Notebook No. 172 - Leverett

COUNTY

Alcona: 31, 32, 33-37, 38-40, 41-46, 47, 48-53

Alpena: 31, 40-41

Arenac: 16-17, 19-20, 28-29, 32

Bay: 16

Gladwin: 18-19, 32

Iosco: 29, 30, 31, 32, 37-38, 46-48, 53

Ogemaw: 17-18, 20-28, 29-30, 32

Oscoda: 30, 31

OTHER STATES: 1-15

INDEX TO

NOTEBOOK NO. 172

(October 1 to November 9, 1901)

October 1. Ann Arbor to Cleveland, Ohio by rail.

October 2. Cleveland to Ashtabula, Ohio, to Kittanning, Pennsylvania, via Franklin, Pennsylvania.

October 3. West of Kittanning with M. L. Fuller in morning. Near Ford City with Fuller and Campbell in afternoon.

October 4. Trip, Kittanning, East Brady and Parker and return, with Campbell and Fuller. Conclusions as to the Parker Oxbow.

October 5. Examination each side of Allegheny Valley below Kittanning. Evidence of two old fluvial plains at 900 feet ± and 980 feet ±. Crooked Creek has 900 -- best developed. The 980 shows well back of Kittanning on west side and near North Buffalo.

October 6. (Sunday) Examined each side of Allegheny just above Kittanning.

October 7. Gravel on west side above Kittanning to Red Bank.

October 8. Red Bank to East Brady on east side of valley. Parker to Emlenton on west side.

October 9. Return to Ann Arbor, Michigan.

October 11. Ann Arbor to Bay City by rail.

October 12. Bay City to West Branch, Michigan.

October 13. Examined country south of West Branch.

October 14. Examine southeast of West Branch to Prescott.

October 15. Examine northeast of West Branch to Lupton.

October 16. West Branch to Sterling and Omer and East Tawas.

October 17. East Tawas to Lincoln and Harrisville.

October 18 and 19. Notes from County Supervisors at Harrisville and preparation of road map.

October 20. Drive with J. H. Killmaster to Greenbush, Mikado, and Killmaster. Gas wells, etcetera.

October 22. Trip, Harrisville to Hubbard Lake with J. H. Killmaster and D. W. Brooks. Copper nugget at Lincoln.

October 23. Trip to Alpena.

October 24. Trip, Black River to Hubbard Lake and Goodsell's.

October 25. Trip, Goodsell's to Elmer's, Alcona, Harrisville and Mikado.

October 26. Trip, Mikado to Bamfield and Thompson's with Gregory.

October 27. Thompson's to AuSable with Gregory. Wells.

October 28. AuSable to Indian settlement, Mikado, Lincoln. Gas southwest of Mikado.

October 29. Lincoln to Curran.

Miscellaneous: Well data, etcetera, taken from back of notebook.

NOTE: The following dates are listed in index, but there are no data on them in this notebook.

October 30. Trip northwest of Curran and then to Vaughn.

October 31. Vaughn to Killmaster and Harrisville.

November 2. Harrisville to Lincoln and East Tawas.

November 3. Trip with Gregory around East Tawas.

November 4. East Tawas to Whittemore, Bay City and Lansing.

November 5. Lansing to Ann Arbor.

November 9. Ann Arbor, Michigan, to Chicago, Illinois.

October 1, 1901. 11:35 a.m.

I take train at Ann Arbor for Toledo, Ohio, and on L. S. & M. S. to Cleveland. Stop overnight at Cleveland.

October 2, 1901.

Continue on L. S. & M. S. to Ashtabula and then to Franklin, Pennsylvania. It is old territory with numerous notes as far as Ashtabula. Aneroid 28.990 at crossing of Nickel Plate and L. S. & M. S. in west part of Ashtabula; 28.930 on plain south of creek in an old glacial channel south of the first till ridge. The ridge is probably 30-40 feet above the channel. In 1/2 mile or so I leave the flat channel and pass through a swell and sag till tract -- swells 10-25 feet or more in height. The railway cuts several and shows a stiff clayey till. There are very few large pebbles in it and few surface boulders.

Aneroid 28.220 at a flat tract 1/2 mile ± just south of where double track ends at Plymouth telegraph station. Probably this is the channel that leads from Ashtabula Creek at Plymouth west-southwest past Austinburg. Aneroid 28.780 at flat tract at Mill Creek. Low swells in the till ridge north of this creek, 5-10 feet ±. Scarcely any drift swells south of the creek to Jefferson. Aneroid 28.920 at Jefferson. There is not a drift swell 10 feet high for several miles southeast from Jefferson within sight from this railroad. Shale outcrops nearly up to level of the plain in many of the stream bluffs. These streams have shallow valleys 10-25 feet deep. Aneroid 28.680 at Dorset. I am still on the plane surfaced drift. The plane surfaced drift extends to within a mile of Leon. A swell and sag moraine there sets in with swells 10-20 feet high. Aneroid 28.540 at Leon. This is near the continental divide. The moraine here is a very inconspicuous feature, but, as noted in my studies in 1890, there are places

where it becomes conspicuous both east and west of this railroad. There is a till ridge in north part of Andover, 20 feet ± in height, that trends northeast-southwest and is the most conspicuous drift aggregate in this belt close by the railroad. Aneroid 28.560 at Andover.

There are occasional swells on the east slope of Shenango Valley along this railroad, but much of the drift is plane surfaced and it is a thin deposit. Aneroid 28.640 at Jamestown at crossing of E. & P. railroad. A high rock upland north of the railroad from Jamestown to within a mile of Osgood. Lower upland south of railroad, but it seems to have a rock nucleus. There is no evidence of a pre-glacial valley along this line, but probably water drained east and west through little ravines and the Little and Big Shenangos. Aneroid 28.540 at summit between Jamestown and Osgood; 28.630 at Osgood at crossing of Erie railroad, but 20-25 feet above that track.

A very large valley leads north from here to the Pymatuning swamp, as noted in 1890 and 1893. It comes in along Little Shenango from the east-southeast. It is a deep trough with high uplands each side that have rather smooth slopes. The average width of the flat bottom is fully 1/2 mile. Drift knolls become conspicuous about a mile west of Hadley. Aneroid 28.570 at Hadley. Part of the village is on a beach of drift, 50 feet ± above the railroad. There is considerable drift in knolls from here up to Sandy Lake at Stoneboro. Aneroid 28.440. This lake drains to the Allegheny but, as noted in 1890, it seems to cross a column near Raymilton. The creek there is in a rock gorge less than 20 rods wide. Aneroid 28.470 at Raymilton. I leave the Wisconsin drift near Raymilton and am in the older drift farther east. Aneroid 28.540 at Polk. This is on the old north flowing west Sandy Creek that crossed French Creek where this railway

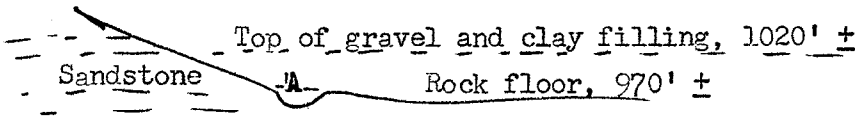
comes into French Creek valley above Franklin a few miles. Aneroid 28.450 at the railway switch and summit northeast of Polk 2 or 3 miles. There are rock ledges in the cuts before I reach this summit and there is only 100-120 rods here between high bluffs. Till is banked against the south bluff of French Creek just below where the railway comes to the creek for 1/2-3/4 mile. It is of blue color in lower part. Farther down the bluff is rock.

Aneroid 28.610 at Franklin at 2:15 p.m.; 28.630 at the Allegheny Valley station. I go east onto the uplands and find a single well-rounded sandstone pebble at 1425 feet A.T. by a north-south stone wall fence along a lane that leads south from the Salem road. It is 4-5 inches in diameter. The hills on each side are above 1450 feet, but this is in a sag near the head of northward drainage into the Allegheny. I take train in the evening to Kittanning. See notes made in 1893 on the Allegheny Valley. I noticed a ledge of thick-bedded sandstone in vicinity of Kennerdell at top of bluff that may be responsible for the boldness of bluff.

October 3, 1901.

932 at top of rock back of Ford City by level from top of shale up to beach that is 964 feet; 925 feet at north-south road in ravine north of Manorville Church. John H. Rice, West Kittanning, says that the wells on the terrace west of river opposite Kittanning, are about 35 feet on the level that is above the 1,000 foot contour, and do not reach rock. They are through a sticky clay from top down to a sand bed near the bottom. There are a few pebbles in the clay. There are occasional little streaks of sand and pebbly material, but much of it is not pebbly. I find exposures on the slope toward a ravine west of West Kittanning that show the clay to carry large blocks of local rock as well as scattered pebbles

of all sorts. The red Medina sandstone is conspicuous here, but I see no granite or greenstone. The drift pebbles west of this ravine are conspicuous up to the 1020 foot contour. They do not seem to have much higher altitude. Where deposited, the rock floor beneath these pebbles, near this ravine, was above the 980 foot contour, or a few feet higher than in West Kittanning, where it stands about 970 feet A.T. The ravine is now cut into rock, as shown at "A".



In the afternoon, M. R. Campbell, M. L. Fuller and I go on electric car to Ford City and then examine the high gravels east and south of there to the limits of the quadrangle. The rock cliff rises to 930-935 feet along the front of the terrace and the gravelly filling carries the level up to 965 feet A.T. The rock floor becomes lower in passing east 1/4 mile, being about 900 feet A.T., as shown by the valley of Tub Mill Creek and a creek that leads north from the terrace. There is a sag or old river channel running near the east bluff that stands 940 feet, where not cut by recent erosion, and in this sag the rock is only about 900 feet. There is considerable gravel of medium coarseness in this tract east and south of Ford City. It contains a great variety of erratics, greenstone, granite, quartzite, etcetera. Most of the material is badly weathered, but we find an occasional rather fresh looking rock. I saved one specimen of red granite that is so fresh as to show a glistening of the glaciated face.

On the narrow ridge on north side of Crooked Creek and south of Tub Mill there is shale nearly to top, but it is capped by a few feet of gravelly material which reaches the 1040 foot contour. It has fewer pebbles of distant derivation than the lower tracts, but we see a few Medina sandstones and a few quartzite pebbles. The pebbles on this higher

tract are all small, seldom over 2 inches in diameter. Those on the lower tract are often 4-5 inches, not including local slabs.

The lower tract has a clay capping several feet thick. It is well shown on the flat north of Manorville Church at an altitude above 980 feet, but on this ridge at 1040 feet, the pebbles do not have much clay on them. The rock under the 980 foot beach is about 970 feet, or in close agreement with the beach west of Kittanning, and is the broadest flat near Ford City. We trace the upper limit of pebbles from the Church northwest past Ford City and find that it is above the 1020 foot contour and may reach 1040 feet all the way. (See notes October 1 and 2, 1893 for this same region.)

October 4, 1901. 8:30 a.m.

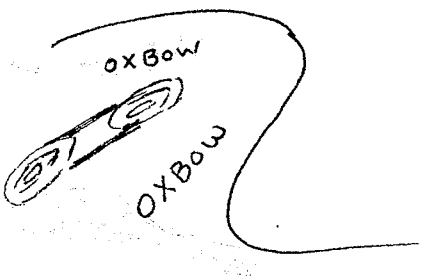
Take train from Kittanning to East Brady with Campbell and Fuller. Aneroid 29.125 = 852 feet at bench mark of U.S.G.S. on bridge abutment in East Brady -- same level as depot platform, but 1½ feet ± above rail. We take road past Queenston up a ravine. Queenston post office is very nearly 1200 feet by three barometers. The summit at head of the ravine, where a road comes in from south-southwest, is 1475 feet by 3 aneroids. The hills nearby are 50-75 feet higher.

