

Notebook No. 230 - Leverett

COUNTY

Gogebic: 34

Houghton: 1, 14, 15-16, 17-22, 25-30

Iron: 23

Ontonagon: 1-15, 22-25, 30-34

OTHER STATES

Minnesota: 16

Wisconsin: 35

I N D E X T O
N O T E B O O L N O . 2 3 0
(August 17 to August 25, 1909)

- Aug. 17. Winona to Greenland.
- Aug. 18. Features around Greenland and Mass City.
- Aug. 19. Greenland to Rockland and Ontonagon and back to Rockland.
- Aug. 20. Rockland to Victoria Mine and back and then to Greenland.
(18-19-20- Wood worked from Mass City to Winona and near Greenland)
- Aug. 21. Mass City eastward along Mineral Range RR to Alston.
- Aug. 22. From near Nisula to Winona Mine and Greenland.
- Aug. 23. Mass City to Sidnaw along C.M. & St. P. on foot.
- Aug. 24. Sidnaw to Kenton, Trout Creek, Bruce Crossing and Ewen.
- Aug. 25. Ewen to Matchwood and Lake Gogebic with Wood.

August 17, 1909, Winona, Michigan

Features near Winona

The drift in this vicinity is a red till with some gravelly knolls. The altitude is about 1,250 feet near the station but is much higher to the northwest near the mine. This morainic land extends NE about three miles to vicinity of Twin Lakes. From the lakes west, there is a plain at about 12-15 feet. It is over a mile across N-S along the wagon road. North of this plain there are hills in which rock rises to about 1,400 feet, A.T. The highest hills are rock to top but lower ones are drift.

Striae

We passed a striated ledge west of Elm River Station showing a bearing about 20° N of W. It is on the east face of a hill and seems to have been produced by a westward movement.

From about a mile north of Elm River northward we saw no rock outcrops, but rock is frequently the nucleus of hills from there southwest to Greenland.

Lake Duluth reached about 1,210 feet

We took the train from Winona to Greenland at 5 p.m. It cuts through a ridge north of Sleeping River 1,242 feet at top. South from the river the railway is in a swamp for 1 1/2 miles whose altitude is 1,210 feet, which we suspect is an old lake level but it lies east of a high ridge that rises above 1,350 feet as shown by the contour map prepared by Menche for Annual Report for 1907. The swamp is on Sec. 31, T 52N, R 36W. and Sec. 1, T 51N, R 37W. also the corners of Section 36 and Sec. 6 of neighboring townships.

Rock ridges near Greenland and Mass City

The ridge covered a large part of Section 36, T 52N, R 37W.

There is a high ridge west of Seager Section house that rises above 1,400 feet. This is in line of Sections 10 and 11, T 52N, R 37W.

I am told that on the Belt mine property on Section 2 on southeast side of the rocky ridge a prospect having failed to reach rock at 250 feet.

There are bare rock ledges near Greenland Junction and southwest from there to Range Junction. There are high knolls of rock around Greenland and Mass City reaching about 1,400 feet. The ridge immediately north of Greenland is heavily coated with red till. It rises nearly to 1,300 feet, Mr. Wood's aneroid reading on highest point being 1,395 feet. The contour map by Menche does not make it catch the 1,400 foot contour.

The flat tract in north part of Greenland village, marl to muck 1,200 feet by Menche's map but the contours on the map do not agree with the surface slopes and it is doubtful if the 1,200 feet comes as far south as the north edge of the village plot. It probably runs east about 2 blocks north of edge of plot.

Shore lines at 1170 and 1185±

There are gravel bars in the northwest part of Greenland near middle of west side of SW $\frac{1}{4}$, Section 26 that run southeast from the west end of the high tract in east part of Section 27. There seems to be a bar extended out to the southeast from the bluff. One is at level of the plain 1185± and there is a little knoll east of it that seems likely to be a shore mark. Below this is a cut bluff about 20 feet high and a bar in front of it (south) that stands about 1,170 feet, A. T.

August 18, 1909 - Greenland, Michigan, 1,197 feet
Highest Duluth shore about 1,192 feet near Greenland

We go to the angling road that leads northwest from Greenland and follow

it 1.4 mile west, then take a log road north to foot of high tract about 1/4 mile east southeast of center Section 27. A rock outcrop here at 1,170 feet has what seems to be grooves being S 20° E., But they are so faint we are not certain they are glacial. We followed the shore northward into Section 22. It lies just west of a newly cut out road for about a mile. Then it turns east northeast for 1/2 mile \pm and then east a short distance. Here a good bar was found and also an offshore bar for 1/8 mile or more. Elsewhere there is a cut bluff. It turns east northeast at east end of this bar and we followed it in that direction about two miles. It there doubles around the east end of a hill and turns southwest. Mr. Wood took a view of the rock cliff at this northeast point. The waves exposed the rock to 20 feet or 80 below top of ridge. We followed the rock back along southeast side of the hill to Greenland but it is not well developed where it faces southeast. There is a large swamp just below it in west part of Section 25.

We examined a hill in south part of Section 25 that shows good wave cutting near base at west end, at same altitude as the beach we traced around the high tract north of Greenland.

This beach is within five feet of as high as Greenland Station and is well defined near the station or north side of a hill that lies between Greenland and Mass City.

No definite evidence of shore line higher than Greenland Station

There is a bar across from this hill to the one north of Greenland with SE-SW trend from near the depot past the schoolhouse to the northwest part of the village. It is not quite so high as the beach being 10-12 feet below beach level in vicinity of the schoolhouse. It is composed of coarse gravel and cobble.

There seems to be a weak beach about 15 feet lower than the highest one.

We examined the hill southeast of Greenland Station for a higher shore but found it all undulating till to height of over 60 feet above Greenland Station. The hill in south part of Section 25 shows nothing above the base that looks like shore action. On the hill north of Greenland there were a few places where we had suggestions of shore action at a higher level about 20 feet above the main shore but we did not find it continuous enough to be certain of shore action. The fact that none could be found on the other two hills on the northwest face makes me more skeptical. The hill south of Greenland has a well defined cut bluff on its northwest face clear out to the southwest end in Section 1 at level of Greenland Station or just below. We followed it past a clearing in south part of Section 35 or about a mile from Greenland Station. We then went east across an undulating till that plasters the northwest slope of the ridge. On the east slope we find a rock outcrop with striae S 35° E with stoss side at the northwest end.

I ascend a hill 1,310 feet high west of Mass City in southwest part of Section 35 and find it has glacial grooves S 35° E on its highest part. The hill is bare rock on its west face above 1,240 feet. A hill west of here across a ravine and west of a shaft is also bare rock over much of its surface down to about 1,200-1,225 feet.

The lake may have extended up the ravine into southwest part of Section 35 but it was a very narrow strip of water at most. Mr. Wood found striae bearing S 35° E on gravel exposures east of the ravine in southeast part of Section 34 and southwest of Section 35.

The high range of hills that lies between Greenland and Mass City rises above 1,350 feet on the east part of Section 35 and drops off very abruptly to about 1,050 feet at its east side, near the line of Sections 35 and 36. It is a sheer bluff or rock for nearly 300 feet in height. The south side is also a sheer rock bluff on Section 35 and on Section 6 past the Mass Mines. The

plastering of till on the west and north sides of these hills and the bare ledges on east show, like the striae, that ice movement was from the west. The rock bases are shaped with stoss side west and north and lee sides east and south.

