

**Open File Report LIIA
FIELD NOTES OF FRANK LEVERETT**

Notebook No. 272 - Leverett

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Book No. 272

Frank Leverett's notes on the Flint, Burt, Durand Atlas Sheets dated October 30, 1919.

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October 30, 1919 – Flushing, Michigan

Delta of Flint River in Lake Saginaw

I took auto-bus to Flint. There is a plain of sandy gravel in Sec. 26 and SW part of 25, but a short distance east of the forks of road on line of Secs. 25 and 36, Flushing Township, till and boulders set in an old channel. The soil map, however, has this mapped the same as the plain of sandy gravel "FG". The clay plain has a level surface clear through to the valley of Flint River, Sec. 36 and 31, Mt. Morris Township. It is 727' at the range line while the gravel is about 740' A.T. The channel bed a mile east is 726'.

Till Plain and Moraine in Mt. Morris Township

We continued east on till plain to middle of line of Secs. 26 and 35, Mt. Morris Township. It has a few boulders. The swells, so far as noted, are all less than 10', and usually not more than 5 to 6' above general level. We went south through Sec. 35 and then east to the Michigan Electric Railroad at the township corner. There is moraine only for one-half to three-quarters mile west of here, the west part of Sec. 36 being till plain and NW of Sec. 1.

I went to Davidson on Grand Trunk Railroad and spent afternoon in tracing contours and getting altitudes on Mr. Sadler's field sheet of the Burt quadrangle.

Features in Southeast Corner of Burt Quadrangle

The channel crossed by the Grand Trunk Railroad west of Flushing near SE corner of the Burt quadrangle barely catches 755' contour at the railway. Mr. Sadler is not certain this is the summit, but as there is an unchanneled flat here he thinks it must be. About one half mile north a definite post glacial stream channel is cut in this valley bottom and it descends 15' in a mile NW. The plain of the old valley floor also descends 10' or more in this mile. I am surprised to find that some of the gravelly land just north of Flushing is higher than till east of it. It catches 740' contour in places. The south bluff one half mile south of business part of Flushing on line of Secs. 34 and 35 reaches 745'. Much of Sec. 34 and the NE part of Sec. 35, Flushing, are below 735' contour and likely to have been covered by Lake Saginaw.

The gravel bars noted yesterday in west section of Flint River a mile NW of Flushing each catch the 720' contour and air part of the delta of Flint River.° There is very little projection of the 715' contour to the north, but the 710' extends one half mile north of the 715' or nearly to the NE corner Sec. 21.

Border of Lake Saginaw, and Delta of Flint River In Lake Saginaw Near Flushing

The 700' and 690' also have northward protrusions on west side of Flint River. The 700' reaching into central part of Sec. 10, and the 690' to Brant Creek Station. The 700' protrudes north on the east side of Flint River nearly to north side Sec. 2. The sandy bar in Secs. 13 and 24 that I noted a few days ago catches 735' contour, but is mainly between 730' and 735'. A ridge on EW road in south part Sec. 24 also catches 735', and so does one in NE part of Sec. 25. The high plain in SW part Sec. 25 that I crossed this morning also reaches 735', but the bouldery land in SE part Sec. 25 is below 730'. Lake Saginaw seems to have extended SE over it to the center of Sec. 31, Mt. Morris Township. (It was found later to reach the west part of Sec. 33.) There are only two small spots of a few acres each in Sec. 31 that rise above 745', lying east of the center. In Sec. 32 only the south part of SW¼ and east part of NE¼ are above 745'. In Mt. Morris Township, Lake Saginaw may have reached about to the 745' contour in Secs. 17, 20, and 29, as noted a few days ago. It seems to have extended up Flint River Valley as far as Sec. 4, Flint Township, and covered most of Sec. 5 and NE of Sec. 6, Flint Township. Yet bars of Lake Saginaw occur close to the river as far down as Sec. 22, Flushing Township. See the contours drawn on the map of Burt quadrangle prepared by Leverett in November 1919.

Glacial Lake Features In West Part of Burt Quadrangle

I sketched in contours on the Owosso soil map in Hazelton Township, Shiawassee County, that aid in showing extent of Lake Saginaw and Lake Arkona. The bar of Lake Saginaw in NE part Sec. 26 is above 740' contour, but in Sec. 24 the highest contour caught by the Lake Saginaw shore is 735'. It may, however, almost reach 740', for to the east of lines of Secs. 18 and 19, Flushing Township, it does reach 740' contour and is not much higher. The bar I noted in NW part of Sec. 24, Hazelton, is along 725' contour and this is highest Arkona. So, also, is the sandy, pebbly deposit near east end of line of Secs. 21 and 28, Hazelton, on west side of a bay of Lake Arkona that I noted October 28. The 725' contour protrudes north one quarter mile into Sec. 21 on this strip. The limits of Lake Arkona in this bay seem to have been in east part Sec. 28, south part Sec. 27, and west part Sec. 26, Hazelton Township. Lake Saginaw extended a mile or more further and covered NE half of Sec. 33, all of Sec. 34, and perhaps all of Sec. 35 for it caught the 740' contour in NE part of Sec. 35, and that runs south in east part of Sec. 35. It may extend to this contour in Venice Township as I noted a very flat surface in north part of Sec. 10, which I find I s just below 740'. Projections of the 735' contour in NW part of Sec. 3, Venice, and in SE of Sec. 33, Hazelton, seem likely to be due to Lake Saginaw and [mark wash] wave work on

west side of this bay. Probably nearly all of Secs. 2 and 3, Venice Township, the north edge of Sec. 10, and the NE corner Sec. 9, and part of Sec. 4 fall inside Lake Saginaw limits. This bay thus had an extension four miles south of the limits of the lake near Shiawassee and Genesee County line, but the bay at the Arkona stage had only about two miles depth in Hazelton Township. The Lake Warren bar that I noted in SE part Sec. 36, Maple Grove Township, catches 675' contour and a light ridge in SE of Sec. 35 is also above 675' contour. Probably nearly 680' as the flat south of it in SE corner Sec. 35 is 677'. The 690' gravelly strip that I traced ESE from a school house into NW part of Sec. 34, Maple Grove, probably runs south near center of the section for the entire east side is too low. The SE corner being only 685'. The Lake Warren shore that I noted October 28 in NE part Sec. 28, Maple Grove, is at the 680' contour, so I traced this contour on the map SE across Sec. 27, and NE corner of Sec. 34, and SW of Sec. 35 to the creek on north edge of Sec. 2, Hazelton. I now recall a slight sandy coating at a dwelling house in north part Sec. 2 about where this contour runs. The contour runs eastward across NE quarter Sec. 2 and north part of Sec. 1, Hazelton, to where I noticed yesterday a distinct shore on the county line of Shiawassee and Genesee about a quarter mile south from the SE corner of Maple Grove Township, Saginaw County.

I find this 660' contour catches the bar NE of Laytons Corner in NW¼ Sec. 15, Maple Grove. It runs just south of the road I traveled when going in to Laytons Corner from the county line westward 2¼ miles and then strike NW across Sec. 15 and passes ¾ mile north of Laytons Corner. Some of the gravelly wash noticed one half mile north of Laytons Corners is a little above this contour. The contours show a rather rapid rise from 655' to 675' in the part of Montrose Township west of Flint River, the rise being made in but little more than a mile. There is then scarcely any rise for a mile or more from the 675' to the SE and south. It is in this flat area the pebbly sand occurs that I traversed on line of Secs. 31 and 32, 29 and 30, Montrose. On the Grand Trunk Railroad south of Montrose the space between 675' and 680' contour is 2¼ miles and the altitude is only 682' three miles south of Montrose at SW corner of Sec. 33.

There is a similar rapid rise in SE Albee Township from 615' to 630' contour in Secs. 25, 26, and 35, and a very flat tract for one to two miles SE and south. A similar rise occurs on line of Secs. 19 and 30. In the first two areas there is sandy land, but the underlying till may cause the rise and possibly these are ice border features – where a bank rather than ridge marks the ice edge – it hardly seems likely that lake action was strong enough to cut back and steepen the slope in this way. In fact it does not look like wave work. The space of nearly a mile in a rise of 15-20' is more like a moraine slope than a shore.

Delta of Flint River is Lake Saginaw Near Flushing

October 31, 1919 - Flushing, Michigan.

I go north and on reaching top of Flint River bluff I find a gravelly bar with several feet of gravel resting on till. The till surface is about 725' and the bar catches 730' contour. The bar trends WNW-ESE and is ½ mile long. The west end being where the bluff turns north in east part Sec. 27.

A bar about 100 rods north of this is 735' where it crosses line of Secs. 26 and 27.

I went east to center of Sec. 26, crossing a small bar that runs NW from the cemetery and catches 730' contour.

On turning north in Sec. 26 I cross the high bar that catches 740' contour. This and the others have more pebbles than the swales between and may be termed gravelly deposits rather than sand or pebbly sand. The bar runs NNW into west part SW¼ Sec. 23 and is about 735' in that section. A higher bar east of it in Sec. 23 catches 740' contour. There is east of it a gravelly plain sloping down to 730' contour. East of this is a swale with a till subsoil and black mucky soil. It seems to have been a line of drainage through this delta like gravelly area. It is nearly ½ mile wide. East of it in Sec. 24 there is another area of gravelly bars, the highest of which are 735'. One is on the E-W road in south park. It is rather uneven in height but is of gravel laid down like the smoother bars.

There is a channel with till under it on south side of this bar in south edge of Sec. 24 and north of Sec. 25. It connects one east of here in Sec. 30, Mt. Morris, with the one west of here above noted in west part Sec. 24 and east part Sec. 23.

A channel follows the east side of this gravelly area in east part of Sec. 24. It has a gravel bar that catches 725' contour, and a gravel pit in it shows it was formed by a north flowing stream. The dip of beds being very marked to the north in lower part like foreset beds, while the top layers are nearly horizontal. The main channel east of this bar is nearly ½ miles wide. The U.S.G.S. altitude on it at NE corner Sec. 24 is 716.8. There is a deposit of pebbly washed material two to five feet deep on the border of the channel exposed by roadside ditches in north part of line of Secs. 19 and 24. This is about 720'. There is till under it at 715' or more.

Shore of Lake Saginaw

I went into Secs. 29 and 20, Mt. Morris, on the east side of this large channel and found some small gravelly bars there up to 740-45'. One 745' area (see contour) has a thin coating over it's south end in west part of Sec. 29, and a bar of sandy gravel running north from it into SW part of Sec. 20, Mt. Morris Township. There is a sandy land east of this bar nearly to south end of the 745' area in NW part of Sec. 29, but the highest land in this 745' area is not coated with gravelly material. There is a

slightly sandy ridge just west of it near line of Sec. 28 and 29, and a better defined ridge on E-W road in west part SW¼ Sec. 20 about twenty rods from west line. This is nearly 745'. There are two slightly gravelly ridges with N-S trend in east half of SE¼ Sec. 19 that are about 740'. They are distinctly visible for 40 – 50 rods both north and south of the E-W road. I am on one in SE¼ Sec. 19. There is another slight ridge of cobbly material along east bank of the broad channel in SW¼ Sec. 19 not far from N-S quarter line. It is east of the 725' contour and slightly above it, possibly nearly 730'. There is thus a difference of about 15' in the altitude of the several weak ridges in Secs. 19 and 20 east of this channel or from 730' up to 745'.

Delta Gravel

I also visited the gravelly area, or gravel capped till area in SW part of Sec. 30, Mt. Morris Township, and found that the gravel deposit is several feet thick in the highest part which reaches 745' contour. There is a gravel pit in the east end of this gravelly area in SE part of SW¼ of Sec. 30 that is 10' deep and extends down to about 730'. The highest part of the till at west end of this area seems to be fully 735'.

Delta Material In Bars

It now seems likely that the east limit of Lake Saginaw is near the 745' contour in central and SW part Mt. Morris Township in Secs. 16, 17, 20, 29, 32 and 33. I did not go into Secs. 31 and 32 today but they are largely below 740', so are likely to have been covered by the water of Lake Saginaw or of the glacial river which came in where Flint River now does, and brought in much of the gravel in the bars I have been examining this morning. I finished inspection of the bars in Secs. 24 and 13, Flushing Township.

Delta With Age of Arkona Deposits

I found the Arkona beach doubling around the Saginaw gravel area in SW part of Sec. 13 and north part of Sec. 24. It is fully 725' and possibly 730' here. The large gravelly bar east of the channel on the town line at corners of Secs. 12 and 13, Flushing Township, and 7 and 18 Mt. Morris, and area adjacent is apparently Arkona and it reaches 735' but is mainly below 730' and 735'. It is 10' or more below the highest Saginaw level.

Arkona Levels In Vienna Township

In Vienna Township from Sec. 33 northeastward the highest Arkona beach is above 735' and it is above 740' east of Clio in Secs. 13 and 14, Vienna Township, one point being 745' there. The general lake level, however, seems to be nearer than 740' contour in eastern Vienna Township while Lake Saginaw there stood near the 750' contour. There is thus a rise of about 15' in the beaches from southern Hazelton Township, Shiawassee County to eastern Vienna Township, Genesee County. That is, Saginaw from 735' to 750', Arkona from 725' to 740'.

Saginaw and Arkona Beaches

I went north in Sec. 13 and found a pebbly deposit over the till to depth of one or two feet up to six or eight feet. In places boulders are visible but generally they are covered so as to only show in ditches. The land is fair farm land in Secs. 13 and 12 but becomes lighter, sandier soil in Sec. 2 and west part of Sec. 1, Flushing Township.