At forks by school house about 2 miles from Monterey, 1465 feet. This overlooks the Allegheny to the northeast. Aneroid 28.820 = 1120 feet where pebbles set in; 29.115 at Allegheny River at Monterey = 850 ± feet A.T.; 28.900 at top of rock shelf on north edge of Monterey; 28.760 at top of gravel = 1150 ± north of Monterey; 28.460 at summit at ridge north of Monterey at forks of road = 1475 feet by 3 barometers; 28.900 at top of rock in the old amphitheater bend southeast of Parker; 28.830 at top of gravel north side of the creek that runs through this amphitheater on a

flat that has a silt capping; 28.750 at top of a gravel bar on south side of rock ridge south of south limb of "Parker Oxbow". This bar is 20 feet ± higher than a sag east of it next to the bluff, and runs out like a spar from the point of high bluff north of here. It has no silt capping nor does the bar north of Monterey.

I seems probable to Campbell and me that this was built up by a current that struck slacker water on the lee side of the bluff and there dropped its load, as indicated by green strip in diagram.

There is no summit of gravel along the face of the bluff back of this bar such as should be present if the filling had reached the bluff. Possibly the high strip of gravel from Manorville Church west along top of the ridge between Crooked Creek and Tub Mill is a bar at south edge of the current. The test of this will be found in the condition of the valley of Crooked Creek south of the ridge. If it contains glacial gravel, the water must have passed across this ridge to deposit it. We find a bar on the west end of south limb of the Parker Oxbow that was built by a current that ran east from the west end of the rock ridge. It is built up to a height a few feet (10-15) above the lowest part of the rock ridge north of the bar. The green color shows how gravel is distributed in the oxbow.



We find that evidence is pretty clear that the Parker Oxbow is the channel of a large stream, presumably the Clarion. It came from the present mouth southwest past Parker to mouth of Bear Creek and then turned abruptly northeast on north side of the ridge enclosed by the channel then returned through the south limb and swung around the point into the amphi-theater like recess on east side of valley. We think the abandonment of the oxbow was due to the stream having cut off the narrow ridge opposite mouth of Bear Creek and thus shortened its course. There is a large recess on the west side of the river from the mouth of the Clarion down to the mouth of Bear Creek in which the stream made its curve to double back into the oxbow. The rock platform at the ends of the channels that form the oxbow seems to be about 175 feet above the present stream (by aneroid). From mouth of Bear Creek, we return to East Brady across uplands, and take train back to Kittanning in evening.

October 5, 1901. 9:20 a.m.

I start down the east side of Allegheny valley from Kittanning and find that north of Garretts Run, on a point between a north tributary of the Run and the river, gravel is found in a knoll (not shown on map) that is about 1020 feet. Along the river face, near south end of this point, shale appears at about 950 feet. In the bluff back of Manorville, rock reaches 920 feet back of a row of houses. Springs issue from the base of the gravel at this level. The gravel nearly reaches 1,000 feet, the 980 foot contour being on the slope a few feet (10-15) below top of terrace. On the east side of this terrace, where it overlooks Garretts Run, the rock is 960 feet ±. Across Garretts Run, on a beach that the creek curves around from a west to a north course, there are only scattering pebbles, and the rock beach is above 1,000 feet. The pebbles show best between 980

and 1,000 feet near top of the face of the bluff. The pebbles occur on the south bluff, east of the bend for only a few rods to a point about south of the intersection of the Garretts Run road with one that comes in from the southwest. Around the base of the hill south of Garretts Run, I see no pebbles above the 1,000 foot contour. On the slope south of this hill, they appear at about 980, 1,000 feet and extend about 20 rods east of the bend of road that leads up the ravine south of hill. South of this ravine there is a terrace at about 1,020 feet, but I see no pebbles on the top. They occur, however, at the south border of the terrace at about 1,020 feet and from there south and west past Manorville Church, as noted October 3, the pebbles are quite evident up to about 1,020 feet, and in places, to 1,040 feet A.T.

I go to the Manorville Church and set aneroid at 1,040 feet at contour just south of Church near first residence. I then cross the shale ridge northward into Crooked Creek valley and find that its broad gradation plain is about 950 feet. There seem to be no drift pebbles east of the first ravine west of the road I am on, but west of that ravine they abound. I go west along north bluff of Crooked Creek to the river bluff. Aneroid 29.190 at top of rock on the brow of the river valley; 29.330 at railroad track at mouth of Tub Mill Creek, very nearly same altitude as Ford City Station; 29.370 at the Allegheny River at ferry, south part of Ford City.

There is a rock platform on north side of river west of here at about 900 feet and back of this, a higher one, 980 feet ± that extends back to the creek that enters the river at North Buffalo. There is only a very thin capping of pebbly material on either shelf, there being rock within 10 feet of surface on both of them. Just below North Buffalo, there is a low rock hill that reaches about 940 feet, back of which is a sag that is about 900 feet. This sag may be the old channel of the creek. The stream now runs

up the Allegheny valley instead of down to join it. There is a thin coating of gravel and cobble on this sag and on the slopes of this low rock hill.

Across the river from here there is a remnant of a high base plane, 200 feet ± above the river (see notes in 1893). The northwest bluff is very high for some distance south from the limits of this quadrangle. The southeast bluff is high just below the mouth of Crooked Creek for a mile or less to where the high base plain sets in.

I return to Ford City along the river bank and cross over at ferry. In the north part of this town, there may be a small tract up to the full height of the Wisconsin gravel filling, but it is only a few acres. It rises above the 800 foot contour. There is silty material several feet deep at top and below this, sand and fine gravel. The wells at Ford City are driven 25 or 30 feet through sandy material and get water above the rock.

October 6, 1901. I

I go north a mile to a sag that leads from the bluff of Allegheny River west to the creek that runs south through West Kittanning. It stands just above 1,020, but carries no pebbles, and I think the head end was higher so that no glacial waters crossed here. The river has encroached on this bluff and thus cut back to where the ravine is no higher than the glacial waters reached.

I also examine the terrace on east side above Kittanning and find that a terrace standing above the 1,030 foot contour just south of the bend where river changes from a west to a south course, carries a heavy deposit of gravel and cobble -- perhaps it extends from 1,020 down to

940 feet. Rock outcrops on the face of the terrace at 940 foot contour, but I find none higher. This deep filling is preserved for 1/2-3/4 mile south from the bend, but farther south it is largely removed and there is only a scattering pebble or occasional thin bed of gravel to show its former presence. I found one quartzoze granite on this terrace, near a cemetery, that is about a foot in diameter. This is the largest erratic yet noted in this quadrangle. Usually they are less than 4 inches in diameter.

At Kittanning, rock outcrops on east bank of river 6-8 feet above low water and the river here is against the west bluff. If a deeper channel exists, it is under the city. Wells usually get water above the rock.

October 7, 1901.

I go north along west bluff to the bend and find a terrace capped with gravel on north side of a small west tributary directly opposite the bend. The gravel is conspicuous up to where aneroid reads 29.400 = 1,000 feet ±. The shelf here is only 15-20 rods wide. In a cleared field east of here, they occur up to where aneroid reads 29.385 at base of the steeper slope = nearly 1,020 feet. I continue east across a ravine and find a heavy deposit of gravel on the next point that projects out from the bluff 30 or 40 rods. Its surface is about 980 feet and the rock at front of point is 940 feet. On the next point east, there is a broad flat of 20 acres ± above the 1,000 foot contour. The gravel on it seems to extend down to 940 feet.

East of this is another broad terrace which the new railroad passes on the north edge of, and which runs above 1,000 feet. This has about 65 feet of gravel, as shown by extensive excavations on its west edge,

making the rock floor very nearly 940 feet A.T. There are extensive remnants from here northeast for a mile farther on north side of the river, or to about a mile south of the line of Washington and East Franklin Townships. The width is 1/4 mile or more much of the way from the second point below mount of Limestone River up to directly opposite mouth of Pine Creek. Above here, for 2 miles or more, there is scarcely any of the old gradation plain preserved on either side of the river. Pine Creek has a base plane at about 950 feet A.T. This narrow part is bordered by massive sandstone ledges that probably account for its narrowness. Blocks several feet in diameter line the slope.

On the east side of a small north tributary of the river, about a mile north of the south line of Washington Township, an extensive terrace sets in that has a deep coating of gravel. Aneroid 29.350 at top of gravel = 1,050 feet ±. It is nearly 1/2 mile north of the river and the high shelf here is 100-120 rods wide. This continues to a point directly opposite the mouth of Mahoning Creek before becoming narrower. It is remarkably high opposite the mouth of the Mahoning, the aneroid reading 29.280, or about 1,100 feet at 1:30 p.m. The Rural Valley map sustains this reading. This shelf has apparently a deep deposit of gravel -- 50-75 feet.

There are no remnants on the east side of the river for several miles below the mouth of Mahoning Creek. A mile above the mouth of Mahoning, where the Allegheny turns from an east to a south course, the west bluff has pebbles and a narrow shelf where aneroid reads 29.240, 1,100 feet ±, at 2:00 p.m. There are a few Medina sandstones among a large number of local rocks. This point commands a view up the Mahoning 3 miles ± and the base plane of that valley that far up is below the level of these pebbles. Aneroid 29.560 at the river north of this place at 2:20 p.m. = 800 feet A.T.

The valley is very narrow (1/3 mile ±) and has very high bluffs from this bend up to Rimer. There is a recess where river turns from east-southeast to north-northeast below Rimer where a narrow shelf stands about 150 feet above the river.

Aneroid 29.290 at top of gravel near Riverview = 1020 feet ±; 29.500 at railroad track at Riverview = 830 feet ± A.T. This is on a slope that extends down to about 850 feet. It is peculiar in being where it seems doubtful if it formed the inner curve of the stream. I am told by a man who lives 1½ miles east of Rimer up the hollow that enters at that village, that he has noticed waterworn pebbles there where several ravines come together to form the main hollow. They may be at the level of the base plane in the hollow. It seems to be nearly up to 1,100 foot contour.

About 1/2 mile below Red Bank, a terrace capped with gravel appears on the west side of the river at an altitude fully 275 feet above the stream, or 1080-1100 feet ± A.T. (See notes in 1893). It extends north to the bend of the river at Red Bank. I examine the point of land south of the mouth of Red Bank Creek and find that the flat tract standing 1100-1120 feet A.T. has pebbles strewn over it. I only succeed in finding local sandstones at the top, but on the slope toward the Allegheny River, pebbles of Medina sandstone and quartzite occur up to 1,080 feet A.T. Possibly a careful search will show them to be present at the top. This seems likely from the fact that the sandstones there show about the same degree of weathering as they do where the erratics or glacial materials are mixed with them.

The steep bluff at the intersection of these streams is about 1,000 feet A.T. and the gravel capping is a notable feature from the top down to that level, or 120 feet, but the gravel nowhere exceeds 20 feet so far as I can see by the road exposure. This touches rock on the slope where it

has been graded 8 or 10 feet.