A large part of Section 6 and all of Section 5 from Mass City westward to the range at the mines is a clay plain with a red clay and few pebbles.

The hill in northwest part of Section 8 and east part of Section 7 is thickly coated with a red till clear to the top and has but little sand or gravel on it. It rises only a few feet above the highest shore line in a narrow strip near center of NW $\frac{1}{4}$ Section 8 that trends ENE-WSW for about 1/3 mile. The west end and north side are notched by the waves down to 15 feet below the crest. On the southeast side there is a more gradual descent yet a definite shore is traceable.

This high shore is not far from 1,192 feet. Greenland Station being 1,197 feet.

There are occasional syenite boulders on the drift south of Greenland where striae bear S 35° E. What is the source of these stones?

August 19, 1909 - 6:45 A.M. - Greenland

Rock hills near Greenland

Altitude 1,195 feet at Capt. Smith's boarding house. The railway Station is 1,197 feet. I go south from Greenland a mile and take road southwest, crossing a low divide in a col between two rock ridges that trend NE-SW at about 1,250 feet. There is drift up to this height banked against the west slope of the east ridge but at higher altitude the hill is nearly bare rock.

At southwest end of the west hill in Section 1 there is a steep rock cliff rising from about 1,160 feet up to over 1,200 feet, made steep by cutting away of drift by the lake. A drift ridge by the road east of here is also notched at 1,180-1,190 feet.

The east rock ridge terminates abruptly with a sheer cliff extending from 1,200 feet or more down to 930 feet. Here a gravel flat of several acres extends out delta like to the south from the end of the ridge. It seems to be a shore level and built by currents from the northeast as well as northwest, a sort of flat topped spit. A creek limits it on the east.

There is gravelly material down to about 855 feet and possibly a shore at that height at this southwest end of the east ridge. The creek is bordered by a clay plain about 840 feet or 30 feet above the level of the stream where crossed by the road from Greenland to Rockland. The clay is laminated rock with sandy partings.

Lake shore at 810-815 (?)

I came to a little stream on the Rockland road about 60 rods ENE of center of Section 11 where beach mark 808 A.T. is placed and from here west the soil is a sandy gravel but there is stiff clay between the two creeks. The plains slopes from the east to the west creek, there being no perceptible bluff at the west one and a bluff 30 feet high at the east one. The east creek seems to be 6 feet higher than west one.

Possibly there is a lake level at about 810-815 feet where this sand sets in.

I now rise rapidly in a southwest course and come to base of a cut bluff at 930-35 feet.

The next notch is at 1,000 feet to 1,010 feet with steep rise to 1,020 feet. There are rock ledges at 975 feet and upward but below this the slope is drift covered (with some red till but sandy gravel near base of bluff).

Highest Duluth shore at about 1,180 feet

There is a definite notch with 1,070 feet base and 1,090 feet top, cut into a deposit or red laminated clay with few pebbles that cross the slope from

1,075 feet upward. The 1,180 foot or upper beach has a fine gravel bar across the recess in southeast part of Section 10. Elsewhere, in Sections 8, 9, 10 and 11 on west and north sides of the hill, it is a cut bluff.

Morainic topography with knolls 10-20 feet high north and east of Rockland in Sections 9 and 10.

Features along railway to Ontonagon

Beach at railway track between 940 and 960 crosses wagon road 1.3 mile east of railroad and runs north 1/2 mile farther before swinging east. About 1/2 mile NE $\frac{1}{4}$ Section 34 80 rods east of center, railroad crosses into Section 34 near 1/4 post of Sections 34 and 35. Long stretch of flat till with occasional boulders and low swells 5-6 feet high or less and a few saucer like depressions.

The first suggestion of a beach is just east of MP 320 where a rapid descent is made to sandy grounds. My aneroid reads 850 at MP 320 and this is at about the level of the shore action. It is not far from center of Section 17. The railway profile shows top of steep grade 40-50 rods Southeast of MP 320 to be 852 feet. So aneroid is about right.

From near MP 320, it is swampy for over 1/2 mile west to culvert 877. There is then undulating till for over 1/4 mile or past MP 321. Aneroid 810 at MP 321. Cuts 5-6 feet and fills 5-6 feet crossing these swells.

About 1/3 mile farther is a beach on east side of a small north flowing stream. This is a low sandy gravel bar or ridge on which railway cuts 2 $\frac{1}{2}$ feet. It trends NNE-SSW. The aneroid reads 795 feet on it. Two more ravines are crossed 30 feet \pm deep and cut in red till.

Then just SE of Milepost 322 for 1/8 mile wide there is a sandy strip with cut by railway 4 feet deep and crossing it. This is near center of Section 6. The railway swings to the north just inside of it.

Laminated clay in cuts near Ontonagon

Rapid descent for 3/4 mile through undulating sandy capped till. Aneroid shows descent of 70 feet.

Nearly plain surface for 1/4 mile before reaching MP 323 but wavy surface in vicinity of the mile post. Swells seem to be till, but have sandy capping 3-5 feet in some cases. This mile post is about 6,000 feet from Ontonagon station and 8,000 feet from end of line. The sand being 8-10 feet deep on east bluff of Ontonagon River just northwest of the sign, one mile from Station. In places there is laminated red clay at its base but usually it rests on stony red till. Between here and Ontonagon the cuts show laminated clay alternating with sand clear down to the edge of Lake Nipissing.

There is a sandy bar of Lake Nipissing east of the river in Ontonagon about 20 feet above lake level that gives a good site for the town. There is a narrow strip of low land back of it on east part of the town. The base of the Nipissing bluff is at about same level as the culvert marked 225 feet above the lake at 2,700 feet from station.

The sandy ground near mile post 323 is 665 feet and south edge of flat surface back of Nipissing is about 685 feet.

Mile post 322 reads 735 feet barometric and the beach southeast - 740 feet.

Mile post 321 reads 785 feet and crest of moraine 775 feet.

The flat tract east of it runs from 770 to 810 feet at mile post 320 and 825 feet at the top of steep grade 40 rods east in cut 8 feet deep.

There is a smooth ridge-like beach leading north from Wood Station across a clearing. Its altitude is same as station about 885 feet.

There is a slough east of it. This is about 319 1/2, Mile post reads 880 feet. The rise is very gradual east from here. Mile post 318 being 890 feet and mile post 317 only 900 feet. At road in Section 35, 915 feet. At the beach a mile southeast, 945 feet at base and 960 feet at top. A conglomerate

cut in Section 8, 970 feet. Top is 980_± feet.

At top of next beach - 1,025 feet. Base is about 1,010 feet. Rockland reads 1,070 feet. It should be 1,090 or 1,093 feet by Gannett.

Highest Duluth beach 1,178 feet

There is a strong beach about 1/4 mile north of the station 85 feet higher altitude. It is made by hand level - 85 feet. The base of the steep bluff is reached at 100 feet or 1,193 feet, a.T. but is not a clear shore feature at this place. Striae just above this 1,175 foot beach at about 1,180-1,185 feet are very distinct in a rock boss and bears south 10° east. The north end of the boss is the stoss side. It looks as if there has never been lake action above 1,175 feet or these striae would have been scoured off by transportation of pebbles. This, however, is on the lee of a bluff where still water prevailed. There are also striae here at 1,175 feet at back edge of the beach gravel under 2-3 feet of till. Also under beach gravel 5 feet lower altitude. I sight south-east with hand level from the 1,178 foot beach and find that it strikes at the well defined shore on west face of the bluff south of Rockland village and there does not seem to be good shore action at a higher level on that exposed face.

