

Some ledges of sandstone stick out of a railroad cut not far from Woodville and sandstone and on a hill south of the railroad scarcely two miles from Jackson I saw heaps of limestone which may probably be quarried there. The ground occupied by the carboniferous limestones near Larra and the spot where the sandstone coal mine is located, appears to be on a continuous level, and it may be that this coal is only a detached patch of coal enclosed in the drift.

Notice for Minchell report. Limestone exposure of 14 feet in Sec. 12 Summit Co. (Township 9) on the land of Michael Shoemaker, S.E. 1/4 of S.E. 1/4 of the section.

Red sandstone, shattered	5 feet
Rusty limestone, brecciated with chert nodules	1 foot
Limestone, in thin arenaceous layers	2 feet
compact bluish gray limestone	6 feet.

Roberts quarry, Spring Arbor. Sec. 17 S.E. 1/4 of S.E. 1/4 section.

Delvye (Sollevue) Eaton Co. Sec. 21, 23, 27, 29, 33, et 35. Carboniferous limestone outcrops.

Leoni, Jackson Co.

Minchell remarks that the Larra sandstone generally in the neighborhood of Sandstone and Woodville coal mines occupies topographically a higher level than the coal.

No authentic report about any lower strata in the worked coal mines below the coal mines.

Sunday May 25. Left Jackson 5 o'clock. Went the road north to Portage river. At the first hill elevation near the pottery works a sandstone outcrop is seen at the foot of the hill. The sandstone does apparently not differ from the sandstone overlying the coal mines. It is very irregularly stratified and the strata are sometimes bent or rolled as if disturbed while yet soft.

Diagram of above

Above them is at least 50 feet of drift which forms the top of the hill. All the way to Portage river the sandrock is hidden from view by the drift but before arriving at the bridge crossing Portage river outcrops of sandstone of soft friable character are seen on the side of the highway.

Across the river for a short distance the rising hill side is formed by drift and under it the slays of the coal formation, white or black, very plastic with trunks of Sigillarias are found. The top of the hill and a large area on its plateau are formed by limestone. The limestone is of white color with smooth conchoidal fracture and stylitic concretions.

The beds are fractured and the fragments of rough nodular character. Tuberculate within the beds and fissures of them are greenish clay and arenaceous masses with nodular limestone pieces included. The limestones has an average thickness of about 12 feet and at its base generally this greenish arenaceous clay with limestone pebbles are accumulated into thin or beds. Very few fossils in the limestone but brachiopods and nautilus etc. are occasionally noticed. The limestone in its stratification also very irregular and dips in various ways. However the whole limestone area seems to extend from northeast to southwest and the prevailing dip is southward.

Several wells are dug by the owners of this limestone land. One with the name of Wright has the wells. The one is situated on the east side of the road close to the line hill. This well is 30 feet deep. Begins in the limestone of the quarry 2 feet, under it a soft greenish argillaceous-arenaceous rock; then 2 or 3 feet of a reddish limestone passing to a dark colored lime; then 6 or 10 feet of very hard sand and limestone; and lowest a coarse soft sandstone very much like the sandstone of Jackson, or the sandstone at the road on the other side of the river portage.

On the west side of the road only a very small distance from the first mentioned well this was dug another well which is only 25 feet deep. He first penetrated 2 feet drift, then he came on 12 feet of black shale, and then into a coarse grained sandstone. No limestone is struck. The strata are in the well in highly inclined position dipping south.

On the south margin of this limestone belt which stretches along the northern side of the portage river are, close under the surface, tenacious clay beds of white or black color with *Ligillaria stens* in abundance. Their (depth is considerable) depth shall be considerable without striking any harder rock with the borer. It is said the (he) experimented down to the depth of 30-40 feet. These clays are decidedly in the neighborhood of the productive coal seams if there are any there.

The relative positions of the limestone, the clay beds and the sandstones cropping out on the other side of the river is not to be seen and further examinations must be made to describe it.

A patch of limestone apparently occupying a higher position (topographic) than the sandstone is exposed on the right hand side of the road, about 1/2 a mile south of portage river. Among the drift I found white limestones with smooth conchoidal fracture which contained several specimens of *Rhynchonella*. This limestone resembles accurately the limestone of portage river and I suppose actually belong to these.

The land along Grand river is of fertile quality and of a gently undulating character.

On top of the wall flanking the left side of Lottage river there is a fine exposure of limestone beds of a striated laminated character, whitish and pervaded by numerous cylindrical nodules of various sizes. Also siliceous portions are in it and on a slight notice several small holes, *Leptostrophia* etc. This limestone is underlain by sandstone. The case is seen very plain in the ditch a side of the road.

The sandstone on the one hand has much resemblance to the sandstone in the other lime quarries which I mentioned formerly. On the other hand it resembles also the ordinary coarse soft white sandstone overlying the coal or exposed in the locations where it is supposed to be the lower Lanna sandstone.

There is some probability that the limestones of this district do not correspond to the sub-carb. limestone. (H.B. subsequent investigations prove this to be an erroneous view) but are rather a subordinate member of the actual coal measures. The sandstones, Woodville as well as Lanna, are one and the same thing and underlie the limestone and perhaps still lower is the plastic fireclay and coal.

Monday May 20. Went to the locality on Michael Showmakers' farm. The place is on section 18 across the river, not on Sec. 12. Going from Jackson, at the place where the airline branches off from the Manchester road, the coarse sandstones of the coal formations were cropping out in the railroad cut. Following the road along the river on the west side of the Manchester road, a series of drift hills occupies the space within the big bend of the river. I crossed them going south and descended to the swampy valley occupied by the southern portion of the river bend.

On the south side of this valley another series of hills ascends which present the outcrops of the limestone formation, which however are confined to a limited area. All the rest of the hillocks evidently of the same structure have their nucleus of rock beds hidden by drift.

In the mentioned outcrop at the base is seen a coarse partly soft, partly harder light colored sometimes greenish sandstone with nodular concretionary structure. The upper portions are hard and rich in calcareous cement. Thickness seen about 2 or 3 feet.

Above them are arenaceous limestones somewhat brecciated with purer portions of true limestone of a gray color containing silicious seams and nodules besides sparry portions interspersed, the rock beds are rough, unhomogeneous and full of irregular fissures and smaller cavities. No fossils found in them. Their thickness including the arenaceous lower limestone beds is 2 or 3 feet.

On top of the limestones a dark brown calcareo-arenaceous easy weathering rock exhibiting in irregular uneven **clabs** and sharp angled fragments with occasional calc-spar crusts or pyritous specks forms the top of the outcrop.

These beds may also have a thickness of 5 or 7 feet. The surface of the hilltop is composed by several feet of gravelly drift. The brown rock is very abundantly represented in all the drift material spread over the country and before this I was not aware of the geological position in the series.

(The following paragraph was crossed out.) I get more and more confirmed in the opinion that the limestones in question are not the representatives of the subcarboniferous limestone but are really younger than the coal measures.

At noon went to Walker's mine. Could not see the mine. He gave me a number of sections received by borings on different places of the premises.

- No. 1. Downward in the shales below the sandstone.
- | | |
|--|--------|
| 1. Black shale with kidney iron ore | 13 ft. |
| 2. Fireclay, re-called by Walker, a sandy hard, easily weathering argillaceous rock with calcites and Sigillaria | 3 ft. |
| 3. Black shale | 15 ft. |
| 4. Coal | 3 ft. |
- No. 2.
- | | |
|---|-----------|
| 1. Shale as in No. 1 | 3 ft. |
| 2. Arenaceous fireclay | 3 ft. |
| 3. Black shale | 3 ft. |
| 4. Coal | 4 1/2 ft. |
| 5. Slaty, poor coal and then hard sandrock with iron pyrites. | |
- No. 3
- | | |
|------------------------------------|-----------|
| 1. Sandstone | 2 1/2 ft. |
| 2. Fireclay | 5 1/2 ft. |
| 3. Black slate | 10 ft. |
| 4. Coal | 4 1/2 ft. |
| 5. Some inches of poor slaty coal | |
| 6. Sandstone as in section before. | |
- No. 4. Towards peritaxillary.
- | | |
|------------------------|-----------|
| 1. Broken sandrock | 3 ft. |
| 2. Sandrock | 24 ft. |
| 3. Dark slate | 8-10 in. |
| 4. Coal | 8 1/2 ft. |
| 5. Slaty coal | 3 inches |
| 6. Sandrock as before. | |
- No. 5. Behind the steeple works.
- | | |
|-------------------|-------------|
| 1. Drift | 11 ft. |
| 2. Sandstone | 30 - 11 in. |
| 3. Black slate | 10 ft. |
| 4. Coal | 4 1/2 ft. |
| 5. Coal, poor. | 3 inches |
| 6. Hard sandrock. | |

No. 6.		
1.	Drift	3 ft.
2.	Sandstone	15 ft.
3.	Coal	3 ft.
No. 7.		
1.	Drift	4 ft.
2.	Sandstone	17 ft.
3.	sandy black slate	11 ft.
4.	black slate	2 - 10 in.
5.	Coal	4 ft.
No. 8.		
1.	Sandstone	33 ft.
2.	Black slate	3
3.	Hard rock with iron pyrites	1
4.	Black slate	10
5.	Coal	4
No. 9. Borings not far from Pottery works.		
1.	Sandstone, SC	30 ft.
2.	Fireclay, sandy	2
3.	Hard slate	3
4.	Hard sandstone	2
5.	Greenish clay	2
6.	Hard sandrock	3
7.	Green shale	2
8.	Sandstone hard	1 in.
9.	Mixed sandstone and slate Black shale	3 3
10.	Grey fireclay	5
11.	Bluish fireclay	7
12.	Cherty sandstone	5
13.	Black shale	7
14.	Coal very hard	3 in.
15.	Cofter coal	2 - 3 in.
16.	Fireclay, black and white	3 - 3 in.
17.	Grey cherty rock	3 - 1 in.
18.	Fireclay	3 - 1 in.
19.	Black shale and chert	10 - 3 in.
20.	Brown shale and iron pyrites	11 - 3 in.
21.	Hard sandstone, white	33
22.	Hard sandstone	15
	Sum.	143 ft.
No. 10. Borings on the other side of the river, east of the tower.		
1.	Drift	3 ft.
2.	Sandstone	37
3.	Concretionary sandstone	3
4.	Lignitic shale	1 in.
5.	Soft coal seam	
6.	Black slate soft	3
7.	Red shale with iron pyrites	10
8.	Hard coal seam	1
9.	Fireclay	1 in.
10.	Grey sandstone	
11.	Black shale, 1 ft. 12. Fireclay 7 ft. 13. Hard shale. 14. Black slate 15. Red shale	

Tuesday 27. Went to Jackson Hill with Mr. J. H. ... it is a ... of
 Wednesday 28.
 Thursday 29.
 Friday 30.
 Saturday 31.

Wednesday 28. Arrived from Spring Arbor at 11 o'clock in Jackson. Went with the station is about 1 mile south of the village. Along the railroad line in several places the and is also seen near the surface, in going from the station to the village. But generally drift overlies it. The drift is almost exclusively composed of carboniferous sandrock besides granitic and metamorphic boulders. Only few Devonian or Niagara pebbles are found.

At a point of a mile west and 1/2 mile north of Spring Arbor village on the plateau of a hill, the limestone is found with its overlying ferruginous limestone and the underlying green sandrock. Portions of this limestone are quite pure, of crystalline texture and purish blue color. No fossils.

The limestone at this place has been used since 40 years as a supply of lime for the surrounding country. It extends over quite a considerable area, but in some places deep drift covering hides it from view. I found it again on a farm along the road from the lime kilns to Jackson, directly one mile north of Spring Arbor village; and again 100 steps this side of where the road from Spring Arbor Mills crosses Sandstone creek. And also on the other side of Sandstone creek to the north of the road, the limestone comes out again.

