

Open File Report LIX
FIELD NOTES OF FRANK LEVERETT

Notebook No. 297 - Leverett

COUNTY

- Alcona
- Arenac
- Genesee
- Gladwin
- Gratiot
- Huron
- Iosco
- Macomb
- Midland
- Oakland
- Ogemaw
- Saginaw
- Sanilac
- St. Clair
- Tuscola

OTHER STATES

- Ontario

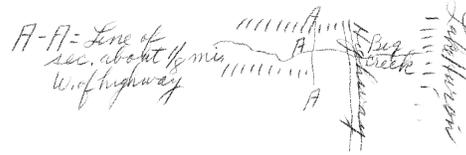
Frank Leverett Notes - Note Book No. 297

Pages 50 to 53 inc.

August 4, 1931

I made a trip with Prof. Sears of the University of Oklahoma and Miss West and Miss Hansen of the Botany Dept. of U. of Michigan into Sanilac Co. to see buried peat that Miss West and Miss Hansen had found exposed in the banks of ravines tributary to Lake Huron. On Big Creek 2 miles N. of Forester there is a section exposed on west side of the highway that clearly indicates a rise of Lake Algonquin such as theoretically occurred as it changed from the Kirkfield (Trent) outlet to the St. Clair outlet at Port Huron. The creek has a well defined terrace representing its level at the time Lake Algonquin discharged to the* present lake level of Lake Huron. This terrace has about 6 feet of stiff clay at top as exposed in the north bank of the creek. Below this are beds of leaves and wood interbedded with fine sand exposed about 8 feet. The wood is beech. There are hemlock cones with the beech leaves. The south bank shows till under the leaves and sand beds, for the till surface rises toward the south side of the terrace and the sand and leaf beds pinch out in that direction.

Big Creek Section in Algonquin terrace.



The terrace is about 25' above L. Huron and 15' above the creek at this exposure. It is obscured by dune sand at and east of highway but well displayed west of the highway

A-A += Line of section

About 1/8 mile west of highway

The creek seems to have cut a channel to a level below the present stream during the Kirkfield stage. Then as the waters rose it aggraded its bed level with fine sand and leafy deposits and floating logs. Then it became a slack water and clay was deposited to a thickness of 6 feet.

The material in the leafy beds will be carefully studied by Miss West and Miss Hansen.

We also examined a peat deposit in a terrace in a stream 3 miles south of Lexington. In a meadow north of the creek about 60 rods west of the highway the peat was bored into by Prof. Sears and several samples taken for study. It is nearly 6 feet and rests on blue clay. There are ~~streaks~~ stumps in its surface but a clear peat below.

*St. Clair outlet or about 25' above

The creek here has many logs on its bank with a few inches of yellow clay above the logs. This clay, however, is likely to have been deposited recently as the creek gets out of bank in freshets. With the logs a few bones of small animals have been found. We found a scapula and a fragment of what seems to be a leg bone of an animal, the size of a wolf*. A farmer living near here thinks these legs may have been recently embedded for he has seen slabs from a saw mill a little further upstream embedded to a depth of four feet. This exposure of logs has not so clear evidence of dating back to Algonquin time as the deposits on Big Creek.

Prof. Sears thinks the beech forest period here may be of similar age to the widespread beech forests of Europe and indicate a cool, wet climate. It is thus important to determine when this change from the Kirkfield to the Port Huron outlet occurred. There have been three episodes. First, the time involved in the discharge of Lake Algonquin past Port Huron. It was long enough to cut down the outlet only 9 or 10 feet. Second, the time

involved in the discharge of the Nipissing Great Lakes eastward past North Bay. Third, the time since the Nipissing waters returned to a discharge past Port Huron. This has been about 4,000 years, and in this time the outlet has been deepened 15 feet.

If only 4,000 years are involved in this deep caving of 15 feet, it is likely that the deepening of 10 feet in the first episode took not over 2/3 of 4,000 years. Probably it took less as the deepening may have gone on more rapidly in the first 10 feet than in the later cutting. It seems probable that the time was not over 2,000 years. This being the case we have the following:

1. Algonquin discharge past Port Huron 2,000 years
2. Nipissing discharge past North Bay x years
3. Nipissing discharge past Port Huron 4,000 years

Time involved is $6,000 + x$ years.

The gorge of the whirlpool rapids was excavated in the second episode. It now appears that the excavation was largely in till and not in the rock. So it may have taken a shorter time than previously estimated. Perhaps it took but a few centuries of at most a period no longer than the third episode, or 4,000 years. If so, the Algonquin waters changed from the Kirkfield to the Port Huron outlet not more than 10,000 years ago. Possibly the time was not more than 8,000 years ago.

On the way up, we went on Gratiot Avenue from Roseville, northward, and were for several miles along the beach of the St. Clair lake that correlates with the Algonquin discharge into Lake St. Clair. This beach is 595 to 600 feet. It shows well in the topographic map of the Mt. Clemens quadrangle.

On our return, we went to a swamp east of Sandusky, three miles, and took two sets of peat samples. In one, the peat is $7\frac{1}{2}$ feet. In the other, about 6 feet thick. A blue clay underlies it. Prof. Sears will examine the clay as well as the peat for organic remains.

