

Notebook No. 206 - Leverett

COUNTY

Alger: 1-9, 10-20, 25-36, 37-39, 40-43, 47, 53-57

Delta: 12, 43-53

Marquette: 9-10, 28, 36-37, 57-62

Ontonagon: 39

Schoolcraft: 14, 20-24

I N D E X

N O T E B O O K N O . 2 0 6

(September 22 to October 5, 1905)

- Sep. 22. Drive northeast from Munising past Miner River and south to Shingleton and west past Wetmore to Munising.
- Sep. 23. By rail, Munising to Autrain River at Dixon. Walk to Mud Lake and northeast to Sixteen Mile Lake and Stillman. Rail to Munising.
- Sep. 24. Excursion on Munising railroad to Mangum and return.
- Sep. 25. Munising, Wetmore, and south to Pete's Lake and back with stallion and mare.
- Sep. 26. Rail, Munising to Chatham. Drive to Eben and back. Drumlins. Drive Chatham south 5 miles and back and north to Au Train. Rail to Shingleton and Steuben.
- Sep. 27. Steuben north to Scotts and McGillis Camp and Shingleton and back to Munising.
- Sep. 28. Launch from Munising to Grand Portal of Pictured Rocks and west to lighthouse at north end of Grand Island. Walked from north to south end of Island. Levels. Barometric fluctuations of lake.
- Sep. 29. Munising to Ridge Station and back.
- Sep. 30. Munising to Chatham by rail. Drive north to Rocky River. Rail Rocky River to Marquette.
- Oct. 1. Marquette to Chatham by rail. Drumlins around Eben. Data on flowing wells near Ewen, Ontonagon County.
- Oct. 2. Chatham to Winters, Whitefish River, Trenary and Rapid River. Notes by Archie Connor at Rapid River. Flowing wells.
- Oct. 3. Rapid River to Brampton and along C. & N. W. past Perkins to Maple Ridge, east to Osier and north to Trenary.
- Oct. 4. Trenary to Eben and Lawson and Skandia. Rail to Marquette.
- Oct. 5. Drive Marquette to Mangum, Pickerel Lake, Skandia and back.

September 22, 1905, 7:45 a.m.

Munising, Michigan. Aneroid 29.225 at level of Lake Superior, 602 feet, A.T. We drive 2 miles northeast along the shore of Munising Bay. Rock outcrops set in about 100 feet above lake level. There is red clayey till above the rock. Aneroid 29.050 = 760 feet (corrected: 770 feet) at terrace or cut by lake action at foot of bluff back of tannery 1 mile northeast of Munising at 8:30 a.m. There is a reddish loamy sand, in places clayey, from here down to top of the sandstone ledges at about 690-700 feet A.T. It seems to be more clayey just above the sandstone than at higher altitudes.

Aneroid 28.960 = 850 feet (corrected) at a cleared farm about 1/2 mile back from the bay at 8:45 a.m.; at Robert Gogarus farm in west part Section 6, T.46N., R.18W. The well at house is 20 feet. Aneroid 28.975 at well = 835 feet. This farm has a loamy soil with some clay and there are low hummocks 10-15 feet. There are occasional very large granite boulders.

We find a ledge at (rock) 715 feet, aneroid 29.075, in a ravine crossed near the township corners. Just east of intersection with a west-east road we find sandstone up to (rock) 780 feet A.T. We go east across a plain 830 feet A.T. to a swamp. Aneroid 28.960 in swamp. Time: 9:25 a.m. East of this is a rise of 10 feet. Aneroid 28.950 on a plain = 875 feet; 28.965 at south end of a large tamarack swamp in southeast part Section 32, T.47N., R.18W., at 9:30 a.m. = 860 feet. This drains southward. The land east is very bouldery and has low hummocks and ridges of sandy material with some pebbles and blocks of stone on surface. The altitude is about 870-900 feet. This runs east for over a mile. The road then drops to a plain bordering Miner River.

Aneroid 29.000 at west border at 9:50 a.m.; 29.100 at Miner River, 750 feet (corrected); 29.050 at east bluff = 800 feet; 29.060 at Munising railroad at an old camp near corner Sections 35 and 36, T.47N., R.18W., and

Sections 1 and 2, T.46N., R.18W., = 780 feet \pm at 10:10 a.m. We go north and find slabs in east part Section 6 that may be dolomitic limestone (see sample). More probably calciferous formation. The drift or dirt on these slabs is calcareous. Aneroid 28.960 = 900 feet \pm (corrected) at slabs of rock. They are only $1\frac{1}{2}$ feet square and 2-3 inches thick. Time: 10:50 a.m. We find the limestone blocks very numerous northeast from here as if there might be ledges at slight depth. The highest altitude is 950 feet \pm . Aneroid 28.950 at forks of road where road to Grand Marais branches off, probably in Section 25. We take a road leading southeast while the other continues north of east.

Aneroid 28.970 at a small stream in Section 25 draining to Manistique River = 880 feet \pm . On the north side this stream is a succession of gravel ridges about 10 feet high and 4-6 rods wide running in a southeast-northwest course. Aneroid 28.950 on the ridges. They have a few boulders and limestone blocks on them and are likely to be glacial. The aneroid reads 28.970 where a road turns from a south to a southeast course at intersection with an old road from the northwest now abandoned.

Aneroid 29.020 at camp in northeast corner Section 6 at noon = 875 feet \pm . There is a well here about 50 feet deep. The soil in this region has clay under it in places. The general average of soil from Munising to here is good with considerable clay loam. It is similar to the soil north of Manistique Lake and this kind of soil continues northeast toward center of T.47N., R.17W.

The hardwood runs east from here about to middle of line of T.47N., R.17W., and T.46N., R.17W. Beyond this is a swamp with cedar, etc., in it. Aneroid 29.020 at camp northeast corner Section 6, T.46N., R.17W. = 875 feet; 29.040 at creek east of camp = 855 feet; 29.050 at railroad track in Section 5, T.46N., R.17W., at 1:45 p.m. = 850 feet \pm ; 29.090 at camp $1\frac{1}{2}$

miles south at 2:20 p.m. = 820 feet \pm ; 29.090 at corner Sections 7, 8, 17 and 18 at 2:35 p.m. = 820 feet \pm (corrected). Numerous boulders in these sections. The surface is flat; timber--maple, elm, etc.; soil--sandy loam.

Aneroid 29.140 at stream 1/2 mile northwest of Shingleton and same at Shingleton = 827 feet A.T. at 3:25 p.m. We take road west on north side South Shore Railroad. Aneroid 29.100 at crossing of Munising Railroad 1/2 mile north of Evelyn Station at 4:10 p.m. = 870 feet \pm . Surface undulating very gently in last mile but for nearly 3 miles west-northwest from Shingleton there was a perfectly smooth inclined plain sloping southeast at about 12-15 feet per mile. It is sandy near Shingleton but becomes more gravelly to the west. No boulders seen east of the Munising Railroad but cobblestones are not rare. Timber mixed, with considerable hemlock and pine. The latter was cut some years ago and the country was burned over nearly out to the Munising Railroad.

About 1/2 mile west of railroad we reach an altitude 25 feet higher, aneroid 29.076 = 895 feet \pm . Just north of road is a cut bank 15 feet high = 875 feet \pm at base. Is this a beach? or border drainage? There are two other similar descents made before reaching Miner River, all within a mile of the river. Aneroid 29.090 at Indiantown church at 4:50 p.m. = 865 feet \pm (corrected). Boulders are numerous for about a mile southeast of Indiantown or to Miner River.

We take road toward Wetmore and rise 20 feet \pm in about a mile, aneroid 29.070 = 880 feet \pm . The surface is wavy and boulder-strewn. We then cross a spruce and tamarac swamp 1/4 mile wide, aneroid 29.100 at 5:00 p.m. = 860 feet \pm . This is in Section 8. There is rolling land west. Aneroid 29.070 on highest points in west part Section 8 = 885 feet \pm . These are boulder-strewn and morainic in aspect. There is some red clay on the knolls but generally the soil is a sandy gravel.

We cross a ridge, aneroid 29.050, and it has points 20 feet higher, or 925 feet. Northwest of it is a pond. Aneroid 29.070 at the pond at 5:10 p.m. = 890 feet; 29.050 on ridge southwest of pond. There are places south of it 40-50 feet above level of pond or 930 feet \pm . Aneroid 29.060, 895 feet, on hill 1/2 mile northeast of Wetmore; 29.100 at Wetmore = 859 feet A.T. at 5:30 p.m.; 29.050 on hill $1\frac{1}{2}$ miles toward Munising where road turns from north to west course in west part of Section 12 = 910 feet A.T.; 29.100 at foot of hill by a cemetery. This is at edge of Lake Algonquin. The lake may have been 10 feet higher than ground at cemetery or 870 feet A.T. (see notes in 1912). There is sandstone outcropping where road descends west of here to the creek in southeast part of Munising up to a height of 75 feet \pm above lake level. Aneroid 29.390 at Russell House = 618 feet A.T. at 6:10 p.m.

September 23, 1905, 7:20 a.m.

Aneroid 29.660 at lake level. We take train on Munising Railroad. Aneroid 29.640 at depot in Munising. Mile Post 4 at brickyard. The clay bluff is 740-750 feet A.T. Mile Post 5, under the Duluth and South Shore, 25 feet \pm lower than that railroad. We rise rapidly past Mile Post 6 to Mile Post 7. Swamp occurs between Mile Posts 7 and 8. There is a cut in a sandy ridge between Mile Post 8 and Stillman. Aneroid 29.330 = 925 feet at Stillman at 7:45 a.m. The cut west of Stillman is in bouldery, sandy drift--glacial rather than lake. Aneroid 29.330 at Mile Post 9; 29.315 at summit 1/2 mile west = 940 feet; 29.330 at Mile Post 10 = 925 feet \pm . A rapid descent begins here. Aneroid 29.370 at Mile Post 11; 29.410 at a swamp and stream by Mile Post 12. There are knolls interspersed with swamps for next mile. Aneroid 29.460 at Mile Post 13; 29.485, 787 feet, at

bridge on Au Train River, 37 feet above the river = 750 feet at river and 787 feet on bridge.

Aneroid 29.460 = 813 feet at Dixon at 8:00 a.m.; 29.515 at Au Train River under Munising Railroad bridge = 750 feet at 8:40 a.m. There is a ledge of rock looking like limestone in river bed here. The bridge is 37 feet above stream by hand level and about 787 feet A.T. by profile. The bluffs of this stream are 50 feet \pm above it within 1/8 mile from it on each side and contain a large amount of the local rock such as appears in the ledge in the bed of river. There are knolls 10-20 feet high around Dixon Station full of these stones.

Aneroid 29.480 = 785 feet on bluffs; 29.465 at a clearing 2 miles south of Dixon on a morainic knoll thickly strewn with large boulders. The boulders are larger here and for 1/2 mile north than in vicinity of Dixon.

Aneroid 29.490 = 768 feet at Mud Lake at 10:00 a.m. The east shore has high bluffs for a mile south of north end. We are on west side and in undulating, stony land with numerous granites and dark colored erratics as well as local limestones and Potsdam sandstones. It is apparently morainic. Slapneck Creek was crossed 2 miles south of Dixon Station. Bohemian Creek comes in very weak at Mud Lake.

A well in Section 8, T.44N., R.20W., is only 20 feet to rock. Another in Section 31, T.45N., R.20W., (east part) was dug and driven to 72 feet and struck nothing but sand. It supplied engines for a narrow gauge rail and a large camp. Made about 1900.

Aneroid 29.510 at Trout Lake = 761.5 + 6 feet due to dam (in Section 6) at 11:30 a.m. This is within 1 foot of level of the portage between AuTrain and Whitefish Rivers, 768 feet. I am told by Mr. Tweedale, who lives in Section 6, that there is a rock bed at depth of 3 feet in parts near south end of lake in Section 31, T.45N., R.20W. There is also rock

at Mr. Tweedale's cellar. There is a rapids near township corners of Townships 43 and 44 North, Ranges 20 and 21 West. There is a lake from near center of Section 6 to north part Section 18, T.44N., R.20W., called Trout Lake which drains south to Whitefish. Altitude 761.5 + 6 feet by dam. It is fed by springs and has a large flow. There is no fall on the Mud Lake draining north to Autrain River from south part Section 31 to south part Section 13, it being 768 feet. There is a tract of 1/2 mile length of cedar swamp between Mud Lake and Trout Lake. There is hardwood timber and stony land on west side of river in much of T.44N., R.20W. There is a flat rock rapids in Section 19, T.44N., R.20W., and Section 24, T.44N., R.21W., about 1/2 mile long.

There is a dam at south end of Trout Lake in north part Section 18 that raises the water 6 feet and this is nearly on a level with Mud Lake, 768 feet. Aneroid 29.500 at Trout Lake at 1:15 p.m. = 768 feet; 29.450 at top of limestone cliff east of lake = 820 feet; 29.440 at foot of a steep sandy bluff, probably a beach = 830 feet ±. (see notes in 1912); 29.400 at top of bluff. There are gravelly knolls on it 15 to 40 feet. Aneroid 29.345 at highest point just north of road near center Section 6 (a few rods east of it = 140 feet above Trout Lake, or 908 feet A.T.). Limestone blocks on its highest part.

Aneroid 29.370 on summit in road; 29.410 at edge of jack pine plains in east part Section 6, T.44N., R.20W., = 855-860 feet. Mr. Tweedale says this ridge runs down the east side of the Whitefish a long distance with plains and swampy tracts to the east and clayey hardwood tracts to the west of it--probably an old ice border running north-south.

The Autrain, he says, has lower falls 25 feet ± about 3/4 mile north of Munising Railroad bridge. The upper falls are at the bridge.

We go north near line Sections 31 and 32 through west part Section 29

to center Section 20, rising gradually and entering hardwood in Section 29. The jack pine covers the east 40's in Section 31, all of Sections 32 and 33, the southeast part Section 29, nearly all of Section 28 and northwest part Section 27, and runs north in east half of Section 21, T.45N., R.20W. Its southern limits are in north part Sections 7 and 8 and 9, T.44N., R.20W. (Outlined by James Tweedale.)

Aneroid 29.340 in Section 29 where slight undulations set in = 900 feet \pm at 2:30 p.m.; 29.315 at south edge of strong morainic ridge in Section 20 on level of outwash apron at a settler's cabin = 925 feet \pm . The moraine rises abruptly 25 feet or more, or to 950 feet \pm . Aneroid 29.230 on highest point on high group of knolls 1/8 mile north of cabin = 1,000 feet \pm at 2:50 p.m.; 29.310 at east base by a well 12 feet deep = 920-925 feet; 29.350 at hill in clearing in east part Section 18 = 880 feet (corrected); 29.380 at Mr. Brown's in east part Section 18 on north side of Joe's Creek = 850 feet (corrected); 29.360 at old camp a mile north-east on north side of Joe's Creek; 29.350 at Joe's Lake at 4:15 p.m. = 870 feet (corrected). This is surrounded by morainic knolls 20-30 feet or more in height. The drift on the north side of Joe's Creek has considerable clay in it. Boulders are numerous and of foreign as well as local rocks.

