

Notebook No. 270 - Leverett

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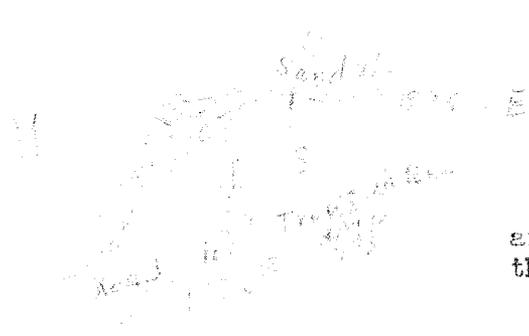
See also...

NOTEBOOK NO. 270 - Dr. Leverett

Shore features west of Trout Lake, Michigan, Aug. 17, 1919.

The divide crossed by the DSSS A RR 150 from Trout Lake separates the waters of Lake Michigan and Lake Superior yet it is swampy and very flat after one passes the sand ridges in about a mile from Trout Lake. At the west end these sand ridges connect with a gravelly beach that is about 860'. It is 23' by hand level above Mile Post 448 on Soo Line RR. It does not cross the RR but swings west and runs parallel with it $2\frac{1}{2}$ -3 miles west of Trout Lake near north end of a private road 2 miles west of Trout Lake and $\frac{1}{2}$ mile from the RR there is a clearing and farmhouse which has three gravel bars of same altitude about 860' which come together at the west end of the prominent belt of sand ridges thus:

Sketch 2 miles west of Trout Lake



These gravelly bars are about the same altitude as the divide NW of Trout Lake Two.

Limestone Ledges

I am told that the wagon road runs west on line of secs. 17 & 20 and across south part of sec. 13, T 44, R 6 N, has a gravelly ridge along or near it that is of similar height to that I noted this afternoon in south part sec. 16 and NW of sec. 21. At the west end of this road by a lumber mill near center of sec. 13, limestone sets in. There is a railway spur in

to this mill from the DSS& A leaving it in sec. 7 and crossing SE corner of sec. 12 and ending near center of sec. 13, T 44 R 7 W. A man at Trout Lake who owns land SW of Kenneth says there are ledges from Kenneth SW to SW corner sec. 29, T 43 R 5 W near bank of Carp River. The limestone strip is a mile or more wide. The limestone is buried under a gravelly outwash farther south & west. This high gravel plain extends east on the road north of Brevoort Lake about to the corner of secs. 16, 17, 20, 21, T 42 R 5 W. Farther east there is lower land with boulders and clay and mucky wet land. It is nearly level about like that crossed by the DSS& A for several miles NW of Moran. The same man says there is a road south for $1\frac{1}{2}$ miles from Fiborn quarry across Wamarack swamp. It then runs west a mile on drier land but with swamp close by on the north - then it runs south to Caffey.

On railway train west from Trout Lake. I took evening train west on Soo Line RR. The benches show up well on N-S road on line of secs. 20 & 21, T 44, R 6 W - one at level I noted in sec. 21 @ 16 at 360'+ - and another a few feet higher (notes Sept. 11 & 12 indicate bench 635'+ near Rexton). Knolls of bouldery drift occur for 2-3 miles west from this place. There is then mainly swamp nearly to Caffey. Limestone hills south of track from near Caffey westward to Rexton - morainic? topography from Rexton about to Garnet. There are knolls 15'+ high with steep slopes. Many boulders including limestone blocks. (Notes Sept. 11 indicate lake covered all these knolls). Rock may occur near level of base of knolls. This area seems not to be above Lake Algonquin for some notching was noted on knolls south of Rexton that makes it seem possible lake action extended to higher altitude than Rexton Station.

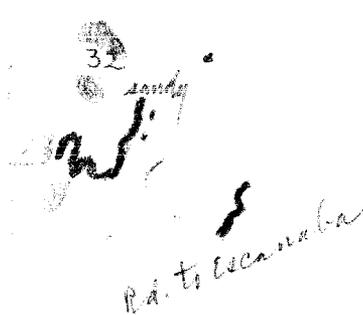
There is a hotel at Rexton so this may be used as a base. (See notes made about 1905 on shore lines south of Rexton and on trip Rexton to Hendricks?? quarry - and numerous nob?? rocks?? that jar??? in Chippewa and Mackinac Cos.) Much rock is exposed around Garnet. (See notes Sept. 11)

Beach runs west from Garnet at a level 5' above station. A mile west it is 1/3 mile north. Bouldery land for a mile further. The sandy ridges in hardwood belt to west border SW of Gilchrist, also in the pine stump land to Hille Conquinner Lake. Limestone ledges set in within 1/2 mile of Engadine - some swamp between there and Gould City. Limestone area for 2 miles west from Gould City. Largely swamp westward past Hunt's Spur and Blaney Jc. nearly to Whitedsh or L en??? - sandy to Manistique. Much flooded area north of track 2 miles east of Manistique due to raising dam on the river at Manistique. (See notes Sept. 10) (Becomes dark here).

Esker near Bark River

Aug. 18, 1919. Bark River, Mich. (Delta Co.).

Esker NE of Bark River in sec. 5, T 38 R 24 W and sec. 32, T 39 R 24 W. Height 15-30' Very narrow. Encloses basin at No. end of West fork. Cobbly on surface. Sandy beneath. Sandy at No. end of East Fork.



Mr. R. W. Peterson joined me at Escanaba and we took train to Bark River. The hill in NW part of village on which schoolhouse stands has limestone at surface and is 30'+ above Bark River Station. It is elliptical NE-SW and thus nearly conforms in trend with neighboring drumlins to the west.

There is slightly hummocky land in a few places NE and east of Bark River aside from the eskers above sketched but most of the dry land has a nearly plane rather smooth surface like ground moraine. There are a few drift knolls as noted in map in west part of sec. 5 and east part of sec. 6 among smoother ridges of drumlinoid type. In secs. 3, 4, 5, the knolls are usually elliptical from NE - SW and so are those in NW part of sec. 10 and NE of sec. 9, T 38, R 24 W.

Drumlin

One crossing line of secs. 3 & 10, west of the middle looks as much like a drumlin as any in the secs. noted north & east of Bark River. It is 1/2

mile or more long and 40-50 rods wide. There are two ridges farther east, one in east part SE $\frac{1}{4}$ sec. 3 and one crossing line of secs. 2 & 11 that have tall birch timber. There is a swamp of black spruce in much of sec. 10 - only the west part & NW corner being dry land. The ridge shown in sec. 15 is very prominent and still covered with hardwood forest. There are a few low wind-drifted sand ridges in SE of sec. 4 and SW of sec. 3, T 38 R 24 W along south side of a swamp that extends west from Norenta??Wovental?? to Bark River (stream). South from Bark River village there is knolly drift in NW $\frac{1}{4}$ sec. 8 with gravel in some cases. The SW $\frac{1}{4}$ has a large drumlin ridge trending NNE - SSW. There is another nearly in line with it in west part NE $\frac{1}{4}$ sec. 17. These stand 30-40' above plains each side. The plains are boulder strewn but have very little undulation.

Esker

The east part sec. 17 and nearly all of sec. 16 are low and probably were covered by Lake Algonquin. There is a short esker ridge east of center of sec. 18 with nearly N-S trend. It is about 15' high and steep sided. In SW part of SE $\frac{1}{4}$ sec. 18 is a group of knolls from the north end of which there is a steep sided gravelly ridge running about 60 rods north - that may continue the esker just noted.

Drumlins near Border of Lake Algonquin

There is a limestone ridge just south of corner secs. 17, 18, 19, 20, that stands higher than average level of surrounding land. A hummocky ridge runs east 1/4 mile into north part NW $\frac{1}{4}$ sec. 20 that may have limestone base but the hummocks are drift.

There is knolly land in SW $\frac{1}{4}$ sec. 17, low knolls 10-15'±. In SE part of sec. 17 is a till plain and the east half of sec. 20 is level with till near surface. It was probably covered by Lake Algonquin. There is a prominent ridge of drumlinoid form extending SSW for a mile from SW part sec. 15 into SE $\frac{1}{4}$ sec. 21. It has a small drift hummock at its south end 15' or so higher.

The drumlin part is about 30-35' high. There is a low sandy strip along its east side that seems likely to have been covered by Lake Algonquin. It is about a mile west of the Algonquin bar that I traced in 1912 SW from near Ford River into NW part of sec. 23.

Notched Drumlins

There is nearly plane surface with till subsoil in much of secs. 28 & 29, most of it below Lake Algonquin level. A knoll near center sec. 28 rose 15'+ above the lake and has a notch at east end 10'+ above border lowland. There is a drumlinoid ridge in NW part of sec. 28 that runs 60 rods WNE into SW part of sec. 21. It is fully 30' above border plains and was surrounded by Lake Algonquin. We went from this ridge by an old logging road SSE to middle of line secs. 28 & 33 across land with till subsoil & very little undulation and low enough to be covered by Lake Algonquin.

There is a cluster of knolls in NE $\frac{1}{4}$ sec. 33 60-70' higher than border plains, or higher than any noted elsewhere today. From this knolly tract there is a ridge running SSW across east half sec. 33. It as well as the knolls was surrounded by Algonquin waters.

We find the slopes notched at the lake level.

Mapping Algonquin Beach

We found the Algonquin Beach blocking Bark River like a barrier near east end of line secs. 28 & 33. It is fully 30' above the stream in NE corner sec. 33. It is 10-12' above lowland NW of it. It runs NE across NW part sec. 27 & SE part sec. 22 so as to nearly connect with the bar traced into sec. 23 in 1912. It stands several feet above the plain west of it and there is a gentle eastward descent from it across the hardwood tract in secs. 23, 26, 27, 35. This is much lower than I had supposed from the land plats. I am told this Algonquin beach runs south into north part sec. 4 T 37 R 24 W a short distance from south end of the till ridge above noted.

Notched Drumlin

There is a large tract south from there with blueberry marshes and sandy or gravelly ridges that is not easy to trace shore lines across. The west part of sec. 32 T 38 R 24 W stood above Lake Algonquin and there is a drumlinoid ridge running across NW part of the sec. and ending in South part SW $\frac{1}{4}$ sec. 29. It is steep sided on the east and seems to have been cut into by Lake Algonquin. There is a tract in NW part sec. 5 T 37 R 24 W that stood above Lake Algonquin. It is undulating hardwood. I could see into it from corner of secs. 29, 30, 31, 32, T 38 R 24 where the highway ends on line of sec. 5 & 6 T 37 R 24 W.

Much of sec. 32 is low wet land below level of Lake Algonquin. There are a few drift hummocks in SW $\frac{1}{4}$ sec. 19 T 38 R 24 but most of the sec. has gentle slopes and runs 30'± in altitude.

Drive from Bark River to Shafter & Perronville.

Aug. 19, 1919. Bark River, Michigan.

We drive north on line secs. 5 & 6 on road travelled yesterday for a mile. (See notes). We cross a low gravelly ridge 1/4 mile north of town line not over 5' high and 10 rods wide looking like a beach but more probably esker. It bears slightly south of west into sec. 31, T 39 R 24 about 30 rods and dies out on a till plain. It extends scarcely 20 rods into sec. 32. So does not connect with esker noted in south part SW $\frac{1}{4}$ sec. 32 (See Aug. 18). We pass a few hummocks of drift 10-20' high in NW part sec. 32 & SW corner sec. 29 that are gravelly but also have till where opened for road material. There are only occasional low drift knolls scarcely 10' high elsewhere in sec. 29.

A half mile west of Shafter and northward from there to Alecto?? are small hummocks 10-15' high but otherwise there is a plain surface. Some rock is exposed among these knolls near Alecto??. There is a very prominent drumlin over a mile long running from south part NE $\frac{1}{4}$ sec. 30 SSW past center

of sec. 31, T 39 R 24 W. It stands 30' or more above the plain east of it. NE of Shafter is swamp in secs. 16, 17, 20, 21, as indicated in my copy from land survey plots.

East of this I found morainic topography in 1912 but west of it is a till plain extending NW to Perronville. There is a swampy strip along Ten Mile Creek 1/8 mile or more wide in secs. 11 & 12, T 39, R 25 W but till plains farther back. A ridge 1/2 - 3/4 mile east of Perronville is drumlinoidal. There is a short esker at Perronville 20' high trending NNE - SSW for 60 rods_±. It reappears south of Ten Mile Creek in a short ridge 50-60 rods. There is a high tract SW of this crossed by the road on line of secs. 10 & 11, that is not an esker!

There is a low flat ridge in its north base that stands 8-10' above wet land north of it that may be connected with the esker and be a spread out SW terminus of it. South of this hill there is a till plain in secs. 14 & 15, T 39 R 25 W with only a few low swells scarcely 10' high. The wet land is 10-20' below the general level of the till plain. West of Perronville in the SW₁ sec. 2 are gravelly knolls of kame rather than esker type 15-20' high. The dry area around corners of secs. 2, 3, 10 & 11 is cobbly sand 8-10' above level of Ten Mile Creek.

Mr. Peterson went west on line of secs. 3 & 10 to prominent knolls. There are sharp ones?? not of esker type but more like kames in SE part of sec. 4, NE of sec. 9 and NW of sec. 10. The highest are about 50' but others are 20-30'

Features near Whitney

Between Perronville and Whitney the knolls are chiefly gravelly and elongated in same direction as the drumlins NNE-SSW but are not typical eskers. They are very bouldery & cobbly. They are in low areas and rise 10-30' or more above the level land. Most of this level land can be cultivated for it is not boggy land. It is partly mapped as swamp tho' really draining well, when cleared.

There is a drumlin immediately north of Whitney in NW part sec. 24 & extending into sec. 27, T 40 R 25 W. Another smooth ridge with trend ENE-WSW lies in NW part sec. 27. There is a prominent drumlin a mile west of Whitney in NE part sec. 32.

We drove 3 miles NW from Whitney to within a mile of Dryads?? and found drumlinoid ridges alternating with spruce & cedar swamps all trending NNE-SSW. The swamp areas are so extensive that but little of this country between Whitney & Dryad is cleared & cultivated. The Whitney farm has 1000 acres under cultivation and there are 40 acres in orchard. Apples here bear yearly instead of biennially. This farm is now owned by the National Pole Co. of Escanaba and has a superintendent, Mr. Householder.

We drove a mile west from Whitney crossing low drumlins 10-20' high with NS trend. There is a more prominent one in NE part sec. 33 about 35' high. There is also one in south part sec. 33. We went south through a till plain for about a mile. Then followed a low drumlin across SE part sec. 5 T 39 R 25 W. There are low hummocks near its north end in east part sec. 5 but generally the lower land is flat. We go east crossing the north end of a high drumlin just east of corner secs. 4, 5, 8 & 9, T 39 R 25. It is 35-40' above a stream west of it and fully 1/2 mile long. Trend is about S 15° W into east part sec. 8. In SW $\frac{1}{4}$ sec. 4 is a hill about 90' high a kame elliptical in NE-SW direction. There are winding gravelly ridges and knolls with till and boulders and much cobbly material in secs. 3, 4 & 10 as noted this morning. We drive east across the tract Mr. Peterson walked over this morning and south on line secs. 10 & 11 where I drove this morning. We continued south crossing a drumlinoid ridge near middle of line secs. 14 & 15 that trends ENE-WSW for nearly 1/2 mile along south side of a wet area and standing 20'+ above it.

SE of this in west part sec. 14 is a sharp esker - like gravelly string of knolls 1/3 mile long with NE-SW trend.

Features near Eustis

There is a till plain from here to a high knoll west of road and stream near middle of east side sec. 22. It is over 50' above the stream and covers 15-20 acres. There is a still more prominent knoll in NE part sec. 27 about 60' high elliptical in NNE-SSW direction. There is also a knoll in south part sec. 22 west of the creek (Forty Swan Creek).

We turned east on line secs. 23 & 26 into a strip of gravelly ridges and knolls, some of esker type that run from center of NW $\frac{1}{4}$ sec. 26 into SE $\frac{1}{4}$ sec. 23. The knolls have much bouldery and cobbly material and some till. Much of sec. 23 is swamp and also much of sec. 25. There is a till plain in sec. 24 except a few low knolls north and east of Eustis Station. This station is south of center of sec. 24, not at west side as shown on Highway Map. There is also no road along south side of Soo Line RR in sec. 23.

We went south across a tract of bare limestone on low ground near center of sec. 25. There are two abandoned farms in here. A drift cover sets in near south side of sec. 25. There is a slightly undulating ridge with drumlinoid type running from SE part of sec. 25 nearly to center of sec. 36. Swamp land each side is extensive and 20-25' lower.

In south part sec. 36 is a small drumlin but SE of it is one of the smoothest sloped drumlins I have seen. It runs south past SE $\frac{1}{4}$ sec. 36 T 39 R 25 W, half a mile SSW. There the slopes change to an undulating type as if low drift hummocks had been dropped on the drumlin, and this runs into north edge of sec. 12, T 38, R 25 W. There are gravelly knolls in chain parallel with this and east of it in SE part sec. 1 and NE of sec. 12.

Notched Drumlin

We went west to a prominent drumlin 25-30' high whose south end is at Harris Station and north end a mile NNE in west part sec. 1. This

This drumlin has a notch across it like a stream channel that had cut half way down to the base but whose bed is 10' or more above low ground both east and west. A strip of low gravelly knolls or slight ridges comes in from the east to this notch as if they had been formed by a stone under the ice sheet which continued west across the drumlin. There is no continuation of this gravelly ridge west of the drumlin and but little material spread out at west end of the channel that crosses the drumlin.

We went north to center of sec. 2, T 58 N 25 across a tract of bare rock in which large masses of protrude 2-5' above the rest of the rock surface. These seem to be in situ rather than boulders of limestone. It seems strange they were not broken up by the over-riding ice. There is perhaps an eighth of the sec. with this bare rock. We went west to line of secs. 2 & 3 to a drumlinoid ridge that has low swells dotting it as if laid down on a drumlin base. It trends NNE-SSW for 1/3 mile. West of it on SW 1/4 sec. 3 is a smooth drumlin 20' or more high and nearly 1/2 mile long. We can see high land to the north near corner secs. 26, 27, 34 & 35 T 59 N 25 but it is not clearly drumlinoid. It looks to be gently undulating and not sharply morainic.