*but we are not sure of its being a wolf.

We went south through Peck, Yale, [Emmet?] Everett, Memphis and Richmond on our return and came to Gratiot Avenue at Muttonville

In correspondence later, F. B. Taylor expressed the opinion that the very slight erosion in the North Bay outlet along Mattawa River does not favor a long period. He thinks perhaps 2,000 years would cover it. This being the case the Algonquin waters may have reached the Port Huron outlet about 8,000 years ago.

This discharge, however, was then divided between Chicago and Port Huron, so the cutting of 10 feet at Port Huron may have taken more than the 2,000 years above estimated. But it seems quite likely the return to this Port Huron outlet was not more than 10,000 years ago.

Pages 83 to end of book. Re Mich. August 25-26, 1933

I went with Prof. D. C. MacLachlan of the University of City of Detroit into the District east of Lake Huron to study shore lines and moraines, a main object being the determination of the northern terminus of the Warren beach and the position of the ice border at the close of the Lake Warren stage.

We drove from Ann Arbor on Plymouth Road to Telegraph Road, then north to eight mile Road, then east on the county line to Gratiot Avenue, which we followed to Port Huron. We crossed St. Clair river into Sarnia, Ontario. The bluff at Sarnia is about 30 feet above Lake Huron or 616' A.T. being higher than on the Michigan side in Port Huron.

The waterlaid moraine has a nearly plain surface from St. Clair River eastward to where the Warren beach crosses it, about 4 miles west of Wyoming. It is clayey and doesn't have a sandy coating such as is present on it on the Michigan side. The Warren beach is rather irregular in strength where it crosses the Port Huron moraine owing to the roughness of the moraine. It has gravel pits where it cut into knolls.

There is a very abrupt change in topography from the nearby plane surface of the waterlaid port. It rises 20 feet or more above the plain in its knolls and the whole surface is undulating. It seems to have stronger expression west of Wyoming than for a few miles east of that village.

The Warren beach bears away from the main border of the moraine near Wyoming and a till plain 2-4 miles wide lies between it, and the moraine much of the way to AuSable River. There is, however, a spur extending north nearly to Thetford on the west side of this stream. The Warren beach is regular and well developed where it is in this till plain.

The beach sits in on the east side of AuSable River, 2 or 3 miles further south than on the west side. It is close to the inner edges of the Port Huron moraine there. It also follows the inner edge of the moraine closely on turning north and is close to it all the way to Goodrich. The beach is well defined all through its course to Maitland River.

Taylor shows a moraine at the bluff of Lake Huron in vicinity of Goderich, but this seems to be an error. (See Map in Trans. Canadian Institute, Vol.X,1913)

He calls it the "Goderich Moraine". There is a double moraine for a few miles north from Maitland River with a stream flowing south between its members. If the name Goderich is to be continued it might be applied to the western or inner member. But it is a question whether the name is necessary. The two members are as closely associated as members of the Port Huron system are in Sanilac and Huron counties in Michigan, and the members there are not given distinct names.

There is a weak beach in Goderich at about 725' which was probably the product of Lake Lundy waters, either

Grasmere or Elkton shore line. It is considerably lower than the Warren beach which passes about 1½ miles east of Goderich. The Warren beach bears NNE from the Maitland River to Dungamon, and is about seven miles inland at Dungamon. It crosses Lucknow valley directly west of Dungamon. There is a bench mark on it at the first road crossing west of Dungamon on west bluff of Lucknow River with elevation 845 feet. Whether or not this is on a sea level datum should be ascertained. It seems rather high for Warren beach this far north.

The course of the beach is nearly north for 12 miles but winding slightly as shown on the field map. It is about as well defined here as at any part of its course in Ontario.

On crossing Clover Valley south of Ripley, it runs eastward three or four miles. We did not trace this part but found the beach 1½ miles east of Ripley. It makes a turn eastward there and ends in a field north of the road. A plain at slightly lower altitude borders its east end.

The beach is well defined north from here as far as Bervis, 6 miles. But we do not find so definite a shore farther north. There is a flat wave washed plain west of the beach south from Bervis with a thin coating of sandy material in places. North from Bervis the surface is not so flat being like a till plain in a waterlaid moraine and shore features are not definite. We noted a short bar 1½ miles SSE of Armor which was the only lake feature seen in a distance of five miles north and west from Bervis.

On the north bluff of a creek a mile west of Armor at the home of a Mr. Conley, we found a faint beach with a deposit of gravel about three feet thick in which a pit had been opened. We were able to trace this weak beach about 4 miles NNE to within a mile west of Eskdale where it dies out in a nearby plain tract south of a well defined moraine.

The Moraine north of Eskdale seems to run NE toward Paisley along the north side of a stream that discharges to Saugern River at Paisley.