There is remarkably little of the Wisconsin drift above the level of the low stream bank, 25 feet ± above the river, anywhere between Kittanning and Red Bank. In the narrow part from Rimer to the mouth of the Mahoning Creek, the river, in places, spreads out to the full space between the rock bluffs. I walked along a gravel and cobble bar at the sharp bend of the river, 1-1½ miles above the mouth of the Mahoning Creek, and found several granite rocks 6 inches in diameter that have a fresh looking surface. It is probable that they are Wisconsin drift. The narrow part of the valley below Rimer has a massive sandstone in its bluffs that probably causes its narrowness. I stop for the night at Red Bank Junction.

October 8, 1901.

I examine the recess in north bluff, back of Red Bank, but do not find any pebbles. There are pebbles at a height of fully 1,050 feet A.T. on a terrace north of Phillipston on west side of a ravine in an orchard back of the dwelling on 1,040 foot contour. The gravel is several feet deep and contains erratics (quartzites, etcetera). I find no more gravel till I reach the point of upland south of East Brady. There is a knoll south of the main point on a point between a creek that runs west and one that runs southwest which carries gravel at about 1,100 feet. There is rounded material on the main point up to 1,140 foot contour, where road rises from East Brady across it. There are only local sandstone pebbles so far as I can discover on the upper part of the slope, but at about 1,100 feet, I find Medina sandstone pebbles. The gravel is strewn down the slope to East Brady in a thin deposit, as noted in 1893. There is a rock shelf at about 150 feet above river on north side, east of a small

tributary of the Allegheny (see notes 1893). Farther east, there is a sloping point carrying thin deposits of gravel up to about 1,140 feet, as determined in 1893 (and again in 1929).

I take train to Parker at noon to examine again the supposed column above the mouth of Clarion River. A broad shelf near Hillville standing 100 feet ± above river at front and rising to about 150 feet at back side, does not seem to be well developed elsewhere. It is too high for the Wisconsin filling. It was probably an accidental or incidental development in the general down cutting. From Parker I go north onto the old base plane of Clarion River. Its rock floor is 160-175 feet above the present Allegheny, or 1020-1035 feet A.T. It seems to be a little lower near its old west bluff than next to the stream. A part of this base plane has only a few feet of gravel, but west of this wagon road is a tract with a thick deposit, as noted in 1893, that reaches 1,140 feet.

I examined the valley above Foxburg to determine, if possible, the precise location of the old divide. A high ridge comes to the river 1-2 miles above Foxburg. Its south edge is about a mile north of Foxburg. On the east side, there is a precipitous bluff here, but on the west, there is a gradual slope up to about 1,200 feet A.T. on which glacial pebbles are scattered. Upon going a mile up the valley to where the river changes from an east to a south course, this gradual slope disappears and both bluffs are precipitous up to nearly 1,200 feet A.T. (290 feet, by aneroid, above the river). There is a very high ridge on each side which rises quite rapidly with slope of perhaps 30 degrees to 1,300 feet and with slope of 15-20 degrees to about 1,500 feet. Points on opposite bluffs about 1,500 feet high are scarcely a mile apart. West from here there are tracts 1200-1300 feet A.T., extending back 1/2 mile to a mile from the river, and the old base planes on small streams tributary to that part of the valley

seemed to be very near 1,200 feet. If, as seems probable, the column was at the bend about midway between Foxburg and Emlenton, it seems to have been not more than 1,300 feet, that being the top of the steep slope.

I go up to the brow of the north bluff at Emlenton and find its altitude to be 1,200 feet, and 1,220 feet at top of hill where I overlook the upland at northeast side of a cemetery. The slope is so gradual in the upper 45 feet that it may be the old valley slope that preceded the change of drainage. It is nearly as high as the precipitous bluff below here at supposed column. The top of bluff, 1,200 feet A.T., is a little lower than the steep slope above the precipitous bluff at supposed column. From this upland north of Emlenton the river has the appearance of cutting ± through a rock ridge 1½-3 miles below the village. From here toward the northwest, or up the present stream, there seems to be a generally lower tract than this ridge below Emlenton. The bluffs, as noted in 1893, are precipitous from Emlenton up to Brandon to a height of about 300 feet above the stream, and the valley is very crooked. There is a chance, though perhaps not a strong one, that the old divide had shifted from the high ridge to some place farther north before the glacial invasion brought on the present drainage of the Allegheny. This part in which the bluffs are so precipitous, has a thickbedded sandstone in its upper part, much of the way from the supposed divide below Emlenton to Brandon.

While at Parker, I found an oil well being made close to the river bank about 10 feet above low water. It has 50 feet of sand and gravel above the first rock, making the rock floor here 40 feet below the river, or about 800 feet A.T.

I take evening train from Emlenton to Franklin, Pennsylvania.

October 9, 1901.

I return to Ann Arbor, Michigan, from Franklin, Pennsylvania, via L. S. & M. S. to Toledo and T. & A. A. from there.

October 11, 1901.

I go from Ann Arbor to Bay City via Durand on evening train, so made no observations north of Durand.

October 12, 1901. 7:45 a.m.

Bay City,Michigan. At M. C. Station, 590 feet ±, aneroid 29.050. I take train to West Branch. The station at West Bay City is on a low flood plain, 6 feet ± above the river. Immediately back of the station there is a rise of 10 feet ± to a sandy ridge == the Nipissing beach. There are low sandy ridges on this plain on the border of Saginaw Bay, 20 feet or less above lake level. They seldom exceed 8 feet in height and are usually but 3-5 feet.

Aneroid 29.045 at Pinconning; 29.020 at Worth. There seems to be a shore line here, the altitude being several feet lower south than it is north of the station. There is clay at slight depth between the low sandy ridges north of Worth. Much flat surface in vicinity of Standish. Aneroid 29.010 at Standish. There is a steady rise from Standish to Sterling. Aneroid 28.865 at Sterling, 743 feet. There are sandy ridges here, but 1/2 mile southeast of here there is a flat tract with black soil. There are a few boulders on the flat tracts among sand ridges northwest of Sterling, but from Bay City to Sterling, I saw but a half dozen or so. There may be a moraine 1-2 miles northwest of Sterling, for there is some undulation here in the till. The railroad cuts one till swell to a depth of 5 feet.

I cross another till ridge capped with sand about 2 miles northwest of Sterling. The cut in till is 10-12 feet. Aneroid 28.800 in cut = 810 feet. There is a flat tract back of it, extending past Alger. Aneroid 28.830 at Alger = 781 feet A.T. There seems to be higher land about 2 miles west of Alger, possibly a moraine.

Near the county line of Arenac and Ogemaw, I cross a till ridge 20 feet ± higher than bordering plane tracts. Aneroid 28.750 = 860 feet ±. There is a rapid descent to Greenwood Station, aneroid 28.790 = 820 feet; 28.740 at Loranger = 865 feet ±. The drift here is a gravelly sand, looking like beach material, but it seems to be too high for Lake Saginaw. About a mile northwest from Loranger, knolls 30-40 feet high appear, just west of the railroad. They seem to be a spur from a moraine to the west. The surface is nearly plane along and east of the railroad about to West Branch. There are swells 10-15 feet high for a mile south of the town. Aneroid 28.650 at West Branch, 953 feet, at 11:00 a.m. A well at the livery across street from West Branch Hotel, is 180 feet, and is probably the deepest in the village. It is said to have had bits of coal pumped up from near bottom when first made.

October 13, 1901. 8:00 a.m.

Aneroid 28.470 at West Branch Station, 953 feet. I drive south on range line, rising to about 1,080 feet on ridge at corners of townships 2 miles south of West Branch. There is much till here and a few large surface boulders. A few gravelly spots occur. Aneroid 28.450 at railroad crossing on line of Sections 6 and 1 = 951 feet ±. It is undulating east from here in Sections 5, 6, 7 and 8. A hill in southwest part of Section 5 is 50-60 feet. The north edge of Sections 7 and 8 is undulating, and so is Section 1, T.21N., R.1E.

Aneroid 28.480 at section corners 3 miles south of West Branch. I turn west between Sections 12 and 13, Edwards Township, and cross a ravine. Aneroid 28.560 = 825-850 feet; 28.540 at corner Sections 11, 12, 13 and 14, Edwards Township. There are prominent knolls in Section 10 and high country west from there. Sections 11, 12, 13 and 14 are gently undulating till with swells 10-25 feet and a moderate number of boulders. The northwest part of Section 23 is undulating, but the rest is plane and so is Section 24 and south edge of Section 13, and has sandy, gravel soil. Aneroid 28.580 on plain near corners of Sections 13, 14, 23 and 24 = 840 ± feet; 28.610 at Edwards Post Office, northeast corner Section 35, 820 feet ±. Gravelly soil on the plain in this vicinity.

Lewis Hurrell, Section 8, Bourret Township, northwest corner, has a flowing well 33 feet deep. Ed Hays, in north part of Section 8, has one about 30 feet. Ira Hays, in east part of Section 5, has one of similar depth. Henry DeLend, in Section 9, west part, also has a flow. Information by Mrs. A. Nelson. U.S.G.S. bench mark at northeast corner Section 7 at same altitude as well. Wells 2-3 miles north of Edwards Post Office are about 30 feet, but do not flow. Aneroid 28.620 on till tract at county line south of Edwards Post Office. This is 10-20 feet above a plain of black, sandy loam south of it = 800 feet ±; 28.650 at Hurrell's flowing well, northwest corner Section 8 = 800 feet ±. I go east from here 2 miles ± to end of road. Aneroid 28.690 = 790 feet ±. In the last mile, there are low sandy ridges 3 feet ± high, with some pebbles in them. They trend northeast-southwest and may be shore lines of Lake Saginaw. Aneroid 28.740 at East Branch of Tittabawassee below old dam in northeast part of Section 16. The banks are 30 feet ± in height below the dam. Low sandy ridges 5-10 feet high occur on west side of river from the county line south past

here. Flat land east of this stream with occasional low sandy ridges; some till spots in the sags with occasional small pebbles and cobblestones. Aneroid 28.720 at John Bourret's residence northwest part Section 34, on a low sand ridge 5-6 feet high = 810 feet ±.

There is a flowing well in Section 12, Bourret Township, on McLean's land, about 90 feet in depth. A well or boring on east side of Section 34 was sunk 50 feet through blue clay and got no water -- by Joseph Price. In northeast part of Section 22, a well was sunk 98 feet on McLean's land that has head within 2 feet of top. Another at camp in northeast part of Section 23 was of similar depth with head near top. At J. W. Dunn's, a mile northwest of Alger, is a boring 75 feet deep that got no water except near top. Aneroid 28.770 at John Bourret's in northwest corner Section 34 at 1:45 p.m.

Aneroid 28.800 at huckleberry marsh in Section 30 on west edge of Arenac County; 28.795, 790 feet ± on sand ridge (beach?) in east part of Section 30 at 3:00 p.m.; 28.810 at Alger, 781 feet, at 3:30 p.m.; 28.800 at east-west road north of Alger 1 mile, 790 feet. Till and boulders here and swells west of here. Aneroid 28.780 at sand ridges on slope of moraine 1/2 mile farther north = 820 feet; 28.740, 750 feet, on crest of moraine near the county line = 860 feet; 28.790 at Greenwood = 820 feet.