Features near Harris

We drove south on line secs. 2 & 3, 10 & 11, over the NE end of a drumlin that runs SSW to the C&N RR a mile west of Harris. It is 20-25' high. South and SE of its south end there are low hummocks with some gravel and cobble. One in NE of SW 1/4 sec. 10 looks like a sharp esker about 40 rods long with E-W trend. These low hummocks abound along the railway from here east to Bark River. There is swamp just south of the RR most of the way from Harris to Bark River. They are seldom more than 12-15' high and in some cases less than 10'. The limestone ledge that outcrops at Bark River schoolhouse also runs SW and outcrops on sec. line road west of Bark River 1/4-1/3 mile. I found no striae preserved as it is badly weathered at top.

Studies near Powers & Spaulding

Aug. 20, 1919. Bark River, Mich. We take train at 7:30 A.M. to Powers on C&N.W. R.R. From there we go south $1/2$ mile and then east across drumlins to the head of Cedar River in NW part of sec. 22, T 38 R 26 W. East of this head is a ridge that I had been told carried an esker on top of a drumlin. There is a sort of hummocky veneer and the ridge is sharp and is composed of stony material but it is not a typical esker. It is not much different from undulating surfaces of other drumlinoid ridges. This ridge, however, is steeper than most drumlins or such like an esker in form but not in structure. There is a lower one east of its south end, that is fully as sharp as an esker but is made of bouldery drift - better classed as stony till.

To the SW is a prominent steep sided drumlin with smooth surface. It is as steep as an esker and 30' high. It is in east part sec. 22. We went SSW from this drumlin past one farther east that runs SSW from center sec. 22. The west half sec. 23 has a large cedar and spruce swamp that extends NE into sec. 14. There is also swamp in SW part sec. 14 & NE of sec. 23. These swamps are each side a chain of drumlin ridges.

In sec. 27 there is a small drumlin east of center and two extending from south part of the sec. into sec. 24 & east part $NE\frac{1}{2}$ of 23. In sec. 28 there is a drumlin on south part and another in NW part running NNE nearly to center of sec. 21. There are two other drumlins east of this in SE part sec. 21 and one in west part sec. 22.

There is a crooked gravelly chain of knolls in west part sec. 21 mainly east of the N-S highway. There is a strip of swamp along a stream west and north of this esker-like chain of knolls in sec. 21 and SE part sec. 20. A drumlin lies west of it in east part of sec. 20.

The north part of sec. 20 is largely swamp and it includes a small lake. There is a small drumlin in Powers and another in line with it to the

SW in SE part sec. 17. The depot and much of the village of Powers are on low ground nearly swampy with higher land both east and west. In the afternoon Mr. Peterson made a trip from Spaulding around to Hermansville and back while I made a similar circuit SE of Powers.

Striae

I followed the C&NW RR 3 miles east and passed three exposures of glaciated limestone surface, one at east edge of Spaulding in ditches at side of the highway. Bearing nearly due SW another with similar bearing about 5/8 mile east in south part sec. 10, a third near center of sec. 11. In all cases in the ditches at side of the highway, in low ground, only a few feet above Cedar River rock is exposed along Cedar River in its bed and banks at the bend in NE corner sec. 22 visited this morning. I saw no glaciated surface there.

Studies near Powers

In secs. 11 & 12 there are numerous small drift hummocks 10' or less and in NE part sec. 11 two about 25' high. They are bouldery cobbly gravelly knolls not of good esker type but more like moraine topography. There are also knolls in the tract north of bend of Cedar River along line secs. 14 & 15. I went south crossing Cedar River near corner secs. 11, 12, 13 & 14.

There is a full???free???frie???drumlin SW of here in NE part sec. 14 that is 25'+. A larger one 35-40' high runs across NW part sec. 13 from south part sec. 12 into sec. 14. There is a large swamp SE of it and south along line of secs. 13 & 14, 23 & 24 for about a mile.

A large drumlin leads??? heads??? SSW across west part of sec. 24. It is 25-30' high. It runs into sec. 26 and has a length of 1 1/2 miles. East of it in south part of sec. 24 is a short esker with NNE-SSW trend. It is 15'+ high and 1/3 mile long.

Near corner secs. 23, 24, 25, 26, is a flat tract in which rock is

struck at 2 to 5' so post holes often strike it.

A large drumlin 45-50' high, crosses the NW part of sec. 25 into east part of sec. 26. I can see another a mile east running from SW part sec. 19 into NE of sec. 25. It lies east of a small lake around which the road swings in NE part of sec. 25. I can see another drumlin in west part sec. 30. There is knolly drift near corner secs. 25, 26, 35 & 36 - knolls 15'+ high. In most of sec. 25 & 36 the surface is nearly plain and part of it in NW of 36 & south of 25 is wet land.

There is a very prominent drumlin 50-60' high in east part sec. 35 & smaller ones west of it, one being north of the E-W road and the other south of it, with some drift knolls at north end and north of road. There are drumlins in SE and in SW part of sec. 36 and I noted one in north part sec. 2, T 57 R 26 W.

Trend of Drumlins

There is a long drumlin running NNE-SSW across sec. 34 passing a little east of center. Another nearly 1/2 mile long runs through the north part sec. 34 & another crosses NW corner. In sec. 33 a drumlin with NE-SW trend runs through the center. Three others to the south, one in sec. 33 and two in sec. 4 have a trend about S 60° W or more to the west than any I have seen elsewhere near Powers. Drumlins farther west in sec. 32 and in sec. 5 trend about NE-SW.

There is a gravelly ridge west of center of sec. 32 that is not of esker type but has the NE-SW trend of drumlin and has in places a smoothed appearance. It may be partly of till.

I returned to Powers along the highway from the south passing drumlins and an esker chain already noted.

Esker & Notched Drumlin (See Russell Report)

Mr. Peterson found a small esker $\frac{3}{4}$ mile north of Spaulding with a sinuous E-W course. It is nearly $\frac{1}{2}$ mile long, 10-20' high and very sharp and ends at a drumlin at the west. Later we found it continued west of the drumlin opposite a notch.

Striae

He crossed 5 drumlins on line of secs. 4 & 9. One is 50-75' high and has a small one or double ridge perched on its crest. Striated ledge bearing NE-SW about 300' east of corner secs. 4, 5, 8 & 9.

From Cedar River west to within a mile of Hermansville he passed only one drumlin, a small one. The land is level with sandy loam soil very little clay. Immediately east of Hermansville are 2 good drumlins. For $\frac{1}{2}$ mile east of Hermansville is flat land not swampy, soil loose-textured.

Little esker-like ridge 300-400' long in west part SW $\frac{1}{4}$ sec. 13 trends N-S 15-25' bunched up at south end. Two good drumlins in sec. 24. The west one crosses into sec. 23. A few hummocks along or near line secs. 13 & 24, T 38 R 27 W.

A good drumlin runs into sec. 13 from the NW part sec. 18, 30' \pm high. Two medium sized ones in south part sec. 18. One in sec. 19 near center. One of smooth slopes and even top runs past corner secs. 17, 18, 19, 20. One runs NNE-SSW near center sec. 17 from RR south about to south line of section. My map notes a fluted drumlin about midway between Powers & Hermansville that is very long $1\frac{1}{2}$ miles \pm extending from near center sec. 8 into north part of sec. 18.

Structure of Drumlins

The drumlins of this region have a large percentage of local limestone as coarse constituents. The red superior sandstone is rather conspicuous in them and in the general drift sheet. Boulders on the general drift sheet are largely granite - there are also local limestone slabs.

Eskers are generally capped by coarse material with a few boulders in some cases. The drumlins are not uniform in structure there being changes from stony layers almost like gravel to clayey or to sandy drift with but few pebbles. The most clayey parts show a sort of lamination as if the material had been plastered on. The imbedded stones also lie flat in the drumlin and seldom are on edge. This seems to favor the view that they are constructive features rather than sculptured out of a drift that once stood as high as their crests or higher, as Russell supposed. (See report for 1906 Mich. Geol. Survey). Eskers are not so uniform in trend as drumlins but have a general SW course in this part of Menominee Co. The drumlins and striae harmonize in direction pretty closely.

Studies near Nadeau

Aug. 21, 1919. Powers, Michigan. Mr. Peterson & I take train to Nadeau. Mr. Peterson examined district east for 2 miles. I went north a mile then east 2 miles and south a mile to join him. He found several drumlins in sec. 17 and some errors in location of streams. I found a sharp narrow ridge immediately NW of Nadeau in SE part sec. 7, T 37 R 26 W running SW for 1/4 mile. It is not opened, however, so I am not certain that it is of gravel. In NW part of sec. 8 there are gravelly esker ridges that lie mainly west of road and form a network over about 40 acres. In the SW part of sec. 5 are drift knolls without drumlin form but in SE $\frac{1}{4}$ sec. 6 are 2 drumlins.

I turned east on line of secs. 5 & 8 and rose to a prominent drumlin that extends SSW to Nadeau. From it I sketched drumlins in north part of sec. 5. I continued east to another drumlin at corner secs. 4, 5, 8 & 9 which is 3/4 mile long. There are extensive bogs NE of it in sec. 4 and SE in sec. 9 more than half of each sec. being wet land. There is a drumlin in NE part of sec. 4 and one in north part of SE $\frac{1}{4}$. A hummocky ridge extends from south part sec. 4 southward into sec. 9. Mr. Peterson found a drumlin running SW from center of sec. 9 & 5 more parallel with it in SW of sec. 9 and NW of

sec. 16. In secs. 3 & 10 are numerous drift knolls 10-20' high (in SW half of sec. 3 & NW half of sec. 10). The NE half of sec. 3 & SE half of sec. 10 have much wet land. There are 2 drumlins in north part sec. 2 and one in south part, but most of the sec. is level and rather wet. There are prominent drumlins in sec. 15 and west part sec. 14, in some cases 75' or more, possibly 100', above low tracts. The largest drumlinoid hill is in NE part sec. 21. It is nearly 1/4 mile wide including slopes & over 1/2 mile long. Possibly it has a limestone nucleus. It is over 100' high. SW of it is a tract of hummocky drift in much of west half of sec. 21 with ridges 15-20' high.

Striae?

Limestone is exposed in roadside ditches on line of secs. 20 & 21, near quarter post. It has been glaciated but the lines are weathered out. I think I detect a few of the coarser ones, with NE-SW trend.

Features near Bagley & Carney???

There is an outcrop on south side of E-W road north of center of sec. 20 near a church. This stands several feet higher than the road. It is shelly rock at top so I find no striae.

There are two fine drumlins in sec. 20 one running SW from near center and the other NE from a little east of center. There are prominent drumlins south and SW of Carney???, each side of the C&NW RR. I followed the RR southward to Bagley while Mr. Peterson went west from Carney. There are small drumlins in central & south part sec. 30.

An esker starts a little SW from center sec. 30 & runs for about a mile to east part sec. 36. It has been opened for road ballast???, in sec. 36 and at other points. Its general course is about SW. Around its SW end is a sandy plain that was timbered with pine occupying east part sec. 36 but there is a swamp south of it in SE part sec. 36. A drumlin runs SW from near center of sec. 36 nearly to SW corner.

There are 3 drumlins on the east and south part of sec. 25 with NE-SW trend. A short esker ridge about 1/4 mile long runs from south part SW $\frac{1}{4}$ sec. 25 southward into NW part of sec. 36. There is a drumlin in NE part sec. 35 and one in west part but most of the sec. is gently undulating till. So also is sec. 26. There is, however, a large drumlin NW of the center of sec. 26.

There are 2 drumlins extending from SE part sec. 27 into north part sec. 34. Two drumlins in west part sec. 34 extend into east part sec. 33. There are 2 in south part sec. 33 extending a little beyond the line into sec. 4. There is a large drumlin running from NW part sec. 33 into SE of sec. 32.

Along Cedar River in secs. 27 & 28, 31 & 22, are knolls 10-25' or more high giving a morainic aspect.

Features near Bagley

There are drumlins west of Cedar River in secs. 21 & 28 and west part sec. 22. I went to corner secs. 27, 28, 33 & 34 then north a mile and then east to join Mr. Peterson at corner secs. 22, 23, 26 & 27. There are two small drumlins in north part sec. 27 that extend but little into sec. 22. There is a more prominent one at corner secs. 22, 23, 26 & 27 lying mainly in SW part of sec. 23. Mr. Peterson passed over about a dozen drumlins in coming from Carney??? to this one. There are seven that lie wholly or partly in sec. 24 as indicated on county map. We went north in sec. 23 & 14 near west side and crossed 5 narrow drumlins in a space of 1/2 mile mainly in SW $\frac{1}{4}$ sec. 14. Some of them are about as narrow as eskers but have the smooth drumlin outline & are composed of till. On the Nadeau farm which embraces sec. 15 & parts of other secs. there is a good deal of nearly plane surface. Two drumlins were noted, one east of center of sec. 15, and the other south.

There is an esker 1 $\frac{1}{2}$ miles long extending from SE part sec. 2 SW across sec. 11 into NE corner sec. 15. It is 10-15' high and opened for gravel at SW end. There is mainly swamp in secs. 2 & 3, NW part sec. 10 and north part of sec. 11 and west part of sec. 1. Also in north part of sec. 12

and between drumlins in south half of sec. 1. There are several drumlins in west half of sec. 6 T 37 R 26 W and an esker in the NE $\frac{1}{4}$ of sec. 6 traversing swampy land in NE-SW course. In the south part of sec. 6 and north of sec. 7 there is a hummocky tract $\frac{1}{3}$ mile+ wide that looks morainic. The knolls are scattered over south part sec. 7 & north part sec. 18 and extend a little into secs. 12 & 13.

We took evening train back to Powers from Nadeau. We mapped today the surface features in NW half of T 37 R 26 W and in the entire east half of T 37 R 27 W. I am told by Mr. Fontanna, proprietor of hotel at Powers that a drumlin lies east of the lake in SW part of sec. 29 T 38 R 26 W and area??? NW of it in east part sec. 30. Much of sec. 30 & 31 is flat rather wet land. Secs. 29 & 32 are mainly good farm land.

Striae

Aug. 22, 1919. Powers, Mich. We go west on C&NW to station (8 mi.) - Cunard???Curwood??? Station. Around this station rock is at surface and shows SW striae just south of station on east side of N-S road.

Features near Faithorne

There are drumlins south and east of here with trend about S 50-60° W. There are smooth troughs between and some are fluted. We went south 3 miles over alternating drumlin and flat strips. The flats are partly swampy. From here we can see and sketch in drumlins in secs. 9 & 16, 8 & 17. We went west along Soo Line RR through a swampy tract between or among drumlin ridges to the twp. line. There is a crooked small gravel ridge of esker type crossing and recrossing the track over the town line. From secs. 12 & 13 westward to the Menominee River there is somewhat morainic topography. In some cases there seems to have been a drumlin on which the morainic material was dumped so as to make the slopes and crest hummocky. There is a drumlin in east part sec. 14 that is not covered with morainic material. We reached Faithorne for dinner. (See notes Sept. 5 on drumlins south of Faithorne Jc.Ⓞ).

Features Near Waucedah

We followed the road bed of Wisc. & Mich. RR northward to the wagon road that runs NE to Waucedah. The hills for a mile out from Faithorne both to the north and SW are prominent and likely to have a rock base. They rise 100' or more above Faithorne Station which is in a valley. Some are smooth like drumlins. As far north as the county line the drift is similar in texture to what we have seen farther east there being clayey and stony material rather than sandy. But on turning NW into Dickinson County the drift becomes sandy and we enter an outwash plain in SW $\frac{1}{4}$ sec. 29, T 39 R 28 W.

Striae

We find striae on a low rock base??? where the railway grade crosses the wagon road in west part sec. 29 bearing S 75° W. It is on a greenstone rock. We found another exposure with similar bearing about 1/2 mile ENE near the east edge of the gravelly outwash. We enter morainic drift in the NE $\frac{1}{4}$ sec. 29, which continues to Waucedah. About 3/4 mile south of Waucedah is a drumlinoid ridge with trend about S 75° W. There is a farm cleared here, the first seen since leaving Faithorne Jc. There is somewhat morainic topography for 3 miles east of Waucedah as noted in 1912 but with drumlins interspersed. We caught an auto ride from Waucedah to Norway. The pine plain sets in on north side of Hamilton Lake near its east end and extends to within 1/2 - 3/4 mile of Loretto.

Waucedah to Norway

There is a till ridge with undulating surface from Loretto eastward with sandy plains both north and south of it. This district is opened for iron from Loretto westward. The Loretto Mine is NE of the village - another mine immediately south. There is not enough drift on the rock range NW from Loretto to cover the rock, so large bare places are exposed.

There is sandy and sandy gravel material banked around the rock ranges from here to Norway. Some of it is bouldery and hummocky but most of it is outwash. At Norway we get in touch with Gordon Murray, Supt. of the Oliver Mining Co., at Norway and he outlines the position of the supply roads that lead into the lumber camps of the Oliver Mining Co. in northern Menominee County. We returned after dark on train to Powers.

Near Stephenson

Aug. 23, 1919. Powers, Mich. We took morning train to Stephenson. It leads through drumlin and esker strips about to Daggett. But knolls are of ~~max~~ morainic type between Daggett and Stephenson from railway west a mile or so. East of the railway there are drumlinoid ridges extending past Stephenson. There is an esker in SW part of Daggett running NNE-SSW and links of esker are found southward across NW part of sec. 11 into east edge of sec. 10 near quarter post. There is a crooked chain of esker ridges in sec. 14 crossing the track and running south. In and around Stephenson there is loose-textured drift with some boulders in it but mainly cobbly and gravelly. There are shallow basins and a few low knolls and ridges but the surface is nearly all place. I went $1\frac{1}{2}$ miles north of Stephenson and then west through a knolly tract that seems likely to be a moraine. It may, however, be only a narrow strip following the Cedar River. I turned south at middle of line secs. 9 & 10 and came into a drumlin strip on line secs. 15 & 16 with smooth troughs between drumlins.