The district west and northwest of Bervis now appears to us as having features of a waterlaid moraine, or series of waterlaid moraines which trend in the course of the drainage lines slightly south of west between the drainage lines there are arched belts filling interstream spaces and guiding the courses of streams which run in swales between them. It is a topography decidedly in contrast with the flat or gentle inclined wave-washed plain west of the Warren beach. This plain as noted above seems to extend no farther north than Bervis, the Penetangore River being at its north edge there. The stream, however, passes into the ribbed sort of land about 2 miles west of Bervis and flows there between two of the low ridges that we suspect to be waterlaid moraines. These ridges are lower than the wave-washed plain south of Bervis. They seem likely to have been occupied by the ice sheet while the beach east of there from Bervis south was being formed.

The series of ridges just noted seem to have been correctly identified by Taylor in his paper and map in the Trans. Canadian Institute 1913. He traced them about as far from the shore of Lake Huron as they are readily identifiable. It now seems probable that from as far south as Pine River the ice was present as a barrier for Lake Warren and that it melted back and formed other water-laid moraines during the Lake Lundy stage.

Taylor's map in Mimeograph 53, U.S.G.S. Fig. 6, page 370, is incorrect in placing the ice barrier of Lake Warren so far south. It seems to be near his ice barrier of Lake Lundy in the late part of the Warren stage. The well defined shore development between Ripley and Bervis seemed to favor the retreat of the ice barrier to this position at a time considerably earlier than the end of the Lake Warren stage. The studies in Michigan support this view. The Tawas moraine shown in Taylor's Fig. 6, Mimeograph 53, is a likely correlative of these waterlaid moraines near Kincardine. The beach of Lake Warren is formed in Michigan on the Bay City moraine in Arenac County. So it antidotes the close of the Warren stage. Neither the Warren nor Lundy shore line is found in Alcona county in the district traversed by the Tawas moraine so that moraine seems likely to have been the ice barrier throughout Lundy time.

On the return we drove from Goderich to Clinton across the Port Huron moraine. There is a lower tract between Holmesville and Clinton than to the west of Holmesville. It seems to be moraine, but there is some sandy coating as if it had been covered by waters of Lake Whittlesey.

The altitude is 880-900 feet. Taylor thinks the AuSable Bay of Lake Whittlesey extended to here and received waters brought down by a stream on the outer border of the Port Huron moraine along or near the present course of Maitland River. (See mimeograph 53, U.S.G.S.)

We drove south from Clinton for 30 miles entering a plain about two miles south of Clinton which continues to Lucan Crossing. Near Hansell we came within sight of the Seaforth moraine which lies east of this plain and just east of Lucan Crossing. The plain seems to hold a pretty uniform altitude being between 860 and 900 feet all the way from Brucefield to Lucan Crossing. It is 860 feet at this railroad crossing and Taylor traced the Whittlesey beach to here from the Thames valley near Komoka. Komoka is about 810 feet. Taylor made the altitude about 900 feet near Clinton thus giving 40 feet rise in about 30 miles. When 2 miles south of Lucan Crossing we were in the Seaforth moraine. We there turned westward to Ailsa Craig and crossed a small morainic ridge about 1½-2 miles east of Ailsa Craig. On its west slope there are features suggesting a shore, and some gravel deposits. These probably are the product of Lake Whittlesey.

We did not see anything near Ailsa Craig that we could identify as the Arkona beach. Spencer put its altitude here at 789 feet. The railroad is 753 feet.

We drove southeast from Ailsa Craig to the road that runs WNW past Arkona through a featureless plain. On

turning toward Arkona we came into moraine topography south of AuSable River, 5-4 miles east of Arkona. It has sharp knolls with till and gravel interbedded, or with till above gravel.

We found Spencer's "Arkona" beach (but really the Whittlesey beach) about ½ mile south of Arkona where a gravel pit is opened in it on east side of the N-S road. The beach runs near this road for ½-¾ mile south being on west side much of the way. It probably turns west there. We took the next road leading west and came to it near the second cross road, 6 miles north of Watford. It runs on the east side of the road southward for 3 or 4 miles. It then takes a SSW course and passes west of Watford. It is said to be 773 feet near Watford by Spencer or 10 feet lower than Watford Station. We continued to the second E-W road south of Watford through undulating lands but did not note a definite beach. We there turned west and came into a flat tract about ½ mile east of the Kings Court branch of G.T.R.R. which we crossed south of Lawrence Station. This station is 724 feet so is above the level of the Warren beach. The undulating land east may thus set in at the edge of Lake Arkona.

We did not see any feature suggesting Warren shore between here and N. Sydenham River, the surface being very flat all the way.

North of Petrolia we came in sight of the Warren beach on the south side of the Port Huron moraine. It does not cross the road we are on (first E-W road north of Petrolia) but is near it for three miles. It then swings around to the north and crosses the Port Huron moraine 3-4 miles west of Wyoming, as noted on our way east yesterday. We stayed at Kincardine the night of August 25. The Algonquin beach there as determined by Goldthwait is 666 feet. It runs south from the village on the east side of the main N-S street. It is a gravelly bar of considerable strength.

The Nipissing shore line is a cut bluff back of the Tennis Court and north of the E-W street that runs to the shore from the center of the village. It seems to be fully 15 feet above Lake Huron at base of the cut bank but scarcely 20 feet. Goldthwait's results are published in Memoir No. 10, Geological Survey Branch Department of Mines, 1910.

