Notebook No. 300 - Leverett

COUNTY

OTHER STATES

OTHER COUNTRIES: 18-20, 30

Leverett's notes - pages 1 - 7 April 12, 1938

I made a trip with Dr. George Stanley to Port Huron. Notes were made of the class of surface material along Gratiot Road on the new U.S.G.S. maps beginning with the Adair map.

Boulders are very numerous in Section 12, Lenox township and there is scarcely any sand and the till some sand, however, was noted for about ¼ mile south of Muttonville.

North of Muttonville in Section 6, Casco township, St. Clair County, cobble and boulders are conspicuous and there is little or no sand.

In Section 31, Columbus township, there is a clay at surface with very few pebbles embedded in it. Surface sand sits in northeast of the junction with Bartel Road in east part of Section 32 on west side of Belle River. There is clay at surface near the junction with Bauman Road east of Belle River. But sand sits in a little further on and there is a deposit several feet thick over blue clay on both sides of Belle River in SE¼ of Section 28, Columbus township. At Snyderville also sand seems to be several feet thick. It becomes thinner in northeast part of Section 27 and southwest of Section 23 and clay is at the surface in east part of Section 23, and west of Section 24 with an occasional boulder in Section 24. In the edge of the Rattle Run map in northeast of Section 24, there is a sand wover -over clay. The road is in a depression along southwest tributary of Rattle Run in Section 18, St. Clair township and clay is frequently exposed with little sand over it. East of Rattle Run in Section 17, there is a thin sand coating over clay usually only 2 or 3 feet. In the Smiths creek map there is very little sand on either side of Pine River in Section 9, St. Clair township and this condition prevails across this map in Sections 10, 2 and 1, St. Clair.

But sand is more conspicuous near the junction with Pickford Road near line of Section 1, St. Clair and Section 36, Kimball township. It is not conspicuous in Section 31, Port Huron township but becomes so in northwest part of Section 32, where it is at the level of the Algonquin beach 607-608 feet.

We went north on Michigan Road on the line of Sections 29 and 30, which is a little above the Algonquin level being 609-610 feet. There is a thin sand coating and it seems probable the Algonquin water covered all of Section 29, except the west and north edge and may have extended into the south part of Section 20 in the swales. The southeast corner of Section 20, is 608 feet or about at the Algonquin level, but the line of Sections 20 and 21 on 32nd street, Port Huron is above it being 611-612 feet. The altitude is 613 feet where 24th Street crosses the line of Sections 16 and 21, Port Huron township. The east half of Section 16, is mostly low enough to have been covered by Algonquin water and this seems to have crossed the east part of the west half of this section and of the southwest quarter of Section 9. There are prominent dunes in the west part of Section 9 reaching 20-25'. They are probably at the border of the Algonquin water.

Page 2:

A sand bar runs southeast from near the center of Section 9 about to the southeast corner of the Section which has an altitude of 606-608 feet or perhaps slightly higher in its highest part. It seems to be free from pebbles but may be a bar in the Algonquin formed by water action rather than by wind.

From near the center of Section 9, there is a sandy bar running north to Water Street, near Campau School, that is 605-606 feet. Black River there interrupts it but the Algonquin shore sits in on the east side of Black River south of Elmwood Street. It is about 608 feet there and it points further north. We traced the Algonquin bar northeastward from the southeast part of Section 16, Port Huron township along west side of Gratiot Road to within two blocks of Black River at 6th and Wall Sts. It holds an altitude of 605-608 feet in much of its course. There is a lower area west of it that is 600 feet or slightly less, that embraces much of the city south of Black River.

We went to see the city engineer Allan Carlisle, Jr., and obtained from him a map of the city. I copied altitudes at many street intersections from a manuscript map in his office setting down most of them that are above 600 feet. The data thus obtained enabled us to outline the Algonquin bars and shore quite definitely.

Mr. Carlisle stated that a flat gravel area has considerable extent on north side of Black River between the river and Pine Grove Avenue. The gravel is within a few inches of the surface and has considerable depth wherever opened. There is a sandy strip with altitude about 600-602 feet. Kuring and Lincoln Avenues run eastward from 12th Street across this sand area about to Stone Street. This is a little below the Algonquin level but is probably of Algonquin age.

In the afternoon we drove out Pine Grove Avenue to Elmwood Street and went west on Elmwood to the Algonquin shore at 16th Avenue. It is 608' and its east base is 601 feet and the lake bed 599 feet at Pine Grove Avenue. West of the beach is a flat sandy area at 608-609' extending to Black River bluff. We think this may be a delta of Black River at Algonquin time.

North from Elmwood it runs to 612' at Garfield Street and is 610-614' from there north to where River Street comes to Pine Grove Avenue. The material is a fine sand in which we saw no pebbles. It is probably a water deposit as its surface is less uneven than an ordinary wind deposited sand. The altitude is 610.8 at the north city limits at Holland Avenue. The Algonquin shore is about 1000 feet east from here on east side of Pere Marquette Railroad.

The beach runs northwest parallel with Pine Grove Avenue across Sections 27 and 21, Fort Gratiot township. It turns northward in Section 17 and runs through center of Sections 17 and 8 and east end. It comes to the shore of Lake Huron about a mile further north near corner of Sections 28, 29, 32 and 33, T.8N., R.17E.

Dr. Stanley suggests the possibility of an Algonquin bar further east than the beach we have been mapping and will in a future trip look

for it and if found run levels to it. (There is such a bar at 603 feet).

We stopped the mapping here and returned to Ann Arbor.

April 20, 1938

Prof. W. E. Powers, of Northwestern University gave an illustrated lecture on the work he has been doing on the moraines of Northeastern Illinois in Kane, Cook, McHenry and Lake Counties. He interprets the Marengo ridge to be early Wisconsin and to correlate with the Bloomington morainic system. But he thinks the part north from Section 21, Hartland township, McHenry county was overridden by the Valparaiso moraine as far west as a line running through Sections 17, 8 and 5, Hartland and Sections 32, 29, 20, 17 and 8, Alden townships. This moraine he thinks continues as the Dorien moraine of the Delevan lobe and the outer moraine of the Green Bay lobe in Wisconsin. From Hartland township it runs southeast into the McHenry quadrangle in Section 2, Seneca township and takes a southeast course past the south edge of Woodstick to Ridgefield and enters the Elgin quadrangle in Section 31, Nunda township and passes south of Crystal Lake Village and comes to Fox River just above Algonquin village. It follows the east bluff of Fox River to Carpentersville and then runs into the west part of the Barrington quadrangle. From there it runs south about a mile from the west edge of this quadrangle into the northwest corner of the Wheaton quadrangle. Its further course is about as shown in Monograph 38, U.S.G.S.

The Minooka moraine is made to run north from Aurora on the east side of Fox River to St. Charles and then cross to the west side and run north to Elgin. It there crosses to the east side and runs northeast soon passing under the Valparaiso moraine. Its further course can only be conjectured for it does not pass beyond the Valparaiso farther north. It is thought, however to have formed an ice barrier that caused a ponding of Fox River drainage to about 830 feet and causing silt deposition on the Gray's Lake quadrangle. The silt is interbedded with the till of the Valparaiso moraine laid down when the ice was advancing westward in that stage to the line traced above. This re-advance seems to have added only a thin coating to the earlier moraines that were over-ridden by it. It, however, gave Fox River its present course as it was melting back and filled channels west of it that had been opened at the Marseilles stage.

The Marseilles stage he thinks reached the southeast end of the Kaneville esker and laid west of the present course of Fox River in the Geneva quadrangle, Otter Creek being along its edge in northern Geneva and southern Elgin maps. Its border he thinks runs from Elgin to Huntley and thence to the northwest part of the Elgin map and passes under the Valparaiso drift west of Woodstock. He thinks it was channeled to a great degree prior to the re-advance at the Valparaiso stage and some of the partly filled channels are traceable in the McHenry maps.

A moraine lying between the Marseilles and Marengo moraines in the Elgin quadrangle is named the Gilberts moraine. It runs south into the Geneva quadrangle and is separated from the Marengo Ridge by a narrow plain. It may embrace the prominent kames in Blackberry township,

Page 4:

Kane County, and the Kaneville esker.

There is a pink tinge in the drift of the Marengo Ridge and in the moraines of the Bloomington system for some distance west. This pink tinge also characterizes the Illinois drift in the district west of the Marengo Ridge.

Alden refers to this in Prof. Paper 106, pages 89-90 and thinks the red material is from Clinton iron ore in eastern Walworth and western Racine and Kenosha counties Wisconsin, so it seems that the Wisconsin ice reworked this material and incorporated it in its drift.

Notebook 300

April 22, 1938. Ralph D. Killian of Perryaville, Mo., sent me a specimen of a granite boulder weighing about 1000 lbs. that was found in north part of sec. 4, T 33 N, R 13 E in Perry Co. near Apple Creek and near the line of Perry and Cape Girardeau Cos. It is a gray granite and not very deeply weathered presumably deposited not earlier than the Illinoian stage of glaciation. It seems probable the ice sheet reached the site of this boulder. Mr. Killian states that "there is quite a bit of evidence (of glaciation) in the particular section where this boulder is located".

May 3, 1938. Denmark. Iowa. I went with Prof. C. W. Cruickshank of Mt. Pleasant, Iowa, to exposures of Coal Measure Sandstone in the NE¼ sec. 6, Augusta Twp., Des Moines Co., that carry specimens of Sigillaria Lepidodendron, Calamites and Stigmaria of each of which class of plants he collected good specimens. The occurrence of Coal Measure Strata here is noted in Keyes Report on Des Moines Co. in Vol. III, Iowa Geol.Surv. and the geologic map of Des Moines Co. But the new geological map of Iowa issued in 1937 omits this exposure.

May 20, 1938. I went by bus from Ann Arbor via Toledo to Springfield, Ohio, for a conference with Dean Schaefer of Wittenburg College and Prof. Swimmerton of Antioch College on the boundery between the Miami and Scioto lobes.

The striae NE of Urbana that have an eastward bearing were visited on May 21 and found to show clearly an eastward ice movement. They are well shown in a quarry south of the center of sec. 2, Salem Twp. on the east side of a N-S road. The quarry in No. part of sec. 1 that exhibited such striae in 1920 is now so filled up that no exposure of ledges in place could be found.

We gave attention to the moraine in the west part of Union Twp. west of Buck Creek and found it has rocks that pertain to formations to the east and is lacking in rocks from formations to the west. This seems to favor the reference of this moraine to the Scioto lobe though it lies directly east of and adjacent to the quarries with the eastward striae. However, we found that the rocks exposed in a railroad cut a mile west of the striated ledge in an undoubted Miami moraine are very similar to

these in the moraine east of the striated ledge. This was a surprise for this moraine is west of the rock formations represented in it. The interpretation seems to involve an ice movement in a pre-Wisconsin stage that carried the rocks into a district south and west of their outcropping ledges. Then the Wisconsin ice reworked this material and built it into the Miami moraine. Profs. Swinnerton and Schaffer plan to give this railroad cut further study and other parts of the Miami moraine near there.

We drove south along the east border of this Miami moraine through Urbana Twp. and found that it shows a graduation from till to outwash gravel setting in near its crest and descending eastward into the gravel plain. This moraine lies east of Mud River valley and passes through the east part of Springfield. Buck Creek breaks through it in this city. The moraine has rather subdued features south of the creek in secs. 21, 22, 23, 27, 28, 29, Springfield Twp. but is more pronounced in secs. to the east on the border of the Springfield topographic map and the west edge of the south Charleston map. There is a small esker in the NW part of sec. 21 with NW-SE trend and a kame near the center of the sec. A narrow strip of glacial drainage runs south from there in east part of sec. 21. A moraine with strong expression lies east of it which has a conspicuous gravel plain on its outer or eastern border, the continuation of the gravel plain through which Buck Creek has its southward course above Springfield. It comes to the north fork of Little Miami River in sec. 8, Springfield Twp. and follows down its valley to Clifton.

The Miami moraine west of this plain dies out in sec. 13, Springfield Twp. Farther south there is a gently undulating till of ground moraine type. East of the north fork of Little Miami in Greene Twp., Clark Co., is a gently undulating till with few knolls over 10' in height. This seems likely to pertain to the Scioto lobe.

There is no such gravel plain along the Little Miami River below Clifton as there is above that village. But the stream has a terrace on its borders 1/3 mile or more in width into which a rock gorge has been cut. On both sides of the Little Miami valley there is gently undulating till of the ground moraine type. It seems probable that the Miami and Scioto lobes were here separated by the narrow strip of terrace

along Little Miami River. That the Miami lobe extended about to the Little Miami is indicated by striae at Yellow Springs bearing east of South that were noted long ago by Prof. Orton. Prof. Swinnerton has not seen such striae but has not made careful search for striae on the ledges in that vicinity.

My notes in 1890 mention gravelly deposits on the east side of Little Miami Valley near Oldtown that I suspected were dumps from the Miami lobe - near its limits. We examined the rocks in two pits and it seemed to Prof. Swinnerton that they bear out my suspicion as the material is largely from formations that outcrop to the west. He will give this matter further study.

The gravel plain directly west of Xenia seems to pertain to a Miami moraine west of it rather than to the Scioto moraine that comes into Xenia from the south. It is higher next to the Miami moraine.

South from Xenia along the Cincinnati Road there is a gently undulating till of ground morainic type which graduates eastward into a more sharply undulating tract of the terminal moraine type. Conditions are similar to the north of Xenia. A Miami moraine comes into the Xenia topographic sheet from Spring Valley in the Waynesville sheet and runs south along the west side of ~~Xenia~~ Caesars Creek into Warren Co. It lies NW of Caesars Creek in the SE part of the Waynesville quadrangle and adjacent part of the Morrow quadrangle.

This is the outer moraine of the Miami lobe. The outer moraine of the Scioto lobe comes up from Cuba in a NW course to Caesars Creek at Harveysburg. North from Harveysburg, Caesars Creek Valley seems to follow the line of meeting of the two lobes. There is but little outwash along Caesars Creek though the presence of springs is said by residents to be due to gravel in its bluffs and not to issuing from rock formations. There is little or no outwash from the Scioto lobe in the sec. between Harveysburg and Cuba where the moraine is well defined with a relief of 30-50'. Conditions there are similar to those along the border of the Shelbyville moraine in Illinois and probably are due to similar cause. The cause is not as yet fully settled. Perhaps melting was not rapid enough at this culminating stage for a conspicuous outwash.

We examined Beaver Valley from Alpha northward to its head on the border of Mad River valley near Fairfield and found it a probable temporary course of Mad River while the Miami lobe was forming the moraine on the west side of Beaver Creek valley. At an earlier time the Miami lobe followed the west side of Mad River past Springfield and crossed the valley near the Masonic Home. Its border then appears to have taken a southward course passing west of Yellow Springs to the Little Miami valley. But no well defined course for Mad River east of this moraine was noted. Mill Creek valley may have been utilized but it is not so well defined as the course through Beaver Cr. valley. I returned by bus to Ann Arbor the evening of May 23.

Prof. Schatzer has found extensive deposits of a blue clay under the till in the Miami moraine north from Springfield on the east side of Mad River Valley, and also under the gravel in the outwash plain east of this moraine. It is exposed in the railroad cut a mile west of the striated ledge north of Urbana. It seems there to be nearly free from pebbles and a water deposit, not a blue till.

Prof. Schatzer has been employed by the Springfield Water Co. to make estimates of the supply obtainable from the gravel beds in the Buck Cr. gravel plain and has thus obtained knowledge of the extent of this clay. He has also done considerable work on the distribution of the deep buried valleys in the vicinity of Springfield but has not published the results.

I later wrote to Prof. Sammerton suggesting a study of the Miami moraine on east side of Mad River valley to determine how far south the rocks from formations lying east of the moraine are found in it and made the suggestion that a pre-Wisconsin ice movement may be involved in the peculiar distribution of these rocks.

Leverett's Notes - Pages 16-31

Letter from Sherman Moore, Principal Engineer, U. S. Lake Survey, Detroit, to R. A. Smith, State Geologist, Lansing, Michigan, in reference to recent earth movements in southeast Michigan:

Detroit, May 28, 1938

Mr. R. A. Smith, State Geologist
Lansing, Michigan.

Dear Mr. Smith:

Thank you for your letter of May 26. I am glad to know that someone else has more confidence in first order levels than in the stability of the earths crust.

I have been trying to determine changes in elevations between the Lakes by comparison of lines of instrumental levels, between Ontario and Erie levels in 1875, in 1898 and in 1937. They show a change at a uniform rate bench marks at Oswego rising with respect to those at Cleveland. Between Lake Huron and Lake Superior levels in 1876, in 1901 and in 1935, again show a change at a uniform rate, Superior-rising. But between Erie and Huron the levels fail to check.

Comparing the lines of 1898 and 1937, the following differences appear, the plus sign indicating that the 1937 values are higher.