Soil Data

I took dinner with George Leonard in SW part of Sec. 1 and he says all of Sec. 2 is light sand soil, so crops suffer in time of drouth. The east part of Sec. 1 has till at the surface and so has the district to the east in central and south part of Sec. 6 and in Sec. 7. The north part of Sec. 6 has bars of sandy gravel of the Saginaw and the Arkona beaches, and gravel of the Saginaw extends into Sec. 5 as noted a few days ago. There are glacial knolls along line of Vienna and Mt. Morris Townships in Secs. 31 and 32, and Secs. 5 and 6 which are veneered with gravel or in some cases have gravel on their slopes.

Gravelly Knolls of Glacial Derivation

The altitude of these knolls is from 730' to 750'. I see no definite westward continuation. There is an abrupt drop to about 715' in west part of the line of Secs. 31 and Sec. 6. The town corners has a U.S.G.S. B.M. 714' and the same altitude ¼ mile south.

Saginaw and Arkona Shore Lines West of Clio

I noted four well defined beach ridges crossing the line of Vienna and Mt. Morris Townships in 1¼ mile east from the town corners. They all bear NE-SW and they die out in Sec. 6 in a lower tract than the moraine strip on the town line. They embrace the Saginaw beach and the First and Second Arkona. The Saginaw is the easternmost one. The Arkona embrace three west of it. None of these ridges are so strong on passing NE into Vienna Township. They seem to be strong only in the exposed situation at the west end of this moraine. In Sec. 32 the glacial knolls are more prominent than the shore features and have gravelly deposits only in their NW slope. I went north on line of Secs. 31 and 32 crossing a till knoll 8' to 10' high with the Arkona gravel on it's north slope. There is a lower Arkona beach that crosses the line of Secs. 30 and 31 about 80 rods from the east end and the line of Secs. 29 and 30 a similar distance from the south end. This runs NE across Sec. 29 and SE corner of Sec. 20, and through center of Sec. 21, and connects with the Second Arkona beach in west edge of Clio in Sec. 22. It is 718' where crossed by line of Secs. 21 and 22. The Second Arkona passes just west of the corner of Secs. 21, 22, 27 and 28 and is 725'. The U.S.G.S. bench mark at this corner is 723' and is about 2' lower than the beach. This Arkona beach is rather faint and is interrupted by gaps in Secs. 28 and 32. It passes just west of the corner of Secs. 28, 29, 32 and 33, Vienna Township. The First Arkona

crosses the line of Secs. 27 and 28 near quarter post and is 735' there and in places in north part Sec. 33, Vienna Township.

Distribution of Sandy and Clay Land East of Montrose

I took road west from Clio to Montrose. It is near the 700' contour for two miles in north part Secs. 21 and 20 and south of Sec. 17, Vienna Township. There is a definite shore at about 700' that runs as far west as east part of Sec. 19 where it comes to east fork of Brent Run. I did not examine further SW to see if it continues to Flint River. There is a lower beach in Sec. 17 running west from Pine Run past the dwelling in east part of the section and dying out near the west side of the section. It is distinctly visible across Sec. 17 from the road on the south line. It probably is about 685' for the 680' contour as sketched in from Mr. Sadler's field map lies ½ mile further north. The soil map represents a sandy area north from this shore line and till south of it (symbol ML for till area).

There is very flat sandy land in Secs. 18 and 19, 13 and 24, Montrose, along this road, but farmers tell me the area marked "C" on the soil map in Secs. 4, 5, 6, 7, 8, 17 and 18, Vienna, and Secs. 1, 2, 3, 10, 11, 12, and north part of Secs. 13 and 14, Montrose, are good farm land with clay subsoil and some clay soil, there being a very slight sand coating. Areas marked "MC" and "ML" in north part of Sec. 24, Montrose, have a black sand with a till subsoil. Further west the "MC" has till soil in south part Sec. 14 and north part Sec. 23. This area is close to the 680' contour, but I see no sign of the shore of Lake Warren here on east side of Flint River. The surface is very flat so wave action may have been weak. The altitude at line of Montrose and Vienna Townships corner Secs. 13 and 24, 18 and 19, is 687.5 on ground. The bench mark is 689.4 but is up on a telephone pole two feet. The area marked "F" on soil map in Secs. 15, 16, 21 and 22, on each side Flint River is ordinary till. This has a light sandy coating west of the river in Montrose village. The lightest sand I have passed between Clio and Montrose is flat surfaced and pebbly and a water deposit. No drifting into dunes seems to have occurred along the line I came into Montrose. I took evening train to Flushing.

Features Near Flushing

November 1, 1919, Flushing, Michigan.

I went to the high land that catches 740' contour on south bluff of Flint River opposite Flushing and find it a smooth till tract with scarcely any sandy coating. It may have been covered by Lake Saginaw waters but to very slight depth. Lower land to the west has some sandy coating but so, also, has land SW of here that is 760' or more, so it is not an easy matter here to find the lake limits. Probably they are a mile or more south where undulating land sets in at 745' to 750'.

Well Data

Well at road forks one mile south of Flushing for village of Flushing drilled by Caster Bros.

Top sand and gravel	15 feet
Blue till (soft)	30 "
Hardpan till	16 "
Sandstone	4 "
Light sandy shale (gray)	40 "
Dark shale	50 "
Light sandy shale	4 "
Dark shale	20 "
Present depth	<u>190 feet</u>

A well less than ½ mile NE penetrated several times as much sandstone as this and got a supply from it at about 75' to 80' depth. Sandstone outcrops in the bed of Flint River by this well at a level about 60' lower. The well is 735' A.T. A well drilled near the bridge in Flushing got into salt water at 140'. It is on ground about 680' A.T.

Features SE of Flushing

I went up the south side of Flint River following line of Flushing and Clayton Townships east from SE corner Sec. 34, Flushing. The flat till occupies north parts of Secs. 1, 2 and 3, Clayton, but the south part of these sections is higher than Lake Saginaw and undulating. The lake limit may be at edge of the undulating land on line of Secs. 1 and 2 at 60 to 80 rods from the north end. There is low land further south both to east and west of this line and ravines cut up the surface badly. The surface is cut up also further west. Some of the inequality is glacial topography and some post glacial erosion. The latter is usually marked by definite steep sided bluffs while glacial swales have gentler slope.

Features Near Flint River Below Flint

There is scarcely any sandy coating on the till on plains or on slopes. That marked on soil map around corners of Secs. 35 and 36, Flushing, and 1 and 2, Clayton, is a very thin coating. It is below 740' contours so may be due to Saginaw waters.

The altitude along the diagonal NW-SE road in Sec. 6, Flint, seems to be below 740' and I did not trace the contour across this section when at Davison. There are only two small areas in south part of Sec. 36 that reach 740' contour. The SW corner Sec. 6 is marked 750' and it looks but little higher there than along this road in Sec. 6. A high point in Sec. 7 that reaches 800' contour is plainly visible from this road.

Much of Sec. 8 is in the valley that runs NW from Swartz Creek to Flint River. It is almost 725' here at line of Secs. 5 and 8 and has a thin sand deposit of yellow color on it's bed. The SW part of Sec. 8 is above reach of Saginaw waters or of the glacial drainage into Lake Saginaw. I crossed Flint River on the bridge in Sec. 4 and went directly north across fields to the upland plain. It has till on face of north bluff of Flint River clear to the top. There is a flat upland on line of Mt. Morris and Flint Townships from about 80 rods from west end of line of

Sec. 33 and Sec. 4 eastward into Flint in Sec. 36, Mt. Morris, and Sec. 1, Flint, where a definite moraine sets in. There are a few gentle swells in Secs. 34 and 35, Mt. Morris, and in Sec. 2, Flint, but it can all be classed as till plain.

Gravelly Delta of Flint River Near Flushing

I went west on the township line of Mt. Morris and Flint crossing the valley that leaves Flint River in Sec. 4 and runs NW through the gravelly delta or near its east edge in Secs. 32, 29, 30, 19 and 18, Mt. Morris. It is about 725' where uneroded by post glacial streams. West of it is a very gravelly delta standing about 745' on highest part. It is highest in a chain of bars along west bluff of this channel which starts in NE part of Sec. 5 and runs toward center of Sec. 32. The gravel coating becomes thin near the N-S road in Sec. 32 and the till has only a slight coating of sandy and cobbly material. In some fields cobbly stones are very conspicuous. Thin [The?] gravel occurs in two bars in Sec. 31, one being east of center section and the other about 100 rods south of it on north side of angling road. The north one catches 745' contour. It has a relief of only 3-4', so the till surface in that vicinity is fully 740'. It is 740' in south part of SW¼ Sec. 32. This till area stands 10' to 15' above a plain west of it in west part of Sec. 31 and adjoining parts of Secs. 30, 25 and 36. The B.M. in this plain is 727' at the section corners. The quarter post ½ mile east is 737.2. It is on a gravelly bar that rises NW to 745' contour. In the SW part of Sec. 25 the till rises above 730' contour and there is only a very thin cobbly coating on the slope. The gravel deposit occurs where the altitude is above 735' and is deep enough so gravel pits are opened in it along bluff of Flint River to depths of 7' to 8'. The well record given above (page 13) shows 15' there at east side SE¼ Sec. 26 on north side of road leading into Flushing.

Features North of Flushing

From Flushing I went north three miles on line Secs. 28 and 27, 22 and 25, 14 and 15, Flushing Township. I find till between the gravel bars as far as SE part Sec. 22, but further north there is poor sandy land in draws as well as on ridges. Part of the line of Secs. 14 and 15 is on a terrace of Flint River below 700'. The area marked "MC" in Sec. 14 and south part of Sec. 11 is till plain with very little sandy coating. Boulders occur and are piled in fields. I find bouldery till south along nearly entire length N-S¼ line road in Sec. 14. The till surface in these Secs. is 725' or slightly more. In Sec. 14 it is below the 725' contour. Gravelly bars in that section that are 5' to 6' above the till catch the 725' contour.

I took auto bus to Flint from Flushing at 11:30 a.m. I took train on Pere Marquette R.R. from Flint To Plymouth at 2:00 p.m. It runs along an esker (which has been largely used up for road ballast) for three miles or more. There are a few knolls in Sec. 33, Flint, and from this area there is a till plain almost to GrandBlanc where moraine topography occurs. The surface is more

undulating south from this village than north and has basins and occasional small lakes. The district south from Genesee County I studied and mapped in some detail years ago, but I did very little field work then in Genesee County.

Imlay Outlet Near Corunna

November 11, 1919

I took train on Ann Arbor Railroad from Ann Arbor to Elsie. This railroad is in the Imlay Outlet at Vernon the track at depot being not more than two or three feet above the bed of the outlet (see notebook page 52). Between Vernon and Corunna a moraine is crossed that lies north of the Imlay Outlet and its inner or north edge followed by Corunna. A flat tract lies north of this moraine that is utilized by the Shiawassee River. It seems to be a glacial drainage channel lying outside the weak Owosso moraine. The stronger moraine south of this channel passes through south edge of Corunna and Owosso, its inner border at Corunna being only 40 rods south of the depot, and the railroad skirts it closely west from Corunna about to limits of Owosso. The depot at Owosso is fully ½ mile north of the inner border of the moraine.

Delta of Imlay Outlet at Duplain

From Elsie I traced the highest shore SW to Duplain on east side of Maple River Valley. I find it catches the 735' contour and nearly reaches 740'. In fact at Duplain gravel and cobble form a thin coating on the moraine up to over 745', but as a rule there is no pebbly concentrate marking shore section so high as 740' contour. The concentrate of pebbly material on ridges as well as on slopes where ridges rise above the shore is a very marked feature from the west side of Sec. 23 SW to Duplain. The area catching 730' contour in east part Sec. 22 and that catching 735' contour SE of center of Sec. 22 carry a thin coating of gravelly material one to three feet or less, so that boulders are not entirely concealed by it. The lower ground south of these gravel coated strips are not coated with gravel but has clayey till soil. There is a beach of sandy gravel at 725' along the angling road in south part of NW¼ Sec. 22. The gravel that stands above 730' in west part SW¼ Sec. 22 has a cobbly pebbly coating on till but there is no such deposit on the ridge at the SW corner Sec. 22 that catch 730'. The stream is about 40 to 50 rods farther east and runs SW across NW part of Sec. 27 to a residence standing between 730' and 735' contours. It then follows the line of Secs. 27 and 28 southward nearly to quarter post. It is strongly developed SW of there on the slope of the moraine and its deposits are fully up to the 735' contour and almost reach 740' contour. There was a bay like extension into north part of Sec. 33 but this has a heavy mucky soil.

Moraine ? Features Near Elsie

The gravelly deposit sets in west of it between 735 and 740' contours and rises above 740' contour near Duplain in east part of line of Secs. 29 and 32, Duplain Township. In Duplain it covers the area that catches the 745' contour thinly [for] and I see boulders imbedded in it. There is a depression south of this that is gravel coated between 740' and 745' contour. There is very little gravel on the till in north edge of Duplain at and below 735' contour. This seems to be the abrupt terminus of a moraine which drops with[in?] the village limits from 745' to less than 725'. The moraine reaches 760' contour within ½ mile SE of Duplain. I have not, as yet, found the line of westward continuation of this moraine. At one time I thought it might be found in the one at Eureka, but it now seems quite as probable the Eureka moraine is continued eastward and forms the divide between streams that flow north into Maple River and those flowing SE[?] and which traverse Secs. 19, 20, 17, 16, 15, and 10, Duplain Township, and may form the nucleus of the ridge on which Elsie stands. The till under Elsie being up to about 725' where the bar is 735' or more. In that case the moraine that terminates at Duplain is earlier than the Eureka moraine. The suggested eastward continuation of Eureka moraine along the divide in Duplain Township is supported not only by its being a divide, but is more thickly boulder strewn than land north or south. In places also it has a definite outer border relief that takes two contours as in north part of Secs. 20 and 21. On my return from Duplain to Elsie I came to this from the south on line of Secs. 20 and 21, and was more impressed than formerly by it, though I noted it in my last trip a few weeks ago when going west on line of Secs. 16 and 21, 17 and 20, Duplain. I found a cobbly, pebbly strip and very faint rise at 720' contour at line of Secs. 16 and 17, and another at 715' contour in south part of Secs. 8 and 9, Duplain. This 715' shore seems to run WSW across north part of NW¼ Sec. 17 and continues into Sec. 18 to cause the westward protrusions of 715' contour.

