Notebook No. 299 - Leverett

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October 27, 1934

I went into Ontario to finish tracing of the Lake Rouge features south from Windsor to Amhurstburg.

In Windsor I leveled up to the ridge south of the waterworks on Langlois St. The terrace north of it is 600 feet and the ridge 609 to 612 feet. South of it at Wyandotte Street the altitude is about 600 feet.

The drainage across the Detroit Interlobate Moraine seems to have started at fully 600 feet A.T. There is a gravelly coating south of the Ambassador bridge to about 600 feet. The 600 feet area in east part of Sandwich has a sandy gravel which by hand level from the 586 BM at the Essex Terminal R.R. is 602 ft.

The bar nearer the railroad is 597 ft. A pit in it 6 ft. deep shows gravel of medium grade, not much rounded.

The delta along Sandwich Ave. below the Ambassador Bridge is about 595 ft. There is a thin deposit over a bluish clay. Apparently a lake clay like that at the brick yards in west part of Detroit. This reaches fully 590 ft. in places. The swales that came into the upper end of Lake Rouge near the south end of the Ambassador Bridge are down to about 590 ft. or 10 ft. lower than in the east part of Windsor and fully 10 feet lower than the gravel deposits bordering the swale south of the bridge.

The east border of Lake Rouge is marked by sandy deposits southward from the delta to about 2 miles into the Amhurstburg quadrangle but are very scanty further south. There is a very level tract with clay soil and scattered boulders over the area below the 600 contour as well as above it.

There is a slight suggestion of shore work west of Lukerville, 1/8 mile S from the crossroads with a perceptible downward slope to the west and a slight sandy coating. This seems likely to mark the Lake Rouge limit. The shore is not clearly defined soth or southwest from there so it is not feasible to trace it into the head of the Big Creek drainage in the way I had hoped to do. The lake may have extended to within two miles of the place where Big Creek is crossed by the M.C.R.R. east of the quarries. The valley of Big Creek is very narrow and sinuous for a mile above the railroad bridge but is wider where the creek turns from a N.W. to a S.W. course. There is a wider channel on a small tributory north from there than on the creek above this bend. It suggests a spillway coming in from the north. This seems to open out into a featureless plain within a mile from the bend of Big Creek. That plain may have been covered by Lake Rouge. Just below the railroad bridge Big Creek valley becomes much broader and has more the appearance of having been a spillway of Lake Rouge. The narrowness near the railway may be due to a rock barrier but I did not see outcrops onthe E-W road ¼ mile north of the railroad where the valley is about as narrow as at the railroad. The limits of Lake Rouge seem to have been within three miles south from the place where Canard River turns from a N.W. to a S.W. course and to have there had a discharge into Big Creek. The map has the name "Splitlog" in the concession that seems to take in the head of the Spillway. The limits of Lake Rouge were probably near a line running westward from where "Splitlog" is put, but the shore is not definite enough to locate precisely. The contour map shows areas above 600 ft. north of Amhurstburg. These are not likely to have been covered by Lake Rouge. The place near Gordon Station where the 600 contour is put very close to Detroit River did not seem to be 30 ft. above the river but I did not level up to it.

The channel that branches off from Detroit River in south part of Amhurstburg is only 5-6 ft. above the present low stage of the river, (570) ft. It has been filled at its head to prevent the river from flowing through it at high stages. This channel though scarcely 1/8 mile wide has the aspect of a strong stream course.

On returning to the bridge I followed Highway 18 from the Canard River north except for a short distance near the border of the Amhurstburg and Windsor maps. A sandy ridge sets in there north of the mouth of Turkey Creek which reaches about 585-586'. This is present for about 3 miles. It is like the ridge on the Michigan side south from River Rouge, a little lower than the Upper Rouge beach.

After crossing the bridge I went west on Lafayette St. along the border of the delta preserved on that side of the Detroit River and along Fort St. past Woodman Cemetery. The delta is mainly north of Fort St. all the way to Rouge River. It is a more sandy feature than on the Ontario side of the river.

Correlative Ice Border of Lake Warren

The correlative ice border of Lake Warren in the district south of Lake Ontario seems to need further study. Taylor thinks the Niagara Falls Moraine marks it.

Fairchild makes the Waterloo-Auburn Moraine a correlative of the "Second Lake Warren". The first Lake Warren he thinks is present no further east than the Pondgeodetic Station near Batavia.

The Niagara Falls Moraine seems to pass eastward to this Pond Station and thus sustain Fairchild's interpretation that the First Lake Warren is found only west from there. It thus seems a probable correlative of the First Lake Warren. The Waterloo Auburn Moraine in that case may find westward continuation in the Barre Moraine as a later moraine and not in the Niagara Falls Moraine. The Niagara Falls Moraine passes close to Fort Hill in Ontario where Spencer reported a definite Lake Warren terrace at 793 ft. This feature may prove to pertain to the Second Lake Warren for the altitude given is 9 ft. lower than that of the First Lake Warren beach at Eden N.Y. As it is further north, one would expect it to be higher than at Eden if it marks the same lake stage, but it may fall more consistently in the Second Lake Warren. In that case, the ice border at the time it was formed probably was at a later position than that of the Niagara Falls Moraine.

The Niagara Falls Moraine as mapped by Taylor (and as appears probable from the contours of the maps of the Dept. of Militia and Defense) runs to the west ~~and to~~ end at the Ontario Basin, keeping above the Niagara Escarpment. Its continuation seems likely to be ~~west~~ Northward from the Dundas Valley in a moraine that is shown in the Hamilton map from Greensville past Millgrove or Blacks Corners to Lowville. Possibly it was further west for Taylor reports in his paper on the Moraine Systems of Southwestern Ontario, p.19, that "Along the front of the ice in this position there was a large glacial river flowing close to its edge from near Limehouse to a point 5 or 6 miles north of Capetown, where it entered Lake waters and deposited a considerable quantity of gravel and sand". The place referred to where ponded water was entered is in the

S.E. part of the Galt quadrangel at an altitude between 800 and 825 feet. This seems to fit fairly well into the Lake Warren plane. It is also at the extreme n.e. limit of that lake at the west border of the Ontario Basin. Moraines in the Hamilton map may correlate with the Second Lake Warren. In this paper, Taylor attempts to bring the Scarboro Moraine to the west end of the Ontario Basin but this seems an unlikely continuation. It is based on a theoretical rather than actual mapping. The position here suggested takes it up to the interlobate over in the N.W. part of the Hamilton map instead of north of Toronto.

A letter from Prof. A. P. Coleman Oct. 25 says, "There is a southward projection of the Interlobate Moraine to Toronto and Scarboro. This is probably what Taylor calls the Scarboro Moraine in his paper on the Moraine Systems in S.W. Ontario in 1913. In that paper he made it run N.E. from Scarboro to Claremont and then east to 4 miles east of Columbus. West of Toronto he thought there were lobes in the valleys of Credit Etobicoke and Humber rivers that reflected the sensitiveness of the ice to topography. He then attempted to correlate it with the Albion Moraine in New York. The inference seems rather farfetched and not easily demonstrable.

In his paper on the Moraine Systems of southwestern Ontario, Taylor, on p.12, mentions the Clinton Moraine, stating that it is a strong moraine lying west and northwest of Clinton and ending abruptly at the Bayfield River. It there passes under the Wyoming (Port Huron) moraines. Its course was not mapped northward from Clinton by Taylor.

This moraine seems likely to be the ice barrier of Lake Maumee at the most expanded stage of that lake. The plain east of the Port Huron Moraine from near Clinton southward to Lucan Ja is apparently the bed of Lake Maumee as exposed outside the Port Huron Morainic System. As noted in our recent leveling at Kinshore, its beach is 920 ft. or about 100 feet higher than the level reached by Whittlesey waters in that latitude. This seems likely to be the "Middle Maumee" the latest of the three Maumee beaches. It is about 780 ft. in the Ann Arbor quadrangle where the upper Maumee is fully 800 ft. The upper Maumee, however, seems to be present clear up to Imlay. It is 820 near the north side of the Rochester quadrangle and about 850 near Imlay. The Maumee beaches in St. Clair Co. at about 820 feet are probably Middle Maumee.

Taylor in mon. 53, p.349, discusses the ice barriers of Lake Maumee, one being in the Huron Basin and the other in the Erie Basin. He thought that Lake Maumee near its close had a short stretch of northern land shore in the vicinity of London Ontario though he had not in 1913 identified the shore there. (Mon. 53, p. 349) on the same page he states that the Yale Moraine may mark the position of the ice at the closing stage of Lake Maumee or possibly the ice barrier was still further north. It now seems probable that the Yale Moraine was such a barrier and the ice became stagnant after forming it and wasted away on the district between the Yale and Port Huron Moraines, and that after it had melted Lake Arkona covered that area in the Saginaw and Huron basins.

The Yale Moraine fades out as a topographic feature near Avoca but it may find continuation southward and take in the "Emmett" moraine in the eastern edge of the Mt. Clemens quadrangle. The Emmett Moraine has been supposed to continue southward into the Grosse Pt. quadrangle but it may be found that it finds eastward continuation on the north side of Lake St. Clair. In that case,

it may run from the St. Clair delta northeastward and pass under the Port Huron Moraine and becovered by that moraine to Clinton, Onario. This view may help to explain why there is a Lake St. Clair Basin, it being the unfilled tract just outside the ice barrier of Lake Maumee. The district on the north side of Lake St. Clair was built up to a level 25 to 40 ft. higher than the bed of Lake St. Clair in a way that is suggestive of deposition at the edge of the ice.

It remains now to search for evidence of the presence of Maumee waters in the district south from Lucan Crossing. Perhaps some of the gravel ridges on the Seaforth Moraine will prove to be lake features rather than glacial. The lake waters seem likely to have been above 825 feet near Strathroy for it is fully 860 ft. near Lucan Crossing. There are a few knolls on the Seaforth Moraine west from Strathroy that catch the 825 contour and some of them are gravelly. An abrupt rise from 825 to 900± near Komoka suggests a shore line. The lobe on the Erie basin passed into Lake Erie near the line of Pennsylvania and Ohio where it passed under Lake Erie on the north side remains to be determined. There seems to have been a great recession of the border in that basin during the life of Lake Maumee. It stood at the Defiance Moraine in the early stage of the lake.

W. A. Johnston in a letter dated Nov. 14, 1934 sent a profile sheet in which he had plotted profiles of the Herman and Campbell beaches of Lake Agassiz taking elevations in Minnesota from these given in Prof. Paper 161, U.S.G.S. and in Manitoba and Ontario from his own work.

A connection between the Herman beaches in Minnesota and in Manitoba as made at Redby and Treherne, and of the Campbell beach at Karlstod and Treherne as the isobases pass through these points very nearly. He interprets from this plotting that the highest beach at Glenmel is the 2nd or 3d highest of the Herman series of beaches and that the beach at Kin at 1365' may be the lowest of the Herman beaches. The tilt rate of the Campbell beach in a NNE direction in northern Minnesota appears to be much less than that of the same beach in Manitoba in a corresponding position.

There is a strong beach at Gunne on the Can. Pac. R.R. 90 miles N. 25° east of Manitou at about 1275 feet which may be the Campbell beach but this is not certain.

The Lake Agassiz deposits east of S.E. of Gunne extend up to at least 1500 ft.

The tilt rate of the highest Herman beach in N.W. Minnesota appears to be about the same as that of the Herman beach in western Manitoba or perhaps a little higher. What appears to be the lowest Herman beach is the only one that is developed north of Treherne except for a beach at 1490 ft. 4 miles west of Cowan. This appears to be a little too high to be a continuation of the highest Herman beach, but may prove to be its equivalent.

A comparison of the tilt rates of the Herman and Campbell beaches in N.W. Minnesota with those of the same beaches in Manitoba suggests that the highland region of N.W. Minnesota and adjacent parts of Ontario were uplifted to a greater extent than the region to the N.W. in Manitoba during the time when Lake Agassiz was falling from the Herman to the Campbell stage; and that the highland region was uplifted to a less extent than the region to the northwest

after the forming of the Campbell beach; that is, the locus of uplift shifted to the north of northwest.

The Kaministiquia, Lake Algonquin, clays occur up to a little above 1500 feet near Raith and Buda nearly at the watershed along the Can. Pac. R.R. N.W. of Port Arthur. This indicates that differential uplift at Raith amounted to about 900 feet for the altitude at the Port Huron outlet ~~or only 60'~~ only 600'. If the profile of the highest Herman beach is extended to Raith an uplift of about 800 ft. is indicated by a comparison of the beach near Lake Traverse (986') and the estimated altitude of its plain at Raith. Perhaps the Lake Agassiz outlet region was uplifted somewhat more than the Port Huron Outlet of Lake Algonquin. The question of tilting is so complicated that Johnston finds it difficult to arrive at satisfactory conclusions.

November 18, 1934. On a trip by auto from Ann Arbor to Cleveland, Ohio, with Prof. Heber Curtis on No. 2 Ohio east from Toledo. This route is near the border of Lake Erie all the way. There is much land near Lake Erie level with reeds, cattails etc. and streams are dead as far east as Vermillion River. East from this river the steep sided ravines appear. The road cuts are generally in clay. In a few places there is a low terrace within 5 ft. of lake level. Is this likely to be the Fort Erie beach? There is such a terrace in Cleveland at the moth of Cuyahoga River.

The autumm meeting of the National Academy of Sciences was held at Cleveland November 19-21.

The papers on Nov. 19 were on Physics, Astronomy and Mathematics. Technical papers. Prof. Curtis gave a moving picture taken by McMath of the Solar prominences which seemed to be about the only one that a mixed audience could get any ideas from.

In the opening of the meeting the presidents of Cass School and of Western Reserve University welcomed the members and Pres. Campbell in response reviewed the achievements of scientific men in the two schools, such as Michelson, Morley and Miller and the valuable contribution by Swasey in astronomical apparatus. Swasey and Miller were present. Swasey is now about 88 years of age and maintains an active interest in scientific matters.

Geologists in attendence Nov. 19 were Bowman, Leith, Leverett, Keith, Schuchert, and Wright and Ruedeman. David White had planned to attend but his physician objected because he has very little reserve strength now.

At the Academy Dinner Nov. 20, the Mary Clark Thompson medal was awarded to Charles Schuchert for important services to geology and paleontology.

On Nov. 21, I presented a paper as joint author with Donald C. MacLachlan on "Variations in tilt lines in the Huron-Erie district."

Attention was called to the difference in the trend of the Arkona and Warren tilt lines in the Saginaw Basin and west side of the Huron Basin. This is very apparent in the Shepherd quadrangle recently issued in photolith form by the U.S.G.S. The Arkona tilt line bears only a few degrees east of North while the Warren bears about N.N.E. The area of uplift thus seems to have been shifted eastward at time of Lake Warren.

Attention was called to the shift in the direction of Warren tilt lines in Ontario, the trend being N.N.E. on east side of Lake Huron and about N.E. on the peninsula between Lake Huron and Lake Erie and back again to N.N.E. in the Erie Basin. It is suggested that relief from ice weighting which came earlier on the peninsula than in these basins may have allowed it to be uplifted somewhat in advance of the uplift within the basins and thus to have induced the peculiar trend.

Attention was also directed to variations in the rate of rise of the Warren beach on the east shore of Lake Huron from about 10 ft. per mile near Goodrich to only a fraction of a foot in the district just north. Variations of this

sort in the shores of Lake Algonquin on the border of Lake Simcoe brought to notice by W. A. Johnston in 1916 (Museum Bull No. 23) and tentatively connected with a fault that appears to have been developed there in late Pleistocene time. The variations in the Warren tilt rate near Goodrich suggest faulting but none has been observed in outcrop as yet.