Aneroid 29.250 at 9 Mile Post on Munising Railroad at 6:00 p.m. = 900 feet \pm . We came northeast from Joe's Lake to a branch of the Munising Railroad near north end of Sixteen Mile Lake and then north to the main line near Mile Post 10 and from there to Stillman. Aneroid 29.220 at Stillman at 6:20 p.m. = 926 feet. The rolling land east of Joe's Lake seems to die out not far east of the lake and boulders become small and rare. The moraine runs past the north end of Sixteen Mile Lake. The undulation is very slight from Sixteen Mile Lake north to the railroad, knolls being seldom over 10-15 feet high. I am told at Stillman that the branch running east from here is

through a nearly plane tract of hardwood and land of gravelly character and good soil for agriculture. It is not clayey, however, like the land west from Stillman.

The well at Stillman is said to be 90 feet deep. There is a sandy soil, but clayey hardpan sets in at slight depth.

We return by train from Stillman to Munising. Aneroid 29.525 at Munising = 618 feet at 7:45 p.m.

September 24, 1905.

Aneroid 29.410 at Munising at 7:30 a.m. at lake level. We take train to Marquette on Sunday excursion. Aneroid 29.320 at Hallston at Mile Post 4 = 680 feet; 29.240 under D.S.S. & A. track; 29.220 at Munising Junction, Mile Post 5; 29.170 at Mile Post 6; 29.115 at Mile Post 7; 29.095 at Mile Post 8; 29.090 at Stillman, 926 feet. Ground just south is 8-10 feet higher. Aneroid 29.090 at Mile Post 9; 29.075 at summit; 29.085 at Vail Junction, 50 rods east of Mile Post 10; 29.160 at Mile Post 11; 29.200 at Mile Post 12; 29.250 at Mile Post 13; 29.265 = 787 feet at Autrain bridge. River is about 750 feet A.T. here. Aneroid 29.245 = 813 feet at Dixon. Clearing with morainic topography--knolls 10-15 feet high, small boulders numerous. Aneroid 29.260, 802 feet, at Slapneck Creek at Mile Post 15; 29.235 at Mile Post 16 = 822 feet. Road here is on south side of Slapneck Creek. Morainic knolls 20-25 feet higher to south. Aneroid 29.210 at Mile Post 17 = 850 feet; 29.200 at Chatham on a limestone hill = 866 feet; 29.175 at Mile Post 18. Undulating land--swells 10 feet \pm . There seems to be limestone in ditches. Aneroid 29.140 at Mile Post 19 = 928 feet. Looks like a cut bank south of track for 1/2 mile west. Aneroid 29.090 at Eben Junction near Mile Post 20 = 969 feet. The profile of Rapid River Branch of Soo Line Railroad makes this 972 feet. Aneroid 29.060 in cut 15

feet deep, 40 rods east of Mile Post 21 = 997 feet in cut; ridge, 1011 feet.

We cross a cedar swamp and rise into still higher land. Aneroid 29.035 in cut 10 feet deep; 29.035 at Mile Post 22 = 1,027 feet; 29.010 at Rumely. Some rises to 1,070 feet at Mile Post 23, aneroid 28.995 = 1,065 feet; 28.985 1/2 mile farther west = 1,085 feet; 28.995 at Mile Post 24 = 1,070 feet (level tableland); 29.015 at Mile Post 25 = 1,039 feet; 29.025 in slough leading northeast about 1/3 mile west of Mile Post 25 = 1,031 feet in bed.

Aneroid 29.010 at Whitefish water tank, 1,040 feet, 1 mile east of Lawson--swampy strip comes in here from northwest along line of stream; spruce, etc. Aneroid 29.000 at Mile Post 27 on edge of hardwood having flat surface = 1,046 feet by profile; 28.975 at Lawson Junction = 1,095 feet. A mile northwest, altitude is 5 feet higher, 1,100 feet, and surface is gently undulating. Aneroid 28.980 at east-west wagon road by a wood camp = 1,067 feet. Large boulders numerous northwest from here in Section 21. Very rapid descent in Section 20.

Aneroid 29.110 where road turns north to Skandia; 29.140 at Skandia = 925 feet. Algonquin (?) beach here. Stiff clay soil. Road descends rapidly on turning east from Skandia. Aneroid 29.240 where track turns north in northeast part Section 17. Stiff red clay soil here. Aneroid 29.300 = 809 feet \pm at Yalmer at 9:00 a.m. There is a gravelly ridge just north of Yalmer probably a beach at 791 feet. Sandy soil, hemlock timber, and flat surface north of this, with occasional low sandy ridges.

Aneroid 29.390 at a sand ridge 10 feet high about $2\frac{1}{2}$ miles south of Mangum; 29.440 in red clay cut 10-15 feet deep--some large boulders and pebbles in it; 29.500 at Mangum at 9:15 a.m., 8-10 feet above swampy tract on Chocolay River, 633 feet; 29.455 on knoll 30 rods east of station on south side of a wagon road, 675 feet. This has boulders on it and is a sandy

drift. The cut south of here shows fine sand in horizontal beds except 5-6 feet of bouldery material at top, 20 feet above track.

We take train back to Munising and enter a red clay 1/2 mile south of Mangum near a flag station (Greengarden). Aneroid 29.320 at gravel ridge 1/4 mile north of Yalmer = 791 feet by railroad profile; 29.310 at Yalmer at 9:35 a.m. about 60 rods north of a Mile Post = 809 feet A.T.; 29.250 = 860 feet \pm a mile south of Yalmer where road turns west by a sawmill; 29.240 at a bank 1/4 mile east = 870 feet; 29.210 at Mile Post 20 3/4 mile northeast of Skandia; 29.170 = 925 feet at Skandia at 9:45 a.m. Topography is morainic here above the 925 foot beach (notes 1912). This commands view of high ranges several miles west.

Aneroid 29.150 at Mile Post 21 from west end of line 60 rods south of Skandia; 29.100 1/4 mile west of Mile Post 22 in cut 25 feet deep. Reddish till at west and sand at east end. Aneroid 29.090 at Mile Post 22; 29.050 at Mile Post 23; 29.000 at Mile Post 24--undulating surface, swells 8-10 feet or more; 29.000 at Mile Post 25--surface nearly plane but with boulders; 28.990 at spur 1/4 mile east; 28.980 1/2 mile west in cuts 6-8 ft; 28.990 at Mile Post 26; 28.990 at Lawson Junction at 10:00 a.m. by Mile Post 27 = 1,063 feet. NOTE: The Mile Posts west from Lawson are counted from the west, but these east are counted from Munising.

Aneroid 29.040 at Whitefish River water tank = 1,036 feet; 29.050 at slough leading northeast near Mile Post 25 from Munising or 13 from west end of this branch. This is 1/4 mile \pm west of Dorsey. Aneroid 29.025 at Mile Post 24 from Munising = 1,070 feet; 29.030 at Mile Post 23 = 1,065 feet. Level land from 24 to 23. Low swells at Rumely at 22 1/2 (1,050 feet) 6-10 feet high. Aneroid 29.070 at Mile Post 22 = 1,027 feet. Here, a rolling tract is entered with knolls 10-25 feet high. Aneroid 29.100 = 1,000 feet \pm at Ferguson near Mile Post 21 from Munising; 29.135 at Mile Post 20 = 970

feet \pm . Limestone seems to be near surface west of Mile Post 20. Aneroid 29.170 at first place where slabs are thrown out of railway ditches; 29.180 at Mile Post 20 = 969 feet \pm ; 29.215 at Mile Post 18 about $3/4$ mile west of Chatham; 29.250 at Chatham at 10:20 a.m. This is $1/4$ mile west of Mile Post 17 = 866 feet. Aneroid 29.300 at Slapneck Creek = 802 feet; 792-- stream; 29.300 at Dixon at 10:28 a.m. = 813 feet; 29.325 at Autrain Railroad bridge at 10:29 a.m. = 787 feet; 29.285 at small lake on north side track about a mile west of river. Considerable swampy land (and marshy) north of track to the junction with spur coming in from Sixteen Mile Lake in Section 35 by Mile Post 10; 29.230 at Addis; 29.170 at summit $9\frac{1}{2}$ miles from Munising; 29.180 at Stillman = 926 feet \pm ; 29.310 at Munising Junction at 10:45 a.m.; 29.350 at top of red clay $1/2$ mile northeast of Junction.

We leave the train at Hallston. Aneroid 29.435 at Hallston; 29.360 on red clay tableland north of Hallston Station. The hills sweep around this on the east and south at a distance of $1/2$ - $3/4$ mile from Hallston and run west a mile or more. This clay plain is bordered on the north by a range of morainic hills covering the north part of $NE\frac{1}{4}$ Section 15 and $NW\frac{1}{4}$ Section 16. Aneroid 29.320 at corner Sections 9, 10, 15 and 16 at 11:35 a.m.; 29.300 on ridges near middle of line Sections 9 and 10.

Aneroid 29.110 on high tracts near Section corners of 9, 10, 3 and 4 at 12:10 p.m. = 1,000-1,010 feet; 29.160 at 12:30 p.m. at brow of bluff to which I leveled September 21 = 966 feet; 29.520 at Lake Superior level at 12:45 p.m. = 602 feet. This high range in Sections 3 and 4 and north part of Sections 9 and 10 drops off to the west more rapidly and to a much lower level than to the south. It is a remarkable heaping-up, apparently entirely of drift right at the head of Munising Bay. There are boulders on the highest points, largely granite.

We tested the red clay at Hallston and found it highly calcareous. It

has a flat top at about 70 feet above Hallston Station, or 850 feet A.T.

The proposed line south from Dixon starts at 813 feet A.T. and rises to 816 feet in 1/2 mile, then drops to 790 feet to 1 mile and holds that for a mile lacking 2 chains. It rises to 812 feet at line of Sections 12 and 13, T.45N., R.21W.; 836 feet at line Sections 14 and 23 (near east end); 870 feet at line Sections 22 and 23 near middle; 890 feet at line Sections 22 and 27 near middle, and 900 feet about 80 rods south-southwest; 905 feet at line Sections 27 and 34 west of middle. Road now runs due south. 920 feet at 80 rods south of line Sections 27 and 34 and 900 feet about 40 rods farther south; 875 feet at town line, Townships 44 and 45 North, R.21W.; 855 feet at line Sections 3 and 10, and 865 feet about 80 rods farther south; 847 feet at line Sections 10 and 15, and 850 feet at line Sections 15 and 22 and at line Sections 22 and 27; 840 feet at line Sections 27 and 34; 835 feet at town line, Townships 43 and 44 North, R.21W.---Sections 3 and 34; 805 feet at line Sections 3 and 10, T.43N., R.21W.; 752 feet at Whitefish River.

September 25, 1905, 7:30 a.m.

Aneroid 29.800 at Lake Superior level = 602 feet; 29.670 at top of sandstone ledges east of paper mill = 720 feet A.T.; 29.630 at a lake terrace at foot of steep bluff = 760 feet; 29.370 = 975 feet (corrected) at high point on hill 1/2 mile east of Munising at 8:20 a.m. Gordon makes altitude 950 feet. This is boulder-strewn at top as well as on the slopes. Aneroid 29.350 on point 60 rods farther south = 1,000 feet (corrected). See notes in 1912. Aneroid 29.500 at old Algonquin beach in back part of cemetery in Section 12 = 860 feet A.T. The highest point noted above is 120 rods northwest from here. The hill east from the cemetery is 900 to 920 feet A.T.

Aneroid 29.465 at place where road to Wetmore turns south at center of SW $\frac{1}{4}$ Section 12 = 900 feet; 29.550 at Wetmore at 9:15 a.m. = 859 feet A.T.; 29.540 at Wetmore at 9:25 a.m. = 859 feet; 29.570 = 837 feet at the pond in Anna River south of station. There is a swamp from this pond east $\frac{1}{4}$ mile to where water drains to Manistique River and Lake Michigan. Anna River enters Lake Superior at Munising. The 870-foot contour which marks a lake level would have a passage through here less than $\frac{1}{4}$ mile wide.

We rise to about 930 feet over an undulating surface south of Wetmore and then across a smooth tract 300 paces to foot of a steep hill at 950 feet, aneroid 29.450. This smooth tract suggests wave washing, but it may be border drainage for a stream in front of the ice when it stood a short distance north of the hill $\frac{1}{4}$ mile or less.

Aneroid 29.360 = 1,025 feet at top of hill $\frac{3}{4}$ mile south-southeast of Wetmore station. There was a Lake Survey Station on this ridge about $1\frac{1}{2}$ miles west from here and its scaffold gives the name "Scaffold Hill". A plain slopes to the south from the very brow of the hill. The plain slopes rapidly southward, being 975 feet at corner Sections 25, 36, 30 and 31, aneroid 29.410 at 10:30 a.m. The largest pebbles are about 3 inches. The soil is a gravelly loam and forest is largely beech and maple. Aneroid 29.415 = 970 feet at $\frac{1}{8}$ post 80 rods south of corners.

A well at Joe Train's camp in east part Section 36 is 104 feet. Head 30 feet \pm below surface; entirely through sandy material. Aneroid 29.420 at camp in Section 36 = 965 feet.

Aneroid 29.430 at quarter post near Munising Railroad crossing on range line. The track is raised 3-4 feet here = 955 feet \pm . Aneroid 29.435 at $\frac{1}{8}$ post 80 rods north of corner of township = 950 feet. We enter pine and hemlock forest here, largely chopped off. Aneroid 29.440

at town line = 950 feet \pm A.T. The plain is flat-surfaced and slopes southward to an old camp about 2 miles south of town corners. Aneroid 29,480 = 920 feet at 11:30 a.m. Here basins 20-25 feet deep set in, some of which contain lakes. Those near the camp are in a chain draining southward. We cross to the west side of a long one and then run south, probably in west part of Section 13, T.45N., R.19W.

Aneroid 29,440 = 960 feet at hills south of Mud Lake at noon. There is a plain south of here a mile or so at about 900 feet A.T. by aneroid at 1:00 p.m. Aneroid 29,575 = 810 feet at a small lake at 1:30 p.m. where we stop for dinner. This is 60 rods southwest of west end of Pete's Lake and is in Section 12. Aneroid 29,560 = 810 feet (corrected) at Pete's Lake at 2:10 p.m. This rolling country runs from near Steuben westward along north side Indian River past Pete's Lake and has its north border at Mud Lake. There is said to be a belt of plains several miles wide south of Shingleton as well as south of Wetmore. This belt comes to a marshy tract near Steuben that covers the country east to Germfask. It seems to run west from where we crossed it about 1 mile. There is a pitted plain from there west to Whitefish River.

I am told that the south border of the hardwood on the range line between T.44N., Ranges 18 and 19 West extends about to middle of line. In Section 19, T.44N., R.18W., plains with pine set in. Sections 30 and 32 are plane with a choppy surface but not bouldery. There is a little hardwood in Section 31. From the town corners--Townships 44 and 43 North, Ranges 18 and 19 West, there are plains for several miles south. There is hardwood bordering Indian Lake on the west. It runs off toward Cooks Mill Station on the Soo Line Railroad.

