Open File Report XL
FIELD NOTES OF FRANK LEVERETT

Notebook No. 208 – Leverett

INDEX
NOTEBOOK NO. 208

(October 29 to November 4, 1905)

Oct. 29.	From Camp in northeast part of Dickinson County, Michigan southeast past Gleason to Northland. Striae, east-west. Notes from Gleason.
Oct. 30.	Notes on features near Northland. Rail Northland to Gleason. Walk to Princeton nine. Stage to Swanzey and rail to Little Lake. Notes on features west of Little Lake.
Oct. 31.	Little Lake to Cyr, Helena, McFarland and Lathrop. Rail to Brampton. Walk to Gladstone. Wells at Gladstone and Gilchrist. Notes on shale, clay, etc. Waterworks supply. General statement as to flowing wells.
Nov. 1.	Rail Gladstone to Rapid River. Drive northeast across Whitefish near mouth of Bill's Creek and on past Sturgeon River, and south to Nahma Junction and St. Jacques. Notes at St. Jacques from Isaac McPhee and others. Flowing wells at Nahma.
Nov. 2.	Drive St. Jacques to Ensign. Rail Ensign to Cooks Mill. Walk Cooks Mill to Manistique.
Nov. 3.	Striae at Manistique. Rail Manistique to Hiawatha and walk through settlement and back to Manistique. Wells, etc. Manistique Waterworks new building.
Nov. 4.	Manistique to Whitedale on foot. Train Whitedale to Trout Lake. Notes around Trout Lake. Train to St. Ignace and Mackinaw and Detroit.
Nov. 5.	On train to Detroit from Mackinaw.
Nov. 9.	Notes on N. H. Winchell's paper on Au Train Channel.
Nov. 10.	Notes on Dr. Bigsby's early writings.
	Notes on Schoolcraft's writings.
	Weather records at Sault Ste. Marie.
	Logan's striae north of Lake Huron and notes on Logan's geology.
Nov. 25.	Visited waterworks at Jackson, Michigan.
	Notes on Goldthwaite's levels and on Gregory's levels.
	Notes from Foster and Whitney report on the Lake Superior Region.
	Notes by S. J. Lewis on well analyses.
	Notes on report on the Northern or Upper Peninsula by Douglass Houghton.
	Notes on report on the geological and mineralogical survey of the mineral lands of the United States in the state of Michigan by C. T. Jackson.

1906

Mar. 31. Trip with Goldthwaite and C. C. Adams into St. Clair County, Michigan

Apr. 1. Studies near Port Huron, Michigan.

May 24. Temperatures in Yucatan in waters in caves.

June 14. Features near Island Lake, Michigan.

Locations of coal mines in Michigan (in back of book).

October 29, 1905. 6:30 a.m.

Aneroid 29.360 at a camp in northeast part of Dickinson County, Michigan in NE¼ Section 3, T.44N., R.27W. I go southeast along the railroad through a flat, sandy, gravel plain with considerable swamp (tamarac, spruce) for nearly 3 miles. I here come to a bouldery district on which limestone occurs--the first I have noted since leaving the Lake Superior shore (see specimens). It is a yellowish color at surface but gray inside and may be siliceous. It responds very faintly to cold hydrochloric acid. A low ridge trending east-west is crossed just south of the first exposures of the limestone blocks. It is gravelly at north end of the cut but becomes a clayey till at the south end. Perhaps this is in the Green Bay Lobe? Aneroid 29.340) at this ridge near county line at 7:30 a.m. There is a tamarac swamp along the stream south of this ridge about 1/2 mile wide. South of this is a hill 30 feet high from which I get a view over a very large tamarac swamp to the northeast. I can see the hardwood timber on the moraine in southwest part of T.45N., R.26W. from here. There is a pine grove east from here on a low swell or ridge, probably in southeast part of Section 17.

Aneroid 29.330 on ridge in Section 18 at 8:40 a.m. Limestone is very abundant on this ridge in cobblestones and small slabs. There are a few pieces of Potsdam sandstone but there are 100 of limestone to one of sandstone.

I continue to a section house south of West Branch in Section 28, aneroid 29.370. The swamps are extensive along the streams but have hills bordering them. I go to Mr. J. R. Travels homestead in northeast part of Section 28 and he outlines the extent of hardwood ridges. They are in west part of Section 15 and north part of 16. There is a little in Section 21 but this has a lot of swampy land. The ridge in Section 21 is in central and south parts. Section 22 is mostly level and had pine, cedar and tamarac with an occasional small knoll. Section 23 is sandy, level, and pine timber. Section 24 is more broken. It has pine, cedar and tamarac. The northeast part in Sections 1, 2, 3, 10, 11, 12, 13 and 14 is nearly all level Norway pine plains, mostly lumbered off. The plains extend east into T.44N., R.25W. to swamps bordering the Escanaba River.

In the southeast part of T.44N., R.26W., in Sections 25, 26, 27, 34, 35 and 36 there is hardwood land broken by strips of cedar and tamarac swamp. A large part of Section 36 is cedar. The southwest part of T.44N., R.25W., is largely cedar with scattered knolls of hardwood. There is some cedar. This kind of land extends 2 miles or more north of the West Branch. North from there, as noted above, is a pine tract with more dry, level land.

Aneroid 29.380 at West Branch of Escanaba River at section house in Section 28, T.44N., R.26W., at 12:15 p.m. I continue along railroad southeast to north part of Section 34 through a cedar swamp. There is hardwood timber 1/4-1/2 mile back from the river and railroad on south bank. Aneroid 29.250 at Gleason in northeast corner Section 9, T.43N., R.26W. The ridges northeast from here are variable in structure and form, some being sharp, gravelly ridges like eskers but more winding; others elliptical or oval knolls, suggesting drumlins but not uniform in trend. The general tendency, however, is to an east-west trend. The tract in Section 3 marked as swamp has several ridges on it but probably 4/5 of the area is cedar swamp. Some knolls have a clayey till full of limestone blocks. The largest knolls and ridges are from 25 to 50 feet high but the majority are less than 25 feet. The knolls become small in the central part of T.43N., R.26W. There seems to be a long hardwood ridge running northeast-southwest across south part of Section 16 and north part of Section 21 into Section 20. Southeast of this for a mile or more are only gentle swells. Indeed, I can see no definite knolls and ridges in Sections 21 and 22 south of the railroad (which here runs southwest). The detour to the east made by the railroad in Section 15 seems to have been to find a low passage over the northeast-southwest ridge of hardwood noted above.

Aneroid 29.260 at outcrop of striated limestone in Section 21, 80 rods southwest of a switch (Ross Station). The striae bear 8-10 degrees south of west (magnetic). About 1/8 mile north of this ledge is a sharp, gravelly ridge like an esker that has a general east-west course for over 1/4 mile parallel with these striae. It is 10-25 feet high, 6-10 rods wide, and winds slightly. It runs past the railroad station east a short distance and west 1/4 mile ±. It has cobble and coarse gravel where opened by pits dug into its slopes. Between here and Northland are several low ridges trending east-west that have a rounded outline like drumlins and are composed of a reddish, stony and clayey till. They are 10-15 feet high, 20-30 rods wide, and 1/4 mile ± in length. The railroad cuts through them from top to bottom.

Aneroid 29.240 at Northland at boarding house at 5:45 p.m. Rock ledges outcrop here on the bluff of the stream (Ford River) to a height of 25-30 feet ±. I am told by J. W. Gleason, Superintendent of the Wolverine Lumber Company at Northland, that hardwood strips run east-west in eastern Dickinson County between the streams. There are tamarac and spruce swamps bordering the streams. One of these hardwood strips

runs through south part of T.44.N., Ranges 27 and 28 West, between West Branch of Escanaba River and Ford River. It also covers part of the portion of T.43N., R.27W., north of North Fork of Ford River. There is another belt on south side of the North Branch of Ford River, but this strip does not extend to the South Branch of Ford River in T.43N., R.28W., and southwest part of T.43N., R.27W., there being a strip of pine plains from about Sections 29 and 32 west up the river across T.43N., R.28W. The rolling hardwood land that I mapped today in north half of T.43N., R.26W., he thinks runs southwest past Alfred s through southeast part of T.43N., R.27W., and then south to Hardwood Station on the Metropolitan branch of C. & N.W. Railroad. The hardwood country runs west across T.42N., R.27W., and T.42N., R.28W. All this hardwood country is rolling and has heavy deposits of drift. Whether it all belongs to the Green Bay lobe is not clear. The belt running from Alfred to Hardwood seems to be the Green Bay Lobe. East of it, in T.42N., R.26W., is a tract similar to the south part of T.43N., R.26W., with considerable swamp and only low ridges, some of which are eskers and some drumlins. This kind of country runs east to the Escanaba River across T.43N., R.25W.

Limestone is found at moderate depth from Northland east and south but not west. It forms the bluff of Ford River. The ridge of drift that sets in south of Northland runs southwest toward Hardwood Station. There is a choppy, gravelly and sandy tract north of Ford River from Northland to Alfred. The high hardwood ridges there come in from the northeast and cross to south side of Ford River about opposite the junction of the North and South Forks.

October 30, 1905, 7:00 a.m.

Aneroid 29.160 at Northland Station. Mr. Gleason tells me that there is a sandy country from Chaning northeast to Hardwood and then east through the north part of Dickinson County to connect with the sandy strip I noted in northeast part of that county. This seems to limit the Green Bay lobe on the northwest. The sandy country runs from Chaning southwest toward Panola. There is some hardwood mixed with pine near Sagola south of Chaning that may be in the Green Bay morainic tract.

Aneroid 29.180 at Northland at 9:35 a.m. I take a logging train back to Gleason. Aneroid 29.150 in rock cut 1/4 mile southwest of Ross Station in Section 21, T.43N., R.26W., (where I noted striae yesterday) at 10:00 a.m. I take a wagon road northeast and rise to a high ridge about 1/2 mile from Gleason. Aneroid 29.050 at crest. It trends east-northeast - west-southwest and is shown on map as outlined yesterday by Mr. Reublln. Aneroid 29.050 at Camp 5 about 80 rods south of center of Section 2 at 11:20 a.m.; 29.040 at 11:50 a.m. at same place. There is considerable elevated hardwood land in this part of T.43N., R.26W., with boulders. There are not sharp hummocks but instead large ridges with broad gentle slopes. The drift is loose textured, gravelly and sandy loam.

I continue northeast to a hunter's camp at center of SW¼ Section 36 on bank of West Branch of Escanaba River. Aneroid 29.100 at stream at 12:40 p.m. This is Camp Cottrell. I go east to Mr. Dean's Homestead in southeast part of Section 36 and from there take a. road northward. It enters pine choppings in a short distance--less than 1/2 mile from Dean's homestead. The hardwood is in a belt only 1-1½ miles wide on north side of the West Branch of Escanaba River, east from this range line. The surface is as rolling in the pine as in the hardwood in Sections 31 and 32, T.44N., R.25W., the swells being 20-40 feet high with broad, gentle slopes. After crossing the stream in south part of Section 30 I am in a sandy plain with scarcely any undulation and standing less than 10 feet above this stream. There is a narrow tamarac swamp along the stream. The soil has scarcely a pebble in it from this creek north 3 miles, but south of the creek there are not only numerous small stones but also large boulders. Limestone fragments are conspicuous and limestone forms the bed of West Escanaba River south of here. As I approach the group of lakes in near corners of Sections 12 and 13, 7 and 18, basins set in and the soil becomes gravelly. I am in a pitted plain from here north to within 2 miles of the mines in T.45N., R.25W. The lakes are in basins about 30 feet below the general level of this plain but there are wide areas around them only 10-feet to 20 feet above the lakes that give the appearance of an undulating tract. The high part of the plain, however, is flat. The pebbles are from 5 inches in diameter down, to small pebbles and sand. They are all crystalline rocks, largely granitic and I am unable to find a limestone pebble. This suggests that the pitted plain belongs to the ice lobe that stood north of it, instead of that on the south. This plain is bordered by a range of gravelly hills running east-west across Sections 29 and 30, T.45N., R.25W., north of a chain of lakes. Aneroid 28.940 at north edge of pitted plain 2 miles south of Princeton mine; 28.880 at wagon road summit; 28.810 on knoll just east of summit in road. About 60 rods east is a hill 60 feet higher. Aneroid 28.890 at Princeton = 1,200 feet ±; 28.980 at Swanzy = 1,140 ±.

The range of hills in Sections 29 and 30 is only 1/4-1/2 mile wide. There is a strip of bouldery land on the north slope but it is narrow. There is a pitted plain from this ridge north to the hills at the mines and these hills have rock in them. The jasper rock is struck at 10 feet at the Princeton mine and it is struck at moderate depth at all except the Stephenson mine (in SW¼ Section 20) where there is 80 feet of sand. This mine is 50 feet lower than the Princeton and about 15 feet lower than the Austin. There are boulders and gravelly material on the hills around the mines and hardwood timber but it is not decidedly morainic and I doubt if there was a halt of the ice margin at this range. There are few, if any, boulders in the pitted plain south of the mines. It had mixed timber with a lot of pine and small amount of hemlock, birch, maple, etc.

October 31, 1905, 7:00 a.m.

Little Lake, Michigan. Aneroid 28.695 = 1,122 feet A.T. I take train to Cyr. There is sandy land to where the railroad turns more to the south about 3/4 mile from Little Lake. A tamarac swamp here sets in that extends a little beyond Cyr Station. Aneroid 28.715 at Cyr = 1,100 feet ±.

I was told by the storekeeper at Little Lake that there are small knolls in Sections 6 and 7, T.44N., R.24W., and in sections west from there in T.44N., R.25W., which have mixed timber and a sandy loam soil. Some are sandy and timbered with hemlock but those with loamy soil have birch and maple as well as hemlock and pine. Some have only poplar brush. These knolls and ridges are shown on the land survey charts and copied on my map of Marquette County. The highest are only 15-20 feet above the bordering swampy land. The swamp around them, he says, is not quite so wet as the tamarac swamp to the east known as the Cyr swamp. There are no settlers in that region and no roads to it. Aneroid 28.635 at ridge 1/2 mile south of cyr. The cut along railroad exposed a gravelly material full of pieces of Potsdam Sandstone and an occasional piece of calciferous limestone. The timber is hemlock, poplar, birch, and a little beech and maple. There are few, if any, boulders on the surface and in cuts. The largest stones are pieces of Potsdam Sandstone.