Lake Features South of Elsie

In the district directly south of the Elsie bar I found a sandy pebbly coating as far as the first creek. There is till exposed between the creeks with gravel setting in a short distance east of the road, and forming a heavy deposit on the ridge in south part of Sec. 13, Duplain Township. There is a thin coating of gravel along south part of line of Secs. 13 and 14 on line of Secs. 23 and 24 from the 715' contour south till is at surface and lake deposits very meager clear to the moraine at corner Secs. 23 and 24, 25 and 26. There is a faint notch near the 730' contour near south end of line Secs. 23 and 24, but the moraine ridge that here catches 730' contour has no gravel on it. The shore action on the slope of the moraine south of Wise Creek in Sec. 23 is very faint and shore deposits meager.

Moraine Features East of Duplain

This seems not to have been so strongly acted upon by wave action as the exposed prominences in Secs. 22 and 28. The moraine in Sec. 23, though very weak in expression, has many boulders, so these are large pits in fields. The north half of Sec. 26 except Bradshaw Hill in NW corner is a plain of clayey till. The south half has a narrow moraine strip scarcely $\frac{1}{4}$ mile wide crossing it with crest 760-765'. Bradshaw Hill has a very steep sided place in its north slope, as steep as if a gravel pit has been excavated in it, but there has not been any excavation. A boggy depression of a few rods diameter and 3-5' lower than the rim stands at the base of this steep place. The hill is a Kame and contains some gravel but has no large pits opened. I am inclined to think this steep place is an ice-contact face and the Kame was built outside like an Alluvial cone, where streams emerged from the ice. The base of this hill is 750' and it is fully 30' high. It catches 780' contour.

Lake Features

Today's work on the highest shore line SW of Elsie confirms by suspicion that there is a higher shore line from Shiawassee Valley west than there is east. So in calculating differential uplift and drawing isobases across the Saginaw Basin it will be necessary to make sure one has the same shore at each end of the isobase. For example: The shore west of North Star at 750' may be a higher shore than the one near Clio at 750'. The extent of this highest shore that appears only west of Shiawassee Valley has not been worked out yet on the west side of the basin north from the Grand River outlet. Possibly it is found only south of the outlet in the Elsie and Perrinton quadrangles and that the Eureka moraine with continuation eastward to Elsie marks the ice border with which this highest lake level correlates.

Tilting of the Shore Lines

This highest shore ought to have at least as much northward rise as the Second Arkona and that is 15-50" per mile between Pompeii and North Star. So if the highest shore west of North Star is 750' (as is the case) it should be not more than 740' west of Pompeii, or scarcely any higher than at Duplain. It seems that the tilting affected country further south than either Pompeii or Duplain, so any tract near Pompeii should be higher than its correlative beach as far south as Duplain.

Drain and Swampy Channel

In the Flint quadrangle there may be similar complication. The sandy bar at 767' $2\frac{1}{2}$ miles west of Mt. Morris, and that at fully 770' at Mt. Morris Cemetery may pertain to a very narrow strip of water between the Flint moraine and an ice border inside the moraine. It may have the same level as the Kersley Lake had at this time and may have discharged westward along the ice border and eventually reached either the Imlay Outlet or one further north. Perhaps the long swamp that leads

SW from the west part of the Chesaning quadrangle across the SE part of the Elsie quadrangle and enters the Imlay Outlet 2 miles east of Ovid was a line of discharge. It may have received a large accession of water from the melting ice sheet. Its summit level is only 743' with whatever peaty growth it carries.

The Caledonia drains in the SE part of the Chesaning quadrangle is in a channel that seems to have been a line of glacial discharge and perhaps of glacial lake waters in a small border or fringing lake next to the ice. The summit near range line of Venice and Caledonia is about 750' and there is a muck deposit on it where I crossed on line of Venice and Caledonia Townships last August. This is far enough east to have taken water pretty directly from the Burt quadrangle if it was ponded to 767' at the sandy bar west of Mt. Morris.

Arkona Beaches Down To 700'

November 12, 1919, Elsie, Michigan

I went north from Elsie and found till between the gravel bar in which Elsie stands and first creek. There is a pebbly sandy loam between this creek and Arkona beach, but below this beach in NW part of Sec. 2 till and boulders are in the soil. There is a light pebbly coating as far down as the 700' contour. There is a pebbly sandy beach at 700-705' that crosses SE part of Sec. 35 and dies out in north part of Sec. 2. The contours indicate that this is well developed so as to control 700' contour from Sec. 35 eastward beyond the levels of the Elsie quadrangle. I traced it last August in the Chesaning quadrangle.

Warren Shore 685'

I went west on the Clinton and Gratiot County line a mile through a till tract with a few boulders. There is a weak shore line about $\frac{1}{4}$ to $\frac{1}{3}$ mile north in Sec. 34 that follows the 685 contour, but drops below it at SW part of Sec. 34. There is a slight gravelly shore about 30 rods north and west of corner of Secs. 33 and 34 Elba, and 3 and 4 Duplain Township that catches 690' contour, but it is developed for only a short distance close to Maple River. There is a bar that catches 680' contour at line of Secs. 33 and 34 south of quarter post which runs WNW to Maple River and then doubles back to the NE and dies out in east part Sec. 33. The main Lake Warren shore is south of this and causes protrusion of 680' contour westward into Sec. 33. This as above noted is 685' in much of this course across Sec. 34.

Lower Shores of Lake Warren

From Bannister I went west $\frac{1}{2}$ mile then north $\frac{1}{2}$ mile and found there is a pebbly sand deposit with slight ridging that covers the area west of the Ann Arbor Railroad and the Diversion Ditch as far down as the 668' contour. There is some ridging below 670' contour north of the E-W road in Sec. 28 Elba Township. This deposit

is less than 675 altitude across Sec. 28 and east half of Sec. 29 but catches the 675 contour in west part Sec. 29 and SE part Sec. 30 Elba Township. This is where the shore had exposure to NW gales and the beach was piled higher than to the east in less exposed situation. This should be classed as a Lake Warren shore line formed near the close of the Lake Warren stage when the outlet had cut to about 660'. The correlative north [?] shore passes through the village of Ashley along the 670' contour but it is a faint feature with low cut bank. There is a cut bank on the south shore in east part of Sec. 29. The 670' contour there traverses a till tract with very little pebbly lake material. The pebbly sand sets in at a small ravine west of center of Sec. 29.

After passing the west end of the 675' strip of beach in Sec. 30 the pebbly sand is continued along the 670' contour across south part of Sec. 30, but there is bouldery till at corner of Secs. 30 and 31, 25 and 36, and westward to the outlet. The sandy material runs south ½ mile along line of Secs. 31 and 36 and is not definitely ridged. The Warren shore is developed along 680' contour in SW part of Sec. 31 and SE of Sec. 36. South of this ridge are two others of slightly higher altitude but probably Warren shore lines. One lies in the south edge of Sec. 31 Elba, and the other just south of the county line in Sec. 6 Duplain Township. The north one runs to a creek bluff at the county line. The south one barely covers the line of Duplain and Greenbush into NE corner of Sec. 1 at a dwelling. These are each partly below 685' and partly above. West of this creek in south part of Sec. 36 is a shore that also is partly above and partly below 685' contour. It leaves the Elsie quadrangle at the county line.

I went east on the county line and found the two ridges blended near middle of line Secs. 6 and 31. The north one dies out in south part SE¼ Sec. 31. The south one has disjointed bars developed in NE of Sec. 6 and NW of Sec. 5 Duplain. The outer one is strong along north side Sec. 5 about to ¼ post and then crosses the county line and runs east to Maple River across SE¼ Sec. 32 and SW¼ Sec. 33. It is above this 685' contour and a small part in Sec. 33 has 690' contour.

Another Warren shore line runs ENE from SE¼ Sec. 31 to center of Sec. 32 and then turns to ESE course and crosses into Sec. 33 south of the ¼ post of Secs. 32 and 33. This beach is barely 680' where best developed and is partly below that contour. There is a faint shore crossing the north end of line of Secs. 32 and 33 that is almost 680', the corner being 675' and 2-3' lower than this shore. This is faintly developed eastward to Maple River in north part of Sec. 33 but is mainly a flat pebbly sand strip. This ridge has very slight development in north part of NE¼ Sec. 32.

Features East of Owosso

From Bannister I took the Ann Arbor train to Owosso. I noted a small hummocky tract in west part of Sec. 31 Rush Township, but knolls are scarcely 5' high. There is

also a slight ridge of sandy gravel like a bench near center of Sec. 32 on east side of the large swamp. It catches 745' contour. The swamp west from here is a peaty bog. The other swamp crossed in south part Sec. 22 Fairfield, is not boggy but has a rich black mucky soil.

From Owosso I took auto bus east to the county line. It traverses a till tract nearly all the way but there are small patches of gravelly and sandy loam. The areas marked Mg represent these patches. The one crossed by north end of line of Secs. 21 and 22 is narrow like a beach and has gravel pits in it. It stands 3-5' above land north of it and is at north border of a glacial drainage channel just below where the channel of Caledonia drain meets the channel coming in from the east. All the other Mg areas visible from this road have no relief above bordering till areas.

Features In SW Part of Burt Quadrangle

The Mf area in Sec. 24 Caledonia Township is a low swell, perhaps 6' above general level and has pebbly sand. From here at the range line of Venice and Caledonia Townships east of the county line. The Flint moraine inner border is about a mile south of this road or two miles from south line of Venice Township. There is a smooth ridge or swell at corner of Secs. 17, 18, 19, and 20 that this road crosses which reaches 785' contour. The bordering plain is 775' at base of the swell on north and west but is only [750 or 950?] to 750 east of the swell.

At the Mg area at corner Secs. 16, 17, 20, and 21 Venice, there is a slight ridge about 3' high and 30 rods long crossing the road east of the corner. It has gravelly material like a beach, yet it seems unlikely to be a lake feature. There is a similar slight ridge about 60-80 rods north in west part SW¼ Sec. 16. These ridges are between 755 and 760'. At the county line the plain is about 760'. The inner edge of the moraine is a mile south at Lennon and has a gentle rise southward from there.

I left the auto bus at the county line, but continued 2 miles toward Flint. This takes over the north end of a spur of the Flint moraine on east half of line of Secs. 17 and 20 Clayton Township, Genesee County. It reaches 775' on the road and about 10' higher in fields to the south. It extends scarcely 1/8 mile into Sec. 17. The plain east of it at corner of Secs. 16, 17, 20, and 21 is 756' and creek bridge north of the corner 753.

Features South of Flushing

I went north through a plain 755-765'. It has till of clayey nature for a mile but looser textures farther north.

I followed Grand Trunk Railroad track across Sec. 4 Clayton, and Sec. 34 Flushing Township. I came into a sandy area in NE part of Sec. 4 about ¼ mile south of the town line. There is an abrupt drop of 10-15' to this sandy area, but sand occurs on the face of the rise. This seems to be 740-745' at base of the steep slope and

perhaps Lake Saginaw extended to here. The surface is gently undulating and has saucer like depressions as well as swells north of this place. So the lake features are obscure and one can hardly place the border. The undulating land along and west of the railway in west part of Sec. 34 has a sandy veneer as high as top of the cuts, but the ridge itself is till. This reaches 750' on highest points. The top of cut is about 735'.

A large area in NE part of Sec. 33 is between 735 and 740'. This has higher land above it on south and west. It probably was carried to very slight depth by highest Lake Saginaw waters. Only a narrow strip on east edge of Sec. 29 was low enough to be beneath Lake Saginaw. Most of this section is above 740' and it has points 750'. Lake Saginaw covered nearly all Sec. 20. A till ridge 740+ in NE part of Sec. 19 may not have been completely covered. The south edge is about 740' and above lake action.

Notes From Topographer On North Part of Flint Quadrangle

I took evening auto bus Flushing to Flint and train in Grand Trunk Railroad Flint to Davison in order to get further data from Mr. Sadler on the Flint quadrangle.

Sadler's Data

[Notes from topographer in No. part Flint Quad.]

The highest measured point in the Flint quadrangle is a gravel hill 2 miles south of Otisville on west side SW ¼ Sec. 34, Alt. 888'. Rogersville is 763'. Genesee Station 741'. P. M. June in east part Sec. 19 Genesee Township 759'. Gravel plain outside the Flint moraine 2½ miles NNW of Otisville in SE part Sec. 8 is 828' on highest land. Several acres catch 825'. In NE part Sec. 16 the gravel plain has several acres above 820' contour. The "Pg" area on the soil map seems to be outwash in Secs. 8, 9, 16, and 17, but the contours indicate moraine further east and north in Secs. 3, 10, and 15. A knoll in SE part Sec. 3 has 840' contour and one in north part Sec. 15 845'. Otisville Station is 817.7'. Altitudes in Arbela Township, Tuscola County, is as follows: NW corner Sec. 33 and SW corner each 741'; NE corner 751'; SE corner 739'. Quarter post Secs. 27 and 28 is 741'. Crest of moraine on line Secs. 27 and 28 is 765+.

