

Notebook No. 176 - Leverett

COUNTY

Antrim: 19, 22-24, 26, 28

Clinton: 35

Crawford: 1, 2, 6, 16-17

Grand Traverse: 33

Kalkaska: 24-34

Montmorency: 7-8, 15-16, 18

Ogemaw: 2, 5, 13, 14

Oscoda: 2, 8-13, 14-15

Otsego: 16, 17-22

Roscommon: 1, 2-6

Shiawassee: 35

Wexford: 34

August 11-31 1902

August 11 - Grayling to Roscommon on train. Drive East into northwestern
Ogemaw County

August 12, drive S W from Roscommon with Livingston and Johnston.

August 13, Roscommon to West Branch by rail. Drive west from West Branch, by rail,
St. Helens to Grayling.

August 14, Grayling to Lewiston by rail. Drive North to Vienna and back. Drive
to Luzerne and Jackpine with Deyerwood.

August 15, Jackpine S E into Ogemaw Co. then N E to Mio and S E to Long Lake and
back.

August 16, Mio to Lewiston with Deyerwood. Lewiston to Grayling and Gaylord by rail.

August 17, Drive with Livingston - Gaylord to Vienna and back.

August 18, Drive S W from Gaylord.

August 19, Drive from Gaylord to Alba. Rail to Mancelona and drive East through
Ward's woods.

August 20, Drive S E past Manistee Lake to Blue Lake and back. Rail, Mancelona to
Kalkaska.

August 21, Drive N W from Kalkaska to Rapid City and back.

August 22, Drive East from Kalkaska to Wards Bridge on Manistee R. and back.

August 23, Drive S. E. of Kalkaska and back to Crofton. Rail to Cadillac and
Ann Arbor.

August 27, Rail, Ann Arbor to Lansing. Aug. 28. Rail, Lansing to Bay City.

August 11, 1902, 6:10 a.m.

Donated by _____

Aneroid 28.575 at Grayling, Michigan, 1130 feet. I take train to Roscommon with B. E. Livingston. Very little ascent for $1\frac{1}{2}$ miles, then a perceptible rise to base of moraine, aneroid 28.540. Aneroid 28.420 = 1280 feet at summit in Section 32 in cut 15-20 feet deep. Aneroid 28.505 at Cheney - 1198 feet; 28.540 at school house at line of Sections 14 and 23 = 1160 feet; 28.570 = 1140 feet at stream in north part Section 26; same at stream in southeast part of Section 26; 28.600 at Roscommon = 1123 feet; 28.630 at Roscommon at 8:00 a.m. We drive west on the county line of Crawford and Roscommon, passing through a sandy jackpine plain for six miles. Near east end of the line of townships 24N and 25N., R.2W., a morainic tract passes south through the east part of Section 1, T.24N., R.2W., and continues (after a gap a mile wide at South AuSable River) through Sections 18, 19 and 30 into Section 31, T.24N., R.1W. It is a sharp range of hills in Sections 18, 19 and 30, standing 40 feet + above the plain west of it. East of this ridge is a till tract covering all of T.24N., R.1W., except a strip 1 - 2 miles wide on the south border and about 1 mile wide on the east border. It is an undulating tract in Sections 17, 20 and 29 and in Sections 6, 5, 4, 3, 2 and 1 and part of the Sections south of these. The central and eastern parts are a nearly plane tract, but at the south border of the till in Sections 25 and 26, there is a ridge 40 feet ± above the plain. There is a swamp between the west end of this ridge in Section 26 and the southern end of the ridge that occupies the west side of the township. It seems likely that a lobe of ice covered T.24N., R.1W., and had these ridges as its west and south borders. The ridges are gravelly, and lighter soil than the till tract which they border. North of this till tract is the prominent moraine noted a few days ago that crosses the south part of T.25N., R.1W., in a West-East course and extends into the southwest

part of T.25N., R.1E. This ridge is very prominent in Section 36, being about 150 feet above the plain south of it, or fully 1300 feet A.T. It is also high on the Township line in Sections 33 and 34 and 35, T.25N., and Sections 2, 3 and 4, T.24N., R.1W., and on the line of Sections 29, 30, 31 and 32, T.25N., R.1W.

Aneroid 28.630 on plain at line of Oscoda and Ogemaw counties, 1 mile east of County corners. J. C. Wilson, in Section 6, has a well at 8 feet that is in clay. Clay is near surface over much of this section. Aneroid 28.640 at corner of Sections 5, 6, 7 and 8. We go east 1 mile, then south. Aneroid 28.640 at corner Sections 4, 5, 8 and 9. Aneroid 28.625 at corner Sections 8, 9, 16 and 17. Aneroid 28.620 near corner Sections 16, 17, 20 and 21 at noon. Aneroid 28.640 at 12:45 p.m. at same place; 28.640 at corner Sections 20, 21, 28 and 29; 28.620 at corner Sections 28, 29, 32 and 33. There is considerable wet swampy land in strips running east and west in Sections 28 and 29, 32 and 33 and a great swamp farther west.

We turn west near line of Townships 23N., and 24N., and go about to corner of Townships 23N., and 24N., R.1E., and R.1W., through a wet tract which has some hardwood but is mainly pine. There is an extensive swamp south, extending nearly to St. Helens. We go through Sections 36 and 25 across a sandy plain to the ridge above noted in Sections 25 and 26. It is about 40 feet high and $1\frac{1}{2}$ miles long and $\frac{1}{2}$ mile wide. We come to dry land in Section 23 with flat surface.

We return south through Sections 23, 26, 35 and 34 across a rather wet sandy tract. Then we go west near township line through this wet tract to Section 33 and angle northwest across Section 33 and west along or near line of Sections 29 and 32 to South AuSable River. We continue west over the south end of the morainic ridge near line of Sections 30 and 31, and find it about 40 feet high. The wet tract through which we have passed

lies on the supposed line of connection between this ridge and the one in Secs. 25 & 26 and seems to be about at the border between the clay land of Twp.24N.R.1W. and the sandy plain of Twp.23N.R.1W. West of this ridge is a jackpine sand plain in Secs. 13, 24, & 25 - 14, 23, & 26. We come to a cluster of hills in N W corner of Sec. 26 that covers most of Sec. 22 and runs S W into Sec. 21. It is 40 - 60 ft. above the bordering sand plain and has a sandy gravel.

It is separated at the west by a swamp a mile wide from the moraine that leads N W from Sec. 19, T.24N.R.2W. to the north side of Higgins Lake, but it seems likely to be a continuation of that moraine.

Peaches in Roscommon Co.

Between this ridge or group of hills and Roscommon there is a sandy plain. The Murray Hills south of this group in Secs. 33 & 34 T.24N.R.2W and Secs. 3,4,5,9, & 10 T.23N.R.2W are very prominent and have, it is said, a good soil for fruit. Some peaches are grown on them. They probably reach 1300 ft. They may be a continuation of the group in Secs. 22, 26 & 21. It is much more prominent.

August 12, 1902. 7:00 a.m.

An. 28.985 at Roscommon 1123'. An. 28.890 on line of Secs. 1 & 12 T.24N.R.3W = 1210 ft. There are points 1250 ft. or more 1 - 2 miles west.

Aneroid 28.955 at Higgins Lake = 1155 ft. The plain east is 1165 - 1180 ft. In SW part of Sec. 22 is a drift ridge 60 ft. higher than the lake. It scarcely reaches into Sec. 27. The range south of Higgins and Marl Lakes in Secs. 3, 4 & 5 is 1230 - 1250 ft. and has good soil.

Well

There is a till tract south of the ridge with very level surface. E. F. Robbins well, at center of Sec. 9, is 35 ft. Alt. 1175 and in till nearly to the water, where gravel sets in.

Clay land in much of Secs. 7, 8, 9, 16, 17 & 18. Sand ridge runs across Sec. 7 in course south of west, passing near the center of section. It is 20 - 30 ft. high and has no pebbles. South of it is a swampy clay plain.

The north edge of plain is, by aneroid, 1175 ft. and the ridge about 1200 ft. The plain becomes a tamarack and cedar swamp in Secs. 7 & 18 near west line. North of the swamp, in Secs. 6 & 7 T. 23N.R.3, Sec. 1 T.23N.R.4W and Secs. 25, 26, 27, 34, 25 & 36 T.24N.R.4W, there is a tract with low sandy knolls and ridges and occasional basins, but most of the surface is plane. The basins, in some cases, have till at bottom. North of this tract is a strong morainic ridge. Aneroid 28.910 at 11:40 where we stop for dinner in Sec. 36, T.24N.R.4W. Aneroid 28.895 at same place at 12:35. Aneroid 28.900 at intersection. There is an occasional clay spot between this swamp and the ridge in T. 24, R.4W and boulders are occasionally seen at the surface. The plain is a little higher and more sandy in Secs. 20 & 21 than farther south.