Aneroid 29,480 at Mud Lake at 3:30 p.m. = 875-900 feet; 920 feet A.T.

at camp in Section 13 at 4:00 p.m.; 29.370 at camp in Section 36 = 965 feet at 4:50 p.m. Occasional stones 6-8 inches in diameter. Aneroid 29.360 at northeast corner Section 36 = 970-975 feet; 29.350 at 1/8 post north 80 rods; 29.335 at 1/4 post of Sections 25 and 30; 29.325 at 80 rods north; 29.305 at northeast corner Section 25 at 5:15 p.m.; 29.285 at 80 rods north. Boulders numerous, 6-8 inches in diameter. This is foot of a very rapid northward rise to crest of ridge. Aneroid 29.260 on crest at 5:23 p.m. = 1,025 feet \pm . This is 200 paces south of quarter post. Aneroid 29.340 at foot of steep bluff opposite quarter post Sections 19 and 24. Few, if any, large boulders here in face of bluff or on the flat north of it. This flat is 3/20 mile or 300 paces across. Aneroid 29.350 at north edge; 29.385 at 80 rods south of section corners on the brow of another bluff; 29.405 at sandy ridge under this bluff at 150 paces north of 1/8 post; 29.430 at section corners south of Wetmore; 29.450 at Anna River 144 paces north of section corners. Wetmore is 320 paces north of section corners, aneroid 29.425 = 859 feet at 5:42 p.m. Aneroid 29.690 at Munising at lake level at 6:50 p.m. = 602 feet.

September 26, 1905, 7:20 a.m.

Munising, Michigan. Aneroid 29.540 at Lake Superior level = 602 feet. I take train to Chatham. Aneroid 29.185 = 926 feet \pm at Stillman Junction; 29.270 at a series of marshes and ponds 1-2 miles west of Au Train River; 29.320 = 787 feet on Au Train River bridge 37 feet above stream at 8:00 a.m. = 750 feet at stream; 29.300 at Dixon = 813 feet. Knolls 20-25 feet higher south of station. Very sharply morainic to the west. Knolls cut by railway are full of local limestone blocks. Aneroid 29.305 at Slapneck Creek = 802 feet A.T. Bluffs south of creek west from here 30-40 feet high. Aneroid 29.235 at Chatham = 866 feet A.T. at 8:10 a.m.; 29.280 = 820 feet at stream north of Chatham 60 rods.

Aneroid 29.245 at the house and barn on experimental farm. Rock is at surface here from top to bottom of hill and the slopes have terraces of rock. The soil is a loamy sand, highly calcareous. The rock formation is the Calciferos. The Trenton is reported to set in 4 miles south of Chatham and is struck there in wells at 6-10 feet depth.

I drive west to Eben and find rock underlying flat tracts at slight depth. There are drumlins near Eben. One south of station on east side of the railroad that runs south is 40 feet high and 1/2 mile or more long--S5-10°E. Its north end is 1/4 mile south of the station. It has loose-textured loamy sandy material at top with boulders and pebbles in it.

Another drumlin, or rather a double-crested ridge, is 1/2 mile east of Eben on south side of the D.S.S. and A. Railroad. It runs southward across the section line road. Each drumlin trends 5-10 degrees east of south. The border tracts are flat. There are ridges northwest and north of Eben but I did not examine them (see notes October 1). I saw no drumlins east of Chatham.

Aneroid 29.150 at Chatham Station at 10:20 a.m. = 866 feet. The ground at schoolhouse 60 rods south is 20 feet higher. The rock here reaches about 880 feet A.T. I drive south across a stream and rise to a tableland about 900 feet A.T. at north edge near the township line. Aneroid 29.115 at 10:30 a.m. = 903 feet at township line. This is flat for 1/2 mile and then begins to slope south. Aneroid 29.140 = 904 feet at road running east 2 miles south of Chatham at 10:40 a.m., at north edge of a spruce and hemlock wet tract--almost a swamp; 29.150 at creek on line Sections 9 and 10 near middle = 887 feet on bridge. There is some cedar and land is swampy near the creek. Aneroid 29.140 = 901 feet at corner Sections 9, 10, 15 and 16 at south edge of wet land. I am told by a man living in Section 11 that much of Sections 9, 10 and 11 are wet flat land. (See notes 1912, notebook 242, p. 50).

I rise south about 30-40 feet to a gently undulating boulder-strewn tract. Knolls 5-10 feet high cover 1/2 acre or less. The boulders are largely Potsdam sandstone but granite and gneiss are not rare. The light-colored calciferous rock that appears at Chatham is not conspicuous on the surface. Aneroid 29.130 at a creek near center of township where a white limestone outcrops in the creek bed and is struck at slight depth in wells. This is called Limestone Creek or Johnson's Creek. The rock is a thin-bedded limestone. Aneroid 29.115 = 905 feet on bridge at Limestone Creek at 11:20 a.m. Boulders are very numerous south as well as north of the creek, there being piles of them in fields in Section 22 where farms have been cleared. The soil from here south is a heavier clay than north of the creek and is classed as clay loam. North of the creek there is enough loam so that the roads pack well, but the roadside exposures look like a sandy gravel.

I return to Chatham and find that the white limestone is present in the cuts in the drift knolls on line of Sections 15 and 16 to within 80 rods of north end of line or to where the steep descent northward to the swampy land begins. Aneroid 29.080 = 936 feet at highest point on line of Sections 15 and 16; 29.115 = 901 feet at corner Sections 9, 10, 15 and 16 at 11:33 a.m. There seems to be a little of the white limestone in a shallow cut in a low ridge a few rods north of section corner that forms the south edge of the swamp.

I saw nothing drumlinoidal south of Chatham on trip to Sections 21 and 22, T.45N., R.21W. Aneroid 29.130 at creek near middle of line of Sections 9 and 10 at 11:40 a.m. = 887 feet; 29.145 at creek south of Chatham. Ledges outcrop on south bluff 20 feet above the creek (Calciferous rock). The unevenness of surface near Chatham is apparently due to the rock rather than to drift heaping, for rock is near tops of ridges.

Aneroid 29.085 at schoolhouse in Chatham at noon; 29.115 at Chatham station = 866 feet A.T.; 29.100 at the experiment farm = 875 feet by surveyor's level at 1:10 p.m.

I take the quarter line road east in Sections 27 and 26. There is a very steep-sided bluff facing west that the road rises onto east of center of Section 27. Its face suggests a drumlin but there is no corresponding steep side on the east but a slightly wavy surface sloping gently eastward. There is a slight ridging of surface in Section 26 with a tendency to trend northwest-southeast or west-northwest - east-southeast. There are not well developed drumlins. The ridges are only 10-15 feet high. The altitude in Sections 27 and 26 near this road is from 860 to 890 feet A.T. The surface is thickly strewn with boulders so that in clearings they are piled in fields and on stumps.

The road angles east-northeast in Section 25 through a flat tract with a sandy soil and few, if any, boulders. The timber is mixed, with hemlock, maple, birch, etc. The aneroid reads nearly as high as on the undulating land in Sections 26 and 27--29.100-29.110 = 860 feet \pm (corrected). Near the range line the road turns north and holds the high level for less than 1/2 mile. A descent of 75 feet is then made, aneroid 29.180 = 785 feet \pm . Aneroid 29.190 = 775 feet at intersection with road that runs from Dixon northward at 1:50 p.m., probably in south part Section 19. The higher country is only 1/3-1/2 mile south of this road intersection. This lower land has maple, birch, and a little hemlock in its south part but in about a mile hemlock predominates and pine also appears.

Aneroid 29.200 where road comes to brow of Au Train bluff in Section 19 or south part of Section 18. There is a gorge 1/8 mile or more wide and over 100 feet deep here. The road soon descends 35 feet to a narrow terrace, aneroid 29.240 = 720 feet \pm , and this is followed by others 10-20

feet in rapid succession, the terraces between the successive banks being only 20-30 rods apart down to where aneroid reads 29,270. These steps are probably in Section 18. There is hardwood timber as well as hemlock here. I find the steps or terraces are about opposite south end of Au Train Lake in Section 18.

Aneroid 29,340 at Au Train Lake at 2:20 p.m. = 610 feet \pm . Near line of Sections 7 and 18 a bluff about 60 feet higher than the lake veers away from it a short distance, leaving a narrow flat 15-20 feet above the lake in Section 7, or 625-630 feet A.T., the width being 30 rods \pm . The road runs on this low tract to a small tributary in Section 6. It then turns northwest into the higher land, aneroid 29,270. There is a slight ridging on this bluff with gravel in ridges in places, though generally sandy.

To the east from Au Train Lake is a tract less than 200 feet above Lake Superior with a high range of hills south of it continuing those I left in Section. It can hardly exceed 790 feet. A tract 100 feet or more above the lake runs out nearly to Lake Superior within a mile or so west of the north end of Au Train Lake, probably in Sections 1 and 36, Townships 46 and 47 North, R.21W., but from Au Train Lake and the big bend of the river near corners of Townships 46 and 47 North, Ranges 20 and 21 West, north to Lake Superior is a low series of ridges 25 feet \pm above Lake Superior which Taylor calls Nipissing beaches. (See his paper in American Geologist). Aneroid 29,320 on the beaches = 611 feet.

Aneroid 29,320 = 611 feet at Au Train Station at 3:00 p.m. There is high land on the south 40's of Section 36 only. It covers all of Section 35 except northeast corner and also covers the west side of SW $\frac{1}{4}$ Section 6 and west part of Section 7 and from there runs across Section 18 to the head of Au Train Lake. It is 130 feet \pm above Lake Superior level.

I take train at Au Train at 3:27 p.m. eastward to Shingleton. Aneroid

29.320 at Au Train = 611 feet. There are sandy ridges out 2 miles or more or to 635 feet \pm , then a flat to Mile Post 122 = 747 feet, where cuts begin. Aneroid 29.200 at Mile Post 122 = 747 feet. The railroad runs along south side of a ravine past Mile Post 121, aneroid 29.150 = 805 feet. Aneroid 29.100 at Ridge Station = 861 feet. There looks to be a beach here just above level of station, or about 875 feet \pm (notes September 29) and a better defined one a little below it (notes September 29). The railroad skirts along the north side of a high range from Ridge to Munising Junction with much lower land to the north for about a mile. There are high hills beyond this low tract to the northeast that may run through to Munising. Aneroid 29.150 = 809 feet at Munising Junction at 4:00 p.m. There are high tracts west of the Munising Railroad south of this Junction.

About midway between Mile Posts 116 and 115, hills south of track 80 rods are 75 feet or more higher, or about 900 feet. There seems to be a little clayey material at base of cuts east of Wetmore. Aneroid 29.060 = 885 feet at summit east of Wetmore about 2 miles; 29.060 in cut 20 feet deep 1/2-3/4 mile west of crossing of the Munising Railroad = 900 feet \pm at top of cut. There is a sloping gravel plain east from here to Shingleton as noted September 22.

Aneroid 29.135 at Shingleton = 827 feet A.T. at 4:30 p.m. I take train to Steuben on the Manistique & Northern Railroad. There is hemlock and scattered maple, birch, etc., for 1/2 mile or more south to McNeil's camp. Aneroid 29.150 = 815 feet \pm at McNeil's camp at 4:40 p.m. Within 1/2 mile south of the camp a spruce swamp sets in at altitude 800 feet \pm . This is scarcely a mile wide. South of it is a rise of about 15 feet to a hemlock tract with sandy soil and flat surface. Aneroid 29.145 = 820 feet \pm at Richardson's Camp No. 69 about 3 miles south of Shingleton in southeast part of Section 7. This tract extends nearly to the stream crossed by the railroad in Sections 17 and 18. There is then a wet tract with hemlock

and changing to cedar and tamarac in places. Aneroid 29.170 at next station Camp 65 = 800 feet \pm . There is a narrow sand ridge here 8-10 feet high timbered with hemlock. A ridge 10-25 feet high runs south from here along west side of track for 1/2 mile or more. There is some maple on it as well as hemlock but it is clear sand where cut into by the railroad. The flat land is partly cedar and spruce and where not too wet has hemlock and some maple. Aneroid 29.180 at next camp--Scott's Station, near center Section 31, T.45N., R.17W., = 770 feet \pm . Hardwood and pine and hemlock land runs east about 6 miles from here. About 2 miles east is a rise of perhaps 60 feet to a tableland of sandy land = 820 feet \pm . Parts of Sections 10, 11, 12 and 13 T.45N., R.17W., are dry land 10 feet \pm above marsh timbered with pine and hemlock now cut off.

We come to a bouldery ridge in Section 12, T.44N., R.18W., that is the first sign I have noted of the moraine since leaving Shingleton. The railroad here turns southeast and runs near the north border of the moraine to Steuben. This station is on the north bank of Indian River in east part of Section 29, T.44N., R.17W. There are prominent morainic knolls in the northwest part of Section 29 and southwest of Section 20. To the south of Steuben the nearest knolls are along the county line south of Bass and Little Bass Lakes. There is a flat sandy plain intervening. There are dry spots but no sharp boulder-strewn knolls or ridges northeast from Steuben but the topography is of the pitted plain type. Aneroid 29.250 at Steuben = 733.5 feet, in east part Section 29 at 5:30 p.m. There is said to be pine plains much of the way from Steuben to Manistique. I stop at Steuben for the night but am not able to gather much information concerning the topography. There are knolls northeast of Steuben for about a mile and the surface is more or less broken northeast to a lake in northwest part of Section 22. The drift is very sandy where cuts are made along the railroad.

September 27, 1905, 6:00 a.m.

Steuben, Michigan. Aneroid 29.320 = 733.5 feet. Hills 1/2 mile east are about 780 feet A.T. There is a narrow strip of hills with gravelly soil running eastward along north side of the railway for 3 miles or more beyond Steuben. It is only 1/4 mile or so in width and the hills are 25-40 feet above bordering plains. They have not the regular contour of an esker belt and seem likely to be morainic. They run through the southwest part of Section 21 and north part of Section 27 and southwest part of Section 26, if I am rightly informed. From Section 21 west there is a broad morainic belt north of Indian River.

There is a plain bordering the lake in Sections 15 and 22 on the southwest, the interval to the ridges and knolls being fully 1/2 mile. This has a fine gravelly sand. I go north through it, passing 1/4 mile west of the lake. Aneroid 29.350 = 700-710 feet at small stream in Section 16 flowing southeast to the lake in Sections 15 and 22. Time: 8:05 a.m. This is less than 10 feet below the bordering sandy plain. The road runs past the west side of a lake in Section 9 that is only 8-10 feet below the bordering plain. The plain has a heavy growth of hemlock timber on it. Soil is sandy with an occasional cobblestone 3-4 inches in diameter. Aneroid 29.345 = 710 feet \pm at lake in Section 9 at 8:25 a.m. There are low dunes at northwest end of this lake.