I sketched 740' contour across Secs. 1, 12, 13, 24 and 23 Vienna Township as that marks about the limit of Lake Arkona at highest stage. Lake Saginaw reached 750' contour in Secs. 24, 26, 34 and 35, so I sketched that in also. The ridge that crosses line of Secs. 34 and 35 north of ¼ post catches 765' contour, so the sand there on its north slope is nearly 760'. (see notes a few days ago.)

The moraine in Sec. 35 has points that catch 790 and 795' contours, but not 800'. The sandy places south of it near ¼ post of Sec. 35 and Sec. 2 is above 765' at north edge but is about 760' along the section line. Mt. Morris

at SW corner Sec. 6 is 783'. Township corner 1 mile north of Mt. Morris 765'.

Topographers Data In SE Part of Flint Quadrangle

From Mr. Stumpf's map in SE part of the Flint quadrangle I got data for section corners, etc., from SE corners of map 6½ miles west and 4½ miles north.

The south boundary of map is 1/3 mile south of the line of Secs. 15 and 22 Burton Township. The SE corner of map is on a morainic ridge. The altitude at ¼ post of Secs. 22 and 23 Davison Township is 876.6. Corner Secs. 14, 15, 22 and 23 is 851.4. Center Sec. 22 is 855.6. Quarter post 15 and 22 is 828. NW corner Sec. 22 is 811.4. Quarter post 16 and 21 is 803. Center of Sec. 21 is 805.5. West ¼ post Sec. 21 is 800.5. Lapeer road at line Secs. 14 and 15 is 819. Grand Trunk Railroad 1 mile east of Davison 813. Section corners in Davison 798.5. Depot in Davison 791.5. Belsay Station 778. The track is 2-3' above natural surface here. There is a bouldery low swell cut through west of Belsay that may be 780'. The road crossing a mile west of Belsay 770' is on a boulder strewn till plain. Boulders occur in Sec. 9, also low swells of till 2-3' high. Flint now is built nearly to east side Sec. 8 and will soon take in all of Secs. 5, 8, 17, and 20 Burton Township. It is also proposed to extend city limits a mile further north on west side of Flint River, or two miles north of the town corners. The limits will also be extended down Flint River valley a mile or more as that is already built upon.

Altitudes near Davison

NE corner Sec. 3	- 832	SE corner Sec. 3	- 798.7
NE corner Sec. 34 Richfield	- 829.5	SE corner Sec. 33	- 794.6
SW corner Sec. 34 Richfield	- 790.4	NW corner Sec. 33	- 789.5
NE corner Sec. 31 Richfield	- 779	SE corner Sec. 31	- 776.5
SW corner Sec. 31 Richfield	- 765.9	SW corner Sec. 36 Ganes	- 761.8

Road intersection south part Sec. 35 Genesee	- 766.5
Sandy ridge near center SW ¼ Sec. 35	- 771
Road intersection south part Sec. 34 Genesee	- 762.2
Quarter post Secs. 3 and 10 Burton Twp.	- 761
SE corner Sec. 3 Burton Twp.	- 761.6
Grand Trunk R. R. at ¼ post Secs. 10 and 11 Burton Twp.	- 770
SE corner Sec. 10 Burton Twp.	- 761.5
Quarter post Secs. 10 and 15 Burton Twp.	- 768.9
Belsay at Grand Trunk R. R. 2' above land	- 778
Bridge ½ mile south of Belsay	- 764.9
SE corner Sec. 12 Burton Twp.	- 775
NE corner Sec. 7 Davison Twp.	- 775
SE corner Sec. 7 Davison Twp.	- 772.7
NE corner Sec. 8 Davison Twp.	- 789.1
SE corner Sec. 8 Davison Twp.	- 774
SW corner Sec. 10 Davison Twp.	- 791.4
SE corner Sec. 10 Davison Twp.	- 816

On Lapeer and Flint Highway -	
Center Sec. 15 Burton Twp.	- 769.9
Line Secs. 19 and 15 Burton Twp.	- 768
Line Secs. 13 and 14 Burton Twp.	- 774
¼ mile east at north end road	- 775
Line Secs. 13 and 18	- 773.5
Knoll ¼ mile south	- 786
Stream ¼ mile east in Sec. 18	- 763
Kersley Creek in east part Sec. 18	- 740
Line Secs. 17 and 18	- 777.9
Line Secs. 16 and 17	- 788.7
Line Secs. 15 and 16	- 793.8
SW corner Sec. 16	- 788.1
SW corner Sec. 17	- 781
SW corner Sec. 18	- 782.3
Quarter post Sec. 19 and 24	- 786.5
Bridge near ¼ post 23 and 24	- 773.7
Water	- 772
Center Sec. 22 Burton Twp.	- 774.8

Features in North Part of the Burt Quadrangle

November 14, 1919, Davison, Michigan. I went to Flint on morning train and by electric car to Birch Run. I went south a mile from Birch Run and found the clay is coated to slight depth with sand from the school building south. There is a ridge of wind drifted sand 1/2 – 3/4 mile SW of Birch Run near center sec. 30. Dune sand also is present in south part sec. 25 and north part sec. 36, also on NE bluff of Pine Run in sec. 35. There is a pebbly sandy plain west of Pine Run but this has been terraced on east side of Flint River and a pebbly concentrate on gravelly loam 1-3' thick covers the till. This is a continuation of the strip I mapped in Saginaw quadrangle a few weeks ago. It extends south into NW corner of sec. 3, Montrose Twp.

The area south of it marked "F" on soil map is light sand with very few pebbles. It may be partly wind drifted. The "C's" area east of it has more pebbly material. In gullies that are crossed along east side of Flint River there is a thin capping of nearly pebbleless clay over the pebbly till. The sandy and pebbly deposits overlie this clay.

Sand Deposits Bordering Flint River

I went south along road near east bluff of Flint River for 4 miles and then west into Montrose. I went south from Montrose across a very flat sandy area to Brent Creek. It is 675' at Montrose, 678' one mile south, and 680' two miles south and 682' three miles south. The soil is a pebbly sand with a slight loam admixture. It is better soil than the west of Burt, yet is said to be subject to frost more than land with greater inequality. This needs further study to reach correct view. Brent Creek village is on a clay plain that covers several square miles to the west and south marked "Mc" on soil map. Between this clay area and Flint River is a strip of sandy land nearly a mile wide that stands a few feet higher than the clay plain. It seems to be the product of the stream and of delta character. There is but a slight pebbly admixture in this sand, and soil is light. I went east from Brent Creek village to corner secs. 3, 4, 9, 10, and then south a mile. The soil is more pebbly and has more loam in area "F1" in sec. 10 than in that marked "Fg", and is still better to the east in area F.

I went west descending to the clay plain about 1/4 mile west of corner secs. 9, 10, 15, 16. This has boulders scattered over it and till with but little lake deposit over it. There is a light sandy deposit in SW of sec. 8 covering less than 40 acres in that sec., but this deposit covers 2 or 3 square miles to the SE in secs. 16, 17, 20, 21, marked "Cs" on soil map.

I went north on line secs. 7 & 8 to see the area "Dg" on soil map, but it differs so little from the bordering till plain that it seems to belong with it. It is flat and has only a very slight and patchy pebbly deposit. I went west on line of secs. 6 & 7 and I saw only a plain of clayey till with scarcely any lake deposit but on turning south on the county line I soon came into a deposit of fine sand that is spread out to the north from the Second Arkona

beach for over 1/2 mile in secs. 7 & 12. It is mainly below 700' contour.

There is a slight ridge in west part SW¼ sec. 6 and in east part of sec. 12 that catches 690' contour and seems to be shore feature. The Arkona beach near south end of line of secs. 7 & 12 is clear sand at base where cut by the road but has cobble stones and boulders on its slope and crest imbedded in a sandy deposit. I noted this sort of feature in a beach west of Burt at 625'±. Boulders there were exposed in beach sand 2-3' below surface as well as on surface.

Features NW of Flushing

I saw scarcely any trace of the highest Arkona on this town line road. The swell areas that catch 725' and the land along the contour have till soil with scarcely any lake material over it. The Saginaw shore at 735-740' is strong in vicinity of the county line. There is till on the inner slope up to 730'± and in NE part of sec. 19 to 740'. This till is classed in three patterns on soil map: Mc, C, and Ml, but it looks to me to have very little difference and I think would be hard for a soil mapper to point out.

The sandy area east of Brent Creek in sec. 20 is very patchy with clay at surface in places but in secs. 16, 17, 21, it is generally several feet thick so ditches do not reach its base. I went into Flushing along railway track in secs. 21, 27, 26, and crossed the Arkona beach where it catches 720' contour.

Border of Flint Moraine North of Flint

November 15, 1919, Flushing, Michigan. I took auto bus to Flint and got off when it turned south on range line 2 miles north of business center of Flint. This is at the base of the moraine. I follow this NNE past the city limits. It is 1/3 mile east of range line here. I then go east to Pere Marquette RR and follow it to McGrew Station. This is 759' and at general level of the plain east of the moraine. This plain has small patches of pebbly sand but as a rule till is at surface. The sandy spots are marked "Mf" on soil map. The altitude is 753' at corner secs. 19, 20, 29, and 30, and 750' on railway 1/3 mile north where it crosses line of secs. 19 & 20 and 768.3 at corner secs. 17, 18, 19, 20, Genesee Twp. This is in a swale in edge of the Flint moraine about 3' above the border of the plain. This border is probably close to 765 alt. for some distance south and it may represent the height of a lake outside the moraine, but I can see no evidence of shore action and there is remarkably little sandy or pebbly deposit over the till on the plain outside the moraine. I followed the border between moraine and plain southward across secs. 19, 30, 31, Genesee Twp. in order to see if there is sandy material and am surprised at the scantiness.

I continued along the border to Flint River in Flint. It crosses to the river bluff about 1/3 mile west of the twp. line of Flint and Burton and follows it SW for nearly 1/2 mile, then it crosses to south side of the river and appears on south bluff about 3/4 mile west of the twp.

line in what would be the SW¼, sec. 13, of that had the rectangular land survey. It is, however, in an Indian Reservation survey with angling survey lines. The U.S.G.S. alt along the crest show 793' to 797' inside the city limits in what would be south part SE¼, sec.14, were this in rectangular survey. The alt. is 797' at city limits on the Flint-Owosso highway about 1/2 mile east from where it crosses the Gd. Trunk RR.

Features in Vicinity of Flint

The railway is on inner slope where this highway crosses with alt. 780.6' on track. The moraine is clayey here and the plain outside has very little sand or silt over the clayey till. The moraine crest is close to 800' as far as the gap in channel bed that crosses it in SW part sec. 22 in area marked "Fg" on soil map. This channel floor is scarcely 760' at the south edge of the moraine. It is 755' at Grand Trunk RR crossing in east part of sec. 21 by U.S.G.S. levels.

The land is undulating and probably to be included in Flint moraine as far north as SW part of sec. 16 and SE of sec. 17 in west side of this channel and to south edge of sec. 15 and the part of Indian Reservation corresponding to south part of sec. 14, Flint Twp. The channel makes a break in the moraine only 1/4 mile wide including slopes. It is smaller than I had in mind from studios some years ago. It is not half so large as the channel that leads west from Swartz Creek village past Duffield and Vernon. I went by auto stage from Flint to Owosso and noted the features just mentioned. The moraine lies so far south in west part of Flint Twp. that is not visible from this road. There is flat land in sec.19, Flint, and secs. 22, 23, 24, Clayton, as well as to the north of this highway. The alt. is 765' at the twp. line SW corner sec. 18, Flint Twp.

At a school house 2½ miles west in south part sec. 15 it is 762.8'. There is a slight ridge about 765' at the residences 40 rods south of here which seems to be a till ridge. There is merely a trace of sand at its east end. It is traceable for about 1/3 mile in north part of sec. 22 and bears slightly south of west. There is a similar low ridge crossing the road south of center of sec. 15.

The area of "Mf" on line of secs. 16 & 21 is till with a mere trace of sand. I should not separate it from other parts of the till plain. The alt. is 764' on it where a road runs north into sec. 16 and 762' at quarter post secs. 16 & 21. The alt. on the moraine spur is 775' at summit and 766' at west base near quarter post, secs. 17 & 20. For other alt. see notes on soil map and notes nov. 12 in this notebook.

I noted this morning gravelly moraine in sec. 17, Genesee Twp., with pits in it opened for road material. I saw no other gravel on the moraine south from here. I returned to Ann Arbor from Owosso having completed the field work planned for this season.

Tilting of Shore Lines

November 17, 1919. In order to clear up the question of the presence of lake waters at higher level west of Shiawassee than east, I worked out the amount of warping as shown by the highest Arkona beach since I am sure of its identification across the entire district from the Perrinton to the Flint quadrangle. In this way I cleared up the direction of tilting and can judge whether the differences displayed by the shore or lake limit above Arkona fit into a single body of water or require water at two stages.

The highest Arkona beach is about 725' in the central part of the Perrinton quadrangle in Greenbush Twp. and 735' in the north part near North Star with points catching 740' in the great bar 2 miles SW of North Star. There is a differential uplift of 10-12' in 8 or 9 miles due north, or about 15 inches per mile.