I run hand levels down to the depot and here 15 sights and 6 inches to track - $15 \times 5 \frac{2}{3} = 85$ feet. So this is 1,175 feet here and in all probability the highest shore.

Highest Duluth beach at Rockland

In the south part of Rockland the main street north-south is along a gravel bar that is very nearly up to the level of this highest shore. The bar dies out at the north, almost due east of the depot. The south end ties onto the rock bluff in east part of Section 16. There is a weak cut farther north along east side of village as far north as the southwest corner of Section 10. There is a low tract in southeast corner of Section 9 of about 10 acres that was probably

submerged but does not show any wave cutting. The track runs west in south edge of Section 9 and barely touches the north edge of Section 16 near the 1/4 post.

This shore runs north from near line of Sections 9 and 8 keeping near the section line for about 1/2 mile before doubling back to the east on the north side of this hill.

From Rockland I can see clearly the wave cutting on north side of the hill west of the Ontonagon River. Its northermost point is about due west of Rockland Station and not far from the range line near corner of Sections 7 and 18, 12 and 13.

While in Ontonagon I sketched on my map all the prominent hills on the land survey plots in T 50N, R's. 39, 40 and 41W. The statement is made on plot for T 50N, R 40 W that a plateau 700 feet above the lake covers several sections in southeast part of the township. It is south of the range of hills that have the copper bearing rocks and that probably form the limits of Lake Duluth in that township. The lake may have extended up the west fork of Ontonagon River south of there.

August 20 - 7 A.M. - Rockland, Michigan

Lower beaches of Lake Duluth

Aneroid, 28,700 at Hotel 10 feet below level of 1,178 foot beach or 1,168 feet.

Aneroid, 28,720 at a lower bar in west edge of south part of village near Copper Range Hotel.

28,785 at Rockland Station = 1,093 feet, A.T.

There is a cut bank 30 rods northeast of Station running NW-SE whose base is 1,107 feet and top about 1,112 feet. Water level was probably 1,108±.

There is another at about 1,080-1,085 feet that shows well along east side of track 1/2 mile south of Rockland Station as a cut bank 12-15 feet high.

There is another bank here just west of the track about 1,065 feet at top. The

water level was at or a little below 1,060 feet. It is near the level of north end of trestle over the ravine between the two rockknobs on south part of Section 16 about $3/4$ mile from Station and on mile post 312.

The wagon road crossing south of this ravine, aneroid reads 28,833 on track - 1,030-35 feet. About 40 rods west on this wagon road is a low sandy beach at 1,010 feet, A.T. Aneroid 28,875. From here a clay plain slopes gradually westward for 60 rods, the reading at west edge being 28,910. Clay has few pebbles. There is then, a very steep descent to 800 feet. Aneroid 29,110 at foot of bluff. About 1.4 mile farther I reach a level flood plain or terrace at 715 feet, Aneroid 29,205. The bluffs just descended are a stiff red clay nearly pebbleless. This terraine has a sandy gravel coating 12-15 feet thick on the clay.

Aneroid, 29,240 on Ontonagon Bridge 20 feet above river at 7:45 A.M. My map shows a BM 69 feet that is probably the bridge level.

I ascend the west bluff in Section 19 and find a bar on crest of a ridge between the river and a ravine coming in from south. The aneroid indicated 925-30 feet where I came up but where I returned 20 minutes later is read 900 feet. Aneroid, 29,990 at last reading. Aneroid, 29,280 at bridge 20 minutes later.

Duluth beach 1,165-1,170 feet at Victoria Mine

From here I go up to the Victoria Mine ascending a very steep bluff to about 950 feet and there rising over wave cut slopes to the highest shore at 1,165-70 feet \pm . The shaft is about 60 feet higher and has 50 feet of drift. The bluff that I ascended has a red clay, all the way up laminated and largely free from pebbles. The drift at the various shafts and borings in vicinity of the Victoria Mine ranges from a few feet up to 130 feet, there being that amount on the brow of the hill overlooking Ontonagon valley. The top of the ridge near the mine by the road is a gently undulating till.

The hill I saw west of Rockland seems to be an isolated one so the island covered scarcely a square mile.

Returning 28,740 at highest beach by Victoria Mine - 1,165-70 feet at 9:30 A.M., a cut bluff 15-30 feet high. Drift on hill at shaft back of it at level 60 feet higher is 50 feet.

Two hundred paces northeast along main road to where it turns northward brings to bottom of next cut bluff at aneroid 28,785 = 1,120 feet \pm .

Two hundred paces further where the intersection with another road from south occurs, aneroid 28,815. At base of cut bank - 1,080-85 feet. Beach 12-15 feet.

Two hundred twenty-five paces north, where a street runs east to houses is base of a low cut bank 5010 feet high. Aneroid 28,855 = 1,045 feet \pm .

Seventy paces down a steep bluff to base of cut, aneroid 28,885 = 1,025'.

Fifty paces of steep slope but smooth to 28,900 = 1,010 feet.

The wave action seems, however, to have reached to 1,025 feet.

A few rods north from here (10-12), this road turns northeast at altitude 1,010 feet.

Aneroid 28,940 = 970 feet \pm at foot of next bluff about 120 rods northeast from bend of road and 20 rods west from where a wagon road turns south. This fork in road is at 970 feet. Very little descent in next 70 rods being along the 970 feet shore.

The aneroid shows 755 feet altitude where the road curves northward and descends a ravine.

29,250 at foot of hill on river terrace.

29,255 = 670 feet on bridge of Ontonagon River at 10:30 A.M.

28,945 at brow of bluff east of river = 960 feet \pm .

29,910 = 990 feet \pm at sand bar west of Railroad track.

40-60 rods, same that read 1,010 feet going down.

28,875 where road crossed railroad at 1020 feet \pm . The aneroid reads 1,020 feet. So the sand bar is at about 1,000 feet.

Shore of Lake Duluth near Rockland

Continuing on wagon road I pass a gravel bar on first of a cut bank at aneroid 28,830 = 1,095 feet. The base of bank is 28,820 = 1,100-1,105 feet. The top has a strong bar 28,795 = 1,125-30 feet. Another bar 28,770 = 1,150 feet, and the highest shore 28,740 = 1,178 feet. 28,725 on highest shore here in Rockland at 1,215 = 1,178 feet.

I go south to the low tract between rock hills 1/2 mile south of Rockland and follow it east. It becomes too high within 1/4 mile east for Lake Duluth water to have passed through.

I come down to the level of Lake Duluth opposite the east end of the south hill. From there a gravel bar runs northeast to the north hill in northwest corner of Section 14. There is a gravel pit in it at the wagon and railroad crossing near north end of line of Sections 14 and 15.

I continue east along Mineral Range Railroad past rock knobs in east part of Section 14. They are bare rock on south side down to 1,075 feet and the summits are nearly 1,200 feet, A.T. There is a steep talus or drift? slope down to 1,035 feet at which level a wet plain is reached with poplar brush. This level is reached by the Mineral Range Railroad, where it comes down to C.M. & St. Paul railway one mile west of Riddle Junction.

Duluth shore lines near Riddle Junction

The railway rises 25 feet or to 1,060± at Milepost 36 about 1/2 mile west of Riddle Junction. About 1/2 mile east of the Milepost is a sandy gravel bar with lower land east of it which runs N-S across the track.