To the east the dry land is knolly and moraine-like so there drumlins do not occur in east half of secs. 15 & 22. There is a large amount of rather wet land NW and west of Stephenson and some dry level ground. This dry ground is generally gravelly. There is a gravelly plain in south part of sec. 10.

Mr. Peterson examined a district NE from Stephenson and found drumlins as well as eskers, and some knolly land of morainic type, also considerable wet land. In the afternoon Mr. Peterson worked SE of Stephenson

while I went south to Ingalls then west to Menominee River and south along the flume?? below the dam to the Power Plant of the Menominee & Morinette Co. just above the mouth of the Cedar. I found less sandy plain on east side of the Menominee than I expected. There is till clear to Cedar River in SE part sec. 27 and in sec. 34 and in the point west of Ingalls on west side of Cedar nearly to west end of the line of secs. 3 & 34. There is a strip of dunes in Sth part of sec. 33 and NE of sec. 4 west of which the land is sandy where not wet, but much of it is alder swamp in Sth sec. 33 and north part of sec. 4. Farther south sandy land occurs in the space between the Cedar and Menominee Rivers and in places there are dune ridges. Just above the mouth of the Cedar on NW side of stream, dunes are 40'+ high. From here I can see a brushy sandy hill 2 miles SW on the east or Mich. bank of the Menominee about 1/2 mile above the bridge, probably in NW part of sec. 21. It looks to be fully 50' high.

There is a very narrow sandy plain south of the mouth of the Cedar scarcely reaching to the east side sec. 16. Till there sets in which is 20-25' above the low sandy plain along the river. The plain at mouth of Cedar is 20-25' above the river. There is a low flood plain also. .

I should have noted that I passed a drumlin on bank of Menominee River about a mile north of the mouth of Cedar River standing 20-25' above the sandy plain. There is a drumlin in SW part of sec. 10 and one near center sec. 15 with small ones. Most of the land in these secs. is nearly plane till with a pitchy deposit of sand. There is a prominent drumlin east of the railroad in the NE part of sec. 10 from which we overlook the sandy plane to the west.

Features near Ingalls

There are two prominent drumlins in the SW part of sec. 11 where the land survey has swamp indicated. The swamp sets in at NE end of these drumlins and extends a mile north into SW part sec. 2. Swamps are narrower

in secs. 10, 14 & 15 than indicated on land survey plats. There is till at or near surface in much of the area marked as swamp and it is none of it boggy - so far as I am able to see.

From NE corner sec. 10 I went east $1\frac{1}{2}$ miles crossing the swamp on line of secs. 2 & 11 above noted, and small drumlins in these secs. and west part of sec. 12. There is a very prominent drumlin in $NE\frac{1}{4}$ sec. 12 fully 60' higher than swamp to the east. This is a large swamp covering about $1/8$ of sec. 1 and much of sec. 31 to the NE. I went north across sec. 1 over the large drumlin, then west into Ingalls. There is a drumlin $1/2$ mile SSE of Ingalls which has a very steep NW side or slope and a much gentler SW slope thus:
It looks as if part of the NW slope has been cut away by the glacial action. There is a very flat tract for 60 rods NW of the base of the drumlin. For $1/2$ - $3/4$ mile NE of Ingalls the topography is knolly or morainic but farther east and north drumlins give most of the relief. Mr. Peterson mapped some large ones 75'+ high in the district NE of Ingalls. He noted a small esker in north part sec. 31 that ends in a swamp at the south.

Features Near Stephenson

My trip this afternoon indicates that there is no moraine along and west of the railroad from Ingalls to Wallace Station and as far west as Menominee River. The moraine that I noted west of Koss in 1912 seems to cross into Wisconsin and run west of south across Marinette Co., Wisconsin. In the village of Stephenson there is generally a gravelly-cobbly material nearly plane, but shallow peaty basins and sloughs?? accent. It is all cultivable, however, and in a ditch a block west of the hotel there is 12-15 inches only of the peaty muck over the till. Knolls and low ridges of gravelly material 5-15' high also occur in the part of the village west of Cedar River.

Sunday, Aug. 24, 1919. Stephenson, Mich. I went directly west on 1/4 line road 2 miles crossing an esker near center of sec. 22 that is 10-20' high and 1/4 mile± long, composed of very stony material. It forks and has spurs even in this short space.

There are two drumlins in west part of sec. 22 and two near center sec. 21 and one in NW $\frac{1}{4}$ sec. 21 and a more prominent one in SW part of sec. 21, its SW end being just east of a schoolhouse. Two small drumlins run ~~it~~ into sec. 29 from NW $\frac{1}{4}$ sec. 28.

There is knolly drift near center of SW $\frac{1}{4}$ sec. 21 and in NW $\frac{1}{4}$ sec. 28 with numerous boulders. A very prominent drumlin runs SW nearly across SW $\frac{1}{4}$ sec. 28. South of it is a smaller one crossing the line of secs. 27 & 28. Low gravelly ridges and knolls are scattered over the SW $\frac{1}{4}$ of sec. 22. They usually have gravel core but a stony cover. West and south from the area examined there is a large amount of swampy land in secs. 19, 20, 29 & 30, T 35 R 27 W. The sandy plain along Menominee River seems only to reach the south part of secs. 28, 29 & 30. In secs. 21, 22 & 28 there are flat mucky areas but most of this land has been cultivated and some of it now has timothy and clover meadow and looks like the bordering till plain. Poplar, alder, cedar & spruce are growing in the flat mucky ground.

I went up the east side of Cedar River for 2 miles above Stephenson. The drift knolls are present among drumlins and in some cases on them so that the surface has a morainic aspect. Mr. Peterson reports that knolls were observed yesterday in his studies east of Stephenson on many drumlins and among them - more than he has seen elsewhere. Possibly a morainic strip runs SE toward Green Bay from just above Stephenson. There is an esker running E-W from east side of sec. 14 to Cedar River and nearly in line with one noted yesterday west of the river a mile north of Stephenson Station. Mr. Peterson crossed an esker yesterday north of center of sec. 13 which was heading toward the one I have just noted but he did not trace it through as it was in a

cedar and tamarack swamp. I came to another esker that runs SW from the SW part of sec. 12 across SE corner of sec. 11 into a spruce and poplar swamp. It may continue into NE part of sec. 14. Drift knolls are prominent on the high ground in east part of sec. 11, some being 25' high and aspect is morainic.

With Prof. Muma East from Stephenson

Aug. 25, 1919, Stephenson, Mich. Mr. Muma, Supt. of Schools, took Mr. Peterson and me in auto east from Stephenson. We crossed a tract with a few drumlins and scattered knolls as far east as secs. 23 & 26, T 35 R 26 W. There we came to a swamp that was under Lake Algonquin. There is a large bar east of here in secs. 18, 19, 30 & 31. The wagon road in sec. 19 follows it pretty closely. It lies within 60 rods west of the N-S quarter line road in sec. 30. There is a gap of about 1/4 mile in NW part sec. 31. It then runs along or near the N-S ~~1/4~~ 1/4 line road in sec. 31 to the Ingallston Twp. line. Then it runs SW across NW part sec. 6, T 34 R 25 W.

There are two knolls 25-30' high in west part sec. 19 of drumlinoid type very bouldery. These seem to be the easternmost ones near this road to Cedar River. There is sandy land all the way to the bay from the Algonquin bar. A gravelly bar probably Nipissing is crossed about 2 miles west of Cedar River. It has cobble and coarse material in it. Within 1/2 mile east, probably in east part sec. 21, is a limestone outcrop in a low knoll 5 - 6' above the swamp.

Another Nipissing gravel bar comes to the road from the SW near west end of line of secs. 22 & 27 and follows the road NE to the central part of sec. 22. The creek that forms the outlet of Hayward Lake there breaks through it. The continuation is in bars in north part sec. 22 and east of center of sec. 15 into SW part of sec. 10 T 35 R 24 W.

There is a low gravelly shore along the shore road SW from Cedar River not more than 10-12' above the level of Green Bay. There is a bouldery ridge setting in 1/2 - 3/4 mile SW of Cedar River village that is 20-23'

above Green Bay and flat topped. The Nipissing shore ties onto west end of it and is about 15' above the lake.

Extent of Lake Algonquin in Southern Menominee Co.

Mr. Hama says the road that runs west on line of secs. 8 & 17, 7 & 18, T 34 R 24 W is sandy clear back to the Algonquin beach in secs. 1 & 12 T 34 R 25 W. We come to a bouldery tract north of Arthur Bay in sec. 19 or 20, T 34 R 24 W that is similar to that near Cedar River being about 20' above the level of the bay and flat topped.

From Arthur Bay to Menominee the road is generally on a low beach 8-10' above the present water level in Green Bay. The land is wet most of the way back to the Algonquin shore & dry strips usually stand less than 10' above wet land. As noted in 1912 the wet land from Arthur Bay SW to Birch Creek Station has usually a clay subsoil of red color but the ridges have loose-textured drift with some entirely of sand. The wet land has cedar, spruce & some birch & poplar. The ridges have hemlock, birch, maple, etc. I saw scarcely any pine until within 5 miles of Menominee.

The City of Menominee, as noted in 1912, stands on a deposit of sandy material of Nipissing age as far west as the railway where it crosses the river. West from this is a rise to Algonquin beaches at the Agricultural School and golf links. The golf links are at the highest shore, the Agri. School on a lower one, rather like an off-shore sandy bar. It does not run continuously like a beach. We come to a well defined beach on the old State road south of the center of sec. 33. It runs SW from there to a sandy knoll in the bend of the river at the golf links in sec. 5, T 31 R 27 W and runs NE across SE part of sec. 28, NW of sec. 29 and SE of sec. 22, crossing the C & NW RR in the east part of that sec. near the E-W quarter line road. It runs across NW corner sec. 23 into SW $\frac{1}{4}$ sec. 14. West of this is another shore that runs NNE across the SE $\frac{1}{4}$ sec. 32 and NW $\frac{1}{4}$ sec. 23 crossing the old State road near the line of secs. 28 & 33, T 32 R 27 W. A bar runs SW from

here to a bouldery knoll in NE part of sec. 33. West and south of this knoll is a till plain that may have been submerged at highest stage of Lake Algonquin. There are sandy ridges capping the gentle swells of till along east side of a creek in sec. 32 and the east slope of the knolly strip seems in places to be notched or to be filled in by shore action. Perhaps the knoll in NE of sec. 33 stood above the lake while everything SW except sandy knoll in the river bend in sec. 5 was covered by Lake Algonquin. There is a sandy bar from the knoll in sec. 33 NNE to one in west part of sec. 28 just west of the old State road. East from this is a strong shore line running nearly north and passing west of center of sec. 28 and connecting at the north near the north quarter post of sec. 28 with a knolly bouldery strip of morainic aspect.

Extent of Lake Algonquin in Southern Menominee Co.

A ridge branches off from this south of the center of sec. 28 and runs toward the NE corner of the sec. Mr. Peterson traced this ridge NNE to the E-W quarter line in sec. 22. The outer shore probably of about same alt. is the bar just noted runs north through the east part of sec. 21 and across SE corner sec. 16 into west part of sec. 15, T 32 R 27 W. There is a very knolly bouldery strip of morainic aspect just outside this shore in secs. 15, 16, 21 & 28 that is less than 1/4 mile in average width. There is a swamp west of it covering a large part of sec. 21 and south part of sec. 16. There are gravelly knolls in SW corner sec. 21. West from this as far as Little River in secs. 20 & 29 there is a very gently undulating tract in which the till has a thin coating of windblown sand. It is a very fertile farming district for the sand usually is only 2-3'. This sand seems to have blown in from the Menominee valley.

We crossed Little River on line secs. 20 & 29 and after passing over a sand covered till for about 1/4 mile we made a descent of 6-8' to the highest terrace of Menominee River. We returned to east side Little River and went north on old State Road through a fine farming district to the north side of

T 32 R 27 W. The sandy veneer is on the till all along the east side of the Little River. In some cases there is a slight shaping into elliptical knolls or very low ridges with NE-SW trend but not as pronounced as in the type drumlin area to the north of Ingalls. This sort of feature occurs eastward to Birch Creek Station.

There is a sharp bouldery ridge on which the church stands $\frac{1}{3}$ mile east of the station which runs SW $\frac{1}{2}$ mile to the railroad. It is as sharp as an esker but seems to have till and boulders as well as gravel & cobble, and is like a narrow morainic ridge. On its east slope is the highest Algonquin shore. It runs parallel with the angling road in sec. 2 and a few rods west of it. The level of this shore is by hand level about 5-6' above base of rail at Birch Creek Station. There is a strong Algonquin beach parallel to the highest shore and about $\frac{1}{8}$ mile east of it in sec. 2. This continues SSW across NW $\frac{1}{4}$ sec. 11 and is likely to run to sec. 22 where Mr. Peterson traced a similar one. Lake Algonquin seems to have covered a swamp in sec. 10 and may have covered the long swamp running S^s through secs. 3, 9, 16 & 21. But a chain of glacial ridges lies east of this swamp from sec. 3 to sec. 28. ^{These???} ~~There???~~ in sec. 3 and NW $\frac{1}{4}$ sec. 10 have the smooth gentle slopes and an elliptical NE-SW form that allies them with faint drumlins. Those farther south from sec. 10 to sec. 28 are hummocky and of morainic aspect.

Morainic Features

We noted hummocky land in central part of sec. 16 nearly surrounded by swamp and there is undulating surface in south part of sec. 9 and north part sec. 16 in a beech and maple strip. There is not so clearly outlined a moraine here as I had expected to find after my reconnaissance in 1912. We took the evening train from Birch Creek to Stephenson, passing through a gently undulating tract to within a mile or so of Wallace. There were conspicuous knolls and definite drumlins set in. We passed an esker about $\frac{1}{2}$ mile long $1\frac{1}{2}$ miles No. of Carbondale in SE part sec. 34 T 34 R 27 W. There are also

prominent gravelly knolls and ridges about a mile south of Wallace and northward from there.

Studies near Hayward Lake

Aug. 26, 1919. Stephenson, Mich. We went with Mr. Kuma SE to the swampy tract crossed around Hayward Lake, our course being east one mile, south $1\frac{1}{2}$ miles, east one mile to NE corner of Miller Twp. There are several drumlins in sec. 25 and two in NW $\frac{1}{4}$ sec. 36.

We went south a mile then east on line of Ingallston & Stephenson twps. 2 miles. We passed several medium sized drumlins and turned south on one at NW corner sec. 4, Ingallston Twp. We passed through a knolly strip near corner secs. 4, 5, 8 & 9. There are only a few low swells in the dry areas in south part of secs. 8 & 9 and north part secs. 16 & 17.

Much of sec. 16 is sandy plain but little above the swamps that surround Hayward Lake and likely to have been covered by waters of Lake Algonquin. We went east across sec. 16 and came into very stony land a few feet higher than the sandy plain before reaching line of secs. 16 & 15. East of here is a strip of swamp that extends south across central part of sec. 15. The swamp is below Algonquin level but this stony land may have stood a little above it. There is a prominent ridge traversing the central part of sec. 15 that is narrow but is of till and smooth like a drumlin. The north end is prominent and marked 70' on map. A settler says the high hill drops off rapidly at the north end $\frac{1}{2}$ mile from Hayward Lake but it slopes down more gently to the south.

Algonquin Beach

East of this ridge is a swamp only $\frac{1}{4}$ mile wide in sec. 22 and east of this a knolly strip that runs NE across NW part of sec. 23 into south part of sec. 14. This has gravelly knolls and till knolls and a morainic aspect.

There is a peaty bog about 1/2 mile wide east of this knolly strip which is held in by the Algonquin beach. We traced this beach from NE $\frac{1}{4}$ sec. 23 northeastward to a strip of hardwood in SW part of sec. 13. This hardwood strip runs north across sec. 12 into sec. 1 and is about 1/2 mile in average width. The Algonquin shore seems to be along its east side. There are ridges marked 40' in this strip.

Features along Shore of Lake Algonquin

It is probable the Algonquin shore follows the east side of this hardwood to sec. 1. From there the bar I crossed yesterday on line of secs. 19 & 30 and traced south about to line of secs. 1 & 6 will connect with this shore. There is a knolly strip in SW part of sec. 23 that the Algonquin bar ties onto and runs south through west part of sec. 26 crossing the road to Arthur Bay 2 3/4 miles from the bay shore close to west side of sec. 26. We followed the state road SW across sec. 22 to west side sec. 27 through a gently undulating till tract of good farm land on which there is an occasional sharp gravelly knoll 20' or more high. Within 1/4 mile east of this road is the swamp that marks the west limit of Lake Algonquin. No definite beach is developed here, however, for the bar to the east above noted, broke the force of the waves.

We turned east in sec. 27 and crossed a low ridge of esker type that lies along the old shore, so that the waters of Lake Algonquin reached its base and found a slight sandy strip there. The esker is 10-15' higher. Near the center of sec. 27 we crossed a low till strip 10'+ above the swamp. This only extends 1/4 mile north of the road but runs south to south side of sec. 27. East of this is swamp to the Algonquin bar in west part of sec. 26. A farmer living on this bar says it runs south through west part of SW $\frac{1}{4}$ sec. 26 but is unable to give its course farther south. (Mr. Paulson, co. surveyor, says it runs south to NW part sec. 2).

We went back to center of sec. 27 and took a road and trail south to a lumber camp (now abandoned) in sec. 34. This till strip only extends to edge of sec. 34. We there find some sandy land on its border marking work of Lake Algonquin but not a strong beach. We continue south about to the town line between tps. 33 & 34 and line of secs. 3 & 34 to a definite old shore that is crossed here by an N-W logging road.