Aneroid 28.810 on ridge west of Higgins Lake; 28.890 at Higgins Lake = 1155 ft. High water is 1158. There is a tract 17 ft. above the level of the lake = 1172 - 1175 ft. The ridge runs along the line of Secs. 15 & 16 but does not in Secs. 9 & 10. There is a low continuation to south edge of a swamp in Secs. 3 & 4. There is also a low ridge or undulating strip along line of Secs. 8 & 17 to prominent hills in Secs. 7 & 18.

Depth of Higgins Lake 126 ft.

Mr. W. S. Wright has sounded in Higgins Lake and found the deepest part of north arm is 84 ft. The south arm has 126 ft. In the narrows it is 82 ft. There is a current past the narrows along bottom of lake where drift wood collects in nets.

August 13, 1902 - 6:45 a.m.

An. 28.870 at Roscommon = 1123. About $\frac{1}{2}$ mile south the R.R. reaches the general

level of the plain at 1145 ft. There is very little change in altitude across T.24N.R.2W. Aneroid 28.850 at switch in SE part of T.24N.R.2W. There is much wet land from Sec. 23 T.24N.R.2W to St. Helen. An. 28.850 at St. Helen. South of St. Helen there is a rapid rise of 25 ft. to a sand plain with Jackpine and scrub Oak. This rises to the SE, soon reaching 1200 ft. 28.770 at Beaver Lake - 12:50

There is a hill 200 ft. higher on line of Secs. 28 & 33 and a ridge of hills 150-200 ft. high from there N NE. The railroad goes down through a Saginaw moraine from Secs. 32 & 33 southeast to a valley where aneroid reads 28.970. The hills are 100-150 ft. or more in height. This valley leads west but not much east of the railroad.

29.080 at West Branch = 9531

We drive west and reach a hill 1050 ft. about $1\frac{1}{4}$ miles west of Twp. line. At Gale lumber camp 1070' (An. 28.960) in NW part Sec. 26. Aneroid 28.820 at corner Secs. 21, 22, 27 & 28, T.22N.R.1E = 1200 ft. This is at the place where hardwood gives place to pine. West from here is a strong morainic tract. At top of hill 120 rods west of Section corners, 1310 ft., 28.720.

Aneroid 28.650 = 1370 ft. on hill near middle of line of Secs. 20 & 29. 28.630 = 1385 - 1390, about 80 rods east of county line on road. The altitude is 25 - 35 ft. higher on hills 40 rods north in SW part of Sec. 19. 28.685 at county line = 1330' \pm . Hills about $1\frac{1}{4}$ miles west in Secs. 23 & 26 T.22N.R.1W, rise above 1400 ft., probably to 1425'. An. 28.530 on hill, probably in Sec. 23, = 1470 ft. A hill $\frac{1}{2}$ - $\frac{3}{4}$ mile north is 60 - 75 ft. higher and several points on the same range NE & NW from here exceed 1500 ft. There is a high range running to the SE part of Sec. 16.

An. 28.750 at SE corner Sec. 8 at James Davidsons = 1280' at 11:15 a.m.
Aneroid 28.740 at 12:15 noon. We drive west across a till tract to the township line and find it 20 - 30 ft. lower at township line than 2 miles east. The surface is nearly plane. There is a change to a swampy tract farther west. We then return to Davidsons. Take road NE to St. Helens through a nearly plane tract of loose textured drift. There are hills each side of road as indicated on map, but they scarcely reach 60 ft. high. We return by train from St. Helens to Grayling.

August 14, 1902 - 6:30 a.m.

An. 28.860 at Grayling - 11:30 . I take train to Lewiston. 28.830 = 1160 ft. in swamp just west of Kneelands. The station is at same level.

Aneroid 28.800 at wagon road in Sec. 12 where railroad leaves the plain and enters moraine = 1185 ft. 28.770 in a pitted gravel plain = 1210 ft. This covers several square miles in a strip 1 - 2 miles wide through which the railroad passes nearly centrally to Judge Station with very little change in altitude. I am then in a moraine to N. AuSable. Its highest points are only 1240-50' along this railroad line.

Aneroid 28.850 at Lovells - 1140 ft. - 20 ft. above North Ausable River.

The moraine NW from here rises 50 - 100 ft. above the level of this Station.

An. 28.870 at swamp. Sec. 9 T.28N.R.1W. East of this swamp is a tract about 50 - 60 ft. higher that seems to be nearly plane and timbered largely with Jackpine. The railroad rises to it gradually and reads 28.810 on it. It is apparently the uneroded gravel plain, while the strip to the west, along North AuSable, is an eroded one. There is an eastward rise and a change to Norway pine before reaching Dana.

An. 28.780 at Dana. The surface here is plane except basins, and the soil is a sandy gravel. Twin Lakes stand nearly as high as this plain. Hills

set in $\frac{1}{2}$ - $\frac{3}{4}$ mile south of the west lake, that rise 100 ft. in places, above this plain or to over 1300 ft. A.T. Aneroid 28,775 at Lewiston at 8:10 a.m.; 28,770 at 9 a.m. about 1310 ft.; 28720 on gravel plain near north end of line of Secs. 14 & 15 T.29N.R.1E.

28,760 in basin near corner Secs. 10, 11, 14, & 15.

Secstions 12 & 13 are strongly morainic and so is the NE part of Sec. 11. An. 28,690 at S edge of moraine where boulders set in on line of Section. The moraine here has only low hummacks 10 - 20 ft. high. It is timbered with hardwood (birch, maple, elm, basswood) and hemlock.

28,680 at John Pauls in SW part of Sec. 2 on edge of moraine = 1300 ft. + A.T.

Well:

Mr. Pauls' well is 142 ft. Reddish stony clay 15 ft. Sand and gravel to water at 140 - 42 ft. 28,650 at corner Secs. 27, 28, 33, & 34 at edge of moraine. This edge is full of cobblestone and boulderets up to nearly a foot in diameter from here SE to Sec. 14. Much of Sec. 34 and the NE corner of Sec. 33 has hardwood timber. Basins are numerous along this border.

Aneroid 28,600 on summit on line of Secs. 21 & 28 = 1370 ft.

28,610 at School house 1 - $\frac{3}{4}$ miles east of Vienna.

Aneroid 28,670 a mile west of School house at cross roads, corner of Secs. 19, 20, 29 & 30. The north part of Secs. 29 & 30 is on the moraine and has hummocks 10 - 20 ft. high.

The south part of Secs. 29 & 30 and north part of Secs. 31 & 32 have cobbly material and lie near an ice margin that passed west into Otsego County.

An. 28,680 - 700 on border. There is a lower plain leading across the NW part of T.29N.R.1E to Bear Lake on which the aneroid reads 28,730; 28,700 on higher plain at the Wilcox farm about 4 miles N NW of Lewiston, probably SW part Sec. 9.

Aneroid 28.770 at Lewiston at 12:30 = 1210' +. There is a nearly imperceptible slope of 60 feet from the Wilcox farm to Lewiston of 15 ft. per mile. Aneroid 28.750 at Lewiston at 12:30 = 1210' I go with Mr. T. H. Deyerwood past east side of East Twin Lake.

There is a nearly plane tract with basins south of East Twin Lake.

There is a group of hills SW of the lake that has points fully 150 ft. above the lake. The line of Montmorency and Oscoda Counties crosses the highest part of the hills. and the section line midway of the township runs NS over the east side of the hills. Much of Sec. 4 T.28N.R.1E, and the S half of Sec. 33, T.29N.R.1E, are covered by this group of hills.

An. 28.770 at Bear Lake at the South end of this group of hills. An. 28.700 on a hill near center of T. 28N.R.1E.

Aneroid 28.750 on plain south of hill. This extends west to the North Branch.

There are boulders and low swells on this plain in Secs. 27 & 28.

Near south line of these sections a Jackpine plain is entered. It only extends east over the west half of Sec. 34.

An. 28.800 on plain on line of Secs. 33 & 34 north of Bear Lake outlet.

An. 28.825 at Bear Lake outlet.

An. 28.790 plain at south side of Sec. 34 T.28N.R.1E.

There is said to be a plain from here west to North Branch and east several miles from here.

Aneroid 28.825 at a marshy stream in Sec. 3, T.27N.R.1E. Here and along Bear Lake outlet there is only a narrow strip of marsh.

Aneroid 28.750, 1 mile east of center of T. 27 N.R.1E. There is a knoll 40 - 50 ft. high setting in on line of Secs. 15 & 22 and running west some distance. There is another hill in Sec. 10 fully as high. The road leads through Jackpine plains.

Aneroid 28.790 on plain on line of Secs. 26 & 27. There is a river near north end of Section line 75 ft. lower than the plain; 28.850 in swamp in south part of Secs. 26 & 27. This has considerable clay under it. There is another swamp in north part of Sec. 33 also underlaid by till. These swamps head a short distance east on high sandy plains but are open west to the river valley.