In my trip east on the Alger road from John Bourret's, I followed sandy ridges along or near line of Sections 27 and 34. I then crossed a swamp in Section 26 (southwest part of section) and came to a till tract with very gentle undulation. This seems likely to be where the landlaid moraine terminates at the southwest, for farther west, there seems to be no undulation in the till. This is presumably the moraine that leads around the head of Saginaw Bay on east side of the Tittabawassee and north side of Cass River, unless it proves to be the continuation of the Gladwin moraine. (Leverett, in 1922, favors latter view). Lane, in Water Supply Paper No.

30, Part II, seems to consider the moraine crossed by M. C. railroad between Alger and Sterling the one that sweeps around east of the Tittabawassee and north side of Cass River. This seems to be true. It seems probable from the accounts of residents, that the till ridge that is crossed by the M. C. railroad near county line southeast of Greenwood leads eastward along and just north of the county line to Rifle River and thence northward past a chain of lakes in eastern Mills and northwestern Richland Townships. North of this, in southeastern Horton and in Mills Township, there is a tract of level, sandy land with tamarack swamps and no settlers or roads that are now passable.

There is a swamp north of Greenwood that drains both to Rifle River and Tittabawassee which stands no higher than Greenwood Station (820 feet) and maybe a few feet (8-10) lower. The outlet to Tittabawassee north of Greenwood is 10 feet ± below Greenwood Station, or 810 feet A.T. There is very little change in altitude for the three miles that I went west from Greenwood or for two miles north on line of Sections 29, 30, 19 and 20, Horton Township (T.21N., R.2E.). There is a small tract of clay on south end of line of Sections 29 and 30, but much of this area is sandy. In Sections 17 and 18, 7 and8, Horton Township, there is a gently undulating till with a liberal supply of boulders. Sections 5 and 6 have a morainic surface and so has north half of Sections 7 and 8. Boulders are more numerous in these sections than along the range line south of West Branch.

In West Branch there are a good many flowing wells, ranging from about 80 feet up to nearly 200 feet in depth. Wells that are of less depth do not overflow. The head is 20 feet or more above surface in the deeper wells.

October 14, 1901. 8:30 a.m.

Aneroid 28.860 at West Branch = 953 feet. I drive east across a gently undulating till tract with swells 5-25 feet high. The highest points are 975 feet ± and the general altitude is 960-975 feet for 2½ miles east from east side of the village. There is then a descent to about 920 feet at road leading south between Sections 26 and 27. There is a high range of hills with its south border 1½-2 miles north of this road. I turn south between Sections 26 and 27 and continue across West Branch of Rifle River. There is till on north side of this stream, and sandy drift on the south side from West Branch to here. The river is about 850 feet where this road crosses, and the sandy tract south of it here is 20 feet higher.

Aneroid 29.010 on bluff of Rifle River; 29.080 at Rifle River at iron bridge on or near line of Sections 9 and 16, Mills Township = 750 feet ±. The bluffs are 50-60 feet and gravelly from top down to within 15 feet of river level. Springs issue at this level that suggest the possibility of clay (Gregory reports rock here). A survey shows 750.6 feet below dam in Section 9. The gravel carries a few cobblestones, but on the whole, is rather fine and has considerable sand with it. There have been attempts to farm this plain but nearly every farm is now abandoned. In places there are blowouts where it is especially sandy. This plain extends east to the east range of sections in Mills Township and seems to have little or no eastward rise. Aneroid 29.000 at border of plain and moraine not far from corners of Sections 11, 12, 13 and 14, Mills Township, at 11:10 a.m. = 825 feet; 28.950 on moraine 1/2 mile farther east = 870 feet; 28.950 on general level of morainic crest south from here on range line.

I go south 1½ miles, then east 1 mile, then south 1/2 mile, then

east into Prescott, and am on undulating till all the way. Aneroid 28.995 at Prescott Station, 793 feet, at 12:30 noon. I was told by Mr. John Mauzeer, former supervisor of Mills Township, now living in Section 12, that the moraine in eastern Mills Township covers Section 1 and much of Section 2. It extends south to Section 25, but is not well developed farther south or west. It runs north along line of Churchill and Logan Townships, forming the divide between Rifle River drainage and streams that flow eastward. Mr. Mauzer states that in the southwest part of Mills Township, Section 30, and parts of Sections 29 and 31, is undulating clay like that southeast of Greenwood and a continuation of it. There is a flat, greasy white clay soil in Section 32. Possibly this tract finds its continuation in the one on east side of Mills Township, but Rifle River makes a break 2½ miles wide.

There is sandy land in Sections 30 and 31, Richland Township, and it extends southwest from these sections to Rifle River along the line of the old railway (now torn up). Rifle River railroad bridge is 768 feet and is said to be over 100 feet above the river. Rifle River is 700.7 feet at county line. There is a clay tract from Prescott south-southwest to Rifle River, north of Sterling. It has low swells 10-15 feet high and is very productive land. It probably is the continuation of the tract crossed by M. C. railroad between Sterling and Alger.

Aneroid 29.000 at Prescott, 793 feet, at 1:30 p.m. The highest points in the village are about 810 feet, the station being in a sag. I go north on line of Sections 22 and 23, Richland Township. Aneroid 28.960 at corners of Sections 22, 23, 14 and 15 = 825 feet ±. Near middle of line of Sections 14 and 15, I reach 840 feet. North end of line, aneroid 28.950 = 835 feet ±. There are a few patches of sand on borders of basins here, but

much of soil is clayey. Swells here are only 5-10 feet. There is little or no ascent to the north here.

Aneroid 28.960 at township line of Richland and Logan, two miles from east end. A stream a few rods north is 10-12 feet lower. Aneroid 28.930 at summit 1-3/4 miles north of township line; 28.975 at creek 1/2 mile farther; 28.890 on sharp knoll in northeast part of Section 22, Logan Township; 28.920 at base of knoll; 28.940 at section corner, 50 rods north of knoll. There is much swampy land north of here to a stream that is the outlet of the large lake in Sections 3, 4, 9 and 10, Logan Township. Aneroid 28.930 at lake = 850-860 feet. There are knolls 30-40 feet above lake level on its southeast border; 28.870 on highest points in Sections 9 and 10. Till capped with sand and gravel in this group of knolls. Till plain in Section 8. Swamp in much of Section 7. Aneroid 28.935 in swamp. This is 15-20 feet below the till plain east of it.

Aneroid 28.910 on undulating till tract at township line. A summit 1/4 mile west is 10 feet higher. The undulating land only extends 1/2 mile south, but runs north as far as I can get a view -- over a mile. It extends west to Rifle River. Aneroid 28.980 at Rifle River = 825 feet ±. There are many boulders in this valley here and on its borders on east side. Aneroid 28.930 on gravel plain west of river ½-1¼ miles. After crossing a sag, I enter a till tract with undulating surface. Aneroid 28.880 at line of Sections 7 and 8 on till swell 15 feet ± high. There is a general rise westward to a summit at Campbell's Corners. Aneroid 28.700 = 1,075 feet ±. There is an undulating till from Campbell's Corners into West Branch. Aneroid 28.840 at West Branch at 6:45 p.m. = 953 feet.

October 15, 1901. 7:30 a.m.

Aneroid 28.840 at West Branch. Peter Neubecker, of Campbell's Corners, made boring 100 feet, but it has no water in it. James Campbell has one on highest point in the village, 130 feet. The altitude is 1,080 feet. Aneroid 28.690. It has about 20 feet of water. A well at the sawmill east of Campbell's Corners on lower ground (60 feet ±) is 90 feet deep and has water 60 feet. The drift here is till at surface, but I am not able to have the well records.

Aneroid 28.800 at stream near township line north of Campbell's Corners = 1,000 feet. There are high hills, two miles west, fully 1,300 feet A.T., and this high range runs west several miles. Aneroid 28.760 at northwest corner Section 36, Klacking Township = 1,035 feet; 28.830 at northeast corner Section 36 = 975 feet. There is a swell and sag till moraine in eastern third of Klacking Township and western third of Cumming Township, with swells 20-50 feet ± in height. It is an excellent farming district. Aneroid 28.850 at corners of Sections 29, 30, 31 and 32, Cumming Township = 960 feet. The morainic topography extends east of here 1/2 mile ±. Boulders are present in moderate number on this swell and sag moraine. There was much maple timber here.

Aneroid 28.810 at corners Sections 19, 20, 29 and 30, Cumming Township on a drift swell 30 feet ± above sags north, east and west 1/2 mile. George Croft's well, in southwest part of Section 20, is 110 feet and has 60 feet. It was nearly all blue clay. Aneroid 28.810 at well. In east part of Sections 20 and 29, a sandy plain occurs. Aneroid 28.810. And in the sections east, 21 and 28, there is a swamp. Aneroid 28.890 at swamp in Section 21. There is a plain of sandy gravel from here east to Rifle River on which the aneroid reads about 28.870; 28.900 at Rifle River in Section 11. There is but a narrow strip of the gravel plain on east side of Rifle

River from here south to where I crossed last night (in Section 9, Churchill Township). I come into a swell and sag moraine in Section 12, Cumming Township. Sections 6 and 7, Hill Township, have prominent knolls 75 feet ± above level of Rifle River. I go east to a school house at or near corners of Sections 5, 6, 7 and 8, Hill Township, at edge of two lakes, one being southeast and the other northeast of the cross road. I go north about a mile along west side of the north lake and have a prominent morainic ridge west of me. This extends to Lupton and I go west along its north edge near the township line. Aneroid 28.815 at Lupton at noon; 28.840 at 1:20 p.m. = 935 feet ±; 28.820 at Rose City Station at 2:40 p.m. = 955 feet ±.

Eugene Atherton, a well driller at Rose City, states that flows are obtained on the slope west of Rose city, 50 feet above the station, at a depth of 50 feet. In main part of the town at 10-15 feet above station, a well at hotel is 160 feet deep. It is nearly all solid blue clay and water is found in sand. The deepest, at barrel factory for heading kegs and barrels, in east part of village, is 241 feet. It was into rock 8 feet. It was a soft whitish sandstone. There was a flow from this rock that barely reaches surface at about level of railroad station. At hotel, in main part of town, a well 160 feet deep is known to have a head more than 40 feet above surface. Mr. Atherton thinks head may extend 50 feet. The flows are obtained for nearly 2 miles up west side of Houghton Creek on road that runs on range line. They are found for about a mile below Rose City on west side of valley. A well six miles west, on the high land, is 175 feet. It only had 20 feet of water. Aneroid 28.730 at highest flows in west part of Rose City, 80 feet above railroad station, or about 1,035 feet A.T.

Aneroid 28.600 on summit 1¼ miles west of Rose City, west of cross roads 30 rods = 1,175 feet ±. There is a range of hills 1½-2 miles west that trends northeast-southwest which are probably over 200 feet above this

altitude (see notes below). I leave the township line near west end of line of Sections 2 and 35 and go south and west over the range of high hills. Aneroid 28.550 at base of steep hills (probably in Section 3, Klacking Township). Aneroid 28.410 at summit in road = 1,370 feet ±. There are points nearby, on north and south, 40 feet higher. This has a sandy drift with a few boulders and cobblestones. There are narrow, valley-like flats among the ridges, one of which the road utilized in ascending to the crest. There is a wider flat tract west of the crest and I am soon out on a plain where aneroid reads 28.440.