In the Elsie quadrangle only the south shore is embraced and it has an ENE course across the quadrangle. It seems to be near the 725' contour clear across the quadrangle, the only place markedly higher being in the great bar in secs. 4, 9, Fairfield Twp., where it is piled up to 735' but part of this bar is below 730' and it is doubtful if the ordinary lake level was as high as 730'. Being in an exposed situation waves may have piled up the gravel several feet above ordinary water during storms or ice jams may have shoved up the gravel. It is rather surprising that the beach is higher here than in the east part of the quadrangle and 1-2 miles farther north. It, however, catches 730' contour at the east border in sec. 32, Brady Twp., and the lake level is likely to have been nearer this contour here than in secs. 4 & 9, Fairfield Twp., Shiawassee Co. There is also the possibility that the bar in secs. 4 & 9, Fairfield Twp., was started by Lake Saginaw and enlarged by Lake Arkona. In the Chesaning quadrangle the Arkona beach is above 730' only at farthest north points in secs. 33 & 34, Brady, and secs. 2 & 3, Rush Twp. Generally it is between 725 and 730' and is below 725 where weak. The beaches here show rise as one gets north but not a perceptible rise eastward so it seems likely this tilt line is nearly S-N.

In the Burt quadrangle the highest Arkona is close to the 725' contour west of Flint River. It rises where it takes a northward course and catches the 730' and also 735' contour in a prominent bar on line of Flushing and Mt. Morris Twp. near corner secs. 12 & 13, 7 & 18. Here it may have been piled up to 5' or more above ordinary lake level as it is an exposed situation. It is below 730' for 1½ miles north, but in north part of sec. 6 it is again in an exposed situation on a moraine and rises above 730' and 2 miles farther on in north part sec. 33, Vienna, it catches 735'. It is above 735' from east part sec. sec. 28 northeastward and catches 740' a mile south of Clio in secs. 27 & 22. A bar a mile east of Clio in secs. 13 & 14 lying out from the main shore is above 740' and barely reaches 745' in west edge sec. 13. This probably was piled up by wave action so lake level may have been but little above 740'.

The data here given indicate that the tilt line was but little east of north. North Star and Clio seem to be on the same isobase and this runs about 7° east of north. If this line were projected into the Huron Basin it would strike the Arkona shore there near Goodell Station. The alt. there is not far from 730' or a few feet lower than at North Star and Clio where it is between 735 and 740'.

The 730' isobase of Lake Arkona in Saginaw Basin runs from corner of twps. 9 and 10 N, Rs 2 and 3 W, eastward to corner of twps. 8 and 9 N, Rs 5 and 6 E thus making 6 miles south in 40 miles east (R 1 E is only 4 mi. wide). From corner of twps. 8 and 9 N, Rs. 5 and 6 E to Goodell is 55 mi. east and 12 mi. south. Were the isobase to continue in same direction as in Saginaw basin it would be only 8¼ south of meridian of Goodells. The departure of only 3 3/4 mi. in a distance of 55 mi. is slight and seems to support the view that there is but little change in the direction of the tilt line in passing from the east side the Saginaw Basin over the "Thung" to the west side of the Huron basin. It is more nearly northward than Taylor has found the tilting to be in the Huron basin by drawing isobase lines across it from the west to the east borders. The direction of tilting in the Saginaw basin seems to be similar to that found by Goldthwait and Taylor in the Michigan Basin.

Silting of Shore Lines

A study of alt. of the Second Arkona beach shows similar results as to the direction of the tilt line to those given by the highest Arkona beach. This beach which is 720' near North Star drops to 710' near Pompeii and is 710' in sec. 5, Greenbush, and also east of Eureka. It first catches 715' in sec. 10, Duplain Twp., and is 717' at Olney corners in north part of Fairfield Twp. and 719' a mile farther east. It seems to have no rise from there to east side of Elsie quadrangle, being 717' at some of the bench marks. In this respect it is like the highest Arkona in east part of Elsie quadrangle. In the Chesaning quadrangle it catches 720' contour in secs. 33 and 34, Brady Twp., where it is farthest north. It catches 720 in central part of Chesaning quadrangle at points a mile west and a mile east of meridian of Easton, but elsewhere in the quadrangle is below 720'.

In the Burt quadrangle it does not reach 720' anywhere west of Flint River and is generally about 715', and in places is below 715'. East of Flint River it rises to 720' in NW corner Mt. Morris Twp. and reaches 725' at corner secs. 21, 22, 27, and 28, Vienna Twp. (T 9 N, R 6 E). It seems to be close to 725' from there NE past Clio to the SW corner of Tuscola Co., points along it being 723, 724, 725' as given by topographers. It is only 723' at SW corner Tuscola Co. There seems to be no differential uplift for 3 or 4 miles from Clio northeastward. No data on it's alt. in Tuscola Co. were obtained farther than notes that it lies along the inner slope of the narrow morainic ridge in Arbela Twp. The isobase for 720' runs from North Star to NW corner of Mt. Morris Twp. 37 miles east and about 8 mi. south. This indicates a tilt

line about 10° east of north or a slightly different result from that given by highest Arkona 7° east of north.

Turning now to the shore features above the highest Arkona we find them quite varied. The highest well defined shore reaches about 750' near North Star and also near Clio, and thus supports the same direction of tilting as the highest Arkona. Above this definite shore there are occasional features that suggest static water. Thus the sandy pebbly bar 2½ miles west of Mt. Morris at 765-767' and the cemetery deposit of pebbly sand in west part of Mt. Morris at 768-770', also the upper limit of sandy material on till around the moraine NW of Mt. Morris in south part sec. 35, and also west part of same sec. at 760 to 765'; also on north slope of the knoll on Dixie Highway in south part sec. 24, Vienna, at 760'. The border between moraine and plain on east side the Flint moraine in southwestern Genesee Twp. is at 760-765' but there is not a clearly defined shore and only a slight deposit of waterlaid material on the plain. There is just enough to suggest that water may have stood at about 760-765'.

Ponding to About 760'

The slight coating of sand here and there on the plain south of Flushing seems to come at 760-765' so generally as to suggest that water covered the plain to about this height, but the scantiness and patchy distribution of this sand indicate only short-lived ponding at this height.

In connection with ponding to about 760' the swale that is drained by Webb Creek near Lennon westward is to be considered as a possible line of discharge for the water. This seems to be fully 765' for where crossed north of Durand it is 764'. There is a lower swale in SE part of the Chesaning quadrangle leading SW from sec. 7, Venice, across secs. 12, 13, 14, 15, Caledonia, that is now ditched to drain SW by the "Caledonia Drain" which is barely 750' at present divide. This has a flat bottom with some peat and muck covering it in vicinity of the divide and may have been a line of drainage southwestward from a basin in Hazelton to Venice Twps. The ponding that seems suggested by these deposits is likely to have occurred as the ice was receding northward and westward from the Flint moraine and was still occupying nearly all the country that later was covered by Lake Saginaw.

It would have fallen to this level of the outlet of Lake Saginaw as soon as there was free communication westward along the ice border to that outlet.

Kearsley Lake

In this connection reference is made to the similar lowering in Kearsley Lake which occupied the plain outside the Flint moraine south and east of Flint and which had an outlet westward from Swartz Creek village past Crapo, Duffield, and Vernon. The head of this outlet is about 778'. It is 773' at Crapo farm and 767' at Vernon by Gd. Trunk RR. Survey is given in White's

Altitudes in Canada. This is a few feet higher than the Webb Creek swale and that is likely to have taken the discharge when the ice border had melted back to the moraine that lies north of this swale at Lennon and westward from there. This swale is 764' on the meridian of Durand as shown by U.S.G.S. levels.

Features near Lennon

Later the ice may have melted back so as to cause a shifting from the Webb Creek swale to the Caledonia Drain swale and lowered the outlet to about 750'. Kearsley Lake may have been at 765' when the waters were a little lower inside the Flint moraine, as there is likely to have been some fall in the passages through the moraine along Flint River and along the channel that leads NW in secs. 22, 21, 16, Flint Twp.

The position of the ice border is ill-defined to the NE or east of Lennon for the moraine on which Lennon stands on north side of the Webb Creek drainage. The moraine as noted a few days ago terminates abruptly 2 miles ENE of Lennon in SE part of sec. 17, Clayton Twp. (T 7 N, R 5 E). I then thought it was a spur from the Flint moraine, but it seems quite as likely to be in the direct line of the ridge on which Lennon stands. Perhaps its continuation is found in a morainic strip that sets in 3 mi. farther ENE in sec. 11 and runs eastward across sec. 12, Clayton, and sec. 7, Flint Twp., and has a point above 800' in sec. 7 & 785' in sec. 12.

Height of Shores East and West of Shiawassee River

The intervening strip in secs. 14, 15, 16, Clayton, is not ridged or decidedly undulatory and stands almost entirely between 760 and 770 contours. If the ice border has the position just suggested the Kearsley Lake drainage might have been into the Webb Creek channel, but not into the Caledonia Drain as that was still beneath the ice sheet.

Passing now to the distinct bordering Shiawassee River, I have already noted that the shore features seem to be a few feet higher to the west of the river in the Chesaning and Elsie quadrangles than to the east in the east part of the Chesaning quadrangle and in the SW part of the Burt quadrangle.

The shore south of the Grand River Outlet (in Duplain Twp.) is about 740' and gravel is piled up above 745' in village of Duplain. This is an exposed place where storm waves might lift the material to a height several feet above ordinary lake level. It seems doubtful if the ordinary lake level was up to 740' but was between 735 and 740'. There is a general indication of lake action along or a little above the 735' contour entirely across Duplain Twp. and eastward across Fairfield and Rush Twps. to the Shiawassee valley. At one place in NE corner sec. 8, Rush Twp., it catches 745' contour and it is above 740' for shore stretches at several places in Rush Twp. and in secs. 11 & 12, Fairfield Twp.

The delta of the Imlay Outlet at edge of Elsie and Perrinton sheets has bars above 735' and thus indicates a lake level correspondingly high. To the north of this delta in sec. 23, Greenbush, a beach catches the 735' contour. Probably the lake was as high as the 740 contour in NE part of Fairfield Twp, for ??? and differential uplift should give greater alt. than in the district SW. In the southcentral part of Fairfield Twp. near the Munson school it is scarcely 735'. A definite beach there in NE part sec. 28 is 732'. In exposed situations in secs. 22 and 28, Duplain, it is above 735' and about to 740' in sec. 28. On passing to the east side of Shiawassee River at Henderson the shore is up to 735' in only a few places where conditions were good for waves to roll material up beyond the ordinary lake level. The difference, however, between the alt. on west and that on east side the river is scarcely 5'. It seems quite probable that the outlet was cut down that amount and the lake correspondingly lowered in the course of the expansion of the lake northeastward by the melting back of the ice border. It appears that at the very beginning of Lake Saginaw in southern Duplain and in Greenbush Twp. the outlet held the lake at fully 735' but by the time it had reached to the east side of Shiawassee river the outlet was between 730 and 735' and it continued to lower so that by the time the waters of the great lake (Lake Arkona) came into the outlet it was down to about 720', and by the time the Second Arkona was developed it was down to about 710'. The drop from the highest Arkona to the Second seems to have been rather abrupt for each shore line stands out clearly and there is not such a transition and filling of the interval with shore features as one would expect if there had been a steady lowering. It is probable some barrier in the outlet which had held it for a long time at the level of the highest Arkona was cut away and thus lowered the lake with corresponding quickness.

Flint Line Nearly N-S

The rise in the Lake Saginaw beach where it turns northward is so much more rapid than in an eastward direction that the tilt line seems likely to be but little east of north as is shown by the two Arkona beaches. Its rate of rise is also so similar to that of the highest Arkona that there appears to have been little or no uplift of differential nature before Lake Arkona waters came into the Saginaw Basin.

Except in the district west of Shiawassee River where the Saginaw beach is 15' or more above highest Arkona the usual interval between them is 10 or 12'. Thus at South edge of Lake Saginaw in T 8 N, the Saginaw beach is 730-735' in Rs 3 and 4 east. In east part of R 4 E, however, (in secs. 26 & 35), it is up to 740' and it gets up to 745' in exposed situations in west part of T 8, R 6 E, in secs. 5, 8, 20, 29, and also on the highest bars in the delta east of Flushing in secs. 30, 31, 32, T 8, R 6 E.

In the same interval the highest Arkona beach rises from 725' to 730-35' keeping about 10' below the highest Saginaw shore line. From the outlet eastward to

Shiawassee River the Arkona beach rises fully 5' or from 720 to 725'. It catches 730' where it runs into T 9 N, R 2 E, because of the northward uplift. It is also above 730' at the exposed place in secs. 4 & 8 T 8, R 1 E where it was heaped up above its level in neighboring secs. But these exceptions being taken into account, it falls below 730' and the lake level probably was ordinarily not much above 725' contour in the district west of Shiawassee River. In the whole length of the south shore from R 3 W to R 6 E, a distance of 45 miles the highest Arkona rises from 720' to fully 730' with points as high as 735'. The Second Arkona in this interval of 45 miles eastward rises from 710' to 720'.

If, as seems probable, the outlet of Lake Saginaw had been cut to about 730' at the time the ice allowed it to extend as far east as Flint River the eastward rise of the Saginaw beach is about 10' or to 740' with height of 745' in the delta on Flint River and in exposed places on the shore east of the delta.