I was told at Little Lake that the knolls in Sections 6 and 7, T.44N., R.24W., and sections to the west have few boulders. There is a sharp sand ridge just south of Helena Station and another 1 mile south. Aside from these the knolls and ridges from Cyr to Lathrop all are loamy. There are no knolls over 15 feet high from Helena to McFarland and a good share of the land is swampy with tamarac and spruce timber. About a mile southeast of McFarland is a knoll 25 feet high east of the railroad. In and around Lathrop are knolls 10-20 feet high that give the surface a morainic aspect for they are closely aggregated, but I am told the knolls are more scattered a short distance away in all directions. There are no high ridges in this vicinity and swamps occupy more than half the surface. Limestone is struck at 5-10 feet in the swampy tracts around Lathrop.

Boulders are not very numerous on the knolls and are scarce in the swamps in this vicinity. Limestone blocks and cobblestones are numerous. This is all a good agricultural region and extends, I am told, west to. Escanaba River from as far north 9.s McFarland. Sections 25. 26, 35 and 36 in T.44N., R.25W., being good land and partly settled.

The ridge that runs from Section 30, T.44N., R.24W., northwest nearly to Helena is said to rise only 20 feet ± above the swamps and has a good soil. The timber is largely hemlock, but there is some birch, poplar and maple.

The Green Bay lobe probably had influence as far back as this ridge. The one south of Cyr Station is not so likely to be its product. It may be the continuation of the belt of moraine that runs through the south part of T.45N., R.26W., into southeast part of T.45N., R.25W. It is possible, however, that the Green Bay lobe formed it, and the crowding of that lobe against the one north of it may account for the high knobs found between Little Lake and Carlshend.

I take train at 10:10 a.m. from Lathrop to Brampton. Aneroid 28.600, 1040 feet ±, at Lathrop; 28.680 on the limestone cut near Maple Ridge Station noted on trip October 3, = 963. There is a large amount of swamp between Lathrop and Maple Ridge. It appears to be 90 per cent of the land in view. What little dry land there is has only low swells 10-20 feet high. Aneroid 28.750 at Trombly (Defiance Post Office) = 900 feet ±; 28.805 at Campbell = 866 feet; 28.850 at Beaver at north edge of the Perkins Moraine = 815 feet ±; 28.900 at Winde where the Perkins branch of C. and N.W. comes in = 790 ±. There is a sharp ridge north of this junction 25-30 feet higher. The junction is in a tamarac swamp. The land is swampy along the railroad all the way to Brampton and for 1/4 mile each side there is nothing more than 10 feet above the swamp, and I can see no knolls west.

Aneroid 29.000, 742, at Brampton at 10:40 a.m. The belt of knolls and ridges I saw on the drive October 3 from Brampton to Perkins and Beaver seems to be restricted to a narrow belt east of the C. and N.W. Railroad. I am told that there is level land clear through to Escanaba River from Winde and Brampton. There is a belt of good farming land west of Brampton in the southeast part of T.41N., R.23W. Aneroid 28.960 at Brampton at 11:30 a.m. where it read 29.000 at 10:40 a.m. = 742 feet ±. There is a sandy plain for 1½ miles south to a group of sharp, bouldery drift knolls lying west of the railroad for 1/4 mile. Aneroid 28.840 on highest knoll = 780 feet ±. They only occupy about 80 acres and are surrounded by swampy land, 35-40 feet lower than the highest knolls except in south where there is a dry plain. Aneroid 28.875 on plain = 745 feet. These knolls are probably in SW¼ Section 33. T.41N.,R.22W. There is a little reddish clay exposed in a plowed field on the slope but they have mainly a sandy loam soil of yellowish color. The sandy plain has a few small pebbles but seldom over an inch in diameter. I follow the railroad to Chaison and see no more drift knolls. The surface, aside from an occasional slight sandy ridge formed by wind, is very flat from Escanaba River east to the bluff west of Little Bay de Noquette. Aneroid 28.810 at brow of bluff 1 mile northwest from Gladstone = 715 feet ±; 28.880 at top of red clay in this bluff = 650 feet. The presence of the red clay so near the surface here suggests its presence farther back and this may account for the wetness of much of this plain, for there are tamarac swamps over quite a lot of it. This red clay is itself free from grit or sand but it is interbedded with sandy and gravelly layers. In some cases pebbly layers have stones 3 inches in diameter. The principal bed of clay is at the top and is 10 feet ± thick. Below this, sand predominates and there are only thin beds a few inches

in thickness. The sand shows considerable cross-bedding.

Aneroid 28.960 at base of steep part of bluff, probably the Nipissing beach, = 620-625 feet; 29.000, 585 feet ±, on low land by the 5oo Line Railroad. The track is 5 feet higher and rises southwest toward the depot which is 612 feet. The town is on a sandy spit that lies southeast of this sag. Probably the sag was over the site of a bay such as now lies north of Gladstone Point in vicinity of the furnace.

Mrs. Martin has a flowing well about 230 feet deep at a boarding house near the furnace in north part of Gladstone. It is a 4-inch well. Made in 1902.

There are 5 flowing wells at the Cleveland-Cliffs Iron Company furnace, ranging in depth from 230 feet to 700 feet. There are two horizons of flowing water, and the lowest is stronger. They are 5-6 feet above lake level. One will rise 26 or 27 feet above lake level. They are 4 inches and 6 inches. The earliest was made about 6 years ago. One at the roundhouse is 700 feet and lacks 12 feet of flowing. The surface is 27 feet above lake level = 607 feet. It is a 10-inch well about half way and 8-inch the balance. Rock is struck at 96 feet or 511 feet A.T. and the well is only cased to the rock.

Gladstone Station is 612 feet by railroad profile. Limestone is not at surface south of Days River until the Escanaba River is reached. The rode is exposed along the Escanaba River down to within a mile of its mouth.

The well at Gilchrist in Mackinac County is 1,111 feet and terminated in shale. Its head is 56 feet below surface. It yields by heavy pumping 60 gallons a minute without loss of head. Drift is 80 feet.

There is a shale cut 1/4 mile long and 6-7 feet deep on the Soo line 3½ miles east of Rapid River.

The deep well about 7 miles north-northeast of Rapid River is now down 835 feet. An old well was down about 800 feet.

Dr. McCallum has land on west shore of the bay in Section 32, T.40N., R.22W., that is excellent for brick. It is within 4 feet of top and is covered with sand. Another red clay in Section 6, T.40N., R.21W., is exposed along east side of the bay. It also runs 1/4 mile or more out into the bay.

The wells in Gladstone are 12-50 feet and there is an interesting series.

1. Coarse sand..... 5-10 feet
2. Quicksand.....30-40 feet
3. Muddy stuff looking like decayed vegetation..... 5- 6 feet
   (This is 20-25 feet below present lake level)

4. Gravel at bottom, with head about level with the bay or 16 feet below the general level of business part of town. Waterworks supply is from the bay at east end of Saunders Point, 600 feet offshore at depth of 36 feet. There is a decided current past this intake through the narrows. It was put in about 17 years ago or 2 years after town was started. It is piped nearly all over the town and scarcely 30 families get water now from other sources. It is municipal. The charges are 5 dollars not including bath and closets and wash stands, but including sprinkling. There are 37 hydrants, 4-inch, each with two 2½-inch outlets. Cost 135,000 with about 4-5 miles at first. Fire pressure, 150 lbs; ordinary pressure, 40 lbs. C. Nebel gave above information.

The flowing well belt follows the west shore of this bay southwest a long distance so that the cities and villages obtain them. Escanaba has several. Oconto, Wisconsin, has its waterworks supply from flowing wells.

November 1, 1905.

Aneroid 29.240 at Gladstone Station at 6:00 a.m. - 612 feet A.T. I take train to Rapid River. Aneroid 29.320 at Rapid River at 7:50 a.m. = 589.6 feet; 29.360 at 8:30 a.m. = 589.6 feet; 29.310 about 2 miles north of Rapid River = 615 feet; 29.330 at Mr. Sam Johnson's in Section 9 at 9:20 a.m. = 600 feet ±; 29.340 at Whitefish River = 590 feet; 29.310 at foot of steep bluff feast of river = 615 feet ±; 29.250 on plains east of Whitefish in Section 10 = 675 feet; 29.225 at north side of plains by foot of a ridge having mixed timber at 10:15 a.m. = 700 feet ±; 29.185, 750 feet ±; on top of ridge on tableland; 29.185 at Hamilton hunting camp in northeast of NE¼ Section 16 by a lake = 760 feet ±; 29.160 at camp 8 of Bay de Noc Lumber Company at noon in Section 11, T.42N., R.20W., = 800 feet.

There have been no boulders and only an occasional sandy ridge on this route since crossing the Whitefish River. It has hardwood and hemlock timber. There is very little clay in this region. I am told by men at the camp that the land that is not swampy from here north to Round Lake in Section 1, T.43N., R.20W., is very sandy and the knolls are only 10-20 feet high.

Aneroid 29.250 at camp in Section 11 at 1:00 p.m. = 800 feet; 29.310 at Sturgeon River in Section 13 = 750 feet. There is no rock on the bluff here but limestone slabs are scattered along the stream bed. Aneroid 29.200 on tableland east of river = 860 feet. This is flat except an occasional sandy ridge. There are few pebbles in the sand, on the flat land and none, so far as I can see, on the ridges. Aneroid 29.290 at Eighteen Mile Greek in south part of Section 17 at 2:15 p.m.; 29.250 on tableland east of creek; 29.210 about 1/2 mile east = 850 feet. I go northeast 3/4 mile on the Sturgeon River road but see no high knobs, nothing more than 20 feet above the general level, and the knolls are all sandy. There are long, narrow ridges that look like beaches but are likely to be wind formed as they contain no pebbles.

I go south from here and enter a pine plain that has been cleared of timber about 1/2 mile south of a good sized creek near line of Sections 21 and 28. The border between the hardwood and pine runs parallel with this creek and about 1/2 mile south of it as far northeast and southwest as I can get a view. Aneroid 29.250 at north edge of the pine belt. This is a very flat tract, = 820 feet. There is some red clay under sand in north bluff of

Sturgeon River similar to that west of Gladstone, and this pine plain reminds me of that.

Aneroid 29.380 at Sturgeon River in Section 33. T42N., R.19W., = 700 feet; 29.465 at Nahma Junction at 5:00 p.m. = 618 feet; 29.445 at St. Jacques at 5:20 p.m. = 630 feet.

The well at the hotel is 35 feet (and 2-inch diameter). Mr. Ed Shay, 1/4 mile east, has one 65 feet, driven well. Mr. Dan McAuly has a dug well 26 feet deep near the hotel. Peter Gagnon has a dug well of similar depth.

There is a strip of till with good soil that runs north 3 miles from St. Jacques and about 2½ south and is a narrow belt scarcely a mile in average width. It is slightly bouldery.

There is a wide belt of sand bordering Sturgeon River from its mouth north as far as I have been today. This Moraine belt running north-south past St. Jacques has a sandy loam soil with cobblestones and occasional boulders. The ridge 3 miles south of Ensign that runs east-west has limestone at slight depth--5 feet ±--and has a rich, clayey soil. The flat land from Ensign south to this ridge has a limestone substratum. It has a sandy loam, rather than sandy soil. The flat land bordering Sturgeon River south from where we crossed in Section 33, T.42N., R.19W., is a mile or more wide up to that point. The high land extends 2 miles south on east side of the river, and there low land sets in that runs south and east to Moss Lake.

At Nahma are two flowing wells; one 133 feet, the other about 80 feet. The deeper one was made in 1883 and is a 2-inch pipe. It will flow scarcely a gallon a minute. It is into rock some distance. The shallower well is 4 inches in diameter and does not reach rock. It will flow a barrel in 5 minutes or less. It was made about 1895. They are owned by the Bay de Noc Lumber Co.

The belt of good land from Moss Lake southeast and east is a clay loam with spots of clay at surface. Its west border runs from the east side of Moss Lake south through Sections 3, 10 and 15 into Section 22. It is farm land and it runs north into Section 24, T.41N., R.19W. Limestone is near surface south of the state road for a short distance in Sections 1, 2, 11 and 12. No rock is exposed around Moss Lake. The east bank is clay and the rest sandy. This covers also Section 31 and part of Section 32, T.41N., R.18W.

Isaac McPhee, of Garden, gave me a lot of information as to the land west and south of Indian River. He has noticed boulders in the northwest part of T.43N., R.17W., in the hardwood but not in the remainder of the township. The part east of Indian River is very level sand but that west is rolling, about like the ridges northeast of Steuben. A belt of hardwood about two miles wide runs west across north part T.43N., R.18W., and south part of T.44N., R.18W. North of it, along Indian River, is a belt of sandy plains and there is a wide belt south of it covering much of T.43N., R.18W. The north half of T.42N., R.17W., is rolling sand land like the part of T.43N., R.17W., on west side of Indian River. There is a little piece of hardwood west of Thunder Lake in Sections 19 and 30, T.43N., R.17W., as well as the larger tract in northwest part of the township.

The greater part of T.44N., Ranges 19 and 20 West, is sandy land with few if any boulders or gravelly drift, and but gently undulating. There is a dryer tract in east part of T.44N., R.19W., than in the west, just as there is in T.43N., R.19W., and it may also be a little higher. In the southwest part of T.42N., R.19W., is some land with red clay and there is a rolling tract in northwest part of T.41N., R.19W., that has a good soil, a first rate sandy loam. This tract is a. continuation of the moderately rolling land with hardwood timber that runs northeast from Sturgeon River across the north half of T.42N., R.19W. This ridge at St. Jacques may be the southward continuation. It is probably morainic, yet there is a remarkable scarcity of boulders and even of small pebbles, a stone over 2 inches in diameter being rare. The relief above lower land west of it on west side of Sturgeon River in T.43N., R.19W., and T.42N., R.19W., is like that of a moraine. It is probable that this lower land laid under the thicker part of the ice sheet. Perhaps this great sandy belt is interlobate between the Green Bay and Lake Michigan lobes. Studies farther east ought to clear this matter up.

November 2, 1905, 6:15 a.m.