On returning to Ann Arbor I wrote to Taylor and W. A. Johnston and sent tracings of our field map showing moraines and beaches.

As a rule the Warren beach is a single ridge but in the part SW of Thetford with E-W trend there on two or three parallel ridges only a few rods apart, and of similar altitude. The northernmost one is along the north side of the road and the others south of the road are on the road. The road for several miles is about ¼ mile north of the concession line and it runs there in order to be on the beach or near it.

The morainic spur SE of Thetford has boulder concentrates on its slopes where the lake waves washed it.

The till of this district is a stiff clay with only a few large stones embedded in it, so far as we saw exposures in bluffs of streams in vicinity of the Warren beach.

Goldthwait makes the Algonquin beach 606-607 at Sarnia. He says it lies just east of the city, one mile. (See Memoir No. 10, Canada Department of Mines, Geological Survey Branch, page 18, 1910).

The Nipissing 596 feet is found 700 yards back from the shore at Port Edward. A gravelly beach with sandy crest. (page 18).

There on other ridges less continuous above and below the Nipissing, those above are gravelly, those below are sandy.

Referring to my field maps in Michigan, I find there was little or no tilting in the Saginaw basin south of the head of the Grand River outlet. The Saginaw beaches in the Southeast part of the Perrinton quadrangle are up to 735 feet and so is the Delta at DuPlain. At the north edge of the Perrinton map a beach reaches 745 feet and bars near North Star 740 feet.

The Arkona beaches in the north part of the Perrinton quadrangle reach 720 feet, but east of Pompeii an Arkona is below 715 feet. This is called "second Arkona on my field map." There are faint shore features at 690 feet probably second Lake Saginaw.

The Warren shore north of the outlet is near the 680 contour. South of the outlet near Eureka is an Arkona beach 712-714' and a beach probably second Saginaw above 690 contour. The Warren is along the 680 contour. A cut bank north of the outlet near Washington Center is 660-665 at base and above 670 at top. This may mark the closing part of the Lake Warren stage, and show to what depth the head of the outlet had been cut. In the Elsie quadrangle the first Lake Saginaw bars and shore features are near the 740' contour. The highest Arkona catches the 725' contour and the second is above 715' near Chapin. The upper Warren is 685' in east part of the quadrangle. It is above the 680 contour north of the outlet north of Ashley. The lower Warren is about 670 feet at Ashley and is a cut bank part of the way. In the Chesaning quadrangle the highest Saginaw is 740 or more. The highest Arkona 725-730 feet. Middle Arkona about 715 feet and lowest Arkona 700-705 feet unless this is second Lake Saginaw?

The Warren shore is rather ill-defined and represented in part by a thin pebbly deposit coating the till. There is a beach at 650-655 feet that seems to be the Wayne.

A beach in the north part near Groveton at about 610 feet seems to be Algonquin. In the Burt quadrangle the delta of Flint River in Lake Saginaw catches the 750 contour, but this lake seems likely to be between 740 and 745 feet. Lake Algonquin probably comes ~~with~~ into the northwest corner of this quadrangle. Lake Warren

seems to have extended about to the 680 contour, but its shore is rather ill-defined.

In the Flint quadrangle the Saginaw beach is along the 750 contour. A beach is traceable northeast into section 18, Thetford township at this height is a nearly continuous feature. Farther north it appears on some of the knolls in section 7, 8 and 5 Thetford township. A sharp narrow morainic ridge in section 27, 28 and 29, Arbela Twp., (T.10N., R.7E.) is only 720 at base of its inner slope but knolls on its crest are 750 to 780 feet. A definite beach in its north side catches 710 contour which is an Arkona. Perhaps the base of this moraine is at an Arkona shore 720-730 feet for a definite bar southwest of there in section 31 is 720-730 feet. This runs southwest into Clio with this altitude. It seems to be the main Arkona shore. There are weaker bars east and south of Clio that catch the 740 contour. Perhaps they are First Lake Saginaw features as well as the 750 feet shore. There is a weak beach between 690 and 700 feet probably second Lake Saginaw. There is also a faint beach just below 680 contour in section 3, Vienna township (T.9,R.6E.) and along it is section 25 and 35, Birch Run township (T.10,R.6E) in southeast Saginaw county that may be the Warren.

A strip of sand above the 660 contour in sections 26 and 27, Birch Run, may pertain to the Wayne shore. Its not so definite as that in the Chesaning quadrangle at 650-655 feet.

In Tuscola county the Warren shore line is nearly 700' where the Port Huron moraine rises above it near Vassar. It is 730' or more at north border of the county.

In Huron county Lane makes the highest part of the Warren beach, northeast of Bad Axe about 770 feet. It drops to 760 feet southeast from there about three miles north of Ruth. Levels by Lloyd Humley make it about 757 at Ruth and 750' at Charleston. It drops to about 700 feet where the Port Huron moraine is crossed by it near Port Huron. It is 687 feet near northeast corner of the Rochester quadrangle and is above 680 contour at the south edge of Rochester quadrangle. This, however, is the untilted part. There seems to be very little tilting of the Whittlesey and Arkona beaches in the Rochester quadrangle or south of Lat. 42° 45'. On the west side of the Saginaw basin the tilting sets in within a few miles north of the head of the Grand River outlet.