The average eastward rise thus appears to be scarcely 3 inches per mile in each of the three shore lines. The rise in a due north course at the west side of the basin as indicated above, is about 15 inches per mile. It is likely to be a little more than 15 inches per mile in a course 7-10° east of north or along the tilt line. The Saginaw shore makes this rise if the Saginaw is assumed to have been 730' south of the outlet at the time the ice had vacated the land near North Star where the beach is 745-750'. The highest Arkona rises from 720' to about 735'. The Second Arkona rises from 710' or less to barely 720'. It may be separated by a somewhat wider interval from the highest Arkona near North Star than it is south of the outlet. The beach is 710' south of the outlet in sec. 5, Greenbush, and is 720' at a cemetery 1 mi. south of North Star. The rise of 10' is made in 8 miles or at a rate of 15 inches per mile.

Estimates of Tilting of Shore Lines

The rise of 15' in the highest Arkona and in the Saginaw is calculated from secs. 23 & 24, Greenbush Twp. and thus has a distance of nearly 4 miles more. So it also is at rate of about 15 inches per mile. The highest Arkona is very nearly 725' in sec. 5, Greenbush, so rises only about 10' in the 8 miles to the large bar SW of North Star in sec. 29, North Star Twp. Probably the Second Arkona would be 705' were it developed as far south as secs. 23 & 24, Greenbush Twp. and thus show 15' rise in about 12 miles north.

In vicinity of Clio the 3 beaches are on 725, 740, 750' thus showing the intervals found at North Star. The uplift here, however, is 3-5' more than at North Star. The level strip of Second Arkona beach from Clio NE to SW corner of Tuscola Co. where it is uniformly close to 725' is an anomalous feature and one that will need to be cleared up by further field study on its extension into Tuscola Co. and on the two highest shore lines in the district NE from Clio. Possibly there is an untilted strip forming a bench or step-tread between strips that have northward rise.

An examination of C. A. Davis' contour map of Tuscola Co. has been made to get light in this matter (see map in 1908 Ann. Rpt. Mich. Geol. Surv.). It shows the highest shore in vicinity of Millington to be close to the 750' contour which is no higher than near Clio. Northeastward from there into Kingston Twp. the highest shore shows a rise of about 30' or 780' in a distance of 22 miles in a course about N. 50° E.

This contour map shows the Lake Warren beach to reach 700' 2 miles north of Vassar and 740' at Gagetown in a distance of 25 miles in a due NE course. The rate of uplift, therefore, seems to be greater to the NE from Millington and Vassar than it is anywhere in the area covered by the 5' contour maps which I have been studying. It also gives apparent support to the occurrence of an untilted area or but slightly tilted area between Clio and Millington.

My studies have not made clear to what point the Lake Warren shores are untilted. The rise of 20' made at the place noted above (2 mi. No. of Vassar) may all occur to the north of the border of the Flint quadrangle for the northerly distance is 10 or 11 miles. If there is a rise of 40' in 25 miles from there to Gagetown the rise of 20' may be made in half that distance to the SW from the Vassar location. In a SW direction one must go 15 miles to reach the edge of the Burt quadrangle at Birch Run. The occurrence of shore lines at about 700-705' and at 690' is well established. They each seem likely to have been formed before Lake Warren waters came into the Saginaw Basin.

Perhaps the one at 700-705' is the lowest Arkona beach, while that at about 690-695' was formed by the Lake Saginaw that was a contemporary of Lake Whittlesay. Possibly both these shores are the product of this Second Lake Saginaw. If the time Lake Whittlesay endured was long there should have been considerable cutting along Grand River outlet and corresponding lowering of the lake level in the Saginaw Basin.

Lake Wayne being only 660' was entirely too low to have discharged into the Grand River outlet. That outlet was only down to 680' at its head when the Lake Warren waters came into the basin to sufficient height to flow down this outlet. The outlet was deepened from 680' to 660' while Lake Warren discharged through it and the head of this outlet was extended about 16 miles farther east, or well into the old lake bed, to secs. 10 and 15, Elba Twp., Gratiot Co., or about to where Lake Wayne sand had been deposited. This amount of deepening and of headward extension of the outlet indicates considerable duration for Lake Warren and the size of the outlet indicates a large volume of water.

Outlet Features and Moraines in Perrinton Quadrangle

In Monograph 51, Taylor's Fig. I, indicates that the western of the two moraines in the Perrinton quadrangle north of Grand River outlet is the Flint moraine and he has the Owosso moraine protrude into Grand River outlet beyond the Flint moraine. I doubt if this protrusion

can be proved correct. It seems more likely the weak Owosso moraine is banked against the east slope of the stronger Flint moraine from opposite Pompeii to the Grand River outlet. The outwash seems to be all outside the Flint moraine. This outwash shows about the same northward rise as is shown by the shore lines east of the two moraines to the north of the outlet. It is 725' 1½ miles north of Maple Rapids, and 730' one mile SE of Perrinton, 740' at twp. line 1½ miles north of Perrinton and 745' at north edge of the Perrinton quadrangle.

The outwash plain north of Ovid is above all lake features being 775-780' at the north edge and sloping to 755-760' at the border of the Imlay outlet in Ovid. The Imlay outlet bed is 730-735' at Ovid but the bluffs each side below here rise to about 760' so the stream probably has cut down the 25 or 30' and this outwash is in harmony with drainage that antedated the cutting of this outlet channel.

The river came into Lake Saginaw 6-8 miles below Ovid at an alt. of 730-735' (as shown by gravel bars in the delta), or at a level as high as the bed of the outlet at Ovid. This delta, however, was cut into a deposit of 15-20' by the large stream that discharged into the Grand River outlet below Maple Rapids. It also cut into extensive gravel deposits south of Maple Rapids. The gravel deposits have bars up to 730' near Prairie School and to 732' at Lowe School and church, and to 725' 1/2 mile east of Maple Rapids, the alt. being the same as across the outlet 1½ miles north of Maple Rapids.

Crapo Farm on Gd. Trunk is 773'
Swartz Creek Station, Gd. Trunk is 778' (near
head of outlet from Kersley Glacial Lake)

A letter from J. H. Jennings, topographer, U.S.G.S., states that in the Durand quadrangle the Imlay outlet is nearly 780' at the east and about 760' at the west. The bed may be above 760 at the west but stream channels cut it in on about down to 760'. At a line running directly north from Durand the flat swamp is 766', and 3 miles east and 1½ north of Durand 770'. Durand on track just west of the depot is 794' by U.S.G.S. levels. Duffield Station is about 780'.

Gannett's Dict. of Alt. makes A.A.RR 791' at Durand.

Whites Alt. in Canada " Gd.T.RR 793' " " and 779' at Duffields. If Vernon Station as well as Durand is 3' too low in Gannett's Dict. of Alt., the bed of the outlet at Vernon is about 764' and this is a mile or so west of the west line of the Durand quadrangle. The stream there is probably 6-8' lower. Vernon Station on Gd. Trunk is 767'.

I find on referring to copy of a letter I wrote Taylor June 13, 1917, the suggestion that the correlative of Lake Whittlesey in the Saginaw Basin (Second Lake Saginaw) probably embraces a beach in the Elsie and Chesaning quadrangles that is about 700'. It seemed to me then that this beach is a little below 700' in west part of Elsie quadrangle but reaches 705' near North Star and near Oakley (see map in secs. 26, 27, 28, Brady Twp.). I see

no reason now for a different interpretation. The beaches below the Second Arkona are so fragmentary as well as weak that there is less certainty of close correlation than on the First and Second Arkona beaches and thus more difficulty of demonstrating whether or not there is northward rise in any of them.

November 20, 1919. On reading Taylor's description in Mon. 53, p. 241, of the Fowler and St. Johns moraines I find he went astray when he thought the moraine south of Fowler crosses to south side of Stony Creek at a point about 4 miles SE of Fowler. Instead it stays on north side of the creek valley but has an interruption at Swagert Channel that led into the Stony Creek channel at this place (4 mi. SE of Fowler). The continuation east from the Swagert Channel is in the St. Johns moraine – there being but one moraine with two names for different sections of it. One of the names should be dropped. It seems preferable to retain St. John's since the moraine really passes through that city, whereas it only passes near Fowler that village being on a flat till plain inside the moraine.

Taylor considered the moraine that follows south side of the Grand River outlet eastward to Eureka to have continuation past Elsie about where I am to place it (see notes Nov. 11, pp. 19-20 of this notebook). He calls it the Owosso moraine. On the map he runs it SE from Elsie along the gravel capped ridge in secs. 13 & 24, Duplain and very faint ridges in sec. 34 and east part sec. 33, Fairfield, and a slender ridge in secs. 3, 2, 11, Middlebury Twp., to the knolly tract bordering the Lewis Drain in sec. 12, Middlebury, and sec. 7, Owosso, and then eastward from Burton to Owosso. He makes the knolls in northern Fairfield Twp. part of a later moraine termed the Henderson which runs in north side of the large swamp in Fairfield and western Rush Twps. I am not quite satisfied with this correlation for it seems not unlikely the ice border run from Elsie to Henderson and not to Owosso. However, I am not able to prove this to have been the case. In his description of the Owosso moraine, Mon. 53, p. 243, Taylor states that he could not find the moraine from the town line 2 mi. SE of Eureka eastward to about 2 mi. east of Elsie.

Corrections to Taylor's Mapping

The moraine map in Mon. 53, Pl VII, shows the St. John's moraine to have a course past Durand while the description given of the St. John's moraine on p. 241 makes it the next one to the south and runs it near Gaines. The map also gives no indication of the Imlay outlet from Vernon down Maple River to Ovid, but instead runs it into the Webb Creek channel and carries it past Corunna to Owosso. There is thus need for considerable revision of moraine and drainage on this map and a correction of Taylor's wrong interpretation of the Fowler-St. John's moraine, and probably incorrect outline of its course in Shiawassee and Genesee counties. So far as the map is concerned it looks like a caricature and does not harmonize with out field maps or with descriptions given in the monography.

It is a question with me whether the St. John's moraine is present on west side of the outwash plains north of Ovid. A later moraine, probably Taylor's Flint moraine, cuts across this in sec. 36, Duplain, and borders the outwash on the northeast. The outwash probably was derived mainly from this later ice border, as it slopes away from the moraine in a SW direction down to the earlier moraine.

Taylor ties together the scattered knolly tracts along north side the lmlay outlet in Essex and Greenbush Twps. To form the Flint moraine. He seems to put the knolly strip south of the outlet in secs. 31 & 32, Greenbush, with the St. John's moraine rather than the Flint. Very likely it is more closely related to the St. John's though lying inside the main belt. The same is true of the slight ridge two mi. east of Fowler. Taylor suggests that the interruptions in the moraine west from Duplain are due to the great outlet river along the ice border in that part and this may have removed moraine material as it was being set free by melting of the ice for several miles west from Duplain.

Taylor correlates a bouldery strip which runs SE on the divide east of Bannister with the Henderson moraine which is traceable, he thinks, from the Saginaw shore in NE part sec. 11, Fairfield Twp., southeastward passing about a mile south of Henderson. It seems to me more probable this bouldery strip correlates or leads into the bouldery till area NW of Oakley and the bouldery district east of Oakley and Chesaning. These all appear to be waterlaid moraine. It is up to the 700' contour for only a short distance in the high tract west of Oakley. It lies between 660 and 700' most of the way across the Chesaning quadrangle but is down to 630' contour in eastern part of the quadrangle as well as up to 700'. The slope is steep from 630 up to 655' in secs. 8, 17, 18, Maple Grove, and westward nearly to Chesaning and this seems to be a morainic slope. It is very thickly strewn with boulders.

The West Haven moraine discussed by Taylor on p. 244, Mon. 53, seems to be merely a part of this bouldery strip in vicinity of Chapin and this bouldery strip passes north of Oakley. I found nothing to indicate that the ice border stood above where Arkona beaches are now developed. It is so much more bouldery north of these beaches across the Chesaning and east part of Else quadrangle than south that I should keep the line of continuation of boulder belts near Chapin below the beaches. The Chesaning moraine and moraine north of Chesaning discussed by Taylor on p. 244 are merely parts of this very bouldery area and are below 700' contour. I should discuss this whole bouldery district as a unit and not attempt to separate it into constituent members. It is likely future visitors or students will see so little topographic evidence for separation that they will wonder why Mr. Taylor made the area so complex. He seems to have made distinctions where there is no essential difference. There is a definitely traceable moraine west of Flushing which rises above land south of it in part of its course. This Taylor considers part of

the Henderson moraine. He thinks this protruded into Flint River Valley at Flushing which is probably the case. It may lie as far east as secs. 29, 20, 17, 16, 9, Mt. Morris, and have a spur extending westward along line of Mt. Morris and Vienna nearly to the twp. corners across secs. 4 & 5, and 33 & 32 into secs. 6 & 31. It seems quite as probable, however, that the ice border crossed at Flushing and ran northward to sec. 2, Flushing, and then eastward past the twp. corners to the recognizable moraine in secs. 6 & 31. The alt. of the till is exceptionally high even where coated with delta gravel and sand causing the marked protrusion of the contours on the east as compared with west side of Flint River. There are many boulders in secs. 29, 30, 31, 32, Vienna Twp., on the slope of the ridge that catches the Saginaw and highest Arkona beach in the latter two secs. Taylor represents this moraine to run past Clio along the line of the Second Arkona beach to connect with the sharp moraine that runs from sec. 32, Arbela Twp., ENE to Millington.