Aneroid 29.400 at St. Jacques Hotel on the ridge = 635 feet; 29.385 on sand ridge east of the hotel = 650 feet; 29.430 at St. Jacques Station = 617 feet A.T. There are scattered boulders on the ridge between hotel and depot. The depot is in a sag. Aneroid 29.410 at hotel at 7:00 a.m. The sand ridge at east edge of this tract of good farm land is sharp like an esker and stands 10-20 feet above it. Probably it was formed by wind as it is clear sand, and there is a sandy plain with low ridges of sand east of it to Moss Lake and to Mahma. There is a clay tract from Ogontz River west across Sections 34 and 33 into Section 32 that rises westward and becomes bouldery near its west edge next to the sand ridges. These sand ridges do not extend south to the railroad track at Ensign but are 1/2-3/4 mile north. A lower belt of sand crosses the railroad west of Mile Post 353 or 1½ miles west of Ensign and runs south on east side of Little Bay de Noquette opposite Gladstone. Aneroid 29.290 at Mile Post 353 at 9:20 a.m. = 681 feet; 29,280 at top of shale in cut 20-60 rods east = 690 feet; 29.230 at Ensign Station at Mile Post 354.5 at 9:50 a.m. = 716 feet A.T. Rock struck here at 10 feet.

I take train east on Soo Line Railroad. Aneroid 29.320 at St. Jacques = 617 feet A.T. Probably Lake Nipissing covered the low tract east from this ridge at St. Jacques. Aneroid 29.350 at Nahma Junction = 618 feet. Ditto on Sturgeon River bridge = 618 feet. River bed is 22 feet lower. Water about 16 feet lower, or 602 feet A.T.

There are sand ridges east-west across south side of Moss Lake, probably Nipissing beaches, so Lake

Nipissing extended to north shore of Moss Lake. These ridges are about 625 feet A.T. The flats near Isabella have a reddish clay with sandy spots. There is an outcrop of limestone a mile west where altitude is 637 feet A.T. It is only 615 feet at Isabella. There is a fine farmland here as noted last night, and it is nearly all under cultivation. The swamp east of here is lower than the sandy plain west. Aneroid 29.380 = 591 feet at Mile Post 369. The land is low but sandy east of Big Fishback River with jack pine where dry, and with spruce and tamarac where wet. Aneroid 29.385 on much of it for 1½-2 miles from the river. A cedar and spruce swamp sets in in Section 23 where the railroad swings from a northeast to a southeast course. A rapid rise is made from this swamp up to Cooks Mill. Aneroid 29.300 at Cooks Mills near Mile Post 375 = 703 feet at 10:30 a.m. Rock is struck here at shallow depth and it is near the surface all over the hardwood belt that covers the southern third of T.42N., R.17W., and a large part of T.41N., R.17W. The wells on this tract are often 60 to 75 feet to a good supply of water. The soil is a sandy loam with some sandy ridges, but is generally a good quality of farming land. It has only a few boulders so far as I can learn. The fanning land extends only a mile or so south of Cooks Mill and about the same distance southwest. In T.40N., R.18W., the only farmland is in the southwest part in Sections 28, 29, 32 and 33. The remainder is largely barren sandy ridges.

The large spring northwest of Indian Lake is 62 feet deep and covers about 1/4 acre. A creek runs from it to Indian Lake that is large enough for gasoline launches to run up. This spring is the head of the creek. The water is sulphurous. There are no ledges around the spring, but there may be a rock bottom. The water is so clear that objects can be seen on the bottom.

Aneroid 29.245 at Cooks Mill = 703 feet at noon. I go northeast to a wagon road that leads across limestone ledges past some old charcoal kilns. The limestone reaches about 740-750 feet A.T. There are sandy ridges 20-25 feet higher. I go east to where the road turns south across the railroad and then follow railroad east, entering the jack pine plains just west of Mile Post 377. This has an altitude 731 feet. The plains have a barren sandy soil with very few pebbles.

There is a gravelly knoll cut by the railroad in west part Section 27; cut is 6-8 feet deep. The maple grove ridge has a cut 20 feet deep and is gravelly and cobbly. The crest is 753 feet. Possibly it is a lake beach, but it seems large, being nearly 1/8 mile wide and 20 feet high. About 3/4 mile east of this, or 1/10 mile west of Mile Post 379 is another ridge with a capping of sand but with angular limestone blocks below. The cut is 21 feet and top about 740 feet. There are some large blocks of Niagaran limestone here and in a small cut about 40 rods west. This ridge has hardwood timber in larger amount than the one marked as maple grove, and there is another ridge 1/2 mile south-east with hardwood. The low ground among these ridges has jack pine. This country marked pine plains is more ridged and morainic-like than the hardwood belt northwest of it. There are, however, only a few boulders on these ridges, most of the material being either cobble and gravel or limestone blocks of rather local, derivation.

Mile Post 379, which is 1/10 mile east of the last deep cut noted, is 715 feet and the cut is 21 feet so it is between 736 and 740 feet at top. There is gravel at slight depth under the low tracts as shown by excavations along the railroad made to obtain filling for the grade.

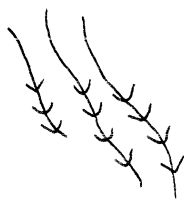
At Delta Junction a hardwood tract sets in that runs from the south end of Indian Lake south-southeast to the shore of Lake Michigan. It has boulders and a clay loam to sandy loam soil and will make good farmland. The altitude is 668 feet at Delta Junction and 660 feet at Mile Post 381, about 3/10 mile east of the Junction. The hardwood has maple and beech and with it some hemlock and birch.

I am told by a farmer living east of Delta Junction that boulders are not so numerous south from here as along the railroad and north to Indian Lake. There are cobblestones on the lake shore at Wiggins Point, but a clay loam with few pebbles back from the shore. About a mile east of Delta Junction there is a descent to a swamp that runs from Indian Lake south to Lake Michigan. The west edge is 614 feet but near Mile Post 384 it is only 600 feet. The Mile Post being 604 feet, and the track is 4 feet above a swamp bordering it.

The Manistique Paver is held up to 599 feet by dams below the railroad bridge. The river here is flowing on limestone ledges. The limestone seems not to be present west of the river at as great an elevation as east, for I saw no exposures along the railroad from Delta Junction to Manistique. The rock is present up to over 600 feet A.T. in the city. The sewers and water pipes are laid in trenches in the limestone. In the northeast part, north of the court house, the rock reaches about 650 feet A.T.

November 3, 1905.

Manistique, Michigan. I find extensive exposures of a glaciated rock surface at west end of a range of sand hills in the north part of Manistique about 120 rods north of the court house. Bearing, S25°E. There are crescentic circles in the rock convex to the south, formed along some of the grooves. They are from 1/2 inch to 1½ or more long. Aneroid 28.940 at the striated ledge.



There is a cobble beach running northwest-southeast past the court house. Aneroid 28.950 on beach. It only runs 1/2 mile southeast to end of a rock hill. There is a

recess east of this hill extending north to a belt of dunes south of the Soo Line Railroad. This was covered by Lake Nipissing and it is probable the dunes are Nipissing. There are also dunes west of these on top of the limestone ledge. The court house is not far from 615 feet.

Aneroid 29.010, 605.7 feet, at Manistique, Marquette and Northern depot in Manistique at 10:00 a.m. I take train north to Beeson's Spur. The land for 3 or 4 miles north of the outlet of Indian Lake is so low that the Manistique River floods it in high water beyond this railroad track. It is 612-635 feet A.T.

Aneroid 28.995, 622 feet, at wagon road crossing probably near line of Sections 12 and 13. There are a few sand ridges south of here on borders of a small stream. From here there is a steady rise in the swamp to Hiawatha, 669.9, aneroid 28.950. There is a sandy bank 30-35 feet high north and east of this station. It has few, if any, pebbles and is timbered. Aneroid 28.940 at Beeson's Spur at 11:00 a.m. Perry Fletcher, in NW¼ of NW¼ Section 9, has well 65 feet.

Aneroid 28.875 on level of upland in northwest corner Section 16 = 735-740 feet. This level is maintained east into hardwood land. The pine land on west edge is ½-1 mile wide. It has few, if any, boulders here and the sand is so light it will drift into low ridges. In the hardwood the land is gravelly, with an occasional boulder on the surface. Wells are 40-65 feet deep and penetrate mainly sand but there are pebbly beds 1-3 feet in diameter. The lakes are in depressions about 40 feet below the tableland. The deepest lake is on the line of Sections 14 and 15 and is 75 feet. There is one in northwest part of Section 15 only 10 feet--several are only 10 feet deep.

Aneroid 28.920 at Mr. Frank Aldrich at 1:00 p.m. = 740 feet. I go east two miles across a nearly plane tract with gravelly loam and occasional boulders. In places there is a clay subsoil several feet thick. There is a point of hardwood running east into Section 12 in the northwest part of SW¼ but on the north and east is pine and in the south along a creek is a swamp.

Aneroid 28.950 at Mr. Byrn's in northeast part Section 14 at 1:45 p.m. = 740 feet ±. In Section 23 I pass a well that has red clay in the dump around the curb but the surface is a gravelly sand with but a little earthy matter. The lakes in Section 18, T.43N., R.15W., are said to be in deep basins as well as those in Sections 14 and 23, T.43N., R.16W. I enter a pine plain in north part of Sections 25 and 26, T.43N., R.16W. It covers much of Sections 25, 26 and 36 in this township, Sections 29, 30, 31, 32 and 33 in T.43N., R.15W., and Sections 4, 5, 6, 7, 8 and 9, T.42N., R.15W. A strip of hardwood timber and gravelly loam soil runs along its northeast from Section 19 through Sections 20, 29, 28, 33 and 34, T.43N., R.15W., and Sections 3 and 10, T.42N., R.15W. to the Manistique River. This seems to mark an ice border fronting the southwest and it probably finds westward continuation in the bouldery moraine in north part of T.43N., R.17W., and the moraine and hardwood on line Townships 43 and 44 North, R.18W. Aneroid 28.985 at south edge of tableland at 3.20 p.m.. in Section 6, T.42N., R.15W., = 700 feet ±; 29.050 in swamp 1/2 mile south; 29.065 at Sturgeon's Hole crossing of railroad where it read 28.995 at 10:40 a.m. = 620-630 feet at 3.45 p.m. There is a sand ridge here, probably Nipissing.

I go southwest 1½ miles to a limestone tract with hardwood timber. Aneroid 29.060 at south edge of the swamp. This is perhaps 5 feet or more above wet parts for there is a sandy border next to the limestone. Aneroid 29.030 on first rock shelf where road turns west; 29.010 on second rock shelf 1/8 mile west where road turns south. About 40-50 rods south is a rise to a higher ledge where a road comes in from west. Aneroid 28.990, 690-700 feet, at top of ledge at 4:20 p.m.; 28.985, 700 feet, about 1/2 mile farther south. Here a descent to the south sets in. Aneroid 29.040 at cross roads 1/2 mile south. by a schoolhouse. Limestone at surface. Aneroid 29.075 a mile farther south at 5.00 p.m. Limestone at surface. Aneroid 29.170 at Manistique at level of business part of city about 600 feet A.T. at 6:10 p.m. The limestone hardwood tract extends south nearly to the outlet of Indian Lake and the limestone appears for 1/4 mile ± south of this station.

There are flowing wells in Manistique about 200-210 feet deep, and some of much greater depth. Hiawatha hotel, near 5oo Line depot. One on Deer Street west of river. Another on west side. One near Bouscherfs saloon in business part of town on east side of river. One near Barnes hotel. Some in east part of city in Lakeside.

The Burrell Chemical plant, on east side of river south of Soo Line Railroad have several, wells and when they are pumped strongly the others stop flowing. The head is but little above the surface, Manistique is now putting in a public water supply, taking water by gravity from Indian Lake to a reservoir in the city, the fall being about 20 feet to the level of the river above the dams. There is a dam 6 or 7 feet high at the brewery on the outlet of Indian Lake, and a rapids near the mouth of the outlet. I am told by a liveryman, Fred Orr, at Manistique who is very familiar with the country southeast of the river that the same sort of red clay with boulders that I noted for 6 miles south of Germfask continues south past Blaney to within 3 miles of Whitedale. The wagon road is through it all the way from Blaney southwest into the northeast part of T.42N., R.14W.

November 4, 1905.

Aneroid 29.530 on the Nipissing beach at court house = 620 feet ±. This runs north across the wagon road past west end of sand dunes to the bend of Manistique River. It is a pebble beach 3-4 rods wide and about 4 feet high where it crosses the wagon road near the range line about corner Sections 1 and 12, 6 and 7. There is a strip of dunes along south side of railroad and wagon road in Sections 7 and 8, T.41N., R.15W., rising 30-50 feet above the railroad track.

There is a swamp along the river in Sections 5 and 6. There is a tableland in east half of Section 5 standing 675-700 feet A.T. Aneroid 29.440 at southeast corner of Section 5. No rock is exposed along the low tract between this tableland and the rock ledges in east part of Manistique nor in the bluff of this tableland which is 60 feet high. Wells 35 to 50 feet deep on the tableland in Sections 4 and 9 do not reach rock. They are through a sandy gravel the entire depth. The surface of this tableland shows an occasional small boulder and a few cobblestones, but cuts in it are a sandy gravel. It has pine and hemlock at the west edge but hardwood within 1/2 mile east and the soil gets more loam, to the east and changes to a clay near a small creek in Sections 2 and 11. Limestone sets in near this creek and is near surface all the way to Whitedale. It reaches an altitude about 100 feet above the lake in Section 36, T.42N., R.15W., and Section 31, R.1W. There is reddish clay with spots of sand. a few granite boulders occur.

The surface is very flat for 2 miles west of Whitedale and extends north as far as I can see with scarcely a ridge 5 feet high. Farther west the limestone has an uneven surface.

South of Gulliver Lake is a range of sand dunes with some points 50 feet or more above the lake. Whitedale Station and the plain north is less than 10 feet above the lake. Aneroid 29.570 at Whitedale at 11:10 a.m. = 624. The lake is very nearly 620 feet A.T.

I am told rock is near surface for several miles north from Whitedale or up to where Mr. Orr stated that knolls of red clay and boulders set in near the Blaney-Manistique wagon road (see notes last night).

