterson of Mich. Agr'l. Exp. Station, East Lansing, as my assistant.

The notes for the Northern Peninsula are recorded in Note Book No. 270. This work was completed Sept. 17. I returned to Ann Arbor and went on Sept. 19 to Lansing and spent Sept. 19 & 20 in finishing the map of the Northern Peninsula that I have prepared for the Michigan Geological Survey.

I went to St. Johns the evening of the Sept. 20 to complete work in the Perrington quadrangle, which I began in 1917. The features north from Lansing look more like moraine than till plain all the way to Looking Glass River but the railway is most of the way in sloughs and one seldom gets high enough to look out over the general surface. The country is much smoother from Looking Glass Valley northward to St. Johns than to the south, and is very flat for about 2 miles outh of St. Johns. In St. Johns there is a morainic ridge.

September 21, 1919 - St. Johns, Michigan

STUDIES IN THE PERRINTON QUADRANGLE

The plain south of the St. Johns moraine is a clayey till with no indication of outwash in vicinity of St. Johns. The morainic ridge terminates at the west side of Sec. 10 about $\frac{1}{4}$ mile east of the city limits and only a

flat till plain occurs further east to the limits of this (Perrinton) quadrangle. It has considerable strength in the city of St. Johns with a relief of about 30 feet on inner border the creat being 790 to 805± and the inner border plain 760'-65'. The plain outside is 775'-785'. The moraine has some gravel but is mainly a clayey till. The width of the moraine is about 1/3 mile including slopes. I went north on line of Secs. 9 & 10, 3 & 4 across till plain to the edge of the Imlay Outlet. The terrace at its south edge is between 725 & 730 feet. The mucky channel is below 715' on the line of Secs. 28 & 29, 33 & 34, T.8N., R.2W. (Greenbush).

The SW part of Sec. 33 Greenbush is upland and has a few acres of hummocky till with cobble & boulders scattered over the surface. These hummocks are above 750' contour and the base about 745'. The highest catch 755' contour. There is less hummocky land than I supposed from notes taken in 1917. The land above 750' contour along or near line of Sec. 33 and Sec. 4 is not hummocky, and has very few stones on surface. There are places where a thin deposit of sand has been blown up into Sec. 33 but this is not causing the hummocky surface. It is gravelly in the draws and on slopes.

From this hummocky area I can see another west of Doty Brook in SW part of Sec. 32 with points as high as 765'. This seems to run NW into east part of Sec. 31 and make a curve around to the west and SW passing just north of center of Sec. 31. There is a nearly featureless till plain south from these hummocky acres to the St. Johns moraine, a distance of 2 miles or more. A ridge on east side of Doty Brook is Sec. 32 has smooth crest and slopes. Its crest for nearly a mile stands between 740 and 745 feet. It is only about 20 feet higher than the valleys each side.

I returned to St. Johns and went to the SW part of city where the moraine reaches 805' contour. The altitude is a little lower on the crest at the head of Doty Brook in Sec. 17, probably about 785 feet. But it rises to 810' contour ½ mile west in east part of Sec. 18 as shown on the Preliminary map of the quadrangle scale 1:4,800. Its inner border comes about to the

Grand Trunk R.R. in SE part of Sec. 7 but only a few acres lie in Sec. 7. The Preliminary map just noted shows its course into the east part of Sec. 13 T.7N., R.3W. The plain outside central part of Sec. 18 is 790 feet while that inside is 765-770 at the edge of the moraine and descends rather rapidly to about 755'. An abandoned gravel pit was noted near center of NE¼ Sec. 17. But there is clayey till on its banks - so the pocket of gravel seems to have been all removed.

September 22, 1919 - St. Johns, Michigan

STUDIES IN THE PERRINTON QUADRANGLE

I went by auto with Fred E. Jacobs over much of the west half of the Perrinton topographic sheet. We crossed the Imlay Outlet north of St. Johns on line of Secs. 32, 33, 28 & 29. Cobbly stream deposit is within a foot or two of 725 contour on line Secs. 28 & 29.

We went west through till plain on line of Secs. 20 & 29 dropping into the outlet near the west end. There is a gravelly bar just north of corner of Secs. 19 20, 29 & 30 that catches 725' contour and runs SE into a recess on north side of the outlet as if a current flowed in that direction. This may be the effect of a lake like condition so that winds would carry currents with them eastward.