Shore Features in Saginaw Basin in Relation to the Cutting of the Grand River Outlet

The studies in vicinity of the Grand River outlet show Lake Saginaw to have persisted while it was cut from about 730 to 720'. Lake Arkona from 720 to 705' or less; Second Lake Saginaw from about 700 to 685' or less; Lake Warren from 680-685' to about 660'. Inasmuch as this lowering of the head of the outlet was in progress in each of the several lakes that discharged through the outlet it should seem not at all surprising that beaches occur at levels that are below the initial level of a particular lake. Thus Lake Warren may have formed shore features at any level between 680 and 660' and Second Lake Saginaw at any level between 700 and 680' and Lake Arkona at any level between 720 and 700', etc. The presence of beaches at these intermediate levels has been noted in the studies this year in Saginaw Basin and it is probable similar detailed study in the Huron-Erie Basin would show shore work by Lake Arkona and Lake Warren at as many levels as such work in the Saginaw Basin. It is perhaps because lowering of the outlet was from the first in rapid progress that Lake Warren shows so indefinite a beach at its highest level (680') in parts of the Huron-Erie Basin. It is not uncommon to find a better developed beach a few feet lower. Conditions of slope of the lake bed near the shore should also have a marked influence on the strength of beach. Thus there might be shallow water off shore for some distance at highest stage of Lake Warren so the beach is an indistinct feature, but when the lake had been lowered to 670' there might be steeper slope in places along its shore and a better condition for forming a beach, so these places might have stronger shore features than those at 680'. In fact, it is rather surprising that each of the shores is generally pretty strong at its initial height and on the whole much better defined for long stretches than is found to be the case at levels reached in the process of lowering occasioned by

cutting down of the outlet. This remark is applicable in other basins as well as in the one here mentioned.

Lake Arkona shores and shores of the Nipissing Great Lakes show well at levels below the initial level but Whittlesey shows no strong shore features except at its full height. Perhaps the Ugly outlet that controlled the height of this lake was not deepened much because of a sandstone bed near its head that would be eroded very slowly compared with the till or glacial material cut into the head of the Grand River outlet. Each outlet that functioned in the glacial lake history thus needs to be analyzed as to conditions for erosion, etc.

Notes on an Early Report by D. D. Owen

One of the earliest references to the large boulders of NE Iowa is found in Owen's Report of the Chippewa Land District forming Senate Doc. 57, 30th Congress, 1st Session, published 1848 – 72 pages.

On pages 69-70 is the following statement: "On the west side of the Mississippi, in the vast prairie region of Iowa, the attention of the geologist is frequently arrested by erratic blocks of enormous dimensions scattered here and there, and half sunk in the ground. Unlike the boulders we have just been considering (among two ranges in Wisconsin), they are far from their original situation.

As they rise amid the ocean of grass, they may be seen for miles; and, in the absence of more conspicuous objects, they form the principal landmarks of the traveler. The larger of them might, in inhabited country, very well be mistaken for cabins in the distance. The one represented on Pl. 2B was uncovered and found to be 50' in circumference, and 12' high. It is probable that at least 1/2 the rock is commonly buried beneath the ground. Hence, may be gathered some idea of their huge dimensions.

These boulders appear to be most abundant along the route which I travelled between the headwaters of the Wapsipinnicon and the Red Cedar and some 10-15 miles beyond the latter, along a belt which may be 20-30 miles in breadth.

Among the smaller of these erratic blocks there is considerable variety; it is, however, somewhat remarkable that almost every large boulder which I examined in this region is a peculiar variety of porphyritic granite, in which the feldspar is of flesh color, and often in large, regular crystals. Of the granite which I found no place in the interior of the Chippewa Land District along my route to Lake Superior, that which was found in place at the first rapids of the Court Creille River comes nearest to the composition and appearance of these prairie boulders. This, however, can hardly be the source whence they have drifted; for the direction of the belt of erratics does not appear to be transverse to the streams; that is, from NE – SW but rather parallel with them from NW – SE.

The only explanation that is at all satisfactory is accounting for the transporting power which has brought these detached masses of granite rocks into their present position is floating ice – ice drifted by currents setting in from the north, before the land emerged from the ocean in the same manner as, at the present time, thousands of tons of rock are precipitated on the bed of the Atlantic Ocean from icebergs, which annually work their way from the north and melt in southern latitudes. No mere currents appear at all adequate to convey such heavy blocks across valleys, and over hills to a distance of hundreds of miles from the parent rock. Their isolated position in the prairie also indicates that they were dropped into their present situation, rather than rolled into it. Under the latter supposition, even if it were possible, they would probably be closer together, and more regularly assorted as to size."

On p. 26 of this report Owen notes the peculiar steepness of one side of a hill at Red Wing at head of Lake Pepin, then called LaGrange Mt. as follows:

"In some instances the hills seem as if split down in the middle, one side being left standing whilst the other had been entirely carried away. LaGrange Mt., at the head of Lake Pepin, represented on Pl. 6 and the Cape de Killio, below the Wabashi Prairie, may be cited as examples in point."

On p. 64 of the report are notes on the huge pot holes at the St. Croix Dalles???. "On the west side of the St. Croix at the dalles??? 400-50' above the present level of the river are large pot holes, some of which are 20-25' in diameter and 15-20' deep. They seem to have been worn into the solid rock by sand, gravel, and loose rocks kept in motion by circular currents of water similar to those now observed in the river at the head of the Dalles. They afford evidence either of the successive upheavals of the trap, or of the waters of the St. Croix having flowed formerly at a higher level."

On p. 69 reference is made to the loess deposits along the Mississippi as follows: "Finally, the fine siliceous and loamy marls widely distributed in the valley of the Mississippi at an elevation 100-200' above the present rivers, containing cyclostonia, physa succinea, hilices, helicina and planorbis, with occasional unio paludina and melanaca and considered to be of the age of the loess of the Rhine in Germany, afford evidence either of a modern rise of the lands of the interior of the United States, or a subsidence of the waters by an excavation of the fine fresh water and deposits, which may have choked up the valleys."

Notes in report by Dr. J. G. Percival, Wisconsin Geol. Surv. Report for 1854 published at Madison 1855 and called usually the 1855 Report.

Page 30-31 refers to deposits on east bluff of Mississippi River as follows: "In the immediate vicinity of the Mississippi, on the surface of the higher ridges and prairies adjacent, accumulations of drift are found, in some instances quite extensive, composed of a fine

sand, usually yellow or light brown, as if formed from the sandstone adjoining that river towards the north. These are generally arranged in hillocks with intervening round hollows or basins, such as are common in drift districts. (Are these dunes?) This sand on the surface is mixed more or less with mould, forming a light soil, but at a small depth is sufficiently pure for mortar. A tract of 203 sq.mi. covered with such drift, and remarkable for its hillocks and hollows, extends from the bluffs of the Mississippi to the valley of the Great Menominee SW of Jamestown village. (This is just north of the Ill.-Wisc. State line), and similar accumulations are met with on the highlands adjoining the Mississippi between Patosi and Cassville. On the summits of the river bluffs, particularly in the vicinity of Cassville, small rolled fragments of the same material as those composing the gravel drift above noticed, are often profusely scattered.”

Are these pebbles part of the glacial drift extending across the valley into Wisconsin from Dubuque Co., Iowa, or are they older than the drift?

To account for the Driftless Area Percival says (p. 30): “The mineral district does not appear to have been invaded to any extent by the gravel and boulder drift which has covered so extensively other parts of the surface in this and the adjoining states. Apparently the bold escarpment backed by the high ridges and prairies along the south side of the Wisconsin River from a point not far east of the Blue Mounds, has obstructed the course of the drift current and turned it east and south around the east point of the ridge at these mounds.”

In Dr. Percival’s report for 1855, published after his death (May 1856), the following remarks are made concerning the drift: (p. 17). “The surface deposits will form an important section in this report, interesting both in a scientific and economical point of view. For the greater part of the surface traversed is covered with loose materials; the rock formations occurring usually only in ravines and escarpments or traversing the beds of rivers. These loose materials appear to have been deposited partly by a drift current acting over the whole surface, partly by local current along valleys, and partly by sediment from still water, either over an extensive surface, or in limited basins. The boulder drifts accumulated in hills and ridges over the general surface where it prevails, is uniformly arranged so as to exhibit the action of extensive currents and eddies. A smaller drift of gravel and cobbles is found limited to the valleys of rivers and appears to have been formed by the action of currents confined to such valleys. The former currents are analogous to those of an ocean; the latter to those of a strait. In the districts where surface is covered by the boulder drift, the surface conforms to the original drift surface, and has only been secondarily modified by washing.”

He then outlines the drift covered part of the state to lie north and east from a line running from the St. Croix in Pierce Co. in an easterly direction near the falls of the rivers to the valley of the Wisconsin and thence south by

the head of the valley of the Sugar River and Monroe to the south line of the state near Pecatonica River.

Recent earth movements “rock flexure” at Appleton, Wisc., discussed by Frank Cramer, Am. Jour. Sec. 30 Series Vol. 39, pp. 220-225, also “ “ “ “ “ “ “ 41, “ 432-434, 1891.

A somewhat full historical sketch of the exploration in the Great Lakes and upper Mississippi region with several very old maps reproduced, is found in Vol. I of the Geology of Minnesota as prepared by N. H. Winchell.

A more recent work on these explorations is by Louise Phelps Kellogg, entitled “Early Narratives of the Northwest 1634-1699” published by Scribners in 1917. In this work two maps are reproduced – one prepared in 1673 to illustrate Marquette’s discoveries. The other in 1688 a portion of Franquelin’s great map. The former represents the Mississippi from its mouth up beyond the mouth of the Wisconsin, and shows the portage from the Wisconsin to the Green Bay drainage and the portage at Chicago between the DesPlains and Lake Michigan. The latter shows the five Great Lakes – Lac Superior, Lac des Illinois, Lac de Hurons, Lac Erie, and Lac Ontario. Mille Lacs is called Lac de Buade; Lake Nipigon is Lac Alepimigon. The Great Lakes are shown in about their right relative positions and with approximation to the correct shape. Mille Lacs Lake is much out of position and the Mississippi drainage is badly distorted.

The Great Lakes were discovered in the first half of the 1600’s and the Mississippi Valley explored in the latter half. The French were gifted for this task with Imperial designs and visions of future greatness, and they were undaunted by obstacles and hardships.

There were two classes of leaders, the military officers of the colonial troops, and missionaries of the church, both recruited chiefly from the lesser nobility and the higher bourgeois class. Officers and missionaries vied with one another in devotion to duty and the service of the Crown. The founder and forerunner of the discoveries and explorers was Samuel de Champlain. It was he who chose the capitol site Quebec (1608) and who ascended the St. Lawrence and the Richilieu to Lake Champlain in 1609. By 1615 he had penetrated to Lake Huron and explored to east coast and learned of the existence of the other Great Lakes to the west which he was not destined to see. He planted the French flag on Lake Huron before the English had settled in New England.

Jean Nicolet, one of Champlain’s aids, in 1634 carried exploration beyond Lake Huron through the Straits of Mackinac out upon Lake Michigan and into its western arm, Green Bay. Nicolet came to New France in 1618.

Champlain and Nicolet expected to find seas instead of freshwater lakes, and dwellers in Asia instead of the savage tribes. Our knowledge of Nicolet’s explorations comes from reports of missionary operations in North America under the auspices of the Jesuit Order and known as the “Jesuit Relations”. After 1632 all

missionary enterprises in Canada were under the control of this Order. Each year reports were written and then arranged by a Superior into a continuous narrative and published at Paris in an annual volume. These were eagerly read by supporters of the missions and had wide circulation. In 1673 their issue was stopped and later there Relations became very rare. A reprint of the entire series issued by the Canadian Government in 1858 and a complete English edition appeared in 1896 under editorial supervision of R. G. Thwaites entitled "Jesuit Relations and Allied Documents 1610-1791", Burrows Brothers Publishers, Cleveland, Ohio. This was completed in 1903 and embraced 73 volumes. "The Journey of Jean Nicolet 1634" is contained in the Relations of 1642 and found in Thwaites edition Vol. 23, pp. 275-279. It was written by Father Vimont, a friend and admirer of the explorer. Nicolet was drowned in 1642 when on a trip to Quebec.

It is not known whether Nicolet went up to St. Mary's River to the Sault. The first well authenticated trip to the Sault was made in 1641 by Father Charles Raymbault who reached Canada in 1637 and Father Isaac Jogues, a friend and early comrade of Raymbault. These explorers found about 2000 Indians at the Sault and they learned about Lake Superior, a great lake that requires 9 days journey to travel its length. Raymbault died in October 1642. Jogues was massacred by Indians in 1644. The account of this journey to the Sault was written by Father Jerome Lalemant in the Relations of 1642 and it may have been based on narratives by the explorers. It is published in Thwaites edition of Jesuit Relations Vol.23, pp. 223-227.

Two young Frenchmen, Pierre Esprit Radisson and his brother-in-law Medart Chonart, Sieur des Grosseilliers made several exploring expeditions of which the third was into Lake Superior either in 1654-1656 or in 1658-1660, and Radisson wrote of their adventures. The account of this voyage and of three to the Iroquois were written in English for the edification of Charles II whose patronage he desired. Radisson had had some unjust treatment which caused him to leave the French and ally himself with British interests. He sided in founding the Hudson Bay Fur Co. He married an English wife and lived for many years in London on his income from the Hudson Bay Co. and died about 1710.

That they may have explored Lake Superior as early as 1654-56 is suggested by a reference in the Jesuit Relations of 1656 to the return of two travelers that year (not named) who had spent two years in the interior of the country.

Nicolas Perrot was an adventurous woods ranger who lived for 35 years with the Indians and became one of the best informed men of his time on Indian habits and history. Descriptions of his adventures 1665-1670 were published in a History by LaPotherie issued in 1716 in four volumes of which the second and third are made up largely of Perrot's journals. Perrot prepared a Memoire in his declining years which remained in manuscript until

1864. This recounted the customs, costumes, and religion of the American savages. Perrot died in 1718.

Father René Menard, a refugee from the Huron Mission succeeded in 1660 in reaching the shores of Lake Superior and wintered in 1680-1681 at the head of Keweenaw Bay reaching the bay head Mar. 1, 1861. In the spring of 1661 he started into the interior to reach the headwaters of Black River to visit some refugee and was never heard from.