I continue north across a creek that runs eastward through Sections 5 and 4. It is bordered by a swamp 1/4 mile wide. Aneroid 29.325 = 725-730 feet at creek at 8:50 a.m. The land is flat north of this creek and only 10-15 feet above the level of the swamp.

Aneroid 29.325 at creek running east across south half of Section 32 = 750 feet \pm (as reckoned from later readings). In the northeast part of Section 32 and southeast of Section 29 is the west end of a tableland 60

feet \pm above the low sandy plain south of it. Aneroid 29,250 on top = 820 feet \pm . It is a glacial deposit with cobblestones from 8 or 10 inches in diameter down to pebbles. I go to its west end on an old railroad grade. It is this that Mr. Cookson spoke of last night and reported it to run east through Sections 33, 34 and 35, T.45N., R.17W. Its abrupt bluff on south side suggests an ice border there facing north. The interpretation is not clear. I go northeast along its north side to a lake and find it in a recess with swamp opening out to the north. It is as low as the plain south of the ridge.

I return to the railroad grade and follow it out to the M.M. and N. Railroad and find another high tract immediately west of the railroad track in Section 30 or 31 with pebbly material in it. The gap between this and the tableland in Sections 29 and 32 is less than a mile. There are sandy ridges in the south part of Section 30 but the north part is largely swamp and much of the land west and southwest to the moraine in Section 34, T.45N., R.18W., is swampy, so I am told by the foreman at McGinnis' Camp (No. 75) in central part of Section 30.

Mr. Lockwood, who works at this camp, says the rolling land covers most of Section 28, southeast part of Section 21, and southwest of Section 27, T.45N., R.17W. It is deeply indented by basins with some lakes. Sections 33, 34 and 35 are more level tableland. He does not know whether the high land runs south into Sections 1, 2 and 3, T.44N., R.17W., but is under the impression that it does. Mr. Lockwood has cut timber in the south and west parts of T.45N., R.19W., and he says the morainic land is all in the southeast corner in Sections 25, 26, 35 and 36. There is rolling land in Sections 1, 2, 3, 10, 11, 12 and 13, T.44N., R.19W., but Sections 4, 5, 6, 7, 8 and 9 are nearly plane. There is considerable wet land in them. There is also a large amount of swamp land along Sturgeon River below

Sixteen Mile Lake. Aneroid 29,300 = 770 feet at McGinnis Station in Section 30 at 11:00 a.m. and at 12:15 p.m.

Mr. E. Cookson, of Manistique, whom I interviewed on train yesterday, came to McGinnis on train today. He says there is a bluff 60 feet \pm high lying back about 80 rods from Stutts Creek in Sections 16, 17, 22, 23, 26, 35 and 36, T.45N., R.17W., that marks the northeast edge of the tableland that I was on near corner Sections 28, 29, 32 and 33. The east part of Sections 29 and 20 is on this high land but it is very choppy land in Sections 20, 21, 28 and 29. The lake in Section 34 is surrounded by rolling land but the rolling land does not extend $1/2$ mile south from the lake. The small lake in Section 3 is in a swamp.

I take train at 12:15 p.m. from McGinnis to Shingleton. Aneroid 29,300 = 770 feet Bar. at McGinnis; 29,240 at Shingleton = 827 feet at 12:35 p.m.; 29,215 at Shingleton at 1:40 p.m. = 827 feet; 29,150 in cut 20 feet deep near corner Sections 15, 16, 21 and 22, T.46N., R.18W., at southeast border of moraine = 890 feet; natural surface 910 feet \pm . Cut has sandy drift with a few cobblestones. Very few boulders along railroad between here and Wetmore. The stony part passes farther north. Aneroid 29,180 at Wetmore at 2:50 p.m. = 859 feet.

I walk into Munising and spend afternoon at courthouse copying swamps from the plat books and the extent of the Lake Algonquin in northeast part of Alger County. There is a cliff marked on the plats in T.48N., R.16W., as the probable shore of Lake Superior. It is perhaps a rock escarpment. The land back of it may also have been submerged to some extent. I think it safe to assume that the strongly developed moraine lies south of this cliff. There is a swamp running southwest from the head of Grand Sable Lake with high morainic tract on its south side but the high country to the north is dune material. It is now heavily forested to within $1-1\frac{1}{2}$ miles of the shore where we saw the bare sand when driving southwest from Grand Marais.

September 28, 1905, 7:45 a.m.

Aneroid 29,520 at Lake Superior. We take a launch for Grand Portal and past the extreme east part of the island at close range. The sandstone has an exposure of about 80 feet and is covered by a stony till 15-20 feet or more. The rock has a perceptible southward dip. It is undercut in places so as to overhang. There are caves and recesses cut back into the rock several feet. This eastern part reaches an altitude of about 800 feet A.T. The cliff is present all around it. A low gravel bar connects it with the main island. It is scarcely 10 feet above lake level so was probably formed by the modern lake at present level.

We run to Miners Castle point on west side of mouth of Miner River. The rock here is between 120 and 150 feet for a mile southwest of the Castle. The Castle at extreme point is only 60-75 feet. Miners River has the 25-foot beach across its mouth. There is a low tract $\frac{1}{4}$ - $\frac{1}{2}$ mile wide running up the valley for perhaps $1\frac{1}{2}$ -2 miles. The slopes are heavily timbered above the rock outcrop southwest from Castle Point. The bluff northeast from mouth of Miners River has fully 120 feet and perhaps 150 feet of ledge above which sand is exposed 30 to 60 feet higher. The highest points are about 200 feet above lake level. A little stream in Section 2, T.47N., R.18W., cascades over the ledges from a height of fully 120 feet. There are dunes on the bluff here, back of which is the swamp in Sections 1, 2 and 11.

Mosquito Creek has a low tract at its mouth with a short strip of the 25-foot beach. It is said to have a rock bed, however, and drops 5-6 feet over rock to enter the lake in Section 25, T.48N., R.18W.

The Pictured Rocks show a dark color--purplish red--near base but this rises only 60-75 feet above lake level. Above it is a pale sandstone. This color is largely surface stain.

Grand Portal is nearly free from the stain. Back of Grand Portal the altitude is 225 to 250 feet, nearly 200 feet of rock.

The Arch Rock, at end of the portal, fell about 3 years ago. The rock is conglomeratic just east of the portal.

Chapel Creek has the 25-foot beach (Nipissing). It is about 60 rods wide and a recess runs back fully 2 miles. East of this stream about 1/2 mile to a mile and back 1 1/2 miles from the shore are very elevated tracts with peaks that are either morainic knolls or dunes. The altitude must be more than 300 feet and may reach 400 feet above the lake.

The stream that cascades 60 feet into Lake Superior from Section 15, T.48N., R.17W., is in plain view from Grand Portal. The high hills noted above are between Chapel Creek and this stream, probably largely in Section 27 but extending perhaps into Sections 22, 26 and 28. Chapel Rock, just east of Chapel Creek, is a low castle scarcely half so high as the Grand Portal.

We get a view from the Grand Portal to Grand Sable Point. The high rock ledges extend about 5 miles beyond the Grand Portal, or about to mouth of Beaver River. From there on to Grand Marais there is only a small amount of rock on the shore and that chiefly near the Grand Sable Point. The shore is mainly drift with sand as well as clay.

The Grand Island chart shows the magnetic variation in 1900 to be 1°07' 30"E, and decreasing 3'7" annually, so the present variation is about 52'E. There is very shoal water from sand point northwest toward the east end of Grand Island just north of lighthouse, the channel over 12 feet deep being less than 1/2 mile in width from the lighthouse north 1/2 mile. Sand bars 4-6 feet below lake level occur both west-northwest and north of Sand Point. Those to the west-northwest are about half way over to Grand Island. For nearly 2 miles northeast from Sand Point there is shallow water for about 1/2 mile offshore from the mainland.

There is a shoal at south end of the main island $1/4$ - $1/2$ mile wide. It is narrow near Williams Landing but widens to the west from the landing and a bar runs out south-southwest, projecting the south end of the west shore fully $1/2$ mile, that has only 5-6 feet of water. There are shoals at the north end of the main island extending from the point east of the lighthouse and from Lighthouse Point itself about $1/2$ mile north, but water here is 9-17 feet deep. There is a similar shoal running west from the extreme western point at north end of the island. Ward Island and Williams Island each have rock with very little cover of soil.

The lake on Grand Island is shut off at south end by the 25-foot beach. It stands 16 feet above Lake Superior or 618 feet A.T. There is high land west, north and east of this lake with sandstone nearly to top. The creek that runs north through the north part of the island is bordered each side by high sandstone bluffs. There is a low tract from north end of island up the creek to the divide between it and the lake and this is not a high divide. There is a sag 100 rods or more wide running along it.

We land at north end of the island. Aneroid 29.500 at Lake Superior level at 11:00 a.m.; 29.460 at top of first bank back of a boathouse $1/2$ mile east of lighthouse. There are boulders of granite, gneiss, etc., imbedded in the soil and also in a strip at top of the ledges where we ascend the slope toward the lighthouse. The soil is a reddish sandy loam. Aneroid 29.330 = 765 feet \pm at top of bluff; 29.325 at lighthouse = 770 feet A.T. The lighthouse is 205 feet above the lake and is 37 feet above the ground, 33 feet above sill. There is a gravelly beach here on the extreme point, probably the equivalent of the 765-foot beach (aneroid) near Munising on the Au Train road. (See notes September 21). The light at Whitefish Point is 76 feet and is 70 feet above ground. Point Iroquois, 72 feet, is 55 feet above ground. Grand Sable Point Station is 107 feet above

lake. The Grand Island harbor light on east side is 34 feet and is 30 feet above surface. The range on main land near Bay Furnace (Onota) is 33 feet and is 19 feet above ground. Marquette, on north point of harbor, is 77 feet and is 33 feet above ground. (From list of lighthouses corrected to January 1875, in pamphlet form.)

We follow the west shore southwest from the lighthouse, descending to about 700 feet A.T. The rock, for a mile or so from here out to extreme west part of the north end of island, is 75-100 feet above the lake. It has 10-25 feet of sand and sandy till above it.

The road leaves the shore and runs about a mile south-southeast up a slope to a rock escarpment, the base of which is about 868 feet A.T. (by Surveyor's level), aneroid 29.190. This is apparently in Section 20. Aneroid 29.100 = 950 feet \pm at top of escarpment. There are low knolls 10-15 feet high. There is a flat surface up to 940 feet. The knolls rise 10 to 15 feet, or to about 950 feet. There are large granite rocks scattered over this high part of the island and diabase rocks. There are many more here than on the lower part of the island north of this sandstone escarpment.

Aneroid 29.140 at place where road begins descent toward south in Section 29 = 923 feet; 29.280 at a lookout platform cut into a reddish sandy till on north edge Section 32 = 781 feet; 29.261 (by survey for road) at what seems to be a shore line 40 rods southeast of this lookout = 800 feet \pm . There are hummocks of sandy till back of it. Aneroid 29.455 at Lake Superior level at 2:50 p.m. at mouth of outlet of the little lake. The beach across the mouth of the outlet is 23 feet above Lake Superior, or 625 feet A.T. The man at the outlet says there is not more than 15 feet rise from this lake across the divide north of it to the creek that drains north. There is a swamp all the way through. The low tract would average

nearly 1/2 mile wide and in places it is nearly a mile. The lake is called Wabasee Lake. There is hemlock and balsam, spruce and black ash on this low tract. There is hemlock and pine north of mouth of outlet for a short distance. The greater part of the island is timbered with beech and maple. There is an elm swamp northeast of the Lake Wabasee. The level of Wabasee Lake is 15 feet above Lake Superior by survey. The highest land east of the swamp northeast of the lake is in Section 35, T.48N., R.19W. The highest west of the swamp is in south part of Section 20 and in Section 29. There is very little difference in level on the two points, both being about 950 feet. The highest in Section 35 is in NW $\frac{1}{4}$. The surface appears to be morainic on the south slopes south of Wabasee Lake, with sharp hummocks of stony drift. The west shore has cliffs 25 to 70 feet high, south from the outlet of Wabasee Lake. The highest land is in Section 15, T.47N., R.19W., in south part of the Section.

Aneroid 29.435 at lake level by Powell's Point at 5:00 p.m.; 29.350 = 675 feet at south edge of clearing; 29.330 to 29.300 over a series of gravelly ridges = 725 feet \pm at highest one; 29.270 = 750 feet at a sharp ridge; 29.255 at the 760-765 foot beach. Back of this the road drops into a ravine, aneroid 29.275, and ascends the ravine southward. Aneroid 29.190 = 820 feet on a ridge at head of this ravine. There is a narrow neck with steep ravines each side of road for 20 rods south. I then rise to the high hill, aneroid 29.130, at first beach ridge on south edge of hardwood forest = 875 feet \pm . This is only 6-8 rods wide, trends northwest-southeast, and has a relief of 10-12 feet on its back side. South of this is a clearing grown up to cherry brush that is also ridged and reaching an altitude of about 900 feet. Aneroid 29.100 on the highest point. This is 15 feet above the ridge to which I came September 21. Aneroid 29.115 on that ridge 30 rods \pm south of the highest one; 29.250 at the summit on the col crossed

by the Munising and Au Train wagon road = 765 feet \pm .

Levels run by H. N. Ormsbee, Assistant Engineer of Cleveland-Cliffs Company, Munising, Michigan. Station "0" at fishing grounds on quarter line of Section 4, east of center and south of outlet of Wabasee Lake. The lake is 15 feet. Ground at quarter line, 23.4 feet. Outlook platform on north edge Section 32 is 179.56 feet. High outlook at south end of tangent about 80 rods east of center Section 29 = 321.6 feet. At north end of tangent, near brow of the sandstone cliff, in southeast part Section 20 is 339.2 feet. Base of sandstone ledge in Section 20 = 266.1 feet or 868 feet A.T. The cut in the old shore line just north is 271 feet in a 12-foot cut, making top of beach 283 above lake, or 885 feet A.T. The top is sandy and may be a few feet above the old lake level. The summit on road south of lighthouse is 199 feet above the lake, or 801 feet A.T. It is near quarter post of Sections 15 and 16, T.48N., R.19W. The highest point crossed by the road south of Wabasee Lake outlet is 70.4 feet or 672 feet A.T. Hemlock Street, in Munising produced to point 2700 feet back from lake is 966.5 feet. There is another point equally high $1/4$ mile northwest and there are still higher points southwest and west.

The water in Murray Bay between south ends of the two parts of Grand Island will fluctuate about 2 feet when there is scarcely any fluctuation at the head of the bay. This Murray Bay is high at lower stages of the barometer and it is also high with south winds. Munising Bay is heaped up by a north wind. The water is generally low in the bay in May. It was 2' 8" lower in May, 1905 than in August, 1903. It begins to rise in June.