I take train to Trout Lake at 11:30 a.m. There is rock near surface wherever land is above swamp level for 2 miles east from Whitedale. There is a flat country with few points more than 5 feet above swamps all the way to Blaney Junction, but I do not see rock after passing Parkington. The soil is a reddish clay and this continues east past Hunt's Spur. The only cut made by railroad is 1/4-1/2 mile west of Hunt's Spur and is 3-5 feet. There is hardwood timber around Hunt's Spur and considerable hardwood east from there, the land being less swampy than I had expected to find from what I saw west of Corinne in September. If cleaned up and ditched there would be cultivable land clear up to Pike Lake. A travel beach runs along the south side of this lake having an altitude 749 feet A.T. It has been excavated for railroad ballast, several acres having been removed to depth of 6 or 7 feet. Aneroid 29.425 at Corinne = 773 feet. The gravel ridge southeast is about 790 feet (see notes in September). Aneroid 29.460 at Bovee, a mile east of Gould City. Probably the gravelly beach I noted in September north of Gould City is about 750 feet and the same as that at Pike Lake.

The country is similar from Corinne to Engadine to that north of Engadine--a clay and gravel with low hummocks. About 1½ miles west of Engadine rock is at surface over several acres. There is a sand ridge a mile ± west of Engadine at about 700 feet.

Hardwood timber is practically continuous, aside from swamps, from near Manistique to the Millecoquin River, but east from this are pine plains and sandy ridges for about 3 miles. Mixed timber there sets in an a cobbly sand with occasional boulders showing in cuts. After passing there for 1/2 mile ± a sandier tract with very few pebbles sets in.

There are occasional ridges but they appear to be sand with few, if any, pebbles. The land has a rather light soil. I am in doubt as to whether the ice border ran southeast along the northeast edge of the pine plains. The cobbly, bouldery strip along the edge of the hardwood suggests an ice line. This may come in back of Pt. Epoufette and Brevoort and run north of Brevoort Lake.

From Trout Lake I go northwest along the railroad 1½ miles to the edge of the sand ridges and to within 1/2 mile of a hardwood belt that lies west of the railroad. There is pine on these sand ridges and east as far as I can get a view. The altitude is about 860 feet on the flat tract north of the ridges. The ridges in places reach 880 feet. The flat tract south of them at Trout Lake is 835 to 840 feet. This seems likely to mark about the level of Lake Algonquin. (See notes in 1912 and 1916.) I am told by residents of Trout Lake that there are similar sand ridges for 2 or 3 miles south of the lake to those north, 20-40 feet high and separated by narrow marshy tracts. There then comes a more extensive swamp, as shown on the Land Survey plats. Sand ridges extend 2 miles or more southeast to the edge of the limestone country. They extend east nearly to Brimley. There is hardwood south of Twin Lakes where sand ridges are as well as on the limestone east of them. The ridges are low after getting a mile south of the lakes.

I take a freight train to St. Ignace. There is sandy land at Ozark at 850 feet or more. Aneroid 29.330 at station. There are sand ridges south of Murray Switch at about 810 feet, 15-20 feet high. The main ridge is a little over a mile northwest of Palms (Kenneth). Aneroid 29.430 at Kenneth Station; 29.500 at sandy ridges north of Carp River a mile at curve in track; 29.540 at Nogi Station on bank of Carp River where a new mill has been built.

A mile south of Carp River is a similar ridge to that north and at about same altitude--29.500. It is 15-20 feet high. The altitude is not far from 700 feet A.T. After passing Greene siding a mile farther south a rapid descent occurs down to about 650 feet. About 2 miles north of Moran an ascent sets in. Aneroid 29.520 at Moran.

From Palms to Moran the surface has been featureless except for the sandy ridges near Carp River--most of it swampy. From Moran south past Allenville rock is near the surface which is uneven, giving it a hummocky aspect. Aneroid 29.520 at Allenville; 29.680 at St. Ignace = 590 feet at 5:40 p.m.

November 5, 1905.

On train to Detroit from Mackinaw. It became light as we passed through Lapeer County and I noticed an undulating surface sets in near Hunter's Creek with basins while south of there are prominent knolls before reaching Metamora.

November 9, 1905.

I read N. H. Winchell's paper in American Journal of Science, 3rd Ser., Volume 2, 1871, pp. 15-19, on the glacial features of Green Bay, in which he mentions that A. S. Wadsworth of the Michigan Geological Survey had rioted a channel with rocky bed and drift bluffs crossing from Au Train to Whitefish Rivers near Mud Lake in Alger County. He speaks of it as but little above Lake Superior. It is, however, 166 feet (or 768 feet A.T., Cleveland-Cliffs Iron Company survey). Rominger refers to this channel in Volume I of the Michigan Geological Survey, but does not believe it was the line of discharge from Lake Superior to Lake Michigan. He erroneously puts the height of the divide at Mud Lake at 300 feet above Lake Superior and suggests that by a little further rise all the Northern Peninsula would have been carried east of the Huron Mountains district.

November 10, 1905.

I read Dr. John Bigsby's paper on Geological and Mineralogical Observations on the northwest portion of Lake Huron, American Journal Science, Volume 3, 1821, pp. 254 to 272.

It includes district between Latitude 45°45' and 46°20' and Longitudes 83° and 84. St. Joseph Island is heavily wooded and rises 500 feet above river. Drummonds Island is an assemblage of rocks and. morasses. The Lesser Manitou is like Drummond. Grand Manitou has bold precipices on the west. The northern mainland is high, barren and rocky. The southern is level, and abounds in dense woods and marshes. The rocks are secondary. Considers the breaks in the Manitoulin chain and at Detours to be due to great rush of waters. I am inclined to the opinion that an enormous body of water has rushed over these countries (a debouchure) swept from distant lands the collosal fragments of rock so frequent in the lake, and formed the beaches called the detours. The fragments are incredibly numerous in Lake Huron and may be divided into two classes, the foreign and the native. The former are more plentiful and are round and smooth. They are seen everywhere, but are collected principally in the interior of the coasts and islands, either in confused heaps or in parallel ridges and crowning the highest acclivities in great numbers, and the fragments are of various dimensions. They belong almost exclusively to the older order of rocks and are, therefore, of a northerly origin--The other class is small, angular and ragged. They are most frequent on the beaches whither they are driven by the waves."

Striae are noted as due to winter ice, "Remarkable instances of this are found on the islets near the south end of St. Joseph, where a few yards from, the water and a little above its level are deposited rolled stones some yards in diameter, with a furrow extending from them to the water, most probably tracing the last steps of the route to their place of rest."

The high beaches were noted. "Many of the facts just stated show that the waters of Lake Huron have been in much greater quantity than at present and to them may be added the marshy alluviums, and the extensive collections of sand around the base of precipices and on the sides of heights. Ancient beaches are not uncommon at some distance from, the water, as on the Lesser Manitou. It is likewise evinced by the belts of rolled masses which gird every slope, and even mark the successive retreats of the lake."

Henry R. Schoolcraft's paper in American Journal Science, Volume 3. pp. 201-216, deals mainly with copper but has a few statements on soils and climate. "With an elevation of 641 feet above Atlantic Ocean and deriving its waters from territories all situated north of the 44th degree of north latitude, Lake Superior cannot be represented as enjoying a climate very favorable to the production of the vegetable kingdom. Its forest trees are chiefly those of the fir kind, mixed with white birch and with some varieties of poplar, oak and maple.

The meteorological observations which I have made indicate, however, a warm summer, the average heat of the month of June being 69 degrees, but the climate is subject to a long and severe winter and to storms, and sudden transitions of temperature in the summer months."

Notes are also made as to water power possibilities at the falls of St. Marys which are said to be 22 feet feet instead of 17 feet, and the country bordering the falls is said to be "such as to admit of an agricultural settlement".

As to mining, he considers the prospects good for extensive mines, and he looks upon the falls of St. Marys as the natural place for- their conversion into metal.

Schoolcraft makes an early reference to the old outlet from Lake Michigan to the Illinois, American Journal Science, Volume 4, 1822, page 289.

"There exists a water communication between the head of Lake Michigan and Chicago, and the river Des Plaines during the periodical rise of the latter, but its summer level is about 7 feet lower at the termination of the Chicago portage than the surface of the lake."

Concerning the richness of the region near Chicago, he says on page 290: "But it is not alone to the sylvan exterior of the country, to the pleasing variety and succession of precious forests, streams, and precipices; or to the geological arrangement of its strata and soils that we find our reflections irresistibly directed. Every emotion raised by the contemplation of pastural and

picturesque objects must yield to considerations of the national and domestic purposes to which it is so admirably adapted by its fine climate and productive soil. We cannot survey without a feeling of delight a country prepared for the future abode of millions of the human species who are destined to augment our national resources and to transmit to posterity the blessings of our republican institutions."

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Schoolcraft's communication on the action of the North American Lakes in American Journal of Science, Volume 44, 1843, Pp. 368-370, pertains to the effect of waves on the Pictured Rocks and of winds on that region that have produced dunes 300 feet above the lake.

In addition to the modern dunes he notes "other arenaceous deposits forming broad, sandy belts, bordering the lakes and supporting a light growth of pine, poplar and birch". These he considers due to a similar action at an earlier period when the waters of the lakes stood at a higher level and occupied a wider area, a condition which is further indicated by the occurrence of wide lacustrine deposits in the same neighborhood.

Weather at Fort Brady, Sault Ste. Marie, June, July and August, 1825 communicated by Dr. Lynn Foote to American Journal of Science, Volume 10, page 303. This occurs in connection with reports from other parts of the United States showing an exceptionally hot sunnier. Cooling effect of wind from Lake Superior shown on June 18 and 19, July 10, 11, 30 and 31, and August 27 and 28, etc. (See Foster and Whitney Report for 1850, Part 1, pp. 41-44, for other climate data.)

	JUNE Hours			JULY Hours			AUGUST Hours		
Date	A.M. 7:00	P.M. 2:00	P.M. 9:00	A.M. 7:00	P.M. 2:00	P.M. 9:00	A.M. 7:00	P.M. 2:00	P.M. 9:00
1	48	58	44	61	66	60	58	66	56
2	49	58	47	59	74	64	59	78	56
3	58	72	59	62	78	65	61	77	64
4	58	76	60	67	71	61	66	72	59
5	64	80	61	64	67	56	63	76	64
6	61	78	67	57	61	51	65	80	66
7	69	81	58	62	71	56	71	76	62
8	71	88	75	64	66	60	67	84	68
9	65	81	64	64	78	70	66	62	55
10	68	80	69	74	82	75	57	67	55
11	67	74	59	66	58	53	62	72	66
12	63	69	57	61	70	58	69	74	65
13	63	61	52	64	80	64	71	79	66
14	62	76	55	66	83	69	69	81	71
15	62	64	57	71	79	66	69	70	62
16	66	68	55	61	76	62	64	70	60
17	64	72	61	71	82	69	65	74	60
18	69	80	56	73	89	76	57	70	55
19	52	66	56	74	88	75	58	72	58
20	59	75	65	76	78	75	63	76	59
21	65	54	49	74	80	68	73	76	65
22	57	62	50	71	78	67	68	80	65
23	58	71	57	67	70	58	67	89	73
24	59	74	62	62	64	56	67	84	70
25	59	54	51	61	66	53	70	88	78
26	57	59	51	57	72	54	73	87	76
27	52	60	50	61	76	62	71	77	70
28	54	56	48	67	80	66	69	59	58
29	59	68	64	69	83	68	64	76	64
30	64	63	59	71	81	66	66	78	62
31				69	60	52	66	62	56

List of striae taken from a long list in Logan's History of Canada, 1863, pp. 890-892; only those of value to Upper Peninsula glaciation being here copied.

Locality	Latitude	Longitude	Bearing
Goulais Bay	46°46'	84°29'	S30°E
Batchawana Bay	46 56	84 27	S23 W
Batchawana, east angle	46 54	84 22	S23 W
Batchawana, east part	46 52	84 22	S 2 E
Macdonald Township, south boundary	46 26	84 00	S40 W
Macdonald Township	46 26	83 59	S25 W
Echo Lake Island	46 33	83 58	S55 W
Echo Lake shore	46 33	83 58	S70 W
Walkers Lake Hill north shore	46 24	83 55	S10 W
Raft Lake, east island	46 31	83 54	S 9 W
Thessalon Lake, west island	46 26	83 49	S17 W
Thessalon Lake, south shore	46 25	83 48	S17 W
Thessalon River above Rock Lake	46 27	83 46	S25 W
Rock Lake, west and south shores	46 26	83 46	S15 W
Rock Lake, southwest shore	46 25	83 45	S15 W
Bruce Mines	46 18	83 44	South
Pallideau Islands	46 16	83 39	S20 W
Pallideau Islands	46 15	83 39	S15 W
Thessalon River mouth	46 16	83 31	S18 W
Wabiquekobinsing Lake (northwest end)	46 19	83 25	South
Wabiquekobinsing Lake (southeast end)	46 18	83 24	S12 W
Pakowagaming Lake, southwest shore	46 15	83 17	S25 W
Katigamaiginska Lake	46 32	83 24	S15 W
Katigamaiginska Lake	46 31	83 22	S 7 W
Wahcomasagaming Lake	46 35	83 19	S17 W
Wahcomasagaming Lake	46 34	83 17	S32 W
Little White River	46 25	83 15	S43 W
Little White River	46 28	83 13	S19 W
Little White River	46 28	83 10	S70 E) S46 W)
Mahcomang Lake	46 23	83 7	S21 W
Mahcomang	46 22	83 4	S15 W
Mahcomang (island)	46 22	83 4	S25 W
Blind River, on Cataract Lake	46 17	83 1	S 8 W
Blind River, below Cataract Lake	46 16	82 59	S 5 E
Blind River mouth	46 11	82 57	S20 W
Blind River, Lake of the Mountains	46 16	82 53	S17 W
Blind River, Lake of the Mountains	46 16	82 55	S 3 W
Lake Huron, north shore	46 14	83 20	S22 W
Lake Huron, north shore	46 12	83 13	S15 W
Mississagi River mouth	46 16	83 13	S10 W
Mississagi Island at mouth	46 11	83 2	S12 W
Mississagi Island at mouth	46 12	83 2	S12 W
Lake Huron, north shore, Lauzon Mills	46 10	82 53	S13 W
Whitefish River (Round Lake, east side)	46 19	81 9	S45 W

References to clays, etc., near border of Lake Superior appear in same volume, pp. 904-907.