I go west near north line of Klacking Township and soon come to a road that runs on the line. I follow this west to township corners (townships 23 and 24 North, Ranges 1 and 2 East), traversing a high sand plain with smooth surface and perceptible westward descent. The aneroid reads 28.470 at township corners = 1,325 feet ±. The plain extends northwest from here over a large part of T.24N., R.1E. The west half of T.24N., R.2E., is also largely a plain. There are morainic hills south of this township corner within 1/2 mile. They are very prominent in Sections 7 and 18, Klacking Township, near the section line, reaching an altitude probably 1,450 feet A.T.

East of this range of hills, in Sections 5, 8 and 17, and south of it in Section 18, there is a gravelly tract with deep basins, but otherwise, nearly plane. This apparently extends east into Sections 9 and 16, and I find that it continues south across Sections 19 and 20 into Sections 29 and 30, Klacking Township. It there comes to the border of the moraine that I noted this morning, and is nearly up to the crest of the moraine. On the pitted plain, aneroid registers 28.440 at rims of basins = 1,350 feet ±, at several places in Sections 17, 18, 19, 20, 29 and 30. On the

moraine's crest, it registers 28.420 = 1,370 feet ±. After passing the crest, I find till of clayey texture nearly up to crest. There are boulderets for a mile or more north of the crest, showing a transition between the cobble and gravel of the pitted plain and the large boulders of the moraine. It becomes dark about the time I cross the crest, but I find that cuts are variable, some being sandy and some a stiff clay on the low tract north of West Branch.

Aneroid 28.860 at West Branch at 6:40 p.m. = 953 feet. C. J. Blakely's flowing well, 185 feet, threw out considerable coal from bottom. It was nearly all blue clay to 180 feet, except a vein of water at 45 feet. Coal was under sand and gravel. C. J. Phelps' well, 152 feet, has head fully 40 feet above surface. It was nearly all blue till. It struck coal at bottom -- apparently a bed. Stephen Weiger's, 155 feet, is 2 blocks east of depot, and has head 40 feet above mouth. Ogemaw County bank has a similar one. Gale Lumber Company's is 165 feet and level is lower than station a few feet. It is 1/4 mile northwest of station. The shallowest flows were about 20 feet, but these are now lowered so they do not flow. There are probably 100 flows 40-80 feet now. Court House well is 170 feet and head is 2 feet below surface.

There are several wells north of West Branch for a mile, and south for 3 miles or more. George's Lake well is about 180 feet and flows 35 feet above surface. It is on ~~level~~ line of Edwards and Horton Townships. There is another strong flow east of the lake in Section 17, Horton Township and north of the lake in west part of Section 7, Horton Township. There are others between there and West Branch.

October 16, 1901. 7:35 a.m.

Aneroid 29.020 at West Branch. I take train to Sterling. Aneroid 29.220 at Alger, 781 feet A.T.; 29.190 at summit of sand capped till ridge, probably near line of Sections 2 and 3, T.19N., R.3E. There is a sand ridge at southeast end of a switch, 60 rods northeast of Mile Post 147 from Mackinac that runs east-west and is 10 feet or more in height. A ridge 15 feet high, about a mile farther, and a till ridge only a mile northwest of Sterling. Aneroid 29.250 at till ridge in cut 8 feet deep; 29.300 at Sterling at Mile Post 150 from Mackinac, 743 feet; 29.100 at summit by church, 825 feet, on line of Sections 28 and 29, Clayton Township; 29.080 at summit on east-west road, 840feet, near east end of line of Sections 21 and 28. There is a point about 5 feet higher in southwest corner Section 22 = 845 feet ±. SWells here, 10-15 feet high. Aneroid 29.170, 760 feet ± at corners Sections 22, 23, 26 and 27; 29.180 at corners Sections 23, 24, 25 and 26. This is about 750 feet, as it is on Warren shore. Wells in this township are ordinarily obtained at 25-40 feet.

Aneroid 29.170 at township line of Clayton and Mason Townships, two miles from south end = 750 feet. There is a faint shoreline here (Warren beach) showing as a cut bank across southeast corner of Section 24 in northeast-southwest course. It is but a few rods from here to where the sandy barrens set in toward the southeast. Barrens extend southeast from here for about two miles that are dry. I then drop down to a flatter and more swampy tract, aneroid 29.220; 29.300 at Omer at 1:00 p.m., 610 feet. The town well at Omer is about 360 feet and overflows. It enters limestone at about 16 feet. The river bed here is in the limestone. Limestone is quarried in Section 1, northeast of Omer (T.19N., R.5E.) and burned for lime. Coal has been mined on south bank of Rifle River, west of Omer, in

Section 3, T.19N., R.4E. Aneroid 29.320, 610 feet, at Omer at 2:20 p.m.

I take train to East Tawas. I soon leave the sand and enter a clay plain, rising to a summit perhaps 2½ miles from Omer. Aneroid 29.270; 29.280 at Twining. Flowing wells here at 20 feet ±. I see no high land nearby. Flat clay with occasional low sandy knolls to Turner. Aneroid 29.300. Flowing well here in street said to be less than 100 feet deep. Boulders numerous a mile or so north-northeast of Turner in fields on west side of railroad. Aneroid 29.260 at boulders. Surface is gently undulating till. (Is it not a moraine?)

Aneroid 29.270 at AuGres River bridge, 15 feet above stream. Very flat northeast of this river for 1-1½ miles; sand ridges then set in 10-15 feet ± in height, among which there are swampy tracts. Aneroid 29.240 at Emery Junction = 671 feet A.T. There are sandy ridges around this station. Aneroid 29.250 at East AuGres River, 10-12 feet above stream; 29.250 at Arn (?) = 663 feet. Sandy soil with only an occasional boulder; till at slight depth. Boulders become more numerous and sand less continuous coating as I descend to the Lake at Tawas. Sandy ridges border the bay at Tawas City at an altitude 6-15 feet above lake level.

Aneroid 29.340 at Tawas, 587 feet A.T. At East Tawas I meet Prof. W. M. Gregory who is studying Arenac and Iosco counties for Dr. Lane. He has mapped the extent of the sand and the clay in some detail and worked up the material for a contour map. Also has obtained records of the borings and examined all the rock outcrops. He has worked in southern Mills Township, Ogemaw County, and finds that the moraine that runs into Section 29 is continued across the Rifle River with a break of but a mile or so. There is considerable clay land near the river on each side in southern third of Mills Township. There is an outcrop of rock at the

bridge where I crossed Rifle River in Mills Township and other outcrops farther down the stream. Professor Gregory recognized that a moraine crossed Rifle River at the bend north of Sterling, and passed southwest toward Moore's Junction.

There is a sandy tract south of Rifle River, east of Sterline, that he considers an old lake border and it finds continuation in the sand that I entered two miles south of Maple Ridge Post Office. It leads northward across the southeast corner of Ogemaw County, and is found on the railway summit west of Whittemore in Iosco County. He has not traced it to the north farther. It will be important to tract it northward as far as possible and determine its relation to moraines in Alcona County.

I obtain notes on the altitudes of stations, summits and streams along the Detroit and Mackinac railroad from East Tawas to Alpena:

Distance		Above Lake Huron
0	East Tawas	7
25-60 chains		6
98	Ridge, natural surface	23
98-120	Railroad grade	16.5
175½	Natural surface	27
209	Natural surface	33
220	Natural surface	33
231	Natural surface	31
240-365	Grade	25
370	Town line, natural surface	25
374	Natural surface	30
419	Natural surface	35
700	Oscoda	25
741½-745	AuSable River bridge	12
742-743½	River bed	- 6
	Surface of water	+ 4
	Plain bordering river	7
798	Summit	28
816+	Van Ettan River bridge	22
816	River bed	+ 3
	Surface of water	+ 9
828	Bluff	33
847	Summit	36
860	Low ground	15
985	Place where new line branches	33

Distance		Above Lake Huron
1045	Summit	40
1057	Channel	17
1075-88	Beach	45 ±
1094	County line, Iosco and Alcona	51
1090	Bank (top of)	53
1090-1288 -	Railway is below 40 and 50 to 40-50 feet	
1261	Handy Station	44
1300	Top of grade	60
1300	Top of grade	60
1317	Downgrade	50
1310-1403	Grade	45-55
1398	West Greenbush	54
1431	Grade	62
1431-1612	Upgrade	62-173
1620	Sag, natural surface	156
1530	Gustin	113
1678	Summit	210
1746	West Harrisville	199
1761	Summit, natural surface	218
1911	Summit	217
1918	Harris Station	210
1942	Summit	227
2044	Sharp summit	228
2156	Rowe Lake	230
2142	Summit	238
2261	Summit, natural surface	242
2304	Bank - top	167
	- base	148
2375	Flat tract begins	25
2416	Border of terrace	28
2430	Low plain, natural surface	5
2468)	Black River	
0)		
189	Top of grade	23
189-290	Plain	23-27
315	Summit	38
532	Ossineke Station	28
970	Point where Alpena western survey starts west on natural surface	35
1174	Alpena	24

NEW SURVEY

From East Tawas		
986	Harrisville Junction	33
1345	Greenbush	60
1445	Summit	68
1640	Harrisville (Main Street	45
	(Dock Street	42
1728(	Grade elevation	23
561(		
457	Sturgeon Point	34.5

Distance		Above Lake Huron
295	Alcona	22.5
215	Stony ridge	41
70	Black River	5

Professor Gregory and I are unable, from present data, to decide whether the moraine that leads from near Greenwood southwest to John Bourret's, is a continuation of the moraine that I traced to McClure from the southwest or is a continuation of one that runs along the east side of Tittabawassee River. The latter correlation seems to be poorly sustained by later studies, there being a continuation of the Saginaw or Port Huron moraine through southeastern Gladwin County into Arenac County and northeast from there to Maple Ridge. It seems probable that the sandy tracts of Horton Township, Ogemaw County, were part of a bay at the north end of Lake Saginaw at its highest and earliest stage. How far the bay extended may not be easy to determine, though it may safely be assumed to reach an altitude as great as near Gladwin (815 feet A.T. ±). Possibly it reached 830 feet or more.

The beach back of Sterling is about 777 feet A.T. and the sand ridge west of Whittemore near corners of Sections 4, 5, 8 and 9, T.21N., R.5E., is 790 feet. This may be the same beach. Professor Gregory thinks its continuation may be northeast through Sections 26, 25 and 24, T.22N., R.5E. Later, I visited the sand ridge west of Whittemore and did not find a good beach. Note: in 1922, it was found that Warren shore is at Sterling and is 745 feet. There is no higher shore east of Port Huron moraine.

October 17, 1901.

I take train from East Tawas to Lincoln or West Harrisville on Detroit & Mackinac railroad. The railroad leads through a low tract of sandy land throughout its course in northeastern Iosco County, but rises near the county line of Iosco and Alcona counties to a gravel and cobble tract standing about 50 feet above Lake Huron, that may be an old beach. There is a gravel pit in it near county line, and there the altitude is 53 feet above Lake Huron.

Near Handy Station, I enter a clay tract that extends north past Lincoln, rising gradually northward. There is but little undulation near the railroad until I am about two miles south of Lincoln but from there north, swells 20-30 feet high abound. There are but few boulders. There are places where the drift is sandy but as a rule it is a loamy clay.

The altitude in east part of Lincoln is 25-30 feet above the station, or a little more than 800 feet A.T. There are points a mile or so east that reach about 840 feet. The drift is largely till from Lincoln east to Harrisville, but just west of Harrisville, it becomes sandy. It is morainic clear through from Lincoln to the old shore in west part of Harrisville. The moraine borders the lake closely, from below Greenbush northward past Alcona. It is sandy for a short distance back from the lake a mile or so, I am told, but back of this, there is a large amount of till, clear through to the railroad.