B.M.	20	St. Clair	+ 1.132 feet
B.M.	26	Marine City	+ 1.140 "
B.M.	28	Algonac	+ 1.123 "
B. M.	32	New Baltimore	+ 1.128 "
		Mean	+ 0.131 "
B.M.	33	New Baltimore	+ 0.017 "
B.M.	41		+ 0.030 "
B.M.	39	Grosse Pointe	+ 0.026 "
		Mean	+ 0.024 "
		Difference	0.107 feet

B.M. 32 and 33 in New Baltimore on old buildings about 600 meters apart.

The possibility of an error in the levels of 1937 has been eliminated by a careful check in the field. The notebooks of 1898 have been carefully checked and no error found. (He then speaks of an earlier line of levels 1877 between Gibraltor and Port Huron of which one B.M. at New Haven has been found and this will soon be tied in with the more recent ones).

There early levels could be contrued to show sliding on the fault prior to 1898 also but they do not seem to be sufficiently accurate to be of much value.

Another point of interest is shown by the comparison of these levels. The land seems to be rising to the south. Straight lines ignoring minor descrepancies on bench marks showing the same tilt above and below the bbeak at New Baltimore of about 0.0025 feet per mile in 35 years.

Comparison of gages at Harbor Beach and at Lexington also show a rise to the south. On the other hand, Cleveland has gone down 0.18 feet in 35 years with respect to Gibraltor.

Very truly yours,

(signed) Sherman Moore, Principal Engineer

The above letter was sent to Prof. Hobbs, who raised the question whether north and south had been exchanged in typing the letter, to which Mr. Moore replied June 2, that there was no confusion the southward rise found between Harbor Beach and Lexington being continued into the St. Clair River and Lake. Also that south of the break at New Baltimore the levels shown southward rise to Gibraltor. Water level comparisons show no change between Gibraltor and Buffalo in 60 years, but with respect to these points Erie, Cleveland and Toledo are going down.

He then notes that he has been studying this earth movement for nearly 20 years, but his large mass of data will need checking and further study before it will be in shape for publication.

He then remarks: "My study has led me to believe that the present movement in the Great Lakes area has but little, if any, relation to that which elevated the old beaches. The records we now have indicate that the present movement is probably a wrinkling such as would result from north and south pressure."

July 15, 1938

I went with Prof. Neil F. Morrison of Windsor, Ontario (who is in attendance at the U. of M. summer school) into Essex and Kent Counties, Ontario, to see the shore lines and other features. We were accompanied by Prof. Adamson of Stratford, Ontario and Charles Queensville Business Administrator of Separate School Board of Windsor.

We found a flat surfaced gravel deposit directly north of Walkerville Junction near Windsor City limits which has a level 3-4 feet above the Junction. This is given as 615' in the Topographic Map of southwest part of Ontario (south of 43030) issued in 1905 by Department of Interior of Canada. But while "altitudes in Canada" make this Junction 611'. Probably it is 615' as the track is on a fill. This gives the gravel deposit an altitude of 618-619' which is about that of the Elkton beach.

We also went to a sandy deposit about a mile southwest of Tecumseh which is back of a sloping bank that I interpreted to be the highest St. Clair shore. The altitude of the sand is about 600 feet. The top of the sloping bank is a little below the 600 contour. We think the wind may have carried this sand back from the shore to a slightly higher elevation.

We went to Essex for dinner, and then to the high area northwest of Leamington. We visited gfavel pits in it. One is in a beach back of the Warren about 3 miles north and 2 miles west of Leamington. That is above the 700' contour of the Essex ~~township~~ topographic map and nearly

½ mile south and west of the Warren beach. The gravel here has been opened to a depth of 20 feet and shows much complexity in bedding and in courseness of material. Some beds dip south or southwest. Some on sandy, others are of gravel suitable for road ballast. The bar has a trend slightly east of north and probably was formed by waves on its east side.

Another large pit is on the Whittlesey beach south of an east-west road two miles north of Leamington and 3½ miles west. In this pit the gravel dips eastward and seems to have been formed by waves coming from the southwest. The beach has less relief on the west side than on the east but probably the stronger winds came from the southwest and built the gravel deposit into the lower land to the east. The bar is about up to 735 feet and the deposit is fully 20 feet thick. Most of the material is of gravel suitable for road ballast. The county owns the pit and has an outfit for mixing gravel in operation there. We went west from this pit to see the cut bluff of Lake Arkona whose base is about 710 feet and top 725' or more. There seems to be Arkona gravel bars east of the Whittlesey bar at about 700 feet or slightly above 700 feet.

We drove from Leamington to Blenheim to see the finely developed Warren shore line near that village. There is a higher Warren bar that is above the 700 contour from Blenheim eastward. and a lower Warren a little below 700 feet that were formed by waves from the Lake Erie basin along the south side of an island. On the north side of this island much of the way from Blenheim to Ridgetown there is a cut bluff with base at about 675 feet and top up to fully 700 feet. It seems to have been cut into by strong waves from the northwest and to have been worked on by these waves down to the time the lower Warren bar of the south side of the island was being formed.

We crossed this island from south-north about 3 miles east of Blenheim. It there has a slightly pebbly clagy till exposed in the roadside ditches. Its altitude here is but little above 700 feet, but to the northeast the island gets up to 750' in a few places, one being at Duart. There highest points as noted in earlier trips seem to have Whittlesey gravel and sand on them.

On our return we went via Merlin to Tilbury and Windsor, by a more direct route than via Leamington.

The gravel bar on the waterlaid interlobate Detroit-Leamington moraine from Essex southeast past "North Ridge is not far from 650' and thus has an elevation different from any shore lines of southeast Michigan, being about midway between the Wayne beach and the Grassmere. How should it be correlated?

At Walkerville Junction there is a marsh several feet lower than the railroad track that I am unable to interpret. It is on the north border of this marsh and at an elevation about 10 feet above it that the gravelly tract is located which I am referring to the Elkton beach.

In the Romney quadrangle opposite Renwick and Coatsville stations of the P.M.R.R. there is a fine gravel beach at 630-635' close to the shore of Lake Erie. That is not quite in harmony with the Elkton or Grassmere beach being, midway between them in elevation. Also to the northeast

from the road that leads to Merwin at gravelly or sandy beach is found at about 650 feet in the NE part of the Romney quadrangle which may be a continuation of the one at 630-635 in the SW part of this quadrangle - for there seems to have been NE differential up lift in this area. There seems to be a nearly continuous narrow strip of pebbly sand from here to where the Warren beach comes to the Lake Erie Shore near Cedar Springs. The Warren beach is a little less than 675 feet at the Lake Erie shore, but rises to 700 feet at Blenheim in about 6 miles. The beach at 700 is the higher Warren. The descent from there to 675' embraces the lowering of Lake Warren by cutting down of the Grand River outlet 15 feet or more. With this lowering the bar seems to have been extended southwestward past Cedar Springs with a descent of about 25 feet. But the pebbly sandy strip to the SW along the Lobe Erie bluff which gets down to 650 feet in the NE part of the Romney quadrangle seems too low to be connected with the Lobe Warren waves, and is not easy to interpret.

July 18, 1938

A letter and maps of Port Huron received from Allan Carlisle, Jr. of the City Engineer's Office threw light on several matters:

1. The extent of Lake Nipissing within the city is shown by a line at 596' elevation aside from the strip on border of Lake Huron and St.Clair River, there is the flooding of the valley of Black River, and of McNeil Creek which heads in "Harrington Swamp". This swamp lies mainly north of the Black River Canal and is now drained into the canal by the "Howe Drain". It is below 600' and is reported to have a peat bottom about 30 feet deep. In an early day 100 years ago logs were floated from this wet area down McNeil Creek to a mill on St.Clair River at the corner of State Street and Armour Street. McNeil Creek now heads south of the canal and it drains into a small lobe in Palmer Park north of Canfield Street between Gratiot Ave., and Armour Street. A sewer now carries its overflow near Armour Street to St.Clair River. The swale below 596' is 400-500' wide from Holland Ave., in the north city limits down to Palmer Park. It there opens into the Lake Nipissing bed, whose border from State St., north is west of Armour Street. The border crosses Gratiot Ave., near Holland Ave., and lies about 500 feet west of Gratiot Ave., northward past Krafft Road. South from State Street the border of Lake Nipissing is close to St. Clair River to within 1/2 mile of the mouth of Black River. This stream has a narrow valley above Military Street and its continuation Huron Avenue, 1200-1500 feet west of St.Clair River. The border of Lake Nipissing or of St.Clair River at the Nipissing stage is east of Military Road southward to the city limits.

The low area along Black River is narrower where the river is inside the city than where it forms the city limits above Washington Ave., being generally 600-700 feet. There is in this part, however, a tributary low area near 10th Street extending south to Howard Street with a west branch near Lapeer Avenue.

A small isolated area below 596' is crossed by Pine Grove Ave., between Scott and Elmwood Streets. It extends SW to 12th Avenue at McPherson Street and has a branch running north past Mansfield Street along and west of 12th Avenue. This may have been shut off by Nipissing deposits as the elevation of the area between it and the Nipissing border is only 1-3 feet above the 596 line and is no where up to 600 feet.

South from here to Black River there is only a small area near Kurney Street between 11th and 12th Avenues that rises above 600 feet. It is sandy and reaches 603'. It seems probable that some deposition by Nipissing waters occurred here. The city engineer states that fine gravel is found at slight depth in it for some distance north from Black River. The surface of this gravel may be as low as 596 feet, the elevation of Lake Nipissing.

2. Another feature shown on the part north of the McNeil Creek swale is a sand ridge at about 603 feet which seems to be a lower Algonquin bar or shore line. Its south end is at Hollis Street west of Gratiot Avenue. It runs N NW to Holland Avenue at Stone Street and comes to Krafft Road at 10th Avenue. Mr. Carlisle says it runs north for a mile or more further keeping about parallel with the shore of Lake Huron. It lies east of the Harrington Swamp. It is sandy at surface but gravel is found in places at slight depth. The city engineer Earle Whitmore took several pictures of the gravel in the face of a sewer along Cherry Street. The top of the gravel he estimates to be 599 feet. It shows a southward dip throughout the exposure. This seems to show that the currents were moving in that direction at this stage of Lake Algonquin, in this place, which is near the south end of the bar above noted.

Ann Arbor

A sewer has been put in on Geddes Avenue from Onondaga to Hill Street, which shows till about to Highland Road. But east of there the bluff on south side of Geddes has about 15 feet of fine sand above the level of the street and it seems to have extended below street level in the sewer trench judging from the material with

which the trench is now filled. Boulders are present above this fine sand at the west end of its exposure. The mode of deposition of this fine sand is a matter of dispute between Prof. Seustius and myself. He regards it as loess but is is coarser than loess . The individual sand grains being visible to the naked eye. It seems also to lie below glacial deposits. So it does not seem to me to be classifiable as .

It is exposed on the north slope of a morainic ridge, whose crest is above 920 feet. The sand is below the 900' contour. The intersection with Highland Road is 889' and the sand is exposed to below that level in the bluff east of this intersection.

August 3, 1938

I went into Essex County, Ontario with Neil Morrison and a Mr. Swan of the summer school university students.

Crossing on the Ambassador Bridge we gave attention first to the delta in the north end of Lobe Rouge west of the bridge it stands above the bending part of the bed of Lake Rouge on the south 10-15 feet or more, and is nearly as much above a swale on its SE border.

We then gave attention to sandy deposits in the SE part of the Windsor shut of the Department of National Defense on Walden Road and on Highway No.3. These are slightly ridged by wind action and probably the sand was laid down on the shore of Lake Rouge. The sand is below the 600' contour and low enough to mark that shore. It seems to extend but little east of Highway No.3 and is most conspicuous near a small stream about a mile from the south edge of the Windsor map. On Walden Road it terminates 1/2 mile from the south edge of the map, and it extends only a little west of Walden Road for 2 miles or more to the north. There is a stiff clay on the Lake Rouge bed west of this sandy belt.

We took the first road east of Walden Road and about 1 1/2 miles east of it and find sandy land along it for about a mile. It then enters a clay plain that was covered by Lake Rouge. We continued on this road to the first road south of Canard River which we took west to Detroit River 5 miles north of Amherstburg. This seems to be within Lake Rouge but near its south end.

A short distance south of this road a swampy channel forms the head of Big Creek which leads southward into Lake Erie, passing about 2 miles east of Amhurstburg.

This E W road crosses a small south tributary of Cauard River which is swampy here. It seems to head close to the head of Big Creek SE of the name "Splitlog" on the Amherstburg map.

We got dinner at Amherstburg and examined the swampy channel that heads close to Detroit River in the south part of the village, and runs southeast into Big Creek.

We took a road east to Big Creek, leaving Detroit River less than a mile south of Amherstburg. There is dead water at the level of Lake Erie on Big Creek here.

We follow the east bank of this creek south 2 miles. The bank or bluff is only about 8-10 feet high most of the way, but is 25 feet or more high east of Amherstburg as shown by contours on the Amherstburg map. We crossed Big Creek and drove west to Detroit River a mile north of Bar Point. This land seems to be scarcely 10 feet above Lake Erie, and part of it is too wet for farm crops.

There is a low sandy pebbly beach east from Bar Point but we are told the lobe has cut away dunes that were on its beach. There are a few boulders on this low area and it seems to have clay or till subsoil, the sand being chiefly on the Lake Erie shores.

An off shore bar, 1/4 mile or less out in the lobe is present east from Bar Point. In places it has vegitation, but generally is at or a little bebw lobe levels.

We returned to Big Creek bridge and went east on Highway 18 about 5 miles rising to 625 feet near the east edge of the Amherstburg map. There is till with scattered boulders but a plane surface here.

We followed Highway 18 to within 5 miles of Harrow, and there took a road leading SE which here is near the 625 contour, but rises above it as we run southeast. The surface seems to be free from knolls until we pass the first road leading south that comes to the shore of Lake Erie 2 miles NW of Colchester. East from this road the surface becomes gently undulating with some knolls up to 8 or 10 feet in height. These are thickly strewn with boulders but generally seem to have a loamy rather than gravelly or sandy soil and subsoil. But one crossed by the SE road 2 miles N of Colchester has cobble and gravel exposed in the road cut and in door yards of dwellings each side of the road. This knoll is above 650 feet. Those to the west for a mile or more may be nearly 650 feet, while boulders abound on there low ridges and knolls, so as to make them difficult to cultivate, there bing in places over 100 boulders in an acre, the level land among them is good farm land with only an occasional boulder.

We went south to Colchester, a summer lake resort, within 1/2 mile north of the village the land rises from 600' to 625 A.T. The lobe bluff in the village is 20-25'. There is little or no till exposed here. There is a sand with boulders inbedded in it for 10' or more, below which is a laminated pale blue or drab colored silt. An exposure on the west side of a cemetery has fully 15 feet of this silt. Mr. Swan took samples for study. Southeast from the cemetery toward Little Point there seems to be more definite sandy beds than west of the cemetery, and less of the silt exposed.

We then followed the bluff of Lake Erie northeast and found it rising to 63 feet at a place between Colchester and Oxley where the map shows the 625 contour in the lobe bluff. Mr. Swan leveled up here with hand level and determined the altitude.

If Lake Erie is 570 feet at present stage the bluff here is 633'. We found no good exposure of the beds in the bluff here as there have been landslips, and vegetation covers most of the surface.

Near Oxley we came to the east end of the high area that catches the 625 contour. There is a rapid descent past the 625 and 600' contours as shown on the Essex map. Further north, however, the contours diverge. There is then a rather rapid slope down a little below the 625 contour, that suggests an Elkton beach. We find this feature for several miles to the north and northwest. The land also becomes sandy as one passes down the slope from the 625' contour. If the contours are correct the sandiness in places reaches fully 625 feet.

We went north and came to Highway 18 about 2½ miles east of Harrow. Just west of the cross roads about 2 miles east of Harrow we came to a sharp ridge 12-16 feet high in which limestone blocks are so numerous as to suggest an outcrop, but the foreman on an experimental Dominion farm is positive that rock is not an outcrop but merely in form of boulders and slabs, like the boulders of tillite granite, etc., found here with the limestone. He informs us that such ridges with limestone in slabs on them are present in several places south and SE from Harrow. The mapping of such places seems to be a matter of importance but we did not attempt it this afternoon.

The surface is gently undulating north of Harrow in the area above 625 feet and boulders are rather numerous. They continue numerous along the highway that runs NW to "Vereker" on Essex map. This seems to be the highest land between two streams that run NW into the Amherstburg map area. This may be an ice border line continuation of the land that is above 625 feet for about 3 miles north of Harrow. The strip south and west from Harrow that stands 625 to 650 feet may also mark an iceborder, found a little later. The Lake Erie lobe evidently was the one to form these high strips, and they appear to be later than the "Detroit Interlobate" moraine that runs from Windsor to Essex and Leamington.

In Monograph 53 U.S. Geological Survey p.289, Taylor, under the heading "Grosse Isle Moraine" says: "On the Canadian side a well defined boulder belt runs west from the high knoll west of Leamington passing north of Kingston and Harrow and trending toward Amherstburg but it has not been traced across the intervening space. The general relations of the topography to the basin of Lake Erie from which the ice came, suggest that this is the normal course of the ice margin from Grosse Isle eastward."