We followed this road westward bearing south of west for perhaps 3/4 mile to a hardwood ridge of till about at line of secs. 3 & 4 but our road here has passed west of the Algonquin bar. The road now runs SSW along the east side of this till ridge and we followed it for about 3/4 mile probably reaching the NE part of sec. 9. We there come to a logging road running NW and followed it making some north courses until we come to the limit of Lake Algonquin in the south part of sec. 33 near quarter post. It is not marked, however, by a definite ridge or beach so there is likely to be a bar still farther SW than our course or somewhere in sec. 9 that protected this part of the shore from wave action. We came to the old angling State road in NE part of sec. 32 and followed it SW to the road that leads west to Carbondale Station. There is undulating till along it and for 1/4 mile west but a large swamp there sets in that includes Grassy Lake and this seems to mark the limit of the morainic strip. The high parts of secs. 6 & 5, T 33 R 26 W are of morainic type but there is a large amount of swamp in sec. 5. We went west to Carbondale over a knolly tract with some short gravelly and cobbly ridges, one being near the west end of line of secs. 1 & 12, T 33 R 27. The knolls usually cover only a few acres but are quite sharp rising to a height of 20-25'. They occur west of Little River near Carbondale as well as east. The stream is in a narrow marshy strip with wild grass on its borders. We stop for the night at Carbondale with Mr. Gouley.

Features near Carbondale

Aug. 27. Carbondale, Michigan, Menominee County. There is a very sharp gravelly & bouldery set of ridges 1/2 mile south of Carbondale in west part NW $\frac{1}{4}$ sec. 11 24 - 25' high. There are lower ones across the RR track in sec. 10. There are low swells for the next 2 miles to Hansen Station in NE part of sec. 22.

We go east to State road at center sec. 24 passing a smooth drumlinoid ridge in west part sec. 24 trending NNE-SSW for over 1/2 mile. The surface is more hummocky along the State road from here north. I went north a mile and then east to center of sec. 17 before I reached the Algonquin shore. There are sharp morainic hummocks along the State road but 1/2 mile east the ridges are drumlin-like and I pass three side by side in central part of sec. 10. East of these there is wet clay land to a ridge near center of sec. 17 on the east side of which I find shore action. A knoll about 40-60 rods NE of center of sec. 17 rises above Algonquin level and I am told by Mr. Miller who lives near center of sec. 17 that there are ridges of till on line of secs. 16 & 17 near north end that rise above the Algonquin shore.

Features near Border of Lake Algonquin

Mr. Peterson went east to the last high ridge which is in west part of sec. 20. From there east the land is level except for low sandy ridges. He did not see a definite gravel beach but is confident this is where the waters of Algonquin reached. The ridge in west part of sec. 20 has many loose limestone slabs on it and other stones. There are a few sandy spots but the land generally is clayey till across sec. 19.

A man living in sec. 24 tells us that there are small tracts of dry land with some boulders here and there in the old lake bed east from where Mr. Peterson and I have been similar perhaps to what we crossed Aug. 25 on the bay shore road north of Arthur Bay on line of secs. 19 & 20, T 34 R 25 W. It is probable that Algonquin waters covered low areas like that in west part of

sec. 17, T 33 R 26 which I crossed this morning but there is no definite shore action on the borders, the knolls to the east having protected these places from strong wave action.

We continue southward on the Old State Road across sec. 25. We find a boulder pavement east and south of a drumlin near line of secs. 25 & 36 about 60 rods east of this road and we noted a cut bank close to the road for 1/4 mile in west part of sec. 25 due to Lake Algonquin. There is also a boulder pavement at middle of west line of sec. 36 where a road leads east. East of this is considerable complexity. A large bar runs NNE-SSW across sec. 36 passing just west of the center. It is cobbly with large rounded?? rolled?? stones 8-10 inches in diameter and has but little firm material where crossed by the E-W road just west of center of sec. 36. Farther south in sec. 36 and in sec. 1 of the twp. south it is capped by dune sand the ridges being 10-15'.

Features near Border of Lake Algonquin

West of this at corner secs. 35 & 36, 1 & 2, is a till island that rose several feet above Lake Algonquin. There is morainic surface at the church 1/2 mile east of Birch Creek Station. Possibly some wave action occurred along the east base of this ridge. There is a group of gravelly knolls 3/4 mile north of Birch Creek. But north from there for 3 miles there is gently undulating till alternating with strips of swamp all trending NE-SW as shown on land survey plats. Ridges are usually only 15-20' above swamps. We went west on line of secs. 10 & 15 and about to middle of line of secs. 15 & 16 being in swamp most of the way for a mile. There is then a strip of till shaped like drumlins on east side but flat on top that lies east of the west branch of Little River. It is 1/4 - 1/3 mile wide and runs to center of sec. 16 and to east side of sec. 9. There is a broad tamarack swamp along the Little River extending nearly over to the Old State Road. The swamp east of here has a sharp gravel knoll west of middle of line of secs. 10 & 15 fully 30' high crossed by the road.

We returned to the highway along C& NW RR and went north past Carbondale to Wallace. There is knolly land around Carbondale but much swamp north and west. At the twp. line $\frac{3}{4}$ mile north of Carbondale is the south end of an esker that is $1\frac{1}{2}$ miles long, its north end being in the SW part of sec. 26. It is very sharp and 15-25' high. East of it in SW part of sec. 35 is a sandy gravel plain with a tamarack swamp on its south border extending eastward well into sec. 35 and north ~~part~~^{part} of sec. 2. The esker is in a swamp from quarter post of secs. 34 & 35 northward through NW $\frac{1}{4}$ sec. 35 into sec. 26.

Features near Wallace

In secs. 26 & 27 there are several sharp gravelly knolls and ridges some 40-50' high that include a little till with the gravel & cobble and seems to be kames rather than short eskers. These ridges continue into Wallace in NW part of sec. 23. West of Wallace $\frac{1}{2}$ mile is a sandy strip that has the appearance of being wind shaped. There are sand blowouts on it. It lies in central part of sec. 22 and runs N-S for $\frac{1}{8}$ - $\frac{1}{2}$ mile. The gravelly ridges and knolls only extend about $\frac{1}{2}$ mile east and north of Wallace. There is a swamp east of the gravelly ridges along a tributary of Little River in secs. 14 & 23 and NE part of sec. 26. East of this there is good farming land across secs. 24, 13, 18 & 19. Swamps there set in as noted yesterday and the lowland between them is sandy. There is good farm land in secs. 5, 6, 7 & 8 and north part of sec. 17 but secs. 4, 9 & 16 are mainly wet or poor sandy land. There are extensive swamps in secs. 20, 21, 29 & 30, separating what is known as the Greenwood settlement or farming district from the district to the west near Wallace and northward from there across NE Milton & NW Ingallston twps.

Studies in Southern Menominee County

Aug. 28, Stephenson, Mich. Mr. Peterson and I take morning train to Birch Creek and walk west from there to the State Road along the line between twps. 32 & 33. There are drumlinoid ridges with NE-SW trend for $1\frac{1}{2}$ miles. We

then come to the marshy tract along Little River. Just before reaching the State Road we pass short gravelly ridges both north and south of this line.

We follow the old State road south a mile through gently undulating till-like ground morainic. We then go west across Little River and find drumlinoid till ridges with NNE-SSW trend in SE part of sec. 6, T 32 R 27 W and follow this strip southward through east part of sec. 7 and central part of 18. The drumlins continue to south part sec. 18. There are drumlinoid ridges in east part of NE $\frac{1}{4}$ sec. 13.

There are very extensive swampy tracts west of this drumlin strip while east of it is lowland partly swampy to Little River. This drumlin strip is only 1/4 - 1/2 mile wide. The dry land in SE $\frac{1}{4}$ sec. 12 and NE $\frac{1}{4}$ sec. 13 has patches of sand on till but is fair farm land. There is also a slight sandy coating on the drumlin belt in south part SE $\frac{1}{4}$ sec. 7 and in sec. 18. There is gently undulating till in sec. 19 and in SE part of sec. 24 near Menominee River standing 30'+ above the river level. The terrace marking highest river action is about 20' above present stage of the river. There is a sandy plain with jack pine and Norway and a little white pine in W $\frac{1}{2}$ sec. 13 T 32 R 28 and north part of sec. 24. We turned south in sec. 13 to the river at mouth of a small creek in sec. 24. The till swell in sec. 24 lies east of this creek.

About a mile above here in east part of sec. 14 we cross a sharp esker 20' high that runs south to the river. About 1/4 mile farther is a till swell near center of sec. 14. Across Menominee River from here to the SW is a till swell at the river bluff and the river has cut into it exposing boulders. It has also on this side the river. Most of the fractional sec. 14 is a sandy plain with jack pine and so is sec. 11 except in the NW corner where there is a till tract fully 40' higher than the river and 20-25' above the pine plain. It extends into the SW corner of sec. 2. A man living in the NW corner of sec. 11 says the strips of dry land east from here in the swamps have a bouldery till. Most of the S $\frac{1}{2}$ sec. 2 is sandy pine plain but the N $\frac{1}{2}$ is mainly

undulating till with some shaping into drumlinoid form. This till tract covers more than a square mile in north part sec. 2, west part sec. 36 and SE part sec. 35. The highest points are 50' or more above the river. It is nearly all under cultivation. The soil is rich clayey to sandy loam. The north part of sec. 35 is pine plain with poor sandy soil and is not cleared. There is good farm land in SE part sec. 26 and the good land extends east from here across sec. 25 and into sec. 30. It is interrupted by swamp in SW part sec. 25. There is red clay in the low ground in north part sec. 26 and NW of sec. 25.

Along Menominee River

A very sharp stony knoll 50' high stands in the north end of sec. 26 and is the cause for the westward deflection of the river. We noted an esker on the Wisconsin side of the river opposite the middle and south parts of sec. 26. It is 25'+ high and trends about N-S for nearly 1/2 mile. About 2 miles farther south opposite secs. 3 & 11, T 32 R 28 W we noted drumlinoid ridges on the Wisconsin side with NNE-SSW trend. The Menominee River has a remarkably small valley in the half dozen miles we have followed it being usually 1/2 - 1/3 mile wide and 20'+ deep. The stream occupies nearly half the valley. In places till swells appear on opposite banks less than 1/4 mile apart. The pine plains that extend back between the till swells are mostly on the Michigan side. I went no farther up the valley than south part of sec. 24 at a church. This stands on a drumlin and there is some shaping into drumlin form in several other places from here south into sec. 2, T 32 R 28 W. The trend is NE-SW in most cases but in SE part sec. 25 and in west part sec. 36 it is more nearly NNE-SSW. The same is true in sec. 19 & 30 of T 33 R 27 W. The residents say there is a narrow strip of ridged drift along the east side of the river nearly all the way up to the bridge west of Wallace. There are farms as far up as sec. 31 & 32, T 34 R 27 W from sec. 24, T 33 R 28 W nearly continuously.

Studies in Southern Menominee County

But for 2 miles above or nearly to the bridge the land is undeveloped. There are farms near the bridge and eastward to Wallace. Some of this land along east side the river is described to be stony clay loam - some as sharp gravelly ridge. I went east from the church $2\frac{1}{2}$ miles to the State road at south side sec. 20, T 33 R 27 W. Sec. 19 has swamps in the NW part and SE part but a strip of drumlin land crosses its central part from NNE-SSW and continues across east part of sec. 30 and east part of sec. 25. Sec. 30 is largely swamp (tamarack). There is an esker which has its SW end in this swamp. I traced it for over 2 miles or to east part sec. 17. It crosses the State road a few rods south of the cross roads in north part of sec. 20 and runs across the ~~SW~~ sec. 17. It may continue into a swamp in sec. 16 along west branch of Little River but is not visible from the State road. It is 15 to 35' high and exceptionally steep sided. When at the crossroads at line of secs. 20 & 29, T 33 R 27 W I could see another large esker 25-35' high a mile south running SW across NW part of sec. 32 into sec. 31. There is also in line with it to the NE in NW part of sec. 29 a lower esker 10-15' high and about 1/4 mile long. The large one to the SW is over a mile long. How far it extends into sec. 31 was not determined.

Northward from sec. 20 for $3\frac{1}{2}$ miles there is gently undulating till with sandy spots and low sandy ridges probably drifted over by wind. They are 5-15' \pm high and tend to give the surface a more uneven undulating character than the till has. The sand is not of a kind and thickness to have much if any bad effect for farming and there is a prosperous farming community here - and westward to the river. But on entering T 34 R 27 W there is a poorer soil and mainly light sand for two miles. It has an occasional low swell with boulders but generally there is sand nearly free from pebbles and in places drifted into dunes. There are swamps each side this State road in north half of sec. 33 but the road is on a sand ridge.

There are prominent gravelly and sandy knolls NE of the bridge in west part sec. 21 rising 30-50' or more above the plain and 50-70' above the river. There are smaller ones east and south in sec. 21 and NE part sec. 29 which are under cultivation.

There is a gently undulating sandy tract from these ridges eastward to Wallace where gravelly ridges set in and run south (as noted yesterday) to the twp. line. Only a small part of this is cultivated land. There is good farm land in north part of sec. 23 but the south part has light sand though the east part is more or less gravelly. I took an evening train from Wallace to Stephenson but Mr. Peterson went to Carbondale and then to Menominee for the night. I walked 18 miles this afternoon and reached Wallace at 6:10 P.M. I made a distance of 7 $\frac{1}{2}$ miles in the last 2 hours 4:10 to 6:10 P.M.

With Numa Northwest from Stephenson

Aug. 29, 1919. Stephenson, Mich. Mr. Numa took Mr. Peterson and me by auto over a district lying NW from Stephenson as far out as the Menominee River west of Nathan. We went first westward to Koss??? crossing a swamp on line of secs. 20 & 25, 19 & 30. There are low sandy spots in it 5-10' high. In west part of secs. 19 & 30 sharp ridges of stony material set in. They are morainic and only in short secs. have resemblance to eskers. There is morainic country west from Koss??? to the great bend of the Menominee with soil ranging from clay loam to gravelly and very stony material. We went to a farmers in NE $\frac{1}{4}$ sec. 27 who has ranged over this region and he says the distribution of swamp land is shown fairly well on the Land Survey plats. One exception is in sec. 22 which has a few sharp knolls and ridges out in the swamp. He thinks the land in this moraine for several miles west from his place will be suitable for agriculture like his own farm which is very productive.

We went from here to Langrie??? and then to Kells keeping near the inner border of the moraine. There is a very prominent morainic ridge

immediately west of Kells 60-70' high and very stony. It trends N-S. West of this ridge is a sandy plain extending to a creek in sec. 10. It is not typical outwash but has occasional boulders. There may be some loam in the soil for the vegetation is thrifty. After passing the creek we are in a nearly plane tract of sandy gravelly land for about a mile. We then cross another morainic strip in sec. 4 along east side of a south flowing stream. It is scarcely 1/2 mile in width, and seems to run N-S parallel with the stream.

Studies NW from Stephenson

The pine plains west of this stream (Shaky River) have a few bouldery knolls scattered through them and are not typical outwash. The surface is not aggraded or built up to an even-surfaced sloping plain but has draws and depressions in which there are clayey and bouldery strips and the whole surface is slightly undulating. - Where we crossed from sec. 33 northward across secs. 28, 20 & 17. There is knolly land along line of secs. 7 & 8 and very prominent moraine in sec. 6, T 36 R 28 W and in the bend of Menominee River in secs. 31 & 32, T 37 R 28 and sec. 36, T 37 R 29 W. Points on it are 80-100' above the river. There is a nearly plane tract of sandy gravel in sec. 29 and west half of sec. 30, T 37 R 28 W and in SW part of sec. 21 more like outwash than most of the so-called Pine Plains. There is strong moraine in east part of sec. 21 and in sec. 16 with knolls fully 100' above Menominee River.

There is a little cultivated land in sec. 29 but general cultivation of land only extends 1 - 1½ miles west of Nathan. There is a prominent ridge immediately east of Nathan 60 - 75'± high but south from Nathan there is nearly plane land with good soil and a few cultivated areas.

We went south from Nathan to Banat and found nearly plane surface and some clayey soil. A drumlinoid ridge lies in east part of sec. 12, T 36 R 28 W and there are a few other ridges scattered along east side of railway north of Banat. We turn SE in SE part sec. 12 and run to center of sec. 20

(T 36 R 27 W) passing a striated limestone outcrop near corner secs. 12, 13, 7 & 18. With SW bearing. It is as low as the general plain and exposed at south side of road. In sec. 8 there is rather sandy plain with scattered ridges and knolls 20-30' high. We are unable to locate position of knolls accurately. On this road it winds around and does not follow closely the course shown on the map.

Features near Daggett

The road runs south through gently undulating till from center of sec. 20 to the north side of sec. 5. There are occasional small gravelly knolls or ridges but they seldom look like the typical esker. There are two prominent drumlins in sec. 5 and west edge of sec. 4, T 35 R 27 W - fully 60' high with NE-SW trend.

In sec. 33 and north part sec. 4 there are sharp gravelly knolls and ridges of irregular form & trend. There is a drumlin crossing line of secs. 3 & 4 near middle. In bend of Cedar River west of Daggett are irregular knolls and ridges of loose-textured drift and in Daggett an esker that runs south to Cedar River in west part sec. 2. There are gravelly ridges and knolls west of railway for $1\frac{1}{2}$ miles farther south. Some of them of esker type. From Daggett I went to Wallace but Mr. Peterson worked east from Daggett 4 mi. in territory north of that previously covered. He found large drumlins 75' high and also numerous knolls, some of them are perched on drumlins.