October 18 and 19, 1901.

I spend these two days at Harrisville, working up a road map of Alcona County and talking with each member of the board of Supervisors concerning the county. There is a large moraine entering the county in its southwest corner and passing north-northeast across the west part of T.25N., R.5E., the central part of T.26N., R.5E., the western part of T.27N., R.6E., and the greater part of T.28N., R.6E. Much of T.28N., R.5E., and the west half of T.27N., R.5E., seem to be a sand plain. It seems probable from descriptions that the moraine in the eastern part of the county bears northwest across the southwest part of T.28N., R.9E., and the central part of T.28N., R.8E., covering much of the latter township and continuing northwestward into Alpena County.

Southwest of Hubbard Lake, there is a great swamp (see map) and south of the lake, east of this swamp, a tract of sandy barrens, covering much of T.27N., R.7E., and extending into R.8E. The eastern half of T.27N., R.8E., is morainic and the barrens are also. There is an extensive clay tract with plane or gently undulating surface, extending west across south part of T.26N., R.8E., and north part of T.25N., R.8E., and continuing apparently some distance into T.26N., R.7E., and T.25N., R.7E. North of this is an undulating tract.

October 20, 1901.

I drive south with J. H. Killmaster along the old beach to Springport then cross over a narrow range of hills and go south on its west side nearly to the Greenbush line before crossing back to the beach. This range reaches 150-175 feet above Lake Huron and, in places, is only 1/4 mile in width. The beach on the east base of this moraine is 60 feet above lake

level at Greenbush Station. The moraine is very sandy drift and has but a few boulders.

We drive west on a road 1/2 mile south of the Harrisville-Greenbush Township line through a morainic tract that is sandy or sandy loam soil to within 2 miles of Mikado or West Greenbush. The drift there becomes clayey and has a nearly plane surface around Mikado. The clayey drift extends south past Handy Station and west to Pine River. We continue to Killmaster in Section 22, Gustin Township, across a gently undulating till tract with very clayey drift much of the way. There is, however, along the line of Sections 26 and 27, and 22 and 23, a strip that has a sandy, gravelly soil and a larger number of cobblestones and boulders. On the very clayey drift, there are remarkably few pebbles.

We find a sandstone pebble in road about 1/2 mile southeast of Killmaster that may be Berea Grit. It is nearly white. In Section 23, we find a red sandstone with bluish white spots in it. This red sandstone is distributed farther north and is likely to be from a lower horizon than the Berea. We find numerous limestone pebbles in the drift around Killmaster that are probably from the Devonian outcrops. They contain corals, crinoids, etcetera. (see specimens)

In the central part of Section 26, there is a strong gas spring boiling up. It has an elevation of 2 or 3 feet above tracts around it. Other gas springs occur up Pine River to Section 10, Gustin Township. There is one on the Simpson and Henry Land in northwest part of Section 34, and one on Loud's land in Section 32. Do they indicate where gas may be obtained by boring, or are they products of decay near surface? The strength of the gas flow suggests rock gas. Mr. Killmaster has made three borings at Killmaster which all get gas just above the rock and one of these also from what is supposed

to be Berea Grit at a depth of 570-610 feet. The following is the record of Well No. 1. It was drilled in 1887.

Pleistocene 1-240
Surface gas also a flow at bottom of drift from gravel bed registered pressure 103 lbs.

Lower Marshall 240-244
A sandstone with large flow of fresh water.

Gray shale ..... 244-250)
Sandstone ..... 250-254) Coldwater Series
Gray shale ..... 254-530)

Red shale ..... 530-550)
Black shale ..... 550-570) Berea shale

Sandstone ..... 570-610 Berea Grit
Gas in top of sandstone and very small quantity of oil. Salt water in sandstone below gas; large flow overcomes gas.

The altitude here is very nearly 100 feet above Lake Huron, or 680 feet. A second well, bored in 1887, on ground 8 or 10 feet higher and about 80 rods north, was sunk 245 feet and found a strong flow of gas in gravel; 67 pounds pressure to square inch at first. This was used for fuel in house of C. H. Killmaster. A third boring, made in 1892, reached a depth of 1,530 feet and cost $5,000. It was on ground 10 feet lower than No. 1, or about 670 feet. The section to 610 feet is very similar to that of No. 1, except that no red shale was found here. The lower part is as follows:

Gray shale 610-760
Dark shale 760-910
Gray shale and limestone beds 910-935
(Hamilton or Traverse)
Dark Shale 935-1000
Gray shale and limestone 1000-1032
Black shale 1032-1090
Limestone, hard ..... 1090-1098 (8 feet)
Limestone, soft ..... 1098-1178 (80 feet)
Limestone, hard ..... 1178-1268 (90 feet)
Limestone, hard ..... 1268-1272 (4 feet)
Limestone, soft ..... 1272-1292 (20 feet)
Color from light to dark.

From AuSable and Northwestern Railroad:

	Feet
Near Bamfield end of profile	25
10 chains	37
20 chains	56
22-32 level	60
40 chains	75
49-56 level	83
Steady upgrade, 56-114	152
114-120 level	152
128-133 level	156
144-154 level	167
Upgrade to 170 chains	183
170-176 chains level	183
Summit level 183-185 at Vaughn	186
Downgrade 185-205 (Mrs. V. S. Hale)	149
205-221 level	149
229 low swell	155
Downgrade to 237	149
Level 237-252 "Riley Hill"	149
Downgrade 252-300	68
Level 300-303	68
Summit 310 chains	77
Downgrade to 324	55
Level 324-338	55
343 chains to 349 level	59
Downgrade to 367	28
Level to 380	28
383-391 level	26
Downgrade to 405	15
Level 405-414	15
419 chains to 426 level	11
437-442 level Bryant	17 = 835

Hardwood along Pine River bottom. Bryant is 18-3/4 miles from AuSable.

Mile Post 18, near county line	840
17¼	839
17 miles	830
16 miles, 260 rods (in sag)	825
16 mile post	825
Depressions 5-10 feet between 15 and 16	
15½, top of steep grade (going west)	820
15-1/8 miles, sag	805
15 at sand pit (in cut 6 feet deep)	810
30-40 rods east of 15 mile post (very poor soil)	800
14½ miles, sandy plain	815
14¼, top of grade (going west)	815
14 mile post (grade is 7 feet above the natural surface)	805
North bend of AuSable River bluff, southwest corner Section 10, T.24N., R.7E.	805
13½ miles, on curve	800

Brow of high bluff. Boulders (occasional along face.) Is this a lake bluff or an ice margin?

	Feet
13 miles (at base of upper bluff)	770
Beadle or Bissonette, in sag	745

Ravine nearby is 30 feet ± lower. A few boulders around the station and on Bissonette's premises.

12 miles	750
11 miles (stumps 2 feet ±)	750
10 miles (Doan Station)	740
High plain 1¼ miles north of Doan	790
9 miles	740

8½ - 9, level

8½ miles at curve	740
8-1/3 miles	730
8 miles	730
Section switch	720
Top of Seven-Mile Hill	715
6 mile post nearbase of hill (Ellton?)	635
5 mile post, jack pine	630
4 mile post (cut 8 feet)	622
48 rods east of 4 mile post	620
3½ mile hill, top of bank, at Algonquin shore	618
Tacker from side track	610
3 mile post	605
Bridge	595
Ridge	615
Crossing of Detroit & Mackinac Railroad	605

October 22, 1901.

Aneroid 29.505 = 625 feet at railroad crossing on Main Street, Harrisville; 29.360 = 750 feet ± at Chapel's well, 2½ miles west, that is said to be 95 feet; 29.405 at Poor Farm = 705 feet ± A.T.; 29.350 at McIntyre's well, 56 feet deep, northeast part of Section 4. Napoleon Shurbeneau in southwest corner Section 34, Haynes Township, has well 117½ feet. Water was in gravel and sand at bottom. It was largely clay first 35 feet. Water rises a good deal. Aneroid 29.350 at well = 750 feet ± A.T. Some quicksand and clayey sand in lower 75 feet. Mr. James Barber, 1/4 mile east, has well 104 feet that has a wider bed but has considerable head.

Aneroid 29.300 on hill in east part of Lincoln = 810 ± feet A.T.; 29.335 at Lincoln Station, 8:00 a.m., 779. D. W. Brooks, in north part Section 36, T.27N., R.8E., has well 36 feet. There was stiff clay 24 feet. Below this was a series of sand, gravel and clay beds (blue clay) to water-bearing sand at bottom. Wells around Lincoln are only 30-40 feet and go through much sand. The west lake of the four near Lincoln, on line of Sections 3 and 35, has marl that Mr. Brooks has run a pole into 10 or 12 feet. There is a lake about a mile east that has a known depth of 110 feet. A copper nugget was found in Section 35, T.27N., R.8E. Mr. Brooks also found 3 pieces of copper in Section 10, T.27N., R.6E. The marl in lake on line of Sections 2 and 35 is clayey and impure where we test on south side of the lake and only 4-5 feet deep. It is full of shells. The tract south of these lakes has a sandy loam with a few surface boulders. Aneroid 29.410 at Pine River near corners Sections 33 and 34, 3 and 4 = 715 feet; 29.300 on uplands west of stream near middle of line Sections 4 and 33 = 815 feet. About 1/2 mile farther, aneroid 29.250 on low ridged belt = 860 feet. At Robert Robinson's, in southwest part Section 3, in a basin, aneroid 29.320 = 790 feet.

We turn northwest in Section 31 and cross Mud Lake railroad grade, aneroid 29.290 = 820 feet ±. Hills and ridges north and west of here are 50-100 feet higher. Aneroid 29.200 at Sharp ranch, general level, at west side. West of here, on township line, hills 50 feet higher, and hills north are 50 or more feet higher. Aneroid 29.170 at summit on a railroad grade in Section 25, T.27N., R.9E., that this angling road follows. It is all morainic here with numerous boulders in the sags; drift is sandy and not profitable for agriculture. Large hill in Section 24, T.27N., R.7E., 100 feet ±; high range of hills in Section 23 and Sections 26 and 27, 34 and 35, trending north-northeast - south-southwest, that reach 1,000 feet. Valley-

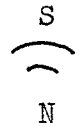
like depression east of it 1/2 mile or more in width, standing about 890 feet in Sections 24 and 23. It rises northward to about 900 feet in Sections 12 and 13. Aneroid 29.200. Hills in Sections 11 and 14 reach 1050-1100 feet.

Aneroid 29.390 at Hubbard Lake at 11:30 a.m. = 730 feet A.T. (680 feet - see later trip); 29.340 at Hubbard Lake at 12:45 p.m. The uplands in Sections 12 and 7 reach about 850-875 feet. Aneroid 29.320 at Sucker Creek on line of Sections 5 and 8 = 700 feet; 29.180 on summit a mile east = 820 feet. Broad swamp on north-south flowing part of Sucker Creek. Aneroid 29.270 at creek west of Henry = 740 feet; 29.150 at township line east of Henry Station= 840 feet. Points about a mile northeast are about 75 feet higher = 915 feet. Aneroid 29.190 at cross roads at middle of township line of Hawes and Haynes = 800 feet; 29.110 on hill a mile northeast of Lincoln; 29.190 at Lincoln Station, 779 feet A.T.

October 23, 1901.

