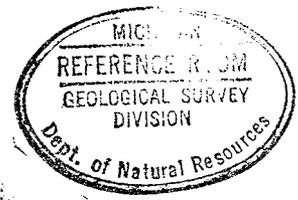


No. 298

LEWIS

Journal of the Michigan Geological Survey
Volume 1, 1911-1912

Notebook No. 298 - Leverett



COUNTY

- Eay: 10, 11
- Genesee: 13-14, 27-28
- Huron: 26
- Iosco: 20
- Lapeer: 9, 13, 28-29, 33-34
- Macomb: 21, 24, 30, 33, 38, 65
- Oakland: 21
- Saginaw: 9
- Sanilac: 9, 22-23, 25-26, 29, 34, 49-52
- St. Clair: 21, 22, 23-25, 30-33, 34, 52-53
- Tuscola: 2, 9, 10, 11-13, 14-18, 27, 28, 47-49

OTHER STATES

- Illinois: 76-78
- Minnesota: 66-67
- Ohio: 19
- Ontario: 2-8, 35-41, 42-47, 54-64
- Wisconsin: 78
- Other States: 4, 38, 41-42, 43, 67-76

Oct. 1911 - 1912. Eastern Michigan & Michigan Geological Survey

Frank Leverett Notes - Note Book No. 298

Pages 1 to 27 inc.

Altitudes on M.C.R.R. Caro to Owendale, Michigan taken from profiles sent me by George H. Harris Chief Engineer. Penninsular Sugar Company Plant one mile south of depot - - - - - 692
Gullies near it cut down to about 665 feet, so Cass River is below 665 feet here.

Caro depot 1500' NW of MPL4 from Vassar		718'
Summit on Pt. Huron moraine 1 mile NW of depot		772'
Another ridge 3/4 mile south of Atwood		758'
Atwood at line sections 22 & 27 Almer Twp.		724
Ridge 1/3 mile (1800-2200') N of Atwood (Warren beach? No.)		726
The Warren beach is nearly a mile south of Masoner at 721' on crest.		
Masoner at line of sections 10 & 15 Almer Twp.		688'
Purdy at line sections 3 & 10		679'
Patterson at Twp. line Almer & Columbia		671'
Ridge 1/2 mile north 665' may be Grassmere		665'
Hutchinson at line sections 27 & 34 Columbia		657'
Colling near S side section 22 Columbia		653'
Abls at line sections 15 & 22 Columbia (Beach?) Elkton?		651'-652'
Duro at line sections 10 & 15 Columbia	ground	643'
	Track	647'
Ashmore near corner sections 2, 3, 10 & 11 Columbia	ground	638'
	track	642'
Huron-Tuscola Co. line near corner sections 1 & 2; & 35 & 36 (Sebewaing)		637'
<i>Bach</i> near line of Brookfield & Sebewaing Twp. (track)		639'
Hall near corner sections 19, 20, 29 & 30 Brookfield Twp		635'
	track	638'
Patton near center section 16 Brookfield		636
Owendale		644'

The Elkton *beach*, as interpreted by Taylor, runs past Coral City about a mile SE of Owendale, and near Wolfton 2 miles N NE of Owendale - It seems to be on ground about 650'

A prominent ridge nearly a mile S of Masoner 721' may be a Warren Beach. It is 5' *lower* than the ridge near Atwood. The profile shows a gravel pit in it. Davis map of Tuscola Co. shows a ridge in sections 15 & 21 running NE - SW past this place. But he does not show one north of Atwood, where the profile suggests a beach at 726'. (Field study later shows it is not a beach). A ridge midway between Hutchinson & Patterson at 665' may be - Grassmere beach?

September 30, 1933

I went into ~~Western~~ Ontario with Prof. H. H. Hobbs, George Stanley and D.C. MacLachlan to get further data on the relation of ice boundaries to the glacial lakes of the Huron - Erie basin.

We crossed St. Clair River at Port Huron to Sarnia, Ontario. We went on the Sarnia-London paved highway eastward. It runs north of east for about 3 miles along the Algonquin beach. We leave the beach as we turn east after crossing a small creek. This is in the area of horizontality so the beach is about 605-607'.

Taylor on p404 of Mon. 53, U.S.G.S. reports faint gravel belts between Sarnia and Wyoming which he interprets to embrace Grassmere and Elkton beaches. We did not note ridges of sufficient definiteness to be readily traced. They seem to be less distinct than in Tuscola Co., Michigan. So MacLachlan probably will not try to map them here.

We crossed the Warren beach directly north of Wyoming where its altitude by Hydro-Electric Power Survey is about 701'. We did not look for the bench mark. So do not know how much the crest of the beach differs from it but if it is at the road intersection the difference is not more than a foot or two.

East from here the beach has a relief of 10' or more above the plains south of it, and even more above that on the north. MacLachlan took a snapshot of it from the south side with his kodak. An orchard on the slope helps to bring out its relief. This is in concession V north as given on the Topographic map Dept. of Interior Sheet 1 SW, published in 1904. There are no contours on the map, but altitudes of the main railway stations are given.

We find the Port Huron moraine has very subdued features its entire width where this highway crosses it. Its relief is less than 20' above the plain outside, south of it, through which the North Branch of Sydenham River flows. Warwick village is at the border and only a few feet above the plains.

We came to a gravelly beach 1 3/4 miles east of Warwick at a level about 750' (see Park Hill Top. map). It seems to be low enough to have been formed by Lake Arkona, and is about 30' lower than the beach 1 1/4 miles farther east that we traced south from Arkona to Watford on August 27, when MacLachlan and I made a trip into Ontario.

We continued east on this Sarnia-London road to the highway that runs north to Arkona and find undulating till like a subdued moraine. It is the Seafirth moraine of Taylor, whose altitude is perceptibly higher than the beach that we noticed 3/4 miles south of Arkona on our trip in August. It is 818' where we turned north. There may be a moraine here with a trend nearly north to south, perhaps N NE to S SW. It is the Seafirth moraine. From the beach south of Arkona, Stanley and MacLachlan ran levels, with Wye level, to the bench mark of the Hydro-Electric Power Commission at Arkona. This B.M. 755' is on the steps of a bank on the NE corner of the main road intersection less than a foot above the ground.

The beach south of Arkona is $29\frac{1}{2}$ feet higher in 784.5 feet A.T. This is at the right height for the Whittlesey shore line, so we interpret it to be the Whittlesey beach instead of a beach formed by L. Arkona

The application of the name Arkona to lake with lower level than the one which formed this beach at Arkona is the work of F.E. Taylor? J. W. Spencer applied the name Arkona to the beach but at the time the beaches now referred to Lake Arkona were not clearly recognized as they were washed down by the rise to the Whittlesey level. The Whittlesey beach was known as Belmore at that time in Ohio, but its correlative north of Lake Erie was not so well known. The beach Spencer saw at Arkona now ~~seems~~ ^{seems} to be the correlative of the Belmore beach off Ohio and to mark the shore of Lake Whittlesey. Spencer seems to have leveled to it at Arkona and made it 789'. (See Am. Journal of Science 1891, Profile Figure).

There is only a narrow lowland at Arkona for the Port Huron moraine comes to the AuSable River from the west within 1/2 mile north of the village on north side of a small stream that discharges into the river at the "Rock Glen" ~~Show~~ in Guide Book 4 of the Int. Geol. Congress in 1913, p102. The Hamilton formation is exposed here to a height of 60 - 70 feet above river level. Hobbs and I visited the glen while Stanley and MacLachlan were leveling. We also went east to the cemetery and found its altitude to be 50 feet by aneroid above the BM 755 in Arkona or 20 feet higher than the beach. As noted on August 27 there seems to have been an advance of ice a little beyond AuSable River for three or four miles east of Arkona, till being spread over gravelly hills there. This being the case the part of Lake Whittlesey south of Arkona was probably for a time separated from the lake on east side of the Port Huron moraine south from Clinton. Whether a channel was found south of the AuSable in the district east of Arkona seems doubtful. We are inclined to think the west flowing part of the AuSable was the main course for drainage from the lake south of Clinton during the development of the Port Huron moraine and the advance south of it was shortlived. The low strip that runs from the "Rock Glen" past Arkona seems likely to be in the line of drainage into the Part of Lake Whittlesey south of Arkona village.

During the blocking of this channel the lake south of Clinton may have been raised to a higher level. There are features on its border suggesting such a rise. One such feature is a beach on east side of the highway within a mile south of Hensall? . It is perceptibly higher than Hensall. The altitude of Hensall is 895' and this beach is probably 25 feet higher. Sept. 20, 1934 MacLachlan ran levels to it and found it to be 920' The channel near Holmesville that leads south from Maitland River into the lake that stood east of the moraine is less than 875 feet. Levels Sept. 20, 1934 make 17 feet lower than Holmesville Sta. Whites Dict. of Altitudes in Canada gives Holmesville Station 880' This makes the channel 863'.

It is ^{filled} with gravel and seems to mark a strong current into the head of the lake that lay south from there to the east of the Port Huron moraine. On the border of this channel directly east off Holmesville there are sandy deposits up to a height of 30 or 40 feet above it. These may mark a temporary high level of the lake and correlate with the beach at ^{Hursell} Hursell. Though it is possible the sand has been blown up above the level of water in the lake. Even if there was continuously an open channel from the lake south of Clinton to that south of Arkona there may have been considerable fall along it. So the lake south of Clinton may not be a part of the big Lake Whittlesey. There is flat land east of Ailsa Craig for 5 miles except the small ridge about a mile east noted in our trip August 27. The flat land ^{east} side of this ridge is less than 800', but the plain rises to 860 feet at its east border. This is its height at Lucan Crossing. The railway there being 863'. There is a gravelly deposit perhaps a delta where the Little AuSable comes into this plain near Lucan Crossing at a level about 860'. The level of the stream there is 841' and railway bridge 865'. This deposit is near the level of the bridge. A lake standing near 860 here may rise near Hursell to 920 feet. The Warren Beach rises 24 feet in this interval. In both places the altitude seems too high to fit Lake Whittlesey. The plain at about 800 feet at base of the ridge east of Ailsa Craig is about level enough to fit Lake Whittlesey and is the bed of the channel at Holmesville which is less than 875' (863'). I have estimated that the 900' is above when projected westward from ^{Minilla} Minilla New York, to this area would strike the Lake Huron shore near Clarks Point SW of Kincardine. In that case the level should be at least 35 feet lower near Holmesville and thus fit the gravel deposit which comes in there from the bend of Maitland River. That river in its SW course is probably along a line of border drainage and not in a ponded strip. But parts of ^{of} Bayfield drainage and AuSable River are in areas which were ponded.

Returning now to the account of our drive. We went north from Arkona across the Port Huron moraine. It has rather subdued expression as in the district west of Warwick. We all ^{so} found it with faint expression where we crossed west of Ailsa Craig.

We filled in a gap in the tracing of the Warren beach that we skipped August 26 for 3 - 4 ^{miles} miles east of the north flowing AuSable River near Sylvan - Its position is close to where we had conjectured about 2 miles south of the highway that runs through Sylvan. We were unable to find a definite beach on the borders of the till ridge east of Ailsa Craig. There is an abrupt change in topography. The ridge ^{head} head till at surface with very little sand or gravel in view where we cross it. Our aneroids indicate that its ^{base?} base is not more than 800 feet so its level is about what Lake Whittlesey should be here.

We found the short section of a beach near Hursell has gravel within $1\frac{1}{2}$ - 2 feet of surface, but there is a loamy soil over it. It is only about $\frac{1}{4}$ miles long, and 20 rods wide. It stands 5 or 6 feet above the land each side. Its altitude probably is about 920 feet. Levels run Sept. 20, 1934 show the gravel to be 17' lower than Station or 857' A.T. (863' by Whites' altitudes in Canada). Hursell station being 895'. The altitude of Hursell seems to have been determined by the geodetic survey, so is to be relied on.

The surface is plain along the highway from Hursell nearly to Clinton. From Clinton westward nearly to Holmesville there is undulating till which becomes coated with sand on the border of the channel that runs south from the bend of Maitland River past Holmesville to Bayfield River. It has a flat bed not more than $\frac{1}{4}$ mile wide where we crossed. There is a gravel pit in it on north side of the highway. The railway here has an embankment above 15 feet high. That is about the level of the depot 874 feet. So the channel appears to be not far from 860 feet. The sand on the slope east of it is up to about 900 feet. It is not in ridges but seems to be a coating on the till.

We came to the Warren beach 4/10 miles SE of the place where the G.T.R.R. crosses the highway. There are gravel pits in it here. MacLachlan plans to run levels to it from the BM of Geodetic Survey 720' on the east wall of the Court House in Goderich. Levels run Sept. 20, 1934 make it 795.5 A.T. He will also determine the elevation of a beach in Goderich which is at about the level of the Court House and which seems to have been found by Lake Lundy.

We drove north to the cross road west of Nile near where the 699 BM of Geodetic Survey is located. It seems to be in a depression but we did not locate it definitely. The culvert is perhaps 15 feet below the plain.

that we infer carries the bench mark

We drove east to Nile. The surface changes here from plain to undulating but we do not find a definite beach such as that west of Dungannon. The altitude is 825', 20' lower than the beach west of Dungannon $3\frac{1}{2}$ miles north of Nile. (See Lucknow Topographic map)

We drove from Nile to Dungannon and were unable to find a definite beach along the highway. But there is a definite beach west of Dungannon $1/2$ mile on south side of Lucknow River at an altitude somewhat lower than Dungannon. Perhaps the altitude 876 of Dungannon concession given by the Hydro-Electric Power Commission is at the village. (The Lucknow map makes the village below 875').

We went to the third road west of Dungannon and there turned north and crossed the G.T.R.R. at place marked "Clover Valley" on road map. We then filled in the gap left SE of Ripley in our mapping of the Warren beach August 27.

From Ripley we drove east to the beach and found the barometer makes it 30 - 40 feet higher than Ripley. Hobb's barometer showed a rise of 45 feet but in returning to Ripley a change of 10 feet has occurred so the altitude may be not more than 40 feet above Ripley Station. Other barometers we carried showed 30 - 35 feet rise to the beach - Ripley is 806' by Whites Dict. of Altitudes so the beach seems to be 840 - 850 feet.

MacLachlan probably will run levels to it. We drive into Kincardine for the night. Levels run Sept. 20, 1934 make it 845' A.T. On Sept. 21 we found a higher Warren a mile east to be 865'

October 1, 1933 - Kincardine, Ontario.

There is a slight bench at 11 feet above Lake Huron below ^a broader Nipissing terrace which is about 23 feet (604' A.T.) at east edge at base of bluff on the Bowling Green, and Tennis Court. The bluff is 12-15 feet high.

There is another notch back of Walker House opposite the bridge on Kincardine River, at about 635 feet. The bank back of it is only 5-6' high, and sandy. Is this a ~~X~~ Brady beach?

The main Algonquin beach runs through the turn a little to the east of the main N - S Street. It is a barrier beach with lower ground east of it. Its altitude is 666-667' as determined by Goldthwait. (See Memoir No.10 Canada Geol. Survey). On p.19 of this Memoir Goldthwait notes beaches in Kincardine at 636' (?), 646', (good) 651' (?) and 660', (good). Obscure beaches noted at 641 feet at railway crossing, and 657 feet in cemetery, a mile south of center of town. The base of bluff by the Nipissing due west of cemetery is 600 feet. It is 604 at foot of Albert Street 1/2 mile north of cemetery. The Nipissing level is probably not less than 604' here in Kincardine.

We drove north on the "Bluewater Highway" about 5 miles. This took us over a till ridge that is strewn with boulders, the best defined ridge of the series that Taylor shows on his map in the Canadian Institute papers of 1913 on "The Moraine Systems of Southwestern Ontario".

The aneroid I used indicated 755' on its crest. It reads 770 on it at Shade. The ridge ~~there flattening~~ out and a lake plain sets in which rises to the beach at Mr. Conley's 1 1/4 miles east of Shade, where we found it in August 27. My aneroid reads only 800' here, but three others read 858 to 870 feet. So mine is likely to be incorrect. The beach at Conley's is 880' as found later by leveling. The altitude is as great as they show favors reference of this beach to Lake Warren rather than Lake Lundy. We followed it northward and were all of the opinion that its strength is such as to compare favorably with the

Warren beach as seen farther south. We found it double for a couple of miles before crossing from Kincardine into Ruce Township? The eastern ridge is higher than the western perhaps 10-15 feet. The beach turns east on south side of Willow Creek and we traced it across ^{our} concession. There is a narrow plain north of it along Willow Creek, but there is undulating till north of the creek. The altitude seems to be at least as low as the beach. There is much higher ground south of the beach. This seems to be the inner border of the Port Huron morainic system. We traced it eastward ^{almost} to Portal. From Portal north to Willow Creek and along Willow Creek to Paisley there are gravelly knolls and an undulating surface but with a subdued expression compared with the moraine ~~to~~ to the south. We are unable to find either a beach or a lake washed plain such as we found as far as the vicinity of Eskdale. The features are not sharply morainic but we are inclined to make them correlate with Lake Warren. It seems doubtful if Lake Warren extended north of the headwaters of Willow Creek.

We went into Paisley along south side of Willow Creek valley passing through a gravelly area of puzzling character. The knolls and ridges of gravel do not line up into a common level. But are at various levels as if built in valleys or depressions that antedated them. The depot in Paisley is on the level of the country bordering the Saugeen valley at 772 feet. The streams in the village are 50-60 feet lower. We went east about 5 miles on the road toward Chisley, and then north a mile and back to Paisley. This showed us a ridging that parallels the North Branch of Saugeen River with a NW-SE trend. The ridges are less than a mile wide including slopes. Between them are plains also less than a mile wide. The ridges rise 20-30 feet \pm above the plains. They seem to be moraines. There may be a series of several ridges and plains. We had not time to carry the study further.

From Paisley we went west to the Bluewater Highway. This took us across a series of low ridges with a trend slightly south of west that may be moraines. The features are similar to those east of Paisley but the trend of the ridges is different.

We came to the Bluewater Highway at the third road northeast of Underwood and returned on it to Kincardine and Goderich. We got dinner at Goderich and then continued south on the Bluewater Highway.

We can see no indication of a moraine along the lake bluff either north or south from Goderich such as Taylor postulated. A letter from him written Sept. 27 says he thought part of the Goderich moraine south of Goderich, had been cut away by Lake Huron, but its east slope is preserved with a swale paralleling it on the east. We do not find such features. There is some sand near the lake bluff that is slightly ridged but with less than 5 feet relief above the land east of it. This is perceptibly lower than the Bluewater Highway. From this highway both north and south from Goderich one can see Lake Huron waters. So there is no intervening higher land.

We were unable to detect Lundy shore lines along this highway, between Goderich and Grand Bend. The Algonquin and Nipissing beaches are generally cut away by encroachments of Lake Huron. Goldthwait noticed an Algonquin terrace 4 miles south of Bayfield. It is 613' at base of a 15 foot bluff. Its edge next to the lake is 610'.

There is a large area below Nipissing level between Grand Bend and Port Frank. There are large truck garden in it. There is a strip of dunes next to the lake and the map shows a stream east of them paralleling the lake and only $\frac{1}{2}$ - $\frac{3}{4}$ mile from it. A "cut off" runs west from the AuSable about 3 miles north of the Grand Trunk R.R. It is 595 feet near the AuSable as given by the Hydro-Electric Power Co. It is large enough to carry the full flow of AuSable River at ordinary stage.

The Algonquin beach is present near Ravenswood 2-3 miles from Lake Huron. We saw it for a mile east of Ravenswood and traced it westward three miles along the highway. It crosses to south side of a stream about $\frac{1}{2}$ mile from the Lake Huron Shore and we did not trace it further.

We drove to Kittle Point to see the large lime concretions in the shale. The largest one about 4 feet in diameter. The coloring matter in them is said by Prof. Hobbs to be bitumen. These are about the largest concretions I have seen.

The shale here rises only 15-20 feet above Lake Huron level. There is a wide boulder strewn modern beach south from Kittle Point in places more than $\frac{1}{4}$ mile.

We went back to the Bluewater highway at Ravenswood and went south in it to Forest. We noted that the Warren (Forest) beach here is several feet higher than the depot, (711'). It is 718-720 feet.

We went south 4 miles from Forest and then west crossing the Warren beach at about 2 miles. We passed through Aberarder, and continued to the boarder of Lake Huron. The Algonquin beach here is about $\frac{1}{4}$ mile from Lake Huron.

On much of the way from here to Sarnia the present bluff is about up to Nipissing level. In places the Nipissing beach is on it within a few rods of the lake. We reached Sarnia at 5:20 P.M. and Port Huron at 5:40. We took supper at Mt. Clemens and reached Ann Arbor about 9 P.M.