November 23, 1934, I went to Monroe, Michigan with Ralph Belknap, S. G. Bergquist and M. Senatus to examine deposits along a channel in the lower end of River Raisin which have been found very difficult to excavate by a company which took the contract to excavate there for harbor improvement. There are test pits now open which extend into this deposit. It is also exposed near the level of the river in that vicinity. This is within a mile of the eastern border of the marsh through which the river flows for 3 miles or more before entering Lake Erie. This marsh is traversed by branching channels or distributaries of River Raisin and thus has the appearance of being a delta of the river. It projects noticeably beyond the parts of the shore of Lake Erie adjacent to it. The test pits and bank of the river show a rather soft clay deposit with few pebbles down to a depth of about 6 ft. Below this there is an indurated till. The pebbles in it are hard to remove and in the exposures on the river bank stand out like door knobs. The pebbles are largely of the local dolomite. They generally are well rounded, especially the larger ones. We cracked a number of the dolomite pebbles and found but little weathered rind and but little rusty penetration in them, and they respond promptly when tested with HCl. The crystalline rocks, granite and greenstone are generally firm and not markedly weathered. Sandstones, however, are usually soft and rotten. The degree of weathering does not appear to be greatly different from that in Wisconsin till. But the degree of induration is far above what one commonly finds in Wisconsin till. It seems probable that this is an Illinoian till. The Illinoian till was noted by a group of geologists, Sherzer, Jefferson and myself in the Livingston channel above Amhurstburg at the time it was being enlarged some years ago. It there rests on the rock whose surface carries glacial grooves bearing S35°-45° W. It seems probable that the Illinoian drift underlies the river between there and the mouth of Raisin River as it is low enough to have escaped erosion in the interval between the Illinoian and Wisconsin stage of glaciation. The thickness of the indurated till near the mouth of Raisin River is found by test borings to reach about 13 or 14 feet. There is a blue shale below it. The channel is to be 21 ft. and this barely takes to the rock in the eastern part. Rock is exposed in the river bed at Monroe and drops down gradually eastward. It is a solid rock in the river bed in the city.

Raisin River has a very shallow valley for several miles above Monroe, scarcely 15 ft. deep, and seems to be on a rock bed. We noted one exposure of blue till under oxidized till about midway between Dundee and Monroe. The blue till is 8-10' and the oxidized a similar amount. Belknap and Senatus examined it Nov. 22 and found the blue till rather hard to penetrate, so they suspect this Illinoian. We did not examine it today as our time was too limited, the trip being made in the afternoon.

I examined the Boonville N.Y. map to see features near home of my uncle, Israel White.

The Mohawk River is below 460 at south edge of map. The Mohawk River is 500' at Delta. A terrace S.E. of Delta is below the 540 contour. The plain west of Delta is 570 to 600+.

Israel White residence above Delta about 2 miles is 540. The terrace on shale back of the house is between 620 and 640 ft.

The upland 2 miles north reaches 1320 ft. The highest contour in N.W. corner is 1720. The altitude at Starr Hill on east border is 1780'. The altitude at Penn Mt. near east border is 1800'.

The name "Minford Silt" is applied by Wilber Stout to the clay deposited in the old Kanawha Valley where it became blocked by ice. It is from Minford in Scroto Co., Ohio, where it is exposed. Stout gives the deposit an upper limit about 800 ft. (Bull G.S.A. Vol.43 pp.148-149, 1932).

Analysis shows the silt in that locality to contain an unusually high content of potassium oxide, K_2O, and the microscope shows that it is made up largely of sericite scales. The source of the material is assigned to the schists of the Piedmont Plateau in the headwaters of New River, a tributary of the Kanawha.

The name was given in an earlier paper Bull.G.S.A. Vol 42 pp 663-672, September 30, 1931, "Minford Silts of Southern Ohio" by Wilbur Stout and Dorothy Schaaf. This paper was prepared for Toronto Meeting Dec. 1930, and submitted for publication Feb. 10, 1931.

Drfft in Petersburg and Lincoln, Ill. Quadrangles.

Note These seem to be a less eroded district than the ordinary Illinoian erosion lying outside the Shelbyville moraine in Northern Christian Eastern Sangamon Logan Northeastern Menard and Eastern Mason County Illinois. Is this likely to be within the limits of a lobe of Wisconsin ice that protruded into the low area east of the Illinois River in these counties? It is a loess-covered district and I have noted a buried soil between the loess and underlying till. This feature seems to suggest pre-Wisconsin age for that drift. It has been described as such in my report - Monograph 38 U.S.G.S. but the very moderate erosion suggests an age not greatly different from Early Wisconsin. On April 30, 1935, I wrote Dr. M. M. Leighton, State Geologist, for his opinion as to the likelihood of a protrusion of early Wisconsin ice over this area. Leighton replied May 2, "In regard to the possible extension of the Wisconsin drift into the area between the Illinois and Sangamon rivers, we have been likewise impressed with the less eroded aspect of the morainal features but we find that where the drift is exposed beneath the loess, the drift was weathered before the deposition of the loess similar to the Illinoian drift".

I noted a black soil under the loess near Lincoln in my early studies in that region. This drift was then correlated with the Kaskaskia ridges and the part of Illinois east of those ridges.

May 22, 1935 -- I went with Dr. George Stanley into the S.W. part of Washtenaw Co. and S.E. Jackson Co. to test the soil mapping in the south part of Sharon Tp. and then trace the drainage from the outwash westward across the ~~Massassenewa~~ Mississinewa Moraine.

We find that the area marked Fl in Secs. 23, 25, 26, 35 & 36 east of the strip of Bs. in Secs. 26, 27 & 35 is an undulating boulder strewn area with a thin surface coating of loamy, gravelly or pebbly material. It has not the ground-up character of an outwash plain but this surface coating may have been laid down as a sort of outwash as the ice border was melting back eastward across the Sections marked Fl (Fox loam) from the Bs. strip that is more rolling and has the aspect of a terminal moraine.

In confirmation of this interpretation we find a pitted outwash on its west border that does not have an undulating surface with knolls rising above its general level, and it is also free from boulders. There are many coarse cobblestones on it up to several inches in diameter. This pitted outwash is also classed as Fl (Fox loam). The gravel deposit here is of considerable thickness - there being pits opened for road material - 20-30 ft. deep at several places. The basins in this tract are 30 ft. or more in depth below the plain in places so the gravel is likely to have that thickness. Its beds dip NW in the part north of Raisin River and it extends to the east base of the Mississinewa Moraine with a slope toward the northwest.

We crossed Raisin River at Sharon Mills on line of Secs. 28 &29, Sharon Tp. and went south to a road leading west in Sec. 5, Manchester Tp. This is in the outwash plain west of the moraine that covers most of the east half of Manchester Tp. (classed as Ft. Wayne Moraine in the Ann Arbor Folio but probably embracing what became the Salamonie & Wabash Moraines in Indiana, as well as the Ft. Wayne Moraine. It is the outer part of this morainic belt that we noted above in the Bs. area in Secs. 26, 27 & 35 Sharon Tp. Just where the continuation of this outer ridge is to be placed, we did not work out but it seems to have been as far north as the border of a great swampy area in Secs. 7, 8, 17 & 18. Freedom and Sec. 13 Sharon Tp. The topography is morainic south of this swamp. The drift is mainly till there but some gravelly knolls occur in it in which pits have been opened. These gravelly parts are mapped as Bs. and the clay till as Ml and Cl. (Miami loam and Conover loam).

We drove west across Secs. 5 & 6 Manchester in the outwash plain. It has large areas lower than the general level one of which is traversed by the N.Y. Central R.R. in Secs. 4 & 5 Manchester. Such areas seem to have had too little filling to bring them up to the full level of the plain for they do not appear to be erosion features such as channels cut in the plain.

Near the county line, we came into a series of bars and swamps that are in the line of discharge of glacial waters westward through the Mississinewa Moraine. The bars are 20 ft. or more above the peaty channels but are considerably lower than the outwash plain to the east or than the Grass Lake plain outside the Mississinewa Moraine. There are bars of this sort as far west as Norvell. One of them east of the mill on north side of Raisin River is opened for gravel and shows beds with westward dip. Stanley took a photograph of this gravel. Such bars may be either an erosional product in cutting the channel in which case the deposit dates back to the time of the Mississinewa Moraine as an outwash from it. Another interpretation is that they

were built by the drainage that led west through the Mississinewa Moraine, as bars in the stream. The first view seems on the whole the more probable one for erosion seems to have been the leading process in the drainage line, whereas deposition was the leading process in forming the outwash plain west of the Mississinewa Moraine. Norvell Station is 942' and the top of the gravel of which Stanley took a photograph is about 5 ft. higher or 947 ft. This is 100 ft. lower than the highest part of the Grass Lake plain in Secs. 5 & 6 Sharon Tp. The U.S.G.S. bench marks these being 1043 at line of Secs. 5 & 6 Sharon Tp. and 1049 at edge of the plain in Sec. 5 where roads fork near center of N.W.¼ Sec. 5. The moraine sets in there as HS = Hillsdale Sandy Loam. The outwash is classed as F=Fox Sandy Loam.

The material in the Fox Sandy Loam is a lighter and sandier quality than in the Fl = Fox loam. This seems to be markedly the case in the part we crossed from Norvell to Francisco.

We returned from Francisco and Ann Arbor on Highway 12.

A paper by M. L. Fernald in Rhodora, Vol. 37, June 1935, deals with "Critical Plants of the Upper Great Lakes Region of Ontario and Michigan". He calls this set of plants "The Pre-Wisconsin Flora of the Upper Great Lakes Region". He quotes A. P. Coleman as follows from Pro Internat. Congr. Pl.Sc.II 1507 (1929): "Some suggestions have been made that parts of the north shore of Lake Superior and other high points on the Upper Lakes show little glaciation. On the Slate Islands some years ago I was surprised to find no evidence of glaciation".

Fernald notes that this is the only station between the Rocky Mts. and Gaspe' for Dryas Drummondii.

Fernald finds "complete disagreement of the botanical evidence of relic colonies of remotely isolated or strictly endemic plants about the Great Lakes, and the current interpretation of many geologists that the flora of the region has been completely wiped out by a wholesale very recent continental glaciation."

The Slate Islands and the neighboring shore of Lake Superior near Jackfish and Schreiber Ontario were studied by two botanists, A. S. Pease and R. C. Bean, in 1933 and their collections placed in the Gray Herbarium at Harvard University. These now await intensive study.

In June 1934, Fernald made a study in Bruce Peninsula between Georgian Bay and Lake Huron of several relic species far isolated from the main areas of these species Fernald found the lower areas had been glaciated but "the highest outcrops of the Niagara Escarpment there often display the undenuded and deeply rotted features which seem to indicate that the Wisconsin glaciation left them as Nunataks"

He then says I am aware that to Stebbins (Rhodora vol.37 pp63-74 1935) it seems unlikely that these Nunataks were large enough to support a Canadian woodland flora. He then says "He may be right; none of us were there to see". Fernald is most impressed by the presence there of the Hart's Tongue Fern - Phyllitis Scolopendrium L. Newm (Scolopendrium Vulgare Sm.) This is widespread around the Mediterranean but has been found in only a few widely separated places in N. America in New Brunswick, New York, in S.E. part of Tennessee and in the Bruce peninsula in Ontario. There it is a rather

frequent and locally abundant plant in fissures and depressions of the dolomite. The American plants differ slightly from the Mediterranean ones so he classes them as var. Americana.

On the Keweenaw peninsula Fernald found glaciation strong at the lower levels, "but at the higher levels, such as West Bluffs 735 ft. above Lake Superior where the deeply weathered trap and Conglomerate Cliffs stand well above the levels of evident glacial till and denudation, subaerial decay and weathering have obliterated any apparent traces of glaciation if there ever were any."

He spent four days in Keweenaw County and says "Keweenaw County has a greater assemblage of remotely isolated relic-species and isolated endemics than any other botanically explored region between the Gaspe' Cliffs and mountains and the driftless area of Wisconsin".

Here occur, usually isolated by many hundreds of miles and often by more than 1000 miles such species as Woodsia, Oregana, Polystichum, ~~Lonchitis~~ *lonchitas*, a fern Asplenium, Montanum, A. Cryptolepis, the Rocky Mountain Pteridium, known between the mountains of Quebec and the Black Hills only on the Bruce peninsula and northern Michigan, Milica (or Bromelica), Smithii, ~~Festuca~~ *Agrostis*, occidentalis, corallorrhiza, striata, an endemic variety of Chamaerhodos Nuttallii of the Rocky Mountains and the Great Plains *raetegue* Douglasii, Potentilla Blaschkiana, noted by Farwell Rhodora V.37. page 164, 1935, Rosa Lunellii (noted by Farwell) Ceanothus Sanguineus, Chimaphila umbellata var. occidentalis, vaccinium membranaceum and *ovalifolium* Collinsia parviflora *Adenocaulon* bicolor, an undescribed Arnica of the Cordellerin series Cordefoliae and several others".

Fernald says (p-208) "To me it seems quite illogical to argue that such species and the many other conservative and now unaggressive species with them have been arriving in post-Wisconsin times from different remote centers outside the area of general Pleistocene glaciation, like the Black Hills or like the Snake River Valley of Idaho. And it seems especially indefensible to maintain that such plants, coming from unglaciated or only anciently glaciated ones, north, south, east and west, should fortunately have all found the tip of the Keweenaw Peninsula (or similarly isolated spots) in post-Wisconsin time and should there have started successful colonies without leaving their long hypothetical cross-country journeys a somewhat continuous train of intermediate stations".

"There is nothing particularly unique about the soils of Keweenaw County, varying from sandstone and greenstones to siliceous or to ~~Calumet~~ *calcareous* Conglomerate, with frequent iron or copper deposits, they offer a fair average of diversified soils".

He calls especial attention to the wild lilac, *Ceanothus* Sanguineus, a characteristic shrub of the Pacific slope which has no nearer place of occurrence than the Black Hills, yet is present on the Keweenaw Peninsula.

He also cites a huckleberry Vaccinium *membranaceum* This. has been spread locally in northern Michigan by various animals. But west of there it is known in typical form only beyond the continental divide.

He quotes Dr. Norman C. Fassett of the Univ. of Wisconsin (Rhodora vol.33 pp.226-227, 1931) as in doubt whether the relic species in the Keweenaw area

could have come in from the Driftless Area of Wisconsin. The relic flora of the Driftless Area has its affinities mostly with the region south of the area of Wisconsin glaciation. The relic flora of the Keweenaw Peninsula seems instead to have migrated there from either the Gulf of St. Lawrence or from the Rocky Mt. region and that in pre-Wisconsin time.

It has been suggested by some botanists that an arid (Xerothermic) climate followed the Wisconsin glaciation and that this may bear on the distribution of plants. Ferwald says, "Personally, I am from Missouri regarding this proposition".

A paper by Dr. W. Wundt of Schwenningen a.N. "Aenderungen der Erdalbedo während der Eiszeit" in Meteorologische Zeitschrift 13.Jahrg. 1950 Heft 8 S.241-250, July 1933. The albedo is the proportion of the reflected to the incident radiation. Albedo from Latin, Albus = White designates the fraction of the sun luminous rays reflected by a plant at full phase allowance being made for the distances of the planet from sun and earth and for the dimensions of the reflecting body(F.W. Very in "Lunar & Albedos".)

The effect of snow covering is to increase the albedo as shown by estimates of reflected radiation on surfaces of snow compared with bare land and other conditions of exposure including cloudiness. Clouds are estimated by C.E.P. Brooks to affect 54% of the earth's surface. This must have been even greater in the culminating part of a glacial stage.

Estimates by Abbot and Fowle and later by Aldrich give the present earth albedo a value of 43% (Astrophysical Observatory Smithsonian Inst. Annal, 1908, Smithsonian Miscellaneous Coll. Vol. 69, 1919.)

Other estimates go as high as 45%, so Wundt assumes a compromise of 44%.

The maximum of albedo for low-lying clouds he finds to be 80%, for those of middle height 60%. The darker (wooded etc.) land surfaces give only 3-5 and the light 24%.

The albedo outside cloud districts has for the northern hemisphere and southern the same for bright surfaces 70% but for dark the northern is 37% when the southern is 40.7% . In intermediate conditions the northern 56% and southern 60.5%.

The percentage of bright surface snow and ice covered is now 3.2% in the northern hemisphere but was 19.6% at the culmination of glaciation. It is now 6.1% in southern hemisphere but was 11.1 in the culmination of glaciation. There is transient snow cover affecting 24.3% of northern and 11.7% of southern hemisphere.

There was in the ice age 16.2 in northern and 10.9 in southern hemisphere. Outside the reach of snow there is in the northern 72.5% and in the southern 82.2%.