Aneroid 28,860 = 1,055 feet ± on sand ridge.

Aneroid 28,885 = 1,036 feet at Riddle Junction in swamp.

A short distance northeast of Riddle Junction, two shore lines appear on the west or northwest slope of a ridge, one at 1,050-55 feet, the other at about

1,090-1,100 feet. The upper one is a sharply defined cut bank 10 feet high. The lower one is less well defined but is marked by a change of slope and a slight notching on the hillside. The lower one lies near the railway for about a mile.

Striae near Winona SSE

I leave the railway a mile west of Mass Station and go north to Greenland over the pass south of the west end of the village. Mr. Wood has found a good beach at the highest lake level on a hill a mile west of here in northeast part of Section 33. The bluff on the west side is very steep and in places 25-30 feet. He followed it for 1/2 mile or more. The hill rises to about 1,260 feet.

Mr. Wood's work yesterday was between Mass City and Winona, chiefly on the large moraine. He found a striated ledge about a mile southwest of Winona with bearing SSE and evidence of the stoss end at the north.

Striae at Rockland S 10° - 12° E.

8 I omitted recording an observation of striae on the ridge east of the road that comes north into Rockland a few rods or near the east 1/4 post of Section 16, bearing S 10-12° E. The bearing as shown by the sun is less than 10 degrees east of south, the observation being made at 15 minutes after noon and the sun then was only 7-8° west of the line of those grooves. There are very heavy grooves passing over the ridge on lines curving upward from north to south and showing that the ice came from the north.

Southward Striae

Mr. Wood found striae north of Mass City, a mile or so, also bearing nearly south. He went to the highest shore on the road west from Winona and found it in Section 33 and traced it N-S for a mile ±. He then went west far enough to see two lower ones, both above 1,000 feet A.T., so he seems not to have got down

to the one that is about 950 feet northwest of Rockland. This evening he has gone on the road from Greenland toward Ontonagon to take notes on shorelines clear out to this one. His notes are as follows:

"Began pacing at corner Sections 26, 27, 34 and 35. At 1 1/2 miles a low ridge like a weak moraine of red till, with crest 1,050 feet. At about 2 miles (3,450 paces) a smooth ridge 1,040 at top and 1,020-25 feet at base with creek on west side, with some evidence of cutting by waves on west side and the slope is sandy. About 2 1/2 miles out (in southeast part Section 20 probably) is a ridge at 957 feet cut into on west side down to 927 feet. It trends North-South. At 3 miles out the aneroid reads 847 feet and there is a smooth slope from 927 feet down past this place."

Shore lines west of Winona

Yesterday Mr. Wood found beaches west of Winona on Sections 4 and 33 as follows:

A beach at 1,040 feet has cut bank 10 feet high. East of 234 paces, at Altitude 1,095 feet, rise of 5-6 feet at a probable shore. East 45 paces at Altitude 1,105 feet, rise of 4-5 feet, bouldery strip at its base showing wave wash. East 35 paces Altitude 1,125 feet, slight rise rather vague. East 250 paces is highest shore 1,195 feet at base and 1,220 feet at top. No definite wave wash higher up.

Strong morainic ridges from near 1/4 post of Sections 4 and 33 eastward to the main road with some points fully 1,400 feet. Drift seems to be thick. Boulders are syenite and diorite.

At the Winona Mine, a boring in southeast part of Section 30 was 207 feet without reaching rock. It was all through clay. Only 20 rods distant a boring penetrated clay 10 feet and then 115 feet of sand and no rock reached.

Reentrant in ice border

About 1/4 mile northeast of these borings is the striated outcrop with bearing S 34° E.

On Firesteel River, there are bluffs of red nearly pebbless clay with Altitude less than 1,100 feet, A.T.

There seems to be a reentrant between the Keweenaw Bay Lobe and West Superior Lobe northeast of Winona. The great plain east of Mass City in headwaters of Firesteel River is in it.

August 21, 1909 - 7 A.M. - Aneroid 28,875 = 1,061 feet at Mineral Range Station Mass City, Michigan

We take train eastward to Simar. The red clay has a sandy capping here but east of first ravine is a clay soil and alder and poplar brush past Peppard which is 1,057 feet.

The material along railway is a nearly pebbleless laminated red clay. About a mile west of Firesteel River is a mine and an outcrop of trap rock. The altitude around this mine is 30-40 feet above the track or about 1,070 feet, A.T. Firesteel River is 1,000 feet below the bridge or 903 feet, A.T., the bridge being 1,003 feet. The east bluff is 1,014 feet to 1,020 feet.

Limestone pebbles near Simar

There are limestone and fine ground black diorite pebbles here such as I saw in Keewatin Drift in southeast Minnesota. Some limestones have trilobite fossils and corals that may be identifiable (specimens). There is also a biotite granite with white feldspar and much quartz that looks like the material seen in Keewatin drift in Minnesota.

We follow the railway track east and pass cuts in a sandy loamy material about a mile from Simar at 1,030 feet in low knolls. The surface part of the cuts here is sandier or more loamy and has less pebbly material than below.

Sand ridges (shore line?)

At the cut 1,536 Chains from Keweenaw Bay, Altitude 1,040 feet - there is a sandy ridge 10-15 rods wide and about 6 feet high that seems likely to be a shoreline. It has no pebbles but the sand shows distinct bedding as if by water rather than wind. It runs east-west across the track which here runs NE-SW.

At 1,515 chains in another sand ridge crest 1,062 if datum is 578 feet. From here east, the profile reads 2.43 feet higher than to the west. This is at an old station. The profile makes 1,440 chains = 1,500 chains here.

Milepost 27 is at 1,435 chains and in 487 feet above datum of profile = 1,062.5 or 1,065 feet, A.T.

At 1,425 chains is a ridge of clear sand, just east of an old sawmill that is 1,075 feet at east base and 1,083½ or 1,086 at crest. No pebbles in it, but looks to be water-bedded. It runs east-west. It is visible from 1/4 mile ±. Another ridge of clear sand at 1,413 chains, is also 1,086 feet.

At 1,406 chains and Altitude 1,090 feet, red clay ridges set in with till clear to top. There may be a shore at 1,086± as this is slightly notched. The pebbles on this till seem to be the same as near Firesteel River - with limestone, black diorite, chert, sandy limestone, etc.

Sand Ridge 1,135 feet

Deep cut at 1,380 chains reach 1,125 feet and here sandy beds at top 10-12 feet resting on red till. At 1,373-74 chains is a ridge with top at 1,137 feet which is clear sand down to 1,119 feet, below which is red clay. Its top is ridged slightly at east edge, as if a shoreline. The whole ridge may have been under water, however, when formed. The ground east of it is only 1,115 to 1,120 feet - so its relief is 17-20 feet.

Cuts at 1,364 chains and 1,365½ in till and muck about 1,180 feet.

The cut, at 1,357 chains, has till with pockets of sand and lenses and interbedded with dip to east. Clear to top at 1,143 feet. There is a good deal

of material here from the copper bearing formations.

Limestone Pebbles in Drift

At 1,350 chains, is a cut 1,161 feet at top. In this, a little sandy material caps the west slope - this till has interbedded sand with eastward dip. Fine grained limestone abounds here and some pebbles of black fine grained diorite.

At 1,330 chains, Altitude 1,165 feet, at top of cut there is some sandy coating, but red till with limestone, black diorite hornblendic gneiss - extends to 1,160 feet.