Sherzer, in Geology of Wayne County Pub. 12 Geological Survey of Michigan, p83, notes two sets of Striae in the Amherstburg quarries. The later set here, as at the Sibley quary in Wayne County has a northwesterly direction and the earlier set a southwesterly. The earlier is much more vigorous than the later ice movement, as is the case at the Sibley quarry. Sherzer noted rather numerous boulders east from Amherstburg, and a gently undulating surface suggestive of an ice border. This is where he puts the "Grosse Isle Moraine". Sherzer did not find striae near Amherstburg with a trend northward or east of north toward the "Detroit Interlobate Moraine". So he expresses some doubt as to its being partly due to ice from the Erie basin.

A letter from W. A. Johnston, Chief of Borings Section of Canada Geological Survey received Aug. 26 states that no borings are listed in his office in vicinity of Harrow, but he thinks the drift is not thick there. It is 72' in a boring 4 miles east of Harrow on Lot 18 Concession 2, Colchester S. Tp. He knows of no limestone outcrops near Harrow.

In Alex L. Du Tait's "Our Wandering Continents" pp. 72-74, the distribution of carboniferous glaciation and bearings of striae in the southern hemisphere are concisely stated.

1. In pre-Cordillera of western Argentina (a) Tillite of Leoncito Encinea striae NNW found beneath beds regarded as upper carbiniferous. (b) Sierra Chaca de Zonda in San Juan striae NNW. Three tillites, the lowest being classes as of Namurian age. (c) Tillite of Jachal (striae NW) and Sierra de Uniaugo, the extension to the north of (b).

2. Sierras of Buenos Aires. Compound tillite of Rio Sauce Grande near Sierra de la Ventona striae N 65° W. Overlain by the Bonete Series with mollusca and the Glossopteris flora.

3. Uruguay. Compound glacials of Fraile Muerto Striae N 40° W and Gregorio striae E-W with unconformity at base.

4. Brazil. (summarized by Oppenheim). Around and presumably beneath the southern half of the great Parana basin between Lat. 21° and 31° S. Acuerally a single basal tillite resting everywhere unconformably on older rocks but compound in certain areas, as in the State of Sao Paulo; thin or missing to the SE in Rio Grande do Sul which is supposed to have lain near the ice center (NW as indicated by erratics). Overlain by shales carrying in Parana lingula and in Santa Catevi or fossils reminiscent of New South Wales and succeeded by the Bonito "Coal Measures" with a Glossopteri flora. The tillite is not definitely known north of Lat. 21° S.

5. Falkland Isles. Thick "Lafonian" tillite striae N-S, resting disconformably on Devono-Carboniferous and followed by Glossopteris beds.

6. South Africa. Vast extent of Dnoyka tillite originating from several distinct centers, usually thin and single in the north but thick and compound in the south striae bear S in the west; SW in the center and SE. Followed in SW Africa by sediments with Eurydesma, Conularia and Myalina, and elsewhere by locustrine shales and Glossopteris beds. Not known just north of the Transvaal for certain.

7. Central Africa. Tillites of Cassanga district of north-central Angola Lat. 9°-10° S; Long. 17° - 18° E. (Monta and O'Donnell) And of eastern Congo in the Lukuga region

(N & NE) (Fourmarier), and between Lake Kivu and the Lualaba River (NW) (Ball, Sheler, Passau, Horneman and Boutakoff), indicating more than one ice advance, and overlain in the Congo by locustrine beds with Glossopteris. The northern limit as yet known is about 1° N.

8. Madagascar. Boulder beds of the Sakamma - Sakoa area in the SW (direction unknown) followed by black shales and ~~coarse~~ coal-bearing strata with the Glossopteris flora and that by an horizon carrying Productus.

9. India. (a) Talchir tillite occupying wide areas in the central provinces. Orissa ~~and~~ and Biher forming the base of the Gondwana system and varying greatly in thickness. (NNE-N though probably variable) overlain by shales and Glossopteris beds. (b) Thin boulder bed of the Salt Range followed by strata containing Eurydesma and Conularia and those in turn by the "Productus Limestone" which includes a layer with the Glossopteris flora. Boulder distribution indicates a NNW movement. (c) Boulder beds of Tanokki and Talhatta in Hazara associated with the peculiar "Agglomeratic Slate" series, and of Blaiui at Simla.

10. Eastern Turkestan. Reference made here to glacials discovered by Norin resting on metamorphosed lower carboniferous? next to the Tarini or Tanni?? basin Lat. 40°-42° N. Long. 88° - 89° E. Overlain by marine beds, probably Permian, because altho' they are situated far within Asia, they are not very distant from those at Spiti.

11. Australia. (a) The five glacial horizons of New South Wales spreading over a lengthy period: the two earliest in the Kuttung Series (Namurian) bearing N 13° W - associated with Rhacopteris, Lipido-dendren, etc., succeeded by those of the Kaunlaroi system, viz., the Lochinvar glacials, the lower morine series, beds with Gangamopteris, Allendale glacials with Eurydesma (lower Permian), Greta Coal Measures, and the Branxton, and muree glacials in the Upper Marines Series (Middle Permian). Recently the Kuttung glacials, volcanics and flora have been found to the west and SW of Cairus up to Lat. 17° S. in northern Queensland. (b) The glacials of Victoria, south and central Australia (Finke River) and Tasmania and those of the Irwin Wooramel, Gascoigne and Lyndon Rivers and of the Desert Basin in the Derby district of western Australia, overlain by marine strata with a Tethyan fauna of upper carboniferous and

Permo-carboniferous affinities, and probably those near to and to the NE of Laverton, Western Australia (Ward). The ice radiated outward from the Tasmanian region during the late carboniferous, reaching the sea in western Australia and northern Nuo, So. Wales. The recurrence during the Permian is marked by erratics in the Upper Marines in the Minilya River area of Western Australia up to Lat. 23½° S. and in the Bowen R. area of Queensland up to Lat. 20° S.

Ice Radiation - pp. 75-76.

With map showing distribution of the late Carboniferous glacial in Gondwana. It is noted that the tell-tale floor showing ice movements is usually exposed only within a selvedge, the pavement passing in the one direction beneath the tillite and being destroyed by erosion in the other. Ice or In?? formation is scanty as to the northern edge of glaciated regions. It is suggested that the Displacement Hypothesis has merits in showing why the present clay remnants of this glaciation are so widespread and reduce the physical obstacles met with under the more current views held by geologists. It is noted that the ground moraine is commonly scantier in the vicinity of the glacial center.

The extreme occurrences in Argentina and New South Wales are today fully 222 degrees apart; those of south and central Africa 31°, and those of Tasmania and North Australia 25°. But under the scheme proposed in the map on p. 76 the regions are condensed into an irregular oval 95° from W-E and 63° from NNW-SSE. This compares favorably with the extent of Pleistocene glaciation in the northern hemisphere.

Leverett's Notes - Book 300

Pages 37 - 49 Inclusive

Notes on F. B. Taylor's paper on the "Galt Moraine and Associated Drainage" Pres. AASS Vo. 48 p228. 1899.

The Galt moraine extends NE from near Paris past Galt To Credit Forks, Ontario. In the northern part of its course it is close to the edge of the Niagara escarpment which runs northward from Hamilton.

The drainage was at first along the outer or west border of the moraine, but later between the moraine and ice edge. For several miles its bed is on the brink of the escarpment. Further down the river cut through the moraine and joined its earlier course at Eden Mills. In the earlier stage the river ran SW from Preston past Ayr, but later it had a course through the moraine longitudinally past Galt and Paris.

The northern part of the area is well occupied by drumlins.

The above festures are clearly shown on the topographic maps. The channel leading across the moraine to Eden Mills being a very marked feature. Notes are made on the map. This paper has an abstract also in Science. Vol. 10. pp.483-490.

October 10, 1938

Dr. F. W. Sardeson wrote results of an examination of drift deposits near Mankato in the older glacial gravel at the south of Indian Lake below Mankato. I found moss agates and petrified woods remarkably abundant. The most of them are brightly polished, as are also chert and quartz pebbles that came from the nearby Cretaceous stream conglomerate. They are also rather common in the old till as well as gravel. Other pebbles in these old glacial gravels are not so conspicuously polished. The gravels are rusty and cemented enough so the face of the pit will stand vertically for a long time in the weather. This is not the case with the Wisconsin gravels.

I found no moss agates or silicified wood in the Cretaceous gravel conglomerate here or elsewhere in Minnesota but they are not rare in the Kausen and older till and gravels, and occur to some extent in the Wisconsin or younger drift deposits.

But it is remarkable that the wood and agate pebbles are polished the same as the chert and quartz pebbles in the Cretaceous conglomerate here or the same as found in the drift. I am thinking

that the bentonite clay and mud balls that occur with the Cretaceous sand and conglomerate explain why the pebbles are so brightly polished. As deposited, the bentonite was of course a volcanic ash in the rivers. But where were the moss agate and woods when they got their bright polish? Are they Critaceous, or are they Tertiary? (Signed, F. M. Sardeson)

October 16, 1938 - Study in SE Jackson County, Michigan.

I went via Manchester to Brooklyn, Michigan to study features in the SE part of Jackson County within the limits of the Jackson quadrangle map. There is a continuous gravelly area west of the Mississinewa moraine in T.4S.,R.2E. with a very broken surface due to swales and basins that are 10-30 feet below the general level of the gravel. The gravel is fine, with considerable sand in it.

The east half of T.4S.,R.1E. is nearly all gravelly and with broken surface as in T.4S.,R.2E.

I went SW from Brooklyn to the line of sections 25 and 26 through a gravel area the highest points on which are above the 1020 contour and all of it above 1000 feet.

Turning south on the line of sections 25 and 26, I came to boulders and sandy till in the north part of the line of sections 35 and 36 on ground at or near the 1000 feet contour. In the south half of this section line the altitude is higher some points being 1030 feet, and boulders are not rare. On the county line sections 35, T.4 and section 2, T.5S.,R.1E. I rise to the 1050 contour near middle of section line and the knolls of this height have a few boulders but seem to be gravelly.

West from these high points is a gravelly area free from boulders that extends west to Goose Creek and is 1015 to 1040 feet. The east part of section 2 and south part of section 1, T.5S., R.1E. have an elevation of 1040-1050 feet and make a natural continuation of the high points above noted on the county line, and seem to be morainic.

There is a gravelly area east of Goose Creek in sections 34, 26 and 27, 22, 23 and 24, the last named group being along the east flowing part of the creek. I did not examine the district south of Clark Lake west of Goose Creek, but went east through section 15 finding it gravelly and with general altitude about 1000-1010 feet.

I went north to corner of sections 10,11,14, and 15 in gravel but on going east on line of sections 11 and 14 I came to boulders near the quarter post at about 1013 feet, A.T. I went north through section 11, and noted a few boulders. At the line of sections 2 and 11 on east side of the road is a sharp boulder strewn knoll about 15 feet high that covers only a few square rods and is shown as a tiny area with 1020 contour on the map.

The SW¼ of section 2 seems to have till and boulders and these may give occasion for the name Stony Lake if they continue into its basin.

I turned NE in section 2 and found a gravelly area in east part of that section and in section 1 to the village of Napoleon. This village is in the line of a glacial drainage from the Fort Wayne moraine near Manchester westward past Norvell and Napoleon to Grand River near Jackson. The altitude is about 960 feet in Napoleon but WolfLake which lies in this drainage line is 939 feet.

The district north of this glacial drainage has already been given a revision, so I went back to Ann Arbor crossing the Mississinena moraine in section 30, Sharon Twp., Washtenaw County. It extends slightly into east part of sections 25 and 36 in Jackson County in T.3S.,R.2E. It covers nearly all of section 19, but only the north part of section 20 Sharon Twp. The general width is about a mile from sections 17 and 20 Sharon C SW to Raisin River. It is much wider to the north of sections 16 and 17. North of sections 5, 8 and 17 are in the outwash plain (Grass Lake Plain) outside the moraine.

November 11, 1938

I made a trip into St.Clair County with Prof. Sentins and two University students James Calver and Henry Van der Schalie to see how definite a shore line Lake St.Clair at the Algonquin stage was developed, and how nearly continuous is the gravel deposit which Taylor called the "St. Clair Esker", which is now known to be an early stream deposit of St.Clair River.

We left Gratiot Avenue at Milton and drove east crossing the Emmett moraine in section 32, T.3N., R.14E. in Macomb County. In previous trips the shore line of Lake St. Clair at the Algonquin stage had been mapped as far NE as section 10 of this township but it seems to be indefinite in the east part of section 10 and in section 11.

Entering St.Clair County on the line of section 6 and 7 T.3N., R.15E. at the east border of the Emmett moraine at an altitude of 597 feet. We could see no clear evidence of this shore. We found sand exposed in a ditch near the quarter post that runs south, but it is a narrow strip there being clay only a few rods either east or west from the ditch. A ditch coming down to this section line from the north about 40 rods further each is in clay.

In this sand were places where tree roots up to 6 inches in diameter had ramified it but only a few small [illegible] of their wood remains, and a brown sand fills the root cavities.

We noted sandy swells south of the corner of sections 5,6,7 and 8, that give the surface a slightly wavy appearance in contrast to the very flat surface of the clay tracts. The sand is conspicuous on much of this section line and border fields. There are no altitudes on this line south of the section corners at 597', but it seems probable that the sand is at lower altitude.

On the line of sections 5 and 8 we came to sand near the "Marsac Drain"., but it seems to be a narrow strip bordering the drain. The altitude here is 596'. It is 599 at corner of sections 4, 5, 8 and 9. We saw very little sand on the line of sections 4 and 9.

On the line of sections 9 and 10 we came to a sandy strip near the quarter post at 597 feet that seems likely to mark the shore. It is 601 at the corner of sections 3, 4, 9 and 10 and clayey there. It seems probable the lake extended up SW on creek as far as the corner of sections 2, 3, 10 and 11, the altitude there being 596 feet. It seems also to have extended about to St. Peters cemetery near the west quarter post of section 12 where sand is conspicuous at a little below 600 feet. Sandy spots are numerous on the road and border fields east from this cemetery in section 12 at an altitude close to 600 feet, but more than half the surface is clayey. The altitude is 601 at the range line at middle of line of section 12 and section 7 and also 1/2 mile east at center of section 7, T.3N., R.16E., and sandy spots are numerous that far east. There is a rise to 604' at the quarter post of sections 7 and 8, and not sandy but south from there sand sets in south of the "Beaubien Drain" at an altitude about 600 feet. From here the shore line seems to run SE keeping north of the SE flowing part of the Beaubien Drain across section 17 into the NE part of section 20 and NW part of section 21.

The sand in places is lined up in low ridges scarcely 5 feet in height but running continuously for 1/4 mile or more.

It now seems probable that St.Clair/ River entered Lake St.Clair at the Algonquin stage in sections 21 and 22, T.3N., R.16E., at an altitude of nearly 600 feet. The gravel bar on Broadbridge Road directly east from here which is a feature of St.Clair River was found to be 600 feet by MacLachlan by levels run in 1934 to it from St.Clair River. It is 27 feet above the level of the river opposite there August 30, 1934.

We spent an hour at the drain on Broadbridge Road west of this bar to enable Mr. Vander Schalie to make a collection of mollusks in the bog, through which the drain passes. Some of these he interprets to be recent or living specimens, but others he thinks may be different from those now found living here. The ditch shows gravel under the layers of fossiliferous material at a depth of less than 3 feet, in the western part of the bog. The pebbles are mainly less than 2 inches in diameter, but a well rounded cobblestone 4 inches in diameter was noted. It seems to be a magnesium limestone.

We noted that the gravel in the bar on Broadbridge Road is of very fine material pebbles mostly less than 1/2 inch in diameter. This bar is well defined for more than 1/2 mile north from Broadbridge Road. It seems to end there and no bars of this sort were found for several miles to the north. So Taylor's sketch in Fig. 10, Mon.53 is not correct on this feature.

How far south the bar runs from Broadridge Road was not determined. The "Sand ridge" shown in Fig.10 to the west of here seems to be what we traced into section 21, but it is a less continuous and weaker feature than the sketch suggests.

We got dinner in Marine City and then went back and forth at intervals of about a mile across the NE part of the Marine City quadrangle from sections 10 and 11 northward and found no indication of gravel bars. We also found more in the SW part of the St.Clair quadrangle until we came to Rose Hill cemetery at line of sections 7 and 18 East China Twp. (T.4N., R.17E.) A gravel bar here is about 10 feet above the BM 591 at the railroad on range line 1/4 mile west of the bar.

Gravel bars set in east from here at the bluff of St.Clair River at an altitude slightly above 600 feet, the BM 601 on the section line of 7 and 18 at Highway 29 being a little below the highest points on the bars near it. The bars run across section 18 in a course slightly west of south, and have a 598 level given at line of sections 18 and 19. This seems to be near the southern limit of the bar. The one at Rose Hill cemetery extends only a short distance north in section 7.