North of Goderich on the Bluewater Highway there is a coating of pebbly sand a few feet thick. It is conspicuous for 2 or 3 miles north from Dunlop on ground about 700 feet A.T. It is likely to be a deposit of Lake Lundy but there does not seem to be a definite beach here.

Notes in profile of Pere Marquette R.R. east from Saginaw.

	<u>Ft. A.T.</u>
Hoyt at junction with Toledo Branch	610
Line secs. 28 & 29 T.12, R.5E.	611
Arnet Station near line secs. 34 & 35	611
Line secs. 35 & 36	613
Kulmbach	613
Gera near line secs. 2 & 3 T.11, R.6E	636
Line secs. 1 & 2	645
Line of Saginaw and Tuscola County	654
Beach ridge near line secs. 5 & 8 T.11, R.7E.	663
Line of secs. 8 & 9	663
Line secs. 9 & 10	665
Low ridge 1/4 mile east	666
Line secs. 10 & 11	672
Ridge 1/3 mile east	678
West base of ridge west of Vassar	678
Crest of ridge west of vassar	690
near overhead bridge of N-S road	
Cass River	650
	Bridge
	Water
Vassar at East street	613
Ridge near corner secs. 8,9,16 & 17	645
Sharp ridge 1/4 mile further east	672
Ridge 1/8 mile further east	681
Line of secs. 15 & 16	682
Ridge 1/3 mile east	683
Ridge near line of secs. 14 & 15	698
Line of secs. 13 & 14	688
Ridge 700-1000' east	709
Two ridges just west of Juniata	715
Juniata, at range line	737 & 740
Ridge 400' east	742.5
Ridge 1/2 mile east	752
Ridge near east end of line of secs. 19 & 30	758
Ridge 800' east of line of secs. 29 & 30	768
Line of secs. 28 & 29	786
Ridge east of line of secs. 27 & 28	786
Ridge 2000' east	824
Mayville	846
Silverwood	910
Plain west of Silverwood	810
Ridge 3/4 mile west of Clifford	802-803
Clifford	860
Ridge about 1 3/4 miles west of Marlette	829
Marlette	900
Stream in sec. 26, T.10, R.12E.	842
Ridge near east line sec. 26-- 35?	806
Brown City	850
Low ridge 1/2 mile east at line sec. 17 & 18	815
There is a plain east of Brown City to the end of the profile about	812
4 miles 800' at end. This is near Valley Center.	

A profile of the Michigan Central R.R. from Bay City south obtained from the State Geologist seems to have errors near Vassar, but is fairly reliable from Bay City to Denmark Jc, and from Vassar south to the county line.

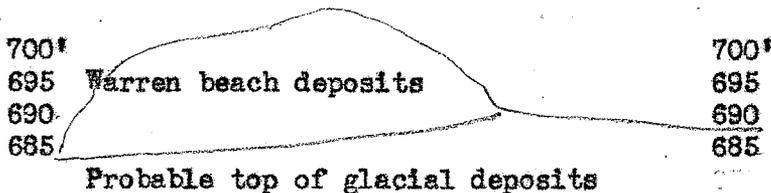
Bay City depot	592
<i>Munges</i>	595
Line of Tuscola & Saginaw Co. about	620
Reese at crossing of P.M.R.R.	629
Beach near line of secs. 17 & 18	642
Beach? 1/2 mile NW of Denmark Jc.	649
Denmark Jc.	649
There seems to be a lack of concordance SE from Denmark Jc. between the profile as drawn [^] makes Vassar at the SM crossing about 643 feet which seems to be correct.	
Ridge near line secs. 18 & 19 Vassar	660
Depressions near line secs. 19 & 20	655
Foot of steep grade in NW part sec. 29	658
Top of grade near line secs. 29 & 32	678
Depression in sec. 32	675
Ridge 1/4 mile S of Tp line (Vassar-Millington)	706
Top of steep grade in S part sec. 4 Millington	726
Foot of steep grade 1/2 mile N of Millington	732
Millington 1	757
Gentle rise for 1 1/4 miles to	770
Level for a mile in sec. 22 Millington	770
This is near NE corner of Flint quadrangle which gives the railway an altitude of about 770'. (see advance photolith map of Flint quadrangle).	

Notes on an M.C.R.R. profile from Bay City to Hunters Creek

Bay City west side station	592.49'
Bed of Saginaw River	557
Water surface Saginaw River	580
Ground at M.P. 107-108	586
Bay City depot. om.p 109m from Detroit	590.37
M.P. 1 by Park St.	595 ground 591
M.P. 2 near Pere Marquette (belt line)	597 " 596
M.C. belt line near 26th St. and M.P. 3	598.784 B.M.
M.P. 4 at Tp line Hampton	598 ground surface
Portsmouth	
Ridge 1100' S. of Tp line	601.5 " "
Ridge 2300' S. of Tp line	602 " "
MP 5 - near range line wood	599 " "
Ridge 2800-3000' S. of MP 5	603.5 " "
MP 6	595.5 " "
Low ground near MP 100-200' S.	594 " "
MP 7	594 " "

* (Insert) and the grade given to Cass River at Vassar.
The profile as drawn - - -

Munger at M.P.8 Track 595.5	595 ground surface
MP.9 and MP 10	591 " "
Arn Station Track 596.48	593.5 " "
MP 11 (1250' SE of Arn.)	595 " "
Ridge 1200' SE of MP 11 Track at	600 " "
Low ground 1700 SE " "	595.5 " "
MP 12	595.5
Ridge near MP 13 Track 607	608 " "
	Algonquin?
Two other ridges within 1/2 mile SE are	607-608
Creek bottom	602
Rapid rise SE of this creek to Elkton beach near Reese	
County line	612
1300-1600 beyond MP 14	626 ground surface
BM at Reese(2800' SE of MP 14)	626.565
Ridge 2000' SE of Reese depot	630 ground surface
This is only 100 feet wide and 3-4' high. It is 500' NW of MP 15	
MP15	627
Ridge near line of secs. 17 & 18 Denmark Tp)	639-640.5 ground surface
MP 16	639
Ridge near MP 17 SE part sec. 20	647
BM at Denmark Jc near MP18	648.222
MP 18	646.5 ground surface
Ridges near corner of secs. 27,28,33 & 34	654-658 " "
A swale between the ridges is	647.5
and one SE of them is	653
There is an abrupt rise to 658' SE of it.	
MP 19 about a mile SE of Denmark Jc	659
MP 20	668
Wayne? beach 900' NW of MP 21 at 675' relief 1-2'	
Base of ridge 550' NW of MP 21(Track 680)	675' ground surface
Change to steeper rise 300' east of MP 21	686
Top of steep rise 500' east of MP 21	695
Crest of Warren beach at 1300-1350'	701.5
Low ground east of Warren beach at 2000-2700	687-88
(see upper profile)	
Ridge east of there facing Cass R. valley	690-691



West

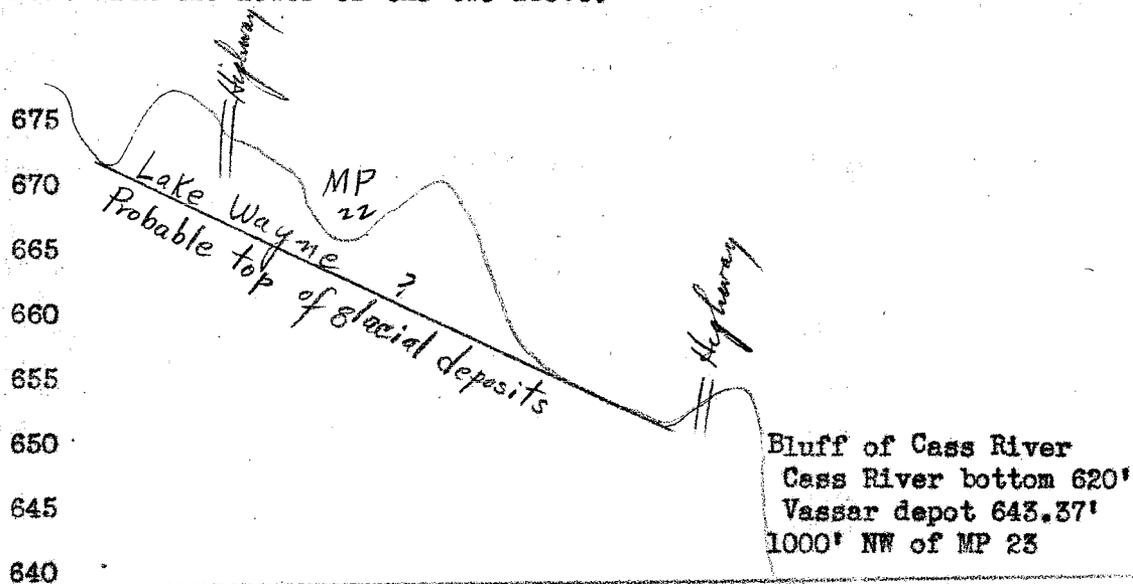
East

690	690
685	685
680	680
	675

West

East

Scale: Vertical 5' per square. Horizontal 100' per square.
 Profile across Warren beaches NW of Vassar on M.C.R.R. The lower one connects with the upper one at west end, and the one beneath connects on the west with the lower of the two above.



Profile across Port Huron moraine west of Vassar, and Warren beach deposits on it:

At Pere Marquette R.R. crossing in Vassar B.M	645.504
Track at " " " " near MP 23	646
Sand ridge near MP 24 (Track 659)	660
Dune 2000' SE of MP 24 (Land each side 657-58)	664
Creek valley near MP 25 (Track 658)	648
Land south of valley	662
Swale about 25.5 miles (Track 660')	652

Ridges S of MP 26 at 1000' and at 2200'	685 & 687 Track 680
Swale 1800-2000' N of MP 27	673
MP 27 (Ridge 1/2 mile S. of MP 27 710')	689
MP 28	718
Ridge 2200' S of MP 28 probably Arkona beach	732
MP 29 at road crossing in valley N edge of Millington	730 Ground
Millington depot	757
MP 30	769 Ground
MP 31 (Ridge near MP)	776
Ridge 900-1100' S of MP 31 (Track 777')	786
Track near NE corner of Flint quadrangle	776
(This is where the U.S.G.S. level makes it that elevation See notes, Oct. 14, 1933.) This is near MP 32	777.65
MP 33 is 810' in steep rise to south by E-W road	
Ridge crest 900' south of MP 34	870
Summit on RR 5000' S of MP 34	879.46
MP 35 in swale near N border of Otter Lake	855 Ground
Otter Lake BM near depot	865.321
Ridge 1/4 mile N of MP 37 (Track 884')	904 Ground
MP 39 at ridge of valley (Valley bottom 759)	775
Ridge at N bluff of Flint R.	788 Ground
Flint River bottoms	750
BM at Columbiaville depot	777.019
Ground at Carpenter Station near MP 43 1/2	804
Summit at MP 45 1 1/2 miles S of Carpenters	823.35
Ground 833' at ridge near MP 45	
Lapeer depot	821
Grand Trunk crossing in Lapeer	827.77
Hunters Creek (Ground near 906')	901
Ridge 1 mile S of Hunters Creek near end of profile	955

October 14, 1933

I went with Drs. Stanley and Seustins to Pine Run in Flint quadrangle where we met Prof. MacLachlin and two assistants from Detroit. We examined the gravel bars in east part of Sec. 14. The higher one is above 740' and the lower close to 740'. They have a rather sandy gravel. They seem likely to be the product of the First Lake Saginaw rather than the highest Arkona. The Arkona beach that runs past Ohio is between 720 and 725' in this vicinity. ~~A~~ lower Arkona in Sec. 31 Arbela Twp., Tuscola County is but little above 710 feet there and in Sec. 29 *Ohio*

The moraine in south part of section 29 and central part of section 20 and north part of section 21 has considerable dune sand in its crest but there is till in it up to 750 feet or more. The till is uneven in height. We do not find it capped with gravel or with any features that indicates a shore of Lake Saginaw. Lake Arkona washed its north slope up to about 730 feet.

There are dunes outside this moraine that catch the 750 and 760 contours. There is some sand on the *flat areas* here, but till and boulders are rather well exposed in the surface coat slight depth under sand. It seems probable that Lake Saginaw water of shallow depth caused a narrow strip south of the Moraine up to 750 feet contours.

We drove east along a road 2 miles north of the county line making short runs north to the crest of the moraine in line of sections 23 and 24, Arbela ~~and~~ on the range line between Arbela and Millington Twps., we found a slight deposit of pebbly sand in the moraine just north of corner of sections 13 and 24, 18 and 19 at what is made 740 feet on *Den's*, Tuscola map. North of this less than 1/4 mile is a strong gravel beach with pits in it that we ~~refer~~ as the Arkona. It appears to be about 15 feet lower than the crest of the moraine. Perhaps MacLachlan will run levels to it from a B.M. at north side of Flint quadrangle.

We traced this gravel beach across the NW part of section 18 and through south part of section 7 Millington to a valley. It then doubles back and runs SE into NE part of section 18. We then ran into Millington for dinner.

We drove south from Millington 2 miles and east 1 1/2 miles to the M.C.R.R. to get its level as based on the U.S.G.S. levels near there. We find the track to be 7 feet above a 770 U.S.G.S. level or 777 feet A.T. The M.C. profile shows an "0" grade for about a mile north from here. Descent then begins into Millington.

There are morainic ridges in sections 22 and 23 Millington which rise to 800'+ but sections 15 and 16 seem to be very little above Millington village and has a gently undulating till. The moraine is prominent in SE part of section 10 and SW of section 11. There is a recess in it in east part of section 11 and west of section 12 - with a gently undulating till in it. The moraine is again prominent in ~~east~~ part of section 12 and runs NE from there on east side of Murphy's Lake. There are dunes in section 10 and south part of section 3 Millington with a SW terminus near middle of line of sections 9 and 10. The land is sandy NW from this dune strip and the sandy land runs east to Murphy's Lake.

The Arkona beach passes about a mile north of Millington and is somewhat gravelly in sections 3 and 4 Millington. We did not trace it far but drove north past west side of Murphy's Lake to the P.M.R.R. through a sandy country in which dunes are present and tracing of a shore line difficult. We examined the cuts in the P.M. railway as far east as one at 786' about 1/2 mile east of Juniata and found sand except close by Juniata where there is gravel at about 740 feet. There is a large excavation in it north of the village. It has a slight sandy cover. We refer that this is the Arkona beach. We examined all the cuts from Juniata west to Vassar and found no gravel in them. The ridges are dunes.

The Warren beach does not seem to be traceable in the district south of Cass River. It is finely developed on the crest of the Port Huron moraine

as noted on a previous trip with MacLachlin. We find today that the moraine rises about it near the center of section 1 Tuscola Twp. Levels will be run to this place to determine whether the beach gets higher in its course on the crest of the moraine from the P.M.R.R. northward. This will also give a check on the Michigan Central profile. We mapped the Warren beach continuously from Vassar northeast to where it is crossed by the Michigan Central north of Caro. It there is 721 feet. The undulations south from there near Atwood station which are 720-726 feet A.T., and which I suspected to be beaches from a study of the profile, do not seem to be such but are instead undulations in a till plain. They do not line up like a shore line should.

We ran into Caro for the night. Stanley and Seustins left us at Vassar and returned to Ann Arbor.

October 15, 1933 - Caro, Michigan

We find the change from a plain to this moraine in Caro at 715 feet just west of the depot of M.C.R.R. is likely to be the Warren shore but there is only a narrow terrace 200' wide to make it and no gravel or sand deposit.

We drove north on line of sections 34 and 35 Almer Twp. and crossed the crest of the Port Huron moraine 1/8 mile north of corner of sections 26, 27, 34 and 35, and came to foot of steep *inner* slope near corner of sections 22, 23, 25 and 27. There is undulating till for a mile further. The Warren beach comes to the line of sections 10 and 11 where the road turns NW from this line. A creek valley interrupts it here. The beach sets in on east side opposite here and runs NE about on Davis 710 contour, but it probably is more than 720' here. It crosses the SE corner of section 2 and runs east to a creek valley in section 1. Almer Twp.; east of this creek there are two ridges of nearly the same elevation. The outer (southern) one crosses the range line 1/2 mile south of the Twp. corner of Columbia, Elmwood, Almer and Ellington, and the runs are 1/4 mile south from it.

On the line of section 31 Elmwood and section 6 Ellington we crossed three of the ridges of Warren beach. We also crossed three on line of sections 31 and 32. The outer one runs to center of section 32 to base of Port Huron moraine. Two others run NE into section 29, one being west of the quarter past and the other east. They run to a creek valley on east part of section 29. We traced the beach in a former trip from this valley ENE across north part of section 28 and SE corner of section 21 into section 22 Elmwood Twp. The moraine sets in 1/2 mile south of there and a swale follows its base eastward in sections 28 and 27 with no definite beach south of it. In sections 22 and 23 there is a wave washed slope up to the level of the Warren beach and this was traced on our former trip from here into Huron County.

We next drove west into Columbia Twp., and came to a weak ridge of sandy gravel in SW part of section 25 that runs SW about to center of section 35. It seems to be a continuation of a ridge crossed by the railway 1/2 mile north of Patterson that is 665'. This may be the Grassmere beach, but it is a very weak feature, and we are unable to continue it further west.

The slight ridge 1/2 mile south of Patterson at 676' does not line up as a shore feature but is an isolated *swale*.

We drove to Colling and ran levels from this station west to Columbia. The station is 653. There is a faint ridge about 1/8 mile west of it that is 4 feet higher or 657'. It seems to run NNE about to the railway 1/4 mile north of Colling.

We find that the beach at Columbia is 654' and not 668 as estimated by Davis. So it seems to be the Elkton beach. There are interrupted gravelly ridges in a string running NE from Columbia to Atke. The elevation is 653' at Atke. This is a pebbly sand and it is only 3 or 4 feet above boarder tracts. There is a winding sand ridge 1/4 mile east of Atke but no gravel in it. We saw no indications of a shore line further east. The surface has such gentle slopes here less than 5 feet in a mile that one can hardly expect shore features to be well defined.

The beach running past Columbia was traced in a former trip to a creek valley in section 31. It seems to be no higher than at Columbia. We used hand level on it looking south from Columbia and found scarcely 2 feet rise above the road intersection there. So it is not more than 656 feet though Davis Map makes it rise above 670 feet.

We next gave attention to beaches east of Akron. There is one in Akron *about* 3 feet higher than the depot ~~at~~ 650' A.T. This seems to be an Elkton beach. So also is one 1/4 mile *crossed* west of Akron that we traced to Woodman in our former trip. It there ~~crossed~~ *crossed* around to the SE to a creek valley. It seems to find continuation in the beach in section 31 that runs NE across sections 32 and 29 to Columbia. We find it is 644 feet near center of section 34 Fairgrove Twp. The beach that is 650 feet at Akron may find continuation in a beach that runs N NE through the east part of section 35 and across NW corner of section 36 into section 25. MacLachlan ran levels east 1 3/4 miles from Akron to a beach that crosses the town line of Akron and Fairgrove about 80-100 rods east from corner of sections 35 and 36, Akron and sections 1 and 2 Fairgrove Twp. He finds it to be about 664 feet A.T. So it probably is the Grassmere beach. We traced this beach in our previous trip from the SW part of section 31 Columbia to the NW part of section 15 Fairgrove Tp. across sections 1, 2, 11 and 10 Fairgrove and section 36 Akron Twp.

A beach in Fairgrove village appears to be its continuation for it is 6 feet higher than the depot or 664 feet A.T. We ran levels from Fairgrove village to the beach SW of there near the corner of sections 19, 20, 29 and 30, Fairgrove Twp. and found it to be 664 feet. This runs south through the east part of section 30 at about this elevation. Davis' Tuscola county map is in error here in giving it an altitude of about 680 feet. This beach seems to set in SW of a creek in the SE part of section 36, Gilford Twp. and about 1/4 mile west of corner of sections 36 Gilford, section 31, Fairgrove, section 6, Juniata and section 1 Denmark Twp., it passes into section 1 Denmark Twp. It appears as a rather faint ridge for 2 miles south southwest to NE part of section 14 Denmark Twp. It is discontinuous and we are not able to trace it further today. For much of the way it is near Davis's 660' contour in sections 1, 12 and 13, Denmark Twp.

We went back through Vassar to Millington. Sandy ridges are crossed from south part of section 19 Vassar Twp., southward into Millington. The country in west part of Millington is on one. We did not find the Arkona beach a well defined feature near Millington. But it is well developed in sections 7 and 18, Millington, as noted yesterday. There is also some gravelly material a mile north of Millington that seems likely to be Arkona. It runs NE across section 4 and the NW part of section 3 into section 34 Vassar Twp.