I went to Alpena and examined the quarry and clay pits near there. Cobbly capping on ridge about 1/2 mile south of corners Townships 31 and 32 North, Ranges 8 and 9 East, at 670 feet A.T.; about the same height at middle of line of Sections 25 and 30, T.32N. The clay pit is in a sag in the Hamilton shale.

Striae at quarry of Cement Company on divergent lines vary from N34° to N68°W. The best grooves are very nearly N40°W.



Crescentic cracks are convex to the southeast.

A ledge is glaciated on southeast side as if ice were moving northwest against it. The last glaciation is on surfaces that dip to the northwest,

so if ice was moving in that direction, it was on a down slope. Data as to the direction here are definitely not decisive, but in 1902, places were found north of Alpena which show clearly that the movement of ice was SOUTHEASTWARD.

Light colored gray limestone	0-36
Bluish limestone	36-52
Gray or white	52-54
Blue fragments with white	54-56
Blue and gray mixed	56-58

Shale of brownish black color at 56-58 and more or less mixed with limestone fragments to 80 feet.

Gray limestone with very fine shell fragments	80-90
Blue limestone	92-94

(Missing from 94-112)

Blue limestone	112-116
Gray limestone	116-120
Bluish limestone	120-126
Gray with but few blue bits	126-130
Blue and gray mixed (fossils)	130-132
Mainly gray limestone	132-136
Dark bluish flaky limestone	136-138
Gray and blue mixed, fine-grained	138-142
Gray limestone	142-146
Bluish limestone	146-150

October 24, 1901.

Black River, Michigan. Aneroid 29.545 = 585 feet A.T. W. R. Smith made a well here that struck a hard material at 36 feet. He moved a few feet and tried a second hole with same result, so it is possibly a rock stratum. He did not drill into it. Sand ridge along east side of north branch of Black River, 20-25 feet above lake. Boulders and clay west of north branch on a plain. Aneroid 29.455 at beach at edge of moraine in Sections 16 and 21. There are a lot of black slate fragments on the beach. I can find no Berea Grit or other sandstone.

Aneroid 29.310 at summit near middle of line of Sections 17 and 20 =

800 feet ±. There are points 25 feet higher near center of Section 17. There is considerable till here of loose texture, and the land is cultivated both sides of road for ¼-½ mile back. Where I come into the moraine on line of Sections 16 and 21, till caps sand of considerable thickness, a feature that is common along the foot of the moraine fronting the lake from here to Greenbush Township. Aneroid 29.380, 735 feet, at stream near corner Sections 17, 18, 19 and 20; 29.350 on till plain where road leads south 1/2 mile into Section 19 = 760 feet. Much of Sections 18 and 19 are flat or gently undulating till. In Sections 30 and 31, there is a high range of hills. Sections 24 and 25, T.28N., R.8E., are also high. Aneroid 29.340 at township line, corners Sections 18, 19, 23 and 24 at 10:00 a.m. = 770 feet; 29.420 at ravine near north end of Section line Sections 13 and 18 = 690 feet; 29.320 at corners Sections 1, 12, 6 and 7; 29.270 at summit on line of Sections 1 and 12, east of middle = 840 feet A.T.; ridge as high northwest past center and in NW¼ Section 1. West side of Section 1 and east of Section 2 high. Drift is a clayey loam. Aneroid 29.250 near west end of line Sections 1 and 12 = 855-60 feet.

Well at Alexander McDonald's in southeast part Section 2 is 103 feet and gets water in sand. There was 20 feet of clay at top. Aneroid 29.240 at well = 860 feet A.T.; 29.220 at summit middle of line Sections 2 and 11 = 880 feet ± A.T.; 29.280 at hill near middle of line of Sections 3 and 10; 29.360 at Spruce post office, corner Sections 3, 4, 9 and 10 on till plain = 750 feet ±; 29.390 at stream on line Sections 4 and 9, 725 feet; 29.425 at creek in Section 7, 695 feet; 29.440 at Hubbard Lake = 680 feet ±; 29.340 1 mile south of Spruce, 770 feet; 29.325 at summit west of township line 40 rods on line of Sections 13 and 24; 29.340 at range line at 3:45 p.m., same as at 10:00 a.m.; 29.340 at Roe Lake Station= 810 feet. Barometer changes fast.

Aneroid 29.210 at summit on line of Sections 5 and 8, Haynes Township = 920 feet ±. Points are 20 feet higher 80 rods northwest = 920 feet ±; 29.305 at Mr. C. W. Goodsell's at 5:40 p.m. in Section 8 on east side = 800 feet ±. Fred Otto, in southeast part Section 5, has a well 56 feet deep. It has very little head but is a strong well. The drift is all sandy. Mr. Goodsell's well, in Section 8, is only 18 feet and goes dry in winter. James Martin, in east part of Section 10, has dug over 100 feet and got so deep that the water from higher up drained out. He then bored 104 feet. It is on a high ridge.

October 25, 1901. 6:20 a.m.

Aneroid 29.400 = 800 feet A.T. at Mr. Goodsell's in Section 8, east side; 29.510 at Black River in Section 3 near Frank Elmer's = 675 feet ±; 29.440 at well at Mr. Elmer's, 735. Well is 64 feet deep: Clay 40 feet, gravel 20 feet, white shale 3 feet. Water came in at bottom and rises 46 feet with head. There are a lot of sandstone blocks of red color with blue spots in it on Mr. Elmer's farm; several chunks a foot or more in diameter. I save a specimen. Joseph Miller, in southwest part of Section 11, has a well about 80 feet. (William Hastings, east side Section 3, gives information.)

Aneroid 29.550 at old shore of Lake Huron in Section 34, T.28N., R.9E. There is a sandy and gravelly flat here but a short distance east, clay and boulders set in. I find a lot of the clay exposed in bed of Black River that people here have called soapstone. It is a brown, pebbleless clay. I take a sample. Aneroid 29.600 at Lake Huron at Alcona, 9:30 a.m. I collect sample of marl 3 miles north of Harrisville.

Aneroid 29.475 at Lake Huron at Springport; 29.330 = 700 feet at crest

of moraine in Section 22, Harrisville Township; 29.350 on plain west side Section 22 = 680 feet; 29.325 at center of Section 21 on a low knoll 15 feet ± high = 700 feet; 29.350 on plain at west line of Section 21 = 670 feet; 29.365 at creek near center Section 20 = 665 feet; 29.340 on plain, west side Section 20 = 680 feet; 29.295 on hill near center Section 19 = 710 feet; 29.310 at township line west side Section 19 = 695 feet. Ridge runs from center of section north-northwest. Hill in southwest part Section 18 is 40 feet higher than middle of Section 19. Aneroid 29.315 at Gustin = 693 feet A.T.; 29.350 at cross roads 1/2 mile west of Gustin on flat tract = 660 feet. Surface is flat west for a mile or more; undulating east in Section 24 and north part of Section 25, Gustin Township.

On Ambrose Thompson's land, south part of Section 15, T.25N., R.8E., is a gas spring.

October 26, 1901. 6:45 a.m.

Aneroid 29.225 at Mikado = 634 feet A.T. Heavy clay for 1½ miles west, then a strip of sand about a mile on borders of Pine River. Marl on east side in a shallow pond with some peat. Pine River delta plain 640 feet; river about 620 feet. Mixed soil -- clay in places and sandy in places; numerous small boulders; extends to Section 1, T.25N., R.7E. A knoll near west side Section 5, T.25N., R.8E., is 715 feet ± -- probably less, for barometer is becoming lower. This is not extensive -- 40 acres ±; above general level.

Sand plain with jack pine and scrub oak in Sections 2 and 3, T.25N., R.7E. It has three levels; one 750 feet ± in Section 2, east side; one 790 feet ± in west part Section 2; one 830 feet in Section 3, aneroid 29.010. The highest has basins in it. In Sections 4 and 5 there is a plain with

clay and sand loam, large pine stumps, 860 feet ± -- probably considerably less. A railroad in Section 5 where good road leads south = 840 feet ±. Railroad grade near Tubbs Lake, 865 feet at 9:30 a.m.; 870 feet at 10:00 a.m. Knolls in Section 6, T.25N., R.7E., and in Section 31, T.26N., R.7E. Tubbs Lake beach in Section 31, 850 feet at 9:45 a.m. Marl in lake forms a platform 10-12 rods wide, 2-6 feet deep; tested with pole from a skiff. Marl is a shell marl and is rather pure. This lake is on the edge of an undulating tract with knolls 15-30 feet high. In one of the knolls in north part of Section 7, we find a lot of blue sandstone that seems to be Berea, also the red sandstone with blue spots in it. Altitude 880 feet. South of this is a swamp, 830 feet.

In west part of NE¼ Section 24 at Mr. Shankle's, 910 at 11:00 a.m.; 930 feet at 12:30 p.m. This is on a till plain that extends east nearly to south fork of Pine River, from Section 19, T.25N., R.7E., northeast to Section 4 and southwest to Section 32, T.25N., R.6E. East of this is sandy barrens. At southeast corner Section 7, altitude 945 feet on low knoll near railroad (narrow gauge). Altitude 945 (900 correction) at Scott Post Office, store and school house in west part Section 27 = 900 feet ±. At crossing of railroad in northwest part Section 27, altitude 950 feet ± (905 corrected). Kame north of Vaughn Lake in Section 21, altitude 1125 feet at 1:20. Low ground northwest of kame 935-960 feet (corrected 1080). Vaughn Station 1050 feet at 1:40 p.m. (really about 1000 feet). West of Vaughn, at cut in Section 7, T.25N., R.6E., along railroad, 6 feet of clay in about 20 feet (exposed) of sand. Altitude 971 feet = 503 feet ±. Glacial conglomerate. Switch in Section 12, 950 feet = 50. Tamarack swamp in Section 12, 930 feet = 50. Terrace, 990 = 50. Gravel plain in Section 12, 1010 feet (really not more than 950 feet).

Barn near Bamfield, 930 = 875 ±. Bamfield Station 895 at 3:20 p.m. =

850 ±. Bamfield Station 855 at 4:00 p.m. Bamfield residence 830 at 4:10 p.m. Changed in last hour 27 feet toward higher barometer. River at Bamfield is 810 ± feet. One mile west, on sand plain, 910. On ridge two miles west-southwest of Bamfield, 1000 feet at 5:00 p.m. Sand plain near stream in Section 21, T.25N., R.5E., = 920. Sand plain in Section 34, 855 feet. Creek in Section 2, T.24N., R.5E., 750. Thompson's residence in Section 11, T.24N., R.5E., 820 at 6:00 p.m.; 770 feet at 7:00 p.m.; 725 feet at 8:40 p.m. Mr. Thomas Thompson reports a marl bed in lake that covers parts of Sections 9, 10 and 16, T.24N., R.5E., and in small lakes farther west.

October 27, 1901. 8:00 a.m.

Aneroid 29.350 at Mr. Tom Thompson's, Section 11, T.24N., R.5E., 850 feet ±; 29.240 on crest of moraine in Section 22 = 940 feet ±; 29.330 on sand plain in Section 13 or 24 at sharp bluff of river, 860 feet ±; 29.470 at river in Section 24 = 735 feet ±; 29.300 on dune in Section 19, T.24N., R.6E., on bow of bluff of AuSable River at 10:00 a.m. = 890 feet. Northeast part of Section 28, T.24N., R.6E., = 840 feet ±. Northwest part of Section 36, T.24N., R.6E., = 930 feet ±. At intersection with road at a quarter post (?) in Sections 31 and 32, 850. Mr. Gregory made this 864 on a former trip; drive northwest of there he made 900 feet.