The neck of land running between Trout Bay and Murray Bay has a ridge 26 feet above the lake level. It runs across the neck about midway. This neck has widened considerably since the land survey was run in 1846. In one case it has advanced 180 feet north from corner Sections 11, 12, 13 and 14,

T.47N., R.19W., the distance in 1846 being about 1 chain (66 feet), and in 1905 it is about 250-260 feet.

Mr. Ormsbee has been on the high hills back from the shore southeast of Grand Portal and found them gravelly knobs with numerous springs at their base. They are in Section 27 and parts of the border sections in T.48N., R.17W. There is flat hardwood land in Sections 32 and 33 with some swamp. These hills lie east of the swamp and circle around to the west across Sections 4 and 5, T.47N., R.17W. There is also a ridge in south part of Section 35, T.48N., R.17W., south of a large swamp. There is high land in the southeast part of T.47N., R.17W., in Sections 35 and 36 and parts of Sections 24, 26 and 35 adjoining sections.

When on Grand Island this afternoon I noticed a rise of ground on Train Point, setting in within a mile south from where we drove to at the old camp September 21. It looks to be 70-75 feet higher than that land, or 710 feet \pm A.T.

September 29, 1905, 7:20 a.m.

Aneroid 29.520 at lake level, 602 feet A.T., at Munising. I take train to Munising Junction. Aneroid 29.300 at Mile Post 117 about 1/4 mile west of the Junction on D.S.S. and A. Railroad = 815 feet at 7:45 a.m. The red clay such as occurs at Hallston is exposed just south of railroad crossing along the Munising Railroad at 780 feet. We follow the D.S.S. and A. track northwest. Aneroid 29.260 at a summit 1 mile west of Munising Junction = 850 feet A.T.; 29.270 at Mile Post 118 = 845 feet A.T. at 8:08 a.m.; 29.270 at Ridge = 861 feet at 8:30 a.m.; 29.250 = 875 feet on a sharp gravelly sand ridge about 300 yards west of station. The stones on its surface are angular to subangular. The cut made by the railroad is in sand. Aneroid

29.285 at Section house (23) at west base of the ridged belt, about 1/4 mile east of Mile Post 120 = 850 feet; 29.305 at Mile Post 120 = 838 feet A.T. at 9:00 a.m. I level back to Section house and find a rise of only 12 feet, making it 850 feet A.T. I continue to Ridge Station and find it 4 sights or 22-2/3 feet. Six sights, or 34 feet above Mile Post 120 is at west base of highest ridge where there seems to have been wave cutting = 872 feet. The top of the ridge is 885 feet A.T., but this may not be a beach. I set aneroid here for 885 feet at 9:30 a.m.

There is a ridge running north 1/4 mile or more from the railroad but it there dies out on a flat about 870 feet A.T. The swamp that is so conspicuous on north side of railroad track for a mile or more east of Ridge is not present here where the wagon road runs northward. The general level of the flat tract north and west of the high range east of Ridge Station is about 875 feet at border of hills.

We go out to a clearing in Section 31 near a creek that comes into the lake at Bay Furnace (Onota ranges) and then strike east into the timber, soon rising to sharp sandy ridges on which aneroid reads 29.250. They look like the shore lines of Lake Algonquin. Aneroid 29.230 = 875 feet \pm at base of a morainic ridge on a section line, probably the line of Sections 5 and 32. The ridge rises east as well as south from here. Aneroid 29.100 on crest of ridge at 10:40 a.m. This range undulates 10-20 feet along the crest. From here it bears south of east and also south of west so that it barely touches the town line at its north base.

We soon drop down to the flat land, aneroid 29.250. This general level holds for some distance east. We cross the north-south road that leads south from Bay Furnace. The cedar swamp 2 miles west of Munising is less than 800 feet A.T. Aneroid 29.190 on crest of ridge west of Munising; 29.400 at cedar swamp at head of swamp on a tributary of Anna River in southwest

part Section 10 at 12:30 p.m.; 29.500 at Lake Superior at 1:30 p.m.

I am told by Henry Russell that the timber is largely pine and hemlock as far north as the south edge of T.48N., R.16W., and several square miles in the south part of T.48N., R.15W., and T.48N., R.14W. Nearly all of T.48N., R.13W., is morainic and mainly hardwood. Mr. Russell made a well east of Indiantown in Section 33, T.47N., R.18W., that entered rock at only 12 feet--apparently the Calciferous. The altitude is more than 200 feet above Lake Superior.

The ravine that I came down from Section 10 to Anna River shows no rock ledges and bears out the idea that there is a preglacial valley coming in from the south or southwest.

There are four small waterfalls over the sandstone ledges east of Munising. The southernmost is near the fish hatching station near line of Sections 11 and 14, T.46N., R.19W., and three near the shore of Munising Bay within 1 to 2 miles northeast of Munising. There are views of two of the falls for sale. I get one of a fall near the tannery $1\frac{1}{2}$ miles northeast of Munising. They are 40 feet \pm in each case.

September 30, 1905, 7:20 a.m.

Aneroid 29.560 at Lake Superior level. I take train to Chatham from Munising. The top of red clay is same level at Mile Post 5 or about 180 feet above Lake Superior or 780 feet \pm A.T. Aneroid 29.345 at Dixon = 813 feet; 29.280 at Chatham = 866 feet A.T. at 8:00 a.m.; 29.270 at weather station on experimental farm = 875 feet by level at 8:30 a.m. There is rock at surface up to 885 feet northeast of here on the quarter line road. Aneroid 29.510 at Au Train River below the falls at 9:50 a.m. There is no gorge cut here but the river simply cascades over ledges where they outcrop. The rock is Calciferous formation. Aneroid 29.450 on drift bluff

west side of lower end of falls below lower cascade; 29.460 at head of lower cascades. Above here are rapids with rock bottom and the ledges rise 10-20 feet above the stream--loose, rotten rock. Aneroid 29.425 on an old flood plain opposite head of the cascades. The moraine rises 60 feet higher. Aneroid 29.420 at head of upper cascades; 29.410 = 750 feet at river under railroad bridge. There is a low cascade of 6-8 feet, 30-40 rods north of railroad bridge. The large upper cascade is about 1/4 mile below bridge and the lower end of lower cascade is called 3/4 mile. Aneroid 29.370 on railroad bridge = 787 feet.

Aneroid 29.335 at Dixon = 813 feet at 10:30 a.m. The cuts west from here for 1/4 mile are loaded with large blocks of the Calciferous rock in a sandy matrix. The drift is more sandy in Sections 25 and 36 than farther west or at least the leaf mold here is so then that sandiness is more apparent.

Aneroid 29.260 at experimental farm station = 875 feet at 11:20 a.m.; 29.275 at Chatham at 11:30 a.m.; 29.220 at Chatham at 12:20 p.m. = 866 feet; 29.190 = 895.6 feet A.T. 1/2 mile north of Chatham a few rods north of quarter post on beach; 29.215 at foot of hill by what seems to be a lake shore about 100 rods south of north end of line Sections 27 and 28 = 875 feet \pm . There is a cedar swamp in front of this bluff (to the north).

There are glacial ridges west of the road just north of corner of Sections 21, 22, 27 and 28, but the swamp runs north on east side of road and soon runs west on north side of the glacial ridges. These ridges are 15-20 feet high and probably above the lake level.

Aneroid 29.220 at a sandy ridge = 870 feet \pm ; 29.250 at base of a series of steps over the Algonquin series of beaches = 845 feet \pm . After crossing a small ravine another drop is made to 820 feet. North of this is a very bouldery sharp ridge with 15 feet or more on back side. Aneroid

29.250 at top = 845 feet \pm . It is just south of a green painted house. Aneroid 29.270 = 820 feet at the house at 12:50 p.m. A steep bluff is 40 rods north of this house. Aneroid 29.330 = 765 feet \pm at foot of bluff at a beach, probably the Battlefield Beach.

Aneroid 29.420 = 675 feet \pm at Rocky River in northwest part Section 15 at 1:00 p.m. There is a large mass of thin-bedded red sandstone on east side of road on a terrace south of this river covering a square rod or more but apparently not belonging here. Aneroid 29.355 on rock ridge north of the river $1/4$ mile \pm = 735 feet. There is rock at surface here, a thin-bedded light colored sandy shale. There are numerous Potsdam sandstone boulders and also Canadian rocks (granites, etc.).

Aneroid 29.370 at base of a cut bank, probably a beach, probably near line of Sections 3 and 10, perhaps 80 rods south = 710 feet (Battlefield?); 29.385 on dunes south of a little creek near center of Section 3 = 695-700 feet; 29.410 at north base of dunes--this may be an old shore line-- = 670 feet (Fort Brady?). There is a belt of dunes along the road in Section 34, T.47N., R.21W., standing 15-25 feet above swamp and bordering flat lands. They are not so bare near north side of the section. Aneroid 29.440 at creek at line of Sections 27 and 34 = 640 feet; 29.430 at a gravel and cobble beach about 60 rods north of this stream = 650 feet. We here leave the hardwood timber and come into a tract that had pine but has been chopped and burned and is now a cherry orchard.

There is a high sandy and gravelly ridge west of the road in Section 27. It is 60 feet \pm above the sandy plain east of it or about 700 feet A.T. Aneroid 29.445 at Rocky River Station = 619 feet at 2:00 p.m.; 29.410 at a gravel beach $1/2$ mile west on D.S.S. and A. Railroad, near Mile Post 130 (?) = 650-655 feet. Sandstone ledges are entered a mile west of the station about $1/4$ mile east of Mile Post 131 with huge blocks in fields.

Aneroid 29.370 at Mile Post 131; 29.350 in rock cut 15-20 feet deep about midway between Mile Posts 131 and 132; 29.330 in cut 8 feet deep just east of Mile Post 132. There are cliffs 50-60 feet high $1/4$ mile northwest of this Mile Post.

Deer Lake has a rock ridge on north as well as south side, 75-100 feet above lake level. Aneroid 29.310 at Onota Station = 745 feet at 2:08 p.m. Rock is at surface all around here and the surface is quite irregular with cliffs 10 to 50 feet high rising above tracts with nearly plane surface. The flatter tracts have rock at surface.

Aneroid 29.345 at Deerton Station on banks of Laughing Fish River and about 15 feet above the stream = 716 feet. This is near Mile Post 136. There is a little hardwood forest left north of Deer Lake and west from there on north side of railroad, but much of it has been cut off along the railroad for charcoal kilns.

Aneroid 29.350 at Whitefish Station = 710 feet \pm . Rock near surface here, in all the cuts, and blocks of sandstone strew the fields. Surface is nearly all plane, but descends rapidly toward Lake Superior. The railroad enters a sandy plain $1/2$ mile east of Sand River Station. Aneroid 29.425 at Station = 622 feet A.T. This is at Mile Post 140 and is about 20 feet above Sand River bed. The railroad runs along the shore of Lake Superior from here to Marquette, traversing a district with numerous parallel sand ridges standing 20-30 feet \pm above the lake. They are timbered with pine, while the sags between have spruce as well as pine. Some of the sags are grassy, as if wet, but most of them are dry land.

Aneroid 29.430 at Mile Post 145 at 2:35 p.m.; 29.440 at Lake Superior level at Marquette at 2:50 p.m. = 602 feet.

October 1, 1905, 8:40 a.m.

Aneroid 29.265 at Lake Superior level at Marquette. I take train to Chatham. There is rock on hills as far out as the Sanitarium but east of the Sanitarium is an exposure of drift about 100 feet high that seems to have till in upper part. Before reaching the Penitentiary rock hills set in and extend to within a mile of Harvey Station at mouth of Chocolay River. The hills do not seem to reach quite to the line of Ranges 24 and 25 West, T.47N., at the lake shore.

Aneroid 29.250 at Harvey Station at mouth of Chocolay River. The railroad keeps below the 625-foot beach for fully 3 miles east of here. There is a swampy tract--cedar--more than a mile across, which the railroad passes through before turning south to Mangum. Aneroid 29.250 in swamp. Where it turns south a red clay is exposed under yellow sand. Aneroid 29.255 at Mangum at 9:05 a.m. The aneroid is evidently unsteady for this is 633 feet.

Aneroid 29.110 = 791 feet \pm at a beach of cobble about 1/2 mile northwest of Yalmer; 29.040 at a new mill by a burnt cedar swamp; 28.960 at Skandia, 925 feet, by upper Algonquin beach at edge of an undulating till tract; 28.800 at Lawson junction with main line = 1,046 feet \pm A.T. This high tract is flat surfaced as far as I can get a view from Lawson to Rumely--no knolls either morainic or drumlinoidal. Aneroid 28.850 at Rumely = 1,050 feet \pm by survey; 28.925 at ridge at a flag station about 1/2 mile that seems drumlinoidal.

Aneroid 28.950 at Eben Junction = 969 feet at 10:00 a.m. The Calciferous formation is at surface here with bare rock over an area of several acres north and east of the station. I leave the train here to make an examination of the drumlinoidal ridges. There is a bank 10-15 feet high only 15-20 rods southeast of the station that has clayey material on

slopes. It is a sort of foothill for the drumlin-like ridge that sets in about 1/4 mile south, as noted September 26.

The stream 40 rods west of Eben Junction is only 10-15 feet lower than the ledges of rock around the station. There is a hill in center Section 30 that rises 25-30 feet above the bordering plain. Slapneck Creek runs on its north and west sides. It is 60 rods wide and 120 rods \pm long. The north end is 80 rods from north side Section 30. There is another hill on Jakob Lehtimaki's land in SW $\frac{1}{4}$ Section 19, near corner. Aneroid 28.940 at top of hill. It trends north-northwest - south-southeast and is very abrupt on both sides. It is only 20-30 rods wide and 1/4 mile long. West of it, and separated from it by a narrow sag, is another that is just east of town line. It is 60 rods by 20 feet high and very narrow. It trends parallel with the one on which Mr. Lehtimaki's house stands. Aneroid 28.930 at north end of Lehtimaki hill. The ridge at Jenks Spur, 3/4 mile west of Eben is on the range line on south half of line Sections 25 and 30.

There is a lake just south of center of Section 19, aneroid 29.000. Aneroid 29.050 at Slapneck Creek in west part Section 19 near junction of two forks; 29.080 at Chatham at 12:50 p.m. = 866 feet. There is a small drumlin in the NW $\frac{1}{4}$ of NW $\frac{1}{4}$ Section 20. It is about 60 rods long and 15 feet high. Aneroid 29.100 at 3:00 p.m. at experimental farm instrument shelter = 875 feet by level.

Aneroid 29.100 = 895.6 feet at old beach about 60 rods north of quarter post of Sections 27 and 28. Mr. Leo Grismer says this shore runs northwest crossing into Section 21 120 rods west of this section line road and continuing and passes near 1/4 post Sections 20 and 21 and enters Section 17 about 120 rods west of corner Sections 16, 17, 20 and 21. The lower beach crossed in south part Section 15 runs west up south side of Rock River and

curves in under this higher one.

There is an old quarry of sandstone northeast of Rock River Station about 1/4 mile from which the rock for the Alger County Courthouse was taken. It was built from rock that was first used in a jail at Au Train. There is rock from the quarry east to the lake shore. There is heavy drift in the northeast part of T.46N., R.21W., east of Rock River.