In a straight line 1/2 mile further north on the Sandstone Creek are the Spring Arbor coal mines. On the side of the hill the coal beds were naturally exposed and found on digging a mill race. The sandstone roof of the coal is missing there and the coal bed from 2 to 5 feet thick is found merely covered by soft black shale and underlain by the same material. It contains a number of *Agillaria* stems transformed into iron pyrites and wood fragments also transformed into pyrites. The coal is otherwise of similar nature with the Jackson coal. The mines are 10 feet deep.

In an artesian well bored 20 feet the lower portions of the bore hole went through sandstone, as was informed by the foreman of Spring Arbor mine. They found a good supply of water, but did not penetrate through it. The surface of the road from Spring Arbor to Jackson is an undulating hill land composed of fertile drift with no rock ledges exposed alongside of it.

Follows 3 pages of data previously copied. Strata of Jackson mines

Thursday May 31. To Napoleon with 7 o'clock train. 1 mile before arriving at Napoleon cut through drift with considerable sandstone material apparently fragments of the carbonif. sandstone. At Napoleon Station, Drill Deep, no sandstone struck in the wells. South of it on the road leading through Napoleon from Jackson in southeast direction sandstones cover a large area of the surface. The rock is perfectly identical with the strata at Stony Point on the Jonesville road. Beds much cracked in irregular directions and stratification generally very irregular. Some good building rock to be obtained but not of first quality. There is not enough elasticity in the rock and by a stroke with the hammer it does not break in the desired directions, no trace of fossils in it. No borings at that place penetrating thro the sandstone. Visible thickness may amount to 50 feet. This is however not anywhere vertically exposed.

The country generally there is flat, little undulating, descending to the branches of Kalsin river. No outcrops of rock seen. Returned to Jackson with 10 o'clock train.

Diagram. Stratification of Napoleon Sandstone. Land fertile.

Stony Lake is a lake 1 mile west of Napoleon but no rocks outcropping. Here the lake surrounded by large boulder drift.

It is probable that the sandstone struck in the borings near Spring Arbor coal mine strike this sandstone but I have at present no particular evidence of it.

At noon went with Express train to Albion. Noticed east of Parma several exposures of the upper limestones of coal formation on the north side of the road. At Albion followed 3 miles up the river branch which is followed by the Jonesville road. On the south side of the river near the bottom of the valley the so-called Napoleon sandstones make an outcrop at a distance of about 1 1/2 miles from town and in another place about 3 miles distant. Then again on the farm of Smith Young on both sides of the river, the sandstones come to the surface. Near the dwelling of Young the sandstone is struck in a well about 10 feet below the surface. At the base of the hill on a level with the river 6 fine springs come out of the exposed sandstone ledges, which there is of a greenish color and quite micaceous.

On the opposite side of the river about 1/2 mile below the house a fine quarry is opened in the sandstone which has entirely the appearance of the Stony Point rock. The exposed strata are about 20 feet. Their stratification is irregular and the rock cracks easy in (or) the lines of stratification, and for this reason cannot be quarried in large dimension blocks. No fossils in it.

On both sides of this river valley and in the city of Albion in all the deeper wells, this sandrock is struck, sometimes under a drift covering of from 10 to 50 feet.

Geiger, the well borer, sunk down several holes which furnished abundance of water. One in the city mill is said to be about 300 feet deep. Another is about 80 feet deep and has not penetrated through the sandstone.

The drift in some places is almost entirely composed of granitic and amorphous rocks as far as the larger boulders are concerned. In other localities much of the sandstone blocks is intermingled. Land quite fertile.

Returned 8 o'clock to Albion. Stayed there over night. From Mr. Morrison of Albion I received the following statements taken from his memory.

The well near the mill is 285 feet deep. First 10 feet drift. Then sandstone of various hardness and color 271 feet. Under it penetrated into shale 4 feet when the boring was stopped. The water rose first several feet above the surface but fell after some time and now does not come within 3 feet of the surface. The lowest 40 feet of the sandstone resembled much the gritstones of Point aux Barques.

Other wells not far distant from the first penetrated almost accurately the same thickness of sandstone and went into the shale for about 100 feet. The shale was dark colored.

Borings at Marengo first went through 60 feet of drift, then about 200 feet of sandstone. Then shale also about 200 feet and lowest through what they called a kind of chalky soft rock, but its quality could not be nearer described to me.

Mr. Morrison had of all these borings more minute details but has lost the memorandum.

Thursday May 30. A very severe cold morning. Visited the stone quarry northeast of Albion from which the material for the mill of Albion was taken. It is situated on the east side of the Eaton Rapids Railroad track about 5 miles from Albion. The coarse grained glistening sandstone, partly white, partly ferruginous, occasionally with conglomeratic portions, forms a series of hillocks which are sufficiently denuded from drift to show the rock. Practically, the sandstone has inferior value. It is no doubt the sandstone above the coal. From this locality I returned south until I struck the road from Albion to Parma.

No clear rock exposures on the whole road except in one place about 2 miles east of the Eaton Rapids railroad line where the sandstones and above them the limestones make their appearance. Everywhere else the drift covers all but is to a great extent composed of debris of the coal formation. I found also a large celled specimen of Strombodes of the Niagara group in the drift, but generally Devonian and Silurian rocks are not abundant.

Close to the station at Parma is a small knoll intersected by a road and exhibits the brown ferruginous calcareous strata. Some limestone and the greenish sandstone underneath but everything thrown into confusion.

By boring a well at the same spot the owner of the place found below a soft white sandstone which he penetrated about 15 feet. Wherever the sandstone came near to the surface in the drift was, besides ordinary sandstone fragments, a great quantity of iron ore nodules of concentrically laminated structure or conglomeratic sandrock boulders with copious iron percentage. Some contained calamites and other vegetable remains.

The brown rock superimposed on the limestone is all the localities is found to have sometimes a brecciated condition, more ferruginous and lighter argillaceous pieces mixed.

Saturday 31. With 7 o'clock train to Woodville. At Woodville no outcrops seen, the drift is much mixed with debris of the coal sandstone and in some places the arenaceous nature of it indicates the close proximity of the sandrock.

Near Woodville mines the sandstone is laid open in a cut of the side track. The mines are not worked. The material thrown out is a carbonaceous shale with many pyrites concretions and with Ligillaria stems transformed into pyrites.

Short distance west of Woodville station masses of the coal limestone of the ferruginous kind and of the purer limestone are mingled with the drift.

Near Sandstone station on both sides of the Sandstone creek in a level marshy meadow ground the shales of the coal formation and coal beds are coming close to surface and are of have been mined there in a very rude manner. Towards the hill a part of the shales have a sandstone roof but the locality is not fit for mining. The strata are the same as at Woodville, contain also numerous Ligillaria stems transformed into pyrites.

Ascending the hill to the north, the coal limestones are found spread over an extensive patch of land. The top of the hill is drift and rises in its highest points perhaps 80 feet above the railroad level. I walked from Sandstone $1\frac{1}{2}$ mile north, then one mile east and came on the next south road down to the railroad again. All this space is covered by undulating drift hills with no rock exposures.

Of the Lingula mentioned by Winchell I could not find a trace in the shales. Also no fish remains in the Spring Arbor mines which I had visited 2 days previous.

On the east side of Jackson north of the railroad within the city limits everywhere the sandrock comes out and is quarried not far from the depot. With 3 o'clock train returned to Ann Arbor. Stayed over Sunday.

Monday June 2. Left Ann Arbor with 9 o'clock train. Left Jackson for Eaton Rapids at 12:50.

The road to Rives Junction is the same as the Lansing Road. Does not offer any exposures except a few cuts through drift hills. Near the Pottery I observed close to the river bed for the first time an excavation in the fireclay beds of the coal formation, which are apparently very similar to the clay beds near Portage River. Near Arland the road strikes close to the Grand river and follows the valley down to Eaton Rapids. The valley is broad, flat, limited by very little elevated undulating drift hills. No rock whatsoever exposed over the whole distance.

At Eaton Rapids are about 6 or 7 artesian wells sunk. I was directed for information to Banker Vaughan which very kindly offered me all the information he could give.

Of one of the wells, the Frost well, I got an accurate record from his memorandum books. It is as follows: Loose material 20 feet.
Sandstone - .

By Mr. Frost I was informed that only about a mile above the city the sandstone crops out in the banks of the river and that further up even the coal is found in the banks of the river for the distance of 3 or 4 miles.

I went to see the sandstone outcrop and found a tolerably solid coarse grained sandstone stained by iron with brown in layers apt for an ordinary building stone, but its stratification is very often irregular (false stratification). The sandstone layers of from 1 to several feet thickness are interstratified with shale beds from a few inches to over a foot thick. The surface of the sandstones is covered with numerous vermicular or fucoidlike relict forms also streaks of carbonaceous matter and sometimes argillaceous-calcareous pebbles are mingled with the sandstone which has undoubtedly its position above the coal.

The country on both sides of the river is a very fine level agricultural land covered with a loamy sand without many boulders, and the thickness of this loose material I suppose is not more than 40 ft before the sandrock which is equally spread out over all this extended level, is struck. About 6 or 8 miles down the river I am told of other outcrops of the sandstone and the coal in the river banks but I did not go to see them.

Made an appointment with Mr. Vaughan to meet him Thursday morning at 9 o'clock at Charlotte depot to make with him an excursion to a locality near Chester where strong evidences of coal shall be found and which to examine I find of interest.

Thursday morning 8 O'clock to Charlotte over a perfectly level country partly overgrown by tamarack swamps, partly susceptible for agricultural purposes. No rock visible. $1\frac{1}{2}$ mile south of Charlotte and 1 mile east an outcrop of sandstone reported.

The borings at Charlotte 730 feet deep. Executed by Geiger. There is no record of the penetrated strata to be had at Charlotte but Geiger is in possession of it. It is said that he penetrated some coal beds. The drift in some other wells at Charlotte is found to be from 50 to 60 feet deep before reaching the sandrock.

North of Charlotte 16 miles, at Grand Ledge on the Lansing, Grand Rapids road, the river cuts through sandstone strata exposing about 100 feet of them with some subordinate coal beds inclosed.

Train to Bellevue leaves at 11:45 min. From Charlotte to Bellevue the railroad leads over a flat country. Undulating low drift elevations are sometimes cut through but no rock beds seen until arriving in sight of Bellevue village, where the brown arenaceous rock and the white limestones of the carboniferous series come out and from there extend for several miles along the railroad track which below town makes considerable sections through it.

All the south side of Bellevue is in the village vicinity formed by ledges of limestone which is in numerous quarries disclosed to the depth of about 20 feet counting in the strata brought to view by the undulation of the strata. The quarries themselves have never penetrated to more than 15 feet of vertical depth. The following is a section.

- Above. 1. Slabs of white limestone .Thickness not determined.
 2. Brown arenaceo-calcareous rock, partly in the form of septaria from very hard to friable with veins of spar or bands of iron ore. Is frequently attenuate, wedge-like 1 to 2 feet. and sometimes makes immediate horizontal transition into calcareous shaly strata of grey color.
 3. White limestone 3 feet.
 4. From 2 to 3 feet of the brown calcareo-arenaceous rock like No. 2.
 5. Limestones more or less pure from 6 to 8 feet.
- Base of quarries.

In the railroad cut similar sections are seen but some of the subsequent deeper strata are disclosed. The lower beds are also limestone which contains considerable of coarse sand and is found in all gradations from pure limestone to a coarse grained sandstone, which forms the sub-stratum of the limestone beds.

A bed within the arenaceous horizon of the lower limestones is of extreme hardness, of sandstone structure, but contains too much spar or (as) cement, that on a fractured face a perfect (Blaetterbruch) (leaf in stone) is conspicuous by looking at it in proper direction.