There is only one small hill of moraine type in west part Sec. 20. The rest of the undulating land has smooth gentle slopes like till plain. In east part Sec. 17, there are gravelly knolls near Marshall school. There is a slight ridging of till in SW part reaching 735' scarcely moraine. See notes in 1917 for other features in Secs. 7, 8, 17, 18 and eastward past Eureka. From these notes it will be seen that water was ponded to about 730 feet south of the Eureka moraine. (See further notes Sept. 23 showing 730' level.)

We continued north to the county line from Marshall School and turned west. The Second Arkona beach lies a few rods south of the county line

in Secs. 5 & 6 and is about 710' where strongest but part of the way it is scarcely high enough to catch 705' contour. The Warren beach is north of the county line much of the way and is between 675 & 680'. It is at base of a cut bluff with an off shore bar 30-40 rods north at about 675'. There are a good many boulders along this Warren shore and at lower levels left as the fine material was carried down the outlet. There is a little sandy and gravelly material mixed with cobble and boulders on the bar on which Bridgeville stands and eastward along it for a mile or more.

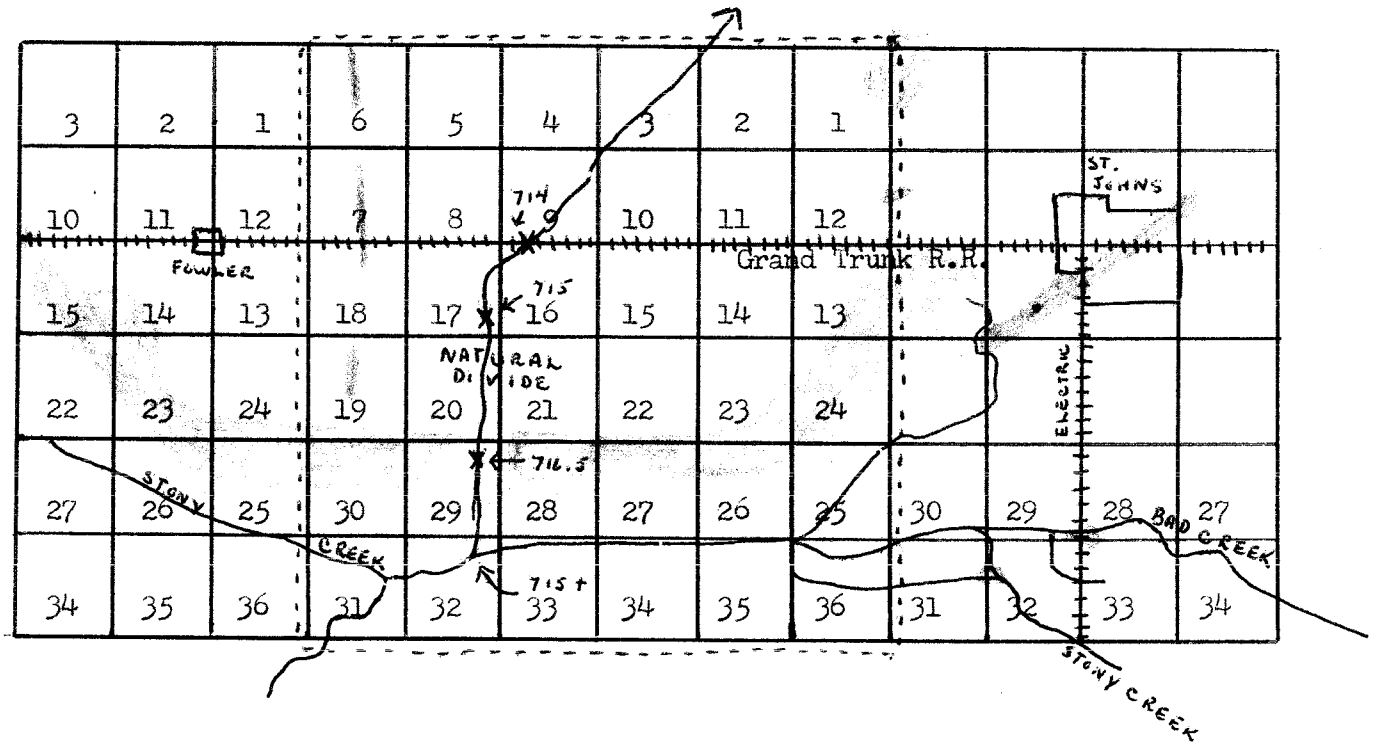
On the north side the outlet we are unable to discern the Warren shore where we cross 680' contour. There is a very bouldery gently sloping plain here. At 690' there is a barely distinguishable bank 2'± high just south of the corner Secs. 13 & 24, 18 & 19. The Second Arkona bar at 710' which we cross ½ mile south of Pompeii is the only strong and distinct shore noted on north side to outlet in east part of T.9, R.3W. The higher Arkona and the Saginaw are very indistinct. The highest Arkona however as noted in 1917 is easily traced from Sec. 21 North Star Twp., SW to the township corners 1½ miles north of Pompeii and the Saginaw shore is well defined in its course across Sec. 30, North Star Twp. along or near 750'. We went west on line of Secs. 12 & 13, Fulton Twp. and then north 2 miles, most of the way on a moraine on which a slight ___(?)___ and notching of slopes was made by Lake Saginaw. We then go west across a till plain between this moraine and one to the west. There is scarcely any sand or gravel outwash along outer border of this eastern moraine. It is a weak moraine and only 1/2 - 3/4 miles wide. The western oneis stronger and fully a mile wide. It has sandy gravel outwash from the line of Fulton and Newark Twps. northward to the limits of the Perrinton quadrangle. In places the sand and gravel strip is scarcely ¼ mile and it averages not more than ½ mile wide, but along and near line of Secs. 21 & 28 Newark, it extends a mile west of the moraine. The outwash is a thin deposit so that rivers 10-15' deep usually cut through it into the till. In part of its area it is only 1-2' thick. It tends to make