Mr. Grismer made a deep well near Ewen, Michigan, in T.48N., R.39W., in Section 21, in 1893. Depth, 355 feet. First flow at 125-138 feet in a gravel bed under "red clay with no grit". Below this water vein was a soft slushy clay and sand down to a gravel bed at 354 feet. The altitude is about the same as Ewen Station--1,134 feet. The well flows a pipe 1-inch in diameter full and would rise more than 16 feet above surface. The temperature stood at 38 degrees from June to November. It would then begin to rise and reached 44 degrees by about the first of January. It would begin to cool off soon after snow melted, the latter part of March. He attributed the low temperature to access of melted snow water and perhaps ice water from neighboring lakes. The lakes are 200 feet or more above the well and are on the high divide between Michigan and Wisconsin, at headwaters of Brule River. Mr. Grismer sold this place to James Howlett.

Three other borings in T.48N., R.40W., at Ewen were 208 to 224 feet. They were in a north-south line 80 rods from end well to end well. They penetrated nothing but red clay until a gravel was struck at bottom. This rested on a ledge of rock--called granite. These are all strong flowing wells--now owned by village.

Another well was made in T.48N., R.41W., 84 feet, in sandstone--a depth of about 60 feet. There was clay to that depth. The head is -12 feet. Jerome Brown did own it. Address--Matchwood Post Office, Ontonagon Co.

October 2, 1905, 7:00 a.m.

Aneroid 29.205 at Chatham = 866 feet. The schoolhouse hill is about 890 feet and the general altitude is about 890 feet from there south to the creek 1/4 mile north of the town line. The creek valley is below 875 feet a little, but it is narrow. The Algonquin beach south of it is 887-888 feet. (See notes in 1912).

The rock ledges south of the creek in south part Sections 33 and 34 reach 885 feet, aneroid 29.185. Aneroid 29.160 on the tableland on line of Sections 3 and 4 = 900 feet \pm ; corners of Sections 3, 4, 33 and 34 is 903 feet. Aneroid 29.180 in the broad swampy tract in Sections 9 and 10 = 887 feet by county engineer's levels; 29.160 at a gravelly ridge at south edge of swamp = 900 feet. It looks a little like a beach. South of it is a rapid rise of 20-25 feet

Aneroid 29.120 = 931 feet at a sharp ridge at north edge of a tableland near middle of line of Sections 15 and 16. It rises 6-8 feet above the tableland and is narrow like a beach but does not seem to be a lake feature, being too high. Aneroid 29.160 = 905 feet at Johnson Creek at 7:45 a.m.; 29.130 on upland 1/2 mile south of the creek = 930 feet. There is a slightly wavy surface here with swells 5-15 feet high. There are numerous blocks of reddish sandstone here, apparently Potsdam.

Aneroid 29.150 = 927 feet at schoolhouse 5 miles south of Chatham. This is at north base of an esker-like ridge of sandy gravel that runs nearly west to east. Aneroid 29.125 on crest just north of where a road runs east. It crosses this road 50-60 rods east and dies out about 80 rods from the north-south road. It runs west-northwest for about 1/2 mile beyond the schoolhouse so the length is nearly a mile. It is only 3-6 rods wide. There is a hummocky tract on line of Sections 22 and 27. A short esker-like ridge near middle of line runs north-northwest - south-southeast, and another

a little farther east runs north-south. Around them the surface is nearly plane. There is a rapid eastward descent, the aneroid reading only 29.190 about 3/4 mile east from the north-south road, or 880 feet \pm .

Farther east, in Section 26, is a clearing with a few small knolls and has flat surface there where the gravel ridges occur. The Algonquin beach near center Section 26 is 869-870 feet. We return west to the north-south road. Aneroid 29.140 = 942 feet on esker by schoolhouse near the center of Sections 27 and 28 at 8:45 a.m.; 29.180 at Limestone Post Office, 1/4 mile south of the esker in Section 28. This is at the general level of a nearly plane tract. This is a sandy loam, rather than clay loam here. Altitude 910 to 912 feet, aneroid 29.180 at crossroads by cemetery, probably north-west corner Section 34. Aneroid 29.165 = 900-910 feet on a sandy ridge, apparently a dune. There are others southeast from here for 1/2 mile. The highest are 35 feet \pm high that seem likely to be dunes = 925 feet \pm . (Railroad Survey crosses one east of here 920 feet A.T.) The general surface through here is nearly plane.

We test soil with HCl but get no response at depth of $1\frac{1}{2}$ feet. Test is in pit near old log schoolhouse, 7 miles south of Chatham. Aneroid 29.225 = 888 feet at schoolhouse at 9:15 a.m. one mile south of town line, Townships 45 and 44 North, R.21W; 29.260 at a creek near south end of line Sections 9 and 10, T.44N., R.21W., = 847 feet \pm . Rock is exposed on the slopes and in bed of creek and is struck in wells south from here near Winters Post Office at from 6 to 14 feet. The postmaster, Mr. Shady, struck water at 14 feet. Aneroid 29.230 = 892 feet, center of T.44N., R.21W. Most of the surface is flat. Aneroid 29.240 = 881 feet at town hall, west quarter post Section 22 (?); 29.250 = 873.3 feet at road running east, corner Sections 21, 22, 27 and 28. Limestone at surface here. It is a pure white limestone that effervesces with cold HCl. The dolomites at

Chatham will effervesce when heated.

We drive east about $1\frac{1}{2}$ miles and south $1/2$ mile to Mr. Walkup's place. There are knolls and ridges of drift here 10 to 25 feet high--the first seen for several miles. I am told by Mr. Nickolson, who lives in Section 22, T.44N., R.21W., that the rolling hummocky land covers the south half of T.44N., R.20W., and is about as hummocky as in Sections 23 and 26 on the west side of river. The knolls and ridges are sharp on west side of river in east half of Sections 14 and 23 and in Sections 13 and 24, and higher than in Sections 22 and 26. Rock is struck at 12 feet at Nickolson's in Section 22 near center of SE $\frac{1}{4}$. Aneroid 29.400 at Whitefish River east of Mr. Walkup's in Section 25 at 11:00 a.m. = 725 feet; 29.320 on hummocky tract around Walkup's 20-25 feet above his house = 820 feet.

We return to the center line road in T.44N., R.21W., at corner Sections 21, 22, 27 and 28. Aneroid 29.240 at 11:40 a.m. where it read 29.250 two hours ago = 873.3 feet; 29.220 at Mr. Fogle's well just drilled in the NW $\frac{1}{4}$ of the SW $\frac{1}{4}$ Section 21. It is 10 feet to rock and is about 40 feet. Another across road is 41 feet--Alfred Maynard's.

Aneroid 29.230 = 870-880 feet at Trenary at level of post office and stores which are 10-15 feet above the depot--865 feet. Trenary station is 865 feet A.T.

There are sharp esker-like ridges just east of this village that run south along Dry Creek on west bank to its mouth $3/4$ mile south of Trenary. One runs about $1/4$ mile north from Trenary. It is 10-15 feet high and only 2-5 rods wide. It has some limestone blocks on it but is not a rock ridge. Parts of it are sandy. Aneroid 29.270 at Whitefish River south of Trenary at 1:15 p.m. = 790-800 feet.

Wells in vicinity of Trenary are 30-40 feet deep and usually obtain abundance of water. It is seldom more than 15 feet to rock. The drift is

a sandy rather than clay loam. I am told that rock is near the surface northwest from here as far as Lawson and Carlshend.

I go south along west side of railroad to intersection with the Chatham and Rapid River wagon road $3\frac{1}{2}$ miles from Trenary, crossing a nearly plane tract similar to that northeast from Trenary. Aneroid 29.245 at road intersection = 845 feet; 29.245 at Camp Four at 2:15 p.m. This is in Section 7, T.43N., R.21W. Altitude, 840 feet \pm .

I drive south through a swampy tract full of mud holes for 4 miles beyond this camp. In the first mile there are a few knolls 10-15 feet high but beyond this is flat surface. Aneroid 29.290 = 810 feet at road leading west called the Lathrop Road (about $2\frac{1}{2}$ miles from Camp 4) at 3:00 p.m.; 29.290 on a long piece of corduroy across a cedar swamp = 810 feet. The timber north from here has been ash, hemlock and birch. South from this cedar swamp small knolls and ridges 10 feet \pm in height occur but most of the surface is flat. The knolls have a loamy soil and blocks of stone, largely limestone. They are of irregular form, like morainic knolls but more scattered. There is some maple and some elm here and very little hemlock.

I come to a clearing and a schoolhouse and several dwellings about a mile farther and the surface seems morainic for $1/2$ mile north of this settlement. Aneroid 29.280 at schoolhouse at 3:30 p.m. = 800 feet \pm . This is at the quarter post south part of Section 30, T.43N., R.21W., and called Osier Settlement.

I go south $1/2$ mile and west $1/2$ mile and then south about a mile to another schoolhouse with a small clearing and 3 residences near it (Osier Settlement). Aneroid 29.315 at this schoolhouse at 4:00 p.m. = 765 feet. This is in north part Section 6, T.42N., R.21W. There have been frequent knolls between these two settlements. Rapid River lies just west of this schoolhouse.

Fred Fournier, in Section 6, SW $\frac{1}{4}$, has a well 16 feet deep entirely clay.

Other wells near here 20 feet deep do not strike rock.

Aneroid 29.340 at level of Rapid River in southwest part of Section 6 at 4:10 p.m. = 725 feet \pm . There is a flat surface from here south except one small ridge in Section 7. The valley is only 15 feet deep in Section 6 but increases to 25 or 30 feet in Section 13, T.42N., R.22W. It has sandy banks and is bordered by a sandier tract south from Section 6. To the north is a loam with some clay in the level tracts among knolls.

Aneroid 29.380 at crossing of Rapid River where stream runs east in Section 19, T.42N., R.21W., = 685 feet. There are rapids here over flat rock. Aneroid 29.350 = 715 feet \pm on sandy plain south of this bend of Rapid River in Section 19. I noticed occasional stones in the sand in Sections 7 and 13 and 18 but here there is a clear sand. It was timbered with pine but is now growing white birch chiefly.

The road soon turns southeast and comes to the west bank of river, probably $1\frac{1}{2}$ miles below the bridge. Aneroid 29.425 at river level or fully 40 feet lower than at the bridge = 640 feet \pm . There is a blue till here on the river bank and there is red clay in terraces west of here to a height of 680 feet or 40 feet above the stream. This is in north part of Section 29.

The road turns south along west bank and soon comes to white limestone which underlies the lowlands along the river at depth of a foot or so. A farm here is very difficult to till because of the stone. It is in Section 29 near south side. Aneroid 29.415 at top of this limestone on south edge of Section 29 at 5:00 p.m. = 650 feet \pm . Railroad here is 662 feet. The limestone is at surface for $1\frac{1}{2}$ miles or more south from here. Farther south the surface is strewn with cobble and small boulders and the soil is a gravelly loam. What little soil there is on the limestone is muck or sand. The muck is, in places, very black.

Aneroid 29.445 at Maplewood School about 3 miles from Rapid River

Village in Section 8 (?) where the wagon road crosses to west side of railroad at 5:30 p.m. = 635 feet. The plain I am on seems to be bordered by a range of hills a mile or more to the west. I come to limestone again 1/2 mile southwest from the schoolhouse where the wagon road turns south, on line of Sections 7 and 8. Its surface is slightly uneven and causes hummocks 5-6 feet high. There were none of these in the exposures a couple of miles north of here. This limestone, like that to the north, is a very thin bedded, flaggy stone. Aneroid 29.450 on the general level of the limestone = 630 feet A.T.

Upon crossing a stream coming in from the west I find a red clay soil instead of the gravelly loam that occurs with the limestone. This clay proves to be a local deposit on the low ground bordering the stream. I soon rise 8-10 feet to limestone here with gravelly loam soil--where there is any soil. The rock is generally at the surface from here through to Rapid river. Aneroid 29.470 at general level of village at 6:10 p.m. = 590 feet A.T.

Mr. Archibald Connor, a land broker, says there is limestone near surface up Rapid River and also on Whitefish River up into T.43N., Ranges 21 and 22 West. It is limestone at surface west from Rapid River to the range line of Ranges 21 and 22 West, T.41N. There is a bluff of sandy drift west from here, extending north along west part of Sections 31 and 30, T.41N., R.21W., and then swings west through Sections 24, 23 and 22, T.41N., R.22W. and then south of west along south side of Days River to the bend in Section 30 and then it bears northwest along west side of the river. There is rock along the bed of Days River where it traverses this high country but the bluffs are of drift. The C. & N. W. Railroad passes north out of this high land at Brampton in Section 21, T.41N., R.22W. East from Rapid River there is a low sandy plain 30-40 feet above Whitefish River that is interrupted by a limestone rock ridge in Section 35, T.41N., R.21W. It runs north 2 or 3 miles to southwest part of Section 14 at Biddles Creek. There is shale up

Biddles Creek in Sections 14 and 12.

There are pine plains west of the limestone ridge, but east of it is mixed timber and clay land for about 6 miles or across T.41N., R.20W. The south half of T.41N., R.20W., is mainly clay but the north half is pine of knolly topography with marshes among the knolls. There seem to be no stones in this belt so it may be dunes. Along Ogontz River south of the Sault Line Railroad some copper and other minerals have been found in the drift. It was found in Section 9, T.40N., R.20W. West of Ogontz River and Bay in T.40N., R.20W., there is limestone and it extends south between the two bays de Noquet, covering T.40N., R.21W., and T.39N., R.21W. There is a strip of sandy land a mile or more wide on east side of Little Bay de Noquet. The limestone runs clear to the west shore of Big Bay de Noquet.

There is a bluff along the east side of Whitefish Township from the head of Little Bay de Noquet up to Mud Lake in T.45N.

There are nine flowing wells in Rapid River:

1. Archibald Connors, 1/2 block east of Main Street, in north part of business part of town. Depth is 270 feet. Made about 10 years ago. It is now running through a pipe 8 or 9 feet above surface. It flows a weak stream--3 quarts a minute. Temperature, 46 degrees. Warmed by being under building.
2. Village well on Main Street, made about 8 years ago. Depth, 273 feet. Rate of flow, 4 gallons from inch pipe. Casing 4-inch for 50 feet. Temperature, 45.5 degrees F.
3. H. W. Coles, east of Main Street, near the river. Made about 8 years. Depth, 258 feet. Rate of flow, 2 gallons from 1/2-inch nozzle. Temperature, 45 degrees.
4. Dr. A. L. Laing's well, west of Main Street one block. Made in 1904. Depth, 273 feet. Rate of flow, 2 gallons a minute from 1 1/4-inch pipe. Temperature, 45.5 degrees.