The upper limestones of the series are generally poor in fossils. However there is lithostrotion, Syringopora and Allorisma to be found in it.

In some of the lower beds near the subjacent sandstones there are limestones which abound in fossils particularly a Zaphrentis, Belerophon, Eproductus(rare). Stictopora or Phaenopora, Fenestrella and particularly numerous Fish teeth.

Wednesday June 4. Re-visited the quarries in the morning and made many collections of fossils. The extent of the limestone is very considerable on both sides of the river south and north of town and principally westward. The rock character remains everywhere similar but a great many minor variations occur in the beds and in the quarries on the north side of the river the arenaceous admixtures to the limestones and the brown ferruginous strata are evidently predominant over the purer kind of limestone. In the river bed in several places the sandy rock beds forming the lower part of the formation are forming the bottom but usually the erosion has been to a greater depth and the bottom of the valley and river is then filled with loose drift material and alluvial sand.

Promised to Mr. M. S. Bracket to return to Bellevue a week after next Monday if no particular impediment should be in the way.

Thursday June 5. Return to Charlotte to meet the gentleman from Eaton Rapids. At 10 o'clock went to Chester Station. Went there along a north road for about 1 mile, then east and followed over the hilly broken land the meanders of Little Thornapple Creek.

The general surface is all drift but in the bed of the depressions through which the creek flows and in ravines, the shales and sandy fireclay beds with black shales and coal beds are found close to the surface. Some very fair coal has been taken out of openings made in search of coal but the coal measures are too much eroded during the drift period and their sandstone covering swept away so that there is little prospect for profitable coal mining here.

The sandy grey colored argillaceous rock contains an abundance of Ligillaria leaves and trunks besides calamites. A few of the experimental borings went down 70 feet. One of them penetrated through the following strata.

1. Argillaceous whitish fine grained sandstone with Ligillaria and calamites 8 feet
2. Whitish fireclay 30 feet
3. Black slate 30 feet.
4. Hard ferruginous rock 8 in.
5. White fireclay with bands of hard ferruginous rock, about 20 ft.

On somewhat higher level only a few steps from this opening black carbonaceous shales with seams of coal are opened, which doubtless form the next stratum above stratum 1 of the above section. This black shale is covered by about 8 feet of alluvial clay and gravel.

In the creek bed about 1 mile at(?) from this place the coal crops out in connection with the sandy ligillaria clay rock. Above them is drift and no sandstone covering. Returned to Charlotte. Sent the specimen bags to Jackson by Mr. Potter. From Chester to Vermontville undulating drift hills ascending on the northeast side of a swampy river bottom. Went on to **Grand** Rapids.

Freiday June 6. Mr. Obrock took me down to the Plaster mills on the west side of the river at the foot of the drift bluffs. Soft bluish shales with nodules of gypsum, thin layers of sandrock and below several massive gypsum beds are making an outcrop. For the lower thick gypsum beds regular mining operations are carried on and the material is close by prepared and ground for the market.

On the other side of the river the **gypsanus** strata are more laid open to the surface and are worked in the style of common quarries, at least so I found it there 10 years ago.

The river bed and its embankments formerly the different layers of the carboniferous limerock were finely exposed, but the river improvements and numberless buildings and manufactories erected alongside the river have perfectly annihilated the former splendid occasion to study the rockbeds. The few ledges opened in one place are almost destitute of fossils except a few lithostrotion stems. The drift hills on the east side of the river are very high, of sandy material and below composed of a blue plastic clay of great thickness. It contains in places numerous pebbles. Other portions are free of them and answer an excellent purpose for making brick. Gypsum formation 1434. in all.

In the morning I saw also a Brewer, Beyrich, which sunk an artesian well 236 feet deep. The strata penetrated are as follows.

	35 ft.	inches
Drift material		
Limestone	14	6
Blue slate	7	
Plaster	1	6
Blue slate	6	6
Flintrock ?	3	6
Shale	7	
Blue slate	1	
Shale	7	6
Flint	2	6
Shale	6	6
Pyritous rock	1	6
Shale	7	6
Pyritous rock	1	6
Shale	1	8
Blue slate	9	6
Pyrites	1	
BlueSlate	2	4
Pyritous rock	2	
Blue slate	4	6
Shale	3	3

Sulph. Rock	2 ft. 6 inches
Sandrock	2 9
Blue slate	2
Sandrock	5 6
Sulph. Rock	2 6
Sandrock	3 4
Blue slate	4
Sandrock	5 2
Gypsum	4 9
Sandrock	6
Blue slate	2 6
Gypsum	5
Blue slate	4 6
Flint	6
Gypsum	6
Blue slate	4 6
Pyritous rock	8 2
White Sandrock	55
Blue slate	6

The well at this depth has a compact overflow of about 500 barrels a day. It is impregnated with soluble salt to make it unfit for beer manufacture but it is not much unpleasant for ordinary drinking purpose.

Of Powel's artesian well in close distance east of Sweet's Hotel I will endeavor to have this afternoon a record. No accurate account was kept. Mr. Powell made from memory the following statements:

Loose superficial masses	14 ft.
Limestone	12
Arenaceous limerock, yellowish, hard	4
Shales and limerock alternating, about	20
Shale with some gypsum beds, about	36 below surface.
Shale and clay down to	204 " "
Sandrock	93
Shale (not penetrated)	10

Below this shale a sandrock of about 100 feet in thickness is found in other deeper wells.

Saturday. Returned home and found my oldest girl seriously sick with endocarditis. Remained at home to attend here until

Monday morning June 16, when I went to Battle Creek. About a mile below the railroad depot under a bridge the river runs over ledges of the fossiliferous marshal sandstone. The beds there are splitting in thin uneven slabs, are quite hard and calcareous but alternate with softer friable strata. The hard rock contains a great abundance of fossils, in particular the large Nucula. Besides those are a smaller species of Nucula, several other lamellibranches, in particular sole-noid forms and Edmondia, then a productus, a rhynchonella, a spirifer, goniatites, Belerophon, Orthoceras, nautilus, crinoid stems, ectr.

The sandstone strata continue from the water level up to the height of the principal street which is about 40 or 50 feet higher. The upper strata do not contain any fossils and are apparently of the same aspect as the Napoleon sandstone.

This Marshall sandstone seems to underlie the whole distance of the of the Kalamazoo river valley from Marshall to Battle Creek. Another outcrop of this sandstone is above town about $\frac{3}{4}$ of a mile where a man has opened a quarry which furnishes a good building stone. Only few shells are found in the quarry.

In Battle Creek an artesian well has been sunk to the depth of about 400 feet. 80 feet of drift covering were first sunk through before striking the sandrock. Then the sandrock with intervening shaly strata form the remainder of the borehole which furnishes plenty of sweet water. The particular statements of the boring experiment I have not found out yet and I believe nobody kept an accurate account of it.

In Battle Creek, Dr. Cox kindly guided me in his carriage to the outcrops of the sandstone.

Up Battle Creek I learn from a man which went up the creek with a boat that no outcrops of any kind of rock are to be seen along the creek before reaching the limestone regions of Bellevue.

From Marshall to Battle Creek an almost level country extends through which the Kalamazoo River flows in a bed with quite flat embankments. Near Battle Creek some drift hills rise on both sides of the river and in a few places the cuts of the railroad are cutting down to near the sandstones.

Thursday 17. June. Revisited the outcrops of Marshall sandstone again and found some additional fossils. In particular I mention a large aviculopecten and several fish teeth. Mr. Cox guided me over some of the environing drift hills. On the south side of the city and of Mr. Cornelius Foundry which bored the wells, I learned the following facts about the borings. Situation in the northeast part of the city.

Drift material before striking the rock 71 feet.
(About $\frac{3}{4}$ of a mile further west on the same approximate level the sandrock is at the surface which assuming the strata horizontal would add 71 feet of sandrock removed by denudation in the artesian well locality).

Sandrock 43 feet.

The drift sinks after that suddenly from 3 to 5 feet and an ample supply of water rose to within 16 feet of the surface.

The boring was then continued to the depth of 440 feet. All the remainder of the hole went through soft shale 326 feet without finding an additional supply of water and then the(y) quit boring.

Two more wells are intended by the city council and special care to observe the penetrated strata will be taken.

At 3:15 went with Peninsular Railroad to Bellevue . On the east side a row of drift hills strikes parallel with the creek passing Bellevue. The valley itself is a flat partly marshy country with no outcrops of rock. At Bellevue Mr. Bracket guided me to a locality said to have shown indications of coal. These are loose coal fragments imbedded in the drift. The indicated place is a few miles southeast of the village.

Made some collections in the limestone quarries but did not ascertain any new facts. Mr. Bracket will during this summer execute some borings the results of which he will communicate to me.

The approximate thickness of the limestone formation I guess at 50 feet, and invariably the underlying strata are a sandrock of coarse grain, soft or hard, sometimes nodular with argillaceous beds interstratified.

Wednesday 18. Afternoon at 4, went by train to Lansing. Slightly undulating drift plain or swampy river valley with no visible rock exposures.

6 miles before arriving at Lansing on Minnis' farm the discovery of a 6 or 8 feet thick bed of coal was promulgated and the place was offered to the Peninsular Railroad Co. But after careful inquiry it proved to be a humbug.

1½ miles above Lansing at the rapids of Grand River the sandstone crops out in the river bank and some of it has been quarried there.

In Lansing 3 artesian wells have been sunk. The first 14 or 15 years ago bored by a man with the name McCabe which is now in the oil region is 1400 feet deep but nobody could give me any information of the series of rock strata which were penetrated.

A second one was bored in the grounds of the Reform School and I think in my memorandum book of 3 years ago I find a copy of the boring results.

A third one is in the yard of the Lansing Hotel, 740 feet deep, furnishing a saline water which rises to within 12 or 15 feet of the surface. But also of this well I could not get any stratigraphical description. A man with the name of Stephens living in Jackson bored it and is in possession of a detailed register of the strata.

Thursday 19. Intend to go with freight train at 7 o'clock to Grand Ledge, but only at 12 a train goes. Arrives at 1 o'clock in Grand Ledge. The village is situated on the banks of Grand River which has carved its bed about 60 feet below the general surface which is formed by drift and only in ravines and in the river valley the rock beds underneath have been denuded from this covering.

The rock beds are visible in the banks of the river beginning about 1 mile above town and continue down the river to be exposed with temporary interruptions for the distance of 9 miles. Further on I am informed no more rock is seen in the river before reaching Grand Rapids.

At the village 3 artesian wells are bored which furnish an ample stream of flowing water which scarcely differs from ordinary well water in taste and chemical composition.

The well at the mineral spring Hotel is situated only a few feet from and above the water level. Its total depth is 105 feet. In the bluff above the borehole in ascending order the following strata are seen.

1. Arenaceous shales of bluish grey color 2 feet
 2. Sandstones compact of middling fine grain with kidney iron ore nodules and vegetable impressions (Ligillaria) 2 feet
 3. Light colored argillaceous sandstone, easy decaying and filled with the leaves and stems of Ligillaria, from 3 to 4 feet
 4. Black carbonaceous shale with bands of kidney iron ore 1 to 1½ ft.
 5. Drab colored arenaceous shales with occasional ledges of sandstone about 15 ft.
- Above which a heavy drift covering forms the upper part of the bluffs.

¼ mile up the river on the opposite side another artesian well is sunk to the depth of 500 feet which furnishes a water more impregnated with saline substances and right opposite the first mentioned well, the third well which is only 65 feet deep is on the other side of the river.

The water of the two opposite wells seem to be in connection. I am told that as soon as one well was opened the other sunk and the pipe which discharged the water had to be cut off for 2 feet.