We find the ridge in the Hill St. Cemetery in St.Clair village is sand but a prominence east of it that carries the elevation 612 may be a feature of the Port Huron moraine, for Prof. Senstins found some till in a slight excavation in it. I did not see this and am not certain that he classed it correctly. It is, however, within the probable limits of the Port Huron moraine and close to the latitude reached by it in the SW part of St.Clair village.

We next went to Port Huron and completed the mapping of the lower Algonquin beach which is about 603 in the north part of the city. The ridge is sandy and has points that are likely to be 610 feet or more for they rise to 15 or 20 feet above marshes on this west border. The wind seems to have drifted the sand here. There is a swamp between it and the main Algonquin which has been drained by a deep ditch southward from section 3, T.7N., R.17E., into the cut off ditch of Black River. Mr. VanderSchalie collected mollusks here each side of the line of sections 21 and 22. He thinks some of them have considerable age.

The beaches are nearly a mile apart on the line of sections 16 and 21 and of 8 and 17, but run together further north in section 5, T.7N.,R.17E.

Gilberts Creek has been drained eastward by a ditch on the line of sections 5 and 8, 4 and 9, into Lake Huron at Lakeview Beach. The Algonquin beach comes to the bluff of Lake Huron in the NE part of section 32, T.8N., R.17E. and is close to this bluff or cut away by it for several miles north or beyond the banks of St.Clair County.

We completed this work and got back to Port Huron at 4 p.m. I had a brief conference with the City Engineer Earle R. Whitmore. He has received all the advance sheets of the U.S.G.S. in St.Clair County Scale 1:31, 680, sent him at my request and greatly appreciates having them.

November 15 - I find that the soil map of St.Clair County shows the bar of sandy gravel runs south from Broadbridge road beyond Roberts Landing nearly to Locust Point or to within 1 1/2 miles of Algonac. It runs fully a mile north from Broadbridge Road into the south part of Survey No.198. It is fully 1/4 mile wide near its north end but is generally scarcely 1/8 mile wide.

There is a very narrow ridge of Plainfield fine sand about 1/2 mile west of this bar that sets in about midway between Broadbridge and Roberts Road and runs south about 2 miles to the south part of Survey No.183. It is between two marshes shown on the U.S.G.S. advance sheet of Marine City quadrangle - A road shown with dashed line follows it south from Roberts Road.

The large channel of St.Clair River west of these ridges is shown to have heavy clay called "Bono Clay" west of Marine City and Clyde loam in sections 26 and 35 China Twp.

The channel seems to be filled on south side of Belle River with Brookston clay loam in sections 23, 25 and 26 China Twp., nearly to 590 feet in south part of sections 25 and 26 and to 590-594 feet in section 23. The bank west of it barely reaches 600 feet, and there seems to be no higher land further east.

The sandy gravel bar is not present for 4 or 5 miles north from survey No.198. There is a narrow strip of "Macomb loam" described to be rather stony soil in SW part of section 18 East China Twp., and running about 1/2 mile farther to north edge of Survey No.303. The ridge of sandy gravel is present in NW¼ of section 18 and SW of section 7 as "Bronson loamy fine sand"; east of it clear to the bluff of St.Clair River is "Bronson Loam". It is in this that gravel pits have been opened in section 7 and NE corner of section 18. A ridge in east part of Section 18 changes from Bronson loam to Guilford loam near line of sections 18 and 13 and runs south into survey No.303. I infer these are all of the sort found in the pits in section 7 and to be classed as river bars.

The soil map shows a strip of dune sand, classed as Bridgman fine sand, running south from the Hillside cemetery in St.Clair village for about a mile. The ridge east of this where the 613 elevation appears seems to be of Bronson loam, and so may have gravel in it. But it seems to be a little higher than any of the St.Clair River bars. It may as noted in Nov. 11 be a feature of the Port Huron moraine.

It now appears doubtful if a swampy channel runs south from the bend of Pine River in section 12, China Twp. Brookston silt loam is the dominant soil east of the low bank along Indian Trail Road that I have supposed limited a channel of St.Clair River on the west.

This Brookston silt loam area is 596-599 in section 12, China Twp. The low bank west of it is 601-607 in sections 11 and 14 China. There seems to be no definite east bank between there and St. Clair River. Instead there are the low bars of sandy gravel, as the only features standing above the Brookston silt loam area. The land with a muck soil seems to set in a mile or more south of Belle River and to have a definite east bank only from survey No. 198 southward. A west bank, however, seems mapable along Indian Trail road in sections 11 and 14 China Twp., and Marsh Road from Belle River south. The St.Clair seems to have covered the district east of this road and to have become restricted to two channels after developing the bar that heads in Survey 198.

The abandonment of the western channel seems to have antedated the Nipissing lobe stage, there being as high a level in the district just south of the bend of Pine River at the Nipissing waters had in the Huron basin viz 596 feet where unaffected by uplift.

The Macomb County soil map shows what seems to be delta deposits on Clinton River at two places. One below Utica comes down about to 605 contour. The other, below Mt. Clemens is below 600 feet. The upper one seems related to a flooded area outside the Mt.Clemens moraine. The other is below the highest shore of Lake St.Clair. They both are largely of Berrien loamy fine sand (Be). The upper part of the upper one is Berrien loamy sand (By) This sets in just below the village of Utica.

Above Utica Clinton River traverses the middle part of a large area of Fox gravelly sandy loam (FG) on which the Warren and Arkona beaches are finely developed (see map of Rochester quadrangle).

The Whittlesey, Arkona, and Warren beaches are identifiable on this soil map largely as Fox gravelly sandy loam.

November 19, 1938

Prof. MacLachlan has a table of altitudes of the Warren, Arkona and Whittlesey beaches on the east side of the Thumb of Michigan in his thesis that indicates a striking relation to the antecline that comes to the border of the south end of the Lake Huron basin from the northwest.

In this district isobases are very different from their general trend.

Thus from Lenox to Atkins the Warren beach is about 700-705 feet. This isobase runs N 58° E and the tilt line is about 32° west of north. This is nearly at a right angle to the regional isobases and tilt lines.

There is a level stretch of the Warren beach at 717' for 5.5 miles north from the line of sections 11 and 14 Grant Twp., St. Clair Co., that is about when the arch of the anticline is located. Further north the isobases are in general conformity to the regional uplift and have a W NW - E SE trend.

There seems to be a similar relation of deformed isobases over the Cincinati anticline in SW Ontario. The 725 isobase runs N NW - S SE in a general way but near Glencoe it is higher than is consistent with this trend so the altitude decreases both north and south from this place. This high altitude comes about in the crest of the anticline.

Page 9:

Our studies have shown remarkable variations in the rate of rise of the latter being between Goderich and Dungamon with a rise of 40' in about 10 miles and a lower altitude a few miles north of Dungamon as was determined on the last trip made to that district with MacLachlan in September 1937.

MacLachlan's Table of Altitudes

Locality	Whittlesey Feet	Upper Arkona Feet	Warren Feet	Whittlesey-Warren interval
Ann Arbor quadrangle	735-740	705-710	680	55 feet
Plymouth	740	710-715	686	54 "
Farmington	741		687	54 "
Birmingham	741		690	51 "
Troy	741		690-693	48-51 "
Richmond	751		700	51 "
Wales	755	728	700-705	51 "
Emmett	768		708	60 "
Arvca	762	740		
Fargo-Blaine		743	713	
Croswell-Lexington		747	717	
Near Applegate	780		725	55
Ubly outlet	800		750	50

The interval between Whittlesey and Upper Warren in western New York as determined by H. L. Fairchild is 45-50 feet as a rule or slightly less than MacLachlan's figures for the Thumb of Michigan (see Bull. 106 N.Y State Museum, pp65-66.)

In Ontario MacLachlan found the interval about the same as on the Thumb.

It should be kept in mind that the high land along the Cincinnati anticline in Ontario was relieved from its ice cover while lobes of ice still persisted in the adjoining parts of the Huron and Erie basins. This may have induced an uplift there in advance of upligt in the basins and combined its effects with what MacLachlan interprets to be a rise of the anticline.

The western limit of tilting in SW Ontario is not yet determined, but it is somewhere between Leamington and Blenheim. The beach near Romny at 630-635 may rise to 650 feet near Dungannon ? the NE part of the Romny quadrangle. It seems to be about 40 feet below the Warren beach, and thus may correlate with the Grassmere beach in Michigan. It may be up to 660 feet at Bleinheim and be at the lower edge of the gravel ridge that runs SW from Bleinheim to the Lake Erie shore on the east side of the ridge. There is a lower Warren beach at about 675' there and on the north side of the island that stood above the Warren beach where a cut bluff is found for some miles in vicinity of Ridgetown with base close to the 675

Nov. 22, 1938. A letter from Lincoln Washburn of Yale University reports his findings in the north part of the No. American continent in a trip there this year - as follows: "We found no indications of a northern limit of glaciation. All the points we touched at were definitely glaciated, as shown by drift or striated pavements or both. On Victoria Island the localities visited included the vicinity of Cambridge Bay, Prince Albert Sound, Mento?? Inlet, and Walker Bay, approximately Lat. 71½° N. Long. 118° W. our farthest north. At Walker Bay and on the northern side of Prince Albert Sound, striae and topography indicated a westward movement of ice out from the island. On Banks Island, drift is also present in the vicinity of De Sale's Bay, but no indication as to direction of ice movement was found here. Unfortunately, I do not yet know whether or not any of the drift we saw on the islands was derived from the mainland. We also observed drift on the mainland coast in the vicinity of Darmley Bay."

He then writes that he hopes to continue work in the Arctic, particularly on Victoria Island, in the near future.

Highest and lowest points in each State, etc.:

	Highest Ft.	Lowest Fr.	
Alabama, Cheaha Mt.	2,407	0	
Alaska, Mt. McKinley	20,300	0	
Arizona, San Francisco Peak	12,611	+100	
Arkansas (Blue Mt.) (Magazine Mt.)	2,800	+55	
California, Mt. Whitney	14,501	-276	
Canal Zone, Cerro Galero	1,223	0	
Colorado, Mt. Elbert, Lake Co.	14,420	3,350	Arkian River
Connecticut, Bear Mt.	2,355	0	
Delaware, Centerville	440	0	
Dist.of Columbia, Tenlaytown??	420	0	
Florida, Iron Mt., Polk Co.	325	0	
Georgia, Brasstown-Bald	4,768	0	
Guam Island	1,274	0	
Hawaii, Maunakea	13,823	0	
Idaho, Hyndman Peak	12,078	720	Snake R.
Illinois, Charles Mound Jo Daviess Co.	1,241	279	Miss. R.
Indiana, Carlos, Randolph Co.	1,210	316	Ohio R.
Iowa, N. border Osceola Co.	1,600	477	Miss. R.
Kansas, W. boundary	4,135	700	
Kentucky, Big Black Mt.	4,100	257	Miss. R.
Louisiana, NW part Claiborne Parish	400	0	
Maine, Mt. Katahdin	5,273	0	

Maryland, Backbone Mt. Garrett Co.	3,340	0	
Massachusetts, Mt. Greylock	3,505	0	
Michigan, Porcupine Mts.	2,023	570	L. Erie.
Minnesota, Mesabi Range	1,920	602	L. Superior
Mississippi, near Inka or Iuka??	780	0	
Missouri, Tamn Sauk, Mt. Iron Co.	1,750	230	St.Francis R.
Montana, Granite Peak	12,850	1,800	
Nebraska, Banner Co.	5,350	825	
Nevada, Boundary Peak White Mts.	13,145	470	Colorado R.
New Hampshire, Mt. Washington	6,288	0	
New Jersey, Hyht Peak, Sussex Co.	1,805	0	
New Mexico, N. Truchas Peak	13,306	2,876	
New York, Mt. Marey	5,344	0	
North Carolina, Mt. Mitchell	6,711	0	
North Dakota, Bowman Co.	3,500	790	
Ohio, near Bellefontaine	1,550	425	Ohio R.
Oklahoma, Black Mesa	4,800	300	
Oregon, Mt. Hood	11,253	0	
Pennsylvania, Negro Mt., Somerset Co.	3,213	0	
Phillipine Islands, Mt. Apo	9,610	0	
Porto Rico, Luquello Mts.	3,532	0	
Rhode Island, Durfee Hill	805	0	
Samoa, Late Tave Island	3,056	0	
South Carolina, Sassafras Mt.	3,548	0	
South Dakota, Harney Peak	7,242	966	Big Stone Lake
Tennessee, Klingman's Dome	6,644	182	LW Miss. R.
Texas, El Capitau	9,020	0	
Utah, Kings Peaks	13,498	?	
Vermont, Mt. Mansfield	4,406	95	L. Champlain
Virginia, Mt. Rogers	5,719	0	
Virgin Islands, Crowe's Hill,St.Thomas Is.	1,550	0	
Washington, Mt. Ranier	14,408	0	
West Virginia, Spruce Knob	4,860		
Wisconsin, Rib Hill	1,940	581	L. Mich.
Wyoming, Gannett Peak	13,785	?	

Shiftings of Drainage in North Central Ohio

In March 1939 I prepared a paper for Am.Jour.of Sci. that discusses the border of the Wisconsin and Illinoian drifts on the east side of the Scioto glacial lobe and the drainage shiftings due to each glaciation. This led me to read papers by Geo. W. White and to show where my mapping differs from his as given in the March 1939 issue of the Am. Jour. of Science.

In an earlier paper Prof. White discusses the drainage history of part of north central Ohio (Ohio Journ. of Sci. Vol. 34, 1934, pp. 365-382).

The main preglacial divides are outlined in Fig. 2 and the widely divergent courses of drainage. In a second map also under Fig. 2 the shiftings in early Quaternary time are indicated. Then in Fig. 3 he shows shiftings in Illinoian time

in one map, and in Wisconsin time in another. The main preglacial divide "extends eastward from central Morrow Co., across southern Richland Co., and along the north line of Knox Co., into Holmes Co., and then ESE to northern Mechanic Twp., where it turns SE and enters Tuscarawas Co. From this divide others that run north and south delimit headwaters of drainage basins. This gave Richland Co. a NW drainage while Ashland, Wayne and northern Holmes Cos. drained northward, the main stream leading through Wooster.

South of this W-E divide was a drainage with SE drainage to Coshocton. West of it was a system that drained the part of Knox Co. lying east of Mt. Vernon southwestward past Danville and Gambier. West of this was a westward drainage from Knox into Morrow Co. The other system turns west in southern Knox Co. and runs south of Centerberg into Delaware Co. and thence to the Scioto valley.

In early quaternary time White gives the Richland Co. drainage an eastward course past Londonville and Shreve to his "Holmes River" and then south past Millersburg and Killbuck to Coshocton, where the enlarged Tuscarawas comes in from the east. The drainage of Knox Co. was southward to form the north fork of Newark R. An east branch drained the part of this county east of Mt. Vernon and west branch - the part west of that city, the junction being near the Knox and Licking Co. line. The N-S divide east of the line of Knox and Holmes Co. was not shifted or tenched at this early time. A small west tributary of "Holmes River" headed near Walhonding. This system is called "Early Pleistocene deep stage". The valleys are interpreted to have been greatly deepened prior to the Illinoian stage of glaciation.

At the Illinoian glacial stage the drainage of Knox Co. southward to form the North Fork of Newark R. continued as in early Pleistocene time. But the drainage of Richland and Ashland Cos. was thrown into a new course southward just below Londonville to form Mohican R. East of this was a Killbuck drainage heading near Wooster and joining the other drainage just below Warsaw. At the Wisconsin glacial stage the Kokosing drainage system was instituted with headwaters in eastern Morrow Co. It trenched an old divide between Mt. Vernon and Gambier and another near its mouth.

The North Fork of Newark R. was stripped of its headwaters in Knox Co. except on the south end of that county. This interpretation of drainage history seems to be well founded. Some of it is evident on the topographic maps.

On p. 372, in a footnote White says: "Ver Steeg rightly concluded (see Ohio Journ. Sci. Vol. 30, 1930, pp. 309-314) that no deep valley leads northward (from Wooster) through Wayne Co. but the present writer believes that a high level (Parker Strath) "valley must have drained northward since the divides west and south of Wayne Co. and in the eastern part of the county enclose a basin whose only natural outlet is northward".

Leverett's Notes - Book 300

Pages 57 - 66(1/3 p.)

July 17, 1939

I went with Donald C. MacLachlan to work out the several beaches in the Goodell's quadrangle of which a map with 5 foot contours has recently been issued.

Our first notes were taken at a gravelly bar crossing Gratiot Road in south part of section 12 Lenox Twp., Macomb County which seems to be at about 680 feet, and rather low for Warren shore unless it is a Lower Warren.