In the ice age this was reduced to 64.2% in northern and to 73% in southern hemisphere. Cloudiness seems to account for the higher percent in southern.

It is probable that the increase of the snow and ice surface was greater on the sea than on the land in the ice age.

The Ice Age albedo Wundt estimates to have been raised 3.9 percent in the northern and 2.3% in the southern hemisphere.

Raising of the albedo 1% is estimated to cause a lowering of temperature 1.24°C. This on the basis of a lowering of 3.9% in the northern hemisphere gives a lowering of temperature there of 4.8°C, and for the 2.3% of the southern hemisphere, the temperature lowering should be 2.85°C (Wundt says 2.3°C).

The average lowering is thus about 4°C. at the culmination of glaciation.

In the literature, we find estimates as follows:

Brickner 4°C in the Alps
Anderson 3°C in North polar lands.
Speight 5° C. in Australia
Penck in most recent estimate (1932) 5° - 6°C.

The temperature lowering naturally was greater near the source of ice accumulation than farther away. It is likely to be near 8° in N. Hemisphere. Klute estimates a snow line lowering of 600 m. in the border districts or about 3.6°C.

It is estimated that the disappearance of present ice sheets would bring the temperature up to that of tertiary time or about 6°C. above the present. Wundt has a paper in the 1934 Meteorlogical Zeitschrift

In Smithsonian Miscellaneous Collections, Vo. 74, Aldrich gives the results of measurements of the reflection from the level upper surface of clouds in the area around Mt. Wilson in southern California. The clouds reflected an average of 78% of the incident sun rays. No evidence of change in the reflecting power with change in solar altitude. From this he estimated the whole earth has 40.4% of reflecting power. This is raised by ~~Bond~~ to 43% (Astrophysical Journal Vol. 43, p.175, and by Russell to 45%, p.190, same volume.

Part of the solar ray is missing owing to water vapor absorption but this is thought to be of small amount.

The Quarterly Journal Royal Meteorological Society, October 1934, has a paper by George C. Simpson, Director of the Meteorological Office, London, England, on "World Climate during the Quaternary Period" pp.425-471, in which Fg 3 (p.432) given below illustrates his view. Solar radiation and resultant cloudiness and precipitation being higher in the glacial stages than in the main interglacial, but bridging over the short wet interglacial stages.

(illus here)

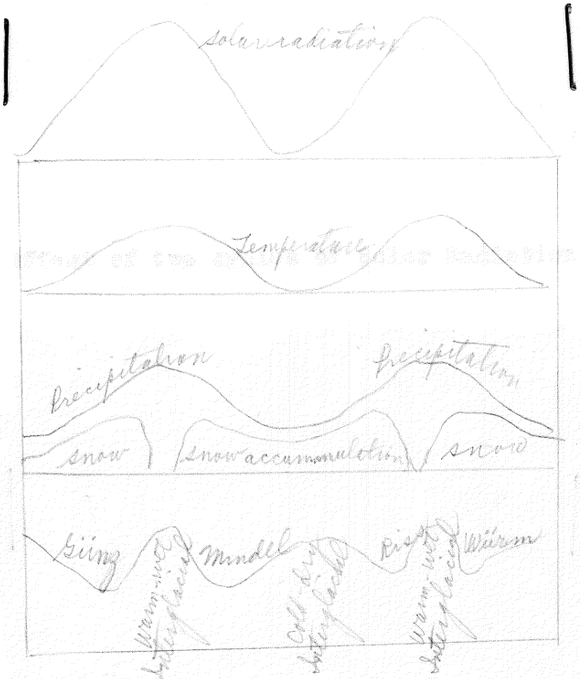


Fig. 3 [illegible] Glaciation.

There are many statements in thispaper that are inconsistent with present knowledge of glacial deposits, showing that he is unfamiliar with the literature, especially that of North American deposits. He seems also to be in error in interpretation of British drifts for he makes the Chalky Boulder clay correlate with Riss glaciation.

The degree of erosion it has suffered is such as to make it a more probable correlative of Mindel glaciation.

Simpson gives a picture of climatic conditions at a maximum of solar radiation.

(1) Increased precipitation in all parts of the world so that deserts practically disappeared. All rivers he assumes carried several times the volume they now carry.

(2) The main annual temperature was higher than at present. Support for this is found in the more extensive distribution poleward of certain animals and plants, or a higher range on mountain slopes. He cites remains of large trees and luxuriant grasses in the New Siberian Islands as evidence that the temperature in the Arctic Ocean was 7°C. higher than now.

(3) If large ice sheets had disappeared, the regions of high and low pressure would be as today and so would prevailing wind directions -- but there would be an intensification of pressure differences and the frequency and intensity of cyclones and cyclonic depressions would be increased. Weather in general would be less pleasant than now -- winters boisterous and summers cloudy and raw. Deserts would not have the high summer temperatures because of clouds and frequent rains.

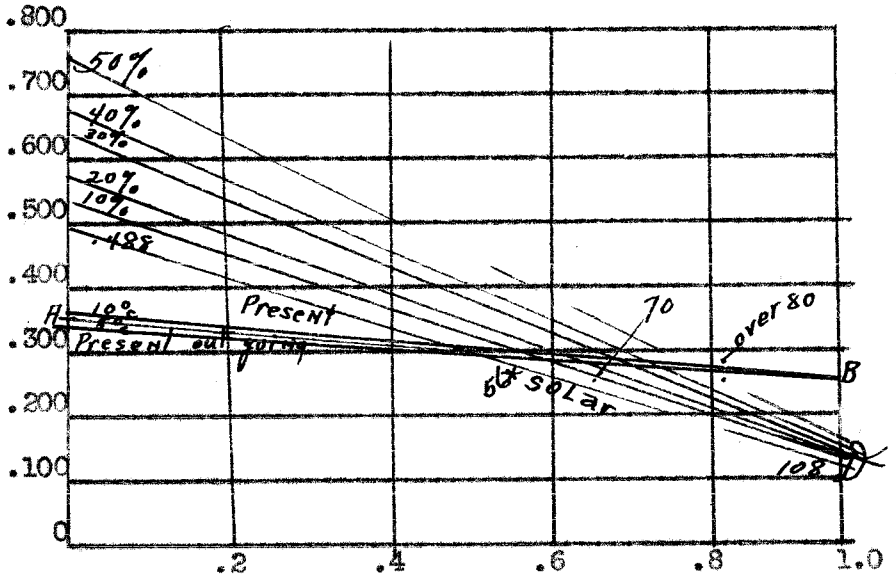
He assumes that we are now working to a minimum of solar radiation and as a consequence ice sheets are limited to the polar lands and mountain tops. The ice sheets do not extend to the isotherm for 0°C. They are small because precipitation is deficient. There is hardly a river in the world which is not too small to match its valley. The deserts show traces of former greater precipitation.

In an earlier paper "Further Studies in Terrestrial Radiation" Mem. R. Meteor. Soc. Vol. 3, No. 21, 1928, the theory was set forth that thermal equilibrium between solar and terrestrial radiation depends upon three factors: (a) the temperature of the stratosphere (b) the temperature of the earth's surface and (c) the amount of cloud. We do not know what determines temperature of the stratosphere but there seems reason to believe it is determined by physical characteristics of water vapor or the temperature at which water vapor can exist, in which case it may be independent of solar radiation. We need therefore consider only variations in surface temperature and cloudiness. The distribution of life now when compared with that in the Riss-Wiirm interglacial leads him to think the mean temperature then was between 5° and 10° higher than now.

As to cloud amount we have very few data. At present the mean cloud amount

of the world as a whole is.54. He thinks it might have increased to .7 or .8 if not more at the maximum of radiation.

In Fig. 9, page 466, which deals with radiation and cloud amount -- if the temperature were raised 5°C and 10°C above the present, the outgoing radiation would be raised only to the two lines above line A-B. The increase would be greatest with clear skies and increase to nothing with overcast skies, for when the skies are completely covered with cloud, no radiation from the ground leaves the atmosphere and the ground temperature is immaterial. The line C-D indicates the amount of solar radiation absorbed by the earth and its atmosphere with varying amounts of cloud.



With no clouds the amount is .488 Cal.CM but with a completely overcast sky it would be only .108, a reduction of 78%. Thus changing the amount of cloud has a much greater effect on incoming solar radiation than on outgoing terrestrial radiation where the two lines A-B and C-D cross gives the amount of cloud necessary for equilibrium between incoming and outgoing radiation. In the figure this is .56.

Fig. 9 Cloud amount and radiation

A-B = Outgoing terrestrial radiation

C-D = Effective incoming solar radiation

The lines above C-D give the amount of solar radiation which would be absorbed if the present amount of solar radiation were increased by 10, 20, 30,40 & 50 percent.

By reading off the points at which the lines of incoming and outgoing radiation intersect will give the amount of cloud which would be necessary for radiative equilibrium with different values of surface temperature and incoming solar radiation. If the solar radiation increased 50%, the cloud amount would have to increase to over .80 to effect a balance, but a cloud amount of .70 would balance an increase of 20% in solar radiation.

Variations in discharge of Mississippi River and certain tributaries in 1933, W. S. Paper 745, Mississippi River at St. Paul 1020 - 14400 Sec.ft.
" " " Prescott, Wis. 2520 - 19800 " "
" " " Winona, Minn. 5430 - 38600 " "
" " " LaCrosse, Wis. 6400 - 45900 " "
" " " Clayton, Iowa 10700 - 77700
" " " Alton, Ill. 27000 - 265,000

St. Croix River near St. Croix Falls	375 - 7060	
Cannon River at Welch, Minn.	36 - 3840	
Chippewa River at Durand, Wis.	1600 - 25,200	
Wisconsin River at Muscoda, Wis.	2480 - 29,300	
Maquoketa R. near Maquoketa	222 - 7580	
Iowa River at Iowa City	83 - 8700	
Iowa River at Wapello had max.	60,800	on April 7
Minimum not given. Sept. min.	840	Sec. ft.
Cedar River at Cedar Rapids (1928-29)	1080 - 67,200	
" " " " " 1927-28	660 - 28,500	
" " " " " 1931-32	760 - 18,600	
" " " " " 1933	----------63,300	
Skunk River at Augusta, Iowa in 1933	62 - 19,200	
Des Moines at Keosauqua, Iowa "	150 - 33,300	
Illinois R. at Beardstown, Ill. "	10,800 - 90,800	
Saugamon R. near Oakford, Ill. "	135 - 30,200	

See Water Supply papers 741, 744 & 745, for great differences in run-off in inches in the upper Mississippi, Great Lakes and New England and New York.

The following altitudes on shore lines of glacial lakes were measured by D. C. MacLachlan in 1934.

Arkona Beaches

St. Clair Co. S. W. of Avora			734 to 744
East of Fargo	Upper beach		740 - 743.5
	Lower beach		732 - 735'
Sanilac Co.	Croswell	Higher	753.15'
	Lower beach from 3 mi. S to Croswell		737.4 - 741.2
"	Two Miles S. of Applegate crests at		764.5, 758, 741'
	The 758 seems to be a bar on slope of the 764.5 beach		
Opposite Applegate		crests at	761' 753' 748'
In Sec. 15 Washington Tp. beach at			758'

Whittlesey Beach

At. R.R. crossing S.W. of Lambs		754 - 755'
Avora		758 - 764
Spring Hill Spit	crest	762.5 base 751'
On hill 2½ miles S. and 1 west of Applegate		780'
(same altitude on a beach 2 miles S.W.)		

Warren Beach

In St. Clair Co.	Goodells	East Ridge Crest	707
		Base of slope	696.5
		West ridge	706 - 708'
	Abbottsford Station		710'
	Clyde Tp. Sec. 14		702
	East of Blaine		713
	2 miles S. of County line		716
	At County line		717
In Sanilac Co.	2 miles n. of County line		716 - 717
" "	5 miles N. of County line		708
	6 miles N. of " "		717
	2 miles N. of Lexington		722
	4 miles N. of Lexington		725
	2 miles S. " Port Sanilac		727 & 720
	(Top of gravel on slope 727 Ridge 720)		
	4 Miles N. of Port Sanilac		724
	9 Miles N. of Port Sanilac 729& 741		
	4½ Miles S. of Huron Co. line		728 - 737
In Huron County	Ruth		749 & 752'
	West of Helena	Several ridges	745 - 759
	East of Verona	" "	748 - 756
	At Bad Axe		760
	East of Bad Axe Sec. 20 Verona Tp.		770 bar
	1 Mile N.E. of Popple Sec. 32 Colfax		749'
	South side Sec. 14 Grant Tp.		744
	S.E. corner Sec. 30 " "		735
In Tuscola Co.	West of Cass City - top of gravel		727'
		bar of lower Warren	714
	Wajamega 3 levels		721, 722, 725
	Vassar in Sec. 1		699.3'
	In west part of Vassar		705'

For profile in Ontario - See p.

Glacial geology of central Long Island, N.Y. by W. L. S. Fleming. Am. J. Sci.(5) vol. 30, 1935 - pp 216 - 238. (Fleming was a graduate student at Yale 1930-31 and this paper is based on his thesis for M. Sc. degree)

There are two Wisconsin Moraines, Ronkonkoma and Harbor Hills. The former is overridden west from Meridian of Manhasset Bay. (1) The first or oldest glacial deposit, Mannetto gravel, is found on prominent Cretacious hills up to nearly 300 ft. The Cretacious forms prominent hills in west half but was not seen in east half of Long Island. Fuller assumed this gravel to be eroded except on these prominences. (2) Jamuco gravel - this has different lithology from the Mannetto gravel (See next page as to till with it). Long Island was not supposed by Fleming to be overridden by ice at either time of gravel deposition. (3) Cardiness clay and Jacob sand -- fossils in them show a moderate climate. They reach a thickness near 150 feet near Brooklyn. (4) Manhasset formation -- this was thought by Fuller to be Illinoian maximum thickness, 210 ft. (a) Hard gravel (b) Montauk till (c) Hempstead gravel. (5) Vineyard erosion interval in which Fuller assumed the bays on the north shore were excavated. (6) Wisconsin drift, including the two morainic belts. Fleming differs from Fuller by putting all post-Gardiner deposits in the Wisconsin.

He found no weathering between the Manhassett and later deposits and doubts the validity of a Vineyard erosion interval. The Manhasset and Wisconsin deposits are similar in lithology. Peat, etc. under recent beaches is post-Wisconsin not Vineyard age. Fleming has been unable to find Maunetto gravel, Jamico gravel, Gardiners clay or Jacob sand for a certainty. He puts the Wisconsin in 3 substages: (1) Herod gravel and sand. (2) Montauk till and succeeding stratified deposits. (3) Upper till ("Wisconsin") and overlying stratified drift and boulders.

Conclusion

Maunetto gravel and Jamico gravel of Fuller may represent pre-Wisconsin glacial deposits, possibly Jerseyan. The Gardiners clay and Jacob sand may fall in the Yarmouth interglacial stage. These four units appear to be of small bulk and of no important topographic significance. The rest of the deposits are referred by Fleming to the Wisconsin stage, divided into Herod, Montauk and Latest Wisconsin. Fleming is now at Trinity College, Cambridge, England.

In a letter dated Feb. 15, 1935, Dr. W. C. Alden writes in reference to Pleistocene of Long Island: "F. G. Wells, who has been working on ground-water problems on Long Island with D. G. Thompson, under Meinzer, does not like Fuller's classification. As I understand it, he considers everything above the Jacob sand and including the Mantauk till as of Wisconsin age, and he thinks the Maunetto gravel is pre-glacial. The latter may, perhaps, be true, but I am inclined to think the Montauk till is distinctly older than Wisconsin and possibly of Illinoian age, especially if there is Illinoian till in New Jersey".

The Gardiner clay is about the best horizon marker in the whole series. If Wells is right in thinking the Montauk till is of Wisconsin age, then the Gardiner's clay might be referred to the Sangamon stage". Alden also notes that Wells and MacClintock found some till in the Jameco deposits on Long Island. This might correspond with Woodworth's Mashup till on Marthas Vineyard. It seems to show that the ice sheet extended into Long Island at that time.