Short distance below the bridge crossing the river on the left side of it a quarry is opened which furnishes a fine valuable sandstone and coal at the same time. The exposed section is as follows:

From top of bluff which bears some drift covering 12 or 15 feet of arenaceous shales with some sandstone ledges or nodular masses of it besides kidney iron ore, and a band of black carbonaceous shale form the declivity below. Then follow from 5 to 8 feet of regular fine sandstone ledges in beds of from 10 to 18 inches which serve a very good purpose for finer masonry work. The beds are however visibly wedging out in places and are supplanted by shales, or, thicker in other places where shale should have its horizontal extension..

Under these sandstones shales white and black laminated form a bed of **from one** to two feet but sometimes sandstone ledges occupy the same position.

In the horizontal continuation next under it is a bed of good coal 15 inches thick. Under the coal are bluish sandy shales and lower a series of sandstones is noticed, but the section below the coal bed is not sufficiently laid open. Opposite this quarry the rocks of the upper so-called Woodville sandstone stand out in picturesque vertical walls about 25 feet high. A description of them is given below.

Friday 20. At 5 in the morning went to a creek below town entering Grand River. It is carved into the upper Woodville sandstone to the depth of about 30 or 40 feet. The sandstone is of the usual coarse grained red colored easy weathering, contains numerous kidney iron ore nodules and in places quartz pebbles, also impressions of vegetables and carbonaceous particles are very common in it. One irregular fossil resembling an encrinite stem but evidently forming the centre of a wooden stem I found in the sandstone. In places the sandstone is of better quality and is quarried for construction of buildings in the village for which purpose it answers very well. By weathering this sandstone has generally a yellow color but fresh pieces protected from the influence of the atmosphere are also perfectly white.

There are however localities where the same beds are so strongly impregnated with ironoxyd that their color has a dark chocolate tint. Such portions of the rock are also much firmer cemented and are of great specific weight.

Boring results of the well above Grand Ledge on left hand side of river 572 feet deep. First below some drift covering whose thickness is not ascertained, White sandstone 14 feet
2. Shale 20 feet
3. White sandstone 173 feet
4. (Putty rock) probably argillaceous shales 135 feet
5. White sandrock 158 feet
Soapstone and alluvia 12 feet
Bottom of well.

First vein of water 40 feet below the surface. Second 110 feet below surface. About 300 feet below surface my informant supposes they struck a bed of limestone but he is not certain about it.

Revisited the righthand side of the river down stream. The shales and sandstone ledges of the coal formation as described in the proximity of the hotel and in the quarry on the opposite side, form the surface rock for $\frac{1}{2}$ mile. Some lower strata partly sandstones and partly shales come in places to the surface. At once, after an interval covered by drift, the Woodville sandstone 25 feet thick rises in abrupt walls along the river and continues so for nearly a mile. It is in places highly ferruginous, contains nodules of Kidney iron ore and numerous vegetable (impressions) imprints, also thin half-inch thick irregular seams of coal.

Under it are occasionally blue shales cropping out and in the bed of the river below are beds of sandstone.

After the Woodville sandstone has continued in tolerably horizontal position lower down the river the shales below rise gradually to the same height occupied by the sandstone. The beds of them are evidently locally disturbed by the excavating process of the river bed and lay in a position that a fault in the strata is supposed by one of the self made geologists of the place. But the general order of the strata is nowhere so disturbed that the irregularities could not be simply considered as entirely local.

The stratigraphical structure of the beds below the coal is as near as can be ascertained as follows.

- 1 Below Woodville sandstone blue arenaceous shales, harder or softer and with occasional layers of sandstone from 15 to 20 feet.
2. A seam of coal $2\frac{1}{2}$ feet thick in places but sometimes thinning out and having the character of a rich carbonaceous black shale.
3. Under the coal bed is a sandy argillaceous rock with many Ligillaria remains which in places gets a soft fireclay of whitish color. Some shale beds follow again and next below from 6 to 8 feet of white fine grained sandstones exactly of the same character as those in the quarry across the river. Below this a 15 inch bed of coal comes out which corresponds to the coal bed in the same quarry and lower alternating layers of sandstone and shale are found. Some of those sandstones which crop out in the river bed are in hard very even slabs and serve a good purpose for flag stones.

The aggregate thickness of the shales and sandstones below the Woodville sandstone as far as seen in this locality I estimate to 50 or 60 feet. Considerable of calksinter is deposited alongside of the escarpments which is used for limeburning. Copious springs of good water issue from under the Woodville sandstone.

Diagram. Ideal Section of above.

300 or 400 steps below the bridge the following section is to be noticed. Below, in the bed of the river, whitish somewhat nodular sandstone blocks with ferruginous dots and seams, and alternating with shaly layers form the first 3 or 4 feet above the water level.

Second stratum is a white ripple marked sandstone in slabs of laminated structure about 3 or 4 feet.

3. Blue slate 2 feet.
4. Sandstone with Ligillaria 2 feet.
5. Black shales or pure coal seam, a few inches thick.
6. Blue shales, with some arenaceous beds 6 or 7 feet.
7. Sandstone with Ligillaria from 1 to 2 feet.
8. Black carbonaceous shale or coal 1 foot.
9. Shaly laminated sandrock 4 feet
10. Sandrock with Ligillaria, several feet.
11. Blue shales. Not exactly determined thickness.
12. Heavy drift covering,
Amounting to at least 30 feet up to the plateau of the hilltop.

In the evening returned to Lansing and from there to Mason. The whole interval offers nothing for observation but a drift plain with occasional hillside accumulations of the material. Much of it is a tenacious clay fit for brickmaking. Only in places boulders or gravel prevail.

At Mason only short distance above the railroad depot which lays at the foot of a 50 feet high drift hill chain which comes up from Jackson and continues further north, in the bed of the creek sandstone strata make an outcrop and are in a small way quarried for home consumption. It is a coarse grained yellow colored somewhat soft sandstone of inferior durability and has all the appearances of the sandstone overlying the coal measures at Jackson.

In the Courthouse yard an artesian well has been sunk but the particulars of the boring could not be found out. Mr. Stephens of Jackson done the boring.

A statement of Dr. - of Grand Ledge concerning the artesian well close to the MineralSpring Hotel is as follows.

The well begins at the foot of the river bluff about 10 feet above water level and overlaid by the strata mentioned above as forming the bluff.

- | | |
|--|---------------|
| 1. Sandstone | 20 feet |
| 2. Fireclay from 3 to 5 feet | |
| 3. White sandstone from | 35 to 40 feet |
| 4. Coal | 16 inches |
| 5. Carbonaceous shales | 3 or 4 feet |
| 6. Shales of considerable thickness .Struck water in a hard conglomerate rock. Flowing water at about 80 feet below surface. | |
| 7. White sandstone and conglomerate rock to the depth of 105 feet below surface. | |

Struck another vein of water and quit boring. A well right on the opposite side of the river struck water at the depth of 65 feet. Borings began in the shales and the waters of both wells seem to communicate. If one is made higher in the outflow the other ceases to run.

Monday 23. Left Ann Arbor for Owosso, arrived there in the evening.

Tuesday. Within city limits on the left side of the river a mine has sunk a shaft to the depth of circa ? 40 feet. It begins in a dark blue shalerock with vegetable remains.

Then a 12 to 15 inch bed of coal, follows
Underneath from 4 to 6 feet of fireclay with Ligillaria leaves follows.

Then another 15 inch bed of coal and below again shales and fire clay follow.

The fireclay is said to be of superior quality, the coal is very sulphurous but in connection with the fireclay it promises to pay well for mining enterprises which after having been abandoned are lately been taken up again by a company from Lake Superior capitalists among whom is Krestuncy (?)

South part of town on the property of Mr. Gučekunst a very copious spring of water has been struck at the base of the drift formation in a pebble conglomerate while excavating a cellar for the Brewery. The water is used for brewing and a bottling institution has been erected on the ground.

Near the depot of the Detroit and Milwaukee railroad at present an artesian well is being sunk. They have at present reached 150 feet. The man engineering the work gave me the following particulars.

Drift	40 feet.
Fireclay with some traces of coal	5 "
Blue shale	20 "
White arenaceous shale	8 "
Blue arenaceous shale	23 "
Hard blue shale partly arenaceous, below	67 "
June 23, evening.	
Wednesday June 25. Mine of Corunna	9 ft. surface
Shale and black slate	30 ft.
Sandrock	3 to 4 ft.
Slate about	5 to 6 ft.
A thin coal bed from	10 to 15 inches.
Fireclay	3 or 4 ft.
Below some feet of slate.	
Then coal	3 feet.
And below 3 feet of fireclay again	
Then 3 to 4 feet of slate	
Lowest a sort of sandy rock approaching the arenaceous fireclay.	
Whole depth about 80 feet below the surface.	

Beds all have an undulating expansion sometimes dipping down, sometimes rising again. All these strata are seen laid open in an oblique descending duct leading to the bottom of the mine. The coal is of hard good quality but contains some pyritous admixture.

In the black shale above the coal some lamellibranches and a Lingula are found. The fireclay beds contain as usual numerous Ligillaria stems and leaves. In the black shales are also hard calcareo-ferruginous concretions of Lenticular shape.

The mine is situated $1\frac{1}{2}$ mile to the northeast of village on the north side of the river on a low swampy bottom, some distance above sandstone is said to make an outcrop in the river. Near the mines where the sidetrack crosses the river, on both sides of it, sandstone of coarse grain and of yellowish color when exposed to the atmosphere is at the surface.

In a shaft filled now with water 10 feet of the sandstone beds are visible close by the railroad track leading to the mine. The rock contains particles of coal and plant impressions and has all the usual qualities of the sandstones above the coal beds at Grand Ledge or Jackson. The river bed itself close by does not exhibit any rock beds. Returned by railroad to Owosso.

Thursday June 26. Took a carriage to Flushing. Passed the old coal mines near Corunna situated a little to the northwest of the mine I visited the day previous. The country to Flushing is a flat rich agricultural land. Near Flushing it becomes more rolling and the Flint River has carved its bed about 50 feet deep through the drift, which is above partly sandy loam, partly gravelly. The lower portions are a plastic blue clay, well stratified and containing pebbles and in places fragments of the strata of the coal series.

A number of copious springs emanates from these clay beds. In the bed of the river and partly in the embankments the strata of the carboniferous formation are exposed. The exposures begin a few miles above Flushing and continue down the river with temporary interruptions for 9 miles below Flushing. Above the town the following section is to be observed,

1. Lowest fine grained sandstones with Ligillaria stems and leaves and quite hard. Several feet visible in the river bed.
2. Blue shales with some subordinate layers of the Ligillaria bearing sandstone, about 4 feet visible.
3. Dark shales with numerous kidney iron ore nodules, 5 feet.
4. Black arenaceous shales with seams of coal, 2 feet visible.
5. Coarse grained sandstone of bluish color with many micaceous scales partly in regular thick beds containing calamites and Ligillaria, partly of very irregular false, discordant stratification, or in thin inch thick beds, the upper strata sometimes finer grained, more whitish. In all about 25 feet. This is the quarry stone of the district.
6. Above these follow from 12 to 15 feet of blue shales which are plainly seen superimposed a small distance below Sutton's quarry on the opposite river side.

Sutton's quarry is on the north side of the river about 1 mile above Flushing, on the south side similar outcrops are seen but generally if one side exhibited outcrops the opposite side did not show any.

In places the sandstones were washed away and the lower shaly and carbonaceous strata are near the surface. Below town 2 miles on Agnus place and 4 miles on F. Hallack's place and in Montrose town in Sec. 28, the sandstones are seen in the river bed and small quarries are opened in them.