Studies near Wallace

I went east from Wallace and found gravelly and sandy drift on knolls and ridges, the trend of ridges being NE-SW. This sort of ridges occurs in secs. 24 & 25. Farther north in sec. 13 & 18 there are drumlins of typical form composed of a more clayey till. The east limit of drumlins seems to be in secs. 7 & 18. Most of the land east from there to Hayward Lake and the ridges south is swampy. There is some flat dry land in sec. 19. There are

knolls and irregular ridges in NE part sec. 17 and north part of sec. 16, T 34 R 26 as noted Aug. 26. The only drumlin ridge seen farther east was in sec. 15 but there may be drumlins east and south of Hayward Lake. They occur north of Hayward Lake as far east as secs. 23 & 26, T 35 R 26 or to the edge of Lake Algonquin.

There is a fine drumlin 30-35' high crossing the line of secs. 7 & 18 T 34 R 26 W. Another in line with it in west part sec. 18, another near middle of line secs. 13 & 18 and one east of quarter post of secs. 12 & 13 (T 34 R 27 W). These have a laminated clayey stony till of reddish tinge. I went to see Ed Paulson, the county surveyor, who lives in NE $\frac{1}{4}$ sec. 18, T 34 R 26 W. He says a line of levels was run west from Arthur Bay along the quarter line made by government men in the Reclamation Service a year or so ago as far as the State road at west quarter post of sec. 27 and the road there is 75' above Green Bay. It is not more than 5' above the level of Lake Algonquin so that is 650'.

Algonquin Beach - 663'±

Mr. Paulson says it has been determined that there is 60' fall from Hayward Lake to Green Bay or very close to that amount. It is his recollection that it is a little more than 60'. The Algonquin beach is 23' higher than the marshy outlet of the lake, so is likely to be 81 - 83' above Green Bay in sec. 19, T 35 R 25 W. This is about 8 $\frac{1}{2}$ miles NNE from the level (650') at west quarter post of sec. 27, T 34 R 26 W, so there may be a rise of nearly 1 $\frac{1}{2}$ feet per mile in NNE direction.

Data by Mr. Paulson

Mr. Paulson says the stream that crosses sec. 7, T 34 R 26 in a SE course enters a cedar swamp and he has noted that some of the water goes south past the corner of secs. 7, 8, 17 & 18 through secs. 18 & 19 but more of the water runs east to Hayward Lake. It is all nearly down to the lake level. Mr. Paulson says that sec. 33, T 34 R 26 W is all above Lake Algonquin except a narrow strip on east edge and is good farm land. The NW half of sec. 4

T 33 R 26 W is nearly all undulating land above Lake Algonquin. He thinks we got nearly a mile south of the town line on Aug. 26 when in the swamps. He thinks we reached a hardwood ridge in SE part of SW $\frac{1}{4}$ sec. 4 and followed its east side into NE part of NW $\frac{1}{4}$ sec. 9.

There is a ridge over 20' high on west side sec. 9 that we probably did not reach. It is stony. The Algonquin bar that we saw in west part sec. 26, T 34 R 26 W runs a little east of south into NW part of sec. 2, T 33 R 26 W. There is a gap at a swamp there but it sets in about 80 rods east of center of sec. 3 and runs westward $\frac{1}{2}$ mile passing near center of sec. 3. This may some of it have been above Lake Algonquin level. It is a hardwood ridge and he thinks it is stony. From Mr. Paulson's I went west crossing a drumlin on line of secs. 12 & 13. There is a strip of knolly drift along its NW border about $\frac{1}{4}$ mile wide. Swamp there sets in that runs southward passing $\frac{3}{4}$ mile east of Wallace. West of this swamp is a drumlin area from near Wallace northward past Ingalls.

Features near Daggett

Aug. 30, 1919. Stephenson, Mich. We took train to Daggett and then went west together 3 mi. Mr. Peterson there turned south and I continued west to Swanson. There are drumlins at frequent intervals from those noted yesterday in secs. 4 & 5 westward to Swanson and for $1\frac{1}{2}$ miles south of Swanson or to south part of sec. 1. They have a NE-SW trend. One large one is in NW corner of sec. 6 rising 50'+ above bordering low ground. The others are small usually 15-20' high about 20-30 rods wide and $\frac{1}{4}$ - $\frac{1}{2}$ mile long. In center of sec. 1 is very high land 50' or more above lowland to the east and on this an oval drumlin stands. Each side of this prominence is cut into by glacial action so as to give the appearance of the slope of a drumlin but there is a tableland at top on which the small oval drumlin was formed. From this elevated tract I can see the ~~high~~ high ridges passed yesterday near Kells, and also high ridges 3 mi. west that we passed yesterday and a high tract a

mile NW of Swanson. The rest of the country is lower. There is a hummocky gravelly area west of Swanson around a small lake (Swanson Lake).

Striae

South of it is a limestone ridge and the railway exposes a striated ledge in SE corner sec. 35 at the one mile sign SW of Swanson bearing S 60° W. There is limestone at surface in Swanson by the schoolhouse but it is weathered and shows no striae.

I found striae also on the town line $3\frac{1}{2}$ mi. west of Daggett on a hill 30' above bordering low ground bearing S 60° W. The hill a mile NW of Swanson has rock ledges exposed with cliffs 15' or more higher. There is good farm land for a mile west of Swanson with clay loam in places. Farther west is not cleared and cultivated. It is more sandy and gravelly and thought to be inferior for farm land. There are, however, fertile spots with heavier soil as noted yesterday. Mr. Peterson and I met at Swanson for dinner. The area he covered was a till plain with a few drumlins as indicated on map. He mapped as far down as 3 mi. south of the town line.

Along RR track $\frac{1}{2}$ mile NE. of Swanson are striated ledges bearing S 70° W with flinty nodules that have protected the stone on the lee side -

Thus: Shown in ~~purple~~ ^{blue}

We came into gravelly esker-like ridges

north of here for $\frac{1}{2}$ mile. They trend

in various directions and are but 10'± and full of rounded boulderets and

large cobblestones. The wagon road leaves the railroad $\frac{1}{2}$ miles north of

Swanson and goes east $\frac{1}{4}$ mile then northward. There are prominent drumlin ridges east of it in sec. 19 rising 25-40' above level tracts to the west.

The moraine seems to be west a mile or more in secs. 26 & 23, T 36 R 28 W.

We find much flat clay land for $\frac{1}{2}$ miles south of Benat similar to that north noted yesterday.

Studies in Southern Menominee County

We took the same road as yesterday across sec. 18 & 20 noting the position of the knolls which set in in the SE part of sec. 18 and continue to center of sec. 20. The ridge crossed near line of secs. 20 & 29 is flat topped till but it has the same trend as the drumlins and its sides are shaped like a drumlin.

We go SE in sec. 29 to sharp knolls in SE part of sec. 29 and SW of sec. 28. They are stony and cobbly with both till and gravel and are very steep and rise 30-40' above the flat land south of them. Mr. Peterson went east and north in sec. 28 to map as far out as the road extends. I went south between secs. 32 & 33 across a remarkably flat tract which has some basins that look like sink holes in limestone.

I went east 1/2 mile on town line and took road south through secs. 4, 9 & 16. There are several short gravelly ridges east of the road in sec. 4 and NE part of sec. 9. A prominent esker starts in south part of sec. 4 and runs SW across NE part of sec. 9 and SW of sec. 8 and is said by a resident in sec. 9 to continue SW through secs. 17 & 18 toward Koss??? and connect with gravelly ridges I noted yesterday north of Koss???

There are 3 small drumlins SE of this esker in sec. 9, two east of road and one west. There is swamp in south part of sec. 9 and sec. 8. There is a plain of sandy gravelly loam in central and north part of sec. 16 similar to that noted Aug. 22 in sec. 15 and SE part of sec. 10. It may be glacial outwash. A drumlin crosses the road 60-80 rods from south end of quarter line. It is steep as an esker but is of clayey ~~massive~~ constitution, more so than most drumlins.

Striae

At south line of sec. 16 where the road turns east there is a striated limestone surface exposed in ditch at side of road with bearing about S 60° W - only a few square feet are exposed.

Studies in Southern Menominee County

I should have noted above that on turning east at Banat Station there is a high clayey ridge running N-S in east part of sec. 13. The soil is clayey for scarcely 1/2 mile into sec. 18. It then becomes a stony loam with gently undulating surface and a few sharp knolls. The stones are so numerous here and southward through sec. 19 as to be a great hindrance to cultivation. This country had pine timber and before the days of lumbering, trees had fallen and turned up masses of earth that cause much extra work to level enough for cultivation of the land. The hummocks made by fallen trees are 3' or more above the hole left by the overturning. The land is as rough as I imagine a shell-torn battlefield in Belgium or France would be. Mr. Peterson found strong moraine in secs. 21, 22, 27 & 28 with knolls and ridges up to 70' in height and with little or no drumlinoid topography.

Features near Stephenson

Aug. 31, 1919 (Sunday), Stephenson, Mich. I went east 3 miles over ground previously covered. I then went 1/2 mile north to corner secs. 17, 18, 19 & 20, T 35 R 26 at a schoolhouse on knolly drift. There is a drumlin covered with small clumps here. One NE of it is not so covered.

Gravelly drift of irregular topography partly like eskers occurs in SE part of sec. 17 and north part of sec. 20. In secs. 16 & 21 drumlins are better developed and there are very few hummocks or gravelly knolls & ridges on them. The same is true of secs. 15 & 22 tho' the SE part of sec. 22 has some hummocky land which extends NE across NW part of sec. 23. There is a large drumlin extending from SW part sec. 14 SSW about to 1/4 post of secs. 22 and 23. East from here the drumlins are small. One in NE part of sec. 14, however, is large enough to show well a mile away. The swamp west of the Algonquin that I traced into sec. 18, T 35 R 25 W a few days ago extends north past the bend of the outlet of Hayward Lake over the E $\frac{1}{2}$ secs 12 as well as sec. 13, T 35 R 26 W and much of the W $\frac{1}{2}$ of sec. 7 but not much into sec. 18.

This swamp was covered by Lake Algonquin but shore markings on its west border seem to be very indefinite. There is a small drumlin in the bend of Hayward Lake outlet in sec. 18, T 35 R 25 W that extends SSW across the road near east end of line of secs. 13 & 24, T 35 R 26 W. It is 15-20' above the swamp so is but little above the Algonquin bar.

Altitude of Algonquin Beach

The Algonquin bar south of the outlet in sec. 18 is 28' above the level of water below the dam. The dam is 5-6'±. North of this stream the gravelly bars are only 18-20' above the water level but there is a little sand that gives higher altitude in places. Perhaps the bars rise northeastward to same height as the one south of the outlet. The one south has boulders in it and the waves seem there to have worked on a glacial ridge but the highest points on the ridge are covered with lake-washed gravelly material. If the top of this dam is at Hayward Lake level and is 60' higher than Green Bay as indicated by the county surveyor, Ed Paulson, the Algonquin bar here is 663' to 665' A.T., i. e., 23' above the water level above the dam. It is 650-652' directly west of Arthur Bay so if my data on Hayward Lake are correct there is a rise of about 12' in $8\frac{1}{2}$ miles in NNE course which is about the course of the tilt line, or about $1\frac{1}{2}$ ' per mile.

I took an abandoned road northward on the Algonquin bar passing east of a small marshy pond in north part of sec. 18. I passed a short stretch of stony land 40 rods or so in south part of sec. 7 but it is not above the level of the lake bar. Aside from this I was on a sandy gravel to an old lumber camp at a stream in SE corner of sec. 6. This stream cuts across a strong bar here just as Hayward Lake outlet does at the dam there being no wet land bordering it and the stream is 12-15' below the level of the gravelly bar.

The gravel bar continues NE across sec. 5 and SE part of sec. 32 and becomes split up into a series in these secs., so I am told by Adolph Durow,

Supervisor of Stephenson Twp., who lives in SE corner sec. 36, T 36 R 26 W.

I took a logging road from the camp northward across east side of sec. 6 and found it level and with some sandy spots but with considerable muck. It is, however, all land suitable for cultivation. In the NE part of sec. 6 I come to the south end of a glacial ridge that runs for 3/4 mile north along line of secs. 31 & 32 and is known as "Basswood Hill". There is an extensive "blueberry marsh" east and north of this hill covering much of the W $\frac{1}{2}$ sec. 32 and NE corner sec. 31, the E $\frac{1}{2}$ sec. 30, about 3/4 of sec. 29 (the east side only being dry) and a little of south part of sec. 20. An Algonquin bar starts at south end of Basswood Hill and runs north on the east side of this blueberry marsh through central part of sec. 32, east part of sec. 29 and then NW about to center of sec. 20 where it terminates at north end of a group of steep knolls that cover part of the SW $\frac{1}{4}$ of sec. 20. Mr. Durow says this is paralleled on the east by another bar that runs north from the NE part of sec. 32 along or near line of secs. 28 & 29 into SE part of sec. 20.

He says there is level dry land from the north end of these bars northward to a creek in sec. 17, T 36 R 25 W. This creek has cut a channel 20' deep in this land in its course across sec. 17.

Studies along Border of Lake Algonquin

I am not able from Mr. Durow's description to decide whether this dry land is part of the bed of Lake Algonquin. He thinks it has few, if any, boulders and is nearly plane. He says there are strong beach ridges and bars of Lake Algonquin east from the north end of these bars across Cedar River so it seems that the bars border at their north end a bay that extended up Cedar River a short distance. There is a very sandy district east of Cedar River in T 36 R 25 W. The country west of the river in NW part of this twp. has rolling stony land and much of it is farmed. There is good farm land partly under cultivation west of the blueberry marsh in secs. 30 & 31. This

farm land has drumlin ridges with NE-SW trend. I saw them in west part secs. 31, 30, 19 and one near corner of secs. 18, 19, 13 & 24 crossing the town line. In the 3 mi. south 5 others cross the town line. There is hummocky land in south part of sec. 36 and in sec. 1 and north and west part of sec. 6 that stood above the level of Lake Algonquin.

Mr. Durow says a hill at SE corner of sec. 34 T 36 R 26 or 2 mi. west of his residence is by road level 80' higher than the SE corner of sec. 36 in a swamp near his residence. This swamp is about down to Lake Algonquin level. A drumlin 2 miles north of his residence is fully as high and so is one in the north part of sec. 25 and one near corner of secs. 22, 23, 26 & 27. The drumlins are in fact prominent in much of the region east and NE of Daggett. The lower land between drumlins is largely swamp especially in secs. 22, 23, 24, 25, 26, 27 & 28; secs. 20, 21, 29 & 30 are largely dry land and have knolls among the drumlins. There is a prominent kame 75' \pm high near center of sec. 30 (in SE $\frac{1}{4}$). Much of sec. 19 is swamp. I took the zigzag road across sec. 30 and went south on range line to south end and west into Daggett. There is much gravelly hummocky land along this route.

Studies near Carney

Sept. 1, 1919. Stephenson, Mich. We take train to Carney noting the drumlins and knolly spots along the line of the railway. For $1\frac{1}{2}$ miles south and a mile north of Talbot there are knolls and gravelly ridges 10-20' high scattered over swampy areas but drumlins are scarce. North from there drumlins are well developed all the way to Powers. From Carney Mr. Peterson went south $1\frac{1}{2}$ miles then east to corner secs. 29, 30, 31 & 32, south between secs. 31 & 32 and east to quarter post of 5 and 32 where I joined him. My route was through north part sec. 29 and west part of secs. 28 & 33 and west to quarter post of secs. 5 & 32.

The row of drumlins that passes just east of Carney is bordered on SE side by a strip of hummocky stony drift in south part sec. 20 and NW of

sec. 29. East of this are drumlins in SE part sec. 20 and north part sec. 29. East of these drumlins is another knolly strip between the drumlins and a swamp that covers the SE part of sec. 29 and north part of sec. 32. I noted a drumlin crossing line of secs. 28 & 33 near quarter post. One crosses line of secs. 32 & 33 north of the quarter post. One crosses line of 32 & 5 less than 1/4 mile from east end. One crosses line of secs. 4 & 33 east of quarter post, a very prominent one 60-70' high. There is considerable swamp in south part of sec. 33 and NW part of sec. 4.

In sec. 5 there is a small drumlinoid ridge west of the N-S quarter line road but most of the sec. is nearly plane. There are knolls of irregular shape and size scarcely numerous enough to give a morainic aspect. There is a hummocky strip along west part of line of secs. 5 & 8 and southward through sec. 8, some of the knolls being gravelly and all are stony.

There is a prominent drumlin in west part of sec. 8 and one in NE part sec. 18. A large drumlin crossed the E-W road near line secs. 16 & 17 but for a mile east drift knolls are associated with the elongated ridges. There is a string of drumlins in sec. 9 NW of center and west of a stream. There are smaller ones in central and east part. In sec. 10 are 2 very prominent drumlins 60-70' high, one in east part, the other in NE part of the sec. The one in east part lines up with one in NW part of sec. 11. There is a very high double drumlin in NW part of sec. 14 lying east of the angling road. This double ridge is perched on an elevated tract whose NW face has the appearance of the slope of a drumlin. But there is a terrace or fluting half way to top. There is another drumlin crossing line of secs. 11 & 19 near quarter post.

Channel Across a Drumlin

In NE part sec. 14 and SE of sec. 11 drift knolls of irregular form give a morainic aspect. But to the east in SW part of sec. 12 there are



some flatings and channelling in which the depressions are only 3-5' lower than the ridges but with all the characteristics of a drumlin and border trough. Three such low ridges occur in a width of 1/4 mile. They trend NNE-SSW and are 1/4 mile or more long. East of these is a prominent drumlin about 1/2 mile long which is notched by a sharp cut a little north of the sec. line of 12 & 13, thus ---



It appears to have had the notch made by a subglacial stream that was not free like postglacial drainage to select a course around the ridge. East of here nearly on the range line between Nadeau and Cedarville twps. is a very prominent drumlin running from SW part of sec. 7 into east part of sec. 13. It is fully 75' higher than bordering lowland. About 3/4 mile farther east is a very prominent drumlin 60-75' high and a mile long from which I am able to map the position of drumlins and prominent knolls and ridges to the south in south part of sec. 18 SW of sec. 17 and north part of sec. 19, T 36 R 25 W. Near the east end of line of secs. 7 & 18 the road crosses a gravelly esker ridge and east of this a narrow drumlin nearly as narrow as the esker. The road then descends to a sandy plain bordering a creek in sec. 17. There are low dunes but the plain is pebbly sand and perhaps a delta in Lake Algonquin.