Between McKays Mountan and the Grand Falls of Kaministiquia. Red clay on banks of Batchawana 1½ miles from mouth. On Schebwah River, red and drab clays, 2 miles from mouth. On Goulais River, 13 miles in direct line from mouth. Clay under sand and restingo n rock is 60 feet. Nodules in the clay. Wood and leaves interbedded with clay on banks of Goulais River, and all overlaid with sand. On south shore of Lake Superior west of mouth of Two Heart River. Bluish drab clay outcrops under the sand in places. Roots and limbs at top of clay at 12-20 feet above lake.

At Grand Sable bed of vegetable matter is covered by a mixed sand and clay above which is stratified gravel and sand, rising to 300 feet above Lake Superior, in this are White cedar, white birch, and balsam, poplar. On lower course of Garden River, red to drab clays containing nodules abound. Similar deposits on Thessalon and Mississagi Rivers and Little White River. Contorted clays under horizontal noted on Little White River.

The clay deposits of the Little White and the Mississagi do not rise to more than 160 feet above Lake Huron, or 738 feet A.T. The clays are also present 6½ miles east of Lacloche. At the bend of Red Clay River which enters southeast corner of Lake Nipissing, stratified red, blue and buff clays occur up to 710 feet A.T. and contain spherical nodules. These clays he refers to the "Saugeen clay". The overlying sand he calls Algoma sand. It covers St. Joseph Island and part of Grand Manitoulin, etc.

Temperatures at Sault Ste. Marie in 1905.

Date	August Maximum	Minimum
1	71	50
2	68	50
3	79	44
4	77	57
5	69	59
6	73	54
7	68	52
8	68	48
9	77	59
10	79	57
11	83	62
12	73	53
13	70	53
14	71	51
15	72	56
16	76	53
17	77	55
18	74	59
19	68	56
20	77	51
21	75	58
22	67	52
23	73	52
24	69	53
25	72	51
26	76	52
27	73	56
28	72	61
29	81	59
30	70	56
31	64	52
	73	54

November 25, 1905.

I visited waterworks at Jackson, Michigan. The wells (12 in number) extend from the waterworks pumping station south about 3/4 mile. There are four on the grounds around the pumping station. The others are at intervals of 300 to 400 feet. The water comes from the south. The engineer states that wells at the Empire wheel Works in north part of Jackson about 2 miles from the waterworks as well as those nearer are lowered by heavy drafts at the pumping station. The combined flow of the 12 wells when siphoned at a level 19 feet below the ground at the waterworks is 6½ million gallons. This is 17 feet below the natural head of the wells. The flow is very much less at the level of the river about 6 feet below the natural head (not more than 2 million gallons a day). There are four 8-inch and eight 10-inch wells. The depths ranged from 200 to 300 feet and one well is about 400 feet. The temperature of water in the collecting basin is 50 degrees F. The water has enough iron to make a dark stain on porcelain and there is a yellowish stain on the walls of the collecting basin. It has little, if any, salt, at least not enough to be appreciable to the taste. The distance to rock ranges from about 50 feet to 100 feet. The drift is sandy. The wells are on ground about 930 feet A.T., or slightly above the ground at M.C. railroad and the same as the old L.S. and M.S. station about 1/4 mile south of the M.C. station. The waterworks are near the L.S, and M.S. station. (For further data see notes taken in June 1905 in Notebook 202.)

At Jackson I met Professor Barrows of the Agricultural College who reports that a wave will travel faster than the wind as he has noted in some rivers in South America that discharge into the Rio De La Plata. He thinks the rise that I noted this fall at Sault Ste. Marie, at Emerson and at Grand Island is likely to be due to a wave started by wind in the west end of Lake Superior. (See p. 39 of this notebook.) He thinks low barometer would not cause a rise of water but opposite. (See F. H. King's Experiments at Madison, Wisconsin) Nineteenth Annual Report U.S.G.S.

Dr. W. J. Beal of the Agricultural College reports that a flowing well was made in March 1905 at the Botanical Garden on the Agricultural College grounds, 177½ feet deep; diameter 3-inch; head +5. Drilled by Packard and Edgerton of Lansing.

A well 300 feet deep by waterworks boiler house did flow but is now pumped.

James Walter Goldthwaite of Northwestern University, Evanston, Illinois, in correspondence, reports results of levels on west side of Lake Michigan as follows: The Algonquin is 672 feet at Washington Island; 620 feet at Sturgeon Bay; 606 feet at Two Rivers, Wisconsin. In the north part of the Door Peninsula are lower shore lines with less rapid slope “each tilted a little less rapidly than the one above.” Below them (and probably overlapping the lower members of the tilted upper series) is a set of beaches which lie nearly horizontal, the highest being a very strong one about 20 feet above Lake Michigan which may prove to be Nipissing. At Sturgeon Bay the Algonquin is 40 feet and the supposed Nipissing 19 feet above Lake Michigan.

South of Sturgeon Bay the highest beach has been extensively destroyed by the cliff recession of later stages (especially the present stage), but by combining scraps of beaches on this shore and on each shore of Green Bay, Mr. Goldthwaite concludes that the Algonquin continues declining southward at a much lower rate than from Washington Island to Sturgeon Bay and at Two Rivers reaches an altitude 26 feet above the lake or 606 feet A.T. The Nipissing at Two Rivers seems to be 16 or 17 feet above the lake or 596-597 feet.

He thinks the beaches are essentially horizontal south from Two Rivers. He considers the Algonquin the equivalent of the Toleston beach of Lake Chicago which, at Evanston, Illinois, stands 24 feet above Lake Michigan, while the Nipissing shore is marked by the strong 15-foot beaches and cliffs along the shore from Waukegan, Illinois southward and which, in places, dominate over the Lake Chicago beaches and have cut back beyond them.

The work by Mr. Goldthwaite was largely by level--a “Y” level being used.

W. M. Gregory writes that the Algonquin has altitudes as follows in Iosco and Arenac counties:

	Feet A.T.	Authority
AuSable near station	620-625	D & M Railroad
Section 14, T.22N., R.8E.	623	D & M Railroad
Section 19, T.22N., R.8E., at Miners Corners	615-617	Gregory, handlevel
Section 36, T.22N., R.8E.	610	D & M Railroad
One mine east of Omer	609	D & M Railroad
South of Omer	610	D & M Railroad
Between Pine River and Saganing (a mile west of railroad)	610-613	D & M Railroad

The east base of the beach between Pine River and Saganing is only 600 feet.

Mr. Gregory says the Nipissing and Algonquin beaches are not completely untangled in these counties, but the altitudes given above are at points where others besides himself have considered the beach Algonquin.

Louis Agassis, American Journal of Science, Volume 10, 1850, pp. 83-101. E. Desor, Proceedings Boston Society Natural History, Volume 3, 1851, pp. 207, 235-236, 242; Volume 4, pp, 28-29, 41-42, 49-51.

On the northern shore of Lake Superior Agassiz noted a southward movement not only by striae but by stoss and lee side of prominences, the rough lee side being the southern face.

Between Michipicoten Island and Sault Ste. Marie--"We more frequently see a deflection to the west than a due north and south course, which is rather normal, along the northern shore proper between Michipicoten and other islands and from the Pic to Fort William; the deep depression ox the lake being, no doubt, the cause of such a deviation, as large masses of ice could accumulate in this extensive hollow cavity before spreading again more uniformly beyond its limits." The cross striation he refers to variations due to the swelling and subsiding of the icesheets and the consequent difference in the resistance of given points to ice movements.

On beaches he notes that lake terraces and also stratified deposits occur at various heights. He thinks there was no land barrier to hold the water up to the highest level which was cut away and the lake thus lowered. Instead, he favors the view of uplifts by which gradual local changes in the relative level of the lake and its shores, as well as between the relative level of the mainland and the sea have given rise to these features. Dikes he thinks having here risen and carried beaches up with them.

Proceedings Boston Society Natural History:

Desor, Volume 3, p. 207, refers to dunes 350 feet high at Grand Sable which belong to "true drift". There is a clear line of demarcation between drift, sand, and red clay. The sand is travelling eastward over ground previously forested.

Desor, Volume 3, pp. 235. Motes red clay along tributaries of Lake Superior 40-60 feet thick covered by a drift deposit, which he correlates with the blue clay of Michigan. On Mackinac Island at a height of 200 feet is a red loam 100 feet thick, corresponding to the red clay of the east end of Lake Superior.

Notes from Foster and Whitney Report on the Lake Superior Region, 1850. Part I. The Copper Region.

HIstorical

The Jesuits reached Canada about 1625 and their reports or "Relations" extend from 1632 to 1672 and are printed in 40 volumes. Explorations by the Jesuits of Canada were started under the auspices of Count Frontenac, Governor General, about 1641.

Sault Ste. Marie was visited in September 1641 by Charles Raymbault and Isaac Jaques, two Jesuits, and found an Indian village of 2,000 souls. The abundance of whitefish in the bay which has received that name made it a resort for Chippewa Indians.

Lake Superior was called by the Indians Kitchigummi (big lake) and Lake Michigan was called Illinois.

René Mesnard was next and in 1660 he coasted along the south shore of Lake Superior in a canoe, reaching Keweenaw Bay October 15 and remaining there through the winter. He was lost in 1661 when attempting to cross the Portage Lake divide.

Claude Allouëz visited the Sault in 1666 and named Lake Superior "M. de Tracy". He continued west past Keweenaw to Choquamegon or La Pointe. He learned of the Mississippi River as a neighboring stream but did not visit it.

In 1668 Claude Dablou and James Marquette proceeded to Sault Ste. Marie to found a permanent mission. A map made by the Jesuits in 1669 and published in the year 1672 is supposed to have been made by Allouez and Marquette.

Charlevoix visited Lake Superior prior to 1744.

Alexander Henry conducted a mining enterprise in the vicinity of the forks of the Ontonagon in 1771 and 1772 but became discouraged. He said the country must become peopled before copper mining would be profitable.

General Cass made an expedition in 1819 (with Henry Schoolcraft as geologist) along south shore of Lake Superior and across to the Mississippi.

Major Long in 1823 skirted the north shore and explored farther north.

The report by Douglass Houghton in 1841 sketched the main features of the Northern Peninsula. The lands of the Lake Superior district were acquired by the United States by treaties with the Indians--Ottawas and Chippewas--in 1836; Menomonees in 1837, and Chippewas in 1843.

In 1847 Dr. Charles T. Jackson was commissioned to survey the mining districts and after he had spent two seasons in the work foster and Whitney took hold, aided by S. D. Hill, Edward Desor, and W. D. Whitney. Hill aided greatly in the mining studies while Desor investigated drift deposits.

The Tahquamenon is estimated to drain 600 and the Manistique ("Manistee") 1,300 square miles. Whitefish, Escanaba, and Ford ("Fort") rivers are each estimated to have 400-500 square miles. The Menomonee is estimated to drain 2,800 square miles. It cataracts, and portages are necessitated.

Seiches or sudden fluctuations in lake level have been noted on Lake Superior and other Great Lakes from the earliest days of exploration.

"In the summer of 1834, an extraordinary retrocession of the waters took place at Saut St. Marie. The river here is nearly a mile in width, and the depth of water over the sandstone rapids is about 2½ feet. The phenomenon occurred about noon. The day was calm, but cloudy. The water retired suddenly, leaving the bed of the river bare, except for the distance of about 20 rods, where the channel is the deepest, and remained so for the space of an hour. Persons went out and caught fish in the pools formed in the depressions of the rocks. The return of the waters is represented to have been sudden, and presented an imposing spectacle. They came down like an immense surge-roaring and foaming; and those who had incautiously wandered into the river bed had barely time to escape being overwhelmed. Our informants were unable to state whether this occurrence was succeeded by a violent wind or storm, but they all concurred in representing the day as calm." (p. 50).

"A similar phenomenon occurred twice the same day, in the latter part of April 1842. The lake was free from ice, and no wind was prevailing at the time." (p. 50)

The statements just copied are given on the report on the authority of Messrs. Ashmun, Pick, and Bingham--old residents of Sault Ste. Marie.

After noting a wave 20 feet high observed in August 1345 between Copper Harbor and Eagle River which came past their boat while the lake was calm but when clouds in the northwest indicated opposing currents of air, the following notes are given: (p. 51)

"While at Rock Harbor, Isle Royal, in the summer of 1847, we witnessed the ebbing and flowing of the water, recurring at intervals of 15 or 20 minutes during the entire afternoon. The variation was from 12 to 20 inches and we took advantage of their recession to catch some of the small lake fish which were left in the pools. The day was calm and clear but before the expiration of 48 hours a violent gale set in."

"On the 23rd of July, 1848, we went from Copper Harbor to Eagle River where we arrived in the evening. The day had been calm--so much so that we were unable to avail ourselves of our sail, in the evening there sprang up a land breeze, but we observed a strong current setting into the river from the lake. The water rose and fell rapidly. The next day a storm commenced and continued for four days."

These and other instances cited are referred by the writers to "a disturbed state of the atmosphere, since they are for the most part succeeded by violent gales."

"We may regard the earth as surrounded by two oceans--one aerial, the other aqueous. By the laws which regulate two fluids thus relatively situated, a local disturbance in the one would produce a corresponding disturbance in the other. Every rise or fall of 1/20 of an inch in the mercurial column would be attended with an elevation or depression of the surface of the ocean equal to one inch." (Wheevell on Tides)

Attention is then directed to De la Beche's notice that the water in some cases shows an atmospheric change before the barometer gives notice." (pp. 52-53)

(See p. 71 of this notebook for an instance.)

E. Desor, Chapter VIII (Foster and Whitney Report, Part I):

Drift deposits conspicuous for 100 miles west from Sault Ste. Marie. At Grand Sable drift bluffs are 360 feet, four classes of drift noted:

1. Coarse materials, pebbles intermixed with loam.

2. Clay resting either on the coarse drift or where that is wanting on the rock, the drift clay of Lake Superior.

3. Sand, gravel, and pebbles, irregularly stratified, resting upon the clay, or upon the rock itself.

4. Isolated boulders, scattered over the surface.

The polished and grooved surfaces which occur in connection with the drift constitute likewise an important feature. The lake terraces and ridges also are recognized.

The coarse drift was thought to graduate upward into the pebbleless clay. They consider it the equivalent of the heavy deposits of drift in New England but think it is only 30 feet or less thick in Northern Peninsula of Michigan.