We turned south 1 1/2 miles west of Millington on line of sections 17 and 18 Millington in what is called "Irish Road" and followed it for 15 miles, to the corner of sections 29, 30, 31 and 32, Richfield Twp., Genessee County. We then went westward on "Richfield Road" to the Dart Highway, then south on it to "Bristol Road" at corner of sections 28, 29, 32 and 33 Burton then west two miles to Highway 23 and south on it to Ann Arbor with a stop for supper at Brighton.

Prof. MacLachlan went to Vassar October 29 and found the Warren beach to be 701-702' at south end of the land laid part of Port Huron moraine in section 1, Tuscola Twp., or the same as the crest of the beach where crossed by the Mich. Central R.R. (see p26 below for profiles along the railroad)

He found conspicuous gravel deposits south of the Port Huron moraine about a mile west of Wahjamega but there may be an outwash *apron* rather than a beach. He found what seems to be gravelly beach material at the west end of the hilly tract in section 3 Fremont Twp. This hilly strip in sections 1, 2 and 3 has sand on its high part and he saw no gravel there. This was classed by Taylor as a strip of Kames.

MacLachlan found no gravel along south side of the plain south of Cass River further east than section 3. Sand is a continuous coating. He found what seems to be a faint Grassmere beach in NE part of Denmark Twp. in sections 1 and 12.

Ridges crossed by the M.C.R.R. near corner of sections 27, 28, 33 and 34, Denmark, with elevation 654 and 658 are probably Grassmere.

Frank Leverett Notes - Note Book No. 298

Pages 32 to 33.

A study of topographic maps on the border of Lake Erie in NW. Pennsylvania shows need of some corrections in altitude of beaches given in Monographs 41 and 53 U.S.G.S.

The Maumee beach near its terminus in vicinity of Girard catches the 780 contour, instead of being 770'. The Whittlesey beach altitudes are correct for the part in the Girard quadrangle being 746 at the Ohio line 748 near E. Springfield, and 752 4 miles farther east. It seems to reach 760 in east part of the Fairview map, and 765' at Swanville in the Erie quadrangle. It appears to reach 780 feet near the east side of the Erie map, south of Wesleyville. This is only 2 1/2 - 3 miles east of Erie where *Mon.* 41, makes the altitude 772 feet. The altitude is 788 near northeast and 787 at the New York line.

The Warren beach has two members at the Ohio - Penn line, the higher one nearly 700 feet and the lowr about 680 feet. A bar outside the upper Warren that is crossed by the Nickel Plate R.R. east of Raccoon Creek catches the 720 contour, but the beach aside from this is below 720 feet in the Girard quadrangle. It seems also to be near 700 feet in its course across the Fairview quadrangle, being in places below 700 feet. But in the west part of the Erie quadrangle it catches 720' for about a mile. This is west of the Presque Isle spit. That spit indicates strong currents drawn by SW winds. Perhaps these winds piled up the beach of Lake Warren at the much earlier time when it occupied the Erie Basin. Yet at that time the ice sheet still occupied the Ontario basin, and one would hardly expect strong winds to be blowing toward the ice sheet from so near a place. The higher Warren is up to 720' near the east side of the Erie quadrangle. It seems to reach about 729 feet near Harbor Creek in west part of the northeast quadrangle. There is a cut bank east of Twelve Mile Gulf instead of a gravel bar. The Warren shore is cut away by the present lake for 2 miles or *more* in the part between Twelve Mile and Sixteen Mile Gulf, and the bluff of Lake Erie reaches 747 feet at one place. The beach is present east from Sixteen Mile Gulf and reaches 740 feet near the Pa-N.Y. line. It is 735' at Jones School over the east bluff of Sixteen Mile Gulf.

The lower Warren seems to be above 700 in the northeast quadrangle.

Taylor has labeled the Upper Warren "Arkona" in the profile forming Plate XVIII in Mon. 53. The profile seems to be incorrect in carrying it up to 740 feet at Erie. It really is scarcely 720' there. He runs it to 720 on the meridian of Girard but it seems to be but little above 700' there.

7

The Whittlesey beach seems to be shown correctly in PC XVIII. The lowest Maumee is also ^{made} near to reach 780' near its eastern terminus near Girard, which seems to be correct.

Lake Warren in Iosco Co., Mich.

In the Annual Report for 1901 Michigan Geol. Survey, p 48. I discuss the AuSable delta of Lake Warren. The plain there given as 630 feet by barometer was found later to be 815 feet by railway profile. It seems to be at the level of Lake Warren or perhaps slightly above it. This profile makes the Algonquin shore 635' at base of "Seven Mile Hill". The top of the bluff there is 712 feet. There is a terrace back of it. Is this a Lake Lundy terrace? ~~Lake Vassar in Iosco County, Michigan~~

Frank Leverett Notes - Note Book No. 298

Pages 44 to 66.

May 12, 1934, Ann Arbor, Michigan

I made a trip by auto with George Stanley of the geology department of the University ~~with~~ Sanilac County preparatory to conducting a field trip of the geology section of the Michigan Academy of Sciences on May 26-27 to see the Glacial and glacial lake features on the thumb of Michigan including the Ugly and Inlay outlets.

We drove on Plymouth Road to Southfield Avenue then north into Oakland County to ~~Elm~~ Michigan Road and east from there through Royal Oak to Gratiot Avenue near the north edge of the Detroit and Grosse Pointe quadrangles. We noted the fine preservation of the Wayne beaches at Royal Oak.

Turning north on Gratiot Avenue at 7.5 miles south of Mt. Clemens, we came to where large excavations of sand and gravel have been made in section 34 Clinton Twp. ($3\frac{1}{2}$ miles south of Mt. Clemens) about 1/4 mile east of Gratiot Avenue on ground above the 600' contour and just west of the highest St. Clair beach. There are several pits two of which are now in operation. There seems to be a continuous sheet of this sand and gravel over an area of 200 acres or more in a strip over a mile long north to south. It is covered to some extent by a stiff lake clay that seems to be *laminated* in places. This is in one pit not less than 5 feet thick. It is outside the limits of the highest Lake St. Clair and therefore is older. There are some boulders in the clay. The sand predominates as gravel is found only in pockets and thin beds and changes abruptly horizontally to sand. The beds show steep dips in places. The deposit seems to be glacial or aque-glacial rather than a lake feature, but we are not able to clear up the way in which it was laid down.

We left Gratiot Avenue at Muttonville about a mile SE of Lenox and went through Lenox to the Whittlesey beach at Richmond. We were along this beach all the way from Richmond to Memphis. From Memphis the beach runs NE into section 30 Wales Twp., St. Clair County. Its course is then northward for about 10 miles to Mill Creek valley in section 7 Kenocock Twp., and then northeastward to Spring Hill at corner of sections 1 and 2 Kenocock and sections 35 to 36 Greenwood Twp., which as noted by Taylor in Monograph 53 U.S.G.S. stands at the entrance to Black River Bay of Lake Whittlesey.

A-

We went from Memphis to Yale through a district just outside Lake Whittlesey. It is a gently undulating till tract as far as the Mill Creek, but has stronger undulation on north or east side of Mill Creek. This is what Taylor classed as the Yale moraine. We went east on a road a mile south of the Sanilac - St. Clair County line and found morainic features of rather pronounced type for four miles or about to the corner of sections 4, 5, 8 and 9 Greenwood Twp., east from there the surface is nearly as flat as a lake bottom but it has a few low swells 5' or so high and seems to be above Lake Whittlesey level clear to the line of Greenwood and Grant Twps. There is a rather weak shore line curving around from a NE to a NW course in NW part of section 12 and SW of section 1, Grant Twp., which seems likely to be the Whittlesey beach.

We did not find the Arkona beaches so definitely preserved in sections 6 and 7 Grant Twp. at Taylor's description in Mon. 53 P.366-367. It seems as vague as in the washed down places further south. We found this to be the case northward from sections 6 and 7 Grant Twp., *to the No. edge of sec. 30, Worth Tp.* in Sanilac County or for over 3 miles. We also were unable to find any Arkona in the eastside of Black River in section 5, Grant Twp., St. Clair County.

We found, however, on our return trip that the Arkona beach is well preserved on west side of Black River south from here in sections 18, 19 and 30 Grant Twp., and in places two distinct branches occur there.

In the bluffs of Black River we were interested in noting a blue till well exposed which seems as indurated as the Illinoian. We noted it in sections 6, 7 and 8 Grant Twp. and in sections 17 and 18, and also on the county line.

There is considerable oxidized till above it and from gravel and sand.

We followed the Arkona shore northward from section 30, Worth Twp., for seven miles or $1\frac{1}{2}$ miles beyond Groswell. It seems to be what Taylor terms the Second Arkona, but in section 19 Worth it runs a half mile east of the township line instead of a mile east of it. It runs NE to corner of sections 7, 8, 17 and 18 and from there north past Groswell is about as Taylor indicated (a mile east of the town line). This beach runs to the bluff of Black River in section 19, Lexington Twp. West of it is another beach, which Taylor calls the First Arkona (p.367) and it runs as he indicates from section 19 across section 18 and it is continued into section 7, Lexington.

We do not find a definite beach around a small island in section 7. There is a low swell at what Taylor terms an "island", but no definite shore ^{leveling} to it and it does not seem to be clearly a lake feature. The Arkona seems to be very indefinite in sections 6 and 7 Lexington. The outwash plain noted by Taylor as covering it near Applegate seems to be entirely east of Black River.

We found the Whittlesey beach a strong feature in NE part of section 12 and in section 1 Buel Twp. As this is scarcely 2 miles west from the Port Huron moraine, ^{we} we are surprised that it has such strength. Taylor noted its strength here (section p.379, Mon.53). It is on a small till ridge, one of several that stood in the Black River Bay of Lake Whittlesey.

We crossed Black River at Applegate and drove south to Croswell through a sandy plain that lies west of the Port Huron moraine. The moraine border is back about a mile from Black River. But south from Croswell the moraine is nearer the river, and in places has been cut into by the stream.

We went east from Croswell across the Port Huron moraine which has its inner border in sections 26 and 35 Lexington Twp. It seems to be further east here than it is to the north or the south.

We turned south at corner of sections 25, 26, 35 and 36, Lexington. The border of Lake Warren is less than a mile west of this road for 4 miles south. It runs to the corner of sections 22, 23, 26 and 27 Worth Twp., and crosses into St. Clair Co. near west end of line of section 2, Grant Twp. We traced it to Blaine.

We there turned west and crossed Black River. We found a strong Arkona beach and a parallel ^{weaker} washer one east of it in sections 18, 19 and 30 Grant Twp. But there is not a strong beach further south.

We went to Spring Hill, but did not find it exhibiting such a succession of loops as Taylor pictures (see p.378). It is "bulb-like" but the beaches are so closely set as to appear as a single ridge. It stands 10-15 feet above ^{bordering} leveling plain.

From Spring Hill we drove to Ruby to see where Black River entered Lake Warren. There is a broad sandy plain here.

To the south in sections 19, 30 and 31 Clyde Twp. there is a strong beach of sandy character. Another about a mile west of it in sections 25 and 36 Keeweeke ^{Nec} Twp. is called "Upper Warren" on my field map. It runs near Goodell's where the railway is 707 (by my field map). This may be a little higher than the beach. The strong shore east of it may be near 700 feet.

We followed the Warren beach southward about to section 27 Wales Twp., and found it a sandy ridge all the way.

We turned west in section 26 Wales. We came to what seems likely to be the Arkona in section 28. It is a definite shore here.

We came to the Whittlesey beach in east part of section 30 Wales, and the road follows it SW from there to Memphis. It is very strong in this part. From Memphis we returned past Mt. Clemens to Eight Mile Road and then west.

May 26, 1934.

The Geology section of the Michigan Academy of Sciences made a field trip under my direction to points of interest on the Thumb of Michigan.

We got together at Mt. Clemens with representatives from Grand Rapids, Mt. Pleasant, Lansing, Saginaw, Detroit and Dearborn and Ann Arbor. Also four persons came from Ohio, Prof. Corman, Prof. Conrey, and another man and a lady. There were about 50 in the party, travelling by auto in at least a dozen machines, so when stops were made it took a few minutes to get unloaded and close enough together to hear the explanations. But we managed to get through to Caro for the night reaching there at 7:30 p.m.

Before lunch at Mt. Clemens nearly all had examined the sand and gravel pits south of Mt. Clemens that I described in my May 12 notes. But no one seemed able to explain the origin of this deposit. It is more extensive than I had thought and has been opened over a distance of fully a mile N-S in a strip parallel to Gratiot Avenue and within 1/4 mile east off it. There is some clayey till as well as some lake clay above it which contains a few boulders, some of which are striated.

In Mt. Clemens *trenches* in Gratiot Avenue are now open that are on a blue clay within 5 feet of surface. This has a few small stones in it, so may be glacial rather than a lake deposit. It is above or west of the shore of the highest St. Clair.

We left Mt. Clemens about 12:30 noon and took the route along the Whittlesey beach from Richmond past Memphis. Thence east past the Arkona and Warren beach and north to Goodells and then to Spring Hill. We passed sand ridges east of Goodells that may be drifted by wind action to positions outside are not consistent (?) or with the Warren shore. They are conspicuous both north and south of Cowby Creek in section 1 and section 11 Wales Township.

coincident (?)

We next went to the Arkona beaches in sections 18 and 19 Grant Twp., and traced one to the bluff of Black River near north end of line of sections 17 and 18. It is then scarcely 1/4 mile west of the edge of the Port Huron moraine, and is very strong. There is another strong ridge west of it that runs N-S through sections 18, 19 and 30 as noted May 12.

We then crossed Black River in section 17 and went to see the fragment of a beach preserved on the east side of Black River near middle of west side of section 8 Grant Twp., which Taylor describes in Mon. 53 p. 368. At this place the moraine slopes down almost to the beach. There is a gravel pit in the beach which reveals its true beach features. Taylor wrote a letter which I read at this place in which he suggests that this unique feature is worth of preservation as a State or National monument.

We returned to the west side of Black River on the line of St. Clair and Sanilac counties, noting the exposures of Blue till that we suspect to be largely Illinoian, but did not stop to examine the till.

We went north to Croswell on a road close to west bluff of Black River and noted the finely preserved Arkona beaches from section 30 Worth Twp. to Croswell.

We crossed to the east side of Black River at Croswell and went north to Applegate through the sandy plain that lies between Black River and the Port Huron moraine.

From Applegate we went east to the Lake Huron shore passing the Warren shore about 2 miles from the Huron shore. The change in topography is a striking feature, but we did not note a definite gravel bar here.

We then drove north 12 miles along the shore. The Algonquin beach is a conspicuous feature much of the way from Port Sanilac to ~~Forester~~ ^{Forester}. It has a ^{generally} gravelly cut bank about 10 feet high.

At Big Creek 2 miles north of ~~Forester~~ ^{Pres} we examined the Chichy and buried peat that Miss West is making use of in her thesis for Ph.D. degree. The age of the clay that overlies the peat seems likely to be about 10,000 years. It was laid down when the Kirkfield outlet was raised so as to cause lake Algonquin to rise to a height sufficient to discharge past Port Huron. The estimate is based on the following:

Time since the North Bay outlet was raised so as to stop discharge of Nipissing waters in that direction estimated as	4000	years
Time the North Bay outlet was operating	2500	"
Time the Algonquin waters were discharging past Port Huron	<u>4000</u>	"
Total	10500	years

Taylor is inclined to make this part of the Algonquin less than 4000 years, but as the discharge was divided between Chicago and Port Huron it seems likely to have taken more time than he allowed ~~of his~~ ⁱⁿ neighborhood of 4000 years. We continued north past Richmondville to the exposures of which Taylor has pictures in Mon. 53 Pl. XII but there has been so much slumping at the place we visited that the till is not exposed. We may not have been to the exact place covered by his photographs.

I had planned to run west on the road a mile south of the Huron and Sanilac County line in which Lloyd Hornby ran levels for me in 1912 - but this is a nearly abandoned road now, on which we would not make the speed needed to complete our schedule. So we went north into Huron County and took an improved road that runs west past Ruth and Ubley.

This gave us a view of the swamp east of Ubley in which a branch of the Cass River heads. There is a range of morainic knolls just east of Ubley around the north end of which this swampy tract passes, as shown on the map by Lane in his Huron County Report.

We did not take roads along the Ubley outlet but ran west across the Port Huron moraine, then south into the outlet 3 miles east of Cass City. Then west to Cass City where the delta is displayed nicely that was formed where the outlet opened into the lake in the Saginaw basin ("Second Lake Saginaw")

We continued west and SW along the main highway to Caro where we spent the night at the Montague Hotel.

May 27, 1934, Caro, Michigan

We went through Wa^hjameja and found the gravel there on south side of the Port Huron moraine is too extensive to be a shore feature. It seems instead to be outwash from the Port Huron moraine. It extends 1/2 mile or more south from the base of the moraine with a slope in that direction. It is present for a couple of miles near Wa^hjameja. The gravel plain has extensions north in the recesses in the moraine.

We crossed the Port Huron moraine on E-W road through Watsonsville and then took a road south on line of Denmark and Juniata Twps. crossing the moraine near south end of the township line. The Warren beach is conspicuous on its west slope in sections 25 and 36 Denmark Twp., and section 1 Tuscola Twp. It reaches and follows the crest of the moraine in sections 1 and 12 Tuscola Twp. into the village of Vassar. (see profile across it on p.26 of this notebook.)

We examined the beach at a pit in west part of Vassar on north side of the highway that runs to Saginaw.

We then drove along the bar that runs SW and which hooks back to the NW in section 22 Tuscola. We then went north on the line of sections 22 and 23 to another bar which sets in on the west part of section 14 and runs westward about 2 miles and hooks around to the SE in the north part of section 21 Tuscola. I had not seen the western end before. I noted a forked bar south of its west end in the central part of section 21 in trip with MacLachlan on September 1933. (note book 297 p.100-101).

We drove south from Tuscola to corner of sections 28, 29, 32 and 33, Arbela Twp. crossing the slender moraine that runs W. SW from Millington to section 29 Arbela Twp. The Arkona beach is in its north slopes as far as this section. The moraine then gets down to the level of the beach and has the beach on its crest. (see the Flint topographic map.)

We followed the Arkona beach SW about 3 miles to the Detroit Saginaw Highway a mile NE of Clio. We then went SE on this highway crossing the Saginaw ~~h~~ bars and highest shore near Pine Run. The outer one is in section 24 and runs from the SW corner northeast to the center of the section. We continued SE on this highway to the line of sections 5 and 6* across the Flint moraine then south on east side of the moraine to the plain covered by Lake Kears~~ley~~. That lake reached about to 770-or 780 contour. Flint River is in a valley that trenches the bed of Lake Kears~~ley~~ and dates from a time when the ice which stood at the Flint moraine and held Lake Kears~~ley~~ had melted away some distance

* (Insert) Genesee Tp. We went east on line of secs. 5+8---

to the NW. This allowed the Imlay outlet to be shifted from a course westward past Durand into the Grand River outlet to one down the present course of Flint River to Flushing. It there formed a delta of sandy gravel in Lake Saginaw and later cut it into shreds as shown in the part of the Burt quadrangle directly east and north of Flushing.

We went to Flint River near the corner of sections 20, 21, 28 and 29 Genessee Twp., to see the trenching in the bed of Lake Kearsley.

We then went west across the Flint moraine and a till plain west of it to the delta near Flushing.

We then followed Flint River from Flushing to Flint in the course (reverse?) of the drainage into Lake Saginaw in the late stage of Imlay outlet.

We got dinner at Flint and several of the members left us there. But about 9 auto loads continued in the afternoon up the Imlay outlet to North Branch. The outlet is larger than I had anticipated from the description by Taylor. I had never followed it through before. We made a stop at the gravelly area west of Richfield center in sections 17 and 20 Richfield. This gravel may be a delta deposit at head of Lake Kearsley, as it is near the level of that lake and also at its eastern limit.