5. Adam Schaible has one made in 1904. Depth, 273 feet. Located 1 block west of Main Street in north part of town. Rate of flow, 6 gallons a minute from 1 $\frac{1}{4}$ -inch pipe. Temperature 45.2 degrees.
6. Village well in south end of town just north of the railroad. Made about 7 years ago. Depth, 273 feet. Diameter, 4-inch but 1 $\frac{1}{4}$ -inch reducer. Rate of flow, 6 quarts a minute. Temperature 45.5 degrees. Ground is probably 590 feet A.T. and escape is 3 feet above surface.
7. Archibald Bodah in north edge of town on Main Street, 3 or 4 blocks north of post office. Made 6 years or less. Depth, 273 feet \pm . Rate of flow: Temperature:
8. Mrs. Josie Fish about 1/2 mile west on north edge Section 32 has well made 7 or 8 years ago. Depth, 273 feet. Rate of flow: Temperature:
9. At Masonville, the school district made one in 1905 that is very strong flow. Depth: Rate of flow: Temperature:
10. There is another at Escanaba Lumber Company store in Masonville.

There are several large flowing wells at the furnace on shore of Little Bay de Noquet, about 1 mile north of Gladstone, near corners Sections 9, 10, 15 and 16, T.40N., R.22W., 6-inch pipes.

There are 2 in the woods north of Rapid River, made in drilling for oil. One is in northeast corner Section 34, T.42N., R.21W.--nearly 1,000 feet deep. The other is 20 rods from it in same section and that is now 850 feet and is still being drilled. Both strong flows. They are on ground not more than 10 feet above Whitefish River. The river has less than 10 feet fall from these wells to its mouth, so the altitude is scarcely 600 feet A.T. The wells are all through limestone nearly the whole depth, but Dr. Lane says the Pre-Cambrian rocks are reached.

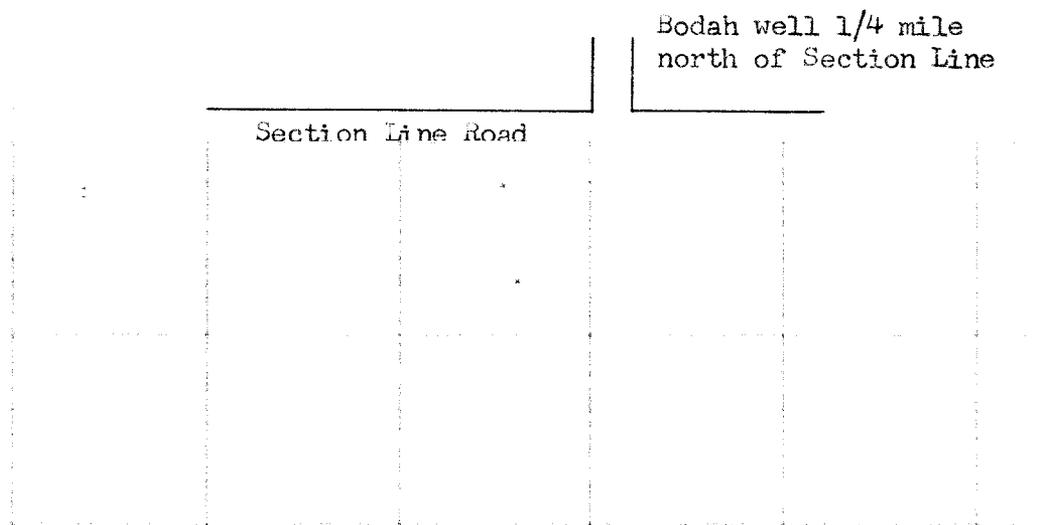
Mr. Connor has examined T.44N., Ranges 14, 15, 16 West and east part of R.17W., and found them all a rolling country of sandy material. No stones noted. South of it is a better belt of land with some clay loam. It is in

better land than the Hiawatha colony is located.

Mr. L. C. Wolfe who helped drill the wells at Rapid River says a very hard rock is struck at about 250 feet that is about 13 feet. There is another hard bed below it under which water is struck at 270-272 feet which gives the flows. The water table in this region is 6-8 feet below surface or at level of bay. The head is about 16 feet above the surface in all the wells, or not far from 600 feet A.T., possibly 605 feet A.T.

The wells at the furnace near Escanaba are about same depth as the wells in Rapid River, and those at Masonville are similar in depth. Wm. Cisco, of Rapid River, is drilling the deep well north of here in Section 34 and was head driller on the wells at Rapid River.

Mr. Wolfe is engineer of Fire Department. There is a tank 20 x 22 feet filled from the river for use in fire. By the south village well is a cistern 30 x 16 feet and 8 feet deep filled from it. Farther south water is drawn directly from bay in case of fire and in north part from the streams. Length of hose, 1850 feet. Susby Rotary Engine No. 1, capacity 700 gallons per minute. Fire Department established in 1898. Chemical Engine 90 galls.





October 3, 1905, 7:45 a.m.

Aneroid 29.350 at lake level in Rapid River village; 29.335 at flowing well of Mrs. Fish 1/2 mile west of Rapid River = 593 feet \pm . I drive west and come to the Nipissing (?) beach in west part of Section 30, T.41N., R.21W. It is 613 feet A.T., with storm beach 619 feet (Hobbs), aneroid 29.295. The bluff is very abrupt and composed of sand in which there are only a few pebbles. It stands 720 feet \pm A.T., aneroid 29.225 at top. The highest points near road are 5-6 feet above this. Aneroid 29.210 about 1/4 mile west = 735 feet (Hobbs).

This high plain commands a view to the east beyond Whitefish River to a rolling tract, apparently dunes. The low tract along Rapid and Whitefish rivers that is swept bare of drift is below Lake Nipissing level at south end. It is this that N. H. Winchell considered an old channel from Lake Superior to Lake Michigan, but my own observations do not sustain that idea. The morainic features along Au Train and Whitefish rivers and the outwash apron noted September 23 show it to be a glacial topography past the divide between Au Train and Whitefish rivers.

As I continue west I pass a lake in a basin 30 feet \pm below the plain that covers several acres and is connected with dry basins to the west nearly as deep. Aneroid 29.240 at the lake; 29.250 at a plain bordering Days River 10-15 feet downstream about a mile east of C. and N. W. Railroad. This has boulders and slabs and cobble of limestone. The stream bed is shaly rock. This low tract extends east beyond Tacoosh River. Before reaching the C. and N. W. Railroad there is a rise to about the level of the plain southeast of this lower tract, but this plain has cobblestones in it and the water table is near the surface so the sand is damp.

Aneroid 29.220 at Days River Station at 9:20 a.m. = 695 feet \pm A.T. I enter a moraine upon turning north from this station. For the first mile knolls are only 5-10 feet high but they are boulder-strewn. In the next mile

a rise is made onto a strong moraine with knolls 20-30 feet high and a moderate number of boulders. The soil here, as well as on the lower ground, is partly clay loam and partly sandy loam. I can see strongly morainic features to the east as far as Tacoosh River.

Aneroid 29.160 = 800 feet \pm on a knoll where a by-road runs west $\frac{1}{2}$ mile south of a frame church $\frac{1}{2}$ mile south of Perkins; 29.180 at the church. A ridge 40-60 rods east is 25 feet or more higher. It is elongated north-south and is 80-100 rods long. The knolls generally are not elongated.

Aneroid 29.180 at Perkins = 791 feet, in west part Section 4, T.41N., R.22W. The moraine is said to run a mile east from here to edge of the low country bordering Rapid River and it runs west nearly to Days River in north part of T.44N., R.22W. Wells strike limestone at Perkins at 10 feet on a flat tract. The wells on knolls 10-20 feet higher are only a few feet deeper--usual depth, 16 feet. Water on hills is from sandy material in the clay.

Aneroid 29.150 at C. and N. W. Railroad on line Sections 6 and 7, $1\frac{1}{4}$ miles west of Perkins at 10:20 a.m.; 29.150 at Beaver Station = 815 feet. The moraine is strong in north part of Section 7 but much of Section 6 is flat. The highest knolls in Sections 7 and 8 are 30 feet \pm .

For $\frac{1}{2}$ mile south from Campbell are sharp knolls 10-20 feet high, strewn with Potsdam sandstone as well as limestone. The knolly surface extends northeast from Campbell. Aneroid 29.110 at Campbell Station at 10:45 a.m. = 866 feet.

Aneroid 29.055 at Trombly on a limestone ridge. Rock is struck at 4 feet in well at a hotel south of station. The well is 55 feet. Aneroid 29.060 on flat tract north of this station 40 rods. To the south there is a descent of 30 feet or more in a mile to a swampy tract that extends to Campbell. The clearings are mainly on the ridges thus far, but the swamps

seem to have a rich muck and clay soil. There are a few boulders scattered over the swamps. The knolls and ridges, whether morainic or limestone, are thickly strewn with them. Potsdam sandstone is a common rock on the surface. Granite and other distant rocks are not rare.

Higher land sets in a mile south of Maple Ridge Station. Aneroid 28.990 = 963 feet at crest of ridge $1/3$ mile south of station at a saloon where I stop for dinner at 11:45 a.m. = 963 feet.

The well at Larson's store is 45 feet and strikes rock at 8 feet. Mrs. O. Klieber, $1/4$ mile west, has well dug and blasted about 30 feet.

The rock outcrops in the cut along railroad at Maple Ridge crest to about 3 feet above the track. Aneroid 28.980 on the crest of Maple Ridge $3/4$ mile south of siding at 12:45 noon = 963 feet A.T. The station is 957 feet.

I take road east and am on the limestone ridge for $1\frac{1}{2}$ miles. I then descend to a flat tract, aneroid 29.040 = 915 feet \pm . Thus far I have seen no well-defined beaches today above the Nipissing beach. About $2\frac{1}{4}$ miles east of Maple Ridge the road runs north for a mile on line Sections 31 and 36 on a flat tract only 3-6 feet above swamp level. It then runs east through a tract with occasional low swells 5-15 feet, but nearly all flat aside from the swells. The aneroid reads 29.030 much of the way on the road north and also east for some distance. Time, 1:15-1:45 p.m. Altitude, 925 feet \pm .

There is a short space about a mile east of the range line near a farm where limestone is at the surface. Aneroid 29.070 at east end of the turn-piked road at 2:00 p.m. This is $2\frac{1}{2}$ miles \pm east of the range line. The road then leads northeast over a gently undulating tract of hardwood timber in Section 28.

Aneroid 29.100 at Rapid River on line Sections 22 and 27 at 3:00 p.m. The bluffs are not abrupt but there is a rise of 20-30 feet on each side within $1/3$ mile back from the stream. The road runs north on line Sections 22 and 23, crossing several ridges 10-20 feet high which probably have a

rock nucleus.

Aneroid 29.060 at an old camp in northeast corner Section 22 on a sandy tract with ash, birch, spruce, etc. The road leads east from here to Osier Station on Perkins Branch of C. and N. W. along section lines 14 and 23, 13 and 24, the station being near middle of line Sections 13 and 24. Altitude, 846 feet. Aneroid 29.055 at schoolhouse in northeast corner Section 24 = 846 feet \pm . Wells at farmhouses in SE $\frac{1}{4}$ Section 14 strike rock at 8-10 feet. It is said to outcrop in places. Aneroid 29.090 at Osier Station = 846 feet; 29.090 at northeast corner Section 24 at 3:30 p.m. = 846 feet.

Aneroid 29.130 at west edge of swamp 1/2 mile east of the range line = 810 feet; 29.130 at intersection with the Rapid River and Marquette road at 3:50 p.m. near line of Sections 18 and 19, T.43N., R.21W., = 810 feet, where I came south yesterday. There are a few small knolls in these sections 10-15 feet high, on each road, more in Section 18 than in 19. Blocks of limestone are numerous on most of the swells. Some have granite and other distant rocks.

Aneroid 29.080 at a clearing, probably in south part of Section 7, at 3:15 p.m. = 840 feet \pm ; 29.075 at Camp 4 in Section 7 at 4:30 p.m. = 840 feet. I take road leading northeast towards Winters, crossing Whitefish River on a bridge in Section 4. Aneroid 29.170 at river = 750 feet \pm ; 29.120 = 800 feet at top of rock bluff. The river is in a rock gorge 45-50 feet deep and only 15-20 rods wide. The rock is a thin-bedded flagging stone that breaks up into small pieces and weathers rapidly.

Northeast from the river the road passes through a broken tract with sharp choppy ridges full of blocks of limestone and perhaps having a limestone nucleus. The ridges are 10-20 feet high and sharp as eskers in some cases. About 1/2 mile back from the river, I reach a general level 90 feet above the stream, aneroid 29.070 = 840 feet, and here leave the sharp ridges.

They occur from this higher level down to the bluff of the river. Is 830 feet \pm the Algonquin level here? No.

Aneroid 29.080 = 835 feet at corner Sections 3, 4, 33 and 34 where the road turns north at 5:10 p.m. This is in a hardwood tract with a little hemlock. The surface is nearly all plane and some of it wet land. Aneroid 29.050 about the corner Sections 27, 28, 33 and 34 on a very level wet tract with considerable hemlock. There are knolls 10 feet or less in height on the slope south of here on line Sections 33 and 34. This extends $1\frac{1}{2}$ miles north. Aneroid 29.050 at limestone outcrop at corner Sections 21, 22, 27 and 28, noted yesterday = 873.3 feet; 29.050 = 881 feet at town hall at 5:40 p.m.; 29.020 $1\frac{1}{2}$ mile west. Ridge 8-10 feet high probably is drift rather than rock. Aneroid 29.025 = 900 feet at Fogle well west part Section 21; 29.040 at marsh near line Sections 20 and 21. This is $1\frac{1}{2}$ mile long and 30-40 rods wide, mainly north of quarter post. From it water drains south through a chain of narrow sloughs.

Aneroid 29.025 at Trenary Hotel = 880 feet \pm . Station is 865 feet. Wells here are 28 to 30 feet. Rock is struck at 8 feet or less. There is rock all along Scotts Creek above Trenary and along the Whitefish northwest on road toward Marquette.

I am told that the township west of this, T.44N., R.22W., is like T.44N., R.21W., with rock near surface and only an occasional knoll of drift. There is a clay loam soil and part of it is settled along the Perkins Branch of C. and N. W. Railway.

The aneroid has been changing so rapidly this afternoon that readings of altitudes are of little value. Mr. Gordon was on train from Chatham to Marquette for much of the afternoon, so barograph is not of use in correcting. The readings yesterday, however, seem to have been reliable.

October 4, 1905, 5:45 a.m.

Trenary, Michigan. Aneroid 28.850 at Trenary = 880 feet at hotel. I take road north, passing a small ridge of gravel west side of road on north edge of village that is elongated north-south and is 15 feet \pm high. There are occasional slight ridgings for the next mile north of esker-like form. Aneroid 28.820 at a railroad switch near Mile Post 371. This is in undulating till with swells 5-10 feet high = 900 feet.

Between here and Dexter Creek 1/2 mile north, there are cuts in ridges full of limestone blocks and cobblestones. Aneroid 28.800 at Dexter Creek near north end of line Sections 31 and 32 at 6:40 a.m. There is another ridge north of the creek that is full of cobblestones. Wells on the farms in Section 32 strike rock at 10-20 feet. The land here is a gravelly loam with productive soil. The limestone in Section 32 is blue and apparently Trenton. Above the blue rock is a white limestone and this is present in the railroad cuts here in large amount.