The clay was called by geologists of the Michigan State Survey "The Tertiary Clay of Lake Superior". From its color it is also called "the red clay". Thickness at Grand Sable is 60 feet and plainly laminated. This is thought to be an average thickness for the region. In places it is unstratified and also pebbly and bouldery, and its upper part may be interbedded with sand. The color is referred to the red sandstone. On the Ontonagon River it occurs up to 500 feet above Lake Superior.

It seems to be limited everywhere to depressions and not found on culminating points. The overlying sand extends outside the limits of the clay and is liable to be present on ridges, and on slopes, as well as in depressions.

The clay seems best developed west of Keweenaw Point, but the overlying sand and gravel is better developed east of there. At Grand Sable near Grand Marais the sand is about 300 feet. At Point Iroquois it reaches 345 feet above the lake (by Lake Survey 410 feet). Gross stratification was noted and referred to changes of currents caused by shifting of the wind, there being no tidal action on the lake. These beds, like the similar ones in the Potsdam and other old sandstones, are thought to have been formed in shallow water.

The following pertinent remarks are made concerning boulders:

"The boulders have from all times and in all countries excited the greatest interest in consequence of their size

as well as of their position. The mere view of a huge block of granite situated, as often happens, on the summit of a hill whilst the rock on which it rests is of limestone or sandstone, is sufficient to excite the curiosity of every thinking man as to the place from which the stranger may have come, and as to the mode by which its transportation was accomplished. We ought not to be astonished, therefore, that most of the theories which have been imagined to solve the problem of the drift should refer chiefly, if not exclusive, to the boulders. From looking at them, in a too exclusive point of view, most geologists have misunderstood their true signification; they have overlooked the other more regular deposits with which they are connected; thus forgetting that the boulders form but a part of the drift formation and represent but one single though striking event in a long period of the earth's history--the Quarternary Epoch. This we consider the chief cause of the insufficiency of most of the theories". (pp. 190-191)

The largest noted was of hornblende, near Carp River, measuring 15 x 11 x 6½ feet. The preponderance of granite, trap and hornblende boulders over sandstone he attributed to the sandstone being more easily destroyed. Most of the boulders are thought to have been transported but a short distance in the Lake Superior region, and in some cases the route they travelled may be traced. Southward transportation from the Marquette iron region is well shown by the fact that none of the iron rocks are found north of the outcrops, while they abound to the south as far as Escanaba River, if not farther.

Valleys, for the most part, carry boulders from the ridges next north of them all through northern Marquette County. It is noted that some of the highest ridges on the Superior Michigan divide have caught nearly all of certain classes of boulders on their north slopes, the ridge having acted as a barrier to prevent further southward transportation. It is mentioned, however, that some of the boulders have been carried as far south as the Ohio River or more than 600 miles from the nearest place from which they could have been derived.

Desor thinks that the great number or proportion of boulders being on the surface they are a more recent deposit than the body of drift, yet not wholly distinct from it. The boulders imbedded in the drift seen to him to be from the same sources as those on the surface and are, in some cases, fully as large as any surface boulders. My theory is admissible that does not account for the boulders in the drift as well as those on the surface.

Striae in the Lake Superior region have best development on the north or stoss side of the ledges. The usual bearing of striae is northeast to southwest both on the shores of Lake Superior and the west side of Green Bay and Lake Michigan.

Region east of Keweenaw Point has 3 sections:

1. Granite and iron section from L'Anse to mouth of Chocolate River.

2. Sandstone section from Chocolate River to Grand Marais.

3. Sandy section from Grand Marais to Sault Ste. Marie.

Striae on an island east of mouth of Dead River show two systems--one north-south, the other N20°E-S20°W. There are also deep trough-like depressions with perfectly smoothed walls, 12-15 feet long, 4 feet wide and 2½ feet deep. Similar troughs occur on Middle Island near Granite Point that bear N20°S-S20°W. Striae south of Negaunee, S50°-50°M.

The following, with regard to striae on the face of a vertical wall, appears on p. 207:

"Finally, I would make mention of a green magnesium rock with vertical walls to the east, along the road leading from the Jackson landing to Teal Lake. The walls, although almost semi-cylindrical, are covered with striae, which may be traced along the surface like hoops around a gigantic cask. This is an important instance, since it goes to show that the striae could not possibly have been made by an iceberg, or any other body floating in the water, but that the agency must have been such as to conform to the direction of the rocky walls."

List of striae: (p. 207)

	Main direction	Secondary and more recent
On Middle Island	N20°E-S20°W	
Island east of Dead River	S20 E-S20 W	North-south
At Worcester	N55 E-S55 W	N5°E
Quartz Ridge 1 mile from mouth of Carp River	N20 E-S20 W	
On quartzose angle in T.47N., R.25W.	N50 E- 60 E to S50 - 60 W	
Iron ridge south of Teal Lake	N55 E-S55 W	
At Jackson forge	N65 E-S65 W	

No striae were noted in the sandstone district.

Concerning the sandy deposits at Grand Sable, the following (pp. 210-211):

"The Messrs. Whitney having ascended to the top of the sand ridge in order to measure its height, found our suspicion entirely confirmed, for they discovered, at the very top, layers and masses of coarse pebbles resting upon the sand and scattered through it. These, of course, could not have been blown up from below."

Terraces 2 miles east of mouth of Two Hearted River as follows: (p. 212)

1.	Gravel beach	5 feet above lake
2.	Sand beach	12 feet above lake
3.	First drift terrace	29 feet above lake
4.	Second drift terrace	46 feet above lake
5.	Third drift terrace	75 feet above lake
	Summit of bluff on plateau,	94 feet above lake

The one at 29 feet is broader than the others.

Striae along the Neebish Channel are north-south (p. 213).

On p. 215 the effect of physical features in determining the course of ice movement is referred to and the parallelism between the ridges and the striae on Keweenaw Point and Isle Royale cited.

The striae appear to Desor as exactly like those produced by glaciers in the Alps and Scandinavia, but he finds it difficult to conceive of a glacier on the wide level country of the northern. United States and Canada.

Desor referred to coarse material at the base of the drift to the same agency that produced the striae--and thinks there is evidence of high elevation when this occurred.

The red clay he refers to a period of low elevation while the included boulders he refers to ice floes such as scatter boulders on the borders of lakes and streams every spring. He was in doubt as to whether the waters were marine or fresh.

The sand ridges or sand deposits above the red clay he referred to water rather than ice and he thought the boulders were transported in water by ice floes. He noted that they are large clear to the limits of the drift along the Ohio and that many show very little rounding and from, this inferred that they were not rolled along in currents of water as some have supposed.

The lake beaches and terraces he referred to halts in a subsiding lake. He called attention in closing to the increased fertility resulting from the accumulation of drift with its varied soil ingredients.

Geology of the Lake Superior Land District, by J. W. Foster and J. D. Whitney, U. S. Geologists. Part 2, The Iron Region and General Geology, Worthington, 1851 (Senate Executive Document No. 4) XVI, 406 pp.

Chapters 1 to 13 are discussions of rocks and fossils, Chapter 13 being by James Hall.

Chapters 14 to 16 inclusive are by E. Desor and treat of surface deposits.

Chapter 17 treats of mountains (Foster and Whitney), Paleozoic formations.

Chapter 18, by James Hall, compares European and American.

Chapter 19, by Charles Whittlesey, treats of lake fluctuations.

Chapter 20, by Charles Whittlesey, magnetic variations.

Chapter 21, by W. D. Whitney, treats of forests, etc.

Appendices, pp, 381-400, on various subjects, prominent among which are barometric observations and well records.

Chapter 14:

A sharp gravel ridge called an osar is described on p. 236. It is compared with those at Andover, Massachusetts, called Indian ridges, and with osars in eastern Sweden. It is near Menominee River not far above the mouth.

On Manistique River (termed Manistee) he noted the rapids at the mouth--the high beaches (60-70 feet) in T.43N., R.14W. The following interesting account of the swamp is given on pp, 239-240:

"Having thus crossed the country in several directions, we are enabled to say that at least one-half of the surface drained by the left branch of the Manistee is composed of cedar swamps. In some places, as for instance in T.44N., R.13W., the dry spots are so limited that they appear actually like islands in a sea, being composed of sand ridges covered with yellow and white pine. A similar belt of pine land lines the river or rather the valley throughout its whole length, and the approach to it is indicated, in this region, by a strip of dry soil, which is no doubt owing to the drainage."……..

"In climbing up the bluff I was often astonished to find that the timbered portions occupied but a narrow belt, as it were a mere embankment to the extensive swamps in the rear. This was the case at a locality on the river in T.44N., R.13W. The bluff is here some 60 feet high composed throughout of fine sand except at the base where there is a layer of clay 8 feet thick. But in spite of that the belt of pine land is less than 100 yards wide. It then slopes down 15 feet and immediately the pine trees are replaced by cedar and tamaracks growing on a wet ground. A distance, therefore, of less than 100 yards is sufficient to prevent the drainage, although the swamp is 45 feet above the river. In order to ascertain if the swamp was not occasioned by some impermeable layer near the surface, I examined carefully the roots of the fallen logs and found them enclosed in the same fine siliceous sand which forms the bluffs."

Concerning the Whitefish, it is stated that "Along the course of the Whitefish, the drift has been excavated so as to leave a wide swamp on each side on which the rock lies near the surface."

Striae:

Striae are noted as follows:

1. Bed of St. Martin's Bay, 2 miles from mouth of Pine River bearing nearly east-west, some being 180^1 to S80°W, others S70 to 80°E to N70 to 80°W. They are fine grooves and also large troughs.

2. At Payment Point, bearing N50-60°E to S50-60°W.

3. West shore of eastern cove of Big Bay de Noc, bearing west-east, fine striae in Hudson River Limestone.

4. At mouth of Escanaba River, Trenton limestone, striae northeast to southwest.

5. At Oak Orchard on west shore of Green Bay, bearing N15-20°E to S15-20°W.

6. Near mouth of Menominee River, nearly east-west.

7. Six miles above Kitson's trading house on Menoninee River, east-northeast - west-southwest.

8. Three miles above Sturgeon Falls, N65°E-S65°W.

9. At foot of the lower Bekuenesec falls, on a hard talcose rock. N70°E-S70°W.

10. At lower Twin fall, M60-70°E to S60-70°W.

11. At foot of upper Twin fall, N65-70°E to S65-70°W.

Limestone pebbles on shore of Lake Superior:

On pp. 246 and 247 the origin of limestone pebbles on south shore of Lake Superior is discussed and the conclusion drawn that Niagaran limestone pebbles may have come from Lake Temiskaming 50 miles north of Georgian Bay. Limestone with Favosites fossils was found near the mouth of Chocolate River. Foster and Whitney think some of the limestone may have come from the northern slope of the ridge between Lake Superior and Hudson Bay.

Beaches and terraces on Mackinac Island (pp. 248-252):

A beach on northwest part of Island back of a farmhouse, 80 feet. Beaches on north slope estimated at 70-80 feet. Terraces west of the harbor. 9.5, 22, 42, 105 feet. In places there are strong gravelly ridges between 22 and 42 feet above Lake Huron.

Beach on Round Island, 46 feet, on south shore. Beach northwest of St. Ignace at 85 feet and others of similar height connect the limestone ridges. Gros Cap ridge has a beach, at 130 feet.

On page 251 it is noted that beaches on the north shore of Lake Michigan are largely of limestone pebbles with scarcely any granite or other distant material. But on the south shore of Lake Superior the pebbles are almost all granite and other foreign material with scarcely any of the underlying Potsdam sandstone.

Attention is also directed to the small size of the pebbles for many miles along the shore east of Grand Marais. (See my own notes about 9-12-05.)

The origin of river belts or deflections is given on p. 262, after citing Chocolate, Two Hearted, etc.:

"If a current, either constant or remittent, sets along a shore, it will continue to flow with equal strength as long as there is no obstacle interposed; but when it meets in its course the current of a river debouching at right angles, the latter will cause the former to abate in velocity, and thus a state of comparative quiet is produced, in consequence of which a portion of the materials is thrown down at the point of confluence. The width of a river bed, however, is not generally greater than is required for the discharge of the waters and hence it follows that the belt cannot encroach upon the river, therefore, instead of bending inward, it increases in a straight line parallel with the beach."

Boulders at Sault Ste. Marie:

These are thought to be striated by the river ice and those below the rapids at a level as high as those at the head of the rapids he refers to a date when the falls were farther down the river. He seems not to have noted that boulders abound at a level 50 feet above the head of the rapids or at the level of Lake Nipissing. It is very doubtful also if there has been much retrocession of the rapids.

On page 387 is a note concerning a rise or fluctuation of the lake at Grand Island in 1845, taken from the Lake Superior Journal, July 23, 1851:

"While at Grand Island a few days since, Mr. Williams gave us an account of a remarkable instance of the sudden rise and fall of water at that place in 1845. In a certain day without any appearance of wind on the lake, the water rose and fell several times during the day from 4 to 5 feet above high water mark. The weather was calm before and after the occurrence, and this was the case for 100 miles, at least, to the northwest of the island, for Captain Smithwick of the schooner Algonquin was that day off Copper Harbor and neary becalmed."

Colonel Charles Whittlesey summarized the available data on fluctuations of the Great Lakes since settlements by white men on their shores and found no basis for the 7 year period of rise and fall popularly believed in.

The Detroit registers show a continual rise 1819-1838, or 19 years, a decline from 1838 to 1841, a rise in 1842, a decline from 1842 to 1851, the date of writing.

The range at Detroit between June 1819 and August 1838 was 5 feet, 3 inches.

At Black Rock, near Buffalo, and also at Buffalo, 5 feet, 3 inches.

At Cleveland. 5 feet, 6 inches between fall of 1819 and June 1838.

Greatest range at Detroit in years 1819-1838 was 6 feet, 8 inches, which includes temporary or sudden fluctuations.

At Black Rock. 7 feet, 1 inch.

At Cleveland, 7 feet, 0 inch.

Whittlesey's discussion is on pp. 319-339.

Notes supplied by S. J. Lewis in well record books:

Milan Wells:

Whitmarsh well at Milan. Analyzed water. Depth, 144 feet; head, -12 feet; made 1897; cost, $130.00. Penetrated quicksand, clay, quicksand, and hardpan to rock at bottom. Mr. Whitmarsh has a well only 12 feet through sand, and has 3 feet of water. It is affected by drought. Cost, $25.