We went north from Richfield center across the Imlay outlet, and then east in the roads nearest the outlet and mainly on it. We crossed Flint River on line of sections 5 and 8 Oregon Twp., 2 miles below Columbiaville. Then went north to Columbiaville through a sandy plain. We then crossed to north side of Flint River and zigzagged on that side as far NE as line of sections 8 and 17 Deerfield Twp. We crossed then to the south side and drove east through an outwash plain of sandy gravel to the line of Deerfield and North Branch Twps. It covers much if not all of sections 9, 10, 11, 12, 13, 14, 15, 16 and 17 Deerfield. North of it is a moraine with small boulder strewn knolls that fills in the area between the outwash plain and Flint River below North Branch. The outwash plain is not shown on the map in Mon. 53 nor in my map of the Southern Peninsula. It seems to be nearly as low as the Imlay outlet. There is a large area of low plain bordering Flint River in Rich Twp. extending north into the edge of Tuscola County which is likely to have been a lake, ^{like} expansion similar to Lake Kearsley. Its extent is shown in the two maps just noted. We went east from North Branch through sections 4, 3, 2, and 1 North Branch Twp. on a ^{gently} undulating low ridge. South of this is a swampy channel of discharge for a glacial lake in Sanilac County that antedated Lake Arkona as well as Whittlesey and may perhaps be

* (Insert) which we suspect served as a line

called an extension of Lake Maumee that followed the recession of the ice sheet from that district. There is a very distinct channel across the divide between Cass River and Flint River in sections 3 and 4 Burnside Twp., which we examined. It is fully 1/3 mile wide and has definite banks in its borders. This channel is mentioned by Taylor in his description of the Mayville moraine in Mon. 53 p. 264, but he says nothing as to its origin. In Gordon's map of Sanilac County in Vol. VII, Michigan Geological Survey a sand ridge is shown in east part of sections 2, 11 and 14 T. 10N., R. 12E. in Sanilac County and given an altitude 790 feet. This may not be a reliable height for the Cass River crossing of Pere Marquette R.R. in section 26 of that township is 806; and this ridge may be still higher. It is at least suggestive of a shore line and one that may open westward into the channel that runs across the divide between Cass River and Flint River north of Burnside.

There is a swampy tract up Cass River as far as sections 10 and 11 Burnside Twp. on west side of the Deanville moraine which opens into the one that we are discussing in section 34, T. 10., R. 12E. It seems to me highly probable that the Mayville and Deanville moraines are close correlatives. This being the case the channel may have been the line of westward discharge from the ice. But the gap at Cass River between the Mayville and Deanville moraines in section 24 as well as the sand ridge to the north suggest a lake outlet following the glacial drainage through the channel.

If allowance is made for the differential uplift it seems probable that this channel would have been lower than those further south on Mill Creek and Belle River that are connected with the Imlay outlet.

We made a circuit NE of Burnside as far NE as the corner of sections 1 and 2, 35 and 36, Tps. 9 and 10 N., R. 12E. from which point we went south two miles on the Deanville moraine and from there west to Burnside.

From Burnside we drove south past Imlay, Almont, Romeo and Washington. We had the shore of Lake Maumee in view much of the way from Imlay south. We went west into Rochester, then south 3 miles and west 4 miles, and south from there to Birmingham and south from Birmingham on Southfield Avenue to Plymouth Road and back to Ann Arbor. Those from Ohio and from Lansing kept with us as far as Birmingham. The Grand Rapids men left us at Imlay. The weather was ideal, clear and cool, the roads in fine condition. All the participants seemed interested in the features. It was on the whole the most enjoyable field trip I have taken with the geology section.

June 15, 1934

I made a trip with George Stanley to the district north of Lake St. Clair. We left Gratiot Avenue at Milton and took the road east on line of sections 9 and 16, T.3N., R.14E. We found the highest St. Clair beach well defined as far east as a small stream in the SW part of section 10 of this township, as a low cut bank, with some sand in the soil of the plain south of it. The top of the bank is about at the 600 contour at the line of sections 9 and 10. There is no detectible bank east from this stream and the soil is a stiff clay nearly to Salt River, but a strip on the west side of Salt River has sandy spots that are above 595 contour. They stand 1-2 feet above lower tracts among them that are less sandy. The southward extension of the 595 contour on west side of Salt River is perhaps a feature of the highest St. Clair shore, but there seems to be a more definite shore east of Salt River at the west base of the Emmett moraine at about 600 feet. A sandy strip runs south through the SE part of section 14 into section 23 which seems to be the product of Lake St. Clair at its highest level. In places it catches the 600' contour and it is above 595 feet as far south as the north part of section 23.

The highest St. Clair shore follows the east base of the Emmett moraine in the NW part of section 13 and west part of section 12 at about 600 feet. But we are unable to trace it eastward into St. Clair County. The surface is very flat as in the district west of Salt River in the NW part of T.3N., R.15E.

On the Emmett moraine in sections 1 and 12, T.3N., R.14E., there is a sandy coating in which cobblestones and boulders are imbedded. There is also a gravelly deposit in which a pit has been opened on the west side of the N-S road in section 1 where the 620' contour has a westward protrusion just north of the E-W quarter line road. The gravel is only 3-4 feet where thickest. It has an earthy admixture, and the pebbles are not much rounded. So it seems to be a rather short-lived shore. We consider it an Elkton beach, and the sand on the crest of the moraine for a mile or more south from here is likely also to be the product of Lake Lundy at the Elkton stage. It is about 620 feet. We did not attempt to trace the Elkton beach into T.4N., but went east on line of Tps. 3 and 4N. into St. Clair County.

On finding that the surface there is too flat to show the limits of the highest St. Clair shore, we turned south and ran to the present shore of Lake St. Clair at Ancherville. There are sandy ridges east

of a creek in sections 7 and 8. They wind about and are evidently wind deposits. The altitude is less than 20 feet above Lake St. Clair, so they are not up to the highest level of Lake St. Clair.

The bank at Anchorville is about 8 feet above Lake St. Clair, and there is a rise to about 12 feet above lake level or 586 feet A.T., a few rods back from the lake.

The sand ridges are probably about 590 feet when strongest.

We took the highway east on the border of Lake St. Clair and found the bank becoming very low before we reached Fair Haven, but the land is dry enough to cultivate as far as the place where the road turns south in section 24, T.3N., R.15E. There is a marsh in sections 25 and 36, but on turning east dry cultivated land is entered at Pearl Beach where the highway comes to the north distributory of St. Clair River about 3 miles west of Algonac. The land, however, stands only 4-6 feet above Lake St. Clair.

We got dinner at the Maples Hotel Tea Room. We then drove north to examine the features shown in Fig. 10, p. 474 of Monograph 53, U.S.G.S. A low ridge sets in SW of Roberts Landing as shown in Fig. 10, but it is not an esker. Instead we find that it ^{carries} covers a thin coating of fine gravel over a clay or clayey till. The pebbles are small, usually 1/2 inch or less in diameter. This is evidently a deposit made by St. Clair River when it was flowing at a level as high as this deposit. We crossed this ridge on a paved road running WNW from near Cherry Beach. Its crest is 17 feet above the low plain east of it. This plain is probably about 580'. The width of the ridge here is over a half mile, and the low plains each side are about 4/10 - 5/10 mile wide. The whole series occupies about 1 1/2 miles from the west bank of St. Clair River. It has this width at Marine City. The gravel deposit covers only a small part of the ridge, and when present accentuates the relief of the ridge. The clay part of the ridge is only 10-12 feet above the low plains each side and these are probably less than 10 feet above St. Clair River as far north as Marine City. The height of the gravel deposit is about 605'. It drops to 601' 9 miles farther south and thus seems to connect with the highest St. Clair shore, 595-600 feet and it seems likely to correlate with it.

Does it date from early Lake Algonquin time or instead from the time when uplift returned the flow through St. Clair River after the Kirkfield or Trout outlet had taken the flow? The St. Clair Basin may have been flooded with a considerable volume of water at both these stages. It probably had a low stage of water when the Kirkfield outlet was in operation. The slight preservation of this gravel seems to favor its being of early Algonquin age.

The gravel bars about 2 miles south of St. Clair have been opened extensively for gravel. It here is in steeply inclined beds dipping southward like a delta deposit. The pits are opened to a depth of 6-8 feet and seem to have reached the bottom of the gravel. The gravel is rather fine with few pebbles over an inch in diameter. I think these pits are in section 18 E. China Twp.

The ridge in south part of St. Clair on east side of the *North* flowing part of Pine River is generally sandy on the surface, but we found pebbles in its highest part. It seems to be 20-25 feet above St. Clair River or fully 600 feet A.T. The gravel bars close to the west bluff of St. Clair River further south are about 20 feet above the river. It is about opposite the southermost of these bars that the Canada side reaches 600 feet as shown by the contour on the Wallaceburg Sheet. Opposite Marine City the bluff on the Canada side is 591-593 feet and the 600' contour is about $1\frac{1}{2}$ miles back from the river. It bears S SE from there away from the river. As this contour marks pretty nearly the limit of the highest Lake St. Clair the Lake was entered by St. Clair River about 2 miles above Marine City. The gravel deposits to the south of Marine City seem therefore to have been carried into Lake St. Clair several miles at about the level of the highest St. Clair Shore. The altitude of this gravel near Roberts Landing was later found to be about 601 feet. (see notes Aug. 30, 1934)

up

We went north of St. Clair village and took a road west on the line of sections 19 and 30, T. 5N., R. 17E., which crosses two of the Spillway channels that cross the Port Huron moraine. They are definite swales $\frac{1}{8}$ mile or so wide running S SW to Pine River valley from the crest of the moraine and slightly trenching the crest. Taylor refers this Trenching to a stage of Lake Lundy when its level was no higher than the moraine crest. (Mon. 53 p. 475)

From St. Clair we went west on paved highway $3\frac{1}{2}$ miles to corner of sections 3, 4, 9 and 10, T. 4N., R. 16E. through a plain in which a pale clay is exposed in ditches that seem to be a lake clay. Altitude 621 at section corner (see Rattle Run map). There are patches of sand on it.

We went south on line of sections 9 and 10 to Belle River, through a plain that seems to be higher than the channels cut by St. Clair River. It is above 620 feet. The channeling was probably no further west than sections 11, 14, 23, 26 and 35 and it is 600 feet or less. A road that *bears* west of south in sections 3, 10, 15 and 22 T. 3N., R. 16E. is on the bank west of the west channel. The altitude is low 601-607 feet or scarcely 10 feet above the swampy channel in these sections.

It seems to be below 600 feet and in places below 590 feet (see Rattle Run map). There are sandy ridges a few feet high along it, and in the district to the west past Starville. The relation to the highest Lake St. Clair was not determined. Starville is 593 feet and section corners a mile east 598 feet.

We found no evidence of a boulder belt north of Fair Haven where Taylor thought there was one. We did not see a boulder in sections 18 and 19 or in sections 13 and 24 or 11 and 14 to the east of Fair Haven. There is a clay deposit here with few if any pebbles in it.

From Anchorville we went west across the south end of the sandy strip that is found at south end of the Emmet moraine and is probably connected with the highest Lake St. Clair.

We then took the road which follows a lower sandy ridge called "Sugar Bush Road" on the Mt. Clemens topographic map. This sandy ridge may be a Nipissing beach of Lake St. Clair. It is the "Lower St. Clair" of the Wayne County Report by Sherzer. We saw no gravel in it, but it has the firm and even crest of a beach in most of its course. The sand is in places drifted into low dunes.

July 7, 1934

With Professor R. C. Hassey I went by auto to study features in Lapeer, Sanilac and Huron Counties.

We drove on Plymouth Road to Telegraph Road then north on it to Pontiac. Then east on Auburn Road to Utica then north through Washington, Almont and Inlay to Goodland Church 5 miles north of Inlay where Taylor thinks the Maumee beach has its terminus. We were near the highest Maumee from south of Romeo to this place. The edge of Lake Maumee is in east part of section 34 Bruce Twp., Macomb County. There is a beach east of highway 59 in the NW part of section 10 and SW of section 3 Bruce Twp., There is a moraine close to the highway in sections 4 and 9, Bruce Twp., and in sections 28 and 33 Almont Twp. A beach is east of this highway in SW part of section 27. The east edge of morainic land is in secs. 8, 17, & ²⁰/~~28~~ Almont Tp. *sections 5 and 8 Inlay and sections 20, 29 and 32 Goodland Twp. ^ The gravel near Goodland Church has a nearly level crest for 60 rods+ at an altitude about 850 feet. It probably was shaped by Lake Maumee as Taylor interpreted but there is surprisingly little evidence of Lake action at this height between Inlay and the Church. Mill Creek traverses the swamp east of here. The width here is less than a mile and it is of similar width to the south between Mill Creek and Belle River.

We went east across sections 21 and 22 Goodland into a nearby plane tract much lower than the moraine that lies west of the Inlay Outlet.

* (Insert) North of Inlay it is at the west edge of the swamp in

Notebook 298

The district SE of Mill Creek seems to have been covered by Lake Maumee in Goodland Twp. Taylor thought there were waterlaid moraines here but if so, they are very indistinct. Definite morainic features are found north of Mill Creek in secs. 2, 3, 10, Goodland Twp. but the surface becomes plane in $\frac{1}{2}$ of sec. 2 and in secs. 1, 11, 12. The border between the plain and moraine bears NNE across secs. 35, 25, 24, Burnside Twp. to Brown City in sec. 18, Maple Valley Twp.

There is an undulating till strip on the north side of the Capac swamp in north part of Lynn Twp., St. Clair Co., which may be a moraine. We traversed it from sec. 7 eastward across the twp. It is less than a mile wide and there is a lower plane tract north of it along the county line of St. Clair and Sanilac Cos. Its border is north of the line in sec. 32, T 9, R 14 E.

In secs. 5 & 8, Brookway Twp. (T 8, R 14 E) there is a gravel deposit in a narrow plain bordering Mill Creek. Its extent up the creek was not determined. It may be a line of glacial drainage into the Capac swamp either from the Yale moraine or from a moraine that runs south through the west half of Brookway Twp. Its altitude seems to be not more than 800'. Does this indicate that there was no ponding above 800' at the time it was deposited? It is rather coarse gravel and seems to have been laid down by a vigorous stream.

Frank Leverett Notes - Note Book No.298

Pages 71 to 115 inclusive.

August 15, 1934

I went with D. C. MacLachlan into SW Ontario to determine the position and tilting of the shores of the glacial lakes. We crossed on the "Ambassador Bridge" and followed Highway No.3 southeastward.

It is on the west slope of the Detroit Interlobate moraine in the Windsor Sheet at an altitude close to 600 feet. The soil is generally clay in this area, but we passed low sand ridges about a mile from the south edge of the map where the map shows less than 600 feet. The relief is 4 or 5 feet and the ridges run parallel with the highway on the east side. There is one each side of a small west flowing stream.

In the Essex sheet the highway reaches the crest of the Detroit Interlobate moraine near Old castle at an altitude above 625 feet. The clay here is pebbly and in places between here and Essex it is cobbly. At Essex we come to a gravel bar that is a conspicuous feature for nearly 6 miles or to a mile SE of Cottam where the electric car line turns south to Kingsville. There is another bar 1 - 1 1/2 miles further SE terminating where the highway turns south. The bar is above the 650 contour for a couple of miles at 2-4 miles SE of Essex as shown on the map, but elsewhere seems to be a little below 650 feet. This is about 10 feet above the usual level of the Grassmere beach and about as much below the level of the Wayne beach. It may mark a storm beach of the Grassmere and be several feet above the ordinary lake level of that time. This seems more likely than to put it in the Wayne at a level 10 feet or so below the ordinary Wayne level. We come to the Warren beach near the 675 contour. We traced this beach around the high area that lies NW of Leamington and found it to be only a little above the 675 contour. It is a cut bluff for 2 or 3 miles on the south side of the area where the 675 and 700 contours are close together, but elsewhere is generally a bar of sandy gravel. It is on a rather steep slope on the north side of this high area.

We found the Arkona shore as a cut bluff 710' at base on the west side of this high area north of Ruthven. The top of the bluff is up to the 725 contour. The Arkona is also found on the east side south from where the Michigan Central RR has a spur to a gravel pit.

It is developed for more than a mile ^{just} east of and under the 725 contour. It is about 710' here. If the contouring is correct there is an Arkona 2 miles west from the north edge of Leamington. The Warren beach forks west of Leamington, each fork being just above the 675 contour. The west fork seems to be but a few feet lower than a ridge that is above the 700 contour. So I suspect the contouring is incorrect. There is a thick deposit of gravel along the highest part of this high area. It is opened to a depth of fully 25 feet in pits south from the Michigan Central Spur without reaching the bottom. The beds vary greatly in coarseness varying from sand to coarse gravel. While generally nearly horizontal they have places where a pronounced dip is found. The dip seems to be eastward toward the lower land. This ridge of gravelly material seems to get up about to 735 feet in its highest part and to have been shaped into a bar by the Whittlesey waves. The thickness of the gravel deposit and its general makeup seem to favor its being a glacial rather than wholly a lake feature. It seems to have very few boulders in it and the coarsest beds are merely a coarse gravel, not very cobbly.

The finest display of boulders noted was in the Arkona at base of the cut bluff north of Ruthven. There is a boulder pavement several rods wide near the base of the bluff. West of this near the 700 contour is a low gravelly bar probably Arkona.

The cause for such a prominent area as this one near Leamington is not clearly understood. It is on the line of the Detroit Interlobate moraine. It may be at a place where the Erie lobe made a sharp turn from SW to NW movement. The Huron lobe probably pressed against its north side and it may have extended past its east side into the present lobe area south of Leamington. Mr. Taylor has held the view that the Huron lobe extended into Lake Erie east of Leamington, and if so the Erie lobe had an undetermined limit out in the basin, and came into the present land area west of Leamington. There are ridges west of there near Colchester and Hurrow that are probably later than the Detroit Interlobate moraine, and entirely the product of the Lake Erie lobe. The highest point on them is about 650 feet. They are mainly above 625 feet. We did not go to them but went eastward on Highway No. 2 into the Romney quadrangle.

About 4 miles beyond Wheatley we came to a gravel beach which is continuous for about $4\frac{1}{2}$ miles close to the shore of Lake Erie. It is 630 to 635 feet A.T. as determined by hand level in one place from the lake near Romney and in the other from the 622 bench mark two miles east of Romney. This is rather high for the Elkton beach, but probably is its storm beach. It is a gravel

suitable for road ballast and there are several pits in it. It runs to the lake bluff at its east end and is cut off.

The topographic map should extend the 625 feet contour to the west end of this gravel bar as its lowest part is about 630 feet and the highest 635 feet. Port Alma is incorrectly shown on the Romney map. It is at the 2nd road east of the place indicated on the map by a road coming from Glenwood station. The altitudes given in White's Dictionary of Altitudes show Glenwood 628, Coatsworth 628 and Rensville 629 stations to be above 625 feet, but the map makes all of them fall below the 625 contour. The map may thus be in error to greater extent than in the contour on the gravel ridge. There does not seem to be errors in the contours in the Chatham map.

We come to the Warren beach where Lake Erie has cut it off 2 miles south of Cedar Springs. For fully 1/2 mile it is below the 675 feet contour in the part between Highway No. 3 and Lake Erie bluff. The highway rises to it at the 675 contour. It stands 5 or 6 feet above the plain each side. It is a broad bar filling all the space included in the 675 contour from here to Blenheim or about 1/8 mile. Its crest is likely to be 680 feet or more at the south. At a gravel pit 2 miles south of Blenheim the gravel is opened to a depth of 17 feet and this takes only down to the level of the plain at the 675 contour. So it is about 692 feet here. It reaches 700 feet at Blenheim. This seems too high to fit the Warren plane. It is probably a storm beach and it may be 10 feet or more above the ordinary lake level. The beach splits at Blenheim one part being from waves on the east or Lake Erie side, and the other from on the west side. That on the west is a cut bluff and the gravel does not reach the top where it is 700 feet. Its base is nearly down to 675 contour. The gravel is present up to the top near Ridgetown and reaches almost 690 feet there.

In the port nearest Lake Erie formed by waves on the east the gravel is up to 700 feet for 4 miles NE from Blenheim. It is then below 700 feet for about 7 miles as it passes Ridley and Morpeth. It comes to the 700 contour 1 1/2 miles east of Morpeth and is near it from there eastward to Polk~~Myka~~. It turns north about 1 1/2 miles south of Polk~~Myka~~ and is above the 700 contour from there north into the Bothwell quadrangle. The other shore keeps below 700 feet to near the north edge of the Ridgetown map.

We spent the night at Ridgetown at the Arlington Hotel.

August 16, 1934
Ridgetown, Ontario

We traced the Warren beach around the north end of an island that extends from Blenheim northeastward about 22 miles to within 2 miles of the Thames River. The beach is 720 feet or more in the highest part near Clachan and near Kintyre in the Bothwell quadrangle. It is 718 feet ^{at} Taylor Spur on M.C.R.R..