Profile along the warren beach in Ontario from near Wyoming northward to terminus. Scale (horizontal each square equals 1 mile
(Vertical " " " 25 ft.
Based on work in 1934 with Donald C. MacLachlan who ran levels at several places Note that the bearing is nearly 5-N from a point south of Park Hill. The tilt line is probably about N. N.E. in this region.

Profile of Warren beach from Blenheim to Shedden, Ontario
The tilt line seems to be about N 50°E here with a rise of 40' in about 40 miles.
Horizontal Scale each square = 1 mile
Vertical scale " " " 25 ft.

Alvinston seems to be on a tilt line N. 70° E.
with a rise of 25' in 15 miles
The isobase for 725' runs N. 20° W. - S. 20°E from near Forest past Alvinston.
But it bears N 60° W - S 60° E from Alvinston to Glencoe and continues
this bearing across Lake Erie to near Erie, Pa.

Sept. 20, 1935.

A test boring for water at site of the Presbyterian Church N.E. corner of block west of Division and South of Huron St.

Altitude at well mouth	854 ft.	
Gravel	70 "	
Mainly till	108 "	Rock surface at 676'
Blue shale	87 "	
Red shale	5 "	
Sandstone with a little water	5 "	
Blue shale	70 "	
Black shale	15 "	
Gray shale	10 "	

Sandstone (Berea or Richmondville) 35' very little water.
Blue shale penetrated 10'
Total 415'

The driller, Mr. Moody, plans to continue a few feet expecting to find more sandstone, as the well at the court house had sandstone down to 425 ft. on ground 18 ft. lower.

Mr. Moody has got wells in sandstone at about 200 - 220 ft. east of Ann Arbor on south bluff of Huron River with fresh water. There was some shale above the sandstone. The altitude of these wells is about 860 ft. Huron River is 742 in the pool above the Geddes dam, so this water in the sandstone is 80-100 feet below river level.

Special publication, No. 176 - price $.10.
Coast and Geodetic survey deals with first - order leveling in Michigan. About 1300 miles have been run on 11 lines.

Line 1, Gibraltar to Lexington	1898-1901
Line 4, Mackinaw to Jackson, Mich.	1916
Line 5, Jackson to Detroit	1916
Line 8, Algonac to St. Clair Flats	1917
Line 10, Grayling to Detroit	1930

This makes the ground of S.W. corner of Fort Wayne grounds in Detroit 597½ ft. At St. Clair on West side of Front St. on top of the north hill in east face of foundation of Mark Hopkins' residence 626.764 ft. The ground surface here is not given but probably is near 625 ft. At Port Huron 1 3/8 miles s. of Black River on west side of Military St. in front of No. 2409, on the curb, a chiseled square with highest point 602.997'. At Port Huron about 3/4 mile below Black River on w. side of Military St. in front of No. 1915 on the curb, a chiseled square 605.163' at highest point within the square.

At Port Huron w. side Military St. at Opera House block at center part of front entrance, a chiseled square at s.e. corner of iron plate 594.720'. At courthouse in Port Huron at N.E. basement door on stone doorstep, top of a brass bolt 598.880'. At Lexington at N.E. corner Main and Lake Sts. at M.E. Church in center of cornerstone 3 ft. above the ground 622.945'.

At Lexington City Hall, in stone door sill of north door, top of brass bolt 622.108'.

The line Jackson to Detroit follows M.C.R.R. The altitude at Francisco ½ mile W. of depot 1021.123'. At Chelsea by depot - 921.983'. At Dexter by depot 861.983'.

Bridge on Huron R. 6/10 mile east of Delhi 818.857. At C. H. in Ann Arbor at N.E. corner a disk 43 marked "843", altitude 842.964'.

At bridge on Huron River 0.8 mile E. of depot on S. end of east abutment a chiseled square 765.202'. At Ypsilanti in park near depot 15 yds. south of tracks, a disk in top of concrete post 718.299'.

At Algonac at junction of Water St. and Pearl Beach road top of an iron cap 4 yards west of west side of Water St. and 1½ ft. north of fence on south side of the road 583.503'. Altitude of ground not given. The altitude at "Old Club" on St. Clair delta is 575.326'. This is under a cement walk from the building to a bridge over the canal. It seems to be very little above level of L. St. Clair.

Geofge Stanley has determined the Ft. Brady beach as shown below. The matter is presented in his thesis for a doctor's degree in University of Michigan.

Stations		Above L. Superior
Grand Moraie Minnesota		9 ft.
Devil Track River		36'
Chicago Bay		52 - 54'
Reservation Bay		62 - 63'
Grand Portage .	(terrace)	74'
Wa usu Pigeony Bay		76.5'
Pigeon Bay		80'
Pine Point		96'
Big Trout Bay		96'
McKellar Point		101.4'
Muck Bay		119 - 127'
Carp River		139.8'
Pie Island		140 - 147'
East of Thunder Cape		183'
"	Strong beach	158'
Port Arthur		170'
Current River	(cut bank)	178 - 186'
Port Arthur golf course		185 - 188'
Miles Bay		220 - 228'
St. Ignace Islet opposite Grand Is.		327 - 335
Mazokowuh (E. of Nipigon outlet)		360 (Lawson)
Winston		383 Coleman
Schreiber		(400 Taylor
		(391 Lawson
Terrace Bay		392 Lawson
Jockfish Bay		418.3 Lawson
Peninsula		410 Taylor
Ft. Brady on East Coast of L. Superior		
Sault Ste. Marie		140' Taylor
Mica Bay (48 miles from ~~Soo~~ Sault Ste to Marie)		220'
Alona Bay		240'
N. Montreal River		250'
Gargantua		290'
Brule		326-341
Trembly		392-399
Algoma Central R.R.		460 Collins
Mile 13		485 ? Collins

For data on this and other shore lines on St. Joseph Island, see Notebook 242, U.S.G.S., giving levels run by Lloyd G. Hornby June 1912.

The Ft. Brady on Mackinac Island is given by Taylor, FIGXXIII in Mon. 53	680'
At Hessel	720'
Sault Ste. Marie, Mich.	740'
Sault Ste. Marie, Outlet	742

On p.437, Mon. 53, Taylor gives a table in which Ft. Brady on Mackinac Island reaches 691' and lower beaches down to 639'. The Nipissing there is 634'.

At North end of St. Joseph's Island, the Nipissing is 648 ft.

The Ft. Brady has weak beach - 696-700
strong " - 727'

There is a cut bluff south of it at 757' at base which may be Ft. Brady. In that case the highest Ft. Brady at Sault Ste. Marie should be above 740 ft.

The bar at 727' on St. Joseph is 36 miles from Mackinac Island and Sault Ste. Marie, Mich. 45 miles. So it fits into the plane of 740 at Sault Ste. Marie and also Stanley's data east of L. Superior, 820' at Mica Bay (see above).

Battlefield beaches on Mackinac Island are 703-734.
The rise to St. Joseph Island, if 734 and 803 are to be correlated, is 69 ft. where the Fort Brady rises 47 ft. (from 680 to 727). The strongest Battlefield beach is 719 on Mackinac Island. Perhaps this correlates with 803 on St. Joseph? If so, the rise is 84'.
May 27, 1936.

I went with Dr. George Stanley from Ann Arbor to Fort Wayne preparatory to conducting the geology section of Mich. Acad. of Science on May 30.

I was surprised to find so subdued a topography south from Somerset Junction on Highway 127 compared with that on Highway 112 between Clinton and Somerset Junction. We went east to Munson on road just north of the Ohio-Michigan line and south from there to Fayette . There seems to be no exposures of gravel in the upper Maumee beach in the vicinity of Fayette. The highway 127 follows the angling road S.S.W. past Hamer instead of going south from Alvordton to West Unity.

There is reported to be a thin deposit of gravel in the highest Maumee beach 40-60 rods, east of the depot in West Unity at similar altitude (about 800 feet). The beach seems to be near 800 feet as far S.W. as Secs. 27 & 34 - T7N - R3E, Jefferson Tp., Williams County in S.E. part of the Pioneer topographic map. Two points on it near the section line catch the 800 contour.

There is a large gravel pit in east part of Sec. 27 on Mr. Oberlin's farm, east of the highway and a short distance N.E. of the cemetery. The gravel is in places 12-15 feet deep. Its bedding is only exposed in a small part of the circuit of the pit owing to slumping that soon follows active operations. The gravel has been screened and is being marketed by persons who have leased it. The highest Maumee is between 790 and 800 as far S.W. as the north part of Defiance Co. There are 2 points above 800 feet on it, near Lat. 41°25', about 2 miles S.W. of Williams Center in Sec. 10, T5N-R2E, (Farmer Tp.). There is an old gravel pit in one of them. What appears likely to be the middle Maumee beach was traced today from Sec.29, Farmer Tp., along the "ridge road" S.W. part Hicksville. It is but little above 760 feet or about 15 feet lower than the general level of this beach in the Ann Arbor, Michigan quadrangle. The interval between it and the highest Maumee in Defiance County, Ohio is about 35 feet while in the Ann Arbor quadrangle it is not far from 20 ft. How much change the highest Maumee makes in altitude in Allen Co., Indiana has not been determined yet as there are no topographic maps in that county. I am quoted by F. B. Taylor in Mon. 53, p.346, to having found the hooked spit on east side of the

A letter from W. H. Jillson May 4, 1936 reports a boulder of quartzite found in the valley of Six Mile Cr. in southeastern Henry County K near the east edge of the New Castle map at an alt. between 500 and 520'. It is about midway between Fool's Hollow and Boyd Branch. It was about 5' above the creek. The boulder has been removed and is now on the Campus of Miami Univ. at Oxford, Ohio. Jillson remarks: "Where one occurs in these creeks and rivers, there must of course be many others". (see p. 75).

Another letter May 6 gives results of a visit to the site of the large granite boulder on the Wagner farm (called "Epworth?? boulder" by Jillson). He finds it is about 3½ mi. south of the south edge of the Springdale top. map. on north side of Beechy Cr. near the Beechy Cr. School (see sketch map on other side of this sheet). He made a barometric determination of the alt. of the boulder. Setting the barometer at the 793 B.M. by Canaan Ch. near Epworth, and finds it to be 930-985', thus checking closely with a reading some years ago, which made it 936'. To reach it take a road S2 from Mt. Carmel about 4½ mi. to where Beechy Cr. comes into North Fork of Licking River from the east. Then east up Beechy Cr. a mile on a road on No. side of creek. Wagner's house is south of the road close by the creek. The boulder is about 1/3 mile north of the road.

Jillson suggests that it may originally have been still higher and gravitated down the slope. The amount of erosion since the earliest glaciation is such as to break down nearly all the surface and remove nearly all of any drift sheet of that time. So an occasional boulder may be all that now remains, together with scattered smaller stones - there being none of the till intact.

(It is really 1009' - see p. 86)

(Dr. Leverett's notebook 299 - pp. 50a, ~~52~~ 52, 53, have maps)

Six Mile channel at New Haven to be 786 ft. Perhaps this was determined by land level.

The VanWert, Ohio topographic map shows the highest Maumee to have a few points near VanWert that catch the 790 contour and the beach generally is not far from 785 ft. Van Wert is about 40°52'.

Fayette is 41°40' or 56 miles north of VanWert. There is a second beach in the VanWert and Delphas quadrangles a little below 780 ft, usually 775-778 ft. which is stronger and more mature looking than the first beach. Is this not the middle Maumee? If so what is the beach at 760-765 in vicinity of Hicksville?

We found gravel pits are being worked on the hooked spit south of New Haven on east side of six mile channel. In the east one, the gravel has clay partings a few inches apart in the lower part of the pit 6 ft. or more below the top. The beds above show a westward growth of the bar with foreset beds dipping in that direction. Dr. Stanley took views here. In part of this pit there are places where the gravel has scarcely any sandy admixture. The pebbles are mostly less than an inch in diameter. These pebble beds are only 1-1½ ft. thick and run for only a short distance. The best defined one is within 5 or 6 ft. of the top of the bar. There is a thin loamy or sandy cover on the bar.

We followed the bar to where it turns south past a cemetery. There is an abandoned pit south of the cemetery. It probably was here that I noted the south dipping beds when here about 1900.

We went a mile further south to center of Sec. 14 Adams Tp., then west across the low tract that converges into the Six Mile channel. It has a clayey soil as indicated on the Allen Co. Soil map (No.30 in maps for 1908 of the U.S. Bureau of Soils).

At the line of Secs. 15 & 16 we rise to the Fort Wayne Moraine. There is some sandy land on the slope. The border of the lake outlet runs across Sec. 9 in SE-NW course passing near Center. Section 8 is nearly all in the moraine.

In Fort Wayne we were joined by F. B. Taylor and drove to sand pits on west side of St. Mary's River in Sec. 22, Wayne Tp. There is a fine gravel here that seems likely to be outwash. Similar fine gravel is exposed in pit in N.E.¼ Sec. 29, Wayne Tp. In both places, it is only about 20 ft. above the water table which we infer is about at St. Mary's River level.

At the Lutheran Cemetery in east part of Sec. 21, there are dunes 30-40 ft.+ above a swampy plain south of them. There may be gravel under the sand here as there is an old pit south of the cemetery.

This fine gravel seems likely to antedate the Lake Maumee outlet and be outwash from the Fort Wayne moraine.

From Fort Wayne we drove to Defiance and then went north on the Whittlesey beach through the Defiance quadrangle and N.W. part of the Napoleon into the ~~Wauseon~~ Wauseon quadrangle.

We then went north to Oakshade through the area with sand knolls. Then east to a highway leading north through Lyons, Jasper, and Fairfield which is near the Maumee beach much of the way to Fairfield. We continued north through Adrian to Highway 112 near Clinton.

May 30. The Geology Section of Michigan Academey of Science went over the ground to New Haven, Ind. that Stanley and I traversed May 27. We then continued down to Huntington on Highway 24. This is on north side of the Fort Wayne outlet on the bluff nearly to the Aboit River but on edge of the outlet beyond there.

The Wabash Moraine is not so conspicuous here where it comes to the outlet than one would look for from Dr. Leverett's description. It is only 30-50 ft. above the outlet, not 100 feet. It has gentle swell and sag topography. Boulders are not very plenty. From Huntington we ran south on Highway 5 to see the Wabash Valley where the river is in a channel of its own cutting. The valley bottom is about 1500 feet wide and the depth is perhaps 75 feet. The road cuts show a dark brown color in the till to 5 or 6 ft., then a lighter brown changing to blue at 15-20 feet. There is gravel under the blue till at 30 ft. or more from level of upland and 10 ft. or more above the bridge. It is rather fresh looking gravel so probably is Wisconsin.

On our return we went to the place where the river enters the Fort Wayne outlet. The Wabash Valley here is nearly one-half mile wide.

In the evening Mr. F. B. Taylor gave a talk to the men in the excursion, as to conditions of moraine forming in Allen County, Indiana, noting feeble ridges (waterlaid) inside the Fort Wayne moraine. Leverett and E. R. Cummings (of Indiana University) also gave talks, the latter on "Bioherms" in the outlet which were to be studied the next day.

May 31 Huntington, Indiana.

We made a stop at the City Park in west part of Huntington where a "Bioherm" is well exposed. This has beds dipping sharply away from a central core. This sort of feature is discussed by Cumings in his Presidential Address to the Paleontological Society of America -- see Bull. G.S.A. Vol.43, 1932, pp.331-352.

A feature of exceptional interest is "Hanging Rock" on S. bluff of Wabash River above the mouth of Salamoine River. It is a "Bioherm" and rises steeply 80 ft. above level of Wabash R. It projects out northward over the river bank in its upper layers. It is a remarkable feature in that the ice sheet did not break it down. Possibly gravel had filled in the district around it in advance of the ice sheet up to a level about as high as the top of the rock in which case it might escape disturbance by the ice sheet.

From Lagro we went north 4 miles and then west across the Mississinewa Moraine and came back south to Wabash along its outer border. It has a very gentle undulation. Its relief above the plain west of it is about 30-40 ft. but is so gentle a slope that it is not a conspicuous feature.

In Wabash at the Big Four R.R. depot, there is a cut through a "Bioherm" that shows a structureless core with sloping beds on its flanks. It is the best exhibit of this sort of feature in the valley.