In Vicinity of Milan shallow wells get water at 10-12 feet; deep wells at 40 to 144 feet. All are hard water. Mr. Lewis analyzed 5 samples from wells at and near Milan and found Mr. Troop's the softest. (See his report submitted for publication.) The Throop well is in Section 35s York Township. Depth, 116 feet; head, -11 feet; cost, $102; diameter, 4 inches; pump pipe, 1¼ inches. Made April 1901.

Jonathan Wardlap (?) well, 62 feet deep; located in Section 32 (?), August Township, is flowing. Cost, $40. Is it not J. Wardle, Section 30?

Wm. Reeves in Milan. Flowing well, depth 40 feet; diameter 4 inches. Supplies 2 houses. A ram is used and 20 barrel tank. Discharges a full (?) pipe.

Wayne Wells:

The wells at two hotels are of similar depth and only one analysis was made. Data meager, for most of the persons about were drunk or ignorant. Many persons depend upon rainwater collected in cisterns, especially for washing. Commercial Hotel, Wayne, in street. Made in 1902. Depth, 14 feet. Can be pumped dry in 20 minutes. The other hotel well is 12 feet.

Dearborn Wells:

Some wells are shallow and in sand. Others deep to base of drift. Majority of wells shallow. Many cisterns in use for washing. No flowing wells. Wagner Hotel, at Dearborn: Depth, 28 feet; has 14 feet of water; dug well; will yield at rate of 300 barrels in 45 minutes. Pumped by gas and steam engine.

Mr. Anthony Wagner drilled at a brickyard in Dearborn 130 feet to rock, but pulled back to 115 feet. Head, -20 feet.

Denton's:

Flowing wells have softer water than usually found in southeastern Michigan, there being in one analyzed only 56 parts per million against +139 in most others. Some gas escapes from some of the wells.

Parsonage at Denton's: Well, 75 feet; diameter, 6 inches; flows. Made in 1902. Cost, $20.

Chelsea:

Fine waterworks plant cost about $25,000. All wells shallow; 21 wells all connected in waterworks building. Depth, 18 feet; diameter, 2 inches. Too hard for boiler use, so creek water is being substituted.

Manchester Wells:

Freeman House, back of hotel: Depth, 70 feet; diameter, 2 inches; pumped by gas engine. Rain water collected for washing. Next door to Hanson's, south of railroad track: Depth, 36 feet; flows. This is 3 blocks from railroad station. George Nisle, in front of livery stable, about 1½ blocks south of hotel: Well 20 feet is pumped. Water from sand.

The flowing wells are about 35 feet deep and have a weak discharge. Few shallow wells not flowing, for wells are driven to about 70 feet. Hard to get data.

Britton:

James Haight, 2nd house south of railroad track. Depth, 142 feet. Made 11 years ago. Hand pump. Several flawing wells 30 to 40 feet. No good supply at less depth. Some typhoid in past 2 years. A van driver at Britton has flowing well 32 feet made 15 years; 6-inch pipe or tile?. Water is drained at overflow and a hand pump used, blue clay under sand.

Near Ridgeway:

Strong flowing wells along Belman beach.

W. W. Crabbe's store well 104 feet; diameter, 2 inches; head, -3 feet. The flowing wells in that vicinity are slightly lower ground or about 75 feet. The Young well selected for analysis because said to be typical. Irving Young well 75 feet; diameter, 2 inches; discharges 1/2-inch stream.

Reading:

Waterworks wells 56 feet deep; diameter, 6 inches; four wells; head, -7 feet. Pumped 10,000 gallons a day. Cost of wells, $700. Cost of system, $21,800. Wells stopped at a hard shale. One flowing well at Reading 200 yards west of a creamery struck the flow at 78 feet but was carried down, to 450 feet without increasing, the flow. Some shallow wells 18 to 30 feet still in use.

Jonesville:

Waterworks system has 3 wells 56 feet deep, 6-inch diameter; one into rock; the others from gravel. All overflow. Water is not easily lowered by pumping. They are located back of or above the railroad station. A few shallow private wells, 12-18 feet in use. Daily consumption in public supply, 300,000 gallons. Cost of plant, $32,000. Population, 1,365.

Quincy:

Waterworks has 5 wells apparently in sandstone. Data hard to get and village officials ignorant.

Klinger's Lake:

George Carson, flowing well, 47 feet; diameter, 2 inches. Flows a full inch stream; cost, 112; head, +20 feet or more. Penetrated hardpan and clay to gravel at bottom. Said to be constant at 42° (52°).

Three Rivers:

Waterworks wells sunk in 1892 and 1894. Depths, 75 to 108 feet; head, +1 foot. Water is pumped. Daily consumption. 330,000 gallons. Seven wells. Said to strike shale at -45 feet ± after penetrating blue clay 8 feet, sand 8 feet, clay 25-30 feet.

Centreville:.

Waterworks wells 10 feet, probably draw from below a spring. They only supply the stores. Private wells 12-18 feet. Much typhoid fever. (Waterworks a stock company.)

Kalamazoo:

Bryant Paper Company well, 125 feet; diameter, 6 inches; made 1900; flows a full pipe. Two shallower wells 6-inch pipe at a new office building.

South Haven:

Waterworks has 20-foot pipe with intake in Lake Michigan in 30 feet of water. Put in about 1900, Daily consumption, 100,000 gallons. Cost of waterworks, $45,000.

Hartford:

Well at the Thomas place now owned by Rector made 25 years ago. Depth, 46 feet; diameter, 2 inches; head, +9 feet. Discharges 1-inch pipe nearly full. Well is near a ridge and in clay.

Paw Paw:

Waterworks well 20 feet in depth and diameter. Weak--can be emptied in 2 hours. Cost of wall, $3.000. Waterworks plant, $15,000. Dykema hotel well, 30 feet, is strong. Diameter, 3½-inch. Four wells were driven at the waterworks, all of which would discharge (into excavated well?) The largest was enlarged to pump from and the others abandoned.

Watson:

John C. Hughes well 92 feet; diameter, 2 inches; head, -3 feet. Deepest well in neighborhood, 150 feet, is at Kilzmiller place 5 miles out, and shallowest at Grange Hall, 26 feet. F. H. Tifft well, 68 feet, flows 1/2-inch pipe full. Made in 1900; cost, $68.00.

Plainwell:

Fire protection provided but no public domestic supply.

Wayland:

A. H. Clark, near lumber yard office, made 15 years; depth, 145 feet; diameter, 2 inches. Flows into stone tank. Enters sandstone 20-25 feet. Dave Stockdale, depth 26 feet; diameter 2 inches. Flows nearly an inch stream. Well in gravel under surface sand.

Holland:

City well on Columbia Avenue. Depth. 30 feet; head, -16 feet; diameter 2½ feet and 2 inch. Principally sand. Gravel at bottom.

Muskegon:

Analyzed water from Hackley and Hume well February 3, 1905 that was collected August 26, 1904. Dept, 230 feet; flow 250 gallons a day; diameter 1 inch; altitude 582.5 feet; head, 587 feet.

Dr. J. G. Jackson, well depth, 237 feet; flows 400 gallons a day from 2½-inch pipe. Water salty. Penetrated clay 50 feet, quicksand 3 feet, clay 7 feet, quicksand 2 feet, clay 170 feet, hardpan 2 feet, soft material 2 feet, hardpan 1 foot. Water struck at 50-60 feet, rose nearly to surface.

Montague:

Well owned by village and located on Bridge street made 1878. Depth. 60 feet (?); diameter 2-inch; flows 7/8 gallon per minute.

Well corner Perry and Spring streets, in town hall. Depth, 37 feet; diameter, 2-inch; flows 2 gallons a minute. Used for fire protection. Water in coarse sand.

Ionia:

H. R. Walker, 404 East Main, well 336 feet. Rock at 257 feet. Flows stronger in rainy weather. Discharge about 30 gallons per minute from 2-inch pipe. Soft enough to wash with. Penetrated:

Sand and gravel (many water veins)	180 feet
Blue clay	2½ "
Coal (rotten)	15 "
Shale with iron pyrites	18 "
Clay and hardpan to rock	?
Rock	3 "
Clay	?
Porous sandstone	

Owosso Junction:

Charles Terry at house. Depth, 16 feet; diameter, 2-inch; cost, $4.00. Good flow--has run 9 years.

Ashley:

Chas. Kerr at farm 1 mile northeast of village. Depth, 600 feet; diameter, 2-inch; flows 1 inch stream.

Village well at blacksmith shop 240 feet. Some water in gravel at 70 feet.

Cadillac:

Dr. J. Leeson. Made 20 years. Depth, 113 or 125 feet; diameter, 2-inch. Well is on a hill.

J. H. Platt. Well in barnyard. Depth, 36 feet; diameter. 2-inch. Dug 20 feet, driven 16 feet. (Suspected to be bad water).

Kalkaska:

Pere Marquette Railroad well. Depth. 28 feet; diameter. 2-inch, Occasional typhoid in city attributed to well water.

Bellaire:

Harry Richard's well, 100 feet; diameter. 6-inch; flows 1-inch stream. Located on low ground 10 feet below street level at waterworks.

South Arm:

J. H. Lamway. Well, 47 feet; head, +2 feet (see Leverett's notes).

East Jordan:

Waterworks wells (see Leverett's notes).

Boyne City:

Cooperage mill (see Leverett's notes). City, in road near Chemical mill. Depth. 26 feet; diameter. 2-inch. Flows into trough. In marl which is 1½-4 feet.

Central Lake:

Cameron Lumber Company. Depth. 222 feet; diameter. 2-inch. Flows 1-inch stream. S and at 30 feet; yellow day, 190. Gravel at bottom. Fisk's well is 36 feet and flows. Made in 1895.

Reed City:

Waterworks wells 50 feet deep, average. One 59 feet. Diameters, 2 to 6 inches. Mater is pumped from a large masonry well into which the flowing wells discharge 20 feet below top. Pump 225 to 240 gallons a minute. A well made by city 15 years ago is 276 feet deep. Diameter, 3 inches. Used for drinking only and separately pumped. Beds variable for 225 feet, then hard clay 51 feet.

Midland:

W. C. Stearns' well, 375 feet; diameter. 3-inch. In Mineral Springs House. Flows. Analysis by Duffield.

Oxford:

Waterworks--five 6-inch wells 65 feet deep. Pumped.

Flint:

Analyzed well 250 feet (?) deep. Two blocks above Bryant Hotel

Imlay City:

Waterworks--five wells, 162-172 feet; flowing (?); salty. Shallow wells 40-50 feet are not salty. Well in street at McKinley Hotel 18 feet deep. Used extensively for drinking.

Capac:

Four 6-inch wells 100-110 feet deep (See Leverett's notes). Yellow clay 3 feet; blue clay 20 feet; gravel 50 feet; hardpan 17 feet; sandstone at about 90 feet. Water struck in rock. Well at Hotel de Burt, 250 feet, is saline.

Richmond-Lenox:

Waterworks--yield 160 gallons a minute by pumping. There was one flowing well here rather weak and no longer used. The shallow wells at Lenox are 10 to 15 feet. They pass through clay into gravel that yields an unfailing supply.

Sanilac Center:

Roberts Hotel well 79 feet; diameter, 4-inch; head, -6 feet. Rock at 33 feet. Yellow clay, blue clay and hardpan above rock. Many wells in Sanilac Center are 60 to 90 feet.

Croswell:

Croswell Hotel well depth 101 feet; diameter, 2½-inch. Through clay and hardpan to gravel.

Lexington:

Pabst well 3 miles south of village (see Leverett's notes, also Dr. Lanes.) Water at 132 feet at base of drift yields 150 gallons per minute. Another vein at 500 feet. School well 42 feet; head, + 8 feet. (See Leverett's notes.)

Yale:

Waterworks wells 70 to 110 feet (5 wells); diameter, 6-inch. (See Leverett's notes). Ferguson well 225 feet to water. Total depth. 440 feet. Flows 48 gallons a minute from 6-inch pipe. Water from sandstone below shale. Only 4-5 feet of sandstone.

Birmingham:

Cyrus Lamb's well 121 feet; diameter, 3-inch. Made 1895. Flows 1/4-inch stream. Salt. Bored by hand. John Buttolph. John Lowrie. Fresh water. (See analysis.)

Romeo:

John Kramer, 1½ miles from town. Flowing well 12 feet. Flows twice as fast in spring. Penetrates blue clay and some gravel. Village supply wells 15 feet deep and 24 feet in diameter.

Milford:

Waterworks--five 10-inch wells 40 feet deep. Flowing wells but water is pumped. Made about 1895.

Holly:

See Leverett's notes.

Howell:

Waterworks wells 68 to 78 feet. Ten wells. Cost of plant $42,000. Consumption 175,000 gallons per day. Not to rock. Wm. Burrett well 38 feet flows into cement tank. Through blue clay to gravel.

Brighton:

Western House Hotel 20-25 feet. Diameter, 18-inch. Crock well.

Fowlerville:

Lockwood Hotel well, 40 feet; diameter. 1¼ inches.

Beaver Island:

Br. Lane writes that a well driller, B. C. Lane, on Beaver Island recently made a well on the highest part of island, 155 feet, that he thinks about reached lake level. It

penetrated hardpan, sand, clay and boulders for 140 feet and sand at bottom. Some air breathing wells occur on the island.

Report on the Northern or Upper Peninsula by Douglass Houghton, State Geologist, submitted February 3, 1840. Published as part of House Document No. 27 on pp. 206-22, Detroit, 1840.

Describes the part lying between the outlet of Lake Superior and the Menominee River. This district is said to have great variety in topography, in soil composition and character of timber, and to possess many of the elements of competence and wealth.

The eastern part is generally flat with marshy tracts of considerable extent while the coast is skirted by islands that give great beauty to the scenery. Attention is called to the prominent limestone tract a few miles back from the coast of Lake Huron and Lake Michigan and on the beaches of Little and Big Bay de Noc.

The soil is calcareous, seldom clayey and usually thickly set with limestone pebbles. As a whole the western portion seemed to him better adapted to agriculture than the eastern.