The Warren beach reaches 684 west of Merrill and 697 at Alamando. It is 725 at the line of Gladwin and Bay counties east of Rhodes and 735 near Bradley and 745' near Sterling. It reaches 770 feet in southwestern Iosco county and 790 feet at the border of the AuSable delta in central Iosco county. It here becomes difficult to trace though the delta may mark its level as far north as southern Alcona county where it is about 800 feet. The beach of the First Lake Saginaw was traced northward from the Grand River outlet where it is 735-740 feet to Gladwin where it is 808 feet. The sandy plain at Greenwood in southeastern Ogemaw county may mark its level at about 820 feet. The sandy plain, however,

rises to 865 feet near Wright Station or Loranger and this may be nearer the level reached by the Lake Saginaw waters.

Data from White's Altitudes in Canada (Second Edition)

Distance Miles		F.T. A.T.
0	Goderich south St.	711'
2.7	Goderich East.	712'
7.9	Goderich Ec. G. & S. Line	665'
8.9	Caruk	605'
12.1	Bayfield beach Sta.	598'
12.5	Bayfield River	590'
13.3	Bayfield Station	662'
18.	Grade	900'
24.9	Zurich corner	842'
30.	Grade	780'

Data from White's Altitudes in Canada (Second Edition) continued:

Distance Miles		F.T. A.T.
30.5	Dashwood	761'
35.4	Concession	830'
36.4	AuSable River	784'
39.2	Grand Trunk Railroad	871'
40.5	Exeter Station	890'
41.3	AuSable River	857'
47.1	Harsall Corner	923'
49.6	Kippen	917'
56.6	Lyndonville	987'
58.3	Seaforth	1012'
0	Dungannon Concession	876'
3.3	Mile	845'
7.5	Canada Pacific RR	871'
9.6	Ben Miller Concession	781'
9.9	Maitland River	729'
14.3	Grand Trunk RR	776'
15.3	Goderich East	712'
18.	Goderich	711'
0	Arkona Jc.	766'
7	Thetford	683'
11.5	AuSable cut off (water grade)	593'
		water grade
18.6	AuSable River	581'
20.4	Grand Bend Station	611'
26.8	Darkwood	761'
10	Poplar Hill	795'
28.4	Keyser	731'
33.2	Arkona Jc.	766'
33.4	Arkona	755'
36.	Birnam	741'
43	Line of Warwick and Plympton	742'
0	Rache Corners	701'
2.3	Wyoming C.P. RR	706'
2.7	Creek	691'
6.9	Petrolia	668'
7.1	Sydenham River	618'
12.2	M.C.R.R.	657'
12.8	Oil City	657'
14.3	Oil Springs	659'
17.5	My's Mills	660'
23.3	Rutherford	627'
28.8	Dresden	601'

Bench marks of Geodetic Stations north from Doderich, Ontario. (See Letter of W. A. Johnston, September 15, 1933)

B.M.	Mileage	Description and Elevation
326	82.4	Goderich W. wall of Court House 720,258 ft. A.T. in second course of stonework above ground
33-R	84.2	In C.P.R. bridge over Blue water highway 2 1/2 ft. above road surface and 12' below bridge section 672,597 ft. A.T.
34-R	85.5	In culvert on Blue water highway at Munlop 700,856 " "
35-R	87.6	In culvert 2 1/2 miles south of Shippagan in coping of west wall 692,196 " "
35-R	89.1	In culvert 1 mile south of S " " in coping in west wall 699,387 " "
37-R	93.4	In wall at north end of Spillway of dam on Lundyow River 602,361 " "
38-R	94.4	In culvert 350' south of red brick SH in coping of west wall 694,641 " "
39-R	95.8	In culvert 1 3/4 miles south of Kings-bridge Church. In Coping of wall (west) 698,221 " "
40-R	97.5	In Kingsbridge church, south wall of tower west of basement window - 4 ft. below brickwork 689,455 " "
41-R	99.5	In culvert in front of Kintal ^{east of} Cemetry. In SW face of coping 667,472 " "
42-R	101.8	In culvert 1 1/2 miles south from where road jogs along here between Cen. XII and XIII. In coping of west wall 651,122 " "
43-R	103.9	In ^{concrete} culvert in a gully 400 feet south of 45° turn in highway. In coping of west wall 636,946 " "
44-R	106.8	In concrete truss bridge 1 mile north of Ambury SW face of west wing wall 673.1 " "

September 15, 1933

I went with Prof. D. C. MacLachlan of the College of City of Detroit to study moraines and beaches in Eastern part of Saginaw County, Northwestern Tuscola County and Huron County, Michigan.

We went north on Highway 23, through Brighton, Fenton and Flint, and left it near the northeast corner of the Burt quadrangle in Section 28, Birch River Township, Saginaw County.

We went north between Sections 27 and 28, then east a mile then north between Sections 22 and 23, where we came to sand ridges at altitude about 650 feet which we think are Grasmere beach of Lake Lundy. We covered other sand ridges in the line of Sections 10 and 11, and near corner of Sections 2, 3, 10 and 11, all of which seem to be Grasmere beach. We saw only one dune, in west part of Section 11. The ridges run east and west and probably are over 640 feet and perhaps 650 feet. The level is 645 at southwest corner of Section 10 in Saginaw quadrangle map and these ridges are probably a few feet higher.