Along the south side of Wabash River in vicinity of Logansport , there is what Cumings terms "Scab-land Topography".

The glacial deposits have been swept away (except boulders) and the rock floor has its surface inequalities revealed. There is one peculiar ledge standing about 15 ft. above border land which is like a perched boulder with open spaces under it but probably is still in its original position.

The ledges are swept bare up to about 50 ft. above river level.

From Logansport we returned up the Wabash Valley and Fort Wayne outlet to city of Fort Wayne. We then went north on Highway 27 through Garrett, Auburn, Waterloo and Angola, Ind. to Highway 112 at Coldwater. This took us through gently undulating till nearly all the way to Waterloo. North of Waterloo is a moraine with outwash gravel on its outer N.W. border.

The rugged topography sets in near Angola and extends slightly into Michigan. But for some miles south of Coldwater, there are alternatives of low moraine ridges and outwash strips. East of Quincey on Highway 112 we crossed a very bouldery strip in which wall fences are made of boulders.

Near Jonesville we came into rugged moraine which is the prevailing topography nearly all the way to Clinton. Bunday Hill is passed on this road and Prospect Hill lies a mile or so south. Bunday is 1234 ft. A tower on it is wrongly stated to be 1434. The top of tower is not far from 1334 ft. Prospect Hill is probably over 1200 ft.

June 15, 1936 -- I went by auto with D. C. MacLachlan across Ontario from Windsor to Niagara Falls. Nothing new was noted until we got within 12 miles of Blenheim on the Highway 3 on shore of Lake Erie. We found a faint beach for several miles farther west than the place where the Warren beach comes to the Lake bluff near Cedar Springs. It may be Grassmere as it is near 650 contour. This was noted last year but was not so impressed on us as today. The Warren beach is very prominent from Cedar Springs to Blenheim with a width of 40-60 rods or more and a relief of about 20 ft. above plains on either side.

Highway 3 gets below the Warren beach when it runs S.E. from Blenheim but comes to it a mile or more west of Morpeth and is along or near it until about 2 miles beyond Palmyra.

There is a great deal of sandy land with low knolls and ridges from Clearville N.E. past Wallacetown. It is below the Lake Warren level west from Wallacetown but MacLachlan thinks it is about in the Warren plane from Wallacetown northeast past Iona? and Shedden. He has marked this part of the shore recently to the east from Wallacetown across the Port Stanley quadrangle into the Tilsonburg.

We left Highway 3 east of Seville and went S.E. past Staffordsville across the deep valleys of Otter Creek and Little Otter Creek. There are exposures

of silt and sand in the bluffs of these creeks as well as surface sand on bordering upland. There is little if any till exposed in them. There are also few stones on the surface until one gets above 800 ft. in the moraines noted near Tilsonburg.

We crossed the Waterlaid Paris Moraine south of Delhi and the Galt Moraine east of Simcoe and noted till exposures on each of them.

There is an abrupt drop east of the Galt Moraine to a level below Lake Warren. East from there a flat surface with few if any sand ridges is found in the east part of the Simcoe quadrangle.

We came back to Highway 3 at Courtland and were on it to Canboro. The land near Welles Corners that stands above 700 ft. has a limestone at slight depth and the drift is rather thin over much of the country east from here to the Niagara River.

From Canboro we went east past Port Davidson and Welland Port to Fenwick.

We then spent enough time on Fort Hill to get the main features in hand. At ~~its S.E. end~~ the SW end there is a plain of considerable extent above the 775 contour with a border above the 800 contour, estimated to be 815-820 ft. This becomes narrow toward the eastend of the Fort Hill elevation but is distinctly in contrast to much of the land above it. There is, however, a rather smooth surface nearly up to 850 ft. south of the Golf grounds in the east part of this high tract. This is just east of the highest points that rise above 875 ft. One of these is 892 ft. Whether the smooth sloping plain that lies below 850' here is a lake bed is not evident. The plain that lies below the 825 contour is more evidently a lake washed plain.

There is a large amount of cobble and rather coarse gravel in the Fort Hill Mass. Several pits in it show a cemented coarse gravel with beds that dip discordantly. A pit on the north slope ½ mile east and mile north of Fenwick has beds dipping steeply southward into the higher land in that direction. The north slope is more rugged and irregular than the south and we did not find a clearly defined Warren shore. The surface is more knolly above 900 ft. than below.

Probably the ice sheet was nearby on the north while Lake Warren was forming a shore on the south side of this prominent glacial feature. In that case there might have been scarcely any wave work there. We continued to Niagara Falls and came in on Lundy's Lane where the Lundy beach has its type locality. It is a distinct feature for over a mile on the west part of Niagara Falls, Ontario.

We crossed over to Niagara Falls, New York and spent the night there at the Prospect Hotel.

June 16. We went to Rochester on the "Ridge Road" on the Iroquois beach. It is a built bar most of the way but in a few places it is a cut bank. There are also a few places where it is double.

In the afternoon a party of geologists attending the A.A.A.S. made a circuit over the district between Irondequoit Bay and the lower end of Genessee River. We went to the lower falls and saw terraces at the level of its top and a higher level.

The district near the Ontario shore between the Gnnessee River and Irondequoit Bay shows a remarkable amount of dissection as the ravines are cut in silt and sand that erodes very easily.

In places Irondequoit bluffs are well exposed and show sand and thin bands of pebbles. There are also places where stones are scattered through the fine material, some being over a foot in diameter but usually less than 6 inches. The bay has small island-like prominences in it in which the beds are horizontal. There are therefore erosion remnants.

On our return we examined exposures in Pinnocle Ridge which show gravel beds in all sorts of altitudes which in places are cemented. There seems to be very little till on it. The ridge is thought by Taylor to be a spur with ice on both sides. It is very steep on both sides. The spur extends about 4 miles E.N.E. from where the Albion Moraine comes to it.

June 17. A field trip was made over the district S.E. of the University which took in the Mendon Ponds Kame area,* the Fairport Channel and the Baker's Hill Warren Shore. The high tract on Baker's Hill standing above 920 feet is sandy with scattered stones on the surface. It shows a very slight bar and swale surface that favors interpretation of lake beach. It seems also to fit into the Warren plane.

*The drumlins are

The Fairport channel which served as a line of discharge for the glacial Lake Dawson is a well defined future that seems to require a fairly long time of outflow for Lake Dawson. The volume of water may have been rather large as the melting Ontario Lobe would contribute materially to it.

June 18. I presented a paper before the Section E. (A.A.A.S.) on the date of deposition of the Delaware Valley gravel train that aimed to show the transportation of the glacial gravel was probably rapid and covered far down the valley while the ice sheet was still covering the headwaters of the river. There was a low sea level at that time to give a good gradient. Probably the sea level was 300 ft. below the present. The Cape May formation which has been correlated with this gravel by the New Jersey geological corps (Salisbury & others) is found to carry a warm climate fauna and flora inconsistent with a glacial stage. So it should not be correlated with the glacial gravel. Some of the glacial gravel is Illinoian and some is Wisconsin. They are both low down in the valley trench. Either one is likely to have been carried down well below present sea levels.. There is need for collecting data on the part that is submerged which is below Philadelphia and Camden. The Cape May overlaps it near Camden as shown by the studies of MacClintock and Richards. The Cape May is thought by them to be mainly of Saugamon age -- a view that seems to me tenable, but it may be in part of Post Wisconsin age.

Prof. Homes read a paper on the Valley Heads Moraine of the Finger Lakes region. Prof. Apfel had a series of slides showing how the ice melted from the highland south of Syracuse and was bordered by a succession of ~~lost~~ east flowing streams.

The complexity of the border drainage is shown in channels at various levels. In reply to the question of the identification of the line of eastward discharge in Lake Wayne time. Apfel said he doubted if it could be identified because the readvance which caused the drainage to go westward in Lake Warren time is likely to have filled the channel of eastward discharge. His paper pictured only a simple recession of the ice border, with no recognition of readvances of the border.

June 18. We started back by auto leaving Rochester on Lyell Ave. and the highway that passes through Spencerport to Brockport. This is above the level of Lake Dawson all the way. We crossed to north side of the Erie Canal at Brockport where the water level is 512 ft. At the county line of Monroe and Orleans Co. we crossed the canal to south side and went west to Albion being much of the way along or near the Albion Moraine.

This highway passes through Medina and Lockport and stays south of the Niagara escarpment to Niagara Falls.

We continued into Ontario from Niagara Falls on Highway 20 past Fort Hill. It now seems to us clear that the Lake Warren shore is north of this highway and nearly back to the 825 contour, but it may be 10 ft. below that contour.

I am in hopes to interest Dr. Kealey of the Canada Geol. Survey in running levels to it from the high point 892 as a starting point. W. A. Johnson says he is working in this region.

We continued on Highway 20 past Smithville and Elfrida, except a slight detour north of the highway to see a ridge east of Elfreda that rises above 700 contour. There is very slight undulation here or at places farther east and west along the divide north of Twenty Mile Creek. But we think it probable the ice border was on or near this divide at time of the closing part of Lake Warren stage. It may have been further south in the beginning of that Lake Stage, perhaps at north slope of Fort Hill.

We went north to Mount Albion to see a knolly strip near the brow of the Niagara Escarpment. This may mark an ice border later than one on north side of Twenty Mile Creek. The knolls seem to be of drift and are 15-20 ft. high.

We kept above the Niagara escarpment in south part of the city of Hamilton. There is bare rock in places here and little or no undulation due to glacial deposits. Probably the drift fills depressions in the rock surface.

We fail to see what basis Taylor had for mapping several moraines in the district west of Niagara River for divides are generally flat.

We took a road that led westward past Ancaster through a knolly strip with more expression than we have found since leaving Fort Hill.

We continued on the highway toward Brantford for three miles from Ancaster. We then went north into the Knolly district that circles through the N.E. part of the Brantford's sheet. This proves to be a belt of sand in which there are scarcely any stones, but the topography is like that of a moraine. The highest ridges are above the 875 contour. It was found on going north

from Capetown that Lake Warren stood a little above the 850 contour, the rock surface being blue up to that level. So these sandy ridges in the N.E. part of the Brantford and S.E. part of the Galt quadrangle rise but little above its level. Perhaps an outwash of sandy material from the ice border was roughened by the advance of the ice over it and thus given a morainic topography. The highest knolls in the Galt quadrangle (S.E. corner) rise above 900 feet.

We found a large area north of Spencer Co. in concessions numbered III, III, IV, IV and V.V. on the Galt map that have bare rock. In the north part of the east III is a cobbly ridge rising above 850 contour that seems to be a lake bar. The strip east and south of Hayesland that stands above 850 feet has a flat surface with bare rock.

This old lake bed extends into the Hamilton quadrangle to the vicinity of Harpers Corners. On its southeast border the surface is ridged and knolly but the material is very sandy. We are disposed to class it as a moraine and take it the correlative of the final stage of Lake Warren.

After a detour on the west edge of the Hamilton quadrangle we went back into the Galt quadrangle and worked westward on the line of concessions IV and V. past the place where Taylor reported a gravel delta. The feature he noted seems to have been in the strip that is above 825 feet for the land below that, has a fine sediment. The rock is near the surface not only when altitude is near 825 but also up to and above 850 ft. in the district between Hayesland and Sheffield. The first cut in till that we found was about 1¼ miles N.W. of Sheffield where a small area is above 875 ft. The land around it seems to have been wave washed to a little above 850 feet. About ½ mile further N.W. the highway 8 enters a district with morainic aspect in which boulders are very numerous, stone wall fences being made of them. This is the Galt Moraine. We crossed it east of Galt and stopped for the night at Galt. The business section of this city is in Grand River Valley at about 800 ft. The high points on the moraine east from here are above 1000 ft.

June 19, 1936. Galt, Ontario.
We went S.E. on Highway 8 to the border of Lake Warren about 4 miles from Galt. We then went south through the west edge of Beverly Tp., Wentworth Co.. When about west of Sheffield we passed over a small area that stands above 850 feet and found most of it swept bare down to the rock but there is a low knoll of drift in its S.W. part. So the lake level here is but little above the 850 contour.

Further south we found till present on ground 800-825 feet but there is a flat surface on the highest part of the prominences.

We went west when about a mile from the south border of the Galt map and came up into undulating land that catches the 825 contour. It seems doubtful if Lake Warren was up to this contour here. We came into the Brantford map near St. George, and took a road leading W.S.W. from this village. It crosses flat areas that are above the 800 contour but the lake bed seems to be below the 825 contour.

We went south on first road west of St. George and took first road west across a flat area that comes up above 800 contour. This seems likely to be within Lake Warren limits. A shallow pit has been opened in it for gravel but it is not well exposed.

We found flat areas with shallow gravel pits in them along Highway 24 for 3 miles N.W. of Brantford that seem to indicate Lake Warren level a little above 800 feet as far south as that city.

South from Brantford the Galt Moraine seems to be the limiting border of Lake Warren. The lake level may keep up about to 800 ft. as far south as Oakland. East of Oakland about 1½ miles there is a slight ridging suggestive of a beach that catches the 775 contour. This may be the Lower Warren. About 2 miles south from there we noted a slight ridging at a cemetery that is ½ mile from south edge of the Brantford map and is above the 775 contour. It is west of the highway that runs southward from East Oakland. In the Simcoe quadrangle we noted a bar in concessions VI, VII and VIII north from TownsendCenter along east side of the highway that is above 750 feet. It may be nearly up to 775 ft. as that contour is near the highway on the west in places. There is a flat area west of Townsend Center that suggests a lake bed with upper limit above 775 feet.

The lake plain is but little below 775 ft. as far south as Simcoe.

The Galt Moraine becomes Waterlaid near Simcoe. Its course seems to be W.S.W. from there. The highest points along it are sand, All ridges rising above 775 ft. seem to be dune sand. A few reach 800 ft. We went west from south edge of Simcoe to a township line (Charlotteville-Woodhouse) then S.E. a mile. We there turned S.W. between concessions VI and VII Charlotteville. We found a few boulders and cobbles here below 775 ft. The ridges west from here that rise above 775 ft. are dunes. The flat land is sandy from here to where the road leaves the Simcoe and enters Long Point quadrangle.

The gulch S.E. of Silver Hill shows sand and silt its entire depth about like the other creek bluffs noted on our way east. We seem to have no definite feature in this region on which to base the level of Lake Warren.

We worked westward near the border of the Tilsonburg and Port Burwell quadrangles to Glen Meyer without getting hold of any definite features on which to base the level of Lake Warren. Prof. MacLachlan may do further work here.

We went from Glen Meyer to A[illegible] and then back to Detroit by the same route we came on June 15.

July 9, 1936. Prof. MacLachlan reported the results of recent study in Canada.

He finds that the Warren gravelly strip near Alvinston runs south into the Lake Warren area on west side of Sydenham River. There was a bay extending N.E. from Alvinston up the Sydenham Valley nearly to Strathroy, covering a plain that is near 725 ft. From Glencoe the lake had a bar running toward Appin between the bay in Sydenham Valley and one in the Thames Valley. The Thames Bay extended as far N.E. as the vicinity of Muncey and Lawrence.

South of this bay, land above the Warren level extends S.W. to vicinity of Dutton as we determined in earlier studies. There is only a narrow strip of Lake Warren bed north of Lake Erie from Wallacetown eastward to the vicinity of Sparta about 5 miles in average width. It then spreads over a wider area 10 miles or more wide in which the limits are difficult to determine as noted on June 18.

Prof. MacLachlan found gravel in places on the Seaforth Moraine in the north part of the Strathroy map which he suspects is the product of Lake Whittlesey. Some west and S.W. of Wanderland catch the 800 contour, and ~~are~~ [one] about 3 miles N.W. of Strathroy, the 825 contour.

He also found gravel areas S.W. of London up to about 840 feet which may prove to be connected with Lake Whittlesey. The Whittlesey level is a little below 800 ft. near St. Thomas so the rise to 840 feet near London is not easy to account for. Prof. MacLachlan worked northeast from St. Thomas and found a gradual rise in that direction to about 840 feet near Paris west of the Paris Moraine. This seems likely to be at the N.E. limit of the lake. Possibly an extra tilting affected the region near London as it is where the ice sheet uncovered the peninsula while still occupying the Huron and Erie basins. As previously noted, the Warren beach shows more rapid rise on the axis of this peninsula than in the bordering basins.