A gravel pit NE of Clachan 1/2 mile is 718-720'. Clachan is 713' and the beach is 2 or 3 feet higher near there. Southwest of Kintyre is a sandy ridge that reaches 725' but a gravel ridge near Kintyre is a few feet lower. The lake may have been not more than 715' at ordinary levels at the north end of this island. But this is surprisingly high for the Warren plane so far southwest. The country is lower to the northeast from this island, a sand covered plain which rises to 725' near Dutton, and reaches 715' about 2 1/2 miles east of west ~~line~~ ^{trace} or 5 miles SW of Dutton - Sandy bars there reach 720 feet. The Warren plane may reach 720 feet at Dutton. This is at the SW end of the mainland shore of Lake Warren, south of Thames River.

The island that extends NE from Blenheim has a few points that reach the 750 contour. At Duart there are low bars of sandy gravel on ^{an} otherwise plane area of perhaps 80 acres which rises above 750 feet. These may be the product of Lake Whittlesey, for the 750 foot isobase drawn from Richmond, Michigan, to near Girard, Pa. on south side of Lake Erie passes ^{near} Duart. About 3 miles NW of Duart is another small area of sandy gravel that is up to 750 feet and perhaps a feature of Lake Whittlesey. There is another ridge of sandy gravel 2 1/2 miles SW of Duart that is above 750 feet. It is about 1/2 mile long and seems to show a lake bar contour. West of this 2 miles is a very small area that reaches 750 and it is a sandy gravel. Just north of Palmyra is a hill of till that reaches the 750 contour. It is the only hill of this height on this island tract that has no material of the lake beach type. There are several lower knolls along the highway west from Palmyra which contains gravel and pits ~~on~~ ^{are} ~~are~~ ^{opened} in them. They are above 725 feet, but they seem to be Kames, with some till with the gravel.

This island seems likely to be a moraine whether an interlobate moraine or one formed by the Huron lobe is not clear as yet. It seems to have a position that will fit in with the Huron lobe and correlate with the Seaforth moraine. A moraine of the Erie lobe comes to Dutton from the northeast, whether it continues as a

waterlaid moraine to this island to meet the Seaforth moraine of the Huron Lobe, and form an interlobate moraine, or instead runs south from Dutton to Lake Erie, is not as yet known. The lake bluff south of Dutton is above 675 feet and the 700 contour comes within two miles of the lake there which is suggestive of a waterlaid moraine from Dutton to the lake bluff.

Northeast from Dutton a definite moraine with some knolls 25 feet or more in height runs across the NW part of the Port Stanley quadrangle. The moraine is spaced over a width of 2 or 3 miles. The highest knolls (1½ miles north of Iona Station) are above the 800 contour and a ridge standing above 775' has a length of about 3½ miles, mainly SW from the high points. There are several knolls further west that catch the 775 contour, and there is one less than 2 miles directly east of Dutton. Several nearer Dutton catch the 750 contour. The surface becomes flat at about 725 feet though sand ridges extend a little below the 725 contour, south and west of Dutton. The Warren shore seems to be near 725 feet in the west part of the Port Stanley quadrangle, but we did not map its position, except for a short distance near Iona Station and north of Shedden. A bench mark on the MCRR 737 is near the level of the beach. It is 1½ miles NE of Shedden in the edge of St. Thomas map.

The moraine which has so strong expression in the Port Stanley quadrangle becomes less conspicuous in the SW part of the St. Thomas quadrangle with a crest below 775 feet for about 5 miles. It then gets up to 800 feet near St. Clair Jc. and is above 775 feet for 3-4 miles eastward.

The part below 775 feet seems likely to be below Lake Whittlesey level and to have been toned down by its waves, if not already a waterlaid moraine. The part of this moraine in the NW part of the Port Stanley quadrangle has considerable sand in its knolls which add to its expression. On the Pere Marquette RR for 2 miles west of Kettle Creek there is a flat plain to the south and a rapid rise to the north the change being at about 760 feet as shown by a 759 BM on the railway. There is a gravelly ridge north of the railway just west of Kettle Creek in which a pit has been opened. This seems to be rather bulky for a lobe feature and likely to be glacial. It is 760 feet or more, but does not come up to 775 feet according to the map. It may have reached the Whittlesey level which seems to be near 775 feet in the vicinity.

East of Kettle Creek just south of St. Thomas is a plain of sandy gravel that is above 750 feet and perhaps is nearly 775 feet. It extends south to the edge of the Port Stanley quadrangle. There is very little ridge development on it. Its origin is not as yet clear. It may be connected with a *remarkable?* morainic loop SE of St. Thomas in the Port Stanley quadrangle, as an outwash. This loop seems to be in the moraine that we have traced to Kettle Creek from Dutton. It reaches 900' in one hill and has strongly morainic expression down to the 800 contour. There seems to be a shore line at its east end at about 775 feet and also on its south border. At the west the shore is below 775 feet. But it may be only a little lower, for there is a 771 BM on it just south of the border between the St. Thomas and Port Stanley quadrangles. There seems likely to have been a bay in Kettle Creek valley above St. Thomas at the Whittlesey stage, covering the land that is below the 775 feet contour.

After making the loop SE of St. Thomas in the Port Stanley quadrangle the moraine runs north passing just east of St. Thomas and swings NE keeping south of Kettle Creek. It may be combined there with an earlier moraine and embrace a strip 2 miles or less in width on the north edge of a plain that covers the SE part of the St. Thomas quadrangle. It is about 800 feet A.T. near St. Thomas but rises to 900 feet near the east border of the quadrangle, and is above 925 feet in the west part of the Tillsonburg quadrangle near Colloden. It is composed largely of till, gravel being inconspicuous, and is gently undulating. In places in the west part of the Tillsonburg quadrangle it has a double crest with a swale between the ridges that drains SW into Catfish Creek passing to the plain south of the moraine near Mapleton in the St. Thomas quadrangle. The border of this plain is above the 800 contour in the east part of the St. Thomas quadrangle. The moraine there set in near the 825 contour, and extends up to 900 feet at the crest. It seems probable that Lake Whittlesey waters extended a little above 800 feet here, but shore features are not clearly defined. A sandy ridge was noted about 2 miles NE of Kingsville about 3/4 mile north of the MCRR and 1/2-1 mile from the east edge of the St. Thomas quadrangle

We did not get far enough south in the part of the Port Stanley quadrangle to see the Warren beach. It is likely to be slightly below 750 feet there. Its 720 isobase runs S SE from near Forest to Dutton. Thus showing a very different trend from the Whittlesey isobase for 750 feet which runs E SE from Richmond, Michigan to Girard, Pennsylvania. This being the case the space between the Warren and Whittlesey plates will become less in passing eastward. It is about 55 feet in the area of horizontality in Michigan and Ohio, and in Ontario south of Lake Huron. We found this to be the interval in the high tract near Leamington.

The Whittlesey seems to be about 775 near St. Thomas but the Warren is not 55 feet lower there. It seems to be about 737 feet near Shedden or scarcely 40 feet lower. The Whittlesey seems to be not far from 800 feet in the vicinity of Tilsonburg. Ridges that catch the 825 contour are above the level of its waves.

We stopped overnight at Tillsonburg at the Arlington Hotel.

On referring to H.L. Fairchild's report, Bulletin 106, N.Y. State Museum, 1907, p.47, Fig.2, I find that the vertical interval between the Whittlesey and the highest Warren at the Pennsylvania - New York line is about 44 feet the Whittlesey being 765 feet and the Warren 721-722 feet. He also finds an interval of 25 feet there between the highest and lowest Warren, the latter being 696 feet A.T. But at State Line Station he makes the Whittlesey 784 feet or more than 60 feet above the Warren. However, he makes the Warren 734 feet at 1 1/4 miles east of the State Line and the Whittlesey 782 feet there by aneroid measurement, thus giving 48 feet vertical interval. The lower Warren there is 715 feet. These data do not seem to harmonize with those in Fig. 2.

In his Fig. 3, the interval at Westfield is 42 feet. The Whittlesey being 795 and the highest Warren 753 feet. There are lower bars at 730, 725 and 718 feet. Wayne bars(?)

At North Collins, N.Y., Fairchild finds the interval 50 feet, the Whittlesey being 850 and the highest Warren 800 feet. There is a lower Warren at 780 feet. The interval of 70 feet between the Whittlesey and lower Warren is said to be the usual space found in the New York area. The Whittlesey gets up to

to 905 feet at the easternmost point at which it was formed 1 mile SE of Spring Brook. It is here 70-75 feet above the lower Warren at Elum Center Station. A table on p.65 sets forth the vertical space at numerous points, and supports the statement that the general space between the Whittlesey and lowest Warren is about 70 feet and between the Whittlesey and highest Warren about 50 feet. If we take 800 feet as the level of Whittlesey at the Ugly Outlet, and at the east side of the Westfield, N.Y. quadrangle, a straight line connecting these points passes close to Tillsonburg thus seeming to support the view that the change from flat to undulating surface in this vicinity at about 800 feet - marks the limit of Whittlesey waters. The till ridges west of Tillsonburg seem to flatten out at the SW end and become waterlaid at about 800 feet. One of them follows the east side of Catfish Creek past Sumner's Corners, and crosses the NW corner of the Port Barwell quadrangle into the Port Stanley quadrangle. It probably continues in a course south of west to the shore of Lake Erie near Port Stanley. The bluff of Lake Erie is above 700 feet except at the gorges cut by streams in the port of the Port Stanley quadrangle east of that village. West from there the 700 contour bears away from the lake bluff. A stream draining east past Sparta to Catfish Creek, and one draining west past Union to Kettle Creek may have had their courses determined by a shallow swale between this waterlaid moraine and the prominent morainic loop north of these streams. Is it probable that this moraine correlates with the Gowanda moraine in New York?

East of this is a till ridge which is traceable about 4 miles SW from Tillsonburg on the west side of Otter Creek. It probably continues as a waterlaid feature, but does not control contours to the degree that the one west of it does.

August 17, 1934, Tillsonburg, Ontario

We drove south from Tillsonburg on the highway east of Otter Creek. It traverses a sand-covered tract slightly ridged in dunes. There is a till ridge on the east side of the Canadian Pacific RR which reaches the 825 contour for a length of nearly 2 miles, but it fades out east of Eden near the 800 contour and is not a distinct feature further south. The altitude drops to 775 feet in the first mile south of Eden.

We followed this till ridge NE to the Highway No.3 which runs east from Tillsonburg to Delhi. Gravel pits on the north side of this highway on the crest of the ridge show a westward dip toward the lower country west of the ridge. It seems to be an outwash gravel at an ice border. The top of the gravel is about 800 feet as determined by its height above the 800 contour ~~on~~ the Tillsonburg map. There is about 15 feet of sand here over the gravel and a strip of sand dunes runs west from here for 2 miles that is above 800 feet except for a small depression carrying an 800 depression contour. There is also a sandy coating along the crest of the ridge southwest from this highway except where it stands above the 825 contour.

This ridge continues NE as a faint feature past Rosanna and connects with a strong moraine 1-2 miles SE of Otterville. That moraine reaches 800 feet in places in the NE part of the Tillsonburg quadrangle, and is about 850 feet from Cornell westward about to the meridian of Tillsonburg. It seems to find continuation in the two till ridges above described that run SW from Tillsonburg. It contacts near Tillsonburg with an earlier moraine that comes in from the northeast nearly to Tillsonburg and there turns westward and runs past Culloden and Lyons its south border being north of the highway that runs through Delner and Brownsville. This moraine is evidently older than the Port Huron morainic system but the one that splits into 3 ridges near Tillsonburg may, together with the Paris and Galt moraines, correlate with the Port Huron system and with the *Gowanda*, Hamburg and *Manilla* moraines in New York.

We drove east on Highway No.3 through a sand covered plain to Delhi making a detour south to Rhineland to see an area that is above 800 feet. That area is sand covered with low dunes. I had suspected it might be in the line of continuation of the Paris moraine SW from Delhi. Perhaps it is, but there is no till ridge here and so far as I can see nothing to distinguish it from the sand covered plain to the west.

The Paris moraine is distinctly traceable to Delhi, although there is considerable sand along its crest. We crossed it south from Delhi and found boulders and till exposed on its SE or inner slope, but the crest here standing above 800 feet is a sand covered ridge.

We continued east across a sand covered plain with low dune ridges scattered on it to the Galt moraine east of Simcoe. The crest east of Simcoe that rises above 800 feet has till at surface and till is exposed to a slightly lower level where we run north across the moraine 2 miles east of Simcoe. We went to a gravel pit 2 miles west of Tyrrell. The gravel is in beds dipping westward from the crest of the moraine. Its surface as shown by the 800 foot contour on the Simcoe map is about 10 feet above the 800 contour at the east end of the pit and drops to near 800 feet at the west end. It seems to be an outwash gravel connected with the moraine. It contains cobblestones and small boulders. There is a sandy deposit a few feet thick over the gravel. North from this pit where the moraine rises above the 825 foot contour till and boulders are at surface. The plain east of the moraine at this place is a clayey till with scattered boulders. The border between plain and the moraine is a little above the 775 contour, from here northward to Nauticoke Creek valley at Waterford. It is probably this border between plain and moraine that Spencer (and later Taylor) interpreted to be the Warren Shore. They give its altitude as 770 feet which is within 10 feet of the border as shown on the Simcoe map.

There are sand ridges south of Waterford just west of the Galt moraine which catch the 800 contour. Water seems to have been ponded to fully 800 feet in the district west of the Galt moraine. This seems likely to have been the last ice barrier of Lake Whittlesey. As shown by the Simcoe map the moraine had a course W SW from Simcoe into the NW part of the Long Point quadrangle with points rising above 800 feet. It seems to have taken a southward course to the Erie basin through the west part of the Long Point quadrangle.

We drove west from Waterford. We passed a gravel deposit on a low terrace west of Nauticoke Creek at about 775 feet. This may correlate with Lake Warren as a delta deposit of the creek.

There is a flat tract of sandy till above 800 feet south of Round Plains. This sandy till continues west to the Paris moraine, which we crossed near Windham Center. This is a gently undulating sandy till and the relief is scarcely 25 feet above border plains. Sand ridges west of it catch the 800' contour. We crossed the eastern ridge of the Tillsonburg series near Rosanna. It has an undulating surface but with very slight relief, but is more undulating than the plain to the east. The width is scarcely a mile.

We went westward through *Delmar* and Brownsville to the road running south ~~to~~ ^{the} Springfield. Then west from Springfield through a flat area that stands above the 800 contour. The change to undulating here is at about 825 feet but, as noted August 16, there are sandy ridges south of Mapleton at about 780 feet which may mark the level of Whittlesey waters, and there seems to be a shore line east of St. Thomas (south of *Farmouth?* ^{or} center) that catches the 775 contour. *Farmouth?*

We got dinner at St. Thomas and then drove NW across a very flat plain after crossing Kettle Creek, to Talbotville Royal. It seems to be about 760 feet. We rose to the 775 contour north of TR., and noted ~~which~~ ^{that} may be a slight notching by wave action just above this contour at about a mile from TR. But there is a nearby feature, *less* plain for 2 or 3 miles further until the altitude is above 800'. The land becomes undulating a little below the 825 contour about 3/4 mile south of Tempo. This is at the border of a broad morainic belt that runs E-W through the middle part of the St. Thomas quadrangle to Thomas River, *Rogman* Creek being in a depression on its north side. It seems to sit in west of Thomas River near Mt. *Bridges* and swing northward along the border of the St. Thomas and Stratho~~ny~~ quadrangles.

Lake Whittlesey probably had a bay extending up Thomas valley to the vicinity of Komoka as Spencer and Taylor have thought, ~~The~~ limit being near the 775' contour. The border of Lake Whittlesey seems to have been near Christina. There are sandy knolls north and east of Christina along the west side of the Thomas valley and they occur above the 775 contour from there to Stratho~~ny~~, but they are few at lower level. Near Roome in the east part of the Stratho~~ny~~ quadrangle the flat land extends a mile or more further northeast than the 775 contour.

We crossed Thomas River on the bridge about due east of Christina where the river makes a NE loop.

In this loop there is a gravel deposit on a terrace that stands between 700 and 725 feet. This may correlate with Lake Warren. There is gently undulating till between these and Burwell ^{Road} between the 725 and 750 contours. We turned NW on Burwell Road and came to prominent sandy knolls near its intersection with *Muncy* Road, 2 miles east of Christina.

From Strathroy we drove west past places where the 775 contour shows loops that I had suspected were due to the Whittlesey beach. But in every case they were of till and showed no shore deposits. These loops are irregularities in the border of the Seaforth moraine.

We turned north about 6 miles east of Watford to see the gravel pits on east side of the road. They are in a low winding ridge, about 1/4 mile long, probably of Kame character. Two pits are open.

We turned back and continued south to the first road south of the Canadian National RR passing one of the loops on the moraine border just north of the railroad and found no shore deposits on it. We then ran west about 7 miles to where a gravel pit is shown on the Strathroy map, north of the road, but could see no pit or any road leading to where the map puts it. There are knolls here that catch the 775 contour, but we saw no shore features on them. Yet we seem to be where Lake Whittlesey had its limit. We here turned south and came in view of a gravel pit about 1/4 mile west of the road and a mile east of Sutorville siding, but did not go to it as it seems to have been unworked recently.

We continued south to a gravel pit in a bar 2 miles W SW of Alvinston that catches the 700 contour. It has been opened for gravel to a depth of about 6 feet. The bar catches the 700 foot contour, and is likely to be a Lake Warren feature. The shore is likely to have been east of the 700 foot contour in the vicinity of Alvinston but we did not go there to make certain of its occurrence.

We went next to a gravel bar NW of Aberfildy that catches the 700 contour. It is over 1/2 mile long and *trends* NW-SE. This gravel pit in it at the road intersection has not been worked recently. This bar probably stands some distance out in Lake Warren, perhaps 5 miles from the east shore. Sydenham River seems likely to have entered Lake Warren about 3 miles SE of Alvinston. This should be tested out on a later trip.

We went west 3 miles on a road 1/2 mile from the south edge of the Strathroy map. From there we drove south into the Bothwell quadrangle past Shetland, where we crossed Sydenham River.

We continued south through the plain to Thames River at Thamesville. There is a gravel deposit here which we find follows down the valley nearly to Chatham. It may correlate with the highest St. Clair beach. It is about 615 at ^{Thamesville} Thamesville but drops to 600 feet or less near Chatham, as shown by Contours on the Chatham map.

We got supper at Chatham, and then took Highway No. 2 ^{past} Fort Tilbury and Maidstone to Windsor and Detroit. We did not note the border of the highest Lake St. Clair, though we rose above it near Comber. It seems to be an inconspicuous feature. I returned to Ann Arbor by bus from Dearborn.

August 29, 1934

I drove with D.C. MacLachlan from Ann Arbor via Flint to the shore lines of Lakes Saginaw and Arkona in Tuscola County. The Saginaw beach is developed above the Arkona in the part of the Flint quadrangle near Pine Run and Clio, and NE from there about to the line of Genessee and Tuscola Counties at about 750 feet. The Arkona there is between 720 and 730 feet. The Saginaw waters may have extended into Arbela Twp., Tuscola County along the south side of the moraine which runs from section 29, Arbela in E NE course to section 18 Millington Twp., but I have not found a definite beach there. The Arkona beach runs near the crest of this moraine; the highest points ^{on} the moraine being only 15-20 feet above it.

It is on the crest on the line of sections 22 and 27, Arbela and on line of sections 13 and 24, but is about 15 feet lower on the range line between Arbela and Millington Twps., sections 13 and 18. The crest there has a sandy gravel deposit which may be referable to Lake Saginaw, but it is not a well-defined lake bar.

North of Millington the Arkona beach has the same altitude as the M.C. RR in the north part of section 9, Millington, Twp. about a mile from Millington depot. It is gravelly here and NE from here to the south edge of section 34, Vassar Twp. It there curves around to the SE and runs back into section 3, Millington Twp.

As noted in a trip in 1933 there is sand at the level where the Arkona should appear in NE ^{and} Millington Eastern Vassar and western Fremont Twps., and we were unable to find distinct shore features there, except near Jugata where there is a large gravel pit. The gravel there is partly covered by dune sand. It seems to be about 740 feet as determined from the profile of the Pere Marquette RR.

We drove east today through ~~Judata~~ to the line of sections 28 and 29, Fremont Twp. The PMRR there is 780 feet and we set an aneroid barometer by it. We then drove north to the Kame area near corner of sections 16, 17, 20 and 21 Fremont. This is a gravelly range of hills, with points up to about 785 feet. The base seems to be about 750 feet and is likely to have been reached by Lake Arkona. There appears to be a lake shore bar just west and north of the corner of sections 8, 9, 16 and 17 with NE-SW trend along the west slope of the Kame area. There are large gravel pits in the high part of the Kame area near the center of section 9 where the aneroid reaches 785 feet. The gravel is excavated to a depth of 150 feet or more and it varies greatly in coarseness with cobbly hills and some boulders in it. Boulders are numerous on the surface. Boulders are also numerous on the lower tract north of this Kame area in sections 4, 5, 8 and 9, Fremont Township.