At 1,318-20 chains is a sandy flat topland tract at about 1,163-5 feet that has no pebbles - cuts 8-10 feet deep.

Shoreline at 1,175 feet, A.T.

There is a flat sandy level at Motley - 1,167.5 or 1,170 feet, A.T. at the east side of which is a till ridge rising to 1,180 feet which marks the crest of the moraine.

Shoreline at 1,175 feet, A.T. (?)

There is a little gravelly material on its west face - suggesting shore action up to 1,175 - 1,177 feet.

A mile east of Motley, at 1236-44 chains and Altitude 1,150 feet, the cuts show small pieces of red sandstone - the first we have noted in cuts today.

The next cut east is sandy to bottom, 8-10 feet at 1,223 chains. Altitude, 1,148 feet at top.

First ridge east of Otter River at 1,115 feet has some gravel with till at about 1,118 feet. There is a stony moraine setting in 4,000 feet east of Otter River bridge with cuts 20 feet deep, the tops of ridges being about 1,130-35 feet and the track 1,111 feet. For 8,500 feet further there is a swell and sag

till tract with small hummocks and very little sand or gravel. Then we enter a cut in sand at 1,074 chains and altitude 1,093 feet. This has no pebbles in it. The next cut east, summit at 1,059 chains has till with a capping of gravel at west end at an altitude of 1,086 feet. This tract has a wave worn, nearly flat surface and seems to be nearly up to lake level. The country west has a morainic topography and even here the depressions are not filled. There is a lower tract immediately west of this wave worn tract that does not show later deposits or cutting. From here down to White Station, there is a slight descent, the altitude being 1,069 feet or 1,071.5 on the level track near White. From White to Nisula, 1 1/2 miles, there is a descent of 50 feet or to 1,020 feet. There is a gently undulating till with a slight sand coating. Red sandstone has been abundant from about a mile west of Otter River. We saw very little farther west. There are a few copper bearing rocks east of Otter River bridge a mile or more - a greenish amygdaloid. The fine grained limestones and cherty pebbles became rare near White but are abundant from Otter River bridge eastward two or three miles. The black diorite is scarce east of White Station. Nisula is in south part of Section 31, T 51N, R 35W (Mr. Matte Mile is in SE $\frac{1}{4}$ Section 19) on south side of Otter River.

Limestone Outcrop

There is a large amount of sand north of Nisula and it has a smooth surface at about 1,040 feet rising gradually westward. Possible there is a shoreline but the ravines and sags make so much interruption it is not easy to trace it.

A mile east of Nisula is a deep till cut in which Niagaran limestone blocks occur, probably from the limestone outcrops in central part of this township. There are also calciferous sandstone blocks such as abound southeast from here. There is a greenish chloritic (?) limestone very fine grained and hard. What is

its source? Ophite rock occurs, such as is commonly called "Smallpox" rock and this is from the trap range to the north or west from here in all probability. The rocks therefore, are so varied as to involve ice movements from north or west and also from the east. The till, in much of this cut, is extremely hard and old looking. The pebbles in some cases are much decayed. So there may be Kansan or Illinois drift here. This is at the east edge of this high country. The flat clay land sets in east of Alston.

The drift is very sandy for a mile east of Nisula but from there to Alston it is clayey with only a few sandy pockets and lenses. Alston is 915.5 to 918 feet, A.T. at Milepost 16 on Mineral Range R.R. There is a thin capping of sand here in the till knolls.

There is a sandy flat tract on the Ontonagon wagon road 1/2 mile southwest of Alston at 935 feet - east of which is an abrupt descent to 910 feet. Each level may represent a shoreline. About 1/4 mile farther west immediately south of the big trestle on the railway, there is a cut bluff 970 feet at base and 985 feet top. This seems to be the equivalent of the Algonquin beach that is 1,080 feet at Calumet, i.e. the highest Algonquin beach.

In southwest part of Section 32 is a beach at 1,010 feet to 1,018 feet, trend NE-SW, that is a distinct foot more. It will come to the railway at the hills west of the trestle near center SW $\frac{1}{4}$ Section 32.

Between these beaches there is undulating till sitting in at 1,010 feet and extending down to 990 feet. Back of this beach is a ridge of till parallel to it NE-SW standing 1,035-1,040 feet, A.T. This looks to have had wave action over it. There is a sag back of it.

There is undulating land at 1,040-70 feet south of Nisula Station along the townline. We go north across Sections 31 and 30 to southeast part of Section 19, crossing a tableland in north part Section 31 and most of Section 30 at about 1,050 feet.

We then drop down in north part of Section 30 to 1,020 feet, but do not find a well defined beach here.

Delta at 975 feet

We do down to the bluff of Otter River in central part of Section 19. It has a delta at 975-80 feet with fine sandy gravel 12-15 feet deep - noting is stiff clayey till with sandy pockets and lenses. The valley here is 80 feet deep. This seems to connect with highest Algonquin beach.

August 22, 1909 - 6:30 A.M.

At Matte Mile residence center Section 19, T 51N, R 35W on Algonquin delta of Otter River 975-980 feet, A.T. Mr. Mile says large pieces of copper have been found in Section 19 and 20 near the banks of Otter River. There are no outcrops of rocks here of any kind and the copper bearing rocks lie several miles northwest from here.

We cross Otter River and come out on an old logging road to a clearing in south part of Section 18 that is on a beach 1,020 \pm , A.T. It trends N-S on west side of a valley. It is a smooth bar standing 3-5 feet above a plain west of it.

About $3/4$ mile farther, probably near northwest corner of Section 18, or possible in Section 13, we cross a deep ravine with southeast discharge on which there is a distinct distinct barren of gravel at 1,055-60 feet. The uplands here are 1,075 feet and very smooth. This terrace may correspond to a lake level, but we did not notice a 1,060 foot beach.

At a small clearing in Section 13 we came to a beach at 1,100 feet running N-S. From here we go northwest to north end of Pike Lake on Section 2 across very steep moraine nearly to the lake. We saw no signs of shore action but this lake seems to be about 50 feet lower than the highest shoreline. We cross over a very high moraine west of the lake in Section 11 and 10 that runs

northeast into Section 2 and southwest across Section 10 into Section 9. It reaches about 1,275 feet where we crossed. The moraine east of the lake does not much exceed 1,200 feet, where we crossed it. This tract west of the lake seems to have been an island about 3 miles long and scarcely 1/2 mile wide. There is a low tract north of it as far as the Twin Lakes with shallow basins and small lakes. There is a shore line in it east of a lake in west part of Section 3, T 51N, R 36W. Plain surface sides from basins extend east and southeast 1/2 mile or so to the strong moraine. This shore seems to be about 1,200-1,210 feet. The plain covers several square miles - southeast part of T 52N, R 36W on the divide between the Otter River and Misery River. It seems to be an outwash tract or pitted plain but is so near the highest lake level that it was probably submerged in part least. Possible it is an interlobate outwash - the moraine on the east being Keweenaw Bay and that on the west the Western Superior Lobe.

Moraine of Keweenaw Lobe and Moraine of Western Superior Lobe

We came to the western moraine about a mile southeast of Winona Station. It covers the greater part of Sections 28, 29, 30 and 31 and north part of Section 32, T 52N, R 36 W. We examined a cut east of Winona Station for character of rock constituents. There is an occasional limestone pebble in it. Red sandstone abounds, and many copper bearing rocks. We did not see any black fine grained diorite pebbles. There is an occasional piece of white chert. The till is red colored and very variable in amount of rock constituents. In places, it is pebbly and cobbly, while in neighboring cuts it is nearly free from pebbles. There are places where laminated caly and sand occur.