We then examined a gravel bar near west end of the line of sections 1 and 12 that is 709 feet on Adair map. This bar is shown in the soil map to continue south 1/2 mile in west part of section 12 and ends near a 684 B.M. on line of sections 11 and 12. It turns westward in SW part of section 1 and runs for 1/2 mile as shown on the soil map. It is above 705 feet which is the altitude at corner of sections 1, 2, 11 and 12 Lenox Twp. We are wondering if this is the highest Warren shore. We drove north on line of sections 1 and 2 rising rapidly over a rather sandy slope and reach 733 at the Richmond-Lenox Twp. line.

The Whittlesey near line of sections 34 and 35 is probably between 745-750 feet - being 10-15 feet above a 735 BM on the township line 20-30 rods suth of the beach.

We followed the Whittlesey beach from Richmond to Memphis, and eastward from Memphis across Belle River into the Goodell's quadrangle.

The beach is 750-755 in north part of section 1 Richmond Twp, but is slightly below 750 feet in SW part of section 31 Wales Twp., St. Clair County. It rises above the 755 contour near the middle of SW¼ section 31 and stays above 755 for about 1/2 mile to the northeast past the center of section 31. The map shows it to rise above 755 feet at only a few places in NE part of section 31 and east part of section 30, Wales Twp.

We leave the Whittlesey beach at the Bernard school and run east on line of sections 29 and 32 to the Arkona beach near the middle of the section line where it catches the 735 contour. It is a little below 735 feet in the east part of section 29 and only part of it is above the 730 contour. It is 733-734 feet at Marquette Road in east part of section 29.

We find another Arkona bar near Fitz Road that is 729 where it crosses Marquette Road. It is above 730 from north part of section 28 northeastward into section 21 and it is nearly 730 feet as far north as Pere Marquette RR in west part of section 21 Wales Twp. This bar is traceable for about 1½ miles in sections 21 and 28. It has very slight relief, only 1-3 feet above border land is not more than 20-25 rods wide. The one west of it has but little more expression, its greatest relief being 3-4 feet. Both were washed down by the higher lobe stage (Whittlesey) that followed their development.

We attempted to trace the western bar further northwest into the district south and west of Lamb, but without success.

We did not attempt to trace them in section 32. The contours suggest a bar at 735 feet running south past the center of section 32. The loops and isolated 725 contours in section 5, Columbus, Twp. do not show clear evidence of an Arkona Shore. Till seems to be close to the surface, and boulders rather plenty. Near the SW corner of section 5 is a gravel pit in a knoll that catches the 725 contour. This seems referable to the Arkona.

We find that the bar above 710 contour in the west part of section 9, Columbus is gravelly. It seems to be the highest Warren beach. A smaller bar 1/4 mile east that catches the 705 contour seems also to be a L.Warren bar. The same is true of bars both north and south of Rattle Run Road in the east central part of section 4, Columbus, that catch the 705' contour. So also is a small bar in the SE part of section 33 Wales Twp. North from there to within about a mile of Goodell's we were unable to find distinct shore features at a level of 700-705 feet. A looped area of 700 feet and north of the corner of sections 10, 11, 14 and 15 Wales Twp. has a cobbly soil and a few surface boulders but the soil map shows it to be Conover silt loam. So it may not be a Lake Warren product. Sand covers a small swell 704' a mile south of Goodell's. Prof. MacLachlan in previous trips determined that sand with flat surface extends SE from Goodells in SW part of section 2, and he considers it a probable continuation of a sandy beach that is in places above 705' in the NE¼, section 2 Wales and SW part of section 36 Kenockee Twp. This sandy belt has a few pebbles in it clear up to the surface so seems to be a lake deposit, and not a wind deposit.

The main Warren beach lies a mile further east in central part of section 1, Wales and SW part of section 31, Clyde Twp. It is above 705 feet in these sections and has pebbles clear up to the surface. Its relief is 15-20' above plains on each side.

This main beach when traced southward drops below 700 feet in the SE part of section 14, Wales Twp., but has occasional points up to 700 feet in SW part of section 23 and NW of section 26 Wales Twp. Its crest drops below 695 feet a short distance NE of the center of section 34. It is there 10 feet below the level of a bar in the SE part of section 33 Wales, about a mile distant in W SW direction and 15 feet below the bar in west part of section 9, Columbus Twp.

Is it probable that the beach in section 9, Columbus is a continuation of that in section 34, Wales, and that it suffered 15 feet more uplift than the one in section 34 Wales Twp. Is it not more probable that only the north part of this main beach is an Upper Warren and that the part where crest is below 700 feet was found as the outlet was deepened.

The break in the western shore from section 33 to section 11, Wales Twp. may be due to unfavorable slope of the lake bed for the development of a definite beach. The Warren shore shows breaks as great as this in the district entered in the Detroit [illegible] embraced.

We drove into Port Huron for dinner going via Smith's Creek and Ramsewood Roads on the way to Port Huron, and returning on Lapeer Road to the beaches near Goodells.

We noted the tendency of dunes in the Smiths Creek quadrangle to blow out eastward as if driven by winds from the west.

We left the area about 4 P.M. and returned on Gratiot and Grosbeck roads to Detroit.

Notes on date that Iowan and Illinoian was introduced.

The Iowan was recognized as a third drift by Iowa geologists and noted in Vol VII pp 17-20 of Iowa Geol. Survey, which was submitted for publication December 31, 1896. On p18 the statement is made that this third drift had its southern limits traced during the past 2 years or in 1895-1896.

The Illinoian was referred to by Gordan in Vol III Iowa Geol. Survey pp241-242, 250-251. My notes were given him in 1894, and his published report was in my hands in May 1895. The Illinoian drift thus seems to have been recognized and notice of it in print before the Iowa geologists recognized the occurrence of the Iowan drift as a third drift and restricted the name Iowan to it.

My field notes indicate that on May 7, 1894, the conception of the Illinoian invasion of southeastern Iowa was clearly reached. I had mapped the terminal moraine of Illinoian drift in Lee DesMoines and Henry Co., -Iowa, in November 1891, but did not at that time realize that it is a younger drift than the outlying Kansan drift ~~in~~ in SE Iowa.

The probability that the Mississippi River occupied the channel west of the moraine in these counties of SE Iowa was also conceived early in 1894.

On May 30, 1928 I called Prof. T. C. Chamberlain's attention to the pre-Kansan drift in Louisa and Muscatine counties, Iowa in a region where gas wells have been obtained which F.M. Witter discussed in a paper in American Geologist in 1892. The gas seems to come from sand and silt below the Kansan drift and beds of soil and much on the surface of the PreKansan drift. This soil is at about 600 feet A.T., and the wells show that the drift is as much as 150 feet below it, or down to 450 feet A.T. This is about 100 feet below the neighboring part of the Mississippi River.

Algonquin beach levels by W. M. Gregory in Iosco Co. (In letter of December 26, 1905).

At Miner's Corners near East Tawas NW corner sec. 19, T.22N., R.8E. is 615-617 feet.

Near Ausable RR depot the beach is 620-625 feet, at points between Ausable and East Tawas it is not over 625 feet except when covered by dune sand. At crossing of D & M RR NE of Tawas in section 14 it is 623 feet.

South from Miner's corners where it crosses the D & M RR in SW¼ section 36, T.22, R.8E. it is 610'. One mile east of Omer village it is 609 feet south of Omer it crosses the D & M RR at 610'

The beach is well developed between Pine River and Saganing at 610-613 feet. The base being about 600 feet. The beach leaves Arenac County at SW¼ Section 36, T.18N.,R.4E. It is about 610-613.

Data on low passes in Ontario by A.P.Coleman in letter of Dec. 21, 1909.

There are several low cols north of Lake Superior.

On Red Paint River NE of Lake Nipigon at 1046.(R.R.Survey)

Near Long Lake at 1040 or 1050 feet
At Misinaibi(1090 feet
I have visited all these cols and found no strongly marked evidence of River action at any of them.

Page 5:

There are boulders and rounded pebbles near the south end of Long Lake which present wave action could hardly produce. If any large river flowed north there it must have been for only a short time. I have interpreted the relationships as implying a brief northward bay of Lake Algonquin.

If a river flowed through there it must, in my opinion, have turned westward past the ice from the Labrador sheet.

In my account of Lake Ojibway I assume that the ice-front was just north of the watershed during the higher stage of Lake Algonquin.

You are aware, I suppose, that well defined lake terraces occur near Gondreau Lake at 1330 feet. (Hand level from nearby RR bench mark.) This is only about 25 miles SW of Missinaibi at 1090 feet.

My notes seem rather meager on the leveling done by Prof. MacLachlan on beaches in western Tuscola County. Notes on the county map show a beach 664 feet that was traced for about 5 miles from Section 15 Fairgrove Twp., northeastward to NW part of section 6, Almer Twp. This also appears in Fairgrove village at 661 feet. It is present in sections 20, 29 and 30, Fairgrove Twp., SW of the village and is given an altitude there of 664 feet. There is also a faint beach at 665 crossed by the Caro and Lake Huron RR in section 34, Columbia Twp. This is shown further east as a weak feature in sections 25, 35 and 36, Columbia Twp.

The entire distance is 12-13 miles from section 30 Fairgrove to section 25, Columbia Twp. This beach was not recognized further northeast either in Tuscola or Huron County. Search for it was made near Grasmere but without success. Why Lane introduced the name Grasmere is, therefore, not evident.

Beaches were found at several lower levels in Tuscola and eastern Saginaw County. The lowest is at 615 feet. Another at 625 feet and one near Reese at 635 to 640 feet. This beach is traced northeast from section 7, Denmark Twp., (at Reese) to section 25 Clifford Twp., with a gap less than a mile in south part of section 34, Clifford Twp. It is absent or vague for 1 1/2 miles to section 17 Fairgrove. It runs N NE from there past Arkron to Woodman at line of sections 23 and 24, Akron Twp. a distance of 6-7 miles. The altitude is 647 at Akron. It may reach 650 at Woodman.

About 3 miles east of Woodman in sections 31, 32, 30, 20 and 21 there is a beach which was found to be 654 feet at Columbia near corner of sections 20, 21, 28 and 29 Columbia Twp. It is here about 10 feet lower than the highest of this series of weak shore lines.

The neighboring part of the Warren beach north of Caro in the inner slope of the Port Huron moraine is 720-725 feet. It is thus about 60 feet above the highest of the weak beaches and 70 feet above the next lower one.

The Warren is about 700 at Vassar and the weak beach at Reese on the same isobase is about 640 feet thus giving a 60 foot interval where the isobase running to Columbia has a 70 foot interval. The beach in Eastern Saginaw County at 625 feet is, however, 70-75 feet below the Warren at Vassar and this may correlate with that at Columbia through the correlation with the 640 beach at Reese seems more probable with that at Columbia.

The series of beaches east from Ruth on the Huron - Sanilac County line to which Lloyd Humby ran levels show what was classed as Grassmere at 703' or about 40 feet below the Warren with other beaches 682 and 672 that were thought to be the split lower members of the Grassmere. The Elkton was interpreted to include a beach at 655 feet and one at 642 feet or about 100 feet below the Warren beach. Perhaps the beaches at 672 and 682 should be correlated with the ones at 640-654 in western Tuscola County, and what had been classed as Elkton should correlate with a beach at 625' in Saginaw County.

It appears rather difficult to make satisfactory correlations or interpretations of these weak beaches - that were put in the Lake Lundy series by Taylor in Monograph 53, U.S.G.S.

Pre-Kansan Wood in Illinois

W. W. Tupper of the Botany Dept. in Univ. of Mich. examined wood from below Illinoian till in Adams Co., Ill. in what is at least as old as Kansan till and reported it to be a primitive pine. His report is dated June 3, 1924: "Two specimens in good state of preservation have been imbedded, sectional and stained. I have gone over the sections in all three planes and feel sure they are both alike, and are undoubtedly a primitive pine - probably a hard pine. They have resin canals normally scattered through the wood, thin-walled epithelial cells, no mod?? paren chy ma. Bars of "sanio, septate tracheids slightly sculptured, fusiform rays, and well marked annual rings. It is one of the most primitive hard pines because of the piciform pitting in its ray?cells. We expect to make microphotographs of this wood next week, and shall save you the best of our prints. Very truly yours, Walter W. Tupper.

In a letter Oct. 10, 1938, Dr. Sardeson tells of finding moss agates and petrified woods in gravel of the "older" drift south of Indian Lake below Mankato. The agates and wood are brightly polished, as are also the quartz and chert pebbles that came from the nearby cretaceous stream conglomerate, and are rather common in the "older" till as well as in the "older" gravels. Other pebbles in the till and gravels are, of course, not polished brightly. The older gravel is rusty and cemented enough so that the face of the pit will stand vertically for a long time in the weather.

I have not been able to find moss agates and silicified woods in the cretaceous conglomerates of Minn. It is remarkable that the wood and agate pebbles are polished the same as the chert and quartz pebbles in the cretaceous conglomerate here, or the same as found in the drift. I am thinking that the bentonite clay and mud balls that occur with the cretaceous sand and conglomerate explain why the pebbles are so brightly polished. As deposited, the bentonite was, of course, a volcanic ash in the rivers. But where were the moss agates and woods when they got their bright polish? Are they cretaceous, or are they Tertiary?

Leverett's Notes - Book 300

Pages 68-76

In a letter March 17, 1926, J. W. Goldthwait states that he did not find clear evidence of marine waters further up the St. Lawrence than Brockville. He says: "the evidence all seems to me (as to Anteve) to point to the sea having failed to pass far beyond Brockville above the present level of Lake Ontario. Certainly Coleman's "Marine beach" along the north side of the lake, west of Kingston, does not harmonize either with the tilted marine limit plane marked by beaches, fossils, etc., in the Ottawa district and east of Brockville, where the westward slanting places is nearing Lake Ontario level; and all clays from Kingston west on typical freshwater clays. Meltwater from the icesheet is a poor excuse for this, in the situation mentioned. Typical salt water clays occur in much more restricted places up the Ottawa valley."

So while I've come to think that we are only commencing to know the extent and complex history of the "Champlain Sea", I've decided that this is no time to try to adopt a new nomenclature. Whatever scheme we might invest now is liable to be over-thrown when we have dug up some more of these facts."

T. C. Chamberlain on the way pebbles are modified so as to be preserved from decay. Letters written Aug. 14 and Sept. 3, 1926.

"I am particularly glad you have run across the pseudo-fresh granite erratics (in Illinoian terraces on the Ohio & Alleghany) to have broken through their deceptive skin and found the signs of weathering within. As I understand, the philosophy of the case lies in this line. Perhaps you recall that I used the expression "pressure polished" a good deal. This related most especially to the close-textured limestones. I supposed this smoothed glazed surface was due to the rubbing of the erratics on clay or similar fine-grained matrix under heavy pressure from the ice. I have learned since that they physicists recognize a surface finishing of this kind. As they interpret the phemomena, the outermost crystallin structure is broken down by the pressure and forced into any crevices or open structure, even the crystalline structure itself, and so covers the outer surface with a vitreous glaze that is closer in texture than the unmodified crystalline surface. This should withstand weathering because of this closeness of texture, which keeps out air and water. This would delay weathering below the glace, but not wholly prevent it, as you have noted"

He then recommends making collection for microscopic and other laboratory studies.

On September 3 he wrote as follows:

The box of specimens came a few days after the letter and I have gone over them as carefully as my poor vision would permit. I cannot draw the line with entire confidence between the pebbles that were, when deposited "pressure polished" to use my old phrase, and those that were "peck marked". My old expression for pebbles that have been rolled rather vigorously by stream or flood.

There is no good reason to think that any very sharp line of distinction exists for the gravels must have been rolled more or less on being laid down as gravel, even if the individual pebbles were fully "pressure polished" when marked out of the till in which the polishing took place. But a large percentage of the pebbles in the collection have a surface that seems to cut across the crystals and have a polished surface and a blunting of angles as well as special smoothness in concavities and on flat surfaces that seems distinctive.

I take it for granted that you know just what I refer to as "peck marking". If one stands on the bank of a strong stream in flood time that has its bottom in gravel (say the Rock River at Beloit) when the dams have given way several times because of the cutting out of the gravel bottom he may hear at intervals a pebble or cobblestone taking a short journey down stream. If the stone is a good sized cobble the "chug, chug" as it strikes some pebble or cobble on its bottom is quite audible, and makes one feel thankful that his finger is not there.
You see there is not only the inertia of the cobble but of the mass of water that is pushing it to be taken into account. Now of course, whenever one cobble strikes another in this forceful way it receives a mark a "peck mark". An examination of the surfaces of cobbles and pebbles in a stream of gravel that has been moved some distance at flood stages in this way shows a "peck-marked" surface that tallies perfectly with this history. These pebbles are very different from the small erratics worked out carefully from well formed till. But it is surprising in how short a space the pressure polished surface will give way to well rounded peck marked gravels."

He then speaks of taking his classes to the Lake Michigan Shore in Jackson Park in Chicago during a time when a stiff wind was rolling waves in and their listening to the click of the pebbles against one another.

Page 3:

The August 14 letter calls attention to the straight course of the moraine at border of the Wisconsin drift on the uplands of Pennsylvania as given by Lewis and Wright and suggests looking into the accuracy of the mapping. He says it is perhaps natural that no sub-lobes were developed when the valleys are not broad as is the case there.