We went east two miles to the county line of Saginaw and Tuscola on line of Section 2 and 11, 1 and 12 Birch Run. The altitude given by Davis in Tuscola County map is 650 at southwest corner of Section 6, Arbela Township. We cross a west flowing stream 1/4 mile north of this corner, and are in sandy land 1/4 mile farther north. We then rise to a ridge of the Port Huron morainic system that lies south of Cass River. The crest is near the township corners. Davis makes the altitude 670 feet here, or 50 feet above the level of Cass River at the county line 1 1/4 miles north of this corner.

The moraine has a well defined crest and a gently undulating surface from here westward past Frankenmuth. The Saginaw topographic map shows it in Sections 27, 28, and 34, Frankenmuth. The highest

contours is 640 feet in northwest part of Section 34. The moraine is cut off by the Cass River in Section 28, and finds continuation westward in north side of the river. It also is out off in Tuscola county at a creek in Section 32, Tuscola Township and finds continuation north of the river east from there. There is little or no sand on it. Boulders are not rare. The bluff at Frankenmuth shows blue till nearly to the top. The moraine north of the river is above 655 feet at east edge of the Saginaw map, and rises to 690 feet in Sections 19 and 30 Tuscola Township, as mapped by Chas. A. Davis. There seems to be remarkably little sand or gravel in the moraine in Frankenmuth Township. I noted a few ridges in Sections 5, 6, 7, and 18, in earlier studies at 635 to 640 feet which are beaches of Lake Lundy, whether Elkton or Grasmere not certain, but probably Elkton.

We went north on line of Frankenmuth and Tuscola Townships to the north end without seeing any shore features. We found a definite ridge of sandy gravel in west part of Section 25, Blumfield Township which we traced southwest across corner of Section 26 and then west across north part of Section 35 and 34 to the edge of the Saginaw quadrangle where the map shows the altitude to be about 635 feet. We traced this into Tuscola county across Section 24, Blumfield Township and a ridge south east of it run northeast across Section 19, and southeast part of Section 18, northwest of Section 17 to center Section 8, Denmark Township passing east of Reese. The altitude near Reese is probably fully 640 feet.

A slightly lower ridge is 625 feet in Sections 27, 28 and 33, Blumfield Township in Saginaw map and this runs into Reese. We leveled to it from the depot and found it 8 2/3 feet higher. The altitude of Reese station being 632 feet, the beach is 640 feet. Near line of Sections 5 and 8, Denmark Township. This ridge is joined by one coming in from the south west south of it and that appears to be a disjointed continuation of the ridge traced from Section 24, Blumfield into Section 8, Denmark. They probably are all near 640 feet in vicinity of Reese.

A lower beach which is 615 feet, east edge of Saginaw Township, map in Section 15, Blumfield, we traced northeast across Sections 14, 11 and 12 into southeast part of Section 1, Blumfield, but were not able to trace it further. It probably is 20 feet lower than the beaches at and near Reese.

The beach that runs through Reese curves around to the southeast in north part of Section 3, Denmark Township, and seems to die out. There is another beach in south part of Section 3, that we traced southwest across west part of Section 10 and southeast of Section 9, which is likely to be higher than 640.

Davis makes the elevation about 650 feet. A beach that seems likely to correlate with the one at Reese sets in in the NE 1/4 section 34, Gilford and runs past Gilford. It is split into at least three ridges in the north part of section 26 and south of 23, but curves around as a single ridge in north part of section 24 from a northeast to a

southeast course and dies out at a creek valley. It seems to be ill-defined in sections 18 and 19, Fairgrove township. But in sections 8 and 17 there are two distinct ridges that we traced northeast to Akron. They are about the altitude of Akron station 647 feet, possibly reaching 650 feet* thus giving a rise of 7 to 10 feet from Reese to Akron. North from Akron there is a single strong beach which we traced NNE to Woodman. It curves around to the southeast in northeast part of Section 23 and dies out at a creek in west part of section 24, Fairgrove township. We were unable to trace it farther.

We mapped a higher beach through east part of Section 30, Fairgrove to center of Section 20. Davis map makes the elevation 660-670+ but it probably is little of any above 660 feet for it seems to be continued on north side of a creek near Fairgrove and to be close to 660 in that village. We traced it north a mile from Fairgrove where it seems to terminate. A probable continuation is found in a beach which sets in in NW $\frac{1}{4}$ section 15, Fairgrove which we traced to Columbia through sections 10, 11, 2 and 1, Fairgrove, section 36, Akron, section 6, Almer and sections 21, 32, and 29, Columbia. Davis gives the altitude of Columbia as 660 and he has a 670 contour south of there in the line of the beach. It leaves this, however, in section 32 and runs west southwest to his 650 contour. Its elevation is probably 660 feet in section 15, Fairgrove and it may be as much as 668 at Columbia. There is a till ridge in sections 16 and 10, Columbia, that causes a definite and rapid rise on its west side where Davis runs 640 and 650 contours near together. This has only a slight and patchy cover of gravelly material where we examined it in north part of Section 10. It seems to terminate there.