Features near Carney

Terrace bordering Cedar River in sec. 16 at road crossing is 26-27' above L.W. of stream. Plain 1/4 mile west is 8-10' higher or 36-37' above stream. This plain extends west to a string of drumlins in north part of sec. 17 and SE part sec. 8 and NW part of sec. 9, and is coated with sand which has a little loam but not enough to be good farm land. It should be kept in pasture or grazing land as it is now. There seem to be no settlers in secs. 8, 9, 16, 17. The drumlin strip might make fair farm land. There is a great spruce and tamarack swamp west of this drumlin strip covering much of the W $\frac{1}{2}$ sec. 8 and nearly all of sec. 5. It is probably as low as the

highest Algonquin level. West of it is another prominent strip of drumlins along which we take a road through secs. 7 & 6 and line of 5 & 6 into sec. 32, T 37 R 25 W. We mapped the drumlins in secs. 31, 32, 29, 30, 19, 20, 17 & 18, T 37 R 25 W. They are in several cases 75' or more in height and very steep. They are usually 1/2 mile or more long. They are clayey so roads over them are in places slightly cloddy. This is a rare feature in the drumlins of this county. They have numerous surface boulders but cuts in them show small stones usually limestone. The surface boulders are very largely of pre-Cambrian rocks. We went west to Carney from ~~Ex~~ Guerley??? Gourley??? mapping the drumlins to sec. 32, T 37 R 26 W west from which we had previously. The results of this afternoon's work in Cedarville Twp. fix the limit of Lake Algonquin farther west and north on west side of Cedar River than I had anticipated. There is no well defined shore in gravel beach along the east side of the drumlin strip in secs. 17, 8 & 9, T 30 R 25 W, but this may be due to a protective bar east of Cedar River. There seems to have been free wave action as far north as sec. 20 where the bar of sandy gravel ends that runs northward from Basswood hill across secs. 32 & 29 into 20. Further study east of Cedar River may clear up this matter. (See notes Sept. 6, pp 77-78)

Features near Spaulding

Sept. 2, 1919, Carney, Michigan. We took morning train to Powers and then went north to a camp in SW corner sec. 9, T 39 R 26. About a mile north of Spaulding is a notched drumlin with esker coming to the notch from the east and then continuing west of the notch. This is probably the one mentioned by Russell. We saw it from a distance this morning but will examine it more closely later. The main part of the drumlin is north of this notch.

In the NW part of sec. 9 and south of sec. 4 is a very large drumlin on which 2 parallel small drumlins are perched. The drumlin is very abrupt at its NE end and a groove circles around it.

This is a wetter strip than farther out from the drumlin and has marsh grass in it.

The drumlin rises 50' or more in perhaps 20 rods.



The ridges we cross or pass near on this road are nearly all drumlins as indicated on the map. They have a smooth crest and slopes. There is an esker which the road follows for 1/4 mile or more in SE part of sec. 20 to the east of a stream flowing south. This is 10-25' high and winds somewhat though maintaining a general WNW course. East of this esker in NW part of sec. 28 and NE of sec. 29, there are irregular knolls and ridges of morainic type. Drumlins occur both to the north and south and this seems to be only a small area.

Farnham???
Features near Farnham and Soo Line RR

There is a large oval drumlin in the north part of sec. 20 and south part sec. 17. Most of the drumlins are narrow and with length several times the width. From the creek in south part sec. 17 to the camp there is mainly level land but small knolls 10-15' high are scattered over it.

At the new camp of Oliver Mining Co. in SW part sec. 9 rock is within a foot or so of surface in places and the Cedar River has a rock bed in that vicinity. I went east along the C & NW Ore RR to Glenham??? Clemham??? Clearman??? Station and crossed ends of several drumlins. Mr. Peterson went south on road past Farnham??? Farnham??? switch on the Soo Line RR from ~~Maxx~~ near Ore. I went south along road leading across secs. 24, 25 & 36 and secs. 1 & 12 to the C & NW RR. There are some hummocks in vicinity of the Soo Line RR in sec. 25 and in sec. 1 but generally there is a smooth drumlin and furrow topography. One of the highest drumlins is in north part of sec. 1 and it has small drift hummocks of stony cobbly material on its crest and slopes. Mr. Peterson mapped a drumlin 2 miles long running from SE part of sec. 35 SSW into NE part of sec. 10. There is an esker along or near the Soo Line RR from north part of sec. 35 SW into north part of sec. 3. It is

uneven in form and trends. Mr. Peterson is not certain that he traced its full length.

Studies near Waucedah & Hermansville

Sept. 3, 1919. Powers to Waucedah on train. Drumlin topography all the way and as far north and south of Waucedah as I can get a view. I walk north a mile to Ore track of C & NW on the Foster City road and come to track??? 1/4 mile west of MP 34 from Escanaba. High smooth ridge south of track from MP 34 past 33. Drumlin NW of 33 runs WSW for 1/4 mile. Marshy swamp north of track from 34 to 33 for 1/4 mile. At the county line by Leeper switch and an old camp there is a low drumlin just north of the track and a higher one south that is a continuation of the high ridge that I have had on south of track for 2 miles. There is a large drumlin SE of Spruce Lake in south part of sec. 8 farther east. They occur each side the track at intervals of about 1/2 mile in secs. 9, 10, 11. There are 3 north of track in sec. 12 - all rather small. Only small ones occur between here and the camp at corner secs. 8, 9, 16 & 17, T 39 R 26 W. One in SE part sec. 7, one in NE part sec. 18, and one in SW of sec. 8. There are small gravelly ridges in north part of sec. 17.

Mr. Peterson found morainic topography or numerous knolls for 1 1/2 miles north of Hermansville 10-25' high. From north part of secs. 34 & 35 northward to the railroad there were drumlins alternating with swamps like the country I traversed from Waucedah eastward. The largest are 50' or more in height. An esker crosses line of secs. 14 & 15 south of center in a NE-SW course. It is 15-20' high. A resident told Mr. Peterson that drumlins are numerous in secs. 23, 24, 25 & 26, T 30 R 27 W.

We drove north to Tanners??? Frances??? from the camp in SW part of sec. 9. There is a small drumlin in SW part of sec. 9 but from there to the NE corner there are irregular knolls and ridges giving a moraine aspect. East of Cedar River, however, there are drumlins. In SE part of sec. 4 the road

follows an esker for a short distance. There are occasional gravelly knolls and short ridges north from here but we do not see drumlins for a space of fully 3 miles. The road then winds around the south end of one that seems to be in west part of sec. 33, T 40 R 26 W. We passed 2 others where the road runs NW in secs. 21 and SW part of sec. 16. There is a low one in south part of sec. 17 where a road to a camp in sec. 18 branches off. Cedar River runs close to the road for 1/2 - 3/4 mile east from here. The drift is loose-textured and in places flat and sandy along this road most of the way to Tanners??? Franceses???. In places it has low ridges 10-20' high that in some cases are like short eskers but more often irregular in trend and form. There are only occasional boulders and those usually small. We passed over a drumlin near line of secs. 4 & 9 just south of a small stream. The drift from here into Tanners??? Franceses???? is clay loam. There is some fine forest of birch, maple, hemlock, etc., in secs. 9 & 4, and the soil is perhaps better than to the south.

Near La Branch and Tanners??? Franceses???

At Tanners??? Franceses??? there is a fine drumlin running NE from near the RR in the west part of sec. 3 into the south part of sec. 36, T 41 R 26 passing near the north quarter post of sec. 3, T 40 R 26 W. Much of it is on the farm of E. Stebbins. On its east slope is a subordinate drumlin lying in NE $\frac{1}{4}$ of NW $\frac{1}{2}$ sec. 3. It is scarcely 1/4 mile long but the large one is nearly a mile.

There is another drumlin in the NE $\frac{1}{4}$ sec. 3 and 2 others south of the RR in the SE part of sec. 3 and SW of sec. 2.

There is a prominent drumlin 1/2 mile or more south of the RR lying NW of the center of sec. 19 and another still farther from the RR. Near La Branch are knolls of irregular form and trend partly till and partly gravelly. We stop for the night at LaBranch in NE part of sec. 11. Mr. Louis LaBranch locates drumlins that are in view from here. One in SE part sec. 11, one in

south part $SE\frac{1}{4}$ sec. 10, one on line of secs. 14 & 15, one at corner secs. 14, 15, 22 & 23.

Features near Dryads

Sept. 4, 1919. LaBranch, Mich. There is a tract of fine land for farming in the SE part of T 41 R 26 W, and the SW part of T 41 R 25 W and south from there a little beyond the C&NW RR. But to the east, north and west of this good tract is a less productive one with sandier soil and fully $\frac{1}{3}$ of it swamp land. Ford River runs through this sort of country. We went through fields on a road leading from LaBranch NE to line of T 40 & 41 at quarter post of sec. 6.

There are low drumlinoid ridges in north part of sec. 12. These do not seem to be prominent drumlins in sec. 1 but it is said to be nearly all dry land, the main swamp being in $SE\frac{1}{4}$ or $SW\frac{1}{4}$ of the sec. In sec. 6 limestone is near surface in a plane tract in center of sec. There are small oval hills in NE part sec. 6 and gently undulating low ridges with NE-SW trend crossing the line of secs. 5 & 6, T 40 R 25 W. There is a fine drumlin in south part of sec. 33, T 41 R 25 with farms on it. It is $\frac{1}{2}$ mile long from NE-SW. We are told there are similar high drumlins 30-60' high in $SE\frac{1}{4}$ of sec. 34 and near center of sec. 35. To the east from there in sec. 36 are swamps with low birch ridges and to the north in secs. 25, 26 & 27 the land is sandy & gravelly where dry but is partly swamp. The NW part of T 41 R 25 W is stated to have sandy and sandy loam soil and to be level or gently rolling. We went south to Dryads on line of secs. 5 & 6, 7 & 8, 17 & 18, T 40 R 25 W. There is some slight ridging on line of secs. 5 & 6 but not shaped into a good drumlin form. There is a fine shaped drumlin in east part $SE\frac{1}{4}$ sec. 7. A large one is crossed on the line of secs. 17 & 18 fully 60' high. At the SW its crest becomes double with a low swale between. The pencil line shows the

outline of the entire hill,

the blue color the forked

crest. There is another drumlin

close to Dryads the NE end of which

lies near the base of SE slope of the forked drumlin. We took C&NW train to Hylas??? from Dryads. The station for Dryads is at line of secs. 19 & 20.

We pass through a drumlin south of center of sec. 18 and the NE end of one in east part sec. 13 and run through two in south and west parts of sec. 12.

Studies in Southeastern Dickinson County

Between LaBranch and Faunas???Faunces??? there are 2 small drumlins in SW part of sec. 2, and two north of the track in NW part of sec. 3. West of Faunas??? is one south of track in north part of sec. 4 where we came out to RR yesterday. A fine drumlin with farm and orchard on it is crossed in SW part of sec. 35, T 41 R 26 W. It runs NE for 1/3 mile or more from the railway and SW for about half as far.

There are low swells south of the railroad in south part of sec. 34. There is dry land in most of the SW $\frac{1}{4}$ sec. 35 and NW part of sec. 4. There is a lot of wet land in sec. 34 which seems by land survey plats to run NE through SE part of sec. 27 and west part of sec. 26 into sec. 23. It is 975-980' where crossed by the C&NW RR and is between MP 19 & 20. There is a prominent drumlin south of track in NE part sec. 33 and one north of track in SW part of sec. 27 that runs NE more than 1/2 mile. We cut through a large drumlin near MP 21 which is not far from line of secs. 28 & 29. It is 30-40' high and runs NE for 3/4 mile and SW for 1/2 mile. The railway cut is 30' deep. There is swamp 1/2 mile wide west of it. There are some drift knolls in vicinity of Helps Station but drumlins are well developed to the SW in south part of sec. 19 and north part of sec. 30. In sec. 24, T 41 R 27 W (in Dickinson Co.) we pass outcrops of limestone and they extend nearly to



Hylas. There are drumlins east of Hylas in sec. 14 and southward into sec. 23. We find them westward also past Hardwood to within a mile of Foster City. There hummocks set in on low ground along the railroad and Sturgeon River. They also show conspicuously on a prominent ridge north of Foster City. There is a smooth hill west of Foster City that looks to be smoothed like a drumlin and with WSW trend. Drift knolls occur on low ground along and near Sturgeon River south of Foster City to the narrows about a mile below the town. There there are prominent bluffs close together 75'+ high and scarcely 500' apart. These bluffs are of till so far as exposed. On east side excavations show exposures 30' high. Below here the valley widens out to about 1/4 mile. There is a plain of this width into which the stream has cut to a depth of 25-30'. The bluffs each side are of till and seem to be of reddish clayey material for 3-4 miles south of Foster City. There a sandy, gravelly strip comes in from the east along Hancock Creek and this is said to extend up to a lake in sec. 32, T 41 R 27 W. South of this sandy strip is clayey drift to where the road crosses the river. In the strip included in the great eastward bend of the river the road runs through a sandy gravelly nearly plane tract. But to the east in sec. 2 there are some high knolls.

I am told by a road supervisor with whom I caught an auto ride when 3 miles out of Foster City that the country east from Sturgeon River has the drumlin topography wherever he has traversed it. The drumlins are separated by swamps about as shown in the Land Survey plats. We come to a fine drumlin on the Holmes farm in north part of sec. 15, T 40 R 28 W on west side of Sturgeon River. Just below this farm a view across the valley shows several wooded drumlins near the river in secs. 13 & 24, T 40 R 28 W.

Striae S 75° W

The trend of the drumlin on the Holmes farm (in sec. 15) is S 75° W and this is the same as the bearing of striae on a rock outcrop just north of the drumlin.

Studies in Southeastern Dickinson County

A well on the drumlin is 77' deep and did not reach rock though it was sunk to a level about 40' below that of neighboring rock outcrops. It is of interest in demonstrating that this is not a veneered rock hill.

West of this drumlin for over a mile is a strip in which rocky knobs protrude to 20'+ above the surrounding land. This is much lower than the drumlin and there is sandy gravel among the knobs. It is probable this was a line of glacial discharge. The river now is in a very narrow passage at the east end of the drumlin, there being steep slopes each side down to the water's edge. This is in striking contrast to the broad low sandy areas to the west that seems a more favorable course for the river.

From the Holmes farm southward to where the road crosses the river near corner of secs. 34 & 35, and secs. 2 & 3, T 39 R 28 W, the drift is generally loose-textured and the altitude scarcely 30' above the stream. There are numerous rock bosses outcropping up to height of 10' or more above the surrounding gravel plain. There is, however, for nearly a mile north from the place where road crosses the river a rather clayey bouldery till standing 40-50' above the stream. It is too high and too clayey to be put into the glacial drainage.

South of the river in north part of secs. 2 & 3, T 39 R 28 W, there is a marshy plain 1/4 - 1/3 mile wide that looks to be an old stream course. A terrace on its south border is 15-20' above the marshy plain and is of sandy material. The river does not run in this marshy plain here but is in a narrow valley with bluffs a little higher than the marshy plain. We rise to a prominent ridge south of the 1/4 post of secs. 2 & 3 which proves to have a drumlin crest, a ridge 20' high and 20 rods wide perched on a tract that stands fully 100' above Sturgeon River. It is a fine drumlin and is farmed. South of this is a still higher ridge that shows fluting and a slight ridging in an ENE-WSW course. It has not so distinct and typical

a drumlin as that to the north. Farther south drumlins of slender type are found immediately north of Waucedah. They are of lower altitude than the ones above noted.

From the high ridge 2 miles north of Waucedah we could see west to the morainic ridges 1-2 miles distant. There are smooth drumlinoid slopes for about a mile farther west than Waucedah. To the south of Waucedah drumlinoid shaping extends scarcely a mile west of the village and farther south as already noted, it is near Faithorn with some knolly land 1-2 miles east of Faithorn.

Features near Hermansville

It now seems that the drumlin limit and the change to moraine is near a line running from Alfred past Foster City to Waucedah and Faithorn passing midway between Waucedah and Loretto and a mile or so east of Faithorn. From Waucedah we caught a ride in auto to Hermansville and thus could map drumlins that cross the highway. The knolly tract north of Hermansville seems to be a narrow strip all in view from the road that leads south into Hermansville. The knolls are gravelly and stony.

Studies in Western Menominee County

Sept. 5, 1919. Hermansville, Mich. We went by freight train to Faithorn Jc. and mapped the drumlins. The topography becomes knolly near the town line in secs. 12 & 13 yet there seems to be a drumlin base in some hills with knolls dotting the crest and slopes. We find drumlins all the way from Faithorn to Nathan that are of typical form. They extend a mile or more west of the railroad as far south as Bird Station and also west of Nathan. The swales have very few drift knolls in them and there is only slight undulation on the crest and slopes of the drumlins. No more than I have seen in the midst of the drumlin area. There is a knolly strip a mile NW of Nathan in sec. 14 and around corners of 13, 14, 23 & 24. But the SW part of sec. 24 and south part of sec. 23 have fine drumlins with ENE-WSW trend and

this is the bearing of the main glaciation.

Studies near Nathan - Striae

Prof. Russell, however, found cross striae near Nathan, the lake??? ones being SSW or SW. There are drumlin features around Nathan that seem also to show a later movement SSW. The east end of 3 small drumlins in SW part of sec. 24 is crossed by a very narrow ridge as narrow as an esker trending NNE-SSW. But this ridge is largely of till of the red clayey type found in drumlins. It is smooth also like a drumlin. It runs south across the road just west of Nathan. It seems likely this drumlin was formed after those with WSW trend, otherwise it could not ride over them. It seems to fall in with the second set of striae in showing a more southward local movement of the ice near the close of the ice occupancy.