We turned east at middle of line of section 4 and 5. There are bars of sandy gravel in section 4 that were probably formed by Lake Arkona. One in the west part crosses the road in a SW-NE course. East of this is a bar running W-E along the road. In section 5 is a bar along the west base of a Kame area. The Kame area is a prominent morainic belt with points up to over 875' by aneroid on line of section 2, Fremont, and section 35, Indianfields. Lake Arkona is likely to have reached its north base in sections 34, 35, 36 and 25 Indianfields Twp. It may have covered the lowest land south of the moraine in sections 10, 11 and 12 Fremont Township, but that low area is probably near the level of the upper limit of Lake Arkona.

In Wells Township the border of Lake Arkona was along the base of morainic knolls and ridges in sections 32, 33, 34, 35 and 36. It probably extended up valley-like areas in section 6, Dayton and in sections 1 and 2. In a similar way low areas were probably flooded *among* the morainic hills and ridges in Kingston Township. These knolls come to within 1/2 mile of Wilmot. The level of Arkona waters near Wilmot seems to be scarcely 10 feet above the station (759.6) or 770 feet or less.

Boulders are conspicuous on the flat areas near Wilmot among the morainic knolls as well as ~~are~~ ^{on} the knolls. There are morainic knolls east of Wilmot in the south part of sections 14 and 15, but these sections and section 13 are mainly flat land which may have been covered by Lake Arkona. It seems to be near the level



of Wilmot or about 760-770 feet A.T. There are morainic knolls in section 12 that show no evidence of having been submerged, but the lake probably covered the plain tracts on their borders. These knolls seem to be at the extreme north end of an interlobate morainic area between the Saginaw and Huron lobes, which is so prominent a feature in the SE part of Tuscola County and adjacent part of Sanilac County. The part in Kingston Township and Laniette Township consists of scattered knolls and ridges with much nearby plane land among them. The moraine is strong and with but little flat land included in it in Dayton and Kaylton Townships, Tuscola County and the SW part of Marlette Township in Sanilac County, SW of Germania.

We drove from Wilmot to LaMotte Station corner of sections 17, 18, 19 and 20 to get the features noted. From there we drove to the LaMotte Esker in the south part of the township in sections 28, 33, 34, 35 and 36. This we find was formed by a stream flowing eastward as shown by the dip of its beds. This is very clearly shown in pits in the SE part of section 35. It is also shown in a pit in the NW part of section 6 Elmer Township. The esker there turned southward and there is some clay involved in it. The chain of knolls running south through the west part of Elmer Township in the swamp along south Cass River have considerable till as noted in my early studies in 1904. So the esker terminates in section 6 as a gravel ridge. Farther south there is a chain of Kames.

There are groups of Kames, chains of Kames and isolated gravelly knolls scattered over the part of Sanilac County west of the Port Huron moraine and east of the Marlette moraine which seems to favor the view that the ice sheet became stagnant in that region. Most of the surface is as flat as a lake plain and other parts have the appearance of ground moraine with gently undulating surface. It is not as yet clear that this tract was covered by a lobe forming a northward extension of Lake Maumee. The features are similar to what are found within the limits of the ~~Black~~ ^{Black} River Bay of Lake Whittlesey, where the flat areas certainly were covered by lake waters, and also much of the undulating till. The beaches are recorded in the larger prominences or Kame areas. There are faint suggestions of cut banks in places above and outside the limits of this bay. One of which are the lines of sections 27 and 34 LaMotte, I noted when on the trip with Prof. Hussey July 7, 1934. We examined this again today. It is in a prominent knoll with what may be wave cut notches in the slopes. But the bordering lower land has a ground moraine topography not so flat as would be looked for in a lobe plain.

We drove to Sandusky after studying the LaMotte Esker, crossing a group of Kames east of Elmer. The surface is flat and swampy from Sandusky eastward to Black River with a few places where till rises slightly above the swamp level. Possibly this was covered by the Black River Bay of Lake Whittlesey as far west as Sandusky, as the altitude seems to be only 770-780 feet, and Lake Whittlesey has a bar 780 feet. Eight miles further south on the line of sections 11 and 12, Buel Township as determined by MacLachlan by leveling. The lake should reach 785 feet or more near Sandusky.

There is a ridge of sand and very fine gravel running south for 1 1/2 miles from the SW part of Sandusky, which stands fully 15' above the plain east of it. This seems a rather large feature to have been produced by Lake Whittlesey, as the plain to the east has very slight descent not suited for strong wave action unless the lake stood 15 feet or so above it. In that case this ridge may prove to be a Whittlesey shore, and the lake level be somewhere near its crest. There is, however, no land near by from which material for such a ridge seems obtainable. We are thus inclined to refer it tentatively to glacial action or to an origin like an esker, rather than a lake beach. There are boulders scattered over it, but where opened in the pits in SW part of Sandusky it is entirely of sand and very fine gravel.

We drove north from Sandusky through a very flat tract for 6 miles. Boulders are numerous on it in sections 4, 5, 8 and 9 Custer. A chain of Kames runs S SW-N NE from section 5, Custer into section 33 Wheatland in which gravel pits are opened near the corner of sections 4 and 5, 32 and 33. This ridge is of uneven height and more definitely a glacial ridge than the ridge at Sandusky. The flat land east of it may have been covered by Lake Whittlesey. This ridge is only about 3 miles from Black River. Muck of the surface is swampy between here and the river, so the altitude is not likely to be much above the *river* level. My map used in 1904 shows a gravel ridge in sections 5 and 8 Wheatland, at the west edge of the swamp through which the river flows. This may be a Whittlesey beach. The road to it we found not suitable for an auto, so we did not go to it today.

We found a very flat surface on the divide between Black River and Cass River in western Wheatland Township, but did not note any well defined Spillway across it. There are spillways further north in Austin Township as I noted in 1904, and as noted by Taylor and named Crumber, Tyre, and Ubly. (see Bull. GSA Vol.8, 1897 pp.40-45). On p.46 of this paper Taylor suggests a SW outlet to Flint River from the swamp on S.Cass River west of Elmer. This was found on the trip by the Michigan Academy of Science in May 1934 to pass 1 1/2 miles N of Burnside.

We drove west across Argyle Township past the village. The surface is nearly all rather flat but some Kames 20 feet or more high were passed that stand in the NE of section 18 and NW of section 17, Argyle Township.

We came to the Hay Creek spillway near west end of line of sections 12 and 13, Evergreen Township, and went north along it to corner of sections 1, 2, 11 and 12. It is only 40-60 rods wide here. Its bed is floored with boulders, left as a concentrate by the cutting into stony till. The channel is 20-30 feet deep. This passes near Cumber but seems to head in a swamp in the SE part of Austin Township 5 or 6 miles east of Cumber. There is a larger spillway passing about a mile north of Cumber, that heads near Tyre. It is this channel that runs SW from Holbrook past the "Stone Wall" in SW part of Greenleaf Township to S. Cass River.

We drove into Cass City to spend the night.

August 30, 1934, Cass City, Mich.

With D. C. MacLachlan I went east to the place where the highway *leaves* the Ubly outlet on the line of sections 30 and 31, Greenleaf Township, Sanilac County. We find a gravel deposit on the east bluff that has the aspect of a lake beach and we suspect it is referable to Lake Arkona. Its altitude as determined by aneroid is 770-775 feet. The gravel is 6-8 feet deep and seems to have been built by waves from the west. It stands a few feet above the land SE of it in the north part of section 31 and on the line of sections 29 and 30. It runs into section 29 about 1/4 mile from the N end of the line of sections 29 and 30. There are several pits in it in the SW part of section 30 but they have

not been in use much for some years so are not well exposed. Levels may be run to this later.

We then drove south to Brown City. We turned east in north part of Marlette Township to road running S past Germania, then east to Juhl across the swamp on S Cass River. Then south to Township line; then west 1 3/4 miles and south to Brown City. We examined the same features that Prof. Hussey and I saw July 7th but decided that they are not certainly lake shore features.

We then drove east 9 miles coming to the Kame area in section 17, Speaker Township. This lies south of the highway with its north border in sections 15, 16 and 17, Speaker Township. The country to the northwest seems nearly level enough to be a lake plain. We went north across the Kame area near Peck. Then east to the Kame area near Buel and north to its north end in SW corner of section 15. MacLachlan finds the level of Lake Whittlesey here to be about the same as in sections 11 and 12 ~~C.E.~~ 780 feet. We drove to the bars on line of sections 11 and 12. They are on the highest land there. MacLachlan has found a beach at 764 feet near this. Is it the highest Arkona? If not, what is its relation to Whittlesey?

He found beaches west of Applegate to be 753 and 761 feet. Are they Arkona?

We got dinner at Crosswell.

We drove south on Highway M51 into St.Clair County and then east to the Lake Huron shore at Lakeport. Then south past Port Huron to St.Clair. We made a detour north of St.Clair west to corner of sections 11, 12, 13 and 14 St.Clair Township, to see the spillways described by Taylor in Monograph 53, pp.473-475. Then south 2 miles and east to St.Clair. MacLachlan will work out their connection with the Elkton beach. The heads of the highest ^{ones} areas are estimated by Taylor to be 635 feet, but those nearer St.Clair River are about 620 feet. The head of Jordan drain is only 614'. See notes October 25, 1937. The highest ones seem to be the same altitude as the Elkton beach at Lexington while the lowest at 620 are near the altitude of the Elkton in the St.Clair basin. Was there a fall of about 15 feet across the Port Huron moraine from a lake in the Huron-Saginaw basin to one in the St.Clair-Erie basin? It seems very important to clear up this matter by a series of levels.

We went to the bar of gravel at the bluff of St.Clair River just south of St.Clair village. The gravel by hand level is 29-30' above the present level of St.Clair River. This is exceptionally low stage now probably about 575 feet making the gravel bar 605' A.T. The gravel is 6-7 feet thick and rests on blue till.

We then went to Cherry Beach about 9 miles down the river and ran levels to the gravel bar west of there where a paved road crosses it. The bar there is 27 feet above the present low stage of St.Clair River. If this is 573 feet as seems probable the gravel bar is 600 feet A.T. here - or 5 feet lower than the one near St.Clair. This seems a natural descent to the highest Lake St.Clair, which is slightly below 600 feet. It also seems to tie on to Lake Algonquin at 607 feet. The lake probably came to within 5 miles of the bar near St.Clair village, in the plain inside the Port Huron moraine. The ordinary level of Lake Algonquin is likely to have been close to 605 feet and its outlet could have been no higher. The bar near St.Clair thus appears to be as high as the head of the outlet.

This bar may be as old as Early Lake Algonquin rather than a feature as recent as the Post-Kirkfield stage. This raises the question whether the highest St.Clair shore is to be correlated with the Early Lake Algonquin or instead with the Post-Kirkfield stage. Possibly a lower beach is to be correlated with the Post-Kirkfield rather than with the Nipissing discharge into the St.Clair Basin.

The same questions came up in regard to the shores of Lake Rouge.
Returned to Ann Arbor from there.

Thickness of Surface Deposits.

In a letter dated August 31, 1934, W. A. Johnston of the Canada Geological Survey states that the drift is quite thick in the area near Ridgetown that stands above the Warren beach. It is 95 feet at Ridgetown. Six wells in Howard Township show thicknesses of 41 to 330 feet. The deepest is on Lot 7, concession 11, of Howard Township. The altitude is above 725 feet in a considerable part of Concession XI, but I am not able to locate Lot 7. Assuming the altitude of the well mouth to be 730 feet the rock surface there is 400 feet A.T. It is about 600' in Ridgetown if near the business section.

On September 18, 1934, Johnston sent the following:

Surface deposits near Glencoe, Ontario:

	To Rock
Lot 13, Conc. 3 Ekfrid, Twp.	130'
Lot 7, R. 5S. Ekfrid, Twp.	195'
4 wells at Glencoe	152 - 163'
Drillers log of one Glencoe well:	
Yellow clay	0 - 117'
Hardpan	3'
Coarse gravel	3'
Fine sand	7'
Quicksand and clay	7'
Hardpan	<u>15'</u>
Total drift	152

The well continued 20' into "soapstone". Surface deposits near Alvinston, Ontario:

Lot 1, Conc. 10, Brook, Twp.	56'
Lot 5, Conc. 4, Brooke, Twp.	65'

It is a question whether the nearby stoneless clay in this *general* ground region is till or lake deposit, or in part one and in part the other; Johnston states that a latitude of 5 feet or more for errors in contours on Wallaceburg map should be allowed as barometer readings were used to some extent to determine contours.

September 11, 1934.

Ann Arbor to Windsor, Ontario with Prof. W. H. Hobb and Prof. I. D. Scott. We drove south a mile from Ambassador Bridge on No. 3, then went west into Sandwich crossing a ^{small} swale 600' area west of the main area. On its slope we found a deposit of gravel up to fully 600 feet deposited by Detroit River when it broke through the Detroit Interlobate Moraine. West of this is a gravel bar a few rods east of the Essex Terminal RR which is eleven feet higher than a 586 BM on the railroad in 597 feet A.T. The gravel is coarse enough for road ballast and has a pit opened in it. The Terminal RR is in a swale a few feet lower than the land between it and Detroit River. There seems to be a gravel deposit as far west as the highway leading to Amherstburg (No. 18) (the first street east of the river in part of Sandwich, and the 2nd in part of the city). There are gravel pits opened west of the highway in south part of Sandwich. The gravel stands a little above 590 feet here, probably 592 feet. It is about 20 feet above the river at present stage. This seems to be a delta at head of Lake Rouge. The material is coarser than that in the delta on the Michigan side, which runs west to Woodmere Cemetery. Its terminus on the Canada side is about 2 miles SW from the Ambassador Bridge near where Highway 18 turns southeast. This is about opposite Woodmere Cemetery, but a space of 2 1/2 miles intervenes where the river has cut away the Delta deposit. In doing so it carried some sandy material that forms a lower Rouge deposit. This is up to 586' in places along the bank near Ojibway. This was not visited today.

We tried to map the east shore of Lake Rouge south from Sandwich into the north part of the Amherstburg sheet. It is rather indefinite but there is a sandy deposit of about 590 feet which seems likely to mark the shore. There is clay land west of it extending 2-3 miles east of Detroit River near the line of Windsor and Amherstburg maps. We drove back to Windsor for dinner and noted a series of swales that pass through the north part of the Detroit Interlobate moraine. One being along the Essex Terminal RR east from the south end of the bridge. We also noted one along Wyandotte Street east of the business section of Windsor. A higher strip north of this street is probably up to the level of the moraine and fully 600 feet, but the Windsor map does not seem to make it that high. The map, however, is not legible there because of a red color in the densely built part of the city. There is

a definite terrace north of this higher strip that faces Detroit River. It seems to be fully 25 feet above the river at its present low stage, 571 - 572'.

We drove east from Windsor to Tilburg on the south side of Lake St. Clair on No. 2 a highway near the 600 foot contour where there are salients, at these salients the slope below the contour seems to have been steepened slightly by the highest Lake St. Clair. But generally there seems to have been no distinct shore features developed. We continued from Tilburg to Chatham on highway 2, at a level below the highest St. Clair shore, through a clay plain.

Thomas River is about at St. Clair level at ordinary stages of the present lake as far up as Chatham. So there is backwater to there at time of strong west winds, we are informed.

We left Highway 2 about 2 miles NE of Chatham and examined the strip of land west of Arnold Creek that is above the 600 contour. This has a sandy coating over a clay deposit that extends a little below the contour. This sand was probably deposited as a delta of Thomas River in the highest St. Clair stage. Arnold Creek seems to have started as a distributary in the delta, for it heads very close to Thomas River and leads away from the river and then runs back to it. There is another stream near Kent Bridge (Big Creek) which heads close to the Thomas and leads away without returning to the river. This also seems to be a distributary.

There is a clay deposit in the river bank at Kent Bridge which is ^{said} to be about 12 feet thick. Wells get water under it in sand or gravel. There is no sand coating near the bridge but it sets in a short distance back from the river. There is gravel in the bed of the river for several miles below Kent bridge, which is being dredged at some places near the Highway 2. Gravel is dredged at points further up at at least to near Wardsville. Whether this has been carried far down by river currents or was present along the river under the clay deposit was not ascertained.

From Kent Bridge we drove NW to Dresden. There are sandy patches as far as the place where survey lines change to an E-W bearing from the SE-NW trend 2 or 3 miles east of Dresden. But west from there we saw no sand on either side of Sydenham River. There is a very flat clay surface. The extensions of the 600 contour near Dresden do not seem to be delta features. We are wondering if such extensions have been correctly mapped. With so flat a surface the boundaries of the 600 area would need careful leveling *to be correctly placed*
We went to the west end of a 600' extension north of the river and then

north across the strip that is put below 600' but could see no definite evidence of more than a foot or two difference. We drove north to Dawn Valley, through a clay plain. From there we went east to Sydenham River at Florence through a clay plain the entire distance. We continued east and found clay land until we were up to about 640 feet. There sand set in and it forms a thin coating from there east to the Thames valley, and up the valley about to the meridian of Glencoe where the gravel of the Warren beach sets in at about 725 feet. There is said to be gravel in the great bend of the Thames above Wardsville from the 700 contour down nearly to the end of the loop. But we did not verify this. Our informant was C. M. Cameron of Glencoe who seems to be a reliable man who has observed closely the extent of such deposits. He has gravel in the Warren bar south of Glencoe that has been worked extensively in past years.

We spent the night at Glencoe, and examined the gravel bar the next morning, September 12. The sand that set in at about 640' may be of the Grassmere lake stage while that at higher levels embraces the Wayne deposits. How far back from the Thames valley the sand extends should be determined as it may throw light on its origin, whether connected with that stream or independent of it. The district south of the Thames as far out as west Lome seems to be sand covered past the highest land between Thames River and Lake Erie, so it there seems to be independent of Thames River.

September 12, 1934
 Glencoe, Ontario

We found Warren gravel bars near the south limits of Glencoe. One 1/4 mile west of the road that runs southward from the village runs nearly to the first highway and has been opened for gravel near that highway and in edge of Glencoe.

There are till swells on the highest points south of Glencoe for about 1 1/2 miles. There is little gravel aside from the narrow beach ridges above noted until one gets nearly to the second highway south of Glencoe. But from there south past the third highway (Highway No.2) there is a broad gravelly belt over 1/2 mile wide formed by Lake Warren. It is mainly above the 725 contour and its highest points are fully 730 feet. They seem to be as high as the till swells further north. The Strathburn *Aerodrenia?* is on this gravelly area. Several pits have been opened in it each side of Highway No.2 and others near the parallel road a mile ^{north} south. The Cameron pit is near that road. The gravel seems to be only a few feet thick. In pits south of Highway No.2 it is about 6 feet. It may reach 10 feet or more on the highest points.

We returned to Glencoe and drove NW to Alvinston. This leads through a level till plain standing near 725 feet, but we do not find any gravel coating. It is perhaps a little above and outside Lake Warren limits. The 725 contour runs east from Glencoe keeping north of the Canadian National RR to within about 3 miles of the east side of the Strathroy map. There probably was a bay of Lake Warren extending into the SE part of the St. Thomas quadrangle about to where MacLachlan and I crossed the Thames River on August 17 with limits near the 725 contour.

We found the Warren beach west of Sydenham River at Alvinston. It is high enough to catch the 725 contour. There is gravel in places to a depth of 10 feet. In places there is a thin gravel deposit over sand. We are told.

We traced the beach about 4 miles NW from Alvinston to a N-S highway that crosses the Canadian National RR about 1/2 mile SE of Armstrong station. It is generally a little below 725 feet except in the vicinity of Alvinston. In places there is a lower bar a few rods from the upper one. But both are above 700' contour.

We were unable to trace the beach beyond the highway mentioned. Probably there was too slight a descent lakeward for waves to be effective. The bars SW of Alvinston noted August 17 are only a little lower than the lower bar in the main shore being above 700'. They probably were formed when the outlet of Lake Warren had cut down to its lowest limit and so represent a late level of the lake.

We drove west from Armstrong through Petrolia across a featureless clay plain, below Lake Warren level. West from Petrolia we came to the waterlaid continuation of the Port Huron moraine but it is about as featureless as the plain to the east. We drove south to Brigden which stands on the bluff of Bear Creek, a stream which seems to run just outside the limits of the Port Huron ice advance from its source to here. But it here turns south toward Lake St. Clair.