The Manistique River had a pool 1/4-1/3 mile wide and over one-half mile long just below the rapids and this made a good harbor for vessels drawing 7-7½ feet of water. The rapids are thought to furnish valuable hydraulic power. The river is known to interlock with the "Touquoimenon" or Tequamenon in its headwater swamps. The country through which it passes is said to be largely well adapted for agriculture and where Indians had cultivated it yielded abundant crops of corn and potatoes, etc. The Menominee also has near its mouth a rapid of 12 feet that will give valuable water power. The Escanaba at that time (1839) had a sawmill in operation at its mouth. Fisheries, he thinks, will prove a valuable resource.

Report on the geological and mineralogical survey of the mineral lands of the United States in the state of Michigan, by Charles T. Jackson. Senate Executive Document No. 1, 31st Congress. 1849, Part 3, pp. 371-935.

On page 389 reference is made to the boulders at Sault Ste. Marie as the product of the ice of rivers and lakes supplemented by ice shoved off from the lake shore. The altitude is put at 20 feet above Lake Superior. It is stated in a footnote that this theory was proposed by Jesuit missionaries 200 years before--"Indeed they seem to have anticipated the glacial aqueous theory of drift."

On page 389 he says "It may be regarded as certain that the waters of Lake Superior occupied much higher level in ancient times; for we observe not only three or four different terraces that formed the ancient shores of the lake, one forming after another as the waters gradually subsided, but we have a still stronger proof of the action of the waves of the lake in the erosion of caverns at Pictured Rocks where the sandstone has been worn into spacious and elevated arches by the action of the surf and the grinding of pebbles driven by the waves."

On page 820 "The relative position of the land and water of lake Superior at some remote period of time appears to have been quite different from their present states as is evidenced by the efforts of the lake on the rocks and the form of the lake bluffs in many places, some 200 feet above its present level."

Agassiz, Proceedings A.A.A.S., Volume 1, 1848, pp. 68-70, calls attention to terraces at various levels up to 300 feet above the lake which he considers the product of the lake. He thought they presented evidences of paroxysms.

The striation seemed to him glacial, for it ground down hard and soft parts of rock surfaces alike, whereas water would channel out the softer portions, leaving the harder in relief.

March 31, 1906.

Took trip from Detroit with Goldthwaite and C. C. Adams to the bar or spit at Grosse Points Farms. This rises in places slightly above 600 feet A.T. and is gravelly sand in these high places. It is an Algonquin bar so the highest water of the Algonquin channel, as it passed from Lake St. Clair into Detroit River, was fully 600 feet.

Continued on Electric to Mt. Clemens and New Baltimore. At New Baltimore the Transition or Nipissing beach is about 582 at base but rises 6 feet higher in sandy bars. We take the "cut off" Electric line from New Baltimore to Marine City and thus cross the west Algonquin channel. It has about 4 feet of black muck where the big ditch runs, beneath which is a blue clay. The banks rise 10 to 15 feet above the surface of the muck and are a gravelly sand. The channel is less than 1/2 mile wide here.

We continue to St. Clair village where we stop for the night. This village is at the place where the Algonquin channel divided and Pine River now comes in through the head of the western channel.

April 1, 1906.

We examine the lower course of Pine River. This meanders in the old Algonquin channel and its surface is about 8 feet below that channel floor. There was trenching to considerable depth below St. Clair River level. This trenching occurred at a time when the water was low in St. Clair River and it is thought by Taylor that at a low stage of Lake Huron between the Algonquin and the Transition beaches of that basin there may have been northward discharge from as far south at the lime kiln crossing. So Pine River would be flowing north instead of south after joining the St. Clair. The St. Clair reaches a depth of about 70 feet at its head. This deep part is on the Canadian side and it is probable that the shallow part of the channel on the Michigan side above the mouth of Black River is due to an encroachment of

the river on that bank. A breakwater now presents encroachment and some filling has occurred on the Michigan side below the breakwater. The bed is said to be a stony till with numerous cobblestones and small boulders (perhaps Illinoian drift?).

The height of gravel on the bank of the Algonquin channel at the place where it divided in south part of St. Clair is by hand level 29 feet above the river or about 606-607 feet A.T., which is fully as high as the Algonquin beach between Port Huron and Port Austin. The floor of the channel is 18 to 21 feet lower or only 8 to 11 feet above the river level of today. It seems very probable that an ordinary stage would have 18 to 20 feet depth of water. The gravel fonts a very low ridge along the top of the old river bank 1-one and one-half feet higher than tracts back of it and 6-8 rods wide. The bed and side of the bank are a stiff clay with only a little sand cover and that not everywhere present even on the flat bed.

We find the meanders of Pine River valley in the old bed of the Algonquin outlet are very sinuous, being letter “S” shaped. We go north from St. Clair to the Somerville Hotel. This is on the Elkton bank at the brow of the bank and there is a thin, patchy deposit of gravelly material along the top of the bank (see notes in 1904 as to height of the bank at this hotel). Back of the brow of the bank or bluff a few rods is a sag that runs parallel with the border of the valley and distant about 6 rods from it. This adds to the beach-like appearance of the brow of the bluff and suggests a beach deposit 2-3 feet thick. The exposures, however, indicate that till sets within 6 inches, there being only that amount of surface gravel, so its relief must be partly due to erosion on the sag on the west.

At the first wagon road north of the hotel that runs west we go in that direction past a schoolhouse to a spillway of the Elkton time. It is about 50 rods wide and 15 feet deep at this place but becomes more shallow to the north near its point of departure from the St. Clair village 2-2½ miles north of St. Clair.

We continue to Port Huron on the electric car and go to the head of St. Clair River. Mr. Danger, a member of the Lake Survey, joins us and tells of the occurrence of tree trunks under the sand and gravel on the west bank of the river very near its head and just above the old waterworks pumping station. The trees were on the top of a day bed about 5 feet above Lake Huron level. The gravel above them is about 18 feet above lake level or 598 feet by hand level. None of the tree trunks are now visible, the slope being grassed over.

About 1/2 mile farther north the gravel takes on the form of a low beach ridge and reaches an altitude of about 23 feet above the lake. We follow this beach north to the cut off channel running from Lake Huron westward to Black River and which was designed to carry a current from the lake into Black River and thus clear out its mouth. In this channel gastropod shells have been exposed from 18 feet or more above lake level down well toward the base. C. C. Adams collects a lot of specimens for determination.

This cut off is just north of Lakeside Cemetery. The cemetery is on the Algonquin beach tat the electric railway is on a lower plain 12-14 feet above lake level from near the south end of the cemetery northward. This plain terminates at the west at an abrupt bank that is apparently the mark of the Nipissing waters when they came back to the St. Clair outlet. Goldthwaite says the altitude corresponds exactly with that of the highest Nipissing on the west shore of Lake Michigan near the Wisconsin-Illinois line. The Algonquin also is the same height here as the Tolleston beach of the Michigan basin and he thinks there is little doubt that Lake Algonquin occupied it. It may, however, have been started by Lake Chicago before the ice withdrew from the north part of the Southern Peninsula. This confluence of the two lakes was the beginning of Lake Algonquin in the Michigan basin and the termination of Lake Chicago.

Opportunity is taken here to note an idea that recently came to me concerning the relation of moraines to Lake Chicago beaches in the north part of the Lake Michigan basin. Inasmuch as the second or Calumet beach does not appear to be present north of Manistee and whereas the moraine which runs into the lake at Manistee seems to be a continuation of the Port Huron Moraine, and whereas the Port Huron Moraine marks a readvance of the ice sheet, as shown by its relation to the Arkona beach (see Taylor, Proceedings Michigan Academy Science, Seventh Report, 1905, pp. 29-36)--in view of all these considerations, it seems likely that the northern end of the Calumet beach has been overridden by a readvance of the ice into the Lake Michigan basin. The drunlin areas, the decidedly red color of the till, etc., are confined to the limits of this readvance. This may be true of the drumlins northwest of Green Bay also, but would not of those in the south part of the Green Bay Lobe.

Further field work should be done to clear up the field both in the Wisconsin and Michigan side of the lake.

I return on electric car in the evening to Ann Arbor, while Goldthwaite remains to study the relation of the Port Huron Moraine to the Arkona beaches.

May 24, 1906.

Leon J. Cole of the Museum of Comparative Zoology of Harvard University has obtained from Edward H. Thompson, U. S. Consul to Yucatan, Progress Yucatan, some temperatures of underground waters as follows:

> In a covered cave, water taken at a depth of 30 feet registered 69 degrees F. about May 1st while in a cave where water is exposed to the sun in the middle of the day it registered 76 degrees F. The latter, known as the Sacred Cenote, is nearly 200 feet in diameter and has vertical walls. The former is covered over except for a small hole and this has only a little access of surface heat. Both are near Chichua Stza. The caves are called "Cenote" = tomb.

June 14, 1906.

I drove from Ann Arbor to Island Lake for purpose of learning how far the Marshall sandstone extends in northeastern Washtenaw and southeastern Livingston counties. A "ledge" that was reported to occur on Briggs Lake east of Island Lake was examined and found to be only glacial conglomerate. It rises 10-15 feet above the lake and outcrops in a cliff that naturally gave rise to the story of a rock outcrop. Wells in that vicinity are generally about 50 feet deep when on the pitted plain that stands between 900 and 920 feet, and none of that enter rock. They are largely through gravel but, in some cases, pass through some till. The cemented gravel such as outcrops on Briggs Lake is also found extensively on the old Briggs farm now run by a Mr. Richards and, in places, is not more than 5 feet and generally less than 20 feet below the level of the pitted plain.

I also saw a small outcrop of it at side of Pere Marquette Railroad track east of an overhead bridge in Section 3, Green Oak Township. Whether this is of pre-Wisconsin age I could not decide. The cementation is firm, but the color is not that of the old drift. Instead. it is a fresh gray color. This so-called "ledge" being only drift. I was compelled to rely solely on drift pebbles of Marshall sandstone for light as to the extent ox this formation. Here also difficulty is found in discriminating sandstones from the Marshall from those in the Coldwater shale that are in sandstone lenses.

There are sandstone blocks in the drift all the way from Ann Arbor to Island lake, though more scarce near Ann Arbor than farther north a few miles. It is not likely that the limits of the Marshall can be determined by drift fragments except in a very general way, with a chance for shifting the boundary back and forth several miles. If this sandstone can be clearly differentiated from sandstone in the Coldwater formation and from the Berea sandstone, the matter may not be difficult. I am not able, however, to recognize differences between these several sandstones. I find, also, that Dr. Rominger is not able to classify specimens from the drift even when they contain fossils.

I gave attention on this trip to the extent or abundance of the Devonian black shale in the drift. It abounds near Ann Arbor but is relatively scarce in southern Livingston County. I found it, however, without much search both in the till and the gravel in northern Green Oak Township. Till is near the surface in Section 3, Green Oak. I gathered some pieces of black shale from it in a cut on the Pere Marquette Railroad just west of Huron River in this section. If this were brought in from the southeast it will indicate a movement a little farther northwest from the Erie basin than I had supposed. There is, however, a possibility that the Saginaw Lobe gathered up Devonian shale in the basin of Lake Huron and spread it out on this region.

The fossiliferous sandstone fragment found in the drift 1/4 mile south of Rushton is thought by W. F. Cooper to be from near the junction of Coldwater and Marshall, probably within 50 feet of top of Coldwater and possibly in base of Marshall.

The sandstones from gravel pit north of Green Oak, Dr. Lane Thinks are likely to be Marshall because of the amount of carbonate of iron, some of them being suggestively rusty with it. (See letters of June 16 and 18, 1906.)

Wauseon Waterworks:

A letter from Carl D. Greenleaf of Waseon, Ohio, June 14, states that a well there was sunk 2,000 feet and yielded nothing but sulphur water and was largely through limestone.

Recently a waterworks well has been deepened to 170 feet and finds 30 feet of good water-bearing gravel in its lower part that yields 250,000 gallons per day without drawing down the head which stands at about 100 feet below the surface.

Location of coal lines in Michigan:

Saginaw County

St. Charles	sec. 5, T.10N.,	R.3E.	(Somers Coal Company)
St. Charles	sec. 17, "	"	(Somers Coal Company)
St. Charles	sec. 17 "	"	(Somers Coal Company)
St. Charles	sec. 10 "	"	Robt. Gage Coal Company
Carbon Mine	sec. 23 "	R.4E.	Carbon Coal Company
Pere Marquette No. 2	sec. 27 T.12N.,	R.4E.	
Chappell and Goodey	sec. 27 "	"	
Bernard Mine 3	sec. 34 "	"	
Saginaw Mine	sec. 31 "	R.5E.	
Uncle Henry Mine	sec. 18 "	R.6E.	
Jimtown Mine	sec. 7 T.11N.,	R.4E.	
Shiawassee Mine	sec. 8 "	"	
Riverside Mine	sec. 4 "	"	
Standard Coal Company No. 1	sec. 6 "	R.5E.	
Standard Coal Company No. 2	sec. 5 "	"	
Ellsworth Coal Company mine	sec. 8 T.10N.,	R.3E.	Abandoned
Pere Marquette No. 1	sec. ? T.12N.,	R.5E.	Abandoned

Bay County

Bay Coal Company No. 2	sec. 4, T.13N.,	R.4E.	
Michigan Coal Company	sec. 25 T.14N.,	R.4E.	
Pittsburg Coal Company	sec. ? T.13N.,	R.4E.	
Wenona Beach Coal Company	sec. 33 T.15N.,	R.5E.	
Wolverine No. 2	sec. 4, T.14N.,	R.5E.	
Wolverine No. 3	sec. 12 T.14N.,	R.3E.	
Central Coal Company No. 2	sec. 30 T.14N.,	R.5E.	
Dutch Creek Coal Company	sec. 1, T.13N.,	R.4E.	
Salzburg W. Bay City	sec. 29 T.14N.,	R.5E.	
Hecla Coal Company	sec. 2, T.13N.,	R.4E.	
Wolverine No. 1	sec. 17 T.14N.,	R.4E.	
Central Coal Company No. 1	sec. 25 T.14N.,	R.4E.	Abandoned

Huron County

Pyrites Mine, Sebewaing.

Jackson County

New Hope Mines 1 and 2, about 3 miles northeast (?) of city.

Shiawassee County

Owosso Coal Company, 3 miles northwest of Corunna.

Kincaid mine, northwest of Corunna.

New Haven Coal Company, near north line of county.

Eaton County

Several small drift mines near Grand Ledge. May be greatly extended.