Also coal beds below the sandstone come out in the river bed and quantities of it have been taken out. The coal is said to be in some of the localities 4 feet thick. Several boring experiments have also lately been made but I could not learn the particulars, partly from ignorance, partly from ill will. They are angry at me because I did not recommend these sandstones for the construction of the State House.

From one boring I found out that first 30 feet of sandstone were penetrated, then about 20 feet of shales. A 4 foot coal bed is said to have been struck 100 feet below the surface, and the bottom rock of the boring is described as a white sandstone. The boring was not much over 100 feet deep.

In the evening rode to Flint along the top of the 50 feet high river bluffs which are principally drift, partly of very gravelly nature.

Near the paper mill 2 miles below Flint the lower tenaceous blue clays with pebbles form the base of the embankment.

At Flint the sandrock is said to make outcrops in the river near the mills but the place is covered by sawdust. Several deeps borings have been made of which I could learn the following particulars from Mr. Decker and Dr. Clark.

The well in Main Street which is flowing sweet water with very slight mineral taste.

Drift material 84 feet.

Sandrock. 12 feet.

First flow of water.

Then a series of shales and sandstone beds with 2 or 3 feet of coal were penetrated.

Then the boring continued in sandstone to the depth of 160 ft when the flow of water was increased.

Below this shale was found.

The total depth of the well is about 360 feet.

Another well has been sunk on the top of the hill north of the river near Dr. Chapin's dwelling house. It is said to be 700 feet deep but was just abandoned by the workmen, the day previous (to) my arrival. As far as I recollect I was told the depth of the drift there was found 125 feet. Then a sandstone was struck. Below this the coal series with its shales and also a coal bed was penetrated. Then sandstone and shale again. The water does not rise higher than to 20 feet below the surface but seems to be in sufficient supply.

Dr. Clark gave me the outlines of a boring 1200 feet deep, made 12 years ago under Crapo's auspices near the city of Flint.

Drift 68 feet

Sandstone 67

Shales and coal with subordinate sandstone layers 35

Then sandstone about 108 " thick.

At the depth of 260 feet from the surface struck sweet water overflowing. After this the boring continued principally in shales with occasionally layers of sandrock to the depth of 1200 feet. The shales furnished a strong saline water. Dr. Clark has an accurate account of this boring in his office. This is given by memory.

Nowhere in the borings of Flint strata representing the subcarboniferous limestone were struck.

From Flint to Owosso a road leads in a straight westerly direction first over undulating drift hills, then over a very fertile flat land, offering nothing but drift at the surface.

Near the mill dam of the Shiawassee 4 miles above Corunna sandstones of the coal formation are outcropping in the river bed and from there soon the district where the Corunna coal mines are worked are reached.

In Sec. 5, in town Owosso. Boring near Owosso for salt to the depth of 1000. A very confused account copied from Mr. Courier's notebook.

Superficial drift	121 ft.
Shale	20 ft.
Coal from 4 to 7 at the depth of 150 ft. from surface.	
Shale	54
Stone ?	15
Shale	33
Sandrock with salt at the depth of 250 feet	250 feet
250 feet of the sandstone.	
At the depth of 469 feet a 3 feet bed of limestone	
At 536 feet another 3 foot bed of limestone	
Shale separates the two	60 ft.
Soapstone	20
Sandstone at 541 feet.	
Sandstone with salt 77 ft. thick. x verse	
Then blue shale and red shale all the way down to 1000 feet.	
Red shale at 673, at 879 and at 966 to 974.	
At 820 to 839 brown limestone	
At 404 to 434 White crystals apparently milk quartz , salespar with iron pyrites.	

The above account of the Owosso boring has to be revised first and ordered.

Friday 27. After arrival from Flint in the afternoon went to the mouth of 6 mile creek into the Shiawassee. The coal formation with its sandstones and shales is said to be visible in many places of the river and its embankments from Owosso down to Six mile Creek.

At Six mile creek below heavy drift bluffs 40 to 50 feet high, dark shales with calcareous kidney ore concretions seem to be highest visible strata. Below about 4 feet of black limestone beds of shaly structure come out in the river bed. They contain numerous fossils. Spirifer, several large orthocerasites and other cephalopodes, besides some crinoid stems and also a few compressed Zaphrentis I noticed.

Under this limestone a coal bed of about 15 inch thickness has been found and some of it taken out. Below the coal a very tenaceous white fireclay comes out in the river, and in this clay are imbedded nodular blocks of greenish white limestone of cone in cone structure . Also other limestones in hard slabs and of bluish color are abundantly found in the river bed and seem to be in loco.

Close by a boring has been made to the depth of 100 feet. For about 20 feet a shaft was made, the rest was drilled.

From this shaft I see thrown out large concretions of calcareous kidney iron ore mixed with white sandstone and partly forming a breccia together. Also dark shales are thrown out and the owner of the place reports that a bed of coal 7 feet thick has been penetrated. Of course such reports are to be taken as hyperbolic but the abundance of coal mixed with the debris indicates at all events the general distribution of coal in this neighborhood. Following the 6 mile Creek upwards the black shales of the coal formation and the arenaceous fire clays with *Ligillaria* make outcrops everywhere. Also the black limestone beds with fossils are found in the bed of the creek apparently in place.

The drift contains numerous limestone pieces from the Hamilton and the Helderberg group. But besides those are very many limestones of the subcarboniferous strata with *Allorisma* and lithostrotion found in boulders of the creek. The subcarboniferous limestone consequently must extend to neighboring localities. This place is worth to be carefully investigated and I intend some subsequent time to spend more time with its investigation.

The artesian well near Detroit & Milwaukee Depot has been continued up to June 28 and the following strata been penetrated. At 168 ft. below the surface the boring was in shales. These continued to 180 ft. depth. Then a white sandrock was struck 16 feet in thickness and furnishing a supply of water. On top of Sandrock a few inches of coal. Below the sandstone again 7 feet of shales were penetrated at the time of my visit.

Continuation subsequently was published in the Owosso paper. Shale bed marked 7 feet continues to 22 feet thickness, lighter strata on top, darker below. Dark blue sandrock alternating with shale and soapstone 46 feet. Then white sandrock 11 feet, shale dark, 5 feet. Last is sandrock 72 feet. Shale continues below at 307 feet below surface.

Monday June 30. Went to Detroit. Saw the Governor and in the evening took the cars for Williamston, passing Plymouth, Salem, Brighton, Howell. From Detroit to Plymouth a flat rich farming country. Between Brighton Howell and Williamston the railroad makes several deep cuts through drift hills but the land in general is very good. Only in a few places marshes.

The coal mine at Williamston is close to the Banks of Cedar River about 100 rods east of the village. Sec. in the shaft.

Sand and gravel		15 feet.
Coal	20 inches	
Fireclay with some seams of sandrock		12 "
Black slate		3 "
Fine white soft fireclay		3 "
A bastard iron ore in a constant bend	6 inches	
Chip slate on top		2
Coal	2½ to	3
Then clay -fireclay		4
And then dark grey slate, bottom of shaft.		

Opened about 12 feet below the coal bed in the sink hole. The succession of these strata is nicely to be observed in the vertical shaft and in the slope leading down to the bottom of the mine. The black chip slate contains numerous *lingula* and *Discina* shells, some compressed *Productus* and a few lamellibranches. The coal is of very fair hard quality, contains little sulphur.

The owners of the mine gave me the results of a number of boring experiments in the neighboring district which exhibit the general uniformity in the composition of the coal series.

Mr. Reigh, one of the proprietors, promised me also the record of numerous borings in the vicinity of Corunna and Vernon, all of which show the wide distribution of the coal but in few places they found it thick enough to be worked with profit.

Mr. Reigh gave me the following accounts of borings.
4 miles west of Williamston, close to the river.

Drift	18 ft.
Black slate	4
Coal	2½
Fireclay	6
Black slate	12
Shaly sandstone	10

½ mile south of this place 60 feet boring without finding the rock.

At Depot of Williamston.

Drift	16 ft.
Soft white sandstone	12
Coal	½
Light slate	6
Dark slate	8
Coal	3
Fireclay	3
Black slate	2
Fireclay	4
Black slate	4
Fireclay	4
Black slate	13
Light slate	7
Black slate	5
Fireclay	3
Shale	14

Boring ½ mile southwest of Williamston Depot.

Drift	28
Sandstone	6
Light grey slate	10
Dark slate	6
Black	7
Coal	1
Fireclay	4
Shale, running into white sandstone, penetrated by the drill hole to the depth of 15 or 20 feet.	3

Drill hole 200 yards north of Williamston coal mine shaft, across the river.

Drift	4 ft.
Sandstone	13
Dark grey slate	1
Coal	3

Then fireclay and below it shale.

Drill hole north of the former.

Drift	18
Coal	7
Fireclay	6

Black slate getting lighter and running into shale rock to the depth of 60 feet.

Thursday July 1. From Williamston to Lansing, Owosso and Saginaw, a tedious travel with freight train over a partly undulating partly level drift plain with no exposures of rock on the line. With few exceptions of some marshy districts the country is well settled. Timber mostly hardwood only locally with some intermingled pine or occasional tamarack swamps.

From Owosso nearly up to St. Charles at which place Mr. F. Ackley very cordially invited me. Numerous outcrops of the coal formation are said to exist in the river and its embankments, particularly a place to be mentioned 9 miles south of St. Charles on the road where also a gentleman whose name I did not learn offered me his friendly services.

The other side of St. Charles to Saginaw a low sandy river plain extends in which except by the artificial borings no other opportunities for observation of the strata are to be expected. Midway between St. Charles and Saginaw City, a large brickyard and tile factory is erected which furnishes an almost white ware and of apparently a very good quality.

Wednesday July 2. Enquired for Dr. Garrigue but did not find him, also Dr. Lathrop, one of the best informed men of the place. I did not find him at home. In the after part of the day I got a severe attack of intermittent fever with spasms over the whole body, particularly spasmodic contract of hands and then gradually upwards from the abdomen to throat and faces. The paroxysm lasted about 3 hours before I felt relieved.

Thursday found Dr. Garrigue and received all desirable information he could give me. Also Dr. Lathrop kindly offered his services as far as he could. I learned from him the accurate boring register of one of the first salt wells. The same which is given in Winchells report in condensed form. The specimens of each stratum were preserved but became destroyed last year by the burning of the building where they were kept.

There are about 100 wells sunk in Saginaw District and the results of all borings are said to be essentially the same of most of them subsequently no accurate record was kept but Mr. Garrigue will in connection with Mr. Lathrop collect for me all the accessible data of former borings, and will take care that in new borings and accurate account and savings of borings will be instituted.

In all wells the carboniferous limestone was struck and forms a reliable geological horizon and in all borings the lower limits of the salt producing rock beds were indicated by bright red shales of considerable thickness, which are considered by the salt men a sure indicator of the productive limits for salt. This red shale is said to be near Salzburg about 1000 feet below the surface, while near Saginaw City it is only 600 feet below surface.

The gypseous formation has not in all borings been clearly recognized but the salt manufacturers say that the waters of a certain depth have to be stopped up or otherwise their pump tubes will in short time be stopped up by a copious deposit of gypsum while the water from lower depth does not incrust the tubes.

The salt water formerly rose to near the surface with in 30 or 40 feet while now most manufacturers have to lower their pumps to the depth of 400 feet below the surface and some of them deeper yet.

July 4. Went to Bay City, passed Wenona Station by mistake and went to Kawkawlin where 3 salt wells are worked. One is 1133 feet deep, another 810 feet and across the river still another 800 feet deep. Mr. Carson an intelligent laborer there gave me the following information about the wells.