The road west from Brigden is probably near the limit of the Port Huron ice. We found the surface ^{more} wave undulating here than north of Brigden.

We turned south on first road east of Courtright for 1 1/2 miles then west across a bar of sandy gravel that catches 625 contour. It may be an Elkton bar. It has a relief of only 2 or 3 feet.

We passed a low sand ridge 3/4 miles west from here that is probably about 610 feet. The EM on RR east of it being 608'.

We drove up the St. Clair valley to Sarnia but saw no gravel deposits such as appear south of St. Clair on the Michigan side.

The area above 625 feet west of Wawanosh Station is a clay ridge. The highway now runs over it. Perhaps the low land east of it near Wawanosh Station was cut down by the flow of St. Clair River through it, but we did not settle this by an inspection of the soil in the low strip. South of Mooretown we found an abandoned channel of Baley Creek east of a 625' ridge.

We returned from Sarnia along west side of St. Clair River to see the spillways on the Port Huron moraine and the river gravels south of St. Clair village, and returned to Ann Arbor via New Baltimore and Mt. Clemens.

September 19 - 22, 1934, I accompanied D.C. MacLachlan and a student assistant in running levels and studying features of glacial lakes in Ontario east of Lake Huron. We crossed at Sarnia and went east on the London Road, Highway No. 7. The highest or ^{outer}intermost shore of Lake Algonquin is along this road for 5 miles. It there turns NE and runs to the shore of Lake Huron. There are large bars of Algonquin age nearer the lake as we noted in 1933 (Oct. 1.). The contours on the Parch map outline them nicely.

We drove north to Utoxeter to see the 725' bar that runs for 1/2 mile north from there. It is a gravel deposit and seems to be a storm feature of Lake Warren, though about 10' above the general level of the lake. The Warren beach is only 717 at Forest several miles N of Utoxeter, but it is up to 725' at the bend in the shore where it turns east 3 miles NE of Forest, and is close to 725' only 1 1/2 miles from Forest, as we noted September 22 on our return. Probably the ordinary lake level at Forst was fully 715' ~~so~~ as ^a storm beach might be up to 725 feet.

Arkona Beach near Burnam 750'

We drove through Warwick to the gravel beach 1 3/4 miles east near the 750 contour. This is preserved for about 1/4 mile south of the Highway No. 7, but seems to have been ^{eroded}worked down by the rise to the Whittlesey level further south. We found it traceable north to Burnam where it is so close to the Port Huron moraine as to be protected from wave action. It has shallow gravel pits 3-5 feet deep.

The gravel is not continuous from the highway to Birnam but is well enough preserved to make a fairly definite shore featur. For a mile south of Birnam it is less than 1/2 mile from the border of the Moraine. It may continue NE from Birnam across one concession, as we noted slight ridging on the next road east a short distance south from where the W-E road intersects it.

Whittlesey above 775' near Birnam

On this road we passed a gravel pit in the edge of the Port Huron moraine just below 775 feet contour. This gravel may be an outwash from the ice border into Lake Whittlesey. There is a Whittlesey bar south of Birnam about 3/4 of a mile that is above 775 contour. It is a strong feature for about 1/2 mile south but rather scanty gravel farther south. We drove north across the Port Huron moraine on a road 1 1/4 miles west of Arkona. Coming to the Warren beach 1 1/2 miles south of Thetford. We there turned east along the beach for 1 1/4 miles. Features here near Thetford were noted in August 1933. A clay ridge rising above Lake Warren level for 1/2 mile north from highway 7 and has strong cuts by the lake at north end a *mile* east of Thetford. On crossing AuSable River and rising to the ridge east we noted a gravel bar where it stands above the 700 contour for about 3/4 miles. The shore of Lake Warren as noted in 1933 is 2 miles south near the inner border of the Port Huron moraine.

Warren Beach 741 NE Park Hill

We drove north from Park Hill to second road north of Park Hill Creek, then east to the Warren beach. We leveled to it from the cross roads east at a school house and found it to have the same altitude 741 feet. This is 5 feet higher than Spencer gave as the level in the railroad 2 1/2 miles east of Park Hill. This interval is about 2 miles.

Near Zurich Warren 765 - lower bar? 750'

We followed the Warren shore north to the highway that runs east to Zurich, and noted a double beach at intervals. Here we leveled to both and found the higher 765' and the lower 750', using the 774' elevation at cross roads as our datum. This place is 165 miles from our last measurement, thus giving a rise of about 1 1/2 feet per mile in a nearly north course. The north place being only a mile further west than the south one.

Gravel Pit just east of Holmesville - 850 contour, Village below 675 contour

We drove east to Hensall across three morainic ridges of the Port Huron system with glacial drainage lines between them where streams flowed south into a narrow bay of Lake Whittlesey in the south-flowing part of AuSable River. The head of the bay seems to have been near this highway at about 820 feet or 35' higher than the Whittlesey beach at Arkona. It is 25 miles north and 15 east from Arkona, and not far from the direction of tilting. In the line of tilting the distance is about 28 miles. The rate thus appears to be about 1 1/2 feet per mile.

The glacial drainage leading south from Maitland River near Holmesville to here shows a fall of 48 or 42 feet in 16 miles counting from the terrace, at Holmesville but only 30 or 24 feet in the *old* river bed. If this is the proper one to use the fall is nearly 2 feet $1\frac{1}{2}$ ' in a nearly due N-S course. If the other it is 3 feet, $2\frac{5}{8}$ ' per mile. As this is not on the tilt line the allowance for tilting is not ~~60~~ *great, so great*. It may be reduced to about 1 foot per mile. Thus leaving $\frac{1}{2}$ ' to 1' per mile for the descent on the bed, and $1\frac{5}{8}$ ' to 2' from the terrace level.

On September 20 we ran levels from Hensall depot to the beach south of Hensall corners and found a rise of 25 feet to 920 feet A.T. Is this a Maumee beach? Or is it due to temporary ponding connected with the Port Huron *advance* with a blocking of southward discharge! Perhaps the Seaforth moraine which lies just east of here is older than the closing part of the Maumee lake stage?

We leveled also to a gravel deposit between the outer and middle member of the Port Huron system at north edge of the Grand Bend ~~Shut~~, it is 824'. The present drainage is NE from here but the glacial drainage may have been southward. It is in either case tributary to the glacial drainage south from Maitland River. It is 5 miles further north than the highway west from Hensall, and but 11 miles from Holmesville. Perhaps the drainage from Holmesville became divided, one part running through a low place in the east member of the Port Huron morainic system to this place and then south, to the head of the Whittlesey bay while the other part drained south on east side of the eastern member of the system. The small size of the channel east of this member favors this view.

We drove past Vorna to Holmesville along the eastern ridge of the Port Huron system. It has very strong expression here. There is a strong moraine outside the Port Huron system at Clinton, as noted last year.

We got the level of terrace and gravelly bed of the southward glacial drainage at Holmesville by hand level from the station which was taken to be 874', but I find White's *altitudes* of Canada makes Holmesville 880'. The terrace is 12 feet lower than the station or 868'. The river bed with gravel pits in it is 30 feet lower, or 850 feet. The *Soderich* map makes the pit 850' (Note August 1937).

From Goderich we ran levels SE on the highway toward Clinton to the Warren shore starting at the 720' geodetic survey B.M. on the court house. The first beach reached is at the gravel pits and is 786'. East of it is a higher one 795.5 feet. There is a gravel coating on west slope of a till ridge east of here by a N-S road north of the highway to Clinton that is nearly 800'. We find no higher gravel deposits or evidence of shore action here. We later went to the beach on north side of Maitland River 2 miles from this place and found a bench mark or altitude painted on a fence by the beach on the road that runs SE to BenMiller, 802' at about 3 feet below the crest of the beach. It is by the letter E in Goderich on the Huron county map we are using. At the cross roads near there by letter R in Goderich there is an altitude 818 on fence. There is a ridge here but we are not able to find an exposure of its material. The one at 805 feet is of gravel suitable for road use. If it is the highest Warren it is nearly 10 feet above the level of the beach south of the river, thus showing a rise of 5 feet per mile. The bar west of Dungannon as noted last year is 845 feet. We found that a survey has been run to it from the Blue Water Highway and there are altitudes painted at each of the cross roads, and at the base of the gravel on west side of the Warren bar, it being 816 feet. A pit in the bar shows it to have 15-20 feet of gravel at its crest. We ran levels to the westernmost altitude of this road survey from a geodetic B.M. 684.6 a mile NE of Port Albert near a NE brick house, and found it checked with that bench mark. The altitudes on the road are:

Bay BlueWater Highway	685.6
At first cross road east	716.8
At second cross road east	742.9
At next road east leading north	783
At next road east leading south	785
Base of gravel bar 816' Top of gravel bar	845

There is thus a rise of about 50 feet in 10 miles from the place SE of Goderich on south side of the river and 40 feet in 8 miles from the place north of the river.

We went north on Blue Water road to ^{IN?}Kurtail and then NE on a road to the county line, 5 miles. A road survey on the county line has altitudes on fences at cross roads, etc., as follows:

Where road from ^{IN?} Kurtail comes to line	697'
At road leading NE to Ripley	775'
At next road leading SW	802'
At next road leading SW	831'

The Warren beach is a few rods east at 848 feet. This is nine miles north of the bar west of Dungannon and only 3 feet higher. MacLachlan scouted over a higher tract SE from this beach and found till at surface of all knolls and ridges so is pretty certain this beach is the highest Warren. There is a strong beach of Lake Lundy west from here with a cut bank 15-20 feet high and a bar at top at 765 feet. East of the bar, gravel coats, the surface up to 774 feet. This is about as much above a bar in Goderich near the Court House (720') as the Warren beach at this county line is above the beach SE of Goderich, in both cases slightly more than 50 feet. This seems to favor making the shore the same one at the Court House as this one at the County *line*. We were able to trace this Lundy shore north 5 miles to Ripley it being near the west edge of the village. We also traced it south across 2 concessions, nearly 3 miles, and a pebbly sand was traced across two more concessions, or to the first road north of the one with the levels noted westward from Dungannon - the total length being nearly 11 miles. There is a cut bank for two concessions south of the county line and for one north.

We next ran levels to the Warren beach east from Ripley. There is a lower Warren $1\frac{1}{2}$ miles east that we visited last year with Hobbs and Stanley. It is 845 feet. East from it are higher bars, the highest being 865 feet near the second cross road east of Ripley. This is only 5 miles N NE from the beach on the county line at 848 feet, or 17 feet in 5 miles. The altitude at Ripley depot 806' was taken from White's altitudes in Canada-First Edition.

We next ran levels from the Lake Huron shore 5 miles north of Kincardine to the Warren beach at Mr. Conley's north of the United Presbyterian Church about 5 miles from the lakes. We took the lake level to be 578' as it is about 3 feet below normal level now.

The storm beach with driftwood in it is	588.5'
The Algoma terrace 15-20 rods wide	599
Top of bank above this terrace	604
Gravel and cobble bar Nipissing	609.5
Plain east of bar	608
Bar at base of steep bluff(Nipissing)	613
Base of Nipissing bluff	610
Top of Nipissing bluff	646
Ft. Brady or Battlefield bar, bouldery	648
Base of Algonquin bluff	659
Gravel on face of bluff in pit south of road (Algonquin beach)	677
The plain east is	685-690
Higher land north is above 700	
Water laid moraine a mile south about	800
Bluewater highway about	765-770
Gentle rise east to about	790
Change to steep rise to Water-laid	

Change to steep rise. Is this a Lundy shore?
 Top of steep rise to Waterlaid moraine 844'
 Near first cross road east of Bluewater highway.
 Gentle rise eastward for about a mile to where
 gravel sets in at 858-860'

This is about 40 rods west of cross roads at the Church.
 On the road north from the church the highest Warren beach is
 reached at 877 feet. This beach as noted October 1, 1953 runs
 northward about 5 miles and there appears to terminate near
 the head of Willow Creek. There is an undulating till north
 of the creek both east and west, with moraine ridges that run
 E NE - W SW here but they trend south of east on east side
 of Saugean River on the north side of the North Branch from
 near Paisley to Chisley as noted October 1, 1953.

The Warren beach is double near its north end. The higher
 member being 10-15 feet above the lower. The place to which
 levels were run is about 10 miles north from the beach east of
 Ripley and only 12 feet higher. It seems to be the highest
 Warren as it is nearly 20 feet above where gravel set in. If
 this rate of rise continues to the north end of the Warren
 beach its altitude will reach 883'. This is about 200 feet
 higher than the untilted part of the Warren beach. On our
 return September 21 and 22 we did some work around Goderich
 and mapped the Warren beach from near Dungannon to a road
 7 or 8 miles south of Goderich that runs east to Holmesville.
 We then went west to the Bluewater Highway. Altitudes are
 painted at road intersections on it, as follows:

Seven miles south of Court House in Goderich	667.1
Eight miles south of Court House in Goderich	662
at 9 1/2 " " " " " "	649.7
Eleven miles south of Court House (1 1/2 north of Bayfield)	645
Bayfields (top of bluff) Bay map	644
Plain in village	670
Road forks in SE part of Bayfield	685.4

The Bluewater highway turns south here. The Warren beach is
 1 1/2 miles E SE on road to Varna. This is 3 1/2 miles north of the
 north border of the Grand Bend map.

We went back to the Bluewater highway a mile south of the
 forks above noted and followed it to where a road runs south
 a mile west of the road through Thetford. We turned west
 on the Warren beach and mapped it as far as Forest. It is double
 or treble much of the way and is up to 725 feet within 2 miles
 NE of Forest. Forest depot is 711 feet, 6 feet lower than the
 Warren beach (717'). We drove south from Forest to Highway 7
 and west on it to Sarnia then followed Gratiot Avenue from
 Port Huron to Eight Mile Road in Detroit. West from there to
 Middle Belt Road and south to Plymouth road and west to Ann Arbor.

On our way to Canada September 19, we followed the Mt. Clemens moraine for 5 or 6 miles north from Mt. Clemens, and found Elkton beach in places at about 625', a pebbly sand slightly ridged.

On our return September 22, we noted that the inner border of the Port Huron waterlaid moraine is 2 miles west of Marysville on Gratiot Avenue and that it is $4\frac{1}{2}$ miles across the moraine on this highway, Pine River follows its outer border. There is some sand in the crest. Between Pine and Belle Rivers the highest land has a pebbly sand perhaps Wayne beach. There is cobbly material NE of Muttonville probably left by Lake Wayne. It is below the Warren beach which runs past Lenox a mile west of Muttonville.

Well Record at Excelsior, Minn.

A letter from F. W. Sanderson Nov. 30, 1933, has the following as to a boring near Excelsior, Minn.: "They have drilled a well at Miz_zentop, the south end of the ridge between Christmas Lake and Silver Lake near Excelsior (Minnetonka Quadrangle). The top of the well is at about 995' A.T. They went through:

Till 127'
Silt 103'
Blue till 51'

To sand and gravel at 281'

The well is on the line of a preglacial river as marked on my map (in recent issue of Pan American Geologist)

The water at 281' is the first flow found and the gravel may be the pre-Kansan river bed. Water rises to 905' A.T.

(Newspaper clipping pasted in notebook)

Development in Sterilization, Softening and Other Processing Extends City and Town Use of Resources

Notable changes have taken place in the method of providing water supplies for both cities and villages, largely in the field of water purification and the development of well supplies.

O. E. Meinzer, of the Division of Groundwater, U. S. Geological Survey, states that because of the improvement of pumping machinery and technique in developing wells in formations of sand, sandstone and gravel, there has been a tendency during the last 10 or 20 years toward increased use of well water.

Water Purification

Improvements in water purification include increased economy of operations and better methods. Also modern sterilization practice has largely done away with highly disagreeable taste-and-odor conditions which formerly were associated with purified water.

Methods of softening water have shared in the general improvement of water

purification. There has been a decided increase in the number of municipal water softening plants.

Mr. Meinzer cites as an example of the improvement in well drilling the Morris station at Camden, N. J., where about 100 old-style wells with a total capacity of 18,000,000 gallons a day have been replaced by nine wells.

Drilling of Wells

The importance of improvement in methods of well drilling is shown by the fact that about 6,500 out of a total of 10,000 public water supply systems in the U. S. are derived from wells, according to estimates made by Mr. Meinzer on the basis of incomplete data collected by the Geological Survey.

Most of the public water supplies are obtained from wells in virtually all the smaller cities of the U. S. except in New England, along the borders of the Great Lakes, and in some of the mountain and piedmont areas of the East and West.

Groundwater is almost invariably free from dangerous bacterial pollution, points out Mr. Meinzer, except in open-textured rocks, such as cavernous limestone, and in other formations near the water table in localities with surface pollution. In most cases of polluted groundwater supplies, the water has been found to be pure after it had been pumped or by surface pollution entering the wells at the top.

Qualities of Groundwater

Groundwater has the merit of nearly uniform temperature and is relatively cool in the summer. It is generally colorless and free from turbidity, except that produced by precipitation of iron oxide; and it is generally free from objectionable odor.

These advantages are particularly important to smaller communities but are of less importance to large cities that can afford effective treatment under rigorous supervision, according to Mr. Meinzer.

The largest groundwater development for public supplies is on Long Island.

Notebook 298

about 100,000,000 gallons a day are pumped for the New York City water department, and about an equal amount is pumped for other public supplies. This development is comparable in size with the major groundwater developments for irrigation.

Wells-Supplies of Houston

The largest city supplied entirely from wells is Houston. About 25,000,000 gallons a day is pumped from the public supply and about an equal amount from private wells.

Cities having between 5,000 and 25,000 population are about equally divided between groundwater and surface water supplies. Of cities with more than 25,000 population, more than one-fourth obtain their public supplies from wells. Of approximately 8,000 cities with less than 5,000 inhabitants that have public water supplies, 2/3 obtain their water from wells.

The 25 largest cities obtain their water supplies, with minor exceptions, from surface sources. On the other hand; there are several millions of private water supplies, chiefly on farms, in villages, and at industrial plants in cities which are obtained largely from wells.

How Nation Gets Water

Mr. Meinzer states that the best estimates available of the number of persons using well-water supplies give a total of 55,000,000 persons; 20,000,000 using public water supplies derived from wells and 30,000,000 to 35,000,000 dependent on private well supplies.

The Public Health Service has cooperated with the Geological Survey in educating the public to the importance of pure and wholesome water supplies. The educational work has been conducted through cooperation by the State Health departments and other public agencies interested in the betterment of health.

However, says Mr. Meinzer, much still remains to be done in providing more abundant, convenient and wholesome water supplies for the smaller communities.

(End of newspaper clipping)

At the Boston meeting of A.A.A.S., Dec. 1933, H. W. Clough of Arcade, N.Y. discussed weather cycles. Four long cycles of solar activity have been recognized outside the 11 year sunspot cycle. Their lengths are: 37, 83, 300 and 1400 years. Similar cycles have been traced in meteorological and other terrestrial conditions. The 37 year cycle culminated recently and is accountable to some degree for the very mild winters of the past few years and of the droughts of recent summers. The 83 year cycle culminated about 1860 and is due to repeat in 1940. The present tendency toward mild winters may be intensified by the overlap of two cycles.

The 300 year cycle culminated about 1725 and is due to return near the end of this century. The last minimum epoch of the 1400 year cycle was at about 650 A.D. and the next will appear near the middle of the 21st century A.D. (See Science for Feb. 21934) Supplement pp. 36.

A terrace in the Latour quadrangle on west side of Crowley's Ridge is 225-250'. This is north of Lat. 34°30' its south end being at Helena, Ark. and much of the city stands on it. What is its age in terms of glacial history? Is it as late as Illinoian?

Crowley's Ridge reaches 400' in a small area of a few acres in this quadrangle.

Notes on the new Miss. R. Conc. topographic maps of Mississippi valley, that Leverett has not purchased but which are in Geol. Dept. U. of M. Malden, Mo. NW corner is up to 350-355'. Plain east of it 305-310'.

Valley Ridge, Mo. Has a "Crowley's Ridge" in east half that reaches 400'. The border plain on east is 290-305'. On west 320-330'. There seem to be dunes in NW corner 320-340'.

Reyno, Ark.-Mo. Plain in SE 1/3 is 295' or less. Rest unmapped above 300-315'.

KNOXEL, Ark.-Mo. Dunes? in NW part 300-310'.

Rector, Ark.-Mo. Low bottom in NW half 275' at SW and 305' at NE. East of this is "Crowley's Ridge" about 10 miles wide. It has 25' contours above 300' & reaches 525 contours.