An. 28885 on river terrace at line of Twps. 26N & 27N at the Grayling & Mio wagon road two miles from east end of the township line = 1090'

Aneroid 28.985 at AuSable River at the Baker bridge near line of Secs. 2 & 3 T.26N.R.1E = 990' \pm . There is a narrow terrace 30 ft. above the river and a low bottom on south side.

Aneroid 28.925 on a terrace south of river.

Aneroid 28.900 on plain in Secs. 11 & 12 = 1065' \pm

Aneroid 28.950 at W. Branch of Big Creek on line of Secs. 23 & 24.

Aneroid 28.900 at Luzerne at middle of line of Secs. 25 & 26 T.26N.R.1E = 1065'.

There is a range of hills east of here on east side of Big Creek that has hardwood timber. There are hills each side of both branches of Big Creek south and west of Luzerne but the streams have valleys nearly a mile wide that have jackpine plains.

I go west and rise to the upland in Sec. 33, T.26N.R.1E, north part - An. 28.785.

This is nearly plane, and timbered with Jackpine and scrub oak.

Aneroid 28.760 at East bluff of a ravine in Sec. 33; 28810 in ravine.

This opens eastward toward Big Creek but is dry.

There is a prominent range of hills south of it. Aneroid 28.650 on ridge in Sec. 2, north of Jack Pine P.O. 30-40 rods; 28.660 at Jack Pine P.O. =

1285 \pm ; 28580 on highest point in Sec. 2 about $\frac{1}{4}$ mile NE of George Hartmans =

about 1360' AT. A point $\frac{1}{4}$ miles east near the county line is perhaps

25 ft. higher than this and there are two hills in the range in Sec. 36

that are as high as the hill I am on.

Well Data

Mr. George Hartmans' well is 187 feet. (1) Soil gravelly 4 ft. (2) Sand to 140 ft. Clay bed a few feet, then sand and gravel to water. Head only 10 feet. Coleman Bristol in SE $\frac{1}{4}$ Sec. 2, has well 168 ft. - - is similar except it had cemented gravel at 75 - 100 ft. +

Mr. Hartman says the range of hills that I am on covers the south half of Secs. 11 & 12 T.25N.R.1W and all of Secs. 1, 2, & 3. Upon entering Oscoda County its south border swings NE across Sec. 7 and runs through the center of Sec. 5 and then crosses the west fork of Big Creek and runs along the Township line south of Luzerne. The range that covers part of Secs. 1,2,3, 4,5,6, & 7 and are along line of Secs. 30,31,29 & 32,28 & 33 are the only prominent ridges on T.25R.1E. The rest of the township is a jackpine plain. The morainic tract in T.26N.R.1E has its north border in Secs. 19,20,21 & 22. Mr. Hartman thinks rock was struck in Roscommon at about 300 ft. in a boring made 15 or 20 years ago for oil. It was sunk about 500 ft. and some oil was obtained.

Ask Robert W. Ward for information of John Trask of Roscommon.

August, 15, 1902. 7:00 a.m. An. 28.600 at Jack Pine 1285 $\frac{1}{2}$. An. 28.720 at north edge of Jack pine plain near center of Sec. 12, An. 28.740 on plain at county line, corner Secs. 12, 13, 7 & 18.

An. 28.740 at corner Secs. 7, 8, & 18. T.25N.R.1E.

An. 28.800 at a tributary of Big Creek near S end of line of Secs. 17 & 18.

An. 28.750 on plain south of valley. There are a few surface boulders in Secs. 17 & 18, but there is a sandy gravel on the plain.

Aneroid 28.750 at corner Secs. 19,20,29 & 30. Occasional large boulders on the plain here but soil is a sandy gravel. There is some clay on north slope of a moraine in Secs. 29 & 30.

An. 28.700 on crest of moraine on line of Secs. 31 & 32.

An. 28.760 at county line at corner of Secs. 31, 32, 5 & 6 = 1170 ft.+
An. 28.760 at Big Creek Valley in south part of Sec. 35; 28730 on plain west of Creek at John Andersons.

Aneroid 28.820 at Big Creek at line of Secs. 27 & 22.

Aneroid 28.750 on plain east of creek on this section line. There is an outcrop of till on the bluff at 10-40 ft. above creek. There is about 20 ft. of sandy gravel above it. Aneroid 28.740 at corner Secs. 23, 24, 25, & 26. Several large boulders near east end of line of Secs. 24 & 25.

Aneroid 28.730 at town line, corner Secs. 24 & 25 R.1E & Secs. 19 & 20 R.2E.

Aneroid 28.730 at corner Secs. 19, 20, 29 & 30; 28.780 in a broad valley or 1 lower plain that covers the NE part of Secs. 19 and the NE $\frac{1}{2}$ or $\frac{2}{3}$ of Sec. 20, and sections farther north and east. It extends S SE to Woodrow. There is a river west of the higher plain east of it in Secs. 21, 28, 29 & 32.

An. 28.875 at Big Creek Valley, on line of Secs. 7 & 8 T.25N.

An. 28.850 on first terrace north. An. 28.815 on second tarrace at corner Secs. 5, 6, 7 & 8.

Aneroid 28.780 on a cobbly terrace near middle of line of Secs. 5 & 6 at Abe Merritts.

Well data

His well penetrates:	1. Sand	10 ft.
	2. Blue Clay	6 ft.
	3. Sand to bottom	<u>74 ft.</u>
	Total	90 ft.

There is only 10 ft. of water in the well.

There is a moraine in Secs. 15, 22, 26, 27, & 35 T.25N.R.2E that seems to connect the morainic tract that runs east through south half of T. 26N.R.1E with the big moraine NW and north of Rose City. I had a fine view of it from the line of Secs. 20 & 29 T.25N.R.2E. It seems to rise about 30 to 60 feet

above the border plain west of it and is said to be narrow - $\frac{1}{2}$ mile₊ in width. I passed an isolated knoll 50 ft. high on line of Secs. 18 and 19 T.25N.R.2E that only covers about 40 acres.

There is a fine view from Mr. Merritts, in east part of Sec. 6, T.25N.R.2E, of the range of hills on the line of T.25N. & T.26N.R.1E in Secs. 34, 35 & 36 & Secs. 1, 2, & 3.

Aneroid 28.780 at Mr. Merritts at 1:00 p.m.

The north side of Secs. 5 and NE corner of Sec. 6 are slightly undulating and 10-25 ft. above the cobbly tract. It has numerous basins. The soil is sandy. An. 28.760 at township line of Twps. 25N. & 26N.R.2E, one mile from west end. In Secs. 31 & 32 boulders and patches of till are at the surface. The surface is greatly undulating with swells 10-20 ft.

Much of Secs. 19 & 20 are timbered with hardwood and have a clay or clay loam soil. There are knolls and ridges 10-50 ft. high but the general altitude is lower than the plain to the south.

An. 28.810 at corner of Secs. 17, 18, 19 & 20. There are few points in these sections more than 25 ft. higher.

In Sec. 17 there is hardwood only in south half, but on Sec. 18 there is more than half hardwood.

28870 at middle of line of Secs. 17 & 18 on a nearly plane tract just north of moraine. Aneroid 28.885 at Lost Creek in Sec. 17.

Much of Secs. 16 & 15 are in a swamp but the sections south of there are morainic. The swamp and sandy plains occupy the interval between this moraine and AuSable River in this township.

I come to the bluff of the river at corner of Secs. 11, 12, 13, & 14 and find it 80 ft. high. There is a bluish till outcrop going up to a height of 50-60 ft. which contains a few large boulders. Above it is a fine, sandy gravel.

The hills a mile SW of Mio are fully 150 ft. above the sand plain on which Mio stands and this is about 80 ft. above the river. These steep hills were timbered with pine, but hardwood sets in a mile or so south. Aneroid 28.915 at bluff of AuSable River near corner of Secs. 11, 12, 13, and 14. 80 ft. above the stream. An. 28.900 at Mio at 3:20. I take road SE through Sec. 18 rising through a ravine to the moraine. It is about 125 - 150 ft. above Mio. An. 28.750 near corner of Secs. 17, 18, 19, & 20, T.26N. R.3E. Aneroid 28.720 at crest $\frac{1}{2}$ mile south of corners. The poor farm is on a similar height in Sec. 24, T.26N. R.2E.

On an abandoned farm, 28.680, in west part of Sec. 29, T.26N. R.3E. The east part is 50-75 ft. higher, or 1300±

The surface is nearly plane in much of Secs. 32 & 33 and the aneroid reads 28.670-680 along road.

28.745 at Long Lake in Secs. 5 & 8 T.25N. R.3E.

The banks are 35 - 40 ft. high. I return to Mio and find aneroid has made no change in the past 3 hours.

John McKenny, of Londs Lumber Co., outlined for me the extent of the high sand and gravel plain in T.25N. R.4E. and south edge of T.26N. R.4E. He says a very elevated plain covers much of Secs. 3, 4, 5, 6, 7, 8, 9, 17, 18 & 19 T.25N. R.4E and the south part of Secs. 32, 33, & 34 T.26N. R.4E. There is a descent from this high plain to the north through a moraine to the AuSable River.