The prominent moraine starts at south side of Misery River about 1 1/2 miles northeast of Winona and extends southwest to the Firesteel River, occupying a belt 5 miles or more wide. In places it reaches 1,400 feet, A.T. The

blue print map by Menche shows its western limits. Its eastern edge is near the Copper Range R.R. from Winona southwest to the Firesteel River.

Striae north of Mass City S 20° east, Altitude 1,420 feet

We noted from the train a few places where shorelines appear on west side of the track both northeast and southwest of Seager section house.

On returning to Mass City by train we made an ascent of the hill north of the town and find it 1,420 feet at top and bare rock. There are striae on its highest part being about S 20° E.

A letter from R. C. Allen reports observation of striae near Iron River in Section 21, T 42N, R 35W bearing S 4° - 10 E (See letter of August 17, 1909 from Iron River, Michigan).

August 23, 1909 - Mass City, Michigan

We follow the C. M. & St. Paul R.R. southeast and go over a very gently undulating sand till to Wasas Station. There is a slight bank at about 1,120 feet which may be a shoreline but in doubt its being a clear case. There is also a slight cut at 1,138-1,140 feet, possibly second beach of Lake Duluth. Just south of Wasas Siding at Altitude 1,147-1,155 feet (1,151 feet summit cut by railway is a deposit of sand along the crest of this till ridge. It is probably 10-20 feet below the level of the highest shoreline.

The slope south of this ridge is coated only in patches with sand, most of the surface being rock till. We descended to altitude 1,076 feet, A.T., in sag. The ground in valley is only 1,067 at lowest place. Beyond this sag is continuous sand past Pori. There is an abrupt rise from 1,130-1,148 feet about $1\frac{1}{2}$ miles north of Pori, which may be 2nd shoreline of Lake Duluth with water level about 1,130 feet. There may be tilting of 8 feet between this and supposed shore north of Wasas.

Highest Duluth shore near Pori is 1,163 feet

The land from here south past Pori is flat sand with a few pebbles at certain horizons but generally free from pebbles. There is higher land 1 1/2 miles east of Pori that probably is at the highest shore of Lake Duluth.

At Wasas Siding 1,150 feet, A.T., a well strikes red sandstone at 40 feet. The well is 245 feet - head 85 feet.

Rock outcrops a mile west of Simar - Section 2, T 40N, R 38W.

At Pori, 1,153 feet, a well is 36 feet and largely sand with a thin bed of "hardpan" at about 20 feet.

In the sandpit, a mile south of Pori, we find considerable chert and grey limestone in fine pebbles. This is in a bar near level of highest shore. Its crest reaches 1,163 feet.

Mr. Woodworth readings at mile posts south of Pori - 1,148 (corrected) at mile post 297 at 12:30 noon, 1,159 at 12:40 o'clock, mile post 296. Still in sandy ridges and sloughs nearly up to level of highest shore. Two miles south of Pori at 295 1/2 is a cut through a till ridge - capped with 6 feet of sandy gravel. Boulders of gabbro and amygdaloid rocks occur in the till. The aneroid reads 1,179 at track and 1,187 at top of hill and 1,195 at top of cut (Profile gives 1,194 top and 1,179 on track). Mile post 295 is 1,191 at 1:10 P.M. This is where railway curves from a straight south to an eastward course NS part of Section 17, T 49N, R 37 W. The gravel in cut, milepost 295 1/2 (or 153,600 feet from Ontonagon end) is probably 30 feet above level of Lake Duluth, at least it is 30 feet above base of cut bank at north end of cut, and nearly through above ridge at the gravel pit 1/2 mile farther north.

Mile post 294 reads 1,237 feet by profile at 1:40 P.M. There is a hill 60 rods northeast about 1,350 feet. It is very steep down to 1,280 feet and a gradual slope above to the west.

An equally prominent hill lies less than 1/2 mile west. There is a prominent range of moraines in hills each side of the railway for the next mile east - drift sandy.

M.P. 293 = 1,287 at 2:10 P.M.

M.P. 292 = 1,335 at 2:30 P.M.

Moraine between Pori and Frost Junction

High ridges both north and south of track from mile post 293-293 are timbered with hardwood but drift seems to be sandy and gravelly, cobbly stuff. In first cut east of mile post 292, there is firm sand horizontally bedded on which occasional boulders about 1 foot in diameter are imbedded as if dropped from an overhanging ice sheet.

At mile post 291 one mile northwest of Frost Junction, altitude on aneroid 1,384 at 2:55 P.M. Near crest of a morainic ridge, that farther west lies south of track - about 1/4 mile farther is the old Frost Junction, 1,392 feet. (The altitude given by Garrett is 1,397). Time 3 P.M.; so change is about 13 feet for here. There seems to be an extensive outwash plane southwest of Frost Station at about 1,395 feet on highest part, originally timbered with hemlock and maple but now largely poplar brush and cherry. There is flat surface south of Frost and horizontally imbedded gravel with open ravine between the old Station and present. The gravel has few stones over 6-8 inches.

Outwash plain near Frost Junction

First station switch has a mile post 289 instead of 290. Altitude 1,388 feet at 3:25 P.M. Real altitude about 1,388 (?) feet A.T.

This gravel plain reads 1,392-1,395 feet at mile post 289 at 3:45 P.M., one mile southeast of Frost (aneroid reset at Frost Junction). The upland plain is 10 feet \pm higher than this mile post which is 1,384 feet. There are deep basins in it southeast of mile post 289 and Norway pine sits in here.

From mile post 289, toward Frost Station, there is some maple mixed with hemlock. The water table lies so low in this region that no wells are found. Water is carried 3 miles to Frost Station by the section men from a spring northwest along the track. Mr. Wood took a view of the desolate view where Norway pine once stood but which is now cut off leaving the dead trees standing. The view was 1/4 mile southeast of mile post 289 looking west. There are deep basins 50± feet in Sections 35 and 36, T 49N, R 37W and Sections 31 and 32, T 49N, R 36W and Sections 5, 6, T 48N, R 36W and Sections 1 and 2, T 48N, R 37W. At mile post 288 at 4:14, the aneroid reads 1,344. This is 30± feet below level of the outwash plain near division of Section 31 and Section 6 making that 1,375±. No boulders in this plain. Basins 75-100 feet deep between mile post 287 and 288. Altitude 1,338 at mile post 287 at 4:40 P.M. in Section 5, T 48N, R 30W.

Fractures between Frost Junction and Sidnaw

Near mile post 286 we find copper rocks, amygdaloids in abundance. There are also many sandstones. One limestone with a coral looking like Zaphrentis in the cut. Aneroid 1,373 feet at milepost 286 at 5 P.M. - 1,369 corrected. Aneroid 1,366 at milepost 285 at 5:25 - 1,356 corrected on edge of hardwood timber probably in north part of Section 16, T 48N, R 36W. Boulders abound in a reddish till in this hardwood tract. There are deep depressions but only a few large knolls. There is one 35-40 feet high just east of milepost 294. Altitude 1,313 at milepost 284 at 5:50 P.M. There is very broken country between milepost 284 and 283 with a deep slough in the west. Aneroid 1321 1363 at milepost 283 at 6:30.