East of Nathan is a prominent hill that looks to be a curved drumlin concave to the SE as shown in diagram. This ridge is just west of a limestone hill 20-25' high on the east slope of which we find striae bearing S 68° W. (magnetic). It may be that this hill caused the ice to take a curving course around its north and west sides and that the drumlin was formed by a curving current. The crest and shapes of this drumlin or drumlin-like ridge have low swells or hummocks on them 3-5' high, which when received close at hand make the ridge seem less smooth than the ordinary drumlin, but when viewed at a distance of 1/4 mile the ridge looks like a smooth drumlin.



Studies in Western Menominee County

There is a narrow strip of rather sandy and gravelly land with knolls and ridges along east side of the Menominee River. North of the road that runs west from Nathan which may be morainic. It seems, however, as if the river from the Soo Line crossing south to the great bend in SW part of

T 37 R 28 W is about along the border of the drumlin country just as the Sturgeon is from Foster southward to the range of hills NW of Waucesah. There seems to be a change to more sandy & gravelly drift at the west limit of the drumlins. It has only a few sharp knolls but is slightly uneven and has a few boulders thus differing from typical outwash plain.

From Nathan to Carney there is a drumlin district in which considerable swamp occurs. As previously noted, a knolly strip follows Cedar River in secs. 22, 27 & 33 (see notes Aug. 21). An esker runs SW from sec. 23 into sec. 26 for about 3/4 mile as visible from the road. From there to Carney there are drumlins about as thick as they can stand. We noted seven in crossing sec. 24.

Features near Nadeau

I went from Carney to Nadeau and talked with one of the Nadeau brothers about the topography on land they own west of here but got very little information. He says there is a prominent drumlin in west part of sec. 9 and one in SE part of sec. 7. There is one in north part of sec. 2. Much of secs. 2, 3, & 10 is swampy but the NE part of sec. 3 is dry land. Secs. 4, 8 & 9 are also largely swamp about as shown on land survey plats and there is a large swamp in sec. 18 and in secs. 20 & 21 and the central part of sec. 16.

Features near Bark River

Sept. 6, 1919. Powers to Bark River. On train. Took horse and buggy at Bark River and drove west 3 miles through territory already mapped then south through a drumlin tract for 6 miles. There are few knolls of morainic type except in secs. 10 & 11, T 38 R 25 W. Cedar River comes out of the drumlin tract into Lake Algonquin in sec. 11, T 37 R 25 W, the southernmost drumlin east of the river being in sec. 11. West of this drumlin Cedar River is in a gravelly plain that is probably as low as Lake Algonquin. The east part of sec. 10 is also on this plain. There is a

chain of gravelly knolls east of Cedar River in south part of sec. 22 and north part of sec. 27, T 37 R 25 W but these seem to be the only knolls on east side of the river south from the drumlin in sec. 11 that rise above Lake Algonquin level.

Features near the Shore of Lake Algonquin

There is a stony strip in east side of river just south of where a road runs west across the river on line of secs. 4 & 9, T 36 R 25 that is about at Lake Algonquin level. It is bouldery up to 40' above river level but is capped by a sandy ridge 5' higher. I leveled west from river on line of secs. 4 & 9 and found the Algonquin shore at 43' above the river level. There is a sandy ridge east of it whose base is 26' and top 31' above the river. It is not pebbly so may be wind-formed. There is till at surface each side of this sand ridge.

There is a prominent chain of drumlins on west side of Cedar River here and for $1\frac{1}{2}$ miles both north and south, and Lake Algonquin reached to the drumlin base but at this place no higher. This is a continuation of the chain noted in secs. 16 & 17 a few days ago. There is a great swamp west of this chain of drumlins from Devil Creek northward across sec. 5, T 36 R 25 into sec. 33, T 37 R 25. This is near Algonquin level and may have been covered by its waters to a slight depth.

On returning Mr. Peterson took a road that keeps east of Cedar River in secs. 23, 14 & 11, T 37 R 25 W to see if there are drift ridges of any sort above the Algonquin beach farther south than the drumlin in sec. 11 but he found only sandy plains with very slight sandy ridges. There is a large amount of swamp in secs. 1 & 2, T 37 R 25 W but drumlins also are present. There is one that comes into this county from Delta Co. on line of secs. 1 & 6 near south end and runs a little into sec. 12. This seems to be the easternmost one.

There are others in north part of secs. 1 & 2 and also in west part. The limit of Lake Algonquin is not easy to fix here, but it seems to have extended north between drumlins in secs. 1 & 6. The high land as noted Aug. 18 extends south on line of secs. 5 & 6, T 37 R 24 W about to middle. So Lake Algonquin shore passes south of this.

I went west on line of secs. 22 & 27, T 37 R 25 W and found only a small area of perhaps 40 acres of hummocky land standing above Lake Algonquin in the NW $\frac{1}{4}$ of sec. 27. Nearly all of sec. 28, the SE part of sec. 21 and SW part of sec. 22 are also low enough to have been covered by Algonquin waters. There is a drumlin in central part of sec. 22 that stood above the lake. North of it and extending into sec. 15 is low land that is likely to have been submerged at highest stage of Lake Algonquin. The water probably reached the east base of a very prominent drumlin 70' high that runs SSW through east half of sec. 21 and NW $\frac{1}{4}$ of sec. 28 and to drumlins in sec. 32 near the road on which we went north to Guerley??? a few days ago. But this is back of the range of drumlins against which the waters of the open lake beat from sec. 27 southward. I went west to road that runs north to Guerley??? and took that north to sec. 8 where I turned east and went back to the road at line of secs. 10 & 11. I found drumlins are wide apart in the district north of Guerley and there seems to be much swamp in secs. 4, 5, & 6, T 37 R 25 W. There are several fine drumlins in secs. 9 & 10. I went east on line of sec. 2 & 11 to end of road and there got a view of drumlins in sec. 2 and was told they occur in north part of sec. 1. Mr. Peterson joined me at corner secs. 2, 3, 10 & 11, T 37 R 25 W and we returned from there to Bark River on same road we came out and took evening train to Escanaba.

Features near Gladstone

Sept. 7, 1919. We went by electric car to Gladstone and examined the tract north as far as where Days River comes out in sec. 4 into the low plain bordering the lake. This plain extends as far west as the wet land

shown on the land survey charts in secs. 9 & 4, 35, 25 & 24. Most of it is sandy with a little peaty much 1-3' over the sand. Along the base of the high bluff there is some till and a slight outcrop of limestone. We found till exposed in Days River valley up to about 30' above the stream south of the road in sec. 4 west of center of sec.

The high plain has a slightly pebbly sand and the pebbles seem to be mainly insoluble rocks there being few limestones and most of them are less than an inch in diameter. We saw good exposures of the lower part of this deposit where the road in sec. 4 rounds the bluff. There is a fine sand without pebbles and with scarcely any cross bedding. The horizontal beds run the whole length of the exposure 30 rods+ with remarkably even texture. I did not see a boulder or coarse rock in the deposit at any level in the trip from Gladstone to Days River. I am wondering how this sand was carried along southward for it is below Lake Algonquin level. Was there a time prior to the Algonquin when the altitude here was higher than when the highest Algonquin beach was formed? The red clay under the sand SW of Gladstone seems a natural deep water deposit but the sand does not.

Studies in Southwestern Alger County

Sept. 8, 1919. Escanaba, Mich. We took Soo Line train to Rapid River and then to Wrenary. The thin coating over the rock from Rapid River north to where the RR crosses the stream in sec. 29, T 42 R 21 W is sandy and stony. I do not see any lake clay or stony clay. The tableland entered by the RR in sec. 20 has sand with very few pebbles so far as exposed by the cuts. We see no stones in it more than 2 inches in diameter.

The knolly tract outside Lake Algonquin has stony till of reddish color. There is a lot of flat land among the knolls at a level about as low as Lake Algonquin as far north as sec. 29, T 43 R 21 W or about to MP 361. The knolls in some cases look as if water had been around them cutting into the base. North from here the country looks to be above all lake action.

From Trenary we go east past Winters and turn south in sec. 22, then go east past a schoolhouse to a swamp that I thought in 1912 was below Lake Algonquin. There is, however, a knolly morainic tract east of it whose highest knolls stood above the lake. There are some places east of center of sec. 25 where the knolls seem to be notched and others where channels wind around among low swells 5-6' high at a lower level than these notched knolls.

Top of ridge west of Whitefish 35' above river

Terrace at 55'

River is probably 750-755'

Features near Algonquin Shore in SW Alger Co.

We are wondering if this indicates stream action in cutting down a channel across the moraine, and shows a sort of rapids. We went east across very humpy land into the NW $\frac{1}{4}$ sec. 25, T 44 R 21 W and find it high clear across to Whitefish River. There is a notch at about 50-55' above the river that corresponds to the lower of the two strong shore lines that I mapped in 1912. The ridge here is 35' by hand level above the stream. The river is probably 750-755'. I cannot see decisive evidence here of a wave notch higher than the one 55' above stream. The ridge here, however, is sandy like a dune and winds about in dune fashion. A little farther west near corner of secs. 23, 24, 25 & 26 I come into a tract that looks to be wave swept that stands about 80' above the river. On its west side there is a chain of morainic knolls and ridges with red till and numerous boulders.

There are basins and other irregular depressions here that make me question whether this is not an outwash plain instead of a wave swept surface - but in either case it seems to call for a water datum at about this height above the river. A swamp lies west of this chain of morainic ridges in sec. 23 and sec. 14 that my studies in 1912 led me to include in

Lake Algonquin. I found a good shore line coming to its north end near line of secs. 11 & 14, and get its level 847'.

We returned to quarter post of secs. 23 & 26 and went south and kept above Lake Algonquin level from north part sec. 26 to the county line at quarter post of secs. 2 & 35. A few rods east and south of here, however, at a new house in NW part of NW $\frac{1}{4}$ sec. 2 there is a shore line the highest Algonquin. East from this for nearly 1/2 mile there is a plain sloping very gently southeastward. A narrow swamp borders it and east of this is a gravel ridge on which there was a stand of pine. This ridge may prove to be the second Algonquin. It is, he thinks, 50' above Whitefish River. This is disputed by others and estimated to be much less, as estimated by Mr. DeLosh???. We are told by Mr. DeLosh??? of Trenary that a large swamp borders West Branch of Whitefish River in secs. 10 & 11, T 43 R 21 W. East from this between the West Branch and East Branch is moderately high land not so high, however, as the land east of East Branch or west of West Branch. The shore of Lake Algonquin seems to be as far west as east part of sec. 15 and to run SW from there through secs. 22 & 28 and 32 to the Ten Mile Spur in sec. 5, T 42 R 21 W. There is a knolly strip along or near this line all the way through and it seems to continue to Perkin's. The district SE of it below highest beach??? levels??? is more sandy as if an outwash from this knolly moraine strip. The ice border may cross East Whitefish River from south end of the moraine by Trout Lake and run along the line just indicated.

Mr. DeLosh says that on the road from Trenary to Carlshend a knolly strip is crossed just before reaching the west line of Alger Co. and Whitefish River breaks through it there. Otherwise there is a plain between here and Carlshend. This strip is a mile or more in width. As a result of today's studies I seem to have shown that the highest beach in sec. 3 T 43 R 21 that stands 802' A.T. is above the strong second beach of the district along the

Au Train-Whitefish lowland. That beach seems to lie east of there and to traverse sec. 36, T 44 R 21 and border the swamp farther south in secs. 1 & 2, T 43 R 21 W. Evidence of a rapids in the narrows in east part of T 44 R 21 has not been found. I am told the highland I was in yesterday in sec. 25 runs into the SW part of sec. 13 and is very prominent in sec. 24. This reaches a narrow passage for the strait from the Superior to the Michigan basin. Several miles long.

Sept. 9, 1919, Trenary, Mich. We went to Winters and then to Chatham on foot and returned by auto in time to take train south from Trenary to Rapid River. This is territory previously covered but the country now is cleared more extensively of brush so I can see the character of land better. There is till plain with only an occasional knoll as far north as the line of twns. 44 & 45 R 21 W. But in secs. 33 & 34, T 45 R 21 and eastward into sec. 35 there is a knolly strip some knolls 20-30' high are very sharp. This probably continues west across the Soo Line RR for I passed through knolly belt 4-5 miles north of Trenary in walking the railway track some years ago.

Studies near Chatham

In secs. 27 & 28 there is an esker previously mapped. South of it for 1/2 mile the surface is plane. This esker trends WNW-ESE and it ends near the knolly belt in SE part of sec. 27. There is till plain for a mile north of it. There are limestone outcrops at Johnson Creek and we see some limestone blocks in the cuts for 1/2 mile north. This seems to be about the northern limit of this formation.

In secs. 15 & 16 are ridges about as sharp as eskers but with some till as well as gravel & cobbles. They trend NNW-SSW and are probably in the direction of ice movement though not in the same course or trend as the esker 2 miles south. Ridges of this sort occur in west part of sec. 3 and in sec. 4. They do not differ much from the drumlinoid ridges previously mapped in vicinity of Eben Jc. These ridges and those in secs. 15 & 16 are 15-30' high.

Some of those near Eben Jc. are a little higher, perhaps 40' high. We ran up to Eben Jc. by auto from the State Farm and noted the shore features west of Chatham. They are much more open to view now than in 1912. There is a bluff here about 30' high. The bluff a mile south of Chatham and that bordering the island SW of Chatham is of similar prominence. It has a strip bank facing SW toward the narrow passage as well as where exposed to strong wave action from the open lake to the north. It seems strange such strong lake shore features were developed in these narrow passages.

The railway south of Ten Mile Spur is in a ravine at MP 358 that continues past 357. It enters the plain 1/2 mile north of 356 but the high land is only 60-80 rods NW of MP 356. MP 355 is at crossing of Rapid River near center of sec. 29, T 42 R 21 W.

The lake action seems likely to have reached a level a few feet higher than Ten Mile Spur (766') for it is 768' at Friday station on the C&N.W. about 2 miles to the SW. It should be not far from 775' and perhaps the wave cut knolls north of Ten Mile Spur have shore features as high as 775'.

Features near Manistique

Sept. 10, 1919, Rapid River, Mich. We take train east to Cook's??? Charles??? Mill. There are few pebbles in the sand in bluff east of Whitefish River. Farm land begins 1/2 mile west of the shale cut in sec. 35, T 41 R 21 W. Level country with a pebbly loam soil from there to Massign. Sand dunes 2 miles west of St. Jacques. Strip of marshy land a mile wide west of the St. Jacques till ridge. Dunes on the ridge around the railway station. There is good soil with limestone at slight depth from Moss Lake past Isabella in area marked "red clay" on Russell's map. We continued to Manistique on the train and passed through very little good land east of Cooks??? Charles??? Mill.

Studies near Manistique

Manistique is on a rock hill east of mouth of river. There is a low strip 2 miles wide east of it filled in with dunes south of the railroad in

secs. 7 & 8. The dam at Manistique has flooded land north of the railroad so it is within 5' or 6' of the level of the railway track. The track is 615'.

How Exp. this

We took a road NE from near corner secs. 1, 5, 8 & 9, T 41 R 15 W and rose to a sandy plain about 700' A.T. The sand has scarcely any pebbles in it. We noted a layer of red pebblesless clay at top of the sand and above this a pebbly sand a few feet thick. This is a very puzzling section to interpret. The upland is very flat and sandy in sec. 4 and northward in sec. 23, T 42 R 15 E. We saw an occasional large granite boulder on this sandy plain from north part of sec. 4 northward. There are no rock outcrops on this road until we get into sec. 27. The land seems to be all sandy to the west of a little stream that runs north across secs. 27 & 28. But east of this stream rock outcrops are numerous.

There is very little drift over the rock from sec. 27 northeastward across secs. 26, 25 & 24, T 42 R 15, and secs. 19, 18, 17, 6 & 9 and 4, T 42 R 14 W. There are cliffs 10-20' or more high as noted in secs. 17, 8, 9, 4 & 3, T 42 R 14 W. We noted a lake ridge of cobbly gravel in the east part of sec. 23, T 42 R 15 W with water-worn material to depth of 7 or 8' but such ridges seem to be very scarce. There was not drift enough to build them with. There is some clayey material in lowlands but there rock is generally near surface. I do not find anything that can be termed moraine anywhere in this district SW of Manistique River in T 42 R 14 & 15. It has only a few boulders and but little till.

We went east between secs. 8 & 17, 9 & 16, T 42 R 14 W and were in flat land on line of 9 & 16 with rock near surface. We turned south on line of secs. 15 & 16 and were in flat wet land nearly to middle of sec. line. There rock ridges set in and the surface is uneven and better drained. It has enough earthy cover to be farmed. We find this sort of land extends south to the Soo Line RR in secs. 34 & 33, T 42 R 14 W.

Striae S 40° E Features near Whitedale

We turned east and crossed sec. 34 & 35 to Whitedale. There is a short, gravelly lake bar crossing this road from WSW-ENE and running east on north side for 60 rods+. It is about 645' A.T. or 14' above the railroad at the mile post near center of sec. 34. We passed a striated rock surface just west of center of sec. 34 with bearing S 40° E. Magn. There is only 2' of earthy material over it. This is somewhat clayey or has clayey spots. There are fields under cultivation in secs. 33 & 34 where the rock is scarcely 1' below surface so the plow is liable to scrape the rock surface. In small areas all through the district traversed today there is no soil on the rock, but there is seldom more than an acre or two in a place. The percentage of land that is bare rock would be small yet these bare places are a conspicuous feature.

I leveled from Gulliver Lake to Whitedale Station and found a rise of 8'. The station is 624' so the lake is about 616'. We took train from Whitedale to Cooks Mill. This leads through a sandy tract all the way. From Delta Jc. west there is a rolling surface with bouldery knolls and ridges rising 25-30' or more above the flats among them. It is all very poor land with sweet fern. There are narrow strips of maple on some of the stony ridges but most of it is pine.