MacLachlan run levels near Fairgrove and found the highest "Lundy" beach about 660 feet. There is a beach at Akron only 647 feet. This is north of Fairgrove so probably is a lower beach. A beach At Reese is 640 feet – the one at Akron.

We drove east from Unionville to Gagetown but saw no definite beach ridges below the Warren shore. This here is a wave-washed slope near the base of the Port Huron moraine, and it has this phase southward into section 22, Elmwood. We left it at the line of sections 23 and 24 and west to Cass City for the night.

Cass City, Michigan September 17, 1933

A deposit of coarse gravel and cobble with thin sand partings forms a delta in the Ugly outlet here as interpreted by F. B. Taylor, many years ago. It seems to be less than 15 feet thick and is underlain by bouldery till, i.e., till with boulders at surface. We find that the gravel is fully as high at its south edge south of center of section 33 as it is at the edge of the Port Huron moraine in Cass City. The depot is 741 feet and the deposit by level with instrument is 745 feet near its south edge about 80 rods south of center of section 33, at gravel pit. The delta extends only a few rods into Section 32.

The valley is about 720-725 feet west of it in SE $\frac{1}{4}$ section 32 or at the level it has at the south side of Section 33. Cass River is below 700 feet contour here, in section 4, Novesta. The Ugly outlet is tickly strewn with boulders on this lower plain and there are a few boulders in shallow swales on the delta.

We drove east to the county line (Sanilac County) and were there at the south bank of the Ugly outlet. A moraine occupies the southeast half of section 36, Elkland township and north part of section 1, Novesta township. It is cut through by the south branch of Cass River in section 2, but continues across sections 11 and 10 into section 15, as indicated on Davis map. We drove to the big swamp in the Port Huron moraine in sections 17, 18, 19, and 20, Elkland. A line of glacial drainage leads down to it from Gagetown which is only 750 feet at the head. The gravel in it extends to the northeast part of section 18, where the swamp sets in. From Gagetown we went into Huron County and found the Lake Warren beach well developed on the moraine ridge that passes through sections 31, 29 and 28, Grant township. Dr. A. C. Lane found its elevation to be 744 feet here. (See footnote page 63, Huron Co. Rept. Vol. 8, Part 2, Mich. Geological Survey)

We took a road north between sections 29 and 30, Grant township and went eight miles, passing the places where Lane has Grasmere and Elkton shore lines, but we were unable to find definite ridges such as we found in western Tuscola County. There is considerable sand near the 660 contour in southwest part of Oliver Twp., and it is represented to run past Elkton on Louis map of Huron County. There is a till ridge 1-2 miles west of Elkton which we traced north for 7 miles through central Chandler township. The crest is perceptible and there are boulders strewn over it. This is probably the Bay City moraine. It is above Lane's 650 contour for several miles and above 640 feet to the valley of Pinelog R. in section 1. The moraine may continue across northwest part of Meade and southeast of Hume township to the southwest part of Port Austin township at the tip of the thumb. Is this moraine a probable ice barrier of Lake Warren? Also does it correlate with some of the Waterlaid moraines noted near Kincardine, Ontario August 26 and 27? The Tawas moraine seems likely to be an ice barrier of Lake Lundy and so do the waterlaid moraines near Kincardine.* We went no farther northeast than the corner of section 5, 6, 7, and 8, Meade township. We were there on a till ridge 650+. We then drove south and found till with scarcely any sand cover, until we crossed a stream near corner of sections 19, 20, 29 and 30, Meade township. Sand set in there at about 690 feet (by Lane's contour). We turned east at corner of sections 27, 30, 31, and 32, Meade and found considerable sand for 8 miles. We found other beaches than these mapped by Lane as "Lower Warren" in sections 32, and 33, Lincoln township and near corners of sections 28, 29, 32 and 33. They probably are about 750 feet. The ridge classed by Lane as an esker in sections 28 and 34, Lincoln is a lake beach correlating with his "Lower Warren." The main

Warren beach is on the moraine in sections 7, 8, 9 and 10, Verona township where Lane gives it an altitude 775 feet. But he makes the Warren 765 feet about a mile west of Bad Axe. A gravel ridge 4 miles south and a mile west is represented to be 770 feet. We found it a less definite feature than his map suggests but it may be a beach. It has some sandy spots.

*Why are the beaches of Lake Lundy less definite ridges in Huron Co.? What relation has the Bay City moraine to beaches of Lake Lundy? Do they lie entirely outside of it in Tuscola & Huron Cos.?

We went east from Bad Axe to this flat tract in the southern Sigel township marked "Lake Whittlesey" on Lane's map. It is a very flat tract with rather heavy soil and with a few boulders. There is not a definite beach at its southwest edge. It may have had a shallow depth of water over it at the highest stage of Lake Warren. It seems to be about the height of the Warren beach, which Lane puts about 770 feet in Sigel township (774 feet in section 18).