1. Drift about 100 feet.
2. Shale partly light colored with seams of carbonaceous slate in same horizon 300 feet.
3. Gypsum imbedded in shales about 100 feet.
4. Continued shales of blue color down to the saltrock which is found at the depth of 700 feet/
5. Saltrock(sandstone) 100 feet/ red

In the deeper wells a succession of partly colored shale beds followed. They did not furnish any additional supply of brine. No limestone was struck in the borings as far as the man recollects.

At Bay City I got from a well borer the following general description of the wells in the place, one of which he just now has sunk to the depth of 930 feet.

1. About 75 ft. of drift clay.
2. Hard pan 20 ft.
3. Shale dark blue or black. 10 feet. Sometimes coal seams in that horizon but insignificant.
4. Shales continue for 50 feet.
5. Change into sandy shales, 250 feet. N.B. At McGrow's well, Portsmouth in this horizon a thick bed of wear coarse quartz-sand with granules bigger than a mustard seed is found.

6. At about 400 feet from surface to the depth of 500 shales of lighter and darker color.
7. Thin strata of limestone interstratified with shales, 50 feet.
8. Sandstone 65 feet thick (first saltrock) strength of brine about 65 degrees of salometer.
9. Thicker limestone strata alternating with shales, about 115 feet. (Depth from surface 720 ft.)
10. Gypsum 25 feet. Gypsum beds are occasionally also found in lower position.
11. Shale with limestone and sandstone layers, below the shales much prevailing to the depth of 930 feet.
12. A thick bed of limestone
13. Shales ~~15-er-20-ft.~~
14. Sandrock 15 or 20 ft.
15. Shales.
16. Principal salt rock, a sandstone with a very hard crust on top. Total thickness 95 feet. water 100 proc. salometer.
17. Light colored whitish shales.
18. Red shales penetrated to the depth of about 50 feet.

Met Mr. Clemens of Ann Arbor at the depot. His clerks very politely introduced me to all places of interest, in particular to Mr. H.M. Bradley an owner of a sawmill and saltworks the well of which is now in progress of boring. His salt pans are new-fitted up with galvanized iron steam pipes running through them.

Mr. Bradley directed my attention to a very well informed man in Ellington on East River (Cass River), Elder McKenney and also informed me of outcrops of limestone with galena and gypsum on Cass River in Town 13 N. 9 E.

July 5. Went with Lt. Dunlap to Alabaster. Not far backwards from the dock under a coating of drift gravel and sand the gypsum is immediately following in thick stratified beds of somewhat brecciated, mottled appearance. The upper portions are lighter colored than the lower layers of the deposit amounting to from 12 to 15 feet in thickness and being almost pure gypsum the argillaceous impurities are dispersed through the gypsum mass like the coloring materials in mottled soap.

Below this gypsum bed the lowest seam of which is dark laminated and arenaceous an argillaceous-arenaceous limestone stratum amounting to about 1 foot or more and in places being prevalently sandy, in others prevalently calcareous follows. These beds contain an abundance of fossils, most lamellibranches of mytiloid form and several brachiopods, spirifer, etc.

Under this limestone soft shales are seen to the depth of 2 or 3 feet. The owner of the quarries, Mr. Smith informs me that he explored about 20 feet deeper and found below again a gypsum bed, then shales and gypsum again in a thick bed which was not penetrated.

He intends deeper boring and promised me to write down the results and send them to me.

3 miles from Alabaster southwest another deeper quarry is opened close to the shore. The gypsum is said to be overlain there by a few feet of shales. About 1 mile north of Alabaster the gypsum is not found any more in the experimental excavations in search of it. Drift material extends to considerable depth and up at Tawas in the borings under the drift no more gypsum but the underlying saliferous sandrock is struck.

Walked up to East Tawas which is 8 miles distant from Alabaster. The shore road offers no rock exposure, all loose sand. And at a short distance from the shore all along a bluff of drift material rises to the height of about 30 feet indicating a lake terrace.

(Pencil memo. Sage in Wenona kept an accurate account of his borings)

Sunday July 6. Salt well at East Tawas of Grant and son.

A Deutscher (German) is a partner and gave me friendliest information.

Sand	30 ft.
Yellow Clay	20
White sand rock	60
Sand red	15
Sand grey	5
Sand red. Supposed to contain iron	40
Shale white	10
Sandy slate red	30
Shale white	5
Sandy slate red	88
Shale blue	35
Sand red	40
Slate white	60
Sand red	5
Shale white	15
Sand red	5
Slate white	40
Sand red	5
Slate white	3
Sandy slate white, first indication of salt	3
Slate white	164
Saltrock grey	195
Slate blue	10

Total 905

If not pumped, the brine rises to the top of the well but is weaker. The pump is sunk to the depth of about 500 feet and gives a supply of 30 gallons per minute while the Saginaw wells only furnish 18 gallons per minute. The Tawas salt is extremely white and dry. Returned Sunday night to East Saginaw. Sent off specimens by Ringler. Expense to East Saginaw from Tawas 2 dollars and meals at East Saginaw 1 dollar. Stage to Vassar 1.50.

Monday July 7. Afternoon at half past one took stage to Vassar. The lower Saginaw valley is a continuous marsh but all along its extent salt works and sawmills are crowded one after another.

From East Saginaw to Vassar a Plankroad leads over a perfectly level but dry country. 20 miles distance the road passed through Frankenbrost. Before arriving in the village the road descends a high drift bluff elevated about 50 or 60 feet above the river bed which is said to have an elevation above Saginaw river of 80 feet.

A man with the name of C. D. Smith, an old land hunter, gave me the following information. Two miles below Vassar sandstone crops out in the river bed. At Tuscola they bored into that sandstone 16 feet and gave it up, (In search of coal) before they sunk through it.

Some 8 miles above Vassar he says the flat rock ledges can everywhere be felt in the river but to his knowledge never make outcrops in the bank until some 6 or 8 miles below the forks of Cass River, where lowest a kind of soft pipestone crops out and above it sandstones identical with the Huron grindstones. Also upwards on both forks this rock is everywhere near the surface and from there to Point aux Barques through the woods only a crust of moor (?) has to be removed from the surface to find the rock. In this pipestone Mr. Smith found numerous nodules of galena.

Thursday July 8. Followed Cass River down to nearly Tuscola village. The river is carved into the drift to the depth of 50 or 60 feet. Its banks are sometimes steep bluffs. Sometimes the ascent to the limiting plateau is gradual.

Nowhere in the bed of the river actual rock ledges can be seen but in numerous places large boulders of metamorphic rocks mixed with fragments of limestone blocks from the Niagara group, the Helderberg and Hamilton group and with some sandstones of the carboniferous group; also of the carboniferous limestone but not many of those form the river bed. The lowest portion of the drift is composed of such boulders and gravel. Higher up blue very hard clay with pebbles (Hardpan) follows in the thickness of about 12 feet visible. Above this a few feet of sand and finer gravel follow which are overlaid by very fine well stratified reddish grey clays entirely similar to the red drift clays of Lake Superior country. The same clays I see also denuded in digging the cellars of Saginaw City.

15 feet of this clay are visible in the bank. Above follow about 30 feet of sand strata mixed with pebbles and gravel by which the height of the plateau is formed and which in places are mixed with much clay. All those upper drift strata bear the most distinct evidence of regular sedimentary origin. The lower hard pan and boulder drift is less distinctly stratified.

Diagram of banks of Cass River.

At 3 o'clock afternoon stage leaves for Cairo, (Caro) situated in Sec. 3, Town 12, R. 9 E. Expense at Vassar 2.50 to Cairo. Arrived 8 o'clock. Next morning,

Wednesday July 9. Took horse and buggy for two days and went up to Cass City. $2\frac{1}{2}$ miles below near the house of Traverse Leech a road leads down to the river where Mr. W. H. Brown lives on a farm in Sec. 6, T. 13, R. 11. The river runs in rapids for 2 miles above and below this place over rock beds. Very little of ledges is in the banks which are composed of drift mixed below with large blocks of the underlying formation.

The strata dip down the river and consequently the highest strata are found below the farmhouse. The lower beds upwards the stream where a series of sandstones of sharp grit, some of them with calcareous seams (veins) of whitish color with ferruginous dots, or of a greyish blue color, some beds argillaceous and micaceous. Also in thickness the beds vary much. In the ledges in loco I did not see any organic remains but in a loose block evidently belonging here I found specimens of *Ligillaria* or *Lepidodendron*.

The sandstones go down to opposite the farmhouse. Below they are overlapped by a blue argillaceous and (or) sometimes arenaceous limestone some beds of which contain numerous fossils and druses with sulphuret of Zinc ectr. Still in higher position are somewhat lighter colored shaly limestones and very hard arenaceo-calcareous beds with flint nodules besides bright red colored calcareo-arenaceous beds which are sometimes true sandstones.

Further on the series is covered up by drift and also in the river bed no more of the rock is seen.

Thursday July 10. Drove to Cass City 3 miles distant from Mr. Brown's. Mr. Brown went with me. From the city one mile south I struck the river. A drift terrace $\frac{1}{2}$ mile distant from it and 30 feet high border it, the other half mile bordering the river is swampy low ground. In the bed of the river in some places the argillaceous limestones with and fossils seem to form the bed but no additional facts were collected. The limestone may be tested for its hydraulic properties. I found also a *Syringopora* in the limestone of which I saw a finer specimen at Mr. Brown's place but thought it to be a boulder of the drift coming from a distant locality.

6 miles above Cass City the sandstone in quite thin layers and interstratified with shale seams is said to make outcrops about 15 feet high, but the burnt timber land along the river did not allow me to proceed within the limited time up that distance.

Returned to Cass City at noon and packed the specimens in a box. The general features of the country is a level plain with good fertile soils. A good many settlers are already spread over the district.

The Hotel keeper at Caro told me that up at Indian Rapids 6 miles above Cass City there are for a mile along the river more important sandstone outcrops than I have seen. A passable road for wagons leads there.

He informs me also that in the town of Ellington south of the village there are extensive bog ore deposits over many acres of land, and by digging he said he penetrated 6 feet into it without getting thro.

Also of a boring in Caro he gives me a superficial account. The boring was performed by one Spangler of East Saginaw. It went 120 ft. deep and after going through deep drift they struck a sandstone. Under it shales and coal and under the coal a soapstone. But how much can be relied on this report I do not know.

(Then follow 12 pages of pencil notes which had been copied and were typed in the foregoing pages. Two rough sketches are included)

Name of Sawmill owner at Vassar is McHose. Parks schoolteacher at Vassar.

(On back cover). (Supposed sequence of strata.)

1. Sandstone above coal about 30 or 40 ft.
2. Grey and black shales, about 25 ft.
3. Coal
4. Black shales. Argillaceous sandstones of fine grain with fireclay containing numerous *Ligillaria* stems. Black shales, fireclay and sandstones alternating beds amounting to 60 feet.
5. Carboniferous limestone 50 feet.
6. Gypsiferous strata 100 feet.

July 1875

Geology of Environs of Saginaw Bay
Ditto of Hillsdale and Branch Co.

Limestone in Monroe Co. --along shore of Lake Erie
and west of it.

Thursday 15. Left Ann Arbor to Detroit. Failed to see Governor Bagley and went on to Fort Huron to go on from there with the Evening Star to White Rock. I arrived 12 o'clock at night.

NP921

Wednesday July 16. Made acquaintance with the owner of the Salt Works, Mr. Thomson, which gave me the specimens saved from the boring of his second salt well which is 555 feet deep. The other salt well is about 150 feet deeper, close by.

From the appearance of the specimens the following remarks may be made. The borings began in the clays of the drift formation at the lake shore of which about 30 feet had to be penetrated before shaly rocks were struck. These shales interstratified sometimes with insignificant layers of sandrock and thin beds of great hardness continue to the depth of 450 feet when a sandrock of about 100 feet thickness is struck which contains the brine. Under this sandrock in the deeper well again shales were found and penetrated to the thickness of 50 or more feet.