Between milepost 283 and 282, two lakes in deep basins east of track. Scored and shallow basins west knolls are very inconspicuous here but are large in mile northeast from milepost 282. Altitude 1,313 corner at milepost

282 at 6:50 P.M. Large cut through reddish silt with a deep gorge 75± feet below railroad.

Probable reentrant between ice lobes at Frost Junction

Moraine east of the gorge at milepost 281 and eastward. Altitude at milepost 281 at 7:15 P.M. = 1,312 aneroid. Aneroid 1,359 corner at milepost 280 at 7:35 P.M.

Aneroid at Sidnaw at 8 P.M. should be 1,364.

There is a nearly plane tract on Sections 25 and 26, T 48N, R 36W. But upon crossing a deep ravine two miles west of Sidnaw, knolls of sand are entered that rise 30-40 feet above the track. They have few pebbles and no boulders so far as we can see. About a mile west of Sidnaw a plain with lakes in it was entered that extends past the village. Southeast of the village is a high moraine rising above 1,400 feet.

It now seems probable, that the moraine north of Frost Junction, which runs ESE along north side of the great pitted plain that we crossed into the northeast part of T 48N, R 36W, is the continuation of the moraine of the Keweenaw Lobe. North of the great pene-plain in the bend of Sturgis River north of Covington. It is reported to cross the Sturgeon near where the river turns north and would naturally continue toward Frost Junction along north side of this great outwash. The material in the outwash is a mixture from the northwest and the northeast for this is in a reentrant. The moraine we passed through before reaching Frost Junction probably turns southwest to form the border of the Western Superior Lobe.

Outwash plain Sidnaw & Kitchi August 24, 1909 - 7 A.M.

Sidnaw, Michigan - Altitude 1,365 feet at milepost 224 at 7 A.M.

Milepost 225 at 7:20 A.M. in sandplain (Bar 1,385 feet)

Milepost 226 at 7:45 A.M. Altitude 1,354 on high part of sandplain that extends south 1/2 mile or more to a moraine.

Milepost 227, Altitude 1,346 in outwash at 8 A.M.

The outwash extends a mile south to a moraine. Boulders are exposed here in the gullies at 15-20 feet below surface of outwash tract. The outwash is very sandy, usually with but few pebbles and these small.

At Anthony, the reading should be 1,357 feet at 8:20 A.M. This is ground level of sandplain and near milepost 228 but the milepost is in a cut and reads 1,345 feet.

At milepost 229, the track is 30-40 feet below the sandplain - Altitude of milepost 229 is 1,293 feet at 8:40 A.M. This is one mile east of Kitchi. The hardwood timber sits in within 1/4 mile southwest and here is silt with the sand but no boulders on coarse rich material. There are deep basins all along the line from Sidnaw to Kitchi.

This outwash tract has a lot of small white quartz pebbles both on this line west from Sidnaw on the Chicago, Milwaukee and St. Paul, northwest. The sandy bed extends past Kitchi. There is a low bank running along south side of track past Kitchi that looks much like a beach - Altitude about 5 feet above Kitchi and base at 1,287 and about 1,295 at top - Kitchi is 1,282. There is a very flat swampy tract to the north as far as we can see that looks like a lake bottom. To the south is broken land full of moraines and basins. There is high moraine and hardwood timber 1 1/2 miles south of Kitchi. The flat land is sand and extends to 3 miles north from Kitchi and seems to be rich black soil in the hardwood but not clay, the subsoil being sandy.

Clay plain west of Kitchi

Farther north are the outwash and pitted plains noted yesterday.

Altitude 1,257 at milepost 231, one mile west of Kitchi at 9:35 A.M.

There is red clay from 1/2 mile west of Kitchi westward but we see no boulders until near milepost 232 - 1 1/4 miles east of Kenton - Altitude 1204 at Milepost 232 at 9:50 A.M.



On bed of Glacial Lake Ontonagon

The aneroid reads 1,145 feet at Kenton at 10:20 A.M. It should be 1,167 feet. There is a tableland here at 1,190-1,200 feet.

We are in a valley here that opens out to the west of Kenton as if in a lake plain.

We take train to Trout Creek - at Milepost 235 - Aneroid 1,168 feet. Sandy land. Gravel ridge just west. Clay bed extends to about 234 1/4. At Milepost 236, altitude 1,168 feet.

There is some red clay west of here. At 237, Altitude 1,144 feet.

Immediately within 1/4 mile south of this Milepost is flat land - lake plain? 1,154 at 1 mile east of Trout Creek. We enter red clay east of Trout Creek and there is clay by the water tank on west bluff of creek on a narrow winding ridge. It is a pebbly clay. The aneroid read 1,138 at water tank at 11 A.M. and 1,155 at Station where it should be 1,161 feet.

Mr. Knoll of Kenton witnessed the southwest edge of this pitted plain that we crossed yesterday between Frost and Sidnaw. It runs from Mill in Section 3, T 48N, R 37W, across Sections 2 and 12 in T 48N, R 36W. In that township it runs southeast across Section 18 and SSE across Sections 20 and 29 into Section 33 and thence south through Section 4 and 9, T 47N, R 36W and then east to Sidnaw.

Features on bed of Glacial Lake Ontonagon

There is undulating hardwood in Sections 18, 19, 20, 29, 30, 31 and 32, T 48N, R 36W and Sections 10, 11, 12, 13, 14, 23 and 24, T 48N, R 37W. There is a large swamp in Sections 15, 22, 23, 25 and 26, T 48N, R 37W. West of this in Section 21 and adjacent points of border sections is a high tract with sandstone exposed in ravines but capped heavily with drift. The sandstone is exposed in Section 20 and west part of Section 21. West and south of this

hill the land is low enough to be below Lake Duluth and possibly the swamp east of it was carbed by the lake. Mr. Knoll says there is very little rise from Kenton along the line of railway leading northward to Mill until one reaches Mill. There is then a steep ascent to Front Junction. There is hardwood west of Mill in Sections 4, 5, and 6, T 48N, R 37W., but south of it is a pine strip running eastward to Mill.

The district between Kenton and Trout Creek has poplar brush and generally sandy soil. In places, clay knolls and ridges rise up 20± feet in the midst of sandy areas. There is some gravel with the sand. It is probably that Lake Duluth has a shore not far north but it is not easy to fix the limits in a district like this with irregularities of soil and surface.

At 1,240, the aneroid had changed to 1,122 feet from 1,165 feet in 1 hour, 40 minutes or about 20 feet an hour. Real altitude 1,161 feet.

One mile west at Milepost 240 is a clay ridge 1,189 feet. Time 1:15 P.M.

Milepost 241 is 1,192 feet. The land is about 1,200 feet 1/4 mile west. This plain has an occasional low swell but much of it is flat. Milepost 242 at 1:50 P.M. reads 1,168 feet at Agate Station.

Milepost 243 is at east bluff of a deep gorge and reads 1,185 feet at 2:15 P.M. The clay plain is about 1,200 feet here.

Morainic Trout Creek to Paynesville

At Milepost 245, altitude 1,240 at 3:10 P.M. on northeast slope of a moraine west of Basco 1/2 mile. About 2/10 mile northeast is a hill probably 200 feet higher than Milepost that may have a rock nucleus. It is the most prominent hill of this region.

At Milepost 246, altitude 1,265 feet at 3:30 P.M. At Paynesville at Milepost 246½, altitude 1,243 feet at 3:45 P.M. Milepost 247 at 3:55 = 1,222 feet.