Father Jean Claude Allouez started from the Sault in 1665 and skirted the south Superior shore as far as Chequamegon Bay where he founded a mission. He later (1668) founded a mission at the Sault and after 1669 for nearly a decade he was working about Green Bay. He died in 1689 at a Miami village in St. Joseph River. He is said to have instructed not less than 100,000 savages and baptized at least 10,000 in his 24 years of service.

He speaks of the Sault which he passed in September 1665 as follows: "Such is the name given to a half-league of rapids that are encountered in a beautiful river which unites two great lakes – that of the Hurons and Lake Superior. This river is pleasing not only on account of the islands intercepting its course and the great bays bordering it, but because of the fishing and hunting which are excellent there."

"On the second September, then, after clearing this Sault – which is not a waterfall, but merely a very swift current impeded by numerous rocks – we entered Lake Superior, - - - - - . The form of this lake is nearly that of a bow, the southern shore being much curved, and the northern nearly straight."

"One often finds at the bottom of the water pieces of pure copper of ten and twenty pounds weight. For sometime there had been seen a sort of great rock, all of copper, the point of which projected from the water: this gave passers-by the opportunity to go and cut off pieces from it. When, however, I passed that spot, nothing more was seen of it and I think that the storms which here are very frequent and like those at sea, have covered the rock with sand. In 1667 Allouez crossed Lake Superior passing by Isle Royale and going up to Lake Michigan [Nipigon]." He says of Isle Royale: "Coasting along the northern shore of this great lake on the 23 we passed from island to island, these being very frequent. There is one at least 20 leagues long, where are found pieces of copper, which is held by the Frenchmen who have examined it here to be true red copper".

Allouez later carried on mission work around Green Bay and then at St. Louis on the Illinois (100 leagues above its mouth) and near the close of his life went among the Miami Indians and died in a Miami village in St. Joseph River in 1689.

The first expedition that followed the course of the Great Lakes was under Francois Dollier de Casson, commonly referred to as Dollier, and a mathematician Rene de

Brehaut de Galinée and for part of the journey the later renowned LaSalle, then a youth. LaSalle went no further with them than the west end of Lake Ontario. These explorers went up Niagara River far enough to be within sound of Niagara Falls and mention the falls but they did not get a sight of them. Instead they went back into Lake Ontario and went to west end of the lake and crossed to Lake Erie from there. They wintered on north side of Lake Erie and went on to the Sault via Detroit River, Lake St. Clair, St. Clair River, Lake Huron and St. Mary's River – interesting notes on features along the course being given.

In 1670-71 the French arranged a great pageant for purpose of laying claim to the territory around the Great Lakes and of impressing the Indian tribes and Sault Ste. Marie was the place selected for it. An account appears in the official state papers. Also one by Perrot in his Memoire (see above) and a third by Jesuit missionaries.

Fourteen Indian tribes living within a radius of 100 leagues were represented. The Cross and the King's Standard were set up with due ceremony on the brow of a hill overlooking the village at the Sault. After blessing the cross there was a great shouting and firing of muskets. Father Allouez promised a eulogy of the King.

The headwaters of the Mississippi were known and some eastern tributaries probably visited by Nicolet, while Radisson is likely to have penetrated to the river itself in its upper reaches. Perrot also had knowledge of this river if he did not visit it.

The first mention of the Mississippi by this name was by Allouez in 1669. The first recorded trip along the Mississippi is that of Joliet and Marquette who among their contemporaries stood accredited with the discovery of the great river, though they did not start on their explorations until 1673. Joliet was a political and Marquette a religious representative in this work. Marquette had replaced Allouez in Chequamegon Bay in 1669 and in 1671 he founded the St. Ignace mission on north side of the Straits of Mackinac.

The journal kept by Joliet was lost by the overturning of his canoe near Montreal but that by Marquette was preserved. His autograph manuscript was kept for a century and a half in the Jesuit Convent at Montreal but an abridged form was published in 1681 by Milchesedre Thevenot in his "Recueil de Voyages".

At the time of these explorations by Joliet and Marquette the Count de Frontenac (Louis de Buade) was governor general of Canada serving from 1672-1682 – Joliet received his appointment from Frontenac. He was born in Canada. Marquette was born at Laore in France.

Their route was from Green Bay by Portage, Wisconsin, to the Wisconsin River and thence to the Mississippi. They then went down the Mississippi as far as Lat. 33° 40' which took about a month (from Lat. 42° 30' to Lat. 33° 40'). They started back July 17 and went up the Illinois River and into Lake Michigan and then to Green Bay. The entire trip took about 4 months. Marquette

spent the winter of 1674-75 on the site of Chicago. He started for St. Ignace in the spring in a very enfeebled condition and was rowed along the eastern shore. He died when they had got as far north as the stream not called Pere Marquette. He was buried there but two years later his remains were carried to St. Ignace and buried at the chapel.

Lewis Hennepin was a priest born in Belgium about 1640 who came to New France in 1675 and became chaplain at Fort Frontenac. He accompanied LaSalle to Illinois and then went with an exploring party to the upper Mississippi, was captured by the Sioux and carried past the falls of St. Anthony to which he gave this name. He was rescued by Duluth and returned to Canada and then to Europe where he wrote accounts of his explorations, and giving prominence to his own achievements.

Robert Cavalier de LaSalle accompanied by Hennepin, Touty (an Italian in French military service), and others came to Niagara in the winter of 1678-79 and Hennepin and Touty spent the winter there while LaSalle returned to Fort Frontenac and came back to Niagara in the spring. Touty then went by canoe to Detroit (perhaps LaSalle and Hennepin also). They then took a sailing vessel, the Griffin, from Detroit to Mackinac (LaSalle with them). LaSalle then sailed southward on Lake Michigan while Touty went to the Sault. Later he started for the mouth of St. Joseph River to meet LaSalle who after sending his ship back from Green Bay had gone to the mouth of the St. Joseph.

LaSalle and Touty went up the St. Joseph to the portage at site of South Bend and head of the Kankakee. They descended the Kankakee and Hennepin was then sent to explore the upper Mississippi. LaSalle then made an overland journey in mid-winter of 1679-80 across northern Illinois, Indiana, southern Michigan and southern Ontario to the Fort at Niagara which showed his great physical endurance as well as strong will.

Touty went to Starved Rock near Utica, Illinois, and then built a fort. He then went up the river to Chicago and on to Mackinac where LaSalle eventually joined him. Then they went together in 1681 to Chicago and down the DesPlains and Illinois to the Mississippi. Mention is made of the "River Chicagou" which is by a portage to the Illinois. The party continued to the mouth of the Missouri six leagues from the mouth of the Illinois. They continued 80 leagues to the mouth of the Ohio (called Ouabacke River). They then continued about to site of Memphis 60 leagues below mouth of Ohio River.

They then continued 50 leagues farther to the village of Capa. This was the limit of Joliet and Marquette in 1673 (see above). They then went to Lake St. Joseph in Tensas Parish Louisiana and later continued to the mouth of the river which was reached April 7, 1682. Pieces of pure copper were noted along the Illinois River. There was a Fort St. Joseph built by Duluth in 1686 about where Fort Gratiot now stands. It was

commanded by Baron LaHautau[outan?] in winter of 1687-88 and destroyed by him in August 1688.

LaSalle continued explorations beyond the mouth of the Mississippi in 1687 and made a camp on Garcitas River in Victoria County, Texas. LaSalle was murdered by some of this fellow Frenchmen at a place in Texas thought by Prof. Herbert E. Bolton to be on Brazos River just above the mouth of the Navasota River (see Mississippi Valley History Review, Vol. II, p. 317).

David Greysolow Sieur Duluth was born in a suburb of Paris and his family was connected with that of Touty who spoke of him as cousin. He had access to the court and held a place on the King's Guard, an honor reserved to youth of noble families alone. He had had some military service in France as early as 1674. He had previously visited New France where some of his relatives held offices in the colony. He came to America soon after 1674 and lived in Montreal in a quiet home among the river side gardens. In 1678 he resolved to take up exploration in the Sioux country. He determined to push beyond the great freshwater seas. He explored the coasts of Lake Superior and then traversed the tangle of swamps and lakes between Lake Superior and the sources of the Mississippi and planted the arms and emblems of France in the midst of the Sioux country, probably on Mille Lacs Lake. He succeeded while in this country in rescuing Father Hennepin and two voyageurs with him. In 1686 Duluth built a Fort at the south end of Lake Huron in order to intercept Dutch and English traders who were trying to break the French monopoly of the northwestern tribes. It was at this Fort that Perrot and Touty brought their forces and related to each other the tales of adventure, and made plans for future progress and growth. Through the influence of these men and Duluth, the French empire was maintained in the west.

Duluth built a Fort on Lake Nipigon and explored extensively north and northwest of Lake Superior. In 1696 he was called to command Fort Frontenac on north shore of Lake Ontario with rank of captain. After Frontenac's death he returned to Montreal and died there in 1710.

Duluth made a trip up to Bois Boule cutting through "about one hundred beaver dams". He then had a portage of about a half league to a lake (the upper St. Croix Lake). "which emptied into a fine river which brought me to the Mississippi". This was June 1680. After this he went to the rescue of Father Hennepin and took him to the Fort at St. Ignace. This was not part of his original plan for he wished to push westward to a salt sea said to be only 20 days journey. (If this was Great Salt Lake it was much farther than supposed). It appears that LaSalle made some complaints about Duluth and it is stated that he was a man who could brook no rivals. (See Wisconsin History, Coll. XVI, pp. 107-110, and Louise Kellogg's "Early Narratives of the Northwest, p. 333 footnote).

"With the close of the 17th century the era of exploration and adventure merged into that of exploitation. For 60 years longer, France held the great interior valley of North America. Then it passed into other hands and at present only a few hamlets and a few French-speaking people remain to remind us of the French regime in the American northwest." (Louise Kellogg's Early Narratives, p. 341).

From C.O. Sauers discussion, Bull. 6, Chi. Geog. Society, "A brief discussion of the exploration, settlement and development of this region near Starved Rock in Illinois Valley is given by C. O. Sauer in the Bulletin 6 by Geog. Society of Chicago in "Starved Rock State Park and its survivors and with it a reproduction of two old maps. One being Joliet's map of 1674 from Jesuit Relations and the other Franquelin's map of 1684 from Parkman's "LaSalle and the Discovery of the Great West."

In this bulletin (p. 35) Sauer explains the silt over till on uplands as follows: A great deal of the water from the melting ice sheet "spread in sluggish sheets over the ground moraine of the prairie upland, and there formed beds of mud. Later the wind shifted about great quantities of dust on the bare upland, especially from the heavily aggraded valleys. In these ways a clayey deposit was formed which marked the ground moraine, and which differs sharply in physical constitution from the true glacial drift and has but ill-defined limits of distribution. How much of the clay was deposited by sluggish waters and how much by wind, is unknown".

Estimates of areas of Lakes exceeding 2 square miles area in the districts covered by the report on the Superior Basin:

	Sq.Mi.	Note
Brule Lake in Cook Co., Minn.	7	
Devil Track Lake " " "	3	This district does not embrace northern Lake
Greenwood L. " " "	2	and northern St. Louis
Mid Rice L., St. Louis Co.	2	Counties, nor northwest-
Grand Lake " " "	3	ern Cook County and thus
Big Lake, Carlton Co.	2	does not take in several
Perch Lake " " "	2	Minnesota Lakes and
Island Lake " " "	2	several on the border
Alcock Lake " " "	3	of Canada and Minnesota
Sturgeon Lake, Pine Co.	2	that have areas exceed-
Hobbs Lake, Douglas Co., Wisconsin	2+	ing 2 sq. miles each.
St. Croix Lake, " " "	2+	It also does not include
Pike Lakes, Bayfield Co., "	3	Lakes in Bayfield and
Iron Lake, " " "	3	Vilas Counties that are
Houshagen Lake " " "	6	outside the limits of
Fresque Isle-Van Wert, Vilas Co.	3	the Superior lobe or its
Big Lake - ????	2	outwash.
Crab Lake " " "	2	
N. & S. Turtle Lakes, " " "	2	
Lac Vieux Desert (Vilas Co., Wisconsin & Gogebic Co., Michigan)	6	St. Croix Lake is in the outwash from Superior Lake. These lakes are combined they are at same level and connected by rather broad lines of water.
Long Lake (Iron Co., Michigan & Forest Co., Wisconsin)	2	
Gogebic Lake (Gogebic and Ontonagon Counties, Mich.)	20	
Chicago Lake, Iron Co., Mich.	2	
Indian Lake, Schoolcraft Co., Mich.	13	
McDonald Lake, " " "	2	
Portage & Birch Lakes, Houghton Co.	20	
Brevort Lake, Mackinac Co.	5	
S. Manistique Lake, " " "	5	
Manistique Lake, " " "	15	
N. Manistique Lake, Luce Co.	2.5	
Lake Betsey, " " "	2	
Siskowit Lake, Isle Royale	2	
Lake Desor, " " "	6	
Geblet Lake, Keweenaw Co.	2	
Independence Lake, Marquette Co.	2	
Lake Michigamee, " " "	7	

There are probably at least 100 lakes in this district with areas exceeding a square mile, and 1000 lakes large enough to show on maps. But the combined area of the 1000 lakes may not be much more than 500 square miles.