Notebook 298

Piggott, Ark.-Mo. Has Crowley's Ridge in NW part with points 525'.

Pascola, Mo. Low plain 255-270' except on west border 275-285+.

Powhatan, Ark. Upland W of Black R not contoured. Bottoms in SE 1/3 contoured up to 290' in bluff.

Walnut Ridge, Ark. Low bottom except in NW corner.

Gainesville, Ark. East half on Crowley's Ridge is up to 525'. Terrace west of ridge is 300'+. But land to west is 280' or less.

Marmaduke, Ark.-Mo. Has Crowley's Ridge in NW 1/3 up to 525'. Gentle slope N of Marmaduke from 350 down to 270'. The SE 1/3 is 250' or less.

Kennett and Hayti, Mo. All in low bottom.

Dyersburg, Tenn. Only about 50 sq. miles in NW part contoured mainly 275-285'.

Strawberry, Ark. Only about 50 sq.miles in SE part contoured 230-240'.

Alicia, Ark. All low bottom, about 250' except narrow strip on west side west of Black River.

Sedgwick, Ark. East part on Crowley's Ridge reaches 425'. Bottoms west of it 240 or less.

Jonesboro, Ark. On Crowley's Ridge except 75 Sq.Mi. of lowland in east part and small area in SW corner. Alt. 220-270' A few points on ridge 500'.

Leachville, Ark.-Mo. Low bottoms 220-230. Rise to 265 in NW corner.

Manilla, Ark.-Mo. Low bottom mainly 220-230'.

Halls, Tenn. Only 10 sq.mi. in NW and same in NE contoured 260-280'.

Newport, Ark. About 25 sq.mi. of upland in NW corner and same in SW. Narrow ridges (dunes?) in the bottoms, trend N-S. Bottoms 215-240'.

Tuckerman & Weimer, Ark. All low bottoms 215-250'.

Dee, Ark. In west half Crowley's Ridge 2-3 miles wide up to 425'. Bottoms on east 205-225'. On west 245-260'.

Marked Tree, Ark. and Evadale. Low bottom 205-225'. Mississippi River in SE corner of Evadale is below 200'.

Rialto, Tenn. Contoured only in valleys of Hatchis R & Cold Cr.

Bald Knob, Ark. About 50 sq.mil in SE part in bottoms about 200'. The uplands reach more than 300'.

Augusta, Ark. Broad White River bottoms 6-8 miles largely uncultivated. Uplands west and plains east are cultivated.

Tilton, Ark. All low bottom.

Vanndale, Ark. On east border Crowley's Ridge up to 375' or more. Bottoms 220-230'.

Princedale, Ark. West part on Crowley's Ridge 425-450'. Bottoms east of ridge 200-210'

Deckerville, Ark. Low bottoms with old Miss. R meanders.

Millington, Tenn. Miss. R crosses NW corner is below 200'. Bottom land there and on Loosahatchie contoured.

Kensett, Ark. Upland only in NW and SW corners.

Gregory and Hunter, Ark. All bottom land.

Wynne, Ark. East half has Crowley's Ridge up to 400'. Bottoms west of it about 210'.

Whitmore, Ark. Crowley's Ridge in west part reaches 435'. Old Miss. meanders east of ridge.

Hazen, Ark. Bottom lands 220-230 with rise in N part of west border to 260'.

Devalle's Bluff, Ark. Bluff W of White River up to 220'; strip east of White R. near Biscoe 190'+. NE & SE parts 180-190'. Broad bottoms of Cache R. 155-170'.

Brinkley, Ark. Bottoms are 180-210'+.

Marianna, Ark. Crowley's Ridge in NE part reaches 400'. Terrace west of ridge 215-250' extends half way down from N. line. Bottoms W (or N???) of Laignelle R. 185-220'+.

Park Place, Ark. Crowley's Ridge in W part of N. half up to 394'. Miss R. barely crosses S. border at "Walnut Bend". Highest part of Natural level ^{or} ~~200'~~ ^{Levee??} 200'+. Old meanders or meanders??? conspicuous.

Clarendon, Ark. Plain W. of White R. 210-220'. Valley bottoms 155-165'.

Holly Grove, Ark. Bottoms 170-180 narrow strip E. of Bladkton 200-205'.

Marvell, Ark. Bottoms mainly 175-180' but partly 210-215'. This lies west of S. end of Crowley's Ridge which barely reaches 400' in Latour quadrangle near Helena.

Pastoria, Ark. Area W. of Arkansas R. contoured to 260'. Plain east of river 210-220'. River about 185' at S.

Altheimer, Goldman, DeWitt, Indian Bay, Ark. All bottom lands.

Noble Lake Upland in SW part up to over 300' (not contoured). Old Arkansas R. meanders, conspicuous. Nat. levees 190-205'.

Varner, Ark. Old meanders of Arkansas R. conspicuous. Natural levees 180-190'. River down to 150' at S. edge.

Gillett, Ark. Old meanders only near river. Highest bottoms 180-190'.

Fennyville, Ark. Only NE corner in bottoms, 10 sq.mi.

Rotan and Red Fork All bottom land. Meanders of Arkansas only near stream.

Page, Miss. Old meanders of Mississippi conspicuous.

Cominto, Ark. Contoured only along east border.

McGehee, Ark. All bottom land.

Choctaw, Miss. Meanders most conspicuous in SE part farthest from the river.

Mist, Ark. Contoured only on lowland in east part.

Lake Village, Ark. Old meanders of Miss. R. in east part.

Tralake, Miss., Baird and Mossy Lake, Miss. Conspicuous Miss. R. meanders.

Seven Pines East part on upland. Miss. meanders in W. part.

Wilmot, Ark. Contoured only in east half.

Edora, Ark. All bottom land.

Swan Lake, After, Mileston, Miss. Meanders of Miss. Conspicuous.

Lexington, Miss. Only west edge contoured.

Haile, La. Contoured only in E. half bordering Ouachita R.

Naff, La. The lowlands are 80-90'. A ridge NE of $\frac{1}{2}$ Bastrop reaches 155' and the north $\frac{1}{3}$ has similar altitude.

Bonita, La. All bottom land.

Oak Grove, La. Ridge runs NNE-SSW through central part. Highest points 125-135'. Width ~~is~~ 2-3 miles. Nat. levees about 100' but bottoms usually below 100'.

Lorenzen, Bayland, Valley, Miss. Conspicuous Miss. R. meanders. E. part of valley on upland uncountoured.

Gellenston, La. The NW part in Morehouse Parish??? reaches 140'. The west edge of map is a little higher than the $\frac{2}{3}$ east of it which stand 65-80'.

Hurricane, La. All below 100'.

Mitchiner Ridges in W or N?? part 100-105'.

Onward, Miss. Old Miss. meanders about 90' SE corner on upland "Haynes Bliff".

Mechanicsburg, Miss. Upland in SE part. Miss. meanders in NW.

Monroe, La. Upland close to Onacheta R. on west. Bottoms 60-70'.

Alto, La. E. half cultivated 70-85' W. in first 60-70'.

Baskinton, La. Narrow ridge in center of SE $\frac{1}{2}$ N-S 5 miles is 100-125'. Remainder below 100'.

Notebook 298

Waverly, La. Has old meanders of Miss. used by Teusas River. Alt. only 70-80'.

Talla ~~Map~~ ^{Jena} La.-Miss. Has meanders of Miss. used by Walnut Bayou.

Columbia, La. Ouachita/ natural levee 65-70'.

Fort Necessity, La. Bottom land mainly below 70'.

Winnsboro, La. Up to 95' in north part near Crowville but mainly below 75'
East part timbered 65'

Shakleford Lake, La. Large meanders occupied by Teusas R.

Jokena-La.-Miss. Only W. edge and Big Black valley contoured. Miss. R. in NW corner.

Harrisonburg. Upland west of Ouachita R. is over 125'. Sicily Island in east part reaches 241'.

Sicily Island The east part of Sicily Island is in this map and has points noted 233, 239, 241, 259'. This island is briefly discussed by A. C. Veatch in the 1902 report La. Geol. Survey pp.156-158. It has been cut off from the upland west of Ouachita R., he thinks, as a result of aggradation about as the Commerce, Mo. bluff has been cut off by the Miss. The Ouachita R. has rapids on the rock now in this passage and the valley or gap is only 1 1/2 miles wide between Sicily Island and the bluff west of the river. This island and the bluff to the west has the resistant Grand Gulf sandstone of Oligocene age outcropping and it is this formation which causes the exceptional narrowness of the Miss. valley here for it continues across the valley in Miss. The surface of Sicily Island has a less capping. Most of the Sicily Island quadrangle is between 45 & 70'.

Pollock, La. Is contoured along Little River and some tributaries. The upland has points above 200'.

Jena, La. Only the SE part around the north end of Catahoula/ Lake is contoured. The lake is below 30'. The upland reaches 180' along the RR east from Jena.

Manifest, La. The NW part 15-20 sq.mi. is upland. In this map the Ouachita, Teusas and Little Rivers unite to form Black River.

Buckeye, La. Has south part of Catahoula Lake (below 30'). The SW part of map is upland.

Kingston, Miss. Only the west side and the Homochito valley are contoured.

Turkey Creek, La. Mainly upland but east side is low 40-50'.

Opelousas, La. The bluff is 60-70'. Bottoms 30'±.

New Roads, La. (Part of Bayou Sara 1 map), Traversed by Miss. R. which 125000 runs close to its east bluff. The contours of upland are taken from Bayou Sara map.

Zachary, La. Part of the Bayou Sara quadrangle 1 . Only the SW corner is 125000 in the Miss. bottoms. The uplands reach 160' in north part.

Baton Rouge, La. This has 5' contours throughout.

Dergouen, La. Has contours only on Bayou Teche in NE part. Weeks island is shown and also Avery island but not contoured. Hilgard in Am. Journ.Sci. January 1869, has article on "Geology of Lower Louisiana" which discusses the "Five Islands". Gate Blanche is 180' and Weeks and Avery Island each 160'.

Belle Isle is a promontory west of Atchafalaya Bay. Hilgard refers to a paper by Thomassey published in 1860 in Geol. pratique de la Louisiana New Orleans, in which the "Grand Coteau des Opelousus" and "Avoyelles prairie" are included with the prominences called "The Five Islands".

Salt was struck on Avery Island in 1862 in a well sunk by D. H. Avery. The level of the top of salt is from $1\frac{1}{2}'$ above sea level to 32' below in part tested. "Orange Sand" forms the nucleus of Avery Island with "Port Hudson" clay on the outer slope and highest points.

On Weeks Island the top and central strata are "Orange Sand". On the exterior lower slope the Port Hudson green and blue clays with calcareous concretions and fresh water shells are found.

Millers Island mentioned by Hilgard overlooks the plain of the Vermilion.

Cote g lee in Lafayette parish may be similar. It trends N or NNE to S or SSW.

Jeanerette, La. Is contoured only along Bayou Teche and that incomplete for 5 and 10' contours (15' complete).

Foster, La. Contoured complete along Bayou Teche.

Napoleonville, La. Contoured along a bayou in NE part with broad natural levee like that of Bayou Teche. It has 5, 10, & 15' contours.

Bayou Sale, La. Contoured along Bayou Sale in SE part. Only contour 5'.
Highest land 8.5'

Belle Isle, La. Contoured in north part along Bayou Teche 5 & 10'.

Morgan City, La. Contoured along Bayou Boueff?? Highest land below 10'.

The Carenoro map shows old meanders of the Miss. on a higher plain than that in which Bayou Teche flows in a broad natural levee made by the Miss. It is up to 50-52' in SE part of the quadrangle and 53.5 about 2 mi. N. of Carenoro Village. The natural levee of Bayou Teche opposite here is 25-27.4' as shown in Arnaville map.

In St. Martinsville map old Miss. meanders near Broussard on between 30 & 35' in Nat. levee. The Bayou Teche opposite has nat. levee up to 25' just north of St. Martinsville. It thus shows very little decline compared with that in the district west of Bayou Teche. How much earlier are the meanders west of Bayou Teche than the great natural levees of the Miss. along Bayou Teche? The features of Iberia Parish are discussed in Geol. Bull. No. 1 of the Dept. of Conservation of State of La. and those of Lafayette and St. Martin's parishes in Bull. 3 of this series. There are several salt dunes?? discussed that have recently come into prominence, three being in St. Martin Parish "Arise la Butte Bayou Bouillon," and

Notebook 298

"Section 28" and one just east, the "Bayou des Glaise" dome. The Anse la Butte is in SW part of the Armandville map and rises 17' above bordering depressions. The others have no surface relief.

A paper in Proc. Indiana Acad. of Sci., Vol. 41, 1932, pp. 351-354, notes drift at the following places outside the limits noted by Leverett and Malott in 1924:

- Sec. 24 T 6 N R 2 E)
- " 36 " ")
- " 19 T 5 N R 3 E) In Jackson Co., Indiana

- " 24 T 3 N R 4 E)
- " 29 " " R 5 E)
- " 32 " ")
- " 35 " ")
- " 4 T 2 N ")
- " 12 " " R 4 E) In Washington Co., Indiana
- " 19 " " R 6 E)
- " 30 " ")
- " 33 " ")
- " 4 R 1 N ")

Sec. 34 T 2 N R 6 E - In Scott Co., Indiana

"Ecological conditions during loess distribution" by B. Shunck, Univ. of Iowa Studies, Vol. 14, 1931-32, pp 38--61.

Loess at Natchez, Miss., was described by Rev. Elias Cornelius in Am.Jrn.Sci.in 1818 and regarded as alluvial.

Richthofeus hypothesis of eolian origin, as the mode of deposition of loess in China made in 1870 did not for some years come to be applied to loess in America. Todd especially wrote against it. The fossils in it are dominantly terrestrial, yet the literature is full of references to "fresh water shells" in it. The few fresh water pulmonates in it usually live in shallow ponds such as might be found in loess-covered districts.

These land forms have not been washed in from adjacent lands but lived in the deposit.

There is no good basis for making it the deposit of a lake or flooded condition of the region. No shore lines or other evidence of a water body.

There is no evidence of a drifting of the shells either in vertical or horizontal distribution. They occur at all levels and are not restricted to low areas, as they should be if drifted in.

Shunck in 1896 advanced the view of an eolian origin gained from a botanical study of the food on which these mollusks feed. He was ignorant at the time of Richthofeus writings on the origin of loess.

The value of this molluscan fauna of the loess for determining climates and habitat conditions lies in the fact that it includes species still living whose habits and dependence upon living plants are well known. The entire fauna is such as to suggest a temperate climate similar to the present during loess deposition.

The evidence is clear that plants had a controlling part in holding the loess

Notebook 298

after it settled on the land to prevent it from washing away. Its uniform thickness in many places suggests deposition in forests rather than grassy plains.

Shunck holds that the fossils in the loess do not sustain the view that the loess was laid down during a time of distinctly colder climate than the present.

The Platte River in Nebraska and the Missouri in that and other states have wide bottoms on which sediment in form of bars ~~are~~ are exposed in dry seasons to furnish material for the wind to gather up and carry over the border lands. These are much more important sources than the surface of the Iowan drift which furnished some material for deposits on its border.

He says a young or freshly exposed drift would soon be covered with protective vegetation and thus not a continuous source of supply such as the river bars. An old ~~drift~~ drift would be more likely to have broad valleys opened in it that would carry bars to supply the loess material. He thus holds it probably that most of the loess was deposited long after the ice had disappeared, and there had been time enough for the large valleys to be found in which the bars are present.

He says in conclusion: "The loess instead of being closely connected with the ice sheets was evidently widely separated from them in time".

Pre-Illinoian loess in Fulton Co., Ill., reported by Geo. M. Ekblow of Ill. Geol. Survey. Location NW $\frac{1}{4}$ of SE $\frac{1}{4}$, sec. 27, T 3 N, R 2 E, in valley of Wilson Creek. See Jour. of Paleontology, Vol. 40, Jan. 1936, for interpretation by F.C. Baker.

The top 6 inches is highly fossiliferous and a few fossils at 12 inches but none from there down. The loess shows reddish or pink color at 70-74 inches but is blue and clayey at 82 inches over a black soil zone.

Below the black soil is a sandy silt showing greenish color at 6' and yellow color at 9 and 12'. Gravel and greenish silt at 15'. A second black soil zone at 18' below upper one. A greenish silt at 21'. A third black soil zone at 23' below top one. Gravel bed at 25' below top black soil zone. He interprets the gravel to be Kansas outwash. The silts are classes as wash with some wind action. The black soil zones as forest products. The blue silt over the top black soil zone suggests water deposition but true loess overlies it and extends to the top of the section. The fossils in the upper 1 foot were classified by F. O. Baker of the Univ. of Ill. and reported in the Journ. of Paleontology, Vol. 10, Jan. 1936, pp. 72-74 as follows:

Polygyra hirsula?? at 2, 4, 6, & 12 inches.

Discus MacClintocki at 2 & 6 inches.

Enconulus Fulvas (Müller) at 6 inches.

Strobileus colyriathica (Say) at 6, 4, & 2 inches

Helicodiscus Paellelus (Say) at 2 & 4 inches

Succinea ovalis pleistocenica (Baker) at 2, 4, & 6 inches

Retinella electrina (Gould) at 2 & 4 inches

Succinea grosveneri gelida (Baker) at 2 & 4 inches

Cochlicona lubrica (Müller) at 2 inches

It is suggested that the Illinoian ice sheet planed off the upper part of the loess and removed an unknown amount of material.

Except Discus MacClintocki all of the species are living in Illinois and the Upper Mississippi valley at the present time. The two varieties of Succinea are found in typical form only in the Pleistocene. Small pupoids abundant in other secs. of loess are notably absent.

On pp. 74-76 of the same paper Baker gives a classification of loess fossils over the Wisconsin drift in Barran Bureau Co., Ill., center of SW $\frac{1}{4}$, sec. 34, T 17 N, R 8 E. The upper 6' of loess is leached. Below it is 5' of calcareous fossiliferous loess resting on gravel.

The lowest 15 inches has but one species of fossil succinea grosveneri gelida (Baker). The next 15 inches has 3 species: S. grosveneri gelida, Columella alticola (Ingersoll), Vertigo modesta (Say).

The next includes an additional species: Pupilla muscorum (Linné). The next higher 15 inches the additional species Discus Cronkheiter anchonyi (Pilsbey).

It is thought the loess was laid down soon after the ice sheet disappeared and that the scarcity of fossils in the lower part is due to lack of favorable conditions for such life. Grassland probably preceded forests and the succinea could thrive in it. Forests probably had started by the time the second 15 in. were laid down - perhaps open woodland. The third and upper 15 inch horizons seem to show a well developed forest habitat.

Of the 5 species here found three are not now found living in Ill. but are widely scattered over regions outside. The loess' fossils here are also all small pupoids. Not a large snail such as inhabit that region today being present. Whether the difference is due to climatic or to environmental changes is not fully cleared up.

Two Creeks Forest Bed - By L. R. Wilson. Trans. Wis. Acad. Vol. 27, pp 31-46, 1932 or 51

On shore of L. Mich. in Manitowoc Co., Wis., secs. 11 & 13, T 21 N, R 25 E. Length of exposure 1/2 mile. Same bed is exposed 3 miles north in sec. 35, T 22, R 24 E.

It is above varved clays in the Gray drift (Middle Wis.) under the Red drift (Late Wis.).

Goldthwait noted it in 1907 and Thwaites visited it later. The varved clay (thickness 12') is a deposit of Lake Chicago. It has gray and some red color and includes sand lenses. The forest bed has several inches of silty sediment over it laid down in advance of the red drift invasion. The red drift is 8' thick.

This is covered by varved Lake Algonquin sediment. At least 82 yrs. are involved in the forest bed as shown by rings on a log imbedded in it. The establishment of the forest may have taken several times as long. The wood is spruce of two species and indicates a climate like that of northern Minn.

Seven species of mollusks, all but one of existing species. Thwaites suggests the red drift gets its color from material in iron ranges to the NW. Moss and peat in the forest bed as well as logs.

Varved clays of Wisconsin by Elmer E. Ellsworth. Trans. Wis. Acad. Sci. Vol. 27, pp 47-58, 1932:

There are four main areas of varved clays.

1. Lake Chicago, Glenwood & later stages
2. Glacial Lake Oshkosh
3. Glacial Lake Wis. (mainly in driftless area)
4. A glacial lake in NW Wis. at end of the Grantsburg lobe.

The varve records were submitted to DeGeer for interpretation and he placed those of NW Wis. several centuries later than those in the Lake Oshkosh and Glenwood stage of Lake Chicago.

It seems to Leverett doubtful if this is the case.