The low country covered by Lake Duluth has its edge 1 1/2 - 2 miles northeast of Paynesville, fully 2 miles north and scarcely 2 miles northwest. There seems to be morainic country all along the south side of the railway from Trout Creek to Paynesville.

We round the curve and turn west near Milepost 248 - Altitude 1,175 at 4:15 P.M. There is high land 2 miles north but between here and there is a great valley low enough to have been under Lake Duluth for a mile east of here. Altitude 1,155 at Gem.

Highest Lake Duluth shore 1,134 at Bruce Crossing

Altitude 1,135 at supposed highest shore. Schriener at Milepost 249 reads 1,153 at 5 P.M.

At Bruce's Crossing the highest shore of Lake Duluth is about 8 feet above the station or 1,134 feet A.T. It runs NE-SW through the southeast part of the village probably as a sand ridge and partly cut bank. The base of the cut bank is about 1,131-1,132 feet while the sandy bar is 1,134 feet. The flat tract reaches nearly a mile southwest from Bruce Crossing to the base of a strong moraine.

One mile west of Bruce Crossing at Milepost 251, aneroid 1,117 at 6:20 P.M. Milepost 252 reads 1,148 feet at 6:45 P.M. It is in a tract of red clay with a few land swells 5-20 feet high. Baltimore Siding reads 1,170. A clay ridge west of here 1/8 mile is 1,180₊. This station is 252 $\frac{1}{2}$. Milepost 253 is 1,196 feet.

The ridge 1/3 mile west reaches 1,273 feet - natural surface on track 1,312 feet. The reading at Milepost 254 is 1,187 feet. There is a rapid descent from here to the river bank, which is 1,130-35 feet. The River at Ewen is almost 1,100 feet. This village has four flowing wells. The shallowest is 181 feet, the others in about 300 feet. The village is supplied from them.

Delta at Lake Duluth Shore 1,134 feet at Ewen

August 25 - 9 A.M. - Ewen Michigan.

Altitude 1,134 feet at depot. This is on a delta of Lake Duluth Age which reaches 1/4 to 3 miles north of the station, and there drops off into a swamp that is less than 1,130 A.T. The surface at Ewen is clay from 1 - 2 feet below which is sand and sandy gravel. The clay is a flood plain deposit. The sand is the delta.

At Milepost 256, aneroid around 1,150 feet, Altitude 1,143.

Fair Oaks station 1,200 feet at 10 A.M. Very flat country with pine and poplar as far south and west as we can see.

West from Ewen

To the north, the surface is unbroken and keeps high for 2 miles or more. The soil is a red clay. The reading at Milepost 258, about 3/4 mile west of Fair Oaks is 1,216 feet at 10:10 A.M. Aneroid reads 1,231 in this place at Milepost 259 at 10:35 A.M. There is a fine residence near here beyond which is a belt of hardwood. I take a view of it from the railway looking northwest at 10:45 A.M.

On bed of Lake Ontonagon

The hardwood is more undulating than this pine plain and may be morainic. The pine plain extends several miles south - from Fair Oaks 6-7 miles and nearly as far south of Matchwood. The hardwood tract, north of Fair Oaks, is about 3 miles across, north-south and 2 - 3 miles east-west. It has a clay plain north of it that slopes gradually to Ontonagon River near the Monarch Mine.

The altitude reaches 1,255 1/2, northeast of Matchwood. The aneroid reads 1,229 at Matchwood at 11:30 A.M. The pine land extends north here to the west branch of the Ontonagon and south 6-7 miles and west to a mile

beyond Topaz. The hardwood area northwest of Fair Oakes is sand to here, a sandy loam soil and undulating surface. It is largely in Sections 5, 6, 7, and 8, T 48N, R 40W and Sections 31 and 32, T 49N, R 40W. North of this is a pine tract.

We take train west from Matchwood at noon, aneroid 1,229 feet at Matchwood. The reading is 1,236 at 2nd Milepost west. It reads 1,241 at station, 2 miles from Matchwood (Groesbeck). Topaz reads 1,255 feet. There is some hardwood here.

It reads (1,260) at Milepost 1/4 mile west. At Milepost 266, altitude 1,282 feet. The old Lake Ontonagon extended to the Trap Range in west and north sides of the West Branch of Ontonagon River, the outlet of Lake Gogebic.

An altitude of 1,286 is reached before descending to Lake Gogebic - near Milepost 268.

It read, at Milepost 269, 1,284 feet near the outlet of Lake Gogebic.

There is a sandy bluff-like rise in north part of Bergland 15-20 feet above the station or about 1,310 feet. This may be an old shore of Lake Gogebic rather than of Lake Ontonagon.

This beach is well defined at Lake Gogebic 20-25 feet above the station at 1,305-1,310 A.T. Mr. Wood left me here to return to Kalamazoo. He leveled up to the supposed Lake Ontonagon beach and made it 1,312 feet.

Drainage of Lake Ontonagon

I continued west on train rising to a summit that reads 1,346 feet at Milepost 277. It reads 1,343 at Milepost 276. To within a mile of there, the siding did not exceed 1,315 feet and I think lower ground occurs to the south, opposite Milepost 277, that will connect the Ontonagon with the Presque Isle River drainage. At 278, this reading is only 1,307 feet. It is likely that the spillway, 1,319 feet of which Dr. Lane wrote me last October. (See first page of note book 228) was near the line of this railway.

The reading is 1,285 feet at Presque Isle River in Section 23, T 48N, R 44W.

About a mile west on north side of track at Altitude 1,310 feet, I pass a gravel ridge looking like an esker that rises to 1,325 \pm feet. The reading is 1,320 feet at Tula near Milepost 282. Small knolls 10-15 feet high in this vicinity, but much of surface swampy. Knolls 25 feet or more high near Milepost 283 - Altitude of track about 1,350 feet. At knolls 1,375 \pm .

Outlet of Lake Ontonagon near N. Bessemer

Plain at 1,350 feet near Milepost 283, 284 and 285. A few boulders, rich loamy, sandy and gravelly till. First maple, hemlock, birch, etc. Altitude at 286 reads 1,355 feet.

Altitude 1,300 on Black River bridge 50 \pm feet above stream.

Altitude 1,334 at Thomaston 287 3/4 miles. Very flat, with maple, hemlock, birch, etc. The hills near Bessemer and Wakefield are in view to the southwest, the nearest ones probably 2 miles and just south of the railway.

There is a rapid westward descent down the Black River plain north of these hills, the reading being 1,210 at Black River bridge. Section 32 or 31, T 48N, R 45 W. The railway here descends into a valley with a bluff on north as well as the range of hills on the south. In places, the north bluff is 100-150 feet and reaches nearly 1,200 A.T.

The aneroid reads 1,160 near Bessemer Junction where stream runs north across the track. The aneroid reads 1,175 at North Bessemer in a valley. There is a rapid westward rise, the reading at Milepost 296 being 1,200 feet in a valley bottom. Reading at Milepost 297, 1,197 feet in swampy valley. 1,194 at Milepost 298. Range of rock hills south 200 \pm feet higher. Cuts in reddish looking till just west of Milepost 298. Big swamp at Milepost 299 - 1,178 feet.

On 1,194 feet of Montreal Station on terrace 20+ feet above a stream 1/8 mile north. Many boulders in this terrace and higher ground each side. This valley seems not to have been occupied by a large stream. Altitude 1,170 feet at Montreal River and state line. Correct altitude of Montreal station is 1,194 feet.