the land better for farming when thin for the plants can reach the till and the soil is easily cultivated.

We came back a mile from the Grange Hall and took road west on line Secs. 21 & 28, 20 & 29 to middle of line Secs. 19 & 20, Newark. After the first mile with sandy gravel we have generally a heavy clay loam soil but there are ia few patches of sandy soil, the sand being only a few inches thick.

We take road south to Middleton through a till plain that is generally very flat. There is a slight prominence in it in Sec. 30 with contours up to 765' while the wider plain is about 750 feet.

We passed gravelly knolls on north side of Pine Creek 2 miles North of Middleton with a large gravel pit. There is 4-5' of sand above a deposit of gravel of medium coarseness, good for road use. The till plain extends west beyond the limits of this quadrangle and south to the old lake outlet. (See Notebook 271).



Map to show channel across the St. Johns moraine. It is 716.5 at summit in south part Sec. 20, T.7., R.3W.

Fourteen inches fall from divide in Swagart (?), Drain south to Stony Creek in about 1½ miles.

Very slight fall north to edge of topographic map. Less than 2 feet. Water sits 3' deep on the divide and stays for weeks.

At Divide:
1. Muck 2 feet
2. Blue clay 1" 8" (Water sediment)
3. Water gravel 2 to 3 feet.

George W. Swagart, St. Johns, gave data:

There is a half mile space between ends of the north Swagart drain and south Swagart. The north terminates in SE¼ Sec. 17, T.7, R.3W. and the south one is in NE part Sec. 20.

Data on ditch altitudes are from Mr. Green, County Drain Commissioner.

Head of drain S part Sec. 17 = 716', Divide may be 716.5'

On E-W ¼ line Sec. 17, 40 rods from east end 715'.

Ground in south side Grand Trunk R.R. in Sec. 9 = 714'.

The road bed of railroad there is 720'.

At north side Sec. 35, T.8, R.3W. Water in ditch 697'.

At junction with Hayworth drain in SE part Sec. 28.

Old ditch level natural creek bed 690'.

New ditch level 684'.

The topographic map gives 688' in Hayworth Creek about 40 rods above junction with drain, but since it was made in 1916, the ditching has lowered its level to about 684 feet, so Mr. Green states.