The moraine stands but little higher than the plain. On the SE side of the plain there is a range of elevated morainic hills rising from Sec. 2, T.25N. R.4E. southwest across Secs. 10, 11, 14, 15, 20, 21, 22, 28, 29, 30 & 31, then west across the south side of T.25N. R.3E., its north border being in Secs. 25, 26, 34, 28, 29, & 31 into Sec. 36, T.25N. R.2E. It there turns abruptly southward through Secs. 1, 12, 13, 23 & 24, 26 & 55, T.24N. R.2E. There is a valley west

of this range in east part of T.24N.R.2E about $1\frac{1}{2}$ miles wide, and west of this, another range of hills. From Long Lake, in Sec. 9, T.25N.R.3E, there is a small valley leading west to Big Creek. It is 8-100 rods wide or about the width of the lake and seems once to have been the lake outlet. It leads through Secs. 8 & 7 T.25N.R.3E. and Sec. 12, R.2E. The gravel plain in T.25N.R.s 3 & 4E. seems to be in a reentrant between the Saginaw lobe and Thunder Bay lobe, or the predecessor of the Thunder Bay lobe. There is a moraine north of AuSable River running from near McKinley past Fairview in a NW course that is perhaps the first, or outer, moraine of the Thunder Bay lobe. It runs past Vienna to Gaylord and follows nearly the divide between Thunder Bay drainage and AuSable drainage in Oscoda and Montmorency counties.

Well at Mio:

The public well at Mio is 106 feet deep and has 30-40 feet of water. There is coarse cobble and gravel in the upper part of the terrace on which this village stands. The stones are largely crystalline erratics. There are very few sandstones or limestones. The constitution or class of rocks is about the same as at Harrisville as noted last year, many quartzites and greenstones, and a moderate number of granites.

August 16, 1902. 6:30 a.m.

An. 28.880 at Mio - Probably about 1000 ft. A.T. on terrace; 28920 on lower terrace in north part of the village.

Aneroid 28.980 at AuSable River. There is a flood plain 10-15 feet above the stream. There is a wide plain north of the AuSable at about the level of Mio, An. 28.880. About $\frac{1}{4}$ mile north of the township corners, the sand becomes a thin coating, and till is exposed in shallow ravines 5 - 10 feet deep, but the surface is plane about to the north end of line of Secs. 36 & 31 T.27N.R.2 & 3 E.

There is an undulating till tract in Secs. 29, 30, 19 & 20 T.27N.R.3E and in Secs. 24 & 25, T.27N.R.2E. In Secs. 26 & 35, there is a strong moraine. The road crosses a ridge 80 rods from west end of section line where aneroid reads 28.780. The till tract extends up the north side of AuSable River to the corner of Twps. 26N. & 27N., Rs. 1 and 2E and the rolling land two miles farther. Then it seems to have pushed eastward here up the valley of AuSable and had its margin near the mouth of Big Creek.

Aneroid 28.630 on high upland, nearly plane, in Sec. 29, T.27N.R.2E; 28.670 on plain at M. J. Woods in NE part of Sec. 19. The NW $\frac{1}{4}$ of Sec. 20 is on the plain and nearly all of Sec. 19. The plain covers Sec. 18, most of Sec. 12, and the NW part of Sec. 16, and nearly all of Sec. 9. It is a gravelly, cobbly tract with basins in Secs. 8, 9, 16 & 17. An. 28.650 on the plain in NW $\frac{1}{4}$ of Sec. 9. Section 4 is moranic except perhaps a little on the west side. Sec. 33, T.28N R.2E is morainic but Secs. 31 & 32 have basins and a nearly plane surface, aside from basins. An. 28.725 at Indian Lake in Sec. 32. The plain north and east of this lake is rather lower than to the southeast, as if it had been cut down. There is very little flat surface and this suggests much erosion.

The moraine NE of this plain extends through Secs. 29 and 30, 20 & 19 and a little across the township line into Sec. 24 & 25. It is there interrupted for a couple of miles by a sand plain but reappears in Sec. 22 and runs N NW to south side of Twin Lakes as noted Aug. 14th.

There is a great gravel plain traversing T.28N.R.2E from NW to SE just outside the Gaylor-Vienna-Fairview moraine. An. 28.670 on gravel plain at corner of Secs. 18 & 19, 13 & 24, T.28N.Rs. 3 & 2 E. An. 28.660 on same plain at corners Secs. 1 & 12 - 6 & 7. An. 28.640 at county line, corner of Townships 28N. & 29N.Rs. 2 & 3E. The plain has been very flat-surfaced the past three miles. There is a gravelly soil with few large pebbles. Aneroid 28.625 at corners Secs. 25 & 36, 30 & 31; 28.615 at corners Secs. 19 & 30, 24 & 25.

The NE part of Sec. 30 and east part of Sec. 19 are morainic.

There is a cobbly tract with wavy surface at the corner of Secs. 19, 30, 24 & 25 and the cobble is conspicuous for about a mile south. There is a valley-like sag running south through the west part of Secs. 24 & 25 but it does not have well-defined bluffs. An. 28.660 on lowest part of the sag at Mr. Wilburs. This valley runs to Wolf lake at the south end. An. 28.620 on plane west of the valley at crossing of the M.C.R.R., a mile east of Lewiston; 28.645 at Lewiston at 11:30 a.m. This is about 1210 ft. A.T. Aneroid 28.640 at Lewiston at 12:15. I take train to Grayling. From the south side of west Twin Lake I catch occasional views of low hills northwest of the lake in southeastern Otsego County. They seem to rise scarcely 60 ft. above the lake or but little higher than the NE border of the outwash apron of the Gaylord-Vienna -Fairview Moraine north and east of Lewiston. The south-east township of Otsego County is said to be very light soil with basins and lakes and the hills are not a conspicuous feature.

Aneroid 28.640 at Dana; 28.740 at creek and swamp at west side of Sec. 3, T.28N.R.1W. This is probably a line of discharge from the moraine. At the end of the creek the swamp is nearly 1 mile wide. West of it is a plain 35' + high, and. 28.700, that lies on the east side of North Branch of AuSable River, 1125 + feet A.T. The tableland west of North Branch is about 50-60 ft. higher than this plain west of Lovells. An. 28.720 at Lovell's Station in Sec. 19 = 1140+ ft. A.T. This is 15 - 20 ft. above the stream. An. 28.640 at Judge Sliding in Sec. 35. This is at the level of a gravel plain or valley about 3/4 mile wide that leads SW, and the railroad passes through the middle of the valley. The bordering uplands rise with blufflike borders 30-50 ft. above this valley. There are numerous basins in the valley and it is a barren tract timbered with a light growth of jackpine.

It shows remarkably little westward descent, the plain aneroid reading 28.650-28.660 for fully 3 miles.

An. 28.680 at edge of lower plain on east branch of AuSable in Sec. 12, T.27 R.3W. 28.700 at East Branch Creek in Section 14, Ditto at Kneelands= 1160'+ (See notes Aug. 14th) Aneroid 28.735 at Grayling 2130 ft. at 2 p.m. An. 28.735 at 5 p.m.

I take train from Grayling to Gaylord. Aneroid 28.540 at Gaylord at 5:30 p.m. Altitude 1343 ft. There is considerable hardwood timber on east side of railroad from Bagley to Gaylord on what seems to be a gravel plain.

Aug. 17, 1902. 8:00 a.m. An. 28.400 at Gaylord, 1343'. An. 28.380 on crest of moraine about 3 miles east of Gaylord. The moraine comes to the town line $\frac{1}{2}$ mile east of Gaylord and is a mile south of town corners.

Aneroid 28.660 at swamp on line of Secs. 30 & 31. T.31N.R.2W; 28.700 at creek on line of Secs. 28 & 29. The swamp along this creek is nearly $\frac{1}{2}$ mile wide. There are high hills each side of it. The timber is beech, maple and hemlock with scattering trees of other sorts. Maple predominates. We go into Sec. 28 to examine the forest north of the creek, then return to a school house at line of Secs. 29 & 32 and go east to corner Secs. 27, 28, 33, & 34. The swamp covers the north edge of Secs. 32 & 33 except near east end of line of Secs. 28 & 27. We go south to the town line and zig east to line of Secs. 3 & 4, T.30N.R.2W. and take the road south to the State road at corner of Secs. 34, 9 & 10. An. 28.600 at Creek by a mill in Sec. 11 north part. The drift here on the slopes of this valley is gravelly sand with but little till, but farther west there is considerable till and a moderate number of boulders. The south edge of the moraine is very cobbly.

Aneroid 28.500 on upland near corner Secs. 1, 2, 11 & 12. In Secs. 5, 6, 7 and 8 T.30 R.1W There is considerable till. The surface is gently undulating and rises to the east. Aneroid 28.370 on tableland about 3 miles west of Hetherton. 28.350 on a sharp hill a mile east of last observation. This altitude is reached on several points between here and Hetherton, and at Hetherton.