In reference to the correlation of the Elkton beach with beaches in New York and at Lundy's lane, Taylor in a letter dated Feb. 25, 1913 says:

"Perhaps you will remember that in my letter of Jan. 28 to you I said that I regarded the Lundy beach as the same as the Elkton in Michigan. As you say, the Lundy is 150 feet below the Warren in New York. I believe it is a fact that the Elkton (lower strand of it) east of Bad Axe is 150 feet below the Warren at Bad Axe (775-625 = 150). In New York, in the vicinity of Alden, we see there beaches at a point higher up the inclined water planes where the altitudes of both are nearly 100 feet higher than on the Thumb but the relative interval between them is about the same."

"One of the things I have suggested was a careful study of the region south and east of Buffalo with a view of determining whether there is a series of split up beaches like those on the Thumb. I think it is highly important to determine whether there is such a splitting in New York coincident in time with that in Michigan. I think the most important part of the area to be studied for this purpose would be included in the 30 minute quadrangle lying next south of the Niagara quadrangle."

Has it been clearly demonstrated that there has been splitting of the Elkton beach in the Thumb? This matter seems to Leverett in ~~1939~~ 1939 to need attention.

In the letter of Jan. 28 referred to above Taylor says:

"In following the Alden moraine down towards the lake I found several fragments of a faint beach about 70 feet below the lower member of the Warren (Forest) beaches.

These fragments run from a point about two miles NE of Elma south westward to the edge of the Depew map. I showed those near Elma to Fairchild, but he would not accept any of them as beaches. They are all weak and faint, but some of them are as clear as if they were strong. The one at the corner half a mile north of Elma is quite good.

Those NE of Elma were pretty faint, but the one SW from Elma running along the north side of the road is good. The one at the cemetery 2 miles west is quite good."

I think an uplift was going on here while the beaches below the Warren were being made so that they are split up and the individual strands are weak, like they are on the Thumb in Michigan.

All the data that I have got so far in New York and Ontario seem to me to indicate that the Daúa or Lundy beach is the same as the Elkton."

As suggested by Leverett in the paper in the July 1939 Am. Jour. of Scienc., the beach near Elma noted by Taylor seems likely to be a closer correlative of the Elkton beach than are the Daúa and Lundy beaches. A sketch map of shore lines below the Warren around east end of Lake Erie is attached below. It was in his letter of Jan. 28, 1913.

In a letter dated June 5, 1905 Taylor suggests that the lowest Maumee lobe stage may have found an outlet in the channel leading west to North Branch from near Brown City as this seems to be lower than the head of the Imlay City channel. A [illegible] of the ice border may have closed this outlet and brought the lobe up to the middle Maumee level. This is a view that may be tr[illegible]

In a letter dated July 28, 1897 Taylor reaches an interesting statement of features at head of St.Clair River.

"As a letter dated July 28, 1897 Taylor makes an interesting statement of features at head of St.Clair River.

"As a result of my investigations around Port Huron and Sornia I founed that the rapids at the head of St.Clair River are not due to an obstructing glacial barrier, but to shore drift from the east side of Lake Huron. In the rapids the river is cutting glacial drift on its west side, but its bank is all gravel and sand on the east side, and that bank is constantly growing by additions brought in by the waves and the shore currents from the east coast. The shore drift from the east coast predominates very strongly over that which comes from the west coast and it tends constantly to build a spit across the head of the river from the east side. To resist this the river has to get up current enough to turn the spit down stream on the east side and keep it there constantly as it tends to grow. In doing this the river, of course, is constantly /ŧó/ẏúíẏd/ crowded over against the glacial drift bank on the west side, and keeps cutting it away. It has cut a great westward bend into that bank, and at the same time it has filled in a space about 1 1/2 miles wide on the east side. The village of Point Edword is built on this. It is a plain made up of a great number of spits of sand and gravel running south and southeast. On the south side these spits partly enclose a bay, mostly very shallow, called "Sarnia Bay."

Leverett's Notes - Book 300

Pages 78 - 90 inclusive

Data on Thunder Bay drainage system by C. O. Wiser of U. of M. Engineering College, from his own surveys in connection with the Land and Economic Survey.

There is a 6 foot dam at north end of Hubbard Lake raising the lobe to 709. The outlet called "South Branch"drops below 700' within a mile below the dam. This branch is flooded in its lower part to 670 feet by a dam on Thunder Bay R. 2 miles below its mouth in east part of section 12 T.31N., R.7E.

Dam No. 1 on Thunder Bay River is in the west part of Alpena and has a pool at 597 feet. The dam raises water 16 feet or from 582 feet.

Dam No.2 is near corner of sections 7, 8, 16 and 17, T.31N., R.8E. and raises the level of river from 608' to 634'.

The 600 contour comes to about 1/2 mile below this dam.

Dam No.3 in section 12, T.31, R.7E. raises level of river from 635 to 670'.

The North Branch which comes into Thunder Bay River in section 33, T.32N., R.7E., drops below the 700 contour about 7 miles above its mouth in section 12, T.32N., R.6E.

Thunder Bay River drops below 700 feet within 2 miles below Long Rapids near the line between T.31, R.32N., R.6E. and near corner of sections 33 and 34, T.32 and sections 3 and 4 T.31N.

The river drops below the 750 contour about 6 miles above Hillman in section 8, T.30N., R.4E.

A dam at Hillman has a pool 742 feet or 10 feet below the railway station. It is a low dam built for local use.

The river drops below 800 feet near corners of sections 21, 22, 27 and 28 T.30N., R.3E. about 5 miles below Atlanta and below 850' about 2 miles.

The fall of 50 feet is made in passing through a moraine in a distance of about 3 miles.

The river probably drops below 900 feet near Atlanta.

The Upper South Branch of Thunder Bay River is below 750 feet to a distance of 16½ miles above its mouth or into the east part of T.29N., R.4E. in Montmorency County, sections 11 or 14. The stream has scarcely any fall in the large swamp in T.30N., R.5E. for a distance of 7 or 8 miles. Turtle lake may not be over 800 feet, but Wisler has no definite data on its altitude.

Professor Wisler has surveyed in the headwaters of the AuSable River in Crawford County. The main river drops below 1000 feet near the line of Crawford and Osceola County. It is 1005 a mile west at mouth of the North Branch. The North Branch is down to 1050 feet near line of sections 15 and 22, T.27N., R.1W. and down to 1100 feet in section 5 of that township. It drops below 1150 at Lovells, and below 1200 feet in section 26, T.29N., R.2W. Wisler has no data further up.

On the main AuSable, the stream drops below 1050 in section 11 T.26N., R.2W. and below 1100 in section 11, T.26N., R.3W. and below 1150 feet 4 miles above Grayling.

The South Branch of AuSable River is down to 1050 feet near line of sections 17 and 20, T.26N., R.1W. and to 1100 feet near line of sections 14, and 23, T.25N., R.2W.

It is 1150 at Lake St.Helens; near its source.

The lowest dam on Kalamazoo River is in the north part of section 15, T.2N., R.14W. about 6 miles below Allegan. The level of the river is 596 to 605 according to the stage of water, but ordinarily is 599 to 600 feet. The pool above this dam is 616 feet and it extends up to the city of Allegan. A dam in the city near center of section 28, T.2N., R.13W. has a pool 627 feet A.T. (Data furnished by Donald May, an Ann Arbor Engineer)

Mr. May also supplied data on the Tittabawassee River above Sanford. The river there is 602.4. It is 611 feet at the line between T.15 and 16 N., R.1W. and 633 at the county line at N edge of T.16R.1E. near corners of sections 4, 5, T.16 and 33 and 34 T.17N.

Below there at mouth of Tobacco River near corners of sections 1, 2 11 and 12, T.16, R.1W. the normal level is 620' and L.W. 618'. Tobacco River is 693 at the junction of streams at Beaverton Pool at Beaverton dam 704' and 673 about 2 1/2 miles below at corners of sections 8, 9, 16 and 17, T.17N., R.1W. It drops to 650' in section 22.

On the Tittabawassee the 650 level is reached in section 23, T.17, R.1E. the level being 654.3 at north line and 646.5 at south line of section 23.

The stream is about 660 at Highwood. An Eastern Tributary entering a mile north of Highwood is 661.4 a mile above its mouth in section 24, T.18, R.1E. It comes to 700 feet near line of sections 28 and 33, T.19, R.2E.

The Tittabawassee comes to 700 feet in north part of section 10, T.19, R.1E.

The highest level determined on the headwaters is 745 feet on the west one in section 12, T.20N., R.1E. and on the east one at line of section 15 and 16, T.20, R.2E.

The pool at Edenville is 636.5; Dam is 15 feet.

Dams on Kalamazoo River and tributaries from House Doc - 72nd Congress.

Dam below Allegan in section 15, Valley Twp, 607-616
Dam in Allegan in section 28, Allegan Twp, 616-627
Trowbridge dam in SW part section 12, T.1N.,R.13W., 644-671.35
Oswego dam near line of sections 17 and 20 L.W. 668, H.W. 671.7 below Pool 683'
In Oswego west port sec. 23, below dam 685.5 Pool 698.5 - 700.5
Plainville dam 699 - 702.7
River at Cooper L.W. 738.9 HW 745
At Twp. line above Cooper river LW. 749.5 HW 754.8
Bryant dam on Portage Creek in Kalamazoo Pool 786.2
[illegible] dam on Portege Cr. in Kalamazoo Pool 809.4
Battle Creek, Monroe St. dam 815-826.8
Main St. dam 834.9-836.5
Verna dam on Battle Creek 824.5-828.4
P LW 827-HW832
Bell east part section 28, 841.4-853.2
Cresco on Kalamazoo R. in section 30 Pool 874.4-875.8
Marshall city dam near line secs. 25 & 36 pool 899-901
On Rice Cr. Mill dam in sec. 25 HW in pool 898
Albion dam at junction of N & S Branches Kal.R.945-946.5 Pool
Homer power dam pool 968'
Mill dam east of Homer Pool 975.7-977.3
Mosherville line of secs. 4 & 9, 1000-1014.2
North Branch at Concord 974.7-984.7
Horton Mill dam Pool 1019

The 1000 contour is crossed in west part of sec. 32, T.3S.,R.3W.
On Augusta Creek 800 crossed in sec. 34, T.1S., R.9W.
On Wabasco Creek 880 in sec. 10,T.1S.,R.8W., Pool.
On Comstock Cr. dam 800-812 in sec. 17, T.2S.,R.10W.
On Gull Creek dam 840-850 in sec. 31, T.1S.,R.9W.

Doc. 80, 73rd Congress 1st Session deals with Grand River, Mich.

The navigation improvements have been confined to the part below Grand Rapids, and by 1932 much of this has been abandoned. The only part in use being below mouth of Bass River in the lower 17 miles where barges carry sand and gravel to the shipping part at Grand Haven. The river has no waterfalls, but has rapids at some of the gravelly sections. The rate of fall below Ionia 88 miles from mouth is only 6 tenths foot per mile.

Rainfall averages about 31 inches and runs-off 35.8% of rainfall.

Most of the dams for power are small, and some dams are for reservoirs. There are 42 in operation in 1932, of which 13 are on the main stream. Consumers Power Company controls 70% of the power.

Floods are frequent on the lower course. The heaviest at Grand Rapids gave a rise of 18-20'. Such floods occurred in 1832, 1844 and 1904. In extreme low water the river is at 585' nearly up to Grand Rapids, 40 miles from mouth.

A dam in Grand Rapids, 41 miles from the mouth has a pool 604.3'.

The Ada dam in section 34, Ada Twp., is 613-636'. The Lyons dam, 2 miles above mouth of Maple R. is 634-647'.

Wagar dam 4 miles further up is 647-657'

Webber dam 2 miles further is 657.4-684.7'
Portland dam 7 1/2 miles further is 684.7-704.3'
Ruins of dam at mouth of Lookingglass R.704.3-718.5
McGee projected dam site - 5 miles above 718.5-750'
Danby projected dam 18 miles above Portland 750-780.5
Grand Ledge dam 11 miles above Danby Site 780.5-789.6
Projected dam 4 miles above Grand Ledge 789.6-808'
Lansing dam, mainly reservoir, near mouth of Red Cedar R. 808-817.7
2nd " " 817.7-832.2 mainly reservoir
Dimondale dam 832.3-840.7 " "
Eaton Rapids dam 862-869'
Jackson reservoir dam, 924-931

Michigan Center 931.2-939.1
Dams on Rouge River
Dam 5 miles above mouth 655-673
Rockford dam 680-694
Dams on Thornapple River
Cascade dam 4 miles from mouth 696-664
Dam 14½ miles from mouth, 3 miles below Coldwater Creek 680-698.6
Middleville dam 24½ miles from mouth 705-713.9
River level at upper bridge in Hastings 770'
RR stations in Hastings 777 and 790 feet.
The river falls below 800 contour near Nashville
M.C.R.R. station in Nashville is 820'
Dams on Flat River.
Dam near mouth 620-629.8'
Dam 5 miles above mouth (Lowell dam) 649-677.8'
Municipal dam for Lowell 14 inches from mouth 711-728'
S . dam 735-743.5
Belding dam 750-761.5'
Greenville dam 802-813'
On looking glass R at Wac 770-774.6'
On Cedar R. 6 miles from mouth 823.3-827.5'

Doc. 94 73rd Congress 1st Session St. Joseph R.
Data on dams in the Michigan part.
Drainage area 4685 sq. miles, 3000 in Michigan
400 small lakes on its watershed
Source is Baw Buse L. at about 1150 feet.
Length of river about 210 miles.
Head of Navigation at Berrien Spgs. at 34 miles.
Fall is 20 feet from 600.5-580.5 feet.
There are 18 power plants (in 1932) on Main River and 52 on tributaries.
Developed head 242.4 feet.
A further head of 46 feet on projected sites.
(1) At King's landing 8 miles from mouth 583-600' 17 feet.
(2) At State line above Niles, 654.5-668.5, 14 Feet
(3) Bristol Indiana sec. 28, T.38, R.6E., 743-758 = 15'
Berrien Springs dam 600.5-622.8'
Buchanan dam 624.8-637'
Niles dam 640-654 - on Dowagiac Cr. near Niles, Sec.13, T.7S., R.17W.
664.5-685.6'

S. Bend 668-679
Mishawaka on St.Joseph R. 682-692 - Ionia Branch 694-717', mouth of
Elkhart River 719'

Mouth of Christen Creek 741-4-745.4.
At Adamsville, Mich. on Christian Cr. 783.8-794.8

Elkhart, Indiana sec.5, T.37N.,R.5E. 720.4-728.4
Goshen, Indiana sec.21,T.36N.,R.6E. 775.8-790.3
Mottvile, Mich. dam 759.4 - 770 - Dam on Mill[illegible] Cr., near mouth 772-786
Constantine 773.5-783.5
Three Rivers 786.3-798.3, On Rodey R. near mouth 786.8-799.8'
Dam in sec. 1, T.6S.,R.11W.(Sturgis dam) 799.7-826.7
Mendon Reservoir dam (projected)828-857
Union City 856-871
Burlington 907.4-914.4
Tekonska 933.1-940.6
Litchfield. (no elevation given)
Hillsdale (no elevation given)

On White Pigeon River, (mouth is 772')
White Pigeon sec.12,T.8S.,R.12W. 796.6-804.6
In Indiana sec.27,T.38,R.3E. 840-855'
On Fawn River sec. 10,T.8 ,R.9W. 873.7-880.4'
Prairie River near Centerville Sec.30, T.6S.,R.10W. 801.7-819.7
On Ruby River at Howardsville in sec. 21,T.5S.,R.12W., 831-837
On Flowerfield Creek (tributary of Rocky R. 833-845' Sec.1,T.5S.,R.12W.
On Portage River Sec.7,T.6S.,R.11W. 791.5 - 800.5
On Portage River Vicksburg 837.7-846.4(sec.13,T.4S.,R.11W.
On Nottawa Creek T.5S.,R.9W. (sec.20) 839-846
On Nottawa Creek at Leonidas sec. 16, T.5S.,R.9W., 848.7-852
Big Swan Creek near Union City T.6S.,R.9W.(sec.11) 840.8-848.3
On Coldwater River T.5S.,R.7W., sec.4, 872.5-882'
On Coldwater River Sec.15,T.5S.,R.7W., 890-893
Hod[illegible] Coldwater R. sec.23T.5S.,R.7W. 905.5-912
" " " sec.24,T.5S.,R.7W. 916-922.8

Muskegon River data from H.D. 72nd Congress

Newaygo Dam 40 miles from mouth 643-652.5
Croton Dam 52½ Miles from mouth 682-722'
Hardy Dam 590 miles from mouth 722-822
Rogers Dam 84 miles from mouth 822-862
Big Rapids Dam 95 miles from mouth 886.5-903.2
Mouth of Hersey Creek at 112 miles 956
Reed City dam on Hersey Creek 1018.5 Pool
Houghton Lake LW 138.4 HW. 1141'
Higgins Lake, 245 miles from mouth 1155.1 L.W., 1157.9 H.W.