Further work near London may clear up the matter.
→ See page 31A, 31B, 31C, 31D, 31E, 31F, 31G, 31H, 31I, 31J.

August 8, 1937 -- The topographic map of the Goderich quadrangle shows the Warren beach to reach the 800 contour in several places as far south as the north bluff of Bayfield River, 10 miles south from the place MacLachlan leveled to on the highway S.E. of Goderich and found to be 795.5 (notes Sept. 1934). So there appears to be no tilting in this interval. There is 13 ft. rise.* There is gravel east of the ridge near a road leading north from this highway up to the 800 contour but no higher.

Leveled by MacLachlan makes it 837' here (Sept. 38)

The beach north of Maitland River on road leading S.E. to Ben Miller is 805'. A ridge at the crossroad S.E. of it is 818'. If this is a lake feature, it will reduce somewhat the remarkable rise to the Lucknow River N.W. of Dungamon where it is 845' at north bluff of the river and its base is 815' on N.W. side.

The Lucknow map makes the 825 contour run with the Warren beach for 3 miles north to Griffins Creek. It gets up to the 850 contour $1\frac{1}{4}$ miles south of Lanes? about $4\frac{1}{2}$ miles from the place where it is 845' by Lucknow River side. It is very near the 850 contour to the north edge of the

* See pp. 94-96

Notes on the Henry Co., Ky. quartzite boulder (p. 51). J. J. Wolford of Miami Univ., Oxford, Ohio, on July 24, 1936, sent the following notes:

A greenish quartzite, with slight banding. Roughly egg-shaped about 18-20 inches long. Found by Prof. Wolford Oct. 4, 1930, along Six Mile Creek about 3/4 mile south of Salem School. A grader working the road which here follows the creek, had apparently dislodged the boulder, perhaps the day I found it. It had been partly covered by alluvium from Six Mile Cr. The elevation is about 520'.

It was delivered to Dr. W. P. Jillson at the office of Ky. Geol.Surv., Frankfort, Ky. It may have been transferred with other Surv. material to the State Univ. at Lexington. Prof. Wolford turned over a picture of the boulder taken in the field to Dr. Jillson. Dr. A. C. McFarlan, Univ.of Ky., may be able to explain its present location.

Horace C. Richards reports finding a concentration of boulders in the bed of Delaware Bay about on a line between Cape May and Cape Henlopen?? at a depth of about 130'. Is this a feature due to a low sea level, the concentration being at the place where Delaware River entered the sea and brought coarse material from the glaciated district?

Prof. Hobbs calls attention to tidal bars as reported by him in Bull.G.S.A. Vol. 16 and in Bull. 270, U.S.Geol.Surv. How did coarse material get to this place in Delaware Bay unless brought down by Delaware River?

R. E. Lamborn of Ohio Geol.Surv. has a paper in Ohio Jour. of Sci., Vol.32, 1932, pp.449-466 on "The Newark drainage system in Knox, Licking, and northern Fairfield Cos., Ohio". It gives a few records on the main "Newark Valley" between Trinway and Baltimore, Ohio, but deals largely with a north tributary that headed on the high upland in northern Knox Co. and joined the main valley at Newark. The paper corrects an interpretation by Leverett that this north tributary headed S. of Utica, there being a well record 2½ miles S. of Utica with 336' of drift and rock floor at 614'. This fits in with records north of Utica which show 300-360' of drift.

At Newark a well south of the Fairground has 397' of drift and rock floor at 537'. The rock floor in the main valley is about 600' at Brinway and drops to 521' near Baltimore in sec. 30, Liberty Twp.

Lamborn suggests a southward continuation of the drainage down the Scioto to the Ohio River at Portsmouth but he doesn't seem to have held the interpretation made by Leverett in a paper read before the Nat. Acad. of Sci., Nov. 1932, that the large valley of the Scioto was made in pre-Illinoian time by a drainage system that embraced much of the Muskingum drainage as well as the Scioto. (See Sci. N. S. Vol. 76 p. 546. Dec. 9, 1932).

A few borings near Baltimore reach a markedly lower level before striking rock than those cited by Lamborn. They were furnished by Lewis K. Cook of Basil and are recorded in Notebook 294, p. 64. One boring shows a rock floor at 449'; another at 433'. Others are at 435, 503, 512, and 549' A.T.

Karl Ver Steeg in a paper in Jour.Geol., Vol. 44, 1936, pp. 918-939, discusses "The buried topography of western Ohio", and presents data on a deep valley leading NW from the Scioto valley in Pickaway?? or Pickaway?? Co. across Madison?? Clark, Champaign, Shelby, Auglaize?? and Mercer Cos., into Indiana which he names Teahs Valley and considers the most probable continuation of the old Kanawha drainage that had been traced by Wright & Leverett into Pickaway Co. (See Prof. Paper U.S.G.S. No. 13, 1903 and Mon.41, U.S.G.S. 1902)

Ver Steeg cites a boring at the London prison farm in Madison Co. that was drilled 525' in glacial material without reaching rock and which reached a level of 538', A.T. On p. 926 he remarks "It is well to remember that the great depth of the buried valleys is probably due to interglacial erosion". As this boring at London is not demonstrated to have a rock floor as low as those cited above near Baltimore, it remains to be determined whether drainage was SE from London into the interglacial Scioto or was in the line of a stream flowing NW as indicated on the map by Ver Steeg. How well supported the line NW is found to be is not clear from the meager data presented in Ver Steeg's paper.

In the Geologisches Zentralblatt in the volume ending Feb. 15, 1937, Keilhack notes a boring in Hela Peninsula near mouth of the Vistula River that reached 510' without entering rock. The lower half is in glacial beds and the upper in postglacial as follows:

Post Ancylus Lacustrine	0-19 meters
Lacustrian beds	19-76 "
Ancylus "	76-81.65 meters
Glacial beds	81.65-153 meters

J. J. Pesty has a paper "Ice action in Teah's Valley, W. Va." in Dennison Univ. Bull. 34, 1934, pp.195-204, which notes striated pebbles at several places. Some bied in side valleys into which the pebbles were rafted on ice cakes.

The rock floor of Teah's Valley is put at 670 at east end, 660 at Huntington and 655 near Ashland, giving a gradient of only 3.3 inches per mile. The present stream in its longer course falls nearly twice as fast. It is 534 on Kanawha near St. Albans and 486 near Ashland, giving a fall of about 6 inches per mile.

June 2, 1937. Trip to Zanesville, Ohio, with Prof. Young to meet the American Forestry Ass'n in a trip June 3 over the Muskingum Conservancy District. We drove via Toledo to Fremont and Norwalk crossing the Warren beach at Clyde, Ohio, and the Whittlesey along the road from Bellevue past Monroeville to Norwalk. From Norwalk we went south on Highway 13 through Mansfield and Mt. Vernon to Newark. Chestnut blight has killed the trees in the district between Mansfield & Mt. Vernon. We came to the National Road Highway 40 of Jacksontown and went east on it to Zanesville. There are numerous deep cuts in the part covered by Illinoian glaciation outside the Wisconsin that are so fresh that exposures are good from top to bottom, but we saw no till nor boulders exposed in any of them. My notes on the topographic maps show boulders to within 10 miles of Zanesville.

In the evening a dinner at the Y.M.C.A. given by Zanesville business men was followed by several speakers explaining the work of the Muskingum projects. It embraces the methods of soil protection by strip farming of strip hillsides with some tree planting and some building of farm reservoirs to collect water for stock. But the most ambitious development is the building of dams for flood control.

About 8000 sq.miles are being so treated - 14 dams are being constructed or planned for the near future at a cost of about $40,000,000, the engineering headquarters being at Zanesville. Records of climatic data are being kept at 300 stations, that embrace rainfall, wind direction and velocity, temperature, and humidity. About 300 maps are made daily.

June 8, Zanesville. We drove east on the National Road Highway 40 to near Bridgeville and then north about 3/4 mile to the "Butler Farm" to see how erosion is being controlled by strip farming and protection of part by reforestation and stopping of grazing.

We next went by Highway 40 to Cambridge and from there via Byesville and Senecaville to the Senecaville Dam. This is the first completed dam of the series of 14 dams. It will furnish power to supply Cambridge but that will draw less than 1 foot from the filled pool. It is chiefly for flood control.

Some of the men in the party visited the Piedmont dam and Clendening dam, the latter being near Tippecanoe. But Prof. Young and I went via Highway 40 to Fairview and then on Ohio No. 8 through Freeport and Tippecanoe to Dover where we all gathered for lunch at the Dover Club House. The topography is very rough in vicinity of Fairview and Freeport near the heads of drainage lines where there has been but little filling of valleys by the diversion of drainage. This filling is about 300' in vicinity of Dover yet even here the bluffs are prominent.

After lunch we drove to "Dover Dam" in the Tuscarawas valley at the place where an old divide was crossed a few miles NE from Dover. The dam here is only partly built. It will be high enough to furnish considerable power but to what degree it will be used for power was not ascertained.

We next drove to the Mt. Bolivar dam where Sandy creek comes to the Tuscarawas. The dam is on the creek and is wholly for flood control, no storage being made except in time of flood. So the bottom lands in the sandy creek drainage can be farmed or used for grazing. This dam is not far advanced. The creek has been diverted by a tunnel through the west bluff and tractors are now working in the old bed.

We went next to the Beach City dam on Sugar Creek NW of the town. Work here is not far advanced. From here most of the party drove back to Zanesville via Cochocton & Dresden. Prof. Young and I went back to Ann Arbor. We followed Highway 250 through Wooster to Ashland; then Lee drove north to Norwalk and returns turned from there on some highways that we drove coming down. We were impressed with the great amount of filling with drift in the elevated land 1200'± A.T. along No. 250. The alt. is as great as in the rugged land SE of Dover but it is a gently undulating tract with good farms all over it.

"The Physiography of South Central Ontario" by D. F. Putnam and L. J. Chapman, Sci. Agri. May 1936. Vol. 16: 9 pp. 457-477.

This deals with the district between L. Ontario and Georgian Bay east from the Niagara escarpment. Two ice movements are noted: 1. The Ontario lobe with north border at the "Oak Ridges Moraine". 2. A somewhat lobate area to the west of Long 77°. The eastern sub-lobe had Rice Lake in its mids.; a middle one with L. Scugog in its midst; and a western one embracing L. Simcoe and border areas.

It is found that the Ontario lobe held its position clear up to the Oak Ridge moraine to a later time than the ice lobes to the north. It also has recessional moraines. While the lobes to the north have a "haphazard topography mainly ground moraine. It is thought they became stagnant while the Ontario lobe was still active. During the recession of both lobes ice dammed lakes were held between their borders and higher land outside. These eventually give place to the fore-runners of the present great lakes; viz., Lake Algonquin and Lake Iroquois.

Ten physiographic areas are recognized:

1. Napanee plain east of Trenton and Marlbank
2. Iroquois lake plain covered by L. Iroquois
3. Ontario till plain north of and above No. 2
4. Pool lake plain lying NW of Toronto from near Claremont to the Niagara escarpment near Milton.
5. The interlobate across from near Long. 78 westward to the Niagara escarpment
6. Schomberg Lake plain from Rice Lake westward nearly to Lake Simcoe at alt. above L. Algonquin.
7. Limestone moraines just south of pre-Cambrian area
8. Drumlin areas
9. Algonquin lake plain
10. Simcoe uplands.

(1) The Nanance plain is a tract with low relief and limestone near surface. The drainage is in channels in the limestone. The marine clays of Gilbert Gulf are present on the lower part. These are the most productive parts of this plain, the limestone areas being largely pastureland.

(2) The Iroquois plain has a maximum of about 10 miles in width but embraces 900 sq. miles to the west of the Napanee plain. Parts of it are given to fruit and truck crops and much of it has a fair silt

(3) The Ontario till plain is rolling to hilly and ranges in alt. from 400' mx. to about 1000'. The greater part is well drained and productive and is largely given to dairying with market at Toronto.

(4) Peel lake plain covers parts of Halton, Peel, and York Cos. The lake bluff left deposits of clay over the till which where thickest shows varves. Deltas of the Humber?? at Woodville (Kleinburg Sta. 700') and of Credit?? R. at Norval show its limit or level. It is quite similar to the till plain in agricultural development.

(5) The interlobate areas are generally hilly land with poor soil. They embrace about 600 sq.mi. and are generally more than 1000' A.T.

(6) Schomberg lake plain. This lies north of the interlobate area and was covered temporarily by lake water with the ice lobe on the north border. This lake was first noted near Schomberg. Other temporary lakes farther east are classed with it. They embrace together about 475 sq. miles. Varved clay is conspicuous in places.

(7) Limestone moraines are in a relatively low area 700' or less that was ice covered at time of Lake Iroquois, otherwise the lake would have covered the area.

(8) The drumlin belts embrace the best land in the district covered by the northern ice lobes and cover nearly 2000 sq. miles. There are at least 3000 of them. Eskers are also conspicuous in the same areas as the drumlins. In some cases they are 75-100' high.

(9) Algonquin Lake plain embraces 1200 sq.miles on border of Lake Simcoe and between it and Georgian Bay.

(10) Simcoe uplands are islands and peninsulars interrupting the Algonquin plain. They cover about 300 sq.miles. Although underlaid by limestone the drift in these uplands is very strong with a large contribution from the pre-Cambrian formations to the north.

An area of Lake Algonquin runs SW nearly to Schomberg and is 724' at SW end. The alt. of Schomberg is 750-775'. This paper does not state to what height the lake called "Schomberg" reached. There is a pass south of Schomberg slightly above 900'. Did this serve as the outlet for the Schomberg waters?

The Alliston map shows the extent of Lake Algonquin SW from Lake Simcoe?? The Schomberg lake clay has a thicknessof nearly 50' near Holland Landing as exposed by recent road building. The varves are remarkably thick, those at Holland Landing average about 7 inches. So perhaps only a century was required to form the deposit. The rock formations exposed in this district are as follows:

1. Pre-Cambrian
2. R or Beekmantown dolomites
3. Black River limestones
4. Trenton limestone
5. Utica shale
6. Lorraine shale
7. Queenston shale
8. Lockport dolomites

The limestone extends to the shore of Lake Ontario nearly as far west as Oshawa. The shales border the lake from there to Hamilton but the shale belt narrows to a narrow strip near Georgian Bay.

Ontario Dept. of Mines, Vol. 45, part VII, 1936, has two papers by Prof.A.P.Coleman.

1. Lake Iroquois, pp. 1-36

2. Geology of the north shore of L. Ontario, pp. 37-74, and a paper by E.M.Kindle. Geology of Pelee or Pelec?? and adjacent islands in Lake Erie, pp. 75-116. The area covered by ice at the time of the greatest extent of Lake Iroquois while discharging through the Mohawk Valley is shown on the colored top.map (Map No.45f).

9. Algon

"Lake Iroquois and related ice front at the time of the Roma Outlet. Scale 5 miles to the inch." This "related ice front"was worked out by Coleman in the field in 1933 when 81 yrs. of age. Being a poorly developed area it must have entailed hardship and called for pluck to carry the study through. The paper by Kinelle?? treats of an island which is largely close to Lake Erie level so it is drained and water pumped from the drains into Lake Erie. Yet 700 people have their homes on the island.

Leveling to Epworth Boulder in 1937

July 9, 1937. Mr. R. B. Maddox of the Univ. of Cincinnati reported on leveling in vicinity of Foxport, Ky. to ascertain the elevation of "Epworth boulder". Began work June 19, 1937. Established arbitrary benchmark at NE corner of Thompson - Farren Store, 2 miles S. of Foxport. Ran 1 mile of levels to Epworth boulder and at intervals setting fixed turning points: At the boulder established elevation on largest fragment in excavation (Determined later to be 1009.3' A.T.). Ran 1/2 mile of return levels to turning point 17. (A. E. Sandbert ⟋⟍ R.B. Maddox).