Spring in southwest part Section 28, 760 feet. Plain near there, 815 feet. Spring is outlet for a dry valley. Dry valley near corners of Sections 25, 26, 35 and 36, 50 rods wide, 765 feet ±. Bluffs of valley, 30-40 feet, or 800 feet ±. This level continues east into Sections 30 and 31, T.24N., R.8E. Then a rapid slope for a mile through a more fertile tract, descending 50-75 feet in a mile. Probable border of ice, for the tracts to the south are reported by Mr. Gregory to have hardwood timber and a clay soil. Drop to a terrace of AuSable River in Section 29 that is 645

feet ± and soon opens out into a plain that extends south beyond limits of vision, and is probably a lake plain. The bluff on its west border south from here is 30-40 feet. The bluff runs east on north side of river to near corners of Sections 26, 27, 34 and 35, T.24N., R.8E., from which point it goes northward and a swamp, marked on land survey map, (a copy of which Mr. Gregory has with him) runs north through east part of Sections 23, 14, 11 and 2, T.24N., R.8E., that is probably at the old lake border. There was apparently a bay from there north along Pine River to a point opposite Mikado, as noted yesterday, and bars were found in Greenbush Township, one of which leads to the gravel pit on D. & M. railroad at county line.

William Elliott, of Oscoda, drilled for salt to 1,040 feet near shore of Lake Huron in 1875, 1876 and 1880. The one in 1880 is as follows:

1. Mainly sand with thin beds of clay 96-100
2. Shale of blue color and soft 5-10
3. Sandstone, white and porous 40-50
4. Shale of dark color, almost black in streaks in a bed of blue shale; dark was friable ...830
5. Limestone 5-10
6. Salt water in gray sandstone 60

A test boring for Pack and Woods at Oscoda in 1879 to a depth of 1,850 feet that has sections as above to 1,040. The salt water sandstone in this well was about 80 feet, or to 1,040; then a red shale, 40 feet ±, was struck; blue and black shale with thin beds of limestone, 770 feet ±, or to 1,850 feet. There was some salt water at about 400 feet. Smith, Kelly and Dwight made first boring in 1875, about 1,040 feet, and 2nd in 1881. Land and Gay made four in 1876-1877, about same depth. Pack and Woods made some in 1878 and 1879. The above data are all from memory, and only approximately correct.

October 28, 1901. 5:45 a.m.

Aneroid 29.800 at Lake Huron in Oscoda. The swamp west of Van Ettan Lake has clay under its north end in Sections 1 and 2. The northwest part of Section 2 is morainic and reaches 650 feet. The moraine covers the west half of Section 35 and much of Section 34 and parts of 26 and 27. It is represented north of the bend of Pine River in a knoll 30 feet ± high in east part of Section 14. Section 15, on southwest side of the river, has an undulating till in south part. The northeast part is flat, sandy land with a low sand ridge running along the southeast side of Pine River valley. This is probably at the level of the 640 foot beach. The barren sand tract rises above the till tract east of it in the north part of T.24N., R.8E., in Iosco and in the southwest part of T.25N., R.8E., in Alcona County. It is an uninhabited wilderness of jack pine, I am told.

Gas springs on Ambrose Thompson's land, in W½ SW¼ Section 15, near center of section, boil up through a mucky blue clay into which Mr. Thompson has run a pole down 14 feet. There are 2 springs 2 or 3 rods apart. There is a slight flash when touched with lighted match. I learn of no gas springs farther south. Is this rock gas? I find sandy loam south of Lincoln from Section 18 north.

October 29, 1901. 7:30 a.m.

Aneroid 29.500 = 779 feet at Lincoln Station; 29.420 on highest point on line of Sections 3 and 34 = 850 feet; 29.550 = 740 feet at stream on section line Sections 3 and 34. Sandy loam to here. Aneroid 29.490 on ridge between forks of Pine River. It is a clay loam. Aneroid 29.545 at swamp on line of Sections 4 and 33 = 740 feet ±. This runs through from Pine River to Sucker Creek drainage and is about 60 rods wide here, at its

narrowest place; clay under the swamp and in the slope west of it. Aneroid 29.430 = 840 feet on narrow gravel plain west of swamp. Is this swamp a fosse? Aneroid 29.410 at abandoned farm near corners Sections 32, 33, 4 and 5. The soil is a sandy loam and ground water is deep down. Pine stumps here are 2 feet or more in diameter. Aneroid 29.370 at a north-south railroad grade, Sections 5 and 32, 900 feet ±. A few shallow basins here; swells very low and boulders small but numerous. Old drainage now dry lands north.

Aneroid 29.440 at Mr. Robinson's farm, 830 feet ±, near corners Sections 5, 6, 31 and 32 in a valley draining south. This valley is fertile and bordering uplands have good pasture land. Strong moraine near township corners, 925-950 -- a narrow strip, scarcely a mile wide. West of this is a plain about 900 feet A.T.

NOTES FROM BACK OF NOTEBOOK NO. 172

Aneroid 29.160 at West Harrisville Station, 779 feet. Ridges east of here 40 rods reach 810 feet and about 2 miles east, 840 feet A.T. The high country reaches nearly to Harrisville.

Frank Elmer, center Section 3, T.27N., R.9W., found lead in digging a well.

William Dolson, Supervisor of Mikado Township, has well 64 feet, 3/4 mile south of Mikado Station. It has soil and yellow clay 12 feet. The rest was blue clay except two thin beds of sand at 45 feet and 50 feet. It was dug about 30 feet and bored remainder -- good well.

John J. Butterfield, 20 rods south and across road, had boring 70 feet that did not get much water.

Well made in old well in west part of Section 27, 22 feet deep, had some oil and was offensive when boiled.

John Clark, Supervisor of Hawes Township, lives in southwest corner Section 27, T.27N., R.8E., has well 65 feet. Loam 3-4 feet; yellowish clay 30 feet; sand 30 feet ±; dry down to 64 feet. Water does not rise in well. Altitude is high.

Arthur Close, north part Section 34, T.27N., R.8E., has well 53 feet. Only a few inches of water at bottom.

Edward Burge, in northwest part Section 34, has well 40 feet.

Aneroid 29.180 at Lincoln Station, 12:30 noon = 779 feet A.T. Line of Sections 13, and 24, T.27N., R.8E., 890 feet. Township line east of there 1/2 mile, 770. Swamp on line Sections 18 and 19, 760 feet. Aneroid 29.210 = 760 feet at cross roads corners Sections 16, 17, 20 and 21; same at Tadge post office, 1/4 mile east of corners on north side of road; same at cross roads at center of township; 29.325 at creek on line Sections 15 and 22 = 665 feet; 29.250 at section corners 14, 15, 22 and 23. Drift here loose-textured. Aneroid 29.200-225 on crest 1/2 mile east; 29.385 at border of lake plain at north-south road in Sections 13 and 24; 29.490 at Lake Huron at Sturgeon Point Lighthouse; 29.430 at beach at township line where it seems to mark water level.

Aneroid 29.670 at railroad track in Harrisville at Main Street = 625 feet A.T. at 8:00 a.m.; 29.510 on high range of hills 1½ miles south of Springport = 760 feet A.T. Undulating tract west of it is 650-670 feet A.T. Summit between Greenbush and Mikado is about 730 feet. Aneroid 29.640 = 634 feet at Mikado or West Greenbush Station at 9:45 a.m.

Aneroid 29.600 at Killmaster's deep boring = 670 feet. No. 3 well, 7 feet, 8 inches above point leveled from. No. 1 well, 17½ feet above point leveled from. Rock was struck at less depth in No. 1 than in No. 3 and a strong flow of water as well as gas is obtained here at about 240 feet.

No. 2 well is about 10 feet above No. 1 and struck gas at 5 feet less depth, or 235 feet. This well has been used for fuel at a farm house. There is a boiling spring on land of Gustin Land Company, near center of Section 26, Gustin Township, that has a large amount of gas with it that induced Mr. Killmaster to bore for gas at Killmaster.

There is another in Section 14, along east branch of Pine River on Gunther land in west part of Section, and on B. Anger's land in north part of section.

In Section 12, T.25N., R.8E., Angus Cameron has a well with considerable oil that Mr. Killmaster has visited.

Frank Blong, southwest part of Section 11, T.26N., R.8E., has a flowing well 65 feet with head 5 feet above surface.

1.	Clay	18 feet
2.	Gravel with small vein of water	8 inches
3.	Clay with hardpan crust at about 30-35 feet and softer clay below	44 feet
4.	Gravel and flowing water	2 feet

Well was made in 1901. Aneroid 29.510 at well at 4:00 p.m. = 700 feet ±.

James Clemens made well 100 feet deep in Section 20, south part, Harrisville Township that has scarcely any water. Wells near there in Sections 21 and 28 are 20-30 feet.

Frank Spencer has a well in center of Section 18, Harrisville Township, 68 feet, that has 40 feet of water.

Aneroid 29.420 at railroad crossing 2 miles south of Lincoln; 29.350 at summit on line of Sections 7 and 18, Harrisville Township = 840 feet ±; 29.590 at railroad track in Harrisville, 5:30 p.m.

In Section 4, Greenbush Township, on land of James McClelland, a boring was put down 95 feet on a ridge about 740-750 feet A.T. It was sand from top to bottom -- no water.

A. D. McDonald, in Section 9, has well 44 feet, with only two feet of water:

Soil, clayey	1½ feet
Clayey hardpan	13 feet
White sand to bottom	

Aneroid 29.480 = 675 feet ± at McDonald's well.

Wells in Greenbush are 14-20 feet. John R. McDonald, in north part of Section 6, Greenbush Township, has a well 44 feet. It was a bluish-black sandy clay in lower part. The upper 20 feet was ordinary till.

Mr. Kirkendall reports a gas spring near Handy Station. Wells near Mikado have, in some cases, a bad odor when obtained in a bluish-black clay.

Adolphus Lovlett, on west side of Section 34, Harrisville Township, made a well fully 60 feet that got no water. It was in blue clay at bottom.

A well across the road in Section 33, has bad tasting water. It is about 30 feet and on land belonging to Mrs. Dan McDonald. Section 33 and west half of Section 34 have rolling till.

Charles Clayton, northwest corner Section 34, has a well 57 feet deep. The lower 17 feet was a hard clay but the rest was loose drift. Altitude is about 700 feet A.T.

William Plunkett, of Oscoda, is making a well for Mrs. Dean in SW¼ Section 22, Harrisville Township. There was 45 feet of dry and hard stony clay. Below this was quicksand to 105 feet where they have abandoned the boring and pulled back to about 50 feet. He made a well at Frank Spencer's in Section 18 that is 66 feet. It has dry sand down to 47 feet, below which is wet sand.

A well 3/4 mile southeast of Lincoln, for Mrs. B. Culver, had been dug 24 feet, was bored to 68 feet, and got water that rises 17 feet.

At Oscoda, there is sand 90 feet. Blue clay to a great depth. William Elliott, hotelkeeper at Oscoda, put in several wells here. They strike rock at about 100 feet (96-100 feet).

Thomas Stone, in southwest part Section 15, T.26N., R.9E., has a well 56 feet deep with only a weak supply of water. The well is in fine sand at bottom.

-o-o-o-o-o-o-o-o-