Page 7:

The gravel plain near Croton where the Muskegon River was
Rouge River to the Grand River has 800 contour at brow of S bluff of Muskegon River which seems to indicate that the plain slopes south from this place to the Rouge River.

This is in sections 26 and 27, T.12N., R.12W.

At east line of section 24 the 840 contour appears in the south bluff between the river and Petit lake. This is about 2 miles below the Croton dam site in section 18, T.12N., R.11W.

Manistee River data from H. D. 72nd Congress. The Stronbeck dam at Manistee has 18 feet head. The hod[illegible] dam at 49.8 miles in section 30, T.2[illegible], R.13W. has pool 807-809' below dam LW 738.5-743.9 HW The 600 contour is at mouth of Bear Creek and the swamp for several miles up Bear Creek is close to 600 feet.

At the Pere Marquette RR near corners of sections 27, 28, 33, and 34 at 26½ miles up the river the LW is 617 and HW 622'.

Junction Dam at 32 miles has LW below 626 and LW pool above 687 feet. This is near corner sections 31 and 32, T.22R13W and sections 5 and 6, T.21. The base of Wheeler Creek Dam at Sherman line of sections 31 and 36, R.8, 11 and 12W. has LW 811 HW 816.
At mile 78. east part sec. 17, T.24, R.11W.
LW 861.8 HW 864.9
At Mile 90 near line sections 10 and 11, T.24, R.10W., LW 894
HW 898.8.
At mile 101 in section 9, T.24, R.9W., LW 917, HW 921.9
At Fife Lake outlet sec. 10, LW 920 HW 925
At mile 112, T.25, R.8W., LW. 949.8 HW 953
At mile 127 the river is below 1010 and the north bluff above 1230.
At mile 132 HW 1018 LW 1015 (sec. 17, T.24, R.9W.
Portage Lake LW 1174.6 The bluff south of outlet in secs. 20, 21, T.26, R.5W. is 1300'
East of S end of Lake the 1280 contour is shown
The level drops to 1100 feet in SW part sec. 14, T.26,R.5W.
On the outlet and in center of sec. 15 on the river.
In sec. 4, T.25, R.6W. LW is 1052

HD 89. 73rd Congress 1st Session
Montreal River Wisconsin and Michigan
Drainage area 280 sq. inches in Iron Co., Wisconsin and Gogebic County, Michigan. River has two main branches, the West Branch entirely in Wisconsin the east partly in Michigan and on State line for 8 miles [illegible] Harley and Ironwood to the [illegible] with West Branch. The fall is about 1000 feet. There is a fall of about 100 feet within a fraction of a ~~mile~~/ mile of its mouth and another less than 4 miles from mouth known as Saxon Falls.

About 2 miles above Ironwood a diversion dam and canal carries the waters of the east branch into a reservoir on the west branch, the "Gile Reservoir" standing at 1195.5 when full. The next pool is west of Harley, Wisconsin, where the C & NWRR crosses west Branch and is 1422.5 feet.

The next pool is below the Soo line crossing and is 1135. The river below it is 1080 feet. A pool at 1080' extends down to a dam 8 miles from the mouth. This pool has a low water level of 1045. The river below it is 1010 feet. It is proposed to raise the dam above Saxon Falls to 1010 feet. The existing pool is 984.2 feet.

The pool below Saxon Fall is 865 feet and extends to 2 miles from mouth. The river level is about 760 feet below it. The pool at the mouth above Superior Falls is 759' when full. The level at brinck of the falls is about 720 feet.

H.D. 97. 73 Congress 1st Session Sturgeon River in northern penninsula, rising in Baraga County at about 1800 feet and entering Portage Lake at Lake Superior level. Length about 30 miles, Drainege area 700 sq. mi. It now in 1932 has one power plant at 30.5 miles from mouth. There seems room for 6 additional power plants. The one now developed has 55 feet head. The first proposed dam is on Otter River with a diversion canal into Sturgoon River near Pelkie about 4½ miles above Otter Lake. Its pool would be about 662 feet and head about 25 feet.

The second dam site is west of Baraga in section 28, T.51, R.34W. Its height 55 feet with pool 715 feet.

The third is the existing one in section 15, T.50, R.35W. with head about 54' and pool 770 feet. The fourth site in section 8, T.49, R.35W. Dam 40' at 38 miles from mouth pool 870'.

The 5th site at about 39 miles in sec. 16, T.49, R.35W.
Dam 115 feet with pool 1020. It is at the "Big Falls".
The 6th site in secs. 11, 12 and 14, T.48N,R.35W.
with dam 120 feet and pool 1195 feet.
This is near mouth of Perch River.
The 7th dam site is in sec. 5, T.48, R.34W.
Dam 65 feet pool 1262 feet extending nearly 6 miles from 60-66 miles from mouth.

H.D. 142. 72nd Congress 1st Session, Carp River
Only one power development in sec. 5, T.47, R.25W.
about 4 miles from mouth; has 608 feet available head. The river falls 620 feet in the lower 5 miles. A storage reservoir at Deer Lake with 10,000 acre feet is 18½ miles above the mouth.

August 20, 1940. Dr. S. G. Bergquist of Michigan State College showed me an airplane map of a drumlin district lying mainly east of Onaway. Presque Isle County, Michigan in sections 3, 4, 5, 8, 9, 10, 15, 16 and 17, T.34N., R.2E. which have a trend S 35° E with very little divergence from that bearing. This area is largely above the 900' contour. Yet it seems to be a ground moraine or till plain and not a terminal moraine.

Dr. Bergquist reports that there are a few drumlins west of Onaway in the edge of Cheboygan County, but as this district is largely in forest the drumlins ~~west of Onaway in the edge of Cheboygan County~~ cannot be shown on an airplane map so well as in the cleared district east of the village where only small areas are still in forest.

Dr. Bergquist and one of his students have recently made a rapid reconnaissance survey of the greater part of LaPeer County to determine the distribution of moraines. Outwash plains, till plains, eskers, and the local lobe areas. He has turned over the maps of LaPeer and of Oakland County showing the results of this survey. An aneroid was used to determine altitudes. From this it appears that the local lobes were near the 900 foot contour on their borders. Both north and south. The outwash plain in section 10 and parts of border sections of T.8N., R.10E. (Mayfield Twp) stands slightly above 900 feet and this correlates with a lobe south of it. Taylor reported this outwash to be 960 feet by aneroid measurement. Probably Bergquist is a more reliable measure as he checked his barometer with one read at a station from which he started work each morning.

He questions the classing of strips in southern Hodley Twp and in Metamora Twp LaPeer Co. as till plain. They seem to him to be terminal moraines and so do the continuation southward into Brandon Twp., Oakland County.

Page 10:

Notes on a paper by Wilber Stout and G. F. Lamb in Ohio Journal of Science Vo. 38 "Physiographic Features of Southeastern Ohio"

After discussing the peneplains, the drainage features are taken up.

Teahs Valley

Rock floor at Scary W. Va. 670 feet
At Huntington 660' At Russell 650'
At Glade and Waverly 640 feet
At Chillicothe 630 feet
Gradient 4 inches per mile
Depth of valley about 300 feet
Width about 1¼ miles.
Marietta Valley joins Teahs at Glade.

Deep Stage Erosion

This preceded the Illinoian glacial stage and was stopped by it.
The rock floor was down to about 460' at Portsmouth and Wheelersburg and to about 460 feet at Cincinnati
It was 480 at mouth of Kanawha River at Pt. Pleasant W.Va.
Newark River floor is 480 ± at Waverly
500 at Chillicothe; 520 at Circlaville and N. Baltimore; 540 at Buckeye Lake; 534 at Coshocton.
They think the interglacial "Cleveland River" drained from as far south as Uhricksville. This is questioned by H.A. Ireland in a paper in Bull. G. A. Sept. 1, 1040, who limits it to the district north of Massillon, the rock floor near Uhricksville being lower than at Massillon. His figures are 784 at Massillon and 630 near Uhricksville. It is 570-600 on the Cleveland River near Barborton and 400 near Akron, as given by Stout and Lamb, and about 100 at Cleveland. They carry the drainage of the whole area west of the Flushing Escarpment into Cleveland River. Ireland carries it down the Tuscarawas from Navarre. (See his Fig.6) Stout and Lamb head the Tuscarawas at Port Washington in the Deep Stage. Ireland interprets the trending of the old col at Port Washington to have been started at the Early Quationary glaciation and maintained through the Yarmouth interglacial stage when the "Deep Stage Erosion" was effected.

Stout and Lambs preglacial "Pittsburgh River" that drained the Monongahela and Lower Allegheny into the Erie Basin is given the name "Warren River" in the time of Deep Stage Erosion after the Early Quaternary glacial stage (i.e., in the Yarmouth Stage). The part of the Ohio between New Martinsville and the mouth of Beaver River they call "Steubenville River" and interpret it to have drained northward. Leverett questions this and thinks there was a small stream there draining down the present course of the Ohio as indicated in Bull. G. 7, Pa. Geol.Survey, and also in Vol.II Jour.of Geomorphology.

Stout & Lamb call the Little Beaver drainage of the Deep Stage Erosion "Negley Creek" and carry it northward. The Stout and Lamb paper overlooks the Early Quaternary glacial gravel at Bellaire and Toronto, Ohio, and says no pre-Illinoian deposits are found in Ohio. This led Ireland to repeat this error in his paper in Bull.G.S.A. Prof. Lamb and Leverett examined the Bellaire deposits together and also deposits opposite East Liverpool, Ohio, near north end of the W.Va. Panhandle, and both of us then referred them to a pre-Illinoian glaciation. Lamb's memory seems, therefore,

to have lapsed on this matter.

Stout and Lamb express doubt of the extension of Illinoian glaciation over northeastern Ohio. This is shown by Ireland to be unfounded skepticism in view of the presence of Illinoian glacial gravel on Sandy Creek near Magnolia and on the Tuscarawas near Port Washington.

This skepticism led Stout and Lamb to make the ridiculous suggestion that the entire drainage of eastern Ohio was into the Lake Erie basin during the Illinoian stage. They argue that the Cincinnati ice dam was a complete barrier to drainage westward and ponded waters east of it discharged northward in what they call "New Martinsville River". A map on p. 77 showing this drainage is called "Post Illinoian" though it aims to show conditions at the culminating position of the Illinoian ice in central and western Ohio. This seems to show another lapse in mental action. They put the old divide at Sardis that was really north of New Martinsville near Proctor, as shown by Leverett in Jour.of Geomorphology. Ireland follows Stout & Lamb in calling it the "Sardis col".

A paper by G. N. Coffey in Ohio Jour. Science, Vol. 30, 1930, p. 373, on "Preglacial, interglacial and postglacial changes of drainage in northeast Ohio", suggests a drainage past Lodi, Ohio, into the Lake Erie basin of a district west of the Cuyahoga line of drainage.

Coffey also thinks there were changes in interglacial times as well as glacial. The paper shows that he has given the subject considerable thought but that many matters are yet to be cleared up before a final interpretation of the drainage history can be presented. He mentions borings near Mud Lake, south of Akron, that penetrated 400, 404, 407, 499' of drift making bed rock floor there as low as Lake Erie level. He thinks there may be an old col on Killbuck Creek south of Millersburg and the upper part of Killbuck drainage went past Lodi into Lake Erie basin, or past Chippewa Lake or both. He also intimates that the Old Kanawha drainage may have taken a NE course from Circleville along the route of "Newark River" and then north down the Cuyahoga valley to Lake Erie Basin.

Was the great size of the Tuscarawas valley near Port Washington due to this?

October 1941. James Calver, a graduate student in the Geol.Dept., presented a thesis in Oct. 1941, as candidate for a Ph.D. degree, on the district bordering Crystal and Platte Lakes in Michigan. The Algonquin beach there is 613-614' at a distance 15 mi. or less north of the hinge?? line. The Nipissing beach is 600-602'. The Algoma beach is 590-595' , its water level probably between 590-593'. A moraine between Crystal & Platte Lake is 780-830' along much of its crest. A moraine between the Platte lakes reaches 790'. This has 5 gravel pits opened in it. An outwash plain near Honor is 740'. Crystal Lake stood at about 610' down to historic time when the dredging in its outlet lowered it. No later beach than Algonquin is found in the Crystal Lake basin. The Platte Lake basins have Nipissing and Algoma as well as Algonquin beaches. Reference is made to I.D.Scott's report on Inland Lakes of Mich., published by the Mich.Geol.Survey.

Leverett's Notes - Book 700

Pages 95-96 inclusive

November 29, 1941, George Stanley took me by auto to the north part of the Blissfield quadrangle, and we mapped the lake features from Ridgeway SW to Raisin River in section 9, Palmyra Twp., and made some notes on the features of the Defiance moraine above the junction of the south Fork and Main River Raisin. We were surprised to find sand of considerable thickness on most of the moraine prominences in sections 28, 22 and 23, Raisin Twp., which rise above 800 feet. In part it is dune sand, but some have gravel and sand interbedded. Good exposures of this were noted near the south end of the line of sections 21 and 22 Raisin Twp.

In the SW part of section 29 west of River Raisin is an exposure of cemented gravel alternating with sand that has few pebbles. South from there in section 32, there is sand over clay on the low west bluff of River Raisin and clay under sand is exposed west from there about to line of sections 31 and 32. The prominences of the moraine in the north part of section 31 and south part of section 30 have considerable sand but may be in part till and gravel.

The small area that catches the 750 contour on the east side of River Raisin in sec. 32, River Raisin, and sec. 5 Palmyra Twp., has boulders and till exposed. The till may extend east along this township line to east end of the section line.

Sand sets in south of an east flowing drain in the north part of sec. 5 and probably covers sec. 4 south of this drain. There may be till in the north part of sec. 4 and SE part of sec. 33 both east and west of the Whittlesey beach.

The higher land in NW part of sec. 33 has a sandy soil both sides of the Maumee beach in sec. 33 and NE part of sec. 32. This beach is above the 760 contour. Is it the lowest Maumee? There is a fairly continuous Maumee beach usually a little above 770 feet from the north side of the Blissfield map SW to the River Raisin in section 32. Raisin Twp. but partly slightly below 770 feet. Above this near the border of the lake plain is a shore line that usually stands about 790 feet. The land between these shore lines is more sandy in general than that east of the 770 shore line. It is a narrow strip 1/4-1/3 mile or less in width.

The lake plain extends a short distance beyond the 790' shore line in the north part of the Blissfield map in Sec. 1, Raisin and Sec. 36, Tecumseh Twp., but scarcely reaches 800 feet.

Page 2:

The Whittlesey beach has recurved spits where it comes to River Raisin Valley in the NW part of sec. 9, Palmyra Twp. We do not find similar spits on the SW side of River Raisin in sec. 8, Palmyra Twp. A west Tributary of River Raisin cuts off a short section of the Whittlesey beach in sec. 8 instead of running north to the river on the outer (west) side of the shore line which seems an unusual procedure.

On the return to Ann Arbor we followed the Whittlesey beach from Ridgeway to York, and from York to Saline took the road west of Saline River and mapped the Maumee beach that is about 760 feet and a higher one 780 feet or more. The Defiance moraine extends down about to the 780 contour.

We had dinner at the Lincoln restaurant in Adrian and kept southeast of the South Fork from there to its mouth on our way back. We drove into Adrian westward from sec. 8, Palmyra Twp.

Notes on Alden's Paper on Illinoian Drift

Alden in Jour. of Geol., 1909, discussed the matter of a post-Illinoian drift in northern Illinois west of the Marengo moraine and reached conclusion that it is a doubtful case, in which it would be "hazardous to assume a more recent age to what appears to be a thin and scattered deposit of fresh, unchanged, or little oxidized drift. He thus rules out Leverett's "Iowan drift" of Monograph XXXVIII, and considers it Illinoian. He thinks a pre-Illinoian is probably present.

He found no well-defined soil and weathered zone between the fresher looking drift and the Illinoian such as separates the Illinoian from the Kansan where there is an overlap. There is a somewhat more youthful aspect of the Illinoian east of Rock River than to the west. It carries drumlinoid ridges and some poorly drained strips and sags on upland which is not the case west of Rock River.

Observations by Leverett based on maps.

The Pecatonica River bottoms, however, are poorly drained as there was backwater filling in it as the Rock River gravel plain was built up in Middle Wisconsin time. This is up to fully 800' near the State line and about 760' at Rockford. This bottom land is between 720 and 740' clear to the west side of the

Rockford quadrangle with several B Ms 732-735'. In the Pecatonica quadrangle the bottoms are mainly below 740 as far up as Pecatonica village and up Sugar River about to the Ill.-Wis. State line. The Pecatonica River is full of abandoned oxbows in both quadrangles and so also is Sugar River. The Pecatonica is below 740 at the west side of the Pecatonica map and for 1½ miles in the Freeport map, at Browne Mill in sec. 1, T 26, R 8 E. The river is about 750 near the NW limits of Freeport at west side, sec. 30, T 27, R 8 E. It is below 760 at the west border of the map in sec. 7, T 28, R 7 E. The river had abandoned oxbows in the Freeport quadrangle as well as the Pecatonica and Rockford quadrangles.