Mr. Hines, in northwest part Section 34, struck a shale in his well. There was 20 feet of earth above it. Mr. Peterson, in north part Section 32, has a well 30 feet deep that entered rock at 20 feet. It has very little water. Mr. Nickel, in northwest corner Section 32, has a well from gravel at depth of 12 feet. Aneroid 28.785 at Mr. Nickel's at 7:00 a.m. = 930 feet.

About a mile north from here water drains to Johnson Creek and then to Au Train River and Lake Superior. Dexter Creek, which drains Sections 31 and 32, leads into Whitefish and Lake Michigan. The divide is rather flat here and about 935-940 feet, with an occasional small knoll 10-20 feet high. Along Dexter Creek a little pine and hemlock occurs with the hardwood.

Aneroid 28.810 at Mr. Nickel's at 8:00 a.m. where it read 28.785 an hour ago = 930 feet; 28.790 on divide between Lake Michigan and Lake Superior on north part of line of Sections 29 and 30 at a summit switch on railroad = 945 feet \pm . The surface here is nearly plane. The soil is a clay loam.

(See notes in 1912 for altitudes Chatham to Trenary by highway level.)

Aneroid 29.815 = 940 feet \pm at Johnson Creek at 8:30 a.m. Potsdam sandstone blocks abound in the divide between this creek and Dexter Creek. No limestone is exposed along creek here. There are occasional low knolls north from here 10-15 feet high but most of the surface is flat. Aneroid 28.750 at Loud's spur, $3\frac{1}{2}$ miles south of Eben on a flat tract at 9:15 a.m. = 970 feet. I take train into Eben.

The surface is nearly all flat until I come to the drumlin-like ridge. This sets in at the creek a mile south of Eben. It is low at south end for $1/2$ mile, 10-15 feet, then it rises to 35 or 40 feet for about $1/3$ mile. Aneroid 28,740 at Eben at 9:25 a.m. = 972 feet A.T. Rock is exposed along this railroad for $1/4$ mile or more south of Eben. Aneroid 28.720 on ridge at range line west of Eben. The railroad makes a cut here 12 feet deep without reaching rock and 20 rods west an excavation at side of track 12-15 feet deep does not reach rock.

Aneroid 28.700 in a cut 15 feet deep $3/4$ of way west between Mile Posts 20 and 21 from Munising. In this cut are sandstone ledges nearly to top that seem to be in situ. The ridge is only 60 rods long and runs west-northwest - east-southeast across track. At the northwest it merges into a higher plain than that south of it. There is a similar high plain south of the track 40 rods south of Mile Post 21. The sag between is about 60 rods wide with bluff-like borders 20 feet high. The plain on south only extends a little west of Mile Post 21 but runs southeast $1/2$ mile or more. These south of track look to be sculptured by ice and probably the bluff on north has also.

About midway between Mile Posts 21 and 22 from Munising are 3 narrow drumlin ridges running north-south across track. They are only 15 feet high, 8-12 rods wide and are close together. They are $1/4$ mile or more long. The surface is not so smooth as on typical drumlins. They are

composed of till, however, and seem to be of the drumlin class rather than morainic ridges. Aneroid 28.690 at Mile Post 22 from Munising and 16 from west end at 10:30 a.m. The nearest drumlin is about 100 rods east and the farthest about 1/2 mile east from this mile post.

A well at Rumely is 30 feet deep and is thought to strike rock at 6 feet--a sandstone. There are falls on the Laughing Fish River $2\frac{1}{2}$ miles north-northwest from Rumely that the blacksmith thinks are nearly 100 feet counting all the cascades. The first is 12-15 feet and then a series of steps down to base. Aneroid 28.650 at Rumely at 11:00 a.m., about midway between Mile Posts 22 and 23 from Munising; 28.650 at Mile Post 23; 28.635 at summit about 1/4 mile west of Mile Post 24. The surface of this elevated tract is plane so that the railroad makes cuts and fills of only 3-5 feet. This is on the divide between Laughing Fish, a tributary of Lake Superior and Whitefish, a tributary of Lake Michigan from Rumely west past Dorsey.

Aneroid 28.650 at Mile Post 24 from Munising in a tamarac swamp. It is only a few rods across this swamp to hardwood timber on east and west borders. This swamp seems to drain south to Whitefish Creek. Aneroid 28.690 at Mile Post 25 from Munising at west edge of a narrow spruce swamp bearing north-south and draining north. About 1/4 mile west is the marsh noted from the railway train that runs northeast and drains into Laughing Fish Creek. Aneroid 28.695 at this marsh at 12:00 noon.

There is a flat swampy tract from here west a mile to Whitefish water tank. Aneroid 28.690 at Mile Post 26, about 100 rods east of water tank; 28.690 at water tank 6-7 feet above Whitefish River.

Query: Has Laughing Fish captured part of the drainage that formerly went south to Whitefish through this swamp?

Aneroid 28.670 at Mile Post 27 from Munising at 12:40 p.m. This is near one of the branches of Whitefish that crosses to south side of track

and follows it east to water tank. Aneroid 28.650 at Lawson at 12:50 p.m. = 1,100 feet; 28.640 at 1:20 p.m.; 28.630 at summit 1/2 mile north of Lawson = 1,100 feet; 28.650 at swamp 1 mile from Lawson; 28.630 at summit 1 1/4 miles from Lawson; 28.650 = 1,084 feet at culvert in southeast corner Section 27 where a magnesian limestone outcrops. This is about 30 rods northwest of an east-west wagon road by Duke's Spur.

The well at Lawson is dug and is into rock a short distance. Depth, probably 20 feet.

A high level is maintained to Mile Post 3 from Lawson or 24 from Marquette. Aneroid 28.650 at 2:20 p.m. = 1,089 feet. Here a rapid descent begins from northwest part of Section 27. This high land has a reddish gravelly clay loam where not swampy, and a pale clay in the swamps. There is only an occasional small knoll 10-15 feet high, the greater part of the surface being very flat. Aneroid 28.685 at line of Sections 21 and 28 by a stream and sawmill = 1,067 feet. Stream runs north.

I follow the section line road west and make only a few feet descent to corner Sections 20, 21, 28 and 29. Aneroid 29.690 at 2:50 p.m. = 1,060 feet ±. There are no knolls to exceed 5 feet in height on this section line. It is a rich clay soil with black muck in places. Granite boulders a foot or so in diameter are numerous. There are occasional pieces of limestone, apparently calciferous, and sandstone blocks of reddish color become numerous on line of Sections 20 and 29 and an outcrop of soft yellow sandstone is found about midway of the section line near a small rivulet. Aneroid 28.720 at outcrop.

A short distance west is a bluff-like descent, probably due to the dropping off of the rock. It occurs near the place where the railroad comes nearly back to this section line before turning north to Skandia in southwest part of Section 20. The railroad skirts around the north edge of this

bluff where it runs southwest in Section 20. Aneroid 28.320 at railroad by base of bluff in southwest part Section 20.

Aneroid 28.350 at Skandia Station = 925 feet. A well about 10 rods east of the station on a low knoll is 25 feet deep and does not strike rock. It goes through clay into quicksand and ends in gravel. There are places north of here within 1/2 mile where rock is near surface, I am told at the station. It is called brown stone.

There are low hummocks 10 feet \pm high on the slope west of the station that suggest morainic topography. From Skandia the high range of hills south of Marquette is in plain view.

I take train to Marquette at 3:50 p.m. At the rounding of the curve to the east 1/2 mile north of Skandia, blocks of brown sandstone are numerous but they seem to be imbedded in drift. Aneroid 28.980 at Yalmer Station = 809 feet; 28.990 at cobbly ridge apparently a beach 1/4 mile northwest of Yalmer. This is the 791 foot beach. From Yalmer to Mangum cuts show considerable till of reddish color. There are, however, sandy ridges also. The cut just south of Mangum has till at top and fine sand with horizontal beds below it.

Aneroid 29.190 at Mangum about 633 A.T.; 29.200 at stream northwest of Mangum 1/2 mile. Altitude of bridge probably 630 feet A.T.; stream 622 feet. North of this stream is a cut 15 feet deep in a sand ridge. There is a swamp between this sand ridge and Chocolay River which runs westward parallel with the railroad. The railroad is in this swamp for a mile or more. It then gets back into the sandy strip at south border of the swamp. The aneroid reads 29.220 at small stream tributary to Chocolay River near its mouth; 29.215 at station by mouth of Chocolay River. Altitude probably 625 feet A.T. It is several feet above a bridge that stands 12-15 feet above lake level. There is a strong beach with cut bluff back of it near the Penitentiary and north from there as well as east, that is 630 feet A.T. by hand level.

October 5, 1905, 7:30 a.m.

Aneroid 29.620 at Lake Superior level in Marquette. The drift accumulations in south part of town north of the Penitentiary have an undulating surface as if morainic. The highest points are about 710-720 feet; Aneroid 29.490. They fill a ravine coming in from the west on south side of the Sanitorium Hotel. There is a reddish sandy till with large boulders of granite, gneiss, quartz, porphyry, etc, 20-25 feet, resting on a fine sand that extends down as far as there is an exposure.

Aneroid 29.600 at 630 foot beach at Chocolay. There is a ridge with laminated clay and very fine sand south of this station. It is strewn with boulders and has a wavy surface. The unevenness is, however, due to sand dunes. There is a gradual descent from its crest south to a creek south of Chocolay that runs east into the river. It is a singular ridge. We soon rise to a higher tract near forks of road that stands 640-660 feet. It has dunes 10-20 feet. This tract fills a recess that extends back south 2 miles \pm to high hills.

Aneroid 29.520, 730 feet \pm , at well on moraine at James Barry's in SW $\frac{1}{4}$ Section 23. The well is 90 feet. It is in drift the whole depth. The lower 9 feet is a hard clay but the rest is loose material, largely gravelly. Very little rise of water.

Carl Whittler, near middle of south side of Section 23, on ground a little lower, has a well 80 feet deep. Very little rise. Section similar to Barry's.

There is high moraine in south half of Section 23, the SE $\frac{1}{4}$ of NE $\frac{1}{4}$ Section 22, and south part of SE $\frac{1}{4}$ Section 15. It is broken by swamps in north part of Section 23 and southeast part of Section 22. Boulders are numerous on the slopes toward Lake Superior. Aneroid 29.625 at Mangum = 633 feet \pm at 10:00 a.m. The moraine lies east as well as southwest of here.

Aneroid 29.625 at Pickerel Lake swamp. The lake is perhaps 5-10 feet lower. Aneroid 29.520 at Mangum's Camp in Section 20; 29.505 at crest of ridge south of camp = 750 feet. This ridged land I am told, extends no farther east than the creek in southeast part of Section 20 and it only covers the south edge of Section 20, the remainder being flat and sloping northward. The ridge seems to run northwest across Section 19. That section is morainic except the northeast corner and north edge.

Aneroid 29.570 = 680 feet \pm at 12:30 p.m. where we stop for dinner 1/2 mile southeast of Mangum near center of SE $\frac{1}{4}$ Section 24. There is a flat here occupying perhaps 80 acres. Southeast of it are knolls. The knolls extend to a small stream that runs north through center of Section 30 but east from these is swampy land. The NW $\frac{1}{4}$ Section 30 and northeast of Section 25 lying southeast of Mangum are morainic, but farther south there is flat land, largely swamp. I am told that the road running east from Yalmer is through flat land with only an occasional low knoll 10 feet or less in height to the headwaters of Sand River. East from there is a rise to higher country.

There is a farm about 2 miles north of Yalmer, apparently in Section 32, T.47N., R.23W., that is on drift hummocks of gravelly character, but all around it the land is nearly level. The moraine is not well defined, I judge, farther southeast than this farm. There seems to be no continuation for it northeast from Mangum's Camp toward Sand River. That region has sandstone near the surface and few, if any, drift knolls. (Consult Mr. Mangum, the postmaster at Marquette, concerning country east.)

Aneroid 29.570 at 1:30 p.m. in Section 24 where we took dinner. No change in last hour--altitude 680 feet \pm . Aneroid 29.620 at Chocoday River in west part Section 25 near quarter post = 630 feet. Both bluffs are drift from top to bottom and there is no rock in the bed. There is till sandwiched between sand beds and capped by a thin deposit of sand. Aneroid 29.520, 720

feet at brow of west bluff of river. The surface is gently undulating and boulder-strewn with reddish till a short distance back from the stream.

Aneroid 29.460 = 775 feet at Heubner well in Section 26 that is said to be 90 feet and no rock. William Preab in west part of Section 26 has a well 110 feet that went through 75 feet of white sand. Aneroid 29.460 at well = 775 feet.

Aneroid 29.445 = 800-825 feet at Green Garden post office in east part of Section 27 at brow of a high ridge commanding a view of the lake and of Marquette.

We take road southeast, rising to a church. Aneroid 29.410 = 830-850 feet. This is flat-topped but does not carry any beach. There is a flat-topped tract 1/2 mile south across a ravine that looks to be 860-870 feet A.T. Southeast from here on the slope toward Chocolay River are sharp hummocks, in some cases 25 feet high and covering less than an acre each. We cross a small tributary first and pass over a ridge about 780 feet A.T. to the main river in southeast part Section 1. This is 750-775 feet A.T., aneroid 29.500.

Aneroid 29.470 at corner Sections 1, 12, 6 and 7, where road leads east to Yalmer (= 775-800 feet) from Wilson's store. From here south are gentle swells 5-15 feet high and a moderate number of boulders. Aneroid 29.400 at corner Sections 12, 13, 7 and 18. Rock is struck at 20 to 30 feet in wells along this road on ground 850-875 feet A.T. There are loose blocks of sandstone strewn over the surface.

The altitude is about 850-875 feet at the store west of Skandia Station at corner Sections 13 and 24, 18 and 19 and about 780-800 feet at Chocolay river 2 miles west of Skandia, aneroid 29.470. The hills near the store west of Skandia are 900 feet \pm A.T., the store being in a depression. The topography is hummocky for the two miles west from Skandia.

Aneroid 29,420 = 830 to 840 feet at crossroads at corners Sections 14, 14, 22 and 23, T.46N., R.24W. In southeast part of Section 10 are very sharp hummocks 20 feet \pm high, but the east parts of Sections 15 and 22 are only gently undulating. Northwest of this hummocky strip is a level-topped tract about 820 feet A.T. with pebbleless red clay and fine sand. There is more of this pebbleless clay and fine sand than there is till from Section 3, T.46N., R.24W., northward.

The low ridges near Chocolay in Sections 7, 8, 17 and 18 may be glacial but they have scarcely any till. Red clay is interbedded with fine sand. There are a few surface boulders and the surface is undulating.

We find the aneroid has changed slightly, hence about 20-30 feet has been added to altitudes since we reached Skandia. The higher number, where two are given, is likely to be more nearly correct than the lower.

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