An accurate register of the boring is said to be in the hands of the well borer but he has not furnished the proprietors of the well with it. The brine is very strong and pure. Furnishes about 110 to 120 barrels of salt per diem.

One mile south of White Rock at the shore blue shales with more arenaceous layers interlaminated make an outcrop of from 15 to 20 feet. Above the shales the tenaceous blue clays of the drift with numerous pebbles and boulders distinctly marked with drift scratches immediately follow. The whole bluff is about 40 feet high.

The upper drift layers are more gravelly and sandy clays of brownish color and seem to cover the blue drift inconformably. In this upper drift very numerous blocks and pebbles of the Hamilton group are found. North of White Rock the drift bluffs continue for a mile. The lower blue clays are largely exposed along the shore but are not eroded down to the shales. In the arenaceous layers of the shales I found 2 impressions of Cephalopodes (goniatites?) and several indistinct other organic traces.

The salt wells do not as I first believed, go through as much drift material, and I think not more than 15 or 20 feet of the surface have to be considered drift. Then the shales immediately follow.

The environs of White Rock are by the late fires badly damaged but on the other hand the clearing of the land, which is of fair agricultural quality, has been alleviated by it. Rock Falls 2 miles south of Sand beach.

Thursday July 17. Went with stage to Rock Falls over a good road leading along the beach. The bluffs have receded there from the lake shore for a few hundred yards (rods). In the creeks the blue clays of the drift with boulders and pebbles are noticed and above sharply defined the gravelly drift of brownish color and more sandy nature.

At Rock Falls a wide plain only little elevated above the lake is spread out and the sandrock ledges are making fine outcrops along the shore. They contain some *Stromatolites* and numerous *Fucoid*-like forms and other vegetable impressions, in particular a large *Fucoid*-like *Suerid canadensis*, and some other peculiar impressions, probably tracks of some mollusc.

Salt well at Fort Hope.

- | | |
|--|---------------|
| 1. Clay surface material | 10 ft. |
| 2. Sandrock (quartzstone) | 5 or 7 ft. |
| 3. Slate rock, arenaceous | about 10 ft. |
| 4. Mixture of sand and blue shale to the depth of 154 feet | strata 33 ft. |
| 5. Slight change in the rock. Becomes harder but retaining the same character continues down to | 535 ft. |
| 6. Very hard rock | 1 ft. |
| 7. From 535 to 535 feet dark blue slate again | 154 ft. |
| 8. Shale with much sand for about | 20 ft. |
| 9. The last 51 feet is coarse whitish sandrock containing the brine. The lower 100 feet are all supposed to contain brine. | |

The gentleman of Fort Hope told me that the well borers at White Rock rinsed the specimens after they got down some depth so the specimens will not be altogether reliable.

Afternoon continued voyage with stage to Huron City. The road ascends 3 miles south of Huron City to the bluffs which before it followed the flat strip of land joining the shore. These bluffs first exhibit only drift but 3 miles before arriving at Huron City sandrock ledges project from their sides clear up to the top. It is a middling fine grained greenish or yellowish sandstone in layers generally not over a few inches thick, but according to the outcrops of a total thickness of 30 or 40 feet. There are numerous quartz pebbles mixed with some of the layers. No fossils observed.

Below the bluffs a flat strip of land extends to the shore. On this superficially some drift and large boulders are spread out but the rock is close under the surface and makes at the lighthouse point fine outcrops.

The sandstones of the bluffs seem downwards to be followed by shales and argillaceous sandstone layers partly resembling the Huron quartzstone, visible thickness in the above exposure amounting to about 10 feet. Usually only 3 or 4 feet are seen.

Under then follows a hard somewhat coarse conglomeratic and strongly pyritous sandstone in a bed from 1 to 2 feet thickness. This is the most obvious rock of Point of Barques. It contains numerous fossil-like relief forms over the surface and many shells, but frequently very obscure *Rhynchonella*, *Orthis*, *Spirifer*, *Orthis* stems, some large brachioid gastropodes, 1 orthoceras and several lamellibranches are most obvious. The same shells are also found in beds of sandstone 1 foot above.

Below the hard sandstone ledge 2 or 3 feet of blue shale with a few seams of sandrock are seen. The deeper strata are not visible. About 100 yards (rods) north of the lighthouse the beach offers no more outcrops and is all sand for more than 2 miles. One mile south of the lighthouse likewise the outcrops disappear and a flat sand beach extends southwards.

Friday July 18. went to Willow Creek near the Tavern of Huron City. There are about 12 or 15 feet of strata exposed which seem to be identical with the rock beds covering the hard pyritous sandrock.

afternoon went to Fort Austin. The higher parts over which the road leads are strewn over with a coarse sandstone which must overlie the gritstones. At Fort Austin this same sandstone forms a promontory on the west part of the city.

A gentleman with the name Skeeny - is going to bore a salt well 1 mile west of Fort Austin. The boring begins in a blue shale. The white sandstone lies close by on a higher level. At his dwelling house he sunk a common well to the depth of about 50 feet and informs me that first he went through about 20 feet of the soft white sandstone under which blue shales follow, of which I noticed the pulverized mud thrown out of the well and of which I preserved a specimen.

He promised me to keep an accurate register of the boring and I promised to the well borer a remuneration if he should keep me specimens of the boring.

Mr. Larned, the owner of the other well says he lost his register but will see if he can find it for me.

Saturday July 19. Visited the spot where the new salt well is located, about 1 mile west of Fort Austin. By digging 12 feet they strike the rock which is very similar to the Huron gritstone. The layers are imbedded or alternating with blue shale and next below a conglomerate bed with calcareous cement and calcareous sandstones of great hardness but similar to the gritstones are found and crop out in the bed of the lake.

Only a short distance further west partly at a higher level the coarse grained soft sandstones identical with those near Fort Austin village form picturesque cliffs and project in a promontory called Flatrock Point. Their thickness may amount to 50 feet, counting the strata forming a small hill back from the shore line. At the shore the cliffs are only 12 or 15 feet high.

At the top of the shale a thin layer of the graptolite is visible as a dark line. It is 2 inches thick and is identical with the graptolite in the lake bottom at the sawmill. I succeeded also to get a number of graptolites from the quarry's bottom several layers thick similar to millstone grit shales, and some fragments of fish bones.

At Willow Creek 3 miles south of Lanes City I found the coarse whitish sandstone with seams of fine-grained conglomerate and of very obvious sigmoidal stratification forming the top strata. Under it come shale beds and then the characteristic grindstone followed, and under the grindstone the previously described alternating shale and sandstone beds with brachiopods follow and are exposed below the sawmill in the village of Lanes City.

I am now also fully convinced that the rocks at Point of Sandrock are the same with the upper sandrock at Willow Creek and with the soft coarse sandrock at Fort Austin.

Monday July 21. With stage to Caseville. Delivered one box of specimens for transportation to Ann Arbor. Fort Crescent, the next place above Fort Austin is at the mouth of Fenwick Creek. The road to this place leads through a fine farming country but a strip of land near the shore is very sandy. In one place not far from the village I see a small outcrop of sandstone on the ditch of the road. West of Crescent Port to Caseville a continuous sand belt stretches out along the lake. A mile or two from the lake is good productive land. Up Fenwick River it is said gypsum was found in digging wells.

At Oak Point a blue sandrock is said to make an outcrop which is described to me as a superior somewhat coarse grained grindstone.

At Caseville 3 salt wells are sunk. One lately bored is 1700 ft. deep. The owner of the well, Frank Crawford was not at home and the man which bored it with the name of John Carroll of Caseville was also in Fort Austin so I could not get any information about the boring.

Went on to Mill Fowl Bay where near the upper sawmill a quarry is opened in the carboniferous limestone. The following section is seen there.

1. Lowest, 40 or 5 feet of a soft greenish sandstone visible.
2. Limestone evenbedded with seams of blint 1 feet.
3. Limestone, 6 inches separated from the former by a thin seam of
4. a thin seam of sandstone. (shale.
- 5 and 6. Limestone 1 foot, the upper portion thinly laminated argillaceous-arenaceous.
7. Limestone, bituminous 10 inches.
8. Bituminous limestone smooth fracture overlaid by a thin carbonaceous shale seam containing *Cypris* and fish scales.
9. 2 banks one foot thick of a blue limestone with smooth fracture.

- 10. 1 foot bank similar to the former but penetrated by many white stems resembling *Syringopora* but with no organic structure recognizable.
- 11. 2 feet of an arenaceous looking whitish limestone containing *Allorisma*. On bare higher ground a few rods back are similar additional ledges now exposed in a ditch which besides *Allorisma* contain a large *Proetus*, *Lithostroton*, *Lagomorthis*, *Senecella* *Syringopora*, large fish teeth.

The lake terrace in which these beds are included in its easterly continuation is all drift and along the lake shore towards the projecting lake point it seems to be a sand beach. The drift terrace has the form of a narrow sand ridge behind which a wide marsh meadow extends, and about a mile from the shore a second well timbered hill land rises which is good agricultural land and is said to offer many outcrops of the carboniferous limestone. One near by on Crawford's land I shall visit tomorrow.

The abandoned settlement, *Ora Labora* is here. The settlers squatted on the sand ridge instead of going back to the second ridge which is good land. They had much fine pine on their land.

Tuesday July 22. Went south of Wild Fowl Bay 1 mile along state road where extended outcrops of the upper carboniferous strata No. 11 spread over a large level swell. From there I followed the outcrops east through Crawford's farm where the upper strata in one limited bed are perfectly replenished with fine silicified specimens of *Lithostroton* in countless numbers.

Above this is a stratum of a brownish colored arenaceous and calcareous rock with nodules of sparry and vitreous matter, bed No. 12, which is the highest stratum seen there. The limestone is of good quality for burning lime but bears of a coarse grained sand rock run through it. The thickness of all the limestone strata No. 11 is about 10 or 12 feet in all.

After noon went with stage to Caseville. Saw Mr. Crawford but could not get any information of his concerning his well. The meagre verbal account I could elicit out of him and his employes was that the well was 1700 feet deep. It began under a drift covering of about 30 feet with a limestone of about 20 feet thickness. The great part of the deeper strata were red and black shales. Some sand-rock layers but shale was the prevailing rock. At the depth of about 200 feet, they say some gypsum was found and at 400 feet a flowing well was struck with mineral but not saline water. They speak of 2 saltbeds, an upper and a lower one and the lower one they suppose to be solid impure salt. Lowest in the well is a grey brown sand-rock.

Wednesday July 23. Walked along the beach to Lake Point. On both sides of the point the lake throws out a calcareous blue hard sand-rock weathering yellowish brown which contains numerous fossils.

Spirifer, productus, Bryozoa, crinoid stems, also a large lime-rock almost composed of shell fragments is thrown out. The rock and shells have strong resemblance to the fossiliferous limestone of Cass River and also the underlying sandrock of a bluish greenish color with micaceous portions resembles the underlying sandrock at Cass City.

In following the beach which is altogether a sand beach, near the the small point following Oak Point eastwards this underlying sandstone once crops out in the bed of the lake and seems to be the surface rock for several miles onward but does not show itself along the beach. But in the lands between the lake shore and the road there are outcrops resorted to me on the land of Mr. Smalley whom I am going to visit today.

To Hat Point nothing but a sand beach is seen. The point itself is formed by cliffs 15 feet high or a little over. It is a coarse grained discordantly stratified rock in thick banks and in thin layers which appear to be the same rock as the Cliffs of Point of Barques. A part of the point is divided from the mainland by underwashing and forms an inverted conical island like those at Pt. of Barques. An old bachelor owns the point which showed himself very hospitable to me although I must say he had very little more to offer than a few mouldy crackers, but the will was good.