June 23, 1937. Located U.S.G.S. benchmark 835.1' at Pleasureville, Ky. after futile search in Foxport. Pleasureville and Foxport are separate towns and not one town having two names, as map suggests. Otherwise location of BM is accurate. Ran 1½ miles of levels off of BM at Pleasureville. Closed early because of rain. (R.B.Maddox ⟋⟍ M. G. Frey).

June 30, 1937. Completed out run of levels to Thompson - Farren store. Closed early because of rain.

July 1, 1937. Ran hand levels from boulder to top of ridge 154' with possible slight rise to SE. The figure 154 is established on large level area on top of ridge. This is 1163' A.T. Completed traverse of work. Total 3½ miles. Were able to take long shots because of good weather and moderate temperature. Amount of leveling 7½ miles. 7 mi. on road 1/2 mi. through woods. R.B.Maddox ⟋⟍

Boulder 1009.3'. Top of ridge 1163'.

As this boulder is now on a steep hillside slope, there is a possibility that it has gravitated down from higher up, possibly from the top of the ridge. Hence the importance of determining the height of the ridge.

The present alt. of the boulder is about 100' higher than low places on the divide west of Licking River south from the Ohio Valley. It seems doubtful if this divide has been lowered 100' by erosion since the boulder was deposited, though some lowering no doubt has taken place if this boulder was brought in in the early part of the glacial epoch. The amount of lowering of this divide since the Illinoian glaciation is very slight for the Illinoian drift itself is still present on the ridges and slopes within its area.

The rafting of the boulder to this height in paroled waters in the Illinoian stage is, therefore, ruled out. The only question now seems to be whether ponding could have occurred to this height in the Early Quaternary glaciation. If not, the ice sheet was the depositing agent at its site.

If only a scanty glacial deposit was made in the early glaciation, one could naturally expect only scattered boulders to be preserved. The balance of evidence seems to favor this interpretation.

Some light on the subject may be obtained from the amount of reduction of the Kansan drift sheet as this boulder is likely to be at least as old as Kansan. Estimates by Gordon and by Bain in Iowa indicate about 50' of average erosion there. This being in a clayey till, erosion may have been relatively rapid or more than thin in a deposit of gravelly or loose texture that would permit water to pass through it more freely than would be the case with a clayey deposit. How would the rate of erosion of this clayey till compare with that of such rock formations as occur near the site of this boulder? It seems probable that erosion would be much slower in these rock formations than in the clayey till. There is some advantage for erosion in the presence of steep slopes at the outset in the rock formations, for run-off is likely to have been show on the Kansan drift sheet until channeling had got a good start. What percentage of post-Kansan time is

involved in developing good channels can only be guessed, but it does not seem likely to have taken more than 25% of the time. It should then have got about to the present state of erosion that the Illinoian drift displays and it drains quite freely and at a similar rate to that of the older Kansan drift. There is some qualification of rate in both drifts on account of the loess capping, as loess permits water to soak in more than clayey till does. Its effect is like that of the lack of channels to give a slow rate of erosion. The combined effect may be such as to make the erosion rate as slow as that on the rock formations. This being the case the reduction of the district around the Epworth boulder may be about 50'. If the boulder is of Nebraskan age it may be higher but not more than 50% higher, thus reaching perhaps 75'.

The average erosion of the Illinoian drift in Ill. appears to be only 15'. The erosion of rock formations in post-Illinoian time is likely to be much less. This appears to be in keeping with observations in Ky. The above comparison or estimate of erosion of Kansan drift seems to favor the view that the divide west of Licking River was not as high as the Epworth Boulder at the time that boulder was deposited. So there seems little or nothing to support the view that the boulder was rafted in there in ponded waters held up by that divide. Early Quaternary glaciation Kansan or Nebraskan seems likely to have reached the site of this boulder.

The boulder at Farmers??? was deposited in ground but little above 800' A.T. so it may have been rafted there in ponded waters. It is now in a ravine that seems to have been cut since the boulder was brought in. There is, however, a possibility that the ice sheet reached to Farmers??? in the early Quaternary glaciation. (see my letter of July 14 to Prof. Bucher under whose direction the leveling was done)

Lucknow map, a distance of 7 miles by the course of the beach (4 miles north and 3 miles eastward). The lower Warren beach which makes the turn from north to east is near the 825 contour. Its crest may be a few feet higher.

The Lundy beach is 765' at the north edge of the Lucknow map and gravel coats the slope east of it up to 774' as determined in 1934. This beach is 720' at Goderich so it shows a similar rise to the Warren beach or 45 ft. in the 18 miles, an average of 2½ ft. per mile, but, like the Warren it may vary greatly in tilt rate. It was only traced four miles into the Lucknow quadrangle and was not noted between the [illegible] and Goderich.

The Goderich and Lucknow maps show no evidence of ridging at the place where Taylor has a "Goderich Moraine". The first moraine is the inner member of the Port Huron Morainic system. It has some farther back from the Lake Huron shore north from Maitland River, then south, the distance being 4½-6 miles while south of the river it is 3½-4 miles. At the north edge of the Lucknow map it is 11 miles from the Huron shore -- there being an abrupt turn eastward near the line of Huron and Bruce counties.

There are three members of the Port Huron Morainic system on the Lucknow map. The Goderich map indicates that the eastern member crosses to the east side of Maitland River just below the mouth of south Maitland River and runs southward parallel with the other members to the Bayfield River. It is represented only by knolls farther south and not a definite ridge, and these die out within 2 miles. Farther south it is probably merged with the middle member and lies west of [illegible] River, a southern tributary of Bayfield River. There are, however, a few knolls east of [illegible] River that rise above the 900' contour that may pertain to the Port Huron system.

The moraine noted at Clinton in 1934 runs northward through the east part of the Goderich map to its N.E. corner, and continues on the S.E. border of the Lucknow map nearly to where Maitland River enters the map. It is closely associated with the Seaforth Moraine which runs north into the S.W. part of the Wingham map from Seaforth and crosses Maitland River where the stream runs westward from the Wingham into the Lucknow quadrangle.

Taylor's Lucan Moraine is traceable only half way across the Wingham map and is a weak feature there as well as in the Seaforth quadrangle.

The Mitchell Moraine is well defined in the Seaforth quadrangle but becomes diffuse in the Wingham and represented by scattered knolls which come to Maitland River about 5 miles below Wingham.. There is a diffuse knolly topography in the part of the Wingham map north of Maitland River that is difficult to interpret.

The Melverton Moraine of Taylor is very clearly traceable across the N.W.

corner of the Stratford map and northward across the west part of the Conistogo map. But it becomes diffuse on the Palmerston map. It may run northward to Mt. Forest passing the headwaters of Maitland River. Another course is northeastward to the N.W. corner of the Orangeville map past the S.E. end of a prominent esker.

This moraine is the easternmost one that seems referable to the Huron lobe. East of it there is a rather high area without distinct morainic belts, but strong moraine sets in in the S.E. part of the Conistogo quadrangle and the east part of the Stratford quadrangle with extensions into the Galt and Woodstock quadrangles. The relation to ice lobes is not clearly apparent.

There is a strong moraine in the east part of the Orangeville quadrangle outside (west of) the Paris-Galt Moraine. A hill on it 3 miles west of Orangeville catches the 1720 contour. The west base of the Moraine there is near the 1620 contour.

The Paris-Galt moraine runs across the east part of the Guelph quadrangle and touches the S.E. corner of the Orangeville quadrangle. It then traverses the west part of the Bolton quadrangle keeping up on the Niagara escarpment. It is met there by the interlobate moraine that lies north of Lake Ontario and perhaps finds in it a correlative for the Ontario lobe was near this moraine while it formed the Paris-Galt morainic system. The Paris-Galt system is now correlated by Taylor with the Port Huron Morainic system though there is need for more field work from the Bolton quadrangle around to the Lucknow and Wingham quadrangles through the elevated tract west of Lake Simcoe and South of Georgian Bay. In the absence of topographic maps, this may be difficult to clear up satisfactorily. Further study in the field seems necessary to properly interpret the moraines west of the Paris-Galt system in the Woodstock, Stratford, Conistogo, Guelph, and Orangeville quadrangles.

In quadrangles further west and south, a fair correlation seems to have been worked out. The Milverton Moraine however is distinct only to the central part of St. Mary's map. It there becomes merged with the Mitchell Moraine.

Sept. 2, 1937 -- I went with Donald MacLachlan to study further the shore lines in the Goderich and Lucknow quadrangles with the new topographic maps in hand.

We crossed from Port Huron to Sarnia, Can. and went east on Highway 7 to a road that runs north to Arkona.

MacLachlan has traced the Warren shore along the south side of the Port Huron Moraine up to Highway 7.near Warwick. It then turns south and leaves Sydenham River on whose north side it lies from near Wyoming to Warwick.

The Seaforth Moraine has a spur on its inner border that extends clear up to AuSable River at Arkona, the cemetery in the east part of the village being on it. We went up there and then north on a road that runs to the river at a place marked "Dam and Powerhouse" on the Park Hill map. This spur is very sandy and gravelly. It is higher than the Port Huron moraine directly north from it, that being mostly up to 800 feet; whereas this spur is up to 850 ft. in places in S. part of the Park Hill map and is 841 ft. about a mile S.E. of Arkona.

We went north through Thedford to the first road that runs east across AuSable River. This is at the bluff of Lake Algonquin which stands near 625' here. We were near it for about 5 miles. The bluff there turns north. We continued east to Park Hill village, then went north to Moray Corners and from there east about 3 miles to the Warren beach. We then followed the beach northward into the Goderich quadrangle making slight alterations in the position we had given it in previous mapping.

The beach is but little above the 775 contour here, probably 780-785 feet. We traced it to the first road south of Bayfield River at a schoolhouse 1½ miles east of the road intersection with Bluewater Highway in S.E. part of Bayfield. Less than ½ mile east of this intersection, the Lundy beach is cut by this road, and it catches the 700 contour from here north for ½ mile past a cemetery on a road that runs to there from Bayfield. This is about ½ mile south of Bayfield River.

We crossed to the north side of the river and found the Lundy beach there along the 700-contour from the river bluff north on east side of the highway that runs from Bayfield to Clinton. This highway crosses it as it turns eastward and again where it takes a recourse.

There is a sandy tract eastward from here to the Warren beach. The land is sandy also south of Bayfield River below the Lundy beach as well as above it. The river seems to have worked the sand down as lake levels dropped.

We found a 784 beach mark close to the Warren Beach at the place where this highway turns east. The upper limit of the beach material here is 787.feet.

We found the beach keeps below 800 feet except at two places about 3 miles south of the Goderich-Clinton highway where the map shows it to be above 800'. It is 795.5 at this highway as determined by MacLachlan by leveling from Goderich. The upper limit of beach material east of it is not more than 800 feet. North from where the 800 contour turns east, about ½ mile north of this highway, there is a cobbly flat extending to the bluff of Maitland River which was covered by Lake Warren. A second bar of Lake Warren on south side of the river is 787 ft. where crossed by the highway. There are gravel pits in it.

There is an oxbow on N. side of Maitland River east from here that is below 700 contour which may be a river correlative of Lake Lundy. There is a terrace on S. side just above there that is above 725 contour which seems likely to mark the river flood plain in Lake Lundy time. Back of it is a narrow 800' strip like a bar which seems likely to be a river feature connected with Lake Warren. The present river there is 675 ft.

There is a broad terrace on S.W. side of the river south from Ben Miller that is partly above 820 ft. and has a little area above 850' which may be of Lake Warren time.

Just below the bend N. of Holmesville, there is a broad terrace below 875' contour. The river is 775' at this bend. This terrace is as high as the

abandoned river course leading south past Holmesville, the gravel pit in it near the highway being at the 850 contour. The terrace at Holmesville is a little below 875 ft. contour, probably about 870 ft.

There seems to have been a glacial drainage eastward to Maitland River near the border of the Goderich and Lucknow maps through a gap in a moraine. There may also have been southward drainage down Sharp Creek to Maitland River at Ben Miller at the east border of a later moraine of the Port Huron system. If so it would have drained up the present river to the bend and met the stream that came down the river. The terraces between the bend of Maitland River and Ben Miller seem to descend down the present course of the river and thus seem to be later than the glacial drainage connected with the Port Huron Morainic system. They may correlate with Lake Warren.

We crossed Maitland River at Goderich and went on the "Ben Miller" road to the Warren beach at the two cemeteries. It catches the 800 contour in both cemeteries and is 805' on a N.W.-S.E. road near the north edge of the Goderich map. This seems to mark the upper limit of Lake Warren in this quadrangle. There is a strong beach running clear to the north bluff of the Maitland River here with a gravel pit in it. East from it is a very flat clayey plain that is partly above 825' but is not much above 800' at the river bluff near the cemeteries. A moraine of the Port Huron system has its inner border about a mile east of the cemeteries. It runs south into a bend of Maitland R. below Ben Miller.

We returned to Goderich for the night.

Sept. 3, 1937. Goderich, Canada — With MacLachlan we drove north on Bluewater Highway to Dunlop, then east to Loyal and S.E. from there coming to a Warren shore line a little below the 800 contour. This is probably the lower Warren that is 787 on the highway S.E. from Goderich, but we saw no definite shore line above the 800 contour.

We took a road running north on the slope of the Port Huron Moraine at about 825 ft. We turned west on road leading to Loyal and found a Warren beach about on the 800 contour. We traced this north on the road a mile east of Loyal. The beach is above the 800 contour and bears away from it in passing northward, being about 40 rods east of the contour at the first W-E. road. A lower beach lies just below the 800 contour on this N-S road. They both bear east of north when they cross the E-W road and were visible for about ½ mile to the north when viewed from the E-W road. We ran into Nile but saw no definite beach on the road that runs W.N.W. from Nile.

We found the lower Warren causes the loops in the 800 contour near Boundary Creek and south from the creek for a mile or more.

The highest Warren is fully 825 from Boundary Creek to Lucknow River. There is a gravel pit in it about ¼ mile S. of Lucknow River that is at 825 contour. This is about ½ mile south of the 845' gravel bar north of Lucknow River so the pit may not be in the highest part of the beach south of the river.

The 845' bar is too high to match the level of the highest Warren farther north for we ran levels down to it at a schoolhouse W.N.W. from Mafeking and found it to be only 839' at this schoolhouse - nearly 4 miles north from the bar at 845' on north bluff of Lucknow River. The highest Warren where normally developed seems to be up to 850 ft. only at the sharp bend near Lothian about 1½ miles from the north edge of the Lucknow map.

The lower Warren gets up to the 825 contour west of Mafeking and seems to be near that contour for 5 miles north to the bend near Lothian.

We found another feature difficult to explain in a gravel deposit at top of a bluff east of Lucknow River, about 2 miles nearly due north from Dungaunon. It there covers a southward extension of the 850 contour and looks like a beach. A terrace on Lucknow River west of this bar is above 825' and seems to match the normal Warren, as developed directly west from there, both being a little above the 825 contour. The Lucknow bluff is up to 850 contour just west of Dungaunon on east side and nearly to it on west side at the gravel bar. There is also a shallow gravel pit on east side on ground above 850 feet. It thus appears probable that the river had to cut across ground at about the level of the gravel deposits and that it spread the gravel before cutting a trench.

For about a mile above the highway crossing west of Dungaunon there is a much narrower valley than above there at the place where the terrace was developed that stands above the 825 contour and where gravel is found on the bluff east of the terrace that catches the 850 contour. This gravel and that on both sides the valley west of Dungaunon may be a fluvial deposit connected with the beginning of the flow of Lucknow River in its present course. It had earlier discharged into Sharp Creek and thence to Maitland River in a channel a little below 900 feet. It may also have run next in a lower course passing the headwaters of Boundary Creek about a mile east of Dungaunon. This is at about 875 Feet. Following this it may have taken its present course and as a first piece of work spread the gravelly coating west of Dungaunon and that above the 850 contour two miles above Dungaunon. Then as it was traveling this tract below (south of) the terrace it meandered enough to produce the terrace or was held at that level by Lake Warren whose shore was at the bend of the river about a mile west of Dungaunon. The Warren waters may have fallen a little short of reaching the top of the gravel deposit on north side of this bend but have been near the level of the gravel on south side or not much above 825 feet. This would bring Lake Warren into a normal plane consistent with 839 ft. at the schoolhouse west of Mafeking four miles farther north.