An. 28.350 at noon. The drift is a stiff till and there are flat fields at this high altitude.

Aneroid 28.380 at Vienna at 12:40 about 1300 ft. A.T. (See notes Aug. 14 for reading near here, 90 ft. above Lewiston.)

Well data

The town well is 124 ft. Vernon Welchs well 30 rods west is 143 ft. and has 30 ft. of water. There is only 10 ft. of clay. The rest is sand.

Aneroid 28.340 = 1300' at Vienna at 2:15. The hardwood and till extends a mile south of Vienna. There is then a pitted gravel plain, on which the Bear Lakes and other small lakes are situated, which stands, at its north edge, about 25 ft. lower than Vienna, or 1275 ft. A.T.

South of Big Bear Lake are a few knolls 20 ft. + above the general level of the plain.

Aneroid 28.430 at head of Big Creek at Alpena State road near line of Secs. 10 & 15 T.29N.R.1W. Aneroid 28.410 on plain west of the creek.

Well data

Aneroid 28.310 at G. W. Colbeck in S. E. corner Sec. 19 on moraine. His well is 118 ft., and struck water at 100 ft. There was scarcely any clay, but on bordering land there is 5-20 ft. The undulating moraine extends west along line of Secs. 19 & 30, 24 & 25, into Secs. 26 & 35. T.30N.R.1W.

An. 28.350 on plain on line of Secs. 26 & 35 near west end, at a burnt strip of hardwood; 28.335 at corners of Secs. 21, 22, 27 & 28 on a low till swell 10-15 ft. above general level; 28.350 on plain at R. R. Crossing $\frac{1}{2}$ mile north. North of here $\frac{1}{4}$ mile the moraine sets in.

An. 28.310 near corner of Secs. 15, 16, 21, & 22. The moraine has small sharp hummocks along its border and the border runs slightly north of west across the north part of Secs. 21 & 20 and central part of Sec. 18,

Aneroid 28.310 at corners Secs. 10, 11, 14 & 15 T.30N.R.3W on high plain.

There is a plain to the east 20-25 ft. lower. Both are strewn with cobblestones.

An. 28.300 at Gaylord \pm 1343. The border of the moraine runs through Secs. 12 & 2 T.30N.R.3W. The lakes in Secs. 12, 11 & 14 are in basins in the gravel plain. This plain has hardwood timber south of Gaylord and the hardwood generally extends a mile or more south of the hummocky border.

Aug. 18, 1902. 8:00 a.m.

An. 28.340 at Gaylord, 1340'. I take a road SW across Sec. 8, T.30N.R.3W to a school house, an. 28.290. An. 28.315 at a lake near line of Secs. 17 & 18, about 80 rods south of school house. There is considerable pine in a strip 2 miles or more in width running north to south from the Twin Lakes NW of Gaylord to Otsego Lake. Aberoid 28.390 at corners of Secs. 17, 18, 19 & 20. I go west to the town hall near corner of Secs. 14, 15, 22, & 23 T.30N.R.4W across a plain of gravelly sand timbered largely with pine.

Well data

Charles Willys made a well in SE corner Sec. 5, T.30N.R.4W. 130 ft. deep, that was entirely in sand. The well had to be curved as it was dug. Wells 2 - 3 miles west on edge of Antrim County are, in some cases, 200-250 ft. Mr. Willys says there is a level tract from Gaylord west to the county line, but about $\frac{1}{2}$ mile west of the county line hills set in.

An. 28.300 at the Town hall 1 mile east of center of T.30N.R.4W. I go south and soon enter the moraine that lies west of Otsego Lake. This moraine covers the south part of Secs. 26 & 27 and all of Secs. 34 & 35.

It occupies the tract between the head waters of the Manistee and Conners Lake outlet in T.29 R.4W a strip about 3 miles in average width. It is largely timbered with hardwood and has a fertile soil. There is said to be a valley extending from the plain west of the townhall in west part of T.30N R.4W. southward to the head of the Manistee River. Its SE border passes through Sec. 33, T.30N.R.4W and Secs. 4 & 5 T.29 N.R.4W.

Aneroid 28.100 on hill near center of Sec. 3, T.29N, R.4W = 1470'. This is about as high as any point on this range. It has boulders and some till. This range seems to get a little lower toward the south.

Aneroid 28.330 at outlet of Conners Lake on line of Secs. 14 & 23. There is a valley about a mile wide running N-S here, that has a bottom 15-20 ft. above Conners Lake. The range of hills between this valley and Otsego Lake is 100-150 ft. higher than the valley. The valley connects at the north with the gravel plain south of Gaylord.

Aneroid 28.350 at lake in SE corner of Sec. 23 = 1230 ±. There is clay under the valley near this lake. Aneroid 28.170 on ridge west of this lake = 1400 ft. about $1\frac{1}{2}$ miles east of Waters Station; - 28.325 at Waters Station at noon = 1250' ±. The lake west of this station is about 20 ft. lower or 1230' ±. It drains southward to the AuSable.

Aneroid 28.300 at Waters at 1:00 p.m.

Well data

Aneroid 28.140 on ridge a mile east of Waters = 1400 ft. This is flat topped and timbered with hardwood. Geo. W. Gilbert has a well on east side of Sec. 28, 175 ft. James Marlett, on west side of Sec. 27, has a well 175 ft. Neither well has much head of water, but there is a good supply. There is scarcely any clay, the drift being nearly all sand. The altitude is 1375' ±. I go east about to the line of Secs. 25 & 26 to the border of a gravelly plain at Chubb Creek. An. 28.300. There is a gap a mile ± wide separating this range of hills from the one west of North Branch. That range extends north nearly to Chubb Creek east from the bend in Sec. 25 and nearly to the east flowing part of North Branch. I return to Gilberts corners on line of Secs. 27 & 28 and go north along the ridge nearly to Otsego Lake. It holds

an altitude of 1400 ft. and possibly some points reach 1425 ft. as far north as Otsego Lake. The highest part of the range of hills is along the west border overlooking the N.C.R.R. There is an isolated hill 50-75 ft. high on north side of the outlet of Otsego Lake just south of Bagley (Selling Station). Aneroid 28.275 at Otsego Lake, 1280' at 3:15; 28.230 at Gaylord at 5 ;.m.

Water Works - Wells at Gaylord

The waterworks well in Gaylord is 80 ft. deep and there are several private wells of similar depth. Thomas Turner's well, on county line 3 miles south of Elmira on Antrim Co. side, is 250 feet. Sylvester Bailey, a mile farther south, has one 225 feet.

Aug. 19, 1902. 8:00 a.m.

An. 28.380 at Gaylord 1343'. An. 28.440 on lowest points 2 to 3 miles west = 1290 - 1300'. There is a sandy gravel along line of Twps. 30N. & 31N. R.3W with considerable pine. Aneroid 28.400 at SE corner Sec. 36 T.31N.R.4W. Secs. 25, 26, 35 & 36 are nearly all plane and apparently free from boulders. Section 34 has some undulation and the north part of Secs. 32 & 33 have sharp knolls. The ice margin appears to have passed SW near the township line near the corner of Secs. 3 & 4.

The surface is wavy and soil loamy with a few boulders, west from here. Mr. Estelle, S. side Sec. 33, has a well 120 ft. deep that is entirely through sand. An. 28.410 at Mr. Estelle's. An. 28.360 on high tableland near corner of Secs. 5 & 6 and middle of S side of Sec. 32. There are a few small boulders here and the soil is loamy.

Well data

Aneroid 28.540 at Thos. Turners well in NE part of Sec. 1 T.30N.R.5W = 1375'.

The well is 250'(See yesterday's notes)

There is a nearly level tableland here with loamy soil and a few small boulders.

Well data

Aneroid 28.350 at Mr. Sylvester Bailey's, NE corner of Sec. 12, where well is 225 ft. The surface becomes broken a mile west from here but is level east. Aneroid 28.400 at corners Secs. 12, 13, 7 & 18. T.30N.Rs. 5 & 4 W. We go west between Secs. 12 & 13. Aneroid 28.370 at corners Secs. 11, 12, 13, & 14. Basins and larger boulders appear in this vicinity.

Aneroid 28.430 at corners Secs. 13, 14, 23 & 24. Wells in this vicinity are about 100 ft. Large boulders are quite common in this region and become more numerous to the west.

Aneroid 28.465 at corner Secs. 14, 15, 22, & 23. Very stony on line of Secs. 22 & 23. There are swales but not hummocks. Aneroid 28.485 at corner Secs. 22, 23, 26, & 27; 28.970 at middle of line of Secs. 22 & 27; 28.500 at corner Secs. 21, 22, 27 & 28. The land is higher in north part of Secs. 21 & 22 than here and also higher about a mile south.