Sept. 11, 1919. Cooks Mill. From Cooks Mill I went up to the hill near north end of line of secs. 29 & 30, T 41 R 17 W and found an Algonquin shore at 35-36' below its summit. The summit is 103.5 higher than the top of rail at Cooks Mill or 806.5. So the shore is about 770-771' A.T. There is a notch on the SW face of the hill at this level making a terrace several rods wide. The bank above the notch is not very steep yet is of cut bank type. The hill has till and bouldery material in it and on it, and I think it never has been covered by the lake. So the 770' beach seems to be the highest Algonquin.

This is a small island about a mile long from NW-SE and 1/8 mile or so wide. NE of it is a low strip and beyond this is land above Lake Algonquin. It covers perhaps 20 square miles lying mainly in T 41 R 17 W but with about 6 sq. miles in T 42 R 17. It seems to run to within a mile of Indian Lake on the NE. It has some sink holes and general underground drainage so no streams are shown in it on the map. Striae were noted $2\frac{1}{2}$ mi. north of Cooks Mill bearing S 15° E. They are ^{on} a hill on line secs. 17 & 18 about 800' A.T.

On Train to Rexton

We take train on Soo Line RR to Rexton in Mackinac County - see old studies for notes as far as Engadine. The ridges from Milli Coquin Lake to Gilchrist are all sand ridges apparently wind formed. They continue east to MP 434. There the rock ridges set in and surface boulders. MP 435 is by N-S road west of Garnet 3/4 mi. There is a gravelly beach at Garnet 5-6' higher than the station or 845'. Between Garnet & Rexton there are a few drift knolls and I see a large drift hill east of Rex in SW part of sec. 32. Both south and north of Rex are sharp hills reaching to about 900' A.T.

Features near Rexton

A lake at Rex flows usually to Lake Superior but at high stages it also discharges south to Lake Michigan. Its present surface is 7-8' lower than Rex Station. The high water stage is about 5' lower than Rex. There is a definite high water beach. There is a sandy tract south of the lake on which the east part of the village of Rex stands which is about 10' above the station. It is flat topped. There are a few coarse pebbles in the sand but most of it is free from pebbles. We find on going south from Rexton that there is a beach much higher than I had anticipated. So that only a few isolated knolls and short ridges in the vicinity of Garnet and eastward past Rex and Coffey stood above the lake. One knoll is 1/4 mile NW of Rex and stands about 90' above the station or 964' A.T. Another is just south

of the town line a mile east of Garnet. It is by hand level about 45-50' above the track at the "Mile from Garnet" sign or nearly 900' A.T.

We found a high ridge $1\frac{1}{2}$ miles north of Garnet in east part of sec. 28. It is 60-75' above the wave washed plain to the west that stands at about the level of Garnet Station 840'.

The lake action is shown up to 20' or more on the slope of this ridge. The ridge is narrow much like a large esker and it trends NNW-SSW which is, I think, the direction of ice movement. I am told at Garnet P.O. that this is the most prominent ridge in the twp. and it seems likely to be as high as the highest land around Hendricks quarry. There is some knolly land immediately east of this ridge extending a little into sec. 27 but the postmaster says it is of very limited extent. A short distance NE is a swamp that extends nearly to the Hendricks quarry. We got a fine view westward from this ridge and saw nothing as high. Hill a mile east of Garnet in NW part of sec. 3 is 48' above RR at MP 3 miles west of Rex and has wave cut notch 25' below top - or at about 865.

Features near Garnet

Beach south of Rexton is 35-37' above Rexton Station at top of stony ridge and 23' at a smooth ridge. The stony ridge looks as if it had been shoved up as a storm beach but the other at 23' above Rexton (MP 469) is at ordinary lake level. This makes it about 897' A.T. and the storm beach 900 - 911'. At the SE end this beach connects with a hill at the range line west side of sec. 6 that rises 25-30' above it or to about 935-40'. I traced the shore markings around this hill and found that only a few acres of it stood above Lake Algonquin. There are two other similar high points to the south of this along west side of sec. 6 that rose slightly above the highest beach. To the west in north part of sec. 1 is a ridge that is very sharp and may rise above Lake Algonquin. From its top I leveled to the schoolhouse

about 80 rods north and found it is higher than the top of the roof. The schoolhouse is in ground between 870 and 880' so this ridge rises above 900'. On our way back from Garnet we passed the summit on the railway at RP 468 a mile west of Rexton and noted beach ridge NE and east of there that is about 5-6' above the Mile Post at level of track but about the same as the ground elevation for at this Mile Post there is a cut, beach is 893'. I think the Mile Post alt. is 887'. There is a broad flat area north of the RR in sec. 36 except at the hill in SE corner noted above.

Features near Rexton

I leveled to the hill NW of the station and made it 16 sights or $16 \times 5 \frac{2}{3}$ ft. above the station or about 90' = 964' A.T. The lake shore at its south base is between 4 & 5 sights or about 25' above the station or almost 900'. I am told there are prominent hills in SW $\frac{1}{4}$ sec. 18, T 44 R 8 W about 3 mi. south of Hendricks quarry. There are still more prominent ones around the quarry in sec. 6 and extending slightly into adjoining secs. 31, 36, 1. I can see them plainly from the hill in sec. 36. at Rexton. SE of Rexton is a prominent hill in NW part of sec. 8 as well as those in sec. 6. We took train east at 8:41 A.M.

There are knolls and ridges strung along the south side of the track for 3 or 4 mi. east from Rex, on some of which I can see a terracing or wave notch as high as 20-25' above the swamps around the knolls. These swamps are about 860', some knolls rise 40-50' above the swamps and seem likely to have been islands in Lake Algonquin at its highest stage. To the north of the RR for 6 mi. east from Rex there seems to be no land higher than Lake Algonquin. The timber has been burnt enough to give much clearer view than when ~~xxxx~~ green.

We took train to St. Ignace from Trout Lake. The swamps south from Kenneth??? nearly to Moran seem to have sandy soil. The limestone tract around Allenville has some clay in the soil. There is then a sandy swamp

nearly to St. Ignace. We were interested in the chimney rock at St. Ignace. It is 35-40' high and less than 20' in diameter. There is drift or gravelly lake material banked against the upper (west) side. We crossed in afternoon to Mackinac Island and went up past the fort and target range over the series of Algonquin beaches to the hill on which the Willberson towers and the waterworks reservoirs are built. It was once a fort called Fort Holmes at time of war of 1812 - named in honor of Holmes, an officer killed in battle on the island in 1813. The Algonquin beaches are found up to 205-210' above the lake. On our return we came down to them at a cemetery. The Nipissing beach is about 60' here at Grand Hotel and there are lower ones down to the present shore at several levels.

Hessel to Haber

Sept. 13, 1919. Mackinac Island to Hessel & Haber.

We went by boat to Hessel and then took road east. There is a drumlin in north part of the village where we turned and two others SE of here. We cross a creek and then pass over the drumlins in sec. 26 (north part). There is one in NE part of sec. 25 that runs SE into sec. 30. We see two others farther south crossing the range line near Cedarville. We turn north and cross one that runs SE into SW part of sec. 19. It and the others south of here are 20-30' high but those we crossed from Hessel eastward are lower, only 10-15' high. They all contain pink colored till. Boulders are numerous on the surface probably as a concentrate due to reduction by lake action following the ice retreat. We passed a bog on line of secs. 19 & 29 about 60 rods wide that seems to be deep, as the road has settled into it and caused the sides of the road to bulge up.

The Cheneaux Islands are mostly low but there seems to be rather high land south of Cedarville on Marquette Island.

We saw no drumlins north of the creek that crosses near south end of line of secs. 13 & 18. Instead there is a gently undulating very bouldery

till with some clay admixture but mainly loose stony loam. This seems likely to be a moraine below Algonquin level in continuation of the one above Algonquin level noted some years ago north and NW of Hessel. This high morainic strip stands out prominently when viewed from the boat as it approaches Hessel.

We are in this undulating till strip for about $2\frac{1}{2}$ mi. or to near middle of line of secs. 9 & 16, T 42 R 1 E. A single beach ridge of cobble and gravel was passed east of a creek near middle of line of secs. 8 & 17. It runs N-S for 80 rods at height of 35-40' above the creek.

We enter a strip with nearly base limestone ledges near middle of line of secs. 9 & 16 and continue in it for over 3 mi. It has huge limestone blocks scattered over the surface some being 8 or 10' high and 15-20' in longest diameter. We turned north in this limestone tract on line of secs. 10 & 11 and come into a heavier drift near north end of the line and a stony loam soil. We turned east on line of secs. 2 & 11 and descended into a swamp that is underlain by red clay. Little knolls in it though strewn with rocks seem also to be till. We turn north on line of secs. 1 & 2 and see good exposures of the red clay on flat land bordering the swamp. It is pebbleless but a few rocks are scattered over the surface. On rising to undulating land we find till with reddish color and a clay loam soil. We turned east at line of secs. 35, 36, 1 & 2 and crossed this till to the twp. corners and a short distance on line of sec. 6 & 31. It is as good soil as any yet seen in the northern peninsula - and most of it is cleared and cultivated. It is held at about \$50 an acre where it has fair buildings, etc.

Studies between Hessel & Raber

We come into a flat tract with the red clay soil east of this that extends NW passing north of Stalwart to the great red clay plain noted in 1905. This flat tract is partly swamp and has a NW drainage. The swamp covers much of sec. 32 and SW part of sec. 33, T 43 R 2 E and much of secs. 4 & 5, T 42

R 2 E. East of this swamp is the bouldery moraine and outwash gravelly strip that I traced nearly to here in 1905. It is 75'+ above the swamp. Its SW part next to the swamp is like an outwash plain and has only small stones but within 1/2 mile larger stones set in. We reach the crest on line of secs. 2 & 35. The NE or inner slope of this moraine is thickly set with large boulders mainly granite but also of limestone. This is steep and in sec. 35 extends down to a swamp. Farther east in south part sec. 36 and north part sec. 1 there is a barren sandy plain north of the moraine. Near the east end of line of secs. 6 & 31 we rise from this onto a bouldery strip that borders Raber Bay and extends nearly to the village of Raber. We saw no limestone outcrops along the road to Raber. These boulders which are largely limestone seem to be a train carried south from outcrops west of Raber. The highland ends directly west of Raber and low swampy land extends from there to Mud Lake and Munuscong Bay. A few Polish families are living in there and a few farmers on dry land bordering Munuscong Bay on the south, a narrow strip. Otherwise it is a wilderness but nearly all of it has a rich clay subsoil, I am told.

Studies near Raber

Sept. 14, 1919. Raber, Mich. (Sunday). There is a rock range east of Gatesville higher than the moraine. It occurs with only slight gaps nearly all the way to Detour close to St. Mary's River.

West of Caribou Lake is a tract of rather clayey till making a thin veneer over shelly rock the cover being from one or two feet up to 15' or more. It is fair farm land, but rather bouldery. The SW part of T 42 R 3 W secs. 6, 7, 17, 18, 19, 20, 21, 28, 29, 30, 31, 32, 33 & 34 has a sandy gravel with slight loam admixture in soil and small and large stones abounding on the surface. It is a continuation of the Kinross belt of moraine and outwash. It extends west into T 42 R 2 W about to the center N-S line. The $\frac{1}{2}$ of that twp. has swamp in secs. 6, 7, 4, 5 and a little in secs. 8 & 9. Also in secs.

29, 30, 31 & 32, next to Lake Huron and very little above it. In secs. 16, 17, 18, 19 & 20 there are prominent rock ridges known as the Hungry Bone Hills about like those we crossed yesterday 2 to 4 mi. farther west. I judge there is a gap in the intervening secs. in which rock hills are not prominent. There are a few low rock hills in the SW part of T 42 R 2 W south of this range of high hills. The range has relief of 100'+ as estimated by the twp. supervisor, Mr. Goetz, storekeeper at Gatesville.

There is a strip of dune sand from Caribou Lake SE. East of this clear to Detour there are gravelly beach ridges crossing nearly plain very stony land with sandy matrix among the stones but probably a clay subsoil. Mr. Peterson found clay subsoil on a road parallel with this a mile farther north. He saw more or less clay subsoil from sec. 22 eastward 7 mi. to Detour. There is not much rock outcropping on either of the roads from Detour west to Caribou Lake but rock is at slight depth. A mile farther north there is a rock range that lies along the border of St. Mary's River.

On Drummond Island

We crossed by gasoline launch to Drummond Island and walked to the settlement. There is a general drift cover several feet thick all the way so we did not see to the amount of an acre of bare rock. There are so many boulders and slabs, however, as to make the land difficult to till and the cultivated clearings are nearly all abandoned until one is within 2 mi. of the village. Some of the depressions bordering the west side of the bay in secs. 29, 32 & 33, T 42 R 5 E have thick clay and good farm land but ridges between are very stony. I am told that a prominent ridge east of the bay has bare rock on high part. It is probably in sec. 34. The land in secs. 24, 25 ~~and 36~~ & 36 is largely under cultivation and is only slightly stony. The N $\frac{1}{2}$ sec. 25 and NW part of sec. 30 (T 42 R 6 E) have a tableland appearance and sandy gravel to depth of 40' or more or to lake level. The sand extends to the lake shore at the village but is low there being step-like descent in secs. 24 & 19.

A few boulders are scattered over this slope. Granite up to several feet. South of this tableland in $S\frac{1}{2}$ of secs. 25 & 30 there seems to be till (or a "hardpan") at slight depth. Mr. MacAdam has a farm here and says the material is very hard to excavate. Mr. Bailey, supervisor of Drummond Island, says there is rock near surface over T 43 Rs 6 & 7 E except a narrow strip of gravelly beach in secs. 21, 22 & 23, T 43 R 6 and a flat red clay area in sec. 31, R 7 E. There is a wide belt of low wet land in the Potaganissing drainage basin with heavy red clay subsoil. There are a few low stony (bouldery) knolls and ridges scattered through it but none over 25' high.

There is a wet tract with red clay east of a bog north of mouth of this stream covering much of sec. 3. Secs. 1, 2, 11 & 12 are variable with some rock ledge, some stony clay and some wet land, partly farm land. There is a stony (but not ledge rock) shore in T 42 R 7 from sec. 4 SE to east part sec. 36. Back of it to the headwaters of Potaganissing River is rather sandy land in secs. 4, 9, 10, 15, 16, 21, 22 & 27, T 42 R 7 E. There may be clay at slight depth between sandy ridges. Marblehead is in secs. 36 & 31 and rock there is high on the shore and a rock shore extends south as far as sec. 27, T 41 R 7 E to a cove or bay. West of this is a fertile tract between the bay and a lake in secs. 21 & 22 and south of the lake.

The Marblehead rock bluff is bare for only a short distance inland. There is considerable earthy cover only 1/4 mile back and ledges are bare only in a few places farther inland. There is a large area of nearly bare rock from Dickinson Lake west to the mill at Johnswood and around the mill and Dry Lake is a farming settlement of Finlanders with some good farms but with stony strips in them. The land from there east is variable and hard to describe.

Striae. Sept. 15, 1919. Drummond Village on
Drummond Island.

We went to Maxton crossing over gravelly ridges in secs. 19 & 20 on

the highest land, old shore lines. In SW part of sec. 21 we pass a striated outcrop. Bearing S 3° E. Rock is near the surface on the road leading NE entirely across this sec. As we approach Potaganissing River there is heavier drift and the knolls are in some cases elliptical drumlinoid form with till of rather clayey texture. Many stones coat the surface but the till has few. The trend is like the striae N-S. I am told by Lewis Cloudman who lives north of the mouth of Potaganissing River that there are numerous drumlinoid ridges east from here in the swamp. The ridges with a different trend are either ridgy or cobbly - the latter being shore features.

Harbor Island is covered heavily with drift rock being exposed only at north end. Another large island only a short distance from St. Joseph Island called Burnt Island has considerable drift on it. We went south on returning from Maxton on line of secs. 28 & 29, T 42 R 6 E and rise near middle into a thick drift tract. This we learn runs in a belt 2 mi.+ wide from here past Dry Lake and Dickinson Lake to the east end of the island. There is a strip of ledges outcropping between it and the south shore. The road to Johnswood Mill is in this as far as south part of sec. 3, T 41 R 6 E. It borders the head of the bay at the mill in secs. 11, 12 & 13. We found no striae on the numerous exposures in and around Johnswood.

We returned by auto to the range line south of Drummond village and go south 2 mi. on the range line. There is a high gravelly bar just south of the cross roads that forms a loop at its SW end thus: 
The land inside the loop is 5-6' lower than the bar.
That outside is 20' or more below it. It is one of the high points of the island probably 100' above the lake.

We returned to Detour and took boat to Sault Ste. Marie and train to Trout Lake, St. Ignace and via MC to Detroit.

(From page 100 in notebook 270)

Algonquin bar in secs. 18, 19, 30 & 31, T 35 R 25 W is 16-18' above swamp west of it, sandy at top, gravelly below - knolls 30' high in west part NW $\frac{1}{4}$ sec. 19. Sec. 33 is hardwood except east edge. The orchard I saw was in NW 40 of sec. 4. The NW half of sec. 4 is hardwood. There is an E-W hardwood ridge in sec. 3, T 33 R 26 running for 1/2 mile with center of sec. near middle old shore - not stony. The ridge from west side sec. 26, T 34 R 26 runs south into NW part of sec. 2. North of center of sec. 16 is a hill 20'+ sandy loam in NE $\frac{1}{4}$ /NW $\frac{1}{4}$. There is a stony ridge over 20' high in SE of SW of sec. 4 and running into NE of NW of sec. 9. Same sort on west side sec. 9. The ridge running NE-SW across sec. 30 is a shore line. Water from SW corner of sec. 8, T 34 R 26 will drain south and also east. The State Road at schoolhouse by quarter post of secs. 27 & 28 is 75' above Green Bay. Hayward Lake is about 60' above Lake Michigan.