(Alden continued)

A weathered zone below loess is more conspicuous west from Rock River than to the east. Limestone pebbles are generally gone to a depth of 2-3'. This in his opinion shows a residuum from 9-12' of the original till. The limestone pebbles and pulverized limestone form 80 to fully 90 per cent so if this is removed the residuum would be only 2-3'.

The valleys west of Rock River seem to have been only partially filled with drift so streams are very largely in their preglacial courses. The dumping of drift in valleys has in places been such as to cause streams to cut across rock points and open rock gorges there. Such as Hershy noted in a paper in Amer.Geol. Vol. 12, 1893. The gorges are discussed in Monograph 38, pp. 493-496 and a table given that shows size of gorges.

The great depth of the preglacial Rock River valley is shown by a well east of the river in sec. 35, Rockford Twp. It is on a terrace 40' above the river and penetrates 285' of drift. Yet Rock River in Rockford has a limestone bed that made it feasible to being forded: hence the name Rockford.

Notes on Leighton's paper in Jour.Geol. Vol. 31, 1923

Table 1, p. 271. To show depth of leaching and thickness of loess, etc.

	Soil	Loess	Leached Till	Total Aver.
Bloomington Drift (56 borings)	1.1'	1.5'	1.1'	3.7'
Belvidere lobe (120 borings)	0.9'	1.2'	1.9'	4.0'

	Soil	Loess	Leached Till	Total Aver.
Green River lobe (119 borings)	1.2'3	3.2'	1.3'	5.7'
Iowan drift in Iowa (146 ")	1.2'	0.5'	3.5'	5.2'
Illinoian drift (150 borings)	0.9'	3.0'	4.2'	8.1'

Drainage lines within the Belvidere lobe are poorly developed. The loess is thin. A few limestone boulders are at surface. Oxidation and leaching are moderate. The Ill. Central RR cut 1/2 mile NW of Avena?? Irene?? shows 2 tills separated by a bed of fossiliferous silt with vegetal traces. Explained as due to retreat and readvance of the ice border of the same ice sheet.

Stream diversions due to the Belvidere Lobe

1. Rock River from an old course past Stilman Valley to Byron into the present course from mouth of Keshwankee River to Byron.
2. Translocation of Keshwankee River from old course past Harrisville into present gorge leading from the junction of the two forks westward past New Milford and Camp Grant. Old divide was east or east ?? of New Milford.

Oxidation is stronger outside than within the Belvidere lobe. The till is more compact and has a greater concentration of residual pebbles. The loess is thicker and rests unconformably on the till. Gumbotil??? was found in a score of places in the Illinoian but only in 2 places within and that where it underlies a fresh drift and was revealed by auger borings. One is in the NE corner of DeKalb Co. The other is in eastern Ogle Co. just north of Lat. 42°. Fig.1 on p. 268 shows gumbotil as follows:

2 under loess in northern Boone Co.
6 in Winnebago Co. east of Rock River and 4 west of Rock River and a gumbotil in SW corner of the county
10 in Stephenson Co. 8 of them south and west of Freeport and 2 north and east and a gumbotil west of Freeport about half way to the county line
1 in eastern Jo Daviess Co. near Stickton
5 in Ogle Co. east of Rock River and 6 west of the river. Of these 4 are south of Polo and Stratford and south of Lat. 42°
1 east of Oregon is north of Lat. 42°
7 gumbotil exposures in Whiteside Co. (2 in NW part, 5 east of Harris) Morrison)
8 gumbotils exposures in Carroll Co.
7 gumbotils in southeastern Henry Co. and one in NW part

3 gumbotils in Rock Island Co. and one in Scott Co, Iowa.
1 exposure in SW part of Bureau Co. 2 in Peoria Co.
4 in Stark Co.

Outside the Belvidere lobe there is a basal clay 1½-4' thick under a looser textured yellow loess. This clay has manganese pellets. 150 borings outside the Belvidere drift show 3.9' of leached soil and loess and 4.2' of leached till. Leighton favors correlating the Belvidere with the Champaign moraine (p. 274) because of similar strength and degree of modification by erosion & weathering, etc., p. 275. There is an esker 1/2 mile long a mile south of Cherry Valley running NE-SW paralleling Kishwaukee River. A larger one near Irene trends at a right angle to this SE-NW- so conforms to the radial flow of the ice lobe. Striae a mile SW of Belvidere bear north of west - p. 276. The moraine near Eldena is definite for 3 miles west of the village and for 8 miles east. The continuation may be NW from the Dixon map across Rock River NE of Sterling. This is along a strip with thin loess. The loess is thicker north of this in Lee and Whiteside Cos.

Gumbotil was noted in SE¼ sec. 33, T 21, R 10 E where there appears to be a gap in the younger drift. The morainic strip south of Green River extends from Sheffield to Geneseo. It has thin loess. South of it is a heavy loess up to 35' thick which becomes thinner southward.

For 6 miles west from the Bloomington moraine this drift laps upon the highland and has kames on its south border. Farther west it lies at lower alt. and has less expression. There is fresh till in an exposure in a ravine in south part of sec. 30, T 16, R 6 E within the belt of thick loess. It overlies a loess-like deposit. In 26 borings in the fresher drift south of Green River the soil & Loess is to 4.7'. Leached till only 1.6'. There seems to be little or no unconformity between loess and till. Such is strikingly shown south of the fresh drift strip. The average of leached till is more than 3 times as great on the Illinoian as on this strip of fresher drift.

The Lower Rapids gorge is made past Saugamon and referable to the invasion of the Green River lobe.

Leighton makes the border of the Belvidere drift run from the Bloomington moraine west of north passing 1½ miles south of Holcomb and 1½ miles west of Davis Jc. and running to Stillman Valley. It then takes a NE course and passes east of New Milford and west of Cherry Valley then NW of Belvidere and northward into Wisconsin near line of Boone and McHenry Cos. This is SE of the drumlinoid area of Boone Co., Ill. and adjacent part of Wisc., an area in which drumlins and striae bear NNW-WSW and the drumlins stand 20-30' or more above intervening sags. He considers that pre-Wisc., yet its drift seems nearly as fresh as that of the Belvidere lobe. In cuts between Roscoe and Caledonia, Leverett found a leaching of till only to depth of 2-3' and no indication of the residual concentration which Alden reports. That seems to be confined to the district west of Rock River. The cascades in Kent Creek in west part of Rockford seems favorable to post-Wisc. time rather than post-Illinoian. This seems more strikingly the case than the section of Rock River valley from the mouth of Keshwaukee River to Byron.

My map of the Rockford quadrangle has a line that I drew in June 1918 to show where the border between a very scanty loess and a more continuous and thicker loess runs. It crosses the SW part of sec. 33, Rockford and north part of secs. 29 & 30. Then runs near center of sec. 12, Winnebago Twp., then NE of sec. 21 and center of sec. 2. In Barrett Twp. it runs NW across the SW part part of sec. 35 and NE of sec. 34 and then westward across south part of sec. 28 and central part of sec. 29. It then runs north along Coolidge Creek to Pecatonica River Twps. about 2 miles west of the Rockford map???. It may run on the east side of the upland between Pecatonica and Sugar Rivers in west part of the Rockford map and keep near the east edge of the upland north of Pecatonica River in Shorland Twp. west of Racoon Cr. There is a gravelly outwash plain farther east filling the map to the Rock River valley at Rockton and then east of Rock River to Roscoe. This line skirts around a broken limestone area lying west of Rock River and south of Pecatonica River where loess is thin but it seems uncertain that the drift is

fresher than in the thicker loess area to the south and west. There seems need for further study of it. Much of it is 100-200' above Rock River - a few small areas being up to 900'.

I am now wondering if anticyclonic wind from the early Wisconsin ice swept over the district west of Rock River that has little or no loess. In which case the ice border may have been east of Rock River except perhaps at Rockford.

In Bull. 43 Illinois Geol.Surv. is a report by Bretz on the Kings quadrangle. It shows the gravelly belt NE of Stillman Valley as "Early Wisconsin Kames and Eskers" and several smaller areas as far SE as secs. 14 & 15, T 41, R 1 E (White Rock Twp.) and east to within a mile of Monroe Center?? and 1/2 mile south of Lindenwood. He has a strip west of Killbuck Cr. in sec. 1, T 42, R 1 E and others on the north and east borders of Killbuck valley in secs. 25, 35, & 36, T 43, R 1 E and sec. 31, T 43, R 2 E and sec. 6, T 41, R 2 E. There is also a winding narrow strip west of Holcomb about 2 miles long running from sec. 3, T 41, R 1 E to the SE corner of sec. 32, T 42, R 1 E.

The Wisconsin border passes about a mile north of Kings but stops it in the NE part of sec. 32, T 41, R 1 E. There is very thin drift farther east in this twp. as shown on my own map. This may be Wisconsin and he gives it the Wisconsin symbol.

He keep the Wisconsin border south of Keshwaukee River clear to the east side of the Kings map.

Leighton's NW extension of the Wisconsin from near Hidena into the district NE of Sterling which I noted on p. 100, may be merely a strip swept by anticyclonic winds outside the limits of the Wisconsin ice. This also may be true of the strip south of Green River. The ice may not have reached as far west as Genesco. The Green River lowland is covered with sand in Prophetstown quadrangle south from Rock River and for several miles farther south in Annawan quadrangle. If the Iowa lobe extended east of Mississippi River as far as Morristown??? and Round Grove, and the Illinois Early Wisconsin about to Genesco, there would have

been a very narrow intervening area. Did this drain westward into the Mississippi south of the LeClaire Rapids? Also does the general occurrence of sand under loess on the borders of the Iowa Iowan and in its pahas depend in some way ≠ on the close meeting of ice lobes in Green River lowland - so that when the Iowa Iowan ice lobe broke up its fragments were floated like ice bergs?

Probable misinterpretation by Westgate

Sept. 22, 1942 - Lewis G. Westgate of Delaware, Ohio, wrote me on Sept. 21: "I note your reference to Beech Flats (in your recent paper in Science, May 22, 1942). The flats are underlaid by silts which are also found farther south around Peebles, laminated silts, exactly like the Minford silts in the abandoned Calif. valley in the line of old Kanawha northward drainage east of the Scioto, I take it preglacial certainly pre-Illinoian. I suppose they all belong to the same system".

This impresses me as a doubtful kind of interpretation on Westgate's part. The Beech Flats seem to have silt over the Illinoian drift thus tying them to that glaciation with its obstruction of the Ohio near Cincinnati.

From Ninth Ann. Rept. Minn.Geol.Survey for 1880.

Low Water of Mississippi River:	Hastings, Minn.	670.5'	
	Winona, Minn.	639.9'	
	LaCrosse, Wis.	626.3'	
	McGregor, Iowa	615.9	H W 634'
In Minnesota River:	Carver, Minn.	699	L.W.
	Belle Plaine	718	L.W.
	Lebudur?[illegible]	735	L.W.
	Mankato (Blue Earth R.)	756	L.W. 774' H.W.
	Minnesota R.	748	
In Big Sioux River:	Sioux Falls	1355'	below falls
	Dell Rapids	1458'	
	Near Sioux Falls Jc.	1479'	
	Flandreau	1501'	
Pilot Mound, Hancock Co., Iowa, about		1425	
Hills west of Spirit Lake		1475-1525	
Hills in northeastern Osceola Co. up to		1675	
Coteau du Missouri at US & Canada line up to		2200'	

Record of well at St. Vincent, Minn., Ninth Ann. Rept. p. 168.

1.	Filling	5'
2.	Alluvium	3'
3.	Pale clayey marl compact and uniform, no water	112'
4.	Limestone concrete with water-worn pebbles, soft easy to drill	15'
5.	Pebbles and sand, some flint?? interspersed	10'
6.	Clay, compact, blue	4'
7.	Sand, very loose; mixed with pebbles, containing water flowing to top of pipe, very salt and unfit for use	16'
	Total	165'

On p. 249 it is stated that Andreas Atlas? shows 3759 lakes of all sizes in Minnesota. Of these 2467 are 1/2 mile or longer and 1292 less than 1/2 mile long. A table gives the number in each county. Kandiyohi has the largest number - 286

Ottertail	273
Wright	259
Cass	206
Stearns	207
Becker	172
Douglas	156
Meeker	121

Houston and Wilkins each have only one lake over 1/2 mile long. No lakes are shown for Pipestone, Rock, Olmsted, Owsley, Marshall Cos. Three classes of lakes (1) Drift Lakes. (2) Fluviatila. (3) Rock basins.

The fluviatile include Lake Popin, Big Stone, and Lake Traverse which are boundary lakes with other States. There are also lakes forming part of Canada and United States boundaries. Some of these may be of Rock Basin class.

Notes on reports by Shaw and Trowbridge on Elizabeth Galena, Illinois quadrangles

In Bull. 26, Ill.Geol.Surv., Trowbridge and Shaw describe drift in the Galena and Elizabeth Ills. quadrangles. In the lower end of Apple River in the Galena area there is Kansan or Nebraska drift extending about 1½ mi. west from Hanover and limited to levels below 800' or 150' below bordering upland. It is deeply weathered compared with the Ill. drift so is surely as old as Kansan stage of glaciation. Boulders up to 2½' in diameter are present but it is mainly of cobblestone size. It is mixed into the red residuary surface clay so is somewhat different from ordinary till. There is also a predominance of local rocks over the erratic crystalline rocks, dolomite, syenite porphyry, quartzite, basalt, and 2 kinds of granite were noted. The occurrence is patchy. Search in adjacent valleys failed to reveal any other occurrence of this old drift. The Ill. drift is present within the Elizabeth quad. from So.Fork in sec. 15, T28, R4E, about 5 miles No. of Stockton, So. past Stockton into secs. 13 & 14, T27, R4E, and boulders are conspicuous in secs. 19,30, T27, R5E, in the Lena quad. west of Ward's Grove ridge

Leverett's Notes - Book 300

Page 107

There are a few erratic pebbles along Hammond Branch in sections 13, 14, 23 and 26, and along Plum River in sections 25, 26, 35 and 36, T.27,R.4E., and a conspicuous amount in section 3, T.26,R.4E., above the junction of Middle Fork and Plum River a mile NE of Edmonville. The deposit is shown in Photo. It is a cobbly material several feet thick. In the bed of Plum River in section 3 several feet thick /// boulders 2-3 feet or more in diameter were noted. Erratics are numerous along Plum River above here, into the Lena quadrangle.

The glacial deposits in the Galena and Elizabeth quadrangles are also discussed in Folio 200, U.S.G.S. "The Galena and Elizabeth quadrangles", by the same writers (Trowbridge and Shaw)

From Report by Hubbell, Roth and Clark, Jan. 23, 1943.

Surface and rock elevations near Ypsilanti, Ann Arbor in Huron Valley and tributary drainage about 845 feet for bed rock surface.

At west limits of Willow Run town site 600'
At Ypsilanti waterworks 590'
East limits of Willow Run site, 542 to 582'
At D[illegible] ? 575 feet.
In vicinity of Bomber Plant Works, at 552-605
East from the Bomber Plant about 560'
Construction work at the Bomber Plant shows;
Delta deposits 17-21 feet.
Clay surface at about 700 feet with nearly level top
Wells near Rawsonville at altitude 670' show about 100 feet of drift and footing foundation for the Bomber Plant. The altitude near by is 690'
These being a Huron River terrace at 670 feet.
Ford Lake above the Rawsonville dam is about 645 feet, and this banks up to SE part of Ypsilanti near the waterworks where rock is struck at 590'

Bedrock at and below Ypsilanti, Michigan.

Tilting of Shore Lines on West Side of Saginaw Basin

Tilting of shore lines on west side of Saginaw Bay, as shown by maps between Lat. 43° and Lat. 43° 45'. The First Saginaw rises 10' from 735-40 to 750' at Lat. 43° 15' and 10' more to 760' in Lat. 43° 30' and 35' more in Lat. 43° 45', or 55-60' in 50 miles.

The highest Arkona rises from 725 in Lat. 43° 05' to 730' in Lat. 43° 15' and to 745' in Lat. 43° 30', and 775 in Lat. 43° 45' or 50' in 47 miles. It thus nearly parallels the First Saginaw beach.

But the Lake Warren beach keeps at 680' as far north as Lat. 43° 15' and only rises to 690' at 43° 30'. It rises 15' more to 705' near Lat. 43° 45'. The total rise is thus 25' whereas the First Saginaw and highest Arkona rise over 50'. This difference plainly puts considerable uplift in pre-Warren time.

Between the Arkona and Warren there is a second Saginaw shore line which is about 20' above the highest Warren. The Warren westward outlet is thought to have followed a Wayne eastward discharge on south side of the Ontario basin.

These notes are made in June 1943 at the time Prof. Donald G. MacLachlan is doing field work on the shore lines west of Saginaw Bay.