There is some stiff clay on line of Secs. 21 & 28, that first I have seen since leaving Gaylord. Aneroid 28.600 at east edge of plain 2 miles east of Alba; 28.605 at Alba, 1171 ft. A.T.; 28.680 at Mancelona, 1117 ft; 28.700 = 1117' at Mancelona at 1:30 p.m.; 28.470 $\frac{1}{2}$ miles east, at center of T.29N.R.6W. = 1330 ft. Hills $\frac{1}{4}$ - $\frac{1}{2}$ mile south and $\frac{1}{4}$ mile SW are 1350 - 1375 ft. A.T. There is a loose-textured drift sandy loam soil, with a few boulders. The surface is not very hummocky, though a few knolls 10 ft.± occur and an occasional larger one. An altitude of about 1350 ft. is reached near the corners of Secs. 13, 14, 23 & 24, (An. 28.450) and there are fewer sags and depressions east from here than west. The soil seems less sandy but as it is timbered, while that to the west has been cleared, it is not so dried out. An. 28.470 = 1330 - 1335 ft. at township line. The timber thus far has had very little hemlock or pine, but in Secs. 18 & 19 T.29N.R.5W., hemlock is a conspicuous tree. I see no pine in these sections or in 17 & 20.

An. 28.490 where road forks off SE into Sec. 20. The surface is slightly uneven in Secs. 17, 18, 19 & 20 with oscillations of 20 ft. \pm . Scattering pines appear about $\frac{1}{2}$ mile farther east or near the corners of Secs. 16, 17, 20 & 21. Near the center of this township I pass a small lake on south side of road. It is in a basin 60 - 65 ft. deep. An. 28.550 at lowest point on road on N side of lake. The lake may be 40 ft. lower; 28.500 on upland east of the lake basin. Thus far there have been only scattering pines. From here east to the Manistee, there is a flat tract with scarcely any undulation but with a perceptible eastward descent. The aneroid changes from 28.500 to 28.540 in the $2\frac{1}{2}$ miles to Ward's railroad (Detroit & Charlevoix R.R.) There is only a slight descent to the river. An. 28.590 at Manistee River. Aneroid 28.570 on the west bank between river and Ward's R.R. The east bank is lower but not swampy, there being heavy pine on each bank. Pine of inferior size remains in the timber for 2 miles west of the railroad but the large pine and hemlock timber has been culled out.

I return by same road to Mancelona. An. 28.550 at old railroad grade near corner of Secs. 13, 14, 23 & 24. In secs. 14 & 23 the hardwood, as well as the pine and hemlock, have few large trees, most of them being a foot or less in diameter.

Aneroid. 28.590 at lake near center of township; 28.540 on road at sag on north side where it read 28.550 when I came out; 28.500 on west side of lake basin; 28.480 where SE road leads off into Sec. 20; 28.450 at township line. I saw no boulders in T.29N.R.5W but there are cobblestones in the sandy loam of the western part, and in Secs. 13 & 24 T.29N.R.6W. An. 28.440 near corner of Secs. 13, 14, 23 & 24 on the flat tableland. Large boulders seems to extend no farther east on this road than Secs. 14, & 23. Those Sections have a good many in the west half. The surface is hummocky where they occur, but the highest points are no higher than the cobbly tableland to the east.

Aneroid 28.700 at Mancelona, 6:15 p.m., 1117 ft. The east border of the plain here has basins in it and there are boulders on the slope nearly down to the plain east of this village.

Aug. 20 7:00 a.m.

An. 28.640 at Mancelona, 1117 ft. An. 28.590 on terrace east of Antrim = 1160'; 28.610 on terrace at a school house at corner Secs. 28, 29, 32 & 33, 1145' \pm . This terrace extends nearly $\frac{1}{2}$ mile east of here. There is a range of hills in the west part of Sec. 32 and SW corner of Sec. 29, standing 50 - 75 ft. above this terrace, or over 1200 ft. This terrace has basins in it. The soil is a sandy loam and there are a few small boulders in it. This terrace, or plain, extends south into Kalkaska County in Secs. 4 & 5, T.28N.R.6W., It then runs SW across sec. 8 to Rapid River. The range of hills west of it extend at least across Sec. 5 & 6, and may run some distance into Sec. 7. I go south on line of Secs. 4 & 5, 8 & 9, 16 & 17, 20 & 21. T.28N. R.6W. On the south part of the line of Sec. 8 & 9, the road rises to the high tableland.

Aneroid 28.500 at corner of Secs. 8, 9, 16 & 17 = 1240'. There is a bouldery till here and hummocky surface. Aneroid 28.480 on knoll 100 rods S of Sec. corners = 1260'. Large boulders on line of Secs. 16 & 17, 20 & 21 in a basin 15 - 20 ft. below bordering hummocks.

Aneroid 28.520 - 1225 \pm at Town Hall of Gold Springs Twp. E Side sec. 20. There is considerable till in Secs. 20 & 21. Aneroid 28.530 at corner Secs. 20, 21, 28, & 29 on general level of uplands = 1215 \pm ; 28.600 in swamp on line of Secs. 28 & 29 that constitutes the head of Boardman River = 1150 \pm There is a morainic tract in Sec. 28 between the head of Boardman River and Manistee Lake. Aneroid 28.550 at corner Secs. 28, 29, 32 & 33 on general level of moraine = 1200. There is considerable till here. There are knolls 15-30 ft. high. A few boulders occur.

Well Data

Bert Thompson, in SE corner Sec. 20, has a well 130 feet. There was some clay below, as well as at, surface. Mrs. Graham, on east side of Sec. 20, has one 130 ft. Mrs. B. B. Phelps, in SW part of Sec. 33, has well about 75 feet, and there are 3 others near there of similar depth. Will Burnhouse well, in Sec. 5, T.27N.R.6W, is 166 ft. This well and others are mostly through dry sand. There are then beds of clay.

(Morris Ray - well driller - Kalkaska)

The deepest well near Kalkaska is 4 miles south and 1 east. It is 207 ft.

(M. N. Lakness - hardware dealer at Kalkaska - drilled.)

Aneroid 28.510 at summit near south end of line of Secs. 32 & 33; 28.525

at S end of line at Phelps School house. I turn east on town line and drive north $\frac{1}{2}$ mile to a plain that borders Manistee Lake. An. 28.550 = 1200±.

It has a few shallow basins. An. 28.565 at lake outlet = 1185. There is a plain a mile east of Manistee Lake standing but 20 ft. above the lake. East of this is a range of hills that leads from south Twin Lake south through Secs. 24, 25 & 36 along west side of Pickerel lake and outlet. It is only $\frac{1}{2}$ mile wide. An. 28.560 on crest on line of Sec. 36 and Sec. 1. The ridge extends some distance south into Sec. 1. Aneroid 28.560 at outlet of Pickerel Lake on line of Secs. 1 & 36. There is a plain about a mile wide along this outlet. East of it is a high morainic tract that extends to the Manistee valley. The ascent to it begins at east part of line of Secs.

6 & 31. Aneroid 28.440 on crest on line of Secs. 5 & 32 = 1275-1300; 28.530 on a flat tract less than $\frac{1}{2}$ mile wide, probably near corners Secs. 4, 5, 32 & 33; 28.375 on hill near corners of Secs. 3, 4, 33 & 34.

I go north between Secs. 33 & 34, 27 & 28 rising to a point in south part of Secs. 27 & 28 where aneroid reads 28.420. The hills are rather gravelly

but have few boulders.

Aneroid 28.550 - 555 on lowland tracts near corners Sec. 21, 22, 27 & 28.

Aneroid 28.555 at Blue Lake at 11:20; 28.560 at 12:45 = 1190 \pm I go west on road to Twin Lakes past south side of Squaw Lake. There is a range of hills on the east and north sides of the lake. The lake is near center of Sec. 9. I rise to high land just before coming to Big Twin Lake. An. 28.450.

Aneroid 28.550 at Twin Lakes = 1200'. Nearly plane with aneroid 28.516 - 520 for $2\frac{1}{2}$ - 3 miles west from Twin Lakes. Moraine with boulders sets in near corners of Secs. 9, 10, 15 & 16. Sharp hummocks in Secs. 9 & 16. An. 28.450 on summit on road 80 rods east of corner of Secs. 8, 9, 16 & 17 = 1290' \pm ; 28.510 at Section corners = 1240'.

Aneroid 28.540 at edge of upland about 80 rods east of corners of Secs. 7, 8, 17 & 18.