We examined the flat tract southwest of Bad Axe which extends into the north edge of Sheridan township. Like that in Sigel township it seems likely to have been covered by shallow water. Lane represents the main Warren beach to run west from Bad Axe three miles and then southwest to the morainic spar near Popple. It is 754 feet at this spar. Lane makes this "Lower Warren" two miles west of Popple 739 feet. A sandy ridge presumably Grassmere runs west southwest through south part of Section 34, Oliver township. It is 680-690 feet by Lane contours.

We went south past Rescue, crossing the weak moraines that carries the Warren beach just north of Mud Lake outlet. Lake Warren covered the plain south of here into Sections 4 and 5, Elkland Township, Tuscola County, and perhaps into Sections 2 and 3. A channel leads south from Section 34, Grant, as reported by Lane across the Port Huron moraine to Cass River at about 750 feet. This probably was the outlet of a small lake where ice barrier was at the moraine north of Mud Lake. On our way back we mapped a small section of the Warren beach in Sections 21, 22 and 28, Elmwood township. It is out 1/2 mile north of the Port Huron moraine.

We then went west of Columbia and mapped the beach that runs southwest from there to Section 15, Fairgrove as described above. We then went east to corner of Sections 13, 14, 23 and 24, Fairgrove township. Then south to the Warren shore near corner of Sections 25, 26, 35 and 36. The Warren beach runs diagonally northeast-southwest across Section 25. We followed it southwest to line of Sections 8 and 9, Juniata Township. We then crossed the Port Huron moraine and followed its southeast border to Vassar. The lake action nearly reached its crest in Tuscola township and covered it in Vassar in Section 12, Tuscola. A bar runs along the bluff of Cass River to east side Section 22 and then doubles back northwest to north part of the Section, where it dies out, gravel pits in it.

There is an isolated gravel bar near west end of line through center of Section 14, Tuscola, with gravel pit. Another gravel bar is in south part of Section 21. It forks at its west end, the north fork turning north to center of the Section and the other west into southwest corner. West from there the Port Huron moraine seems to have been too low to permit bars to form on it in Lake Warren stage. (See notes May 27, 1934, on a bar north of this that ends in north part of Section 21).

We crossed Cass River at Tuscola, and drove south through a sandy tract with low dunes to the Millington moraine in southwest Arbela township. There are dunes on its crest here and on the plain south of it in Genesee County. The features in Genesee County are mapped in the four quadrangles that center near Flint (Flint Burt, Holly and Durand).

In Monograph 53, Taylor traced Elkton and Grassmere beaches in Huron and Tuscola Counties, the Grassmere from near Grassmere past Canboro into Tuscola County, 2 miles west of Gagetown; the Elkton from near Elkton past Wolfston and Creel City, page 403. In Tuscola County he traced the beaches about to the highway that runs northwest from Vassar to Richville. He gives the Grassmere a descent of 40 feet from Grassmere to the latitude of Reese. From contours on Lane's and Davis' map it is from about 700 feet to 660 feet. (Taylor's has it from 720 to 680 feet) page 406. On page 404 Taylor noted faint ridges of Grassmere and "Lundy" between Sarnia and Wyoming, and north of Thetford, but more between Forest and Lake Huron. The Elkton may have been cut away.

Taylor thinks the Grassmere and Elkton beaches on west side of Lake Huron and horizontal about to latitude of Lexington. (See page 405 and Fig. 15, page 505, Mon. 53, U.S.G.S.)

Notes in Profile of Detroit & Huron Railway

	Pt. #.
Terminal in Cass City at P.O. & N.P.R.	786.5 + 6 ft.
Ridge near Porvins	748.7 + 6 ft.
Cass City depot	733 + " "
M.P.1, Nat surface 725. MP 4735 Ridge near	747 + " "
M.P.5, " " 733. Ridge near MP3, 737.9 MP4	733 + " "
M.P.5, near Holmstier 734 track bet. surface	730-731 + " "
Bluff at MP.5,6, base 731', top 735', MP.6	745 + " "
MP.7, 754' Greenleaf at 7.4 miles	756 + " "
MP.8, 764' Out at 8 1/2 nat. surface	780 + " "
MP.9, 778' Summit near 9.5 - 789, MP 10	786 + " "
Arbela near MP.11 and at mile post	761.5 + " "
Summit at 11 1/3 miles 771' MP.12	767 + " "
Ridge at 12 1/7 miles 772.8' MP.13 near road	760 + " "
Ridge at 13 1/4 miles 763' Ridge 6 mi. south of MP.14 (beach)	757.5 + " "
McIntyre near MP.14 - 752.5 MP.15	754.24 + " "
MP.16 - 752.7 Ridge at 16.6 miles, beach ?	754 + " "
MP. 17 near road - 753.77 Summit near road	757 + " "
Summit near MP. 18	759 + " "
Bad Axe depot	759.9 at 31.6 miles + " "

Perhaps 7 or 8 feet should be added to bring these altitudes into harmony with Bad Axe 758 feet and Cass City 741 feet. A letter from Charles A. Klemschmidt proprietor of hotel "Gordon Tavern" at Cass City September 29, reports that the D. & H. and P.O. & N. railways have always used one depot as they are units of the G.T.W.R.R. system. The intersection is about 100 rods south of the P.O. & N. depot.