We ran east from Mafeking across a moraine west of Lucknow River that crosses to the east side of the river just below here.

Lucknow River has a broad cobble strewn valley here standing in part above 875 feet. This seems to find continuation south on the east side of the moraine that passes just east of Dungaunon and eventually reached Maitland River. Another moraine, on which Belfast stands, separates this line of drainage from one east of it that is but little below 900 ft. at its place of departure from the present course of Lucknow River.

The village of Lucknow is in the broad line of glacial drainage that is continued in the lines leading to Maitland River.

A line of glacial drainage comes into the Lucknow valley from the west near

the line of Bruce and Huron Counties. It is a narrow channel about 1/8 mile wide. that runs clear through the moraine west of Lucknow. This moraine is exceptionally wide, 4-5 miles, directly west from Lucknow. There is another moraine east of Lucknow that runs south near the east edge of the Lucknow map, and has Maitland River on its outer or east border in the south part of the Lucknow map. This moraine seems to be a member of the Port Huron system.

We found a few places where slight development of gravel beaches occur at lower levels than the Warren beach. The Lundy beach was traced in 1934 for about 4 miles south from the north edge of the Lucknow map. It is about 765 ft. at this north edge. There is a weak beach at nearly 750 feet, south of Lucknow River, about 2 miles west of the Warren shore.

A faint beach or ridging of sandy gravel was noted near the 725 contour 1¼ miles ESE of Sheppardton, and also on both sides of Boundary Creek near the 725 contour. The one that is nearly 750 ft. seems to be near the Lundy level for this latitude.

We went back on the Bluewater Highway to Forest. We then went west to the Lake Huron shore and took a road nearest the lake from there nearly all the way to Sarnia. The course is marked on the Perch map. We reached Port Huron for supper and returned to Ann Arbor at about 9 P.M.

September 10, 1937 — An advance sheet of the Smith's Creek quadrangle in St. Clair County, though lacking contour gives a fair idea of the latitude of the waterlaid part of the Port Huron moraine. Its crest is 673-676 at south bluff of Black River near Wadhams, 660 feet at the Grand Trunk R.R. crossing, 650 feet a mile east of Kimball and 650-651 feet for 2 miles farther south. Its crest is 648-649 feet at Gratiot Road (U.S. Highway No. 25) ½-1 mile WSW from Marysville Corporation limits.

The spillways noted by Taylor in Mon.53 U.S.G.S. and shown in Fig. 10, p-474, set in less than ½ mile south of Gratiot Road, in Secs. 1 & 2 St. Clair Tp. 75 N. R16 . The second one in SE part of Sec 1, is 628.7' and one in SE part of Sec. 12 is 622 ft. It will be important to determine how much above the level of the beds of the spillways the deposits made by the streams that formed these reaches. Lake Lundy waters were at least that high at the head of the spillways. MacLachlan has found that gravel deposits at the SW end of one of them are 620 feet or in harmony with the Elkton beach on the St. Clair and Erie basins. It is important to determine whether the lake in the Huron basin stood say higher than 620'.

The advance sheet of the Goodell's quadrangle shows the Whittlesey beach to be 755 ft. in Sec. 31 & 30, Wales Tp. It is about 758 in east part of Sec. 6. The Warren beach is 691-696 on the diagonal road in Secs. 12, 13 & 14, Wales Tp. T6 N, R 15 E) and about 696 in Sec. 1.

In the Adair quadrangle it appears to be higher than 695' between Muttonville and Richmond, for Muttonville is 695' and a mile N. of Muttonville, 706' near the Warren beach.

This raises the question whether the beach in Secs. 1, 12, 13 & 14 Wales is not a Lower Warren. A sand ridge near Goodell station seems to be a little above 700 ft. but being sand it may be drifted up to a higher level than Lake Warren. The Warren shore near Muttonville and Richmond is not so sandy, and appears to be at Lake Warren level at about 700 ft.

In northern St. Clair County the Warren beach reaches 718 ft., but it seems to be not more than 700 feet where the Port Huron moraine is crossed by it on north side of Black River near corners of Secs. 26, 27, 34 & 35, T 7 N, R 16 E.

October 7, 1937. I went into Jackson County with George Stanley to see the esker and accompanying features in vicinity of Wolf Lake. We examined first a bouldery strip in Grass Lake Tp. (T 3 S, R 2 E). This runs from near the center of Sec. 13 WSW to Wolf Lake across Secs. 14, 15, 16, 21 & 22. The boulders are on the general level of the district and also on slopes and in lower areas. A few pits were noted in which boulders are included with course cobbly gravel at various depths. The beds in some cases dip westward at very steep angles. One of the best is in the north part of Sec. 20. This is in the face of a bluff-like rise that probably reaches fully 1000 feet for the relief is fully 60 ft. above the marshes on the border of Wolf Lake that are 940'. We interpret this boulder strip to be older than the outwash of the Mississinewa moraine and not a dependency of that moraine. Its eastern end is about a mile west of the outer edge of that moraine and this interval is occupied by a gravel plain that seems to be of finer material than that of the bouldery strip. We went to the edge of the Mississinewa moraine on the line of Secs. 18 & 19, Sharon Tp., Washtenaw County. It is made up of bouldery, cobbly shift with hummocky topography standing only a few feet above the bordering outwash plain.

This plain is above 1040 feet in the NW part of Sharon Tp. near line of Secs. 5 & 6 and probably is of similar altitude in Secs. 8, 17 & 18. This part of the outwash plain in Sharon Tp. is drained by Mill Creek, a territory of Huron River. The bouldery strip in Grass Lake Tp. drained to Grand River, the divide being near the county line of Washtenaw and Jackson Counties. It is probable that the waters that laid down the outwash plain in NW Sharon Tp. found westward discharge while the icesheet was forming the moraine and the Mill Creek draining came later after the ice sheet disappeared, there being some advantage it possessed above that of the original westward drainage to Grand River. A similar shifting to Raisin River drainage took place in streams south of this bouldery strip which originally drained westward to Grand River. This involves the large drainage of Goose Creek as well as a stream that runs through Secs. 24, 23, 22, 27 & 34, T 3S, R 2 E, whose head is within the limits of the bouldery area in N part of Secs. 23 & 24. This interesting shifting of drainage needs a topographic map with 10' contours to make interpretations complete and satisfactory. A large area now tributary to Raisin River extending as far east as the Ft. Wayne moraine near Manchester formerly drained westward to Grand River.

After examining the bouldery strip in T 3 S, R 2 E, we drove into the area covered by the new map of the Jackson quadrangle entering it on line of Secs. 12 & 13, T 3 S, R 1 E. We came to a till area near corners of Secs. 11, 12, 13 & 14 that is boulder strewn and has a rather clayey till exposed in ditches near the section corners. This has fine swells that rise above the

1010 contour. There ~~in general are~~ are other small areas near here that are above 1000 ft. and some of these are gravelly. The Grass Lake outwash plain is about 1000 ft. in this vicinity. Points on it in Sec. 1, T 3 S, R 1 E, are above 1010 ft. and these are not boulder strewn, nor is a slight prominence of gravelly nature at middle of the line of Secs. 13 & 14 that is 1006. Boulders are, however, present at a little below 1000' on the road leading south from the center of Sec. 14, probably as high as 980 ft. and they are conspicuous on the slope to the south to below the 960 contour - or down to the plain that marks the glacial drainage from the Ft. Wayne moraine.

We next examined a moraine in Secs. 27, 28 & 29, T 3 S, R 1 E. It is strewn with boulders and has a fairly definite morainic topography with knolls 10-20 ft. high. The esker called "Blue Ridge" on the topographic map seems to start in the NW part of Sec. 28 and to be superimposed on the moraine as its closing feature of deposition. The morainic topography is present about to the center of Sec. 29. Further SW there is the conspicuous esker "Blue Ridge". There is a gap in it west of Cranberry Lake about ½ mile wide. It is very prominent through Sec. 31, T 3 S and Sec. 6, T 4 S, R 1 E, but it is less prominent in Secs. 1, 12 & 13, T 4 S, R 1 W. Grand River passes through a gap in it in Sec. 12.

Where most prominent, the crest of the esker is 1020-1030 ft. or nearly 50 ft. above bordering plains on each side. This esker carries a remarkably coarse material with boulders and coarse cobble included in the gravel.

It seems to us probable that the boulder strip in T 3 S, R 2 E, the moraine in T 3 S, R 1 E and this esker are all near the junction of the Saginaw and Huron-Erie ice movments ~~or~~ a sort of interlobate feature, like a submarginal spur on the inner border of a moraine which comes into the Jackson quadrangle on the north side of Kalamazoo River and curves around to the south embracing the headwaters of Grand River and Goose Creek, a tributary of Raisin River. Bunday Hill is in this part and Prospect Hill is near where it made the southward turn. The esker comes to it near where the turn is made.

On our return we drove east from the esker on the line of Tps. 3 & 4 S. through a plain that is nearly flat and were surprised to find no boulders along the roadside or in border fields. The soil is loamy and has few pebbles. Perhaps this flat area has a lake deposit over the till? There is need for collecting well records here and giving the drift careful inspection to clear up the nature of the surface portion.

October 25, 1937 -- I went with Prof. Ralph Belknap into St. Clair County to examine the spillways across the waterlaid Port Huron Moraine as given on the Rattle Run and Smiths Creek maps (Advance Sheets) of U.S.G.S. We went east from Gratiot Ave. on a road a mile south of the line of Tps. 3 & 4 N, R 14 E to see if it shows any traces of the highest Algonquin shore of Lake St. Clair but were probably outside its limits a small fraction of a mile.

We found the Emmett Moraine is sandy in north part of Sec. 36, T 4 N, R 14 E, above the 630 contour and has scattered boulders with the sand about as in Secs. 1, 11 & 12, T 3 N as noted in June 1934. Whether or not the sand at levels above 630' is an Elkton feature is not clear. We went east into St. Clair County on line of Secs. 30 & 31, T 4 N, R 15 E. There is a clay soil

nearly to the east end of the section line but there is a sandy soil near corners of Secs. 29, 30, 31 & 32. It is sandy on the line of Secs. 29 & 30 northward past the quarter post and apparently up to about 640 ft. or 10 ft. below the BM at north end of the Section Line. This seems too high to be referable to the Elkton lake stage.

We went east on the "Meisner Road" through what Prof. Belknap says is considered the best farming district in St. Clair County. The soil generally is clayey but there are occasional small sandy spots. This is the condition as far east as the corner of Secs. 20, 21, 28 & 29, T 4 N, R. 16 E -- and down to about 620 ft. from 650 ft. where we turned east.

The sand becomes more conspicuous on the line of Secs. 21 & 28 but clay soil is fully as extensive. This sand is between 614 & 620 in altitude. We went north on line of Secs. 21 & 22 rising from 614 to 618'. The sand is more conspicuous near north end of this line and slightly ridged or wavy. This is near Belle River and we suspect it was brought in as a delta deposit.

We went west on line of Secs. 16 & 21 rising to 623 at west end. Sand is more conspicuous here than further east. We crossed Sec. 16 on a road near S. bluff of Belle River but found only thin and patchy sand. We crossed Belle River at a mill in west part of Sec. 15. We continued north on line of Secs. 15 & 16 and found sand more conspicuous near north end of line than near the river and at about 620'.

Continuing north on line of Secs. 9 & 10 we found more sand in north half than farther south and at altitude about 620 ft.

We went east on the "Hart Road" and found sandy land in east part of line of Secs. 3 & 10 at 614 ft. and there are sandy spots further east to the bank of the St. Clair channel near middle of line of Secs. 2 & 11.

This road takes past the S. end of the loop made by Pine River in this St. Clair Valley. There is a sandy strip east of the north flowing part of Pine River in and near a cemetery. The river enters St. Clair River a few rods S. of Clinton St. about ¼ mile north of the line of Tps. 4 & 5 N.

There is low land on Clinton St. for 4/10 mile west from St. Clair River, but at Vine St. the low land extends only a few rods west from the river.

A strip of higher land extends south between Jordan drain and this low area a little beyond the township line and there is also an extension beyond the town line on west side of Jordan drain. This higher land may, however, be outside the limits of the Port Huron moraine from Clinton Street southward. This seems to be suggested by the occurrence of gravel deposits north of Clinton St. on the west side of Jordan drain. This drain is cut down at its south end to match the old St. Clair channel west of the present river.

There are sandy deposits on Danford Road at the St. Clair city boundary between Clinton and Vine Sts. that may lie outside the Port Huron Moraine. They are a little below 620'. The gravel north of Clinton St. west of Jordan Drain is probably fully as low.

Another gravel deposit is S.E. of Town Hall in the N.W. part of Sec. 23, T 5 N, R 16 E. It is 620-625'. It is on the west bank of "Angel Creek drain" at 10' or more above low land along the drain. It remains to be determined whether these are outwash deposits of the moraine or instead are connected with the spillways and thus of the age of the Elkton beach. They are far below the level of Lake Whittlesey which was probably as high as 700' here -- so it seems more probable that they are of the age of the spillways and mark the level of water in them before the channeling was completed or before the Elkton water level was lowered at the close of that lake stage.

The depth of these spillways is so great as to suggest their being cut to some extent later than Elkton time. St. Clair River may have divided its waters between the present channel and these old ones while opening its course through the Port Huron moraine after the time of Lake Lundy as it did south of St. Clair city.perhaps down nearly to Algonquin level or 600± A.T. This is suggested by the low altitude of the Jordan drain in its southern end. It is opened widely below the level of the Elkton beach.

The northernmost spillways (in Secs. 1, 2, 11 & 12, T 5 N, R 16 E.) have channels with beds at 630-635 ft. These seem to match the Elkton stage of Lake Lundy but the Angel Creek drain may have continued a little longer. The Brandywine and Jordan drains seem to have been in operation down to a later time. The level at the head of Brandywine spillway has not been determined, but the head of Jordan spillway near corner of Secs. 17, 18, 19 &20, T 5 N, R 17 E, is about 615 ft. and close to St. Clair River. Its bank there is scarcely 625 ft. (624' on St. Clair map) as determined by hand level today, starting at St. Clair River with assumed elevation of 576 ft. This is the head of the east spillway of Jordan drain. The west spillway starts near the river a mile farther north and seems to be fully as low as the east one.

The bed of Brandywine spillway at the range line corner of Secs. 7 & 18, 12 & 13, is 620-622' but sand on its east bank near the R.R. crossing on line of Secs. 7 & 18 is 630 ft. The water level in the channel may have been that high. The bed of the Angel spillway is 620-621 ft. at the Fasbender School. This creek or spillway is about 1/3 mile wide here and seems to be wide to the N.E. across Sec. 12, T5 N, R 16 E. Its banks are about 630-632'. The gravel deposit near the town hall at 620-625' is on the west bank of Angel Creek and as above indicated may be connected with this spillway.

The Brandywine and Angel Creek drains unite before reaching Pine River. There is a gravel deposit at about 611 ft. on west side of Brandywinenear center of Sec. 26. This is about 10 ft. above the bottom land on Pine River.

There is an island between Hurst and Brandywine Creek drains mainly in Sec. 23 but extending into Sec. 26 that is probably fully 628 ft.

Further study of these spillways may follow the receipt of the Port Huron and St. Clair maps.

We returned via Marine City and the road that runs west above Robert's Landing. which crosses the gravel deposit at 600' to which MacLachlan ran levels on August 30, 1934. A BM at east end of this road is 582'. A bench mark at corner of Secs. 16, 17, 20 & 21, T 3 N, R 16 E, is 599.5 at about 1½' above ground surface. A mile farther west, a BM is 593', both below Algonquin stage of Lake St. Clair.

Der Löss und Seine geotechinschen eigenschaften by Dr. Ing. Alfred Scheidig, Bergakadamie - Freiberg in Saxony, Germany, 1934, 233 pages with 132 text figures and 6 tables.

(The literature cited embraces about 380 titles yet is very deficient in Amer. lit. The map showing loess in No. Amer. is a caricature.
Table 2. Different hypotheses on the origin of the loess. Quotes from early papers of Amer. authors attributing views they have discarded. Chamberlin 1897, Salisbury 1896, Leverett 1896)