Aneroid 28.620 at corner Secs. 7, 8, 17 & 18 on a gravel plain or terrace; 28.610 on plain $\frac{1}{2}$ mile east of Westwood; 28.660 on lower plain $\frac{1}{2}$ mile NE of Westwood at level of Westwood Station, 1088 ft. There are deep basins on this lower plain north of here in Secs. 30, 19 & 20. T.29N.R.6W. Some are 50'. Aneroid 28.640 at Mancelona, 1117'. The supervisor of Mancelona Twp. informs me that there is a tract with numerous basins leading from Sec. 19, T.29,R.5W. eastward through Secs. 20 & 21 to the lake I passed yesterday on the drive east from Mancelona. There are also basins in Secs. 10 & 11 of that township. The morainic tract with boulders and hummocks, covers Secs. 5 & 6 and parts of Secs. 4, 7 & 8. The range of hills that runs north along west side of Manistee River in T.28,R.5W terminates within $\frac{1}{2}$ mile south of the county line in Secs. 2. The range running NW from Blue Lake extends nearly to the county line between Starvation Lake and Crooked Lake. This hilly tract that has its terminus near Starvation Lake runs south nearly to the Manistee River in a strip almost 3 miles wide in Twp. 28N. & 27 N., R.5W. It passes east of

Bear Lake.

I took train from Mancelona to Kalkaska after dark so made no observations.

Aug. 21, 1902. 7:15 a.m.

An. 28.810 at Kalkaska = 1018'. I drive north 3 miles making a gradual rise to middle of line of Secs. 4 & 5. An. 28.785. I here find a bank 10-15 ft. high running NE-SW marking the SE edge of a terrace cut in the gravel plain. I turn west on the township line and descend near middle of line of Secs. 5 & 32 to a terrace 30 ft. lower. An. 28.835. The bank at edge of this terrace trends NE - SW across Secs. 5 & 6. The west side of this lower terrace passes near the township corners, Twps. 27N & 28N. Rs. 7 & 8W. I turn north to Rapid River Valley on line of Secs. 31 & 32, T.28N.R.7W. descending through a bouldery hummocky slope that probably marks an ice margin. An. 29.015 at School house on low plain on river near middle of west side of Sec. 31. Aneroid 29.015 at switch on Pere Marquette R.R. in Sec.31; 29.080 at bridge on Rapid River in Sec. 30. High bluffs border the river from Sec. 31 northward that are strewn with boulders. The ice margin comes to the river on Secs. 32 & 29. The margin passes north near the line of Secs. 29 & 30 along the east bluff of Rapid River. An. 28.825 at corner of Secs. 19, 20, 29 & 30. at the east edge of moraine. The border trends NE from here and the moraine rises about 20-25 ft. above the plain. The moraine extends into the NW part of Sec. 21 and SW of Sec. 16, but Sec. 9 and east part of Sec. 8 are on the plain. The moraine crosses the NW part of Sec. 4 in a NE - SW course. An. 28.800 at corner Secs. 8, 9, 16 & 17; 28.790 at corner Secs. 4, 5, 8, & 9 on sandy plain. Knolls in the north part of Sec. 4 rise 25 feet or more above this plain. I go west on line of Sec. 5 & 8 and enter the moraine near the middle of the section line. Its crest is almost at the border and at same altitude as the plain, an. 28.780.

There is a big descent to the west through this moraine. The moraine is very bouldery. An. 29.070 at swamp at west side of Sec. 6. An. 29.060 at NE corners of Sec. 12 in channel. An. 29.060 in same channel at middle of line of Secs. 11 & 12. The channel is 40 rods_± wide and continues SW to Rapid River. It is flat bottomed and bouldery and cobbly and is likely to have been a line of glacial drainage.

Aneroid 29.085 at same channel near middle of line of Secs. 11 & 14.

Aneroid 29.250 at Rapid River in Sec. 14; 29.310 at Rapid City at 11:45.

This is about 610 ft. A.T. There is a flat topped tract back of a group of hills about 1 mile SE of Rapid City that seems likely to be the continuation of the channel. I have traced from Sec. 31, T.29, R.7W through to Rapid River. The hills on north side of Rapid River are close to the stream and extend west nearly to the railroad. South from Rapid City for two or three miles the hills are $\frac{1}{4}$ - $\frac{1}{2}$ mile east of the railroad. The railroad turns west in north part of Sec. 33 and follows the base of the moraine to Barker Creek. A morainic spur runs north from just west of Barker Creek into the space between Round lake and south end of Elk Lake. There is a morainic ridge west of Rapid City on west side of Torch River. Aneroid 29.320 at Rapid City at 1:00 p.m. I go south along east edge of this sandy plain covered by Lake Algonquin to the SE part of Sec. 28, T.28N, R.8W. I then enter the moraine on road near line of Secs. 33 & 34. An. 29.220 at Grange Hall in west part of Sec. 34, at base of steep morainic hills.

Well data

John Morrison, on south side of Sec. 34 on high part of moraine, has a well 227 feet. Altitude 970 ft. Aneroid 28.910 at well.

I continue SE $\frac{1}{2}$ mile then go east into Sec. 2, reading on summit in west part of Sec., An. 28.900. This is at about the level of the gravel plain south of here. Wells in this vicinity get water at 40 - 60 ft. The aneroid reads



28.890 on gravel plain on line of Secs. 11 & 12. There is a depression between this and the moraine in south part of Secs. 1 & 2 where it reads 28.950. There is a chain of basins in a trough in Secs. 13, 14, 23, 22 & 21. Aneroid 29.000 at lake by town hall in a basin about 60 ft. deep; 28.880 at Kalkaska. The chain of basins leading from Sec. 13, and the lake at the town hall are 50 - 60 ft. below the gravel plain, but there are places between the basins that are only 20 - 30 ft. below the plain. This basin tract is but little more than $\frac{1}{4}$ mile in width. There are numerous deep basins in Secs. 19, 20, 29 & 30. Wilson Tp. (T.27N.R.8W.)

Aug. 22, 1902. 7:15 a.m.

Kalkaska, Mich. An. 28.960 = 1018'. I go north a mile and take road east through a sandy plain, crossing Boardman River on line of Secs. 11 & 14, and reaching the moraine near township line. An. 28.930 at Boardman River. An. 28.920 at east edge of plain. Where the road rises into the moraine there is a curious arrangement of till and assorted.

The beds of sand and gravel under the till, as well as above, dip eastward at an angle of $30^{\circ} \pm$. The till is of reddish color and very sandy.

Aneroid 28.750 at summit on road about 80 rods east of corner of Secs. 7, 8, 17, 18, T.27N.R.6W.. There is a plain from here east that is nearly free from boulders. Boulders are numerous on the slope of the moraine to the west. The moraine has knolls 20-30 ft. or more in height. An. 28.780 on plain near corner Secs. 8, 9, 16 & 17. There is a basin 40 ft. deep at the corners. It is the only deep basin I have seen on this plain. There are shallow saucer-like depressions 10 - 15 ft. deep covering several acres in some cases. Small stones 6 - 8 inches in diameter are numerous, but I see no large boulders in this section. I go south past the town hall. An. 28.790 at town hall in NE corner Sec. 20.

Well data

Wells in this vicinity are about 50 feet deep. They penetrate normally 2 - 4 ft. of earthy material that makes the rich soil of this region. Below this is white sand. Secs. 20 & 21 are level and much of Sec. 28, but 29 and east side of Sec. 28 are morainic with knolls and ridges 20'± in height. This moraine is reported to run south between swamps through Secs. 29, 31, & 32, 5 & 6. An. 28,780 at corner of Secs. 20, 21, and 28, and 29 on plain. I here go east. There is a gradual descent of about 15 ft. in the first half mile then a rapid descent of 30 - 35 ft. to a swamp on east part of line of Secs. 21 & 28. An. 28,840 at swamp. There is a rise of 8 - 10 ft. near corner of Secs. 22, 23, 26 & 27 to a sandy plain. An. 28,830. Aneroid 28,810 on west bluff of Little Manistee River, line of Secs. 24 & 25. An. 28,830 at river. An. 28,700 on ridge in NE part of Sec. 25. The slopes of this ridge are very sandy and I see only a few small stones, no large ones. From here I descend, within $\frac{1}{2}$ mile, to a pitted plain. An. 28,750 at general level of the plain at place where two narrow gauge railroads cross near corner Secs. 19, 20, 29 & 30 T.27N.R.5W. This plain extends north to Bear Lake in Secs. 17 & 20, and leads down Black Creek to the Manistee River. There is a low tract extending east from it into Sec. 27, T.27N.R.5W. South from this low tract there is a moraine in Secs. 35, 34, & 33, T.27N, and Secs. 3, 4, 8, & 9, T.26N.R.5W. It rises 125 - 175 ft. above the Manistee River, or 1225 - 1275 ft.± A.T. It has some very sharp knolls. It rises steeply above the plain south of it as if that plain were a valley of erosion. The plain along the Manistee is fully 100 ft. lower than the pitted plain when I crossed it south of Bear Lake, and may have been cut down nearly that much. From the moraine north of Manistee River in T.27N.R.5W, I had a view of a prominent moraine south of the river in south part of T.26,R.5W.

Aneroid 28.880 at Manistee River at Wards bridge at 11:30 a.m.; (In Sec. 11, T.26,R.5W.) 28.860 at 12:30 a.m.

Aneroid 28.795 at Little Manistee River at 4 p.m. where it read 28.830 at 10:00 a.m.; 28.790 in swamp 2 miles west; 28.725 on high plain 1 mile west; 28.710 on ridge 80 rods south. Aneroid 28.750 at corner Secs. 28 & 29, 32 & 33. Only northeast part Sec. 29 is morainic. Aneroid 28.780 in swamp on line of Secs. 30 & 31; 28.740 on moraine, corner Secs. 25, 26, 35 & 36; 28.725 at corner Secs. 26, 27, 34 & 35; 28.840 at corner Secs. 22, 23, 26 & 27 near north edge of moraine. Aneroid 28.900 in swamp 1 mile S of Kalkaska; 28.915 at Boardman River at Kalkaska above the dam, only 2 ft. below level of swamp; 28.915 at Kalkaska Station. There is a group of sharp morainic hills in Secs. 12 & 13 & 14 T.26N.R.6W., rising 150 ft. more or less, above the Manistee. It seems to be an isolated group and is probably a continuation of the range that follows the north side of the Manistee in T.26N & 27N,R.5W. The range along east side of Little Manistee, however, comes down to a swamp near the township corners only $1\frac{1}{2}$ - 2 miles north from this group of hills, so this group may constitute the continuation of that range. There is another isolated group of hills west of the Little Manistee swamps in Secs. 8, 9, 16 & 17. T.26N.R.6W. that probably belongs with one of these moraines. A small tract in Secs. 28 & 29 T.27N.R.6W is morainic and boulder strewn-knolls 25 ft.± high. It is out of line with any of the moraines. The great swamp in south part of T.27N.R.6W and south from there along Little Manistee River is a puzzling feature, for it stands so much below the gravel and sand plain on the west and north. It looks like a great basin rather than a valley of erosion. Its border, where I crossed in Secs. 21 & 28, rises 40 ft. above the swamp. On my way back to Kalkaska I mapped the north border of the

moraine that lies SE of Boardman River.

Aug. 23, 1902 - 7:00 a.m.

An. 28.970 at Kalkaska - 1018'. I go south and come into a bouldery swamp a mile south of the river. The boulders are in sand and gravel. Knolls set in $\frac{1}{2}$ mile farther south, but the surface is nearly all plane for $1\frac{1}{2}$ miles farther. Aneroid 28.940 at corner of Secs. 28, 29, 32 & 33; 28.040 at township line, corner Secs. 32, 33, 4 & 5. The sharp moraine sets in $\frac{1}{4}$ mile south from this corner. From here the north border of the sharp moraine turns westward to Crofton and is reported to be just east of the G.R. & I.R.R. from Crofton to South Boardman. An. 28.840 at corner of Secs. 4, 5, 8 & 9, T.26N.R.7W. An. 28.800 on hill on line of Secs. 8 & 9, 100 rods east. There are shrp knolls 30 - 50 ft. high in this vicinity thickly strewn with large boulders.

Aneroid 28.785 on next hill $\frac{1}{2}$ mile farther east; 28.800 at corner Secs. 3, 4 9 & 10 on slope west of high ridge that runs southwest from Sec. 3 across corner of 10 into 9.

Aneroid 28.740 - 1245 feet on high ridge 60 rods west at R. L. Scofe's residence.

Well data

A well here is 207 ft., and one in hollow 40 rods west is $174\frac{1}{2}$ feet. It has 13 ft. of water. Eli Hill, in SW corner sec. 10, has a well over 200 ft. deep. Aneroid 28.860 on plain east of this moraine at corner of Secs. 2, 3, 10 & 11. The SW part of Sec. 11 and NW of Sec. 14 are morainic, but east from there is a swampy plain. Aneroid 28.810 at corner Secs. 10, 11, 14 & 15; 28.860 in swamp 120 rods east of these corners.

Aneroid 28.880 at corner of Secs. 14, 15, 22 & 23 on a sandy plain. I left the moraine 80 rods north of this corner. It keeps north of line of 15 to 22. Aneroid 28.900 at edge of moraine at Lodi, corner Secs. 16, 17, 20 & 21. The moraine is $\frac{1}{2}$ mile north of here. The well at post office is 27 ft.

The NW part of Sec. 21 and SW part of Sec. 16 have a weaker morainic topography than the rest of Sec. 16. Knolls in the center and west parts of Sec. 16 are 50 ft.+ , while these are only 10 - 15 ft. In Sec. 19 there is a slope southward from the moraine into a swampy tract.

An. 28.870 at corners Secs. 17, 18, 19, & 20. There is a pitted gravel plain bordering the south half of line of Secs. 19 & 20, but the north half is on a moraine of gentle type. Aneroid 28.900 at corner Secs. 19, 20, 29 & 30; 28.900 at town line at corner Secs. 19, 30, 24, & 25, on gravel plain. Only the SE part of Sec. 24 is on the plain, the rest being morainic. The border crosses the line of Secs. 24 & 25 $\frac{1}{2}$ mile west of town line, and crosses the NW corner of Sec. 25 and SE part of Sec. 26, passing just north of Birch Lake. I learn by inquiry of residents that the bouldery morainic tract covers Secs. 27 & 28 and NW part of Sec. 34 and most of Sec. 33 T.26N.R.8W. South from there a sandy plain sets in which extends into the edge of T.25N.R.8W. The moraine covers most of the SW quarter of T.26N.R.8W and runs west from there into Grand Traverse County. I take a road north across the moraine between Secs. 22, & 23, 14 & 15. There is a swamp in Sec. 14 that is nearly as low as the sand plain. An. 29.000. There is a sandy knoll north of it, 20 - 25 ft. high. The east half of Sec. 11 is morainic except at north end. Crofton is on a plain that has a few boulders like that $1\frac{1}{2}$ - 3 miles south of Kalkaska. Aneroid 29.000 at Crofton = 1025 ft. at 11:00 a.m. There is a little hardwood on west side of G.R. & I.R.R. both SW and north of Crofton within a mile of the village that has gentle swells, but the greater part of Secs. 1 and 2 and the NW part of Sec. 11 are level sandy land.

Aneroid 29.000 at Crofton at 11:50; 29.015 at South Boardman. The moraine crosses the road into south part of Secs. 16 & 17 and its border is on north edge of Sec. 19. Southwest from South Boardman I rise into this moraine.

An. 28.950 at line of Secs. 31 & 32 at a switch. There are small hummocks here. Aneroid 29.910 = 1100 ft. near county line. There are swells 10 - 20 ft. higher near here on the crest. An. 28.980 at Fife Lake = 1025'. This is 25 ft.± below a pitted plain. There is a moraine on the SE border to Fife Lake and west border. About $2\frac{1}{2}$ miles from Fife Lake near Copps siding I enter a gravel plain. An. 28.940 at north edge of gravel plain. It is timbered with Jackpine. There is a moraine on east side of the outlet of Fife Lake but the west side has a gravel plain except on the immediate borders of Fife Lake where it is morainic. This gravel plain extends beyond Walton Junction. An. 29.000 at Walton Junction. An. 29.090 at Manistee River bridge 30 ft.± above stream. There is a low plain for $1\frac{1}{2}$ miles± south of the river. The railroad then runs around the east side of a group of hills. About $1\frac{1}{2}$ miles farther south it passes west of a group of hills noted last year from Manton. They extend south for about two miles on east side of railroad. West of the railroad is a nearly plane tract, swampy in part. An. 28.890 at Manton. An. 28.750 at Gilbert Station. An. 28.580 at summit in a cut 20 - 25 ft. deep = 1410'±. An. 28.695 at Cadillac = 1295 ft. I take T. & A.A. R.R. to Ann Arbor. Some reddish till in cuts $1\frac{1}{2}$ - 2 miles SE of Cadillac.

The railroad reaches about 1400 ft. and hills near it are 1475 ft.±
(For notes from here to Ann Arbor see last year's work.) The tract north of Elsie $1\frac{1}{2}$ miles reads only 700 ft. A.T. by aneroid.

Aug. 27, 1902. 9:10 a.m.

An. 29.140 at Ann Arbor R.R. Station in Ann Arbor. I take train to Ann Pere. The plain north of O'Hara's is, by topographic survey, 934. Northfield Station is 952 ft. Whitmore Lake Station is 903 ft. County line road is 908'.

Aneroid 29.050 at Ann Pere crossing.

Aneroid 29.130 at Lansing t MC & PM Depot.

Aug. 28, 1902. 5:30 p.m.

An. 29.160 at Lansing at MC & P M Station. Take train ~~for~~ Bay City. Aneroid 29.180 at Bath. There is a narrow moraine southwest of this village. There are a few knolls just north of Lansing but between these strips of moraine there is a flat 2 or 3 miles wide with some flags, & swampy places. Aneroid 29.220 at Lookingglass River; 29.215 at Laingsburg.

Some undulating land between Bath and Laingsburg but it is mainly plane, or very gently undulating.

Aug. 29, 1902

An. 29.575 at MC Station Bay City = 587 \pm ft. A.T.