From Hat Point to Flatrock point is a rectilinear distance of 6 miles. The intervening bay at the eastern side exhibits the grindstone strata with its characteristic fossils. The western side at the mouth of Penibog River (Port Crescent) is a sand beach. The rocks of Hat Point retrace land inwards and may be followed for a mile in southerly direction.

Small diagram of above.

$3\frac{1}{2}$ mile west of Hat Point is the farm of Mr. Smalley. On the road side along which the telegraph wire leads about 100 rods west of the dwelling house, the coarse grained sandstones similar to those at Hat point come to the surface and are denuded for some distance.

South of Oak Point on south side of the road, the farm of Mr. Klump is situated. I am informed that he found ledges of rock in a swampy flat behind his house which he thought were hydraulic limestone and which will probably be the same hard calcareous sandrock ledges which are coming out of the lake bottom at Oak Point.

Thursday 24. Went with a small steamer to Bay City. Passed different islands and observed the shoreline all along the distance which is with exception of the mentioned outcrops at Wild Bowl Bay all sandy. Delivered a box of specimens to Debeurman for transportation.

Friday. With Landing-Jackson road as far as Henderson station. Visited Dixie Creek again and followed Chiantone River for 5 miles down to the farm where the water was higher than before and no good opportunity to observe the bed of the river. In the banks along the mentioned place at Dixie Creek only drift is exposed. In the drift I found specimens of a limestone with large *Lyellia* shells like those of the coal measures of Illinois. In the same rock pieces also the impression of a *Strophodonta* or other similar *Brachiopod* was noticed by me. In the nodules of calcareous hard rock which is often flinty with cracks through the mass filled with spar, or sometimes representing regular kidney iron ore, I found at Dixie creek leaves of ferns. The outcrop of the coal measures under drift banks 30 feet high is superficially very much disturbed and dislocated, partly mixed with the drift material.

Saturday July 17. Went to Ann Arbor.

Tuesday 20. To Detroit and Monroe. The limestone appear to be the surface rock from Denton village all the way down to Monroe where in the bed of the river the lower Silurian strata of the Helderberg group are largely exposed the rock is of a sandy rough fracture of laminated structure, bituminous but destitute of fossils. Breaks partly in larger blocks of sufficient durability for building purposes. At the courthouse square the city is boring an artesian well which is just in progress.

Not far from it formerly a well was sunk to the depth of 137 feet. The record of which was handed to me by Banker Johnson. Monroe artesian well. Bored by Leiger.

Clay and sand	1 ft.
Grey limestone	3
Blue limestone	3 inches.
Dark grey limestone	5
Blue limestone	11
Grey limestone	14
Slight flow of water	
Blue limestone	3
Grey limestone	59
Blue limestone	3
Grey limestone	3
Blue limestone	33
Blue slate	30
Strong flow of water between 60 and 74	
Boring stops in the slate.	

Mr. Johnson also informs me that 3 miles up Raisin River close to the river an outcrop of sandstone is seen. Dr. Lovett whom I visited in the evening promised me to accompany me to the spot.

On the land of Judge Christensen several years ago a boring for oil was made to the depth of about 300 feet.

Wednesday July 30. Went with Dr. Dorset (Dorsch) up the river for 9 miles. About 7 miles above town in the neighborhood of Jackett's farm the river bed is formed by massive sandstone beds containing some spirifers and other fossils in poor preservation. The sandstone is partly very compact, flint-like. Other portions are friable partly iron colored, partly snow-white. Higher up the river the dolomitic limestone again forms the surface rock and is largely exposed and quarried along the other side of the river near Bruckner's former farm. The limestone is evidently nearly the same as seen in the river bed at Monroe and is immediately superincumbent the sand-rock. Very few fossils are noticed in it. And some beds are filled with small cavities of acicular spar leavelets. The thickness of the quarry stones amounts to not over 12 or 13 feet.

It is strange that in the boring at Monroe nothing of the sand-rock bed is struck which otherwise seem to have a wide distribution. They were wet with in the borings at Christianson's place.

In the afternoon I drove out six miles northwest of Monroe to Bond's farm near Caldwell's, where over space of 50 acres the same sandstone which I saw in the river is denuded. It is partly very soft friable and snow-white and is quarried for some Pittsburg Glass factories. Other portions are harder and somewhat stained with iron. They contain indistinct traces of fossils.

But are immediately overlaid by about 8 feet of limestone strata of hard crystalline structure containing corals, Favosites and cyathophylloids, brachiopods and Bryozoa (sajas) Dalmanites and Phacops. Other portions are dolomites of grey color with earthy crystalline structure similar to the stone of the lime quarries. The thickness of the sandstone is not observable but 5 or 6 feet of it are at all events visible. The locality is close to the upper course of Sandy Creek in the northeast corner of Raisinville township.

At 5 in the evening by railroad to Adrian. No outcrops of rock there and no deep borings.

Thursday 31. With 11 o'clock train to Jonesville. The west half of the interval is formed by high drift hills. The east half is more gently undulating land indicating shales as the substratum of the drift which in places contains much of shale particles intermingled.

Not far east of Hillsdale station in the railroad track brownish colored thin bedded sandstones make an outcrop, which evidently represent the Marshal group. Also in the environs of Jonesville the hillsides offer limited outcrops of the Marshal sandstone with characteristic fossils. But in the bottom of the valley the sandstones seem to be washed out and the excavation filled up with drift material. Also the top portions of the hills are formed by gravelly drift. It rains all the afternoon and little out doors can be done.

... drift ...

... containing ...

From Battle Creek the railroad extends through the level river valley ...

Deiger, who promised me for today the records of some of his borings, failed to appear ...

Went in northwest direction along the Malabar and South Haven railroad ...

In the cuts made by the railroad I find an inferior ...

On top of this lower gravel a crust of calcareous (calc matter) is spread out ...

During the day I made considerable collections of the fossiliferous boulders, several Trilobite pygidia among them. In a large sandstone boulder resembling the older quartzites in hardness, numerous fragments of a large kind of Trilobite were found. The geological age I have not got the means to determine.

Monday Aug. 4. Went along the hill sides southwest of Kalamazoo. The drift there is not near as rich in rock pieces of the Marshall group than on the northwestern side and I could make only a few collections. Among other things I found a good specimen of Goniatites and saw very large Spirifer impressions of the shape of Spirifer impressions from the Hamilton group.

Lastward along Mich. Central the drift does scarcely contain any of the before mentioned fossiliferous rocks and is more of the sandy nature or fine gravel, of mostly calcareous pebbles besides the metamorphic.

At 4 o'clock in the afternoon took train for Allegan and Holland. The road leads along the Kalamazoo river through a little undulating country. Near Allegan the undulations are somewhat stronger. Drift is a sandy clay and sometimes gravel. Towards Holland much sand is on the surface. Below the sand a tenacious blue clay with gravel and larger boulders is found. North of Holland about 1 mile, sandstones make an outcrop which are quarried for local demands.

Tuesday, Aug. 5. One and $\frac{1}{2}$ miles northwest of Holland on Black River in a low flat the sandstones contemporaneous with the Point of Barques quarries and Marshall sandstones form the surface rock under a covering of a few feet of sandy drift. The upper beds are of a greenish gray color with considerable mica and similar to the lit. of Barques grindstones containing no fossils. 2 or 3 feet of it in regular layers are exposed. Intermediate are lenticular seams of soft sand without any cement. In the bottom of the quarries a firmer cemented more calcareous sandrock with all the characteristic Marshall fossils is found.

In the drift the ferruginous pebbles and kidney iron ore nodules with fossils are sparingly distributed. They seem to be derived from a stratum of higher geological position than the Marshall sandstones but until now I could not find the rocks in situ.

A few miles north of Holland large deposits of bog iron ore are spread out over the swampy plains and it is contemplated to erect an iron furnace in Holland and to melt the ore in connection with Lake Superior ore. The lake of Holland is connected navigably with Lake Michigan which is 4 miles west of Holland.

In the afternoon proceeded by railroad to Grandville. The country between Holland and Grandville is entirely level but best dry fertile land, a whitish clay soil. Near Grandville some hill undulations are on the south side of the road but we does not suppose from the surface a material change of formations.

The village Grandville and a belt extending for several miles south of it and north to Grand Rapids is all underlain by gneiss. East of Grandville the gneiss are covered in a variably thick mantle of boulder drift and clay, or fine shales of green rock consisting of shaly former cliffs washed by the water and subsequently **enveloped** in the drift strata. Under this plaster are a few calcareous seams mixed with plaster, and then follow about 1 or 2 feet of dark soft shale. This a solid well stratified mass of gypsum follows 15 feet thick. This is the bed used principally in the quarries.

Lower still as far as known shales alternating with various other gypsiferous and calcareous beds are found but no deep holes have been sunk here. Some of the calcareous beds may be worth trying for cement. No fossils seen in the quarries except in a ferruginous sandstone boulder which contains Trilobites and a brachiopod shell.

Wednesday 8. Returned by rail to Holland and from there to South Haven. Long delay at Holland. From Holland along the railroad part of the land sandy as far as the beach sand belt extends, otherwise clay soil. The drift is most fine material, clay and sand with few boulders or gravelly beds except in deeper cuts where the gravel is found mixed with the fossiliferous kidney iron ore nodules. At the mouth of Kalamazoo river big ravines in the drift and quite hilly broken country. Further south a wild swampy forest land as far as Grand Junction.

From Grand Junction to Kalamazoo the surface is undulated with drift hills, clay and sand, for the first half of the way, then the cuts of the railroad go down to the large gravel beds well stratified and alternating with sand beds. In places the gravel is baked into a puddingstone by calcareous cement. Fossiliferous kidney iron ore in certain localities very abundant, in other places more scarce. Brickyards are here and there noticed.

Wed. Aug. 8. revisited the railroad cuts on the South Haven road. Went six miles distance. With 2 o'clock express train return to ANN ARBOR.

Last of Kalamazoo the fossiliferous iron ore is rare in the drift deposits and towards Albion the admixtures are fragments of the coal measures series, which however included similar kidney iron ore nodules but not fossiliferous and of a more arenaceous character.

Monday 11, Aug. Visited Governor at Detroit.

Tuesday Aug. 12. To Grand Rapids. Found Mr. Menzies a fool, not worth further consideration. But Mr. Currier made me acquainted with Dr. Barber, Prof. Strong and a young book merchant which all three their best to give me what information they had. On their advice I went to Niles where they had heard of outcrops of carboniferous limestone.

Wednesday went there by Detroit and Milwaukee Railroad. The drift hills along the road are attaining considerable height and near Ada they ascend about 100 feet above the level of the river. From the Depot I went along Thornhill Creek which on one or the other side is lined by high drift bluffs of partly clayey or sometimes gravelly nature. 7 miles above Ada in the river beds mineral springs are rising and a bathing place has been created there by Mr. Chas. Holt. The drift contains there also numerous pebbles of the ferruginous sub-carboniferous pebbles with fossils and very large angular clubs of sub-carb. limestone caving (growing) its close proximity.

The lower portion of the drift bluffs is crowded with large metamorphic boulders. And in the loamy gravelly sand Mr. Holt, a former California miner, has washed out some coarse granules of gold. And to convince me, he tried the experiment under my eyes with success. Of outcropping rock ledges nothing has been found in the valley and if there was any outcrops the observing talent of Mr. Holt's family would doubtless have taken notice of it. At Mr. Holt's, a Mr. Thompson with family stayed for his health and takes baths.

Only small distance above the mineral springs is Cascade village but without a cascade. However the river runs in quick rapids at the spot and almost all the way down to its junction with Grand River.

Wednesday Aug. 13. Stayed over night with Mrs. Chas. Holt on (e Thornhill Creek, a very intelligent and amiable family which had some boarders using the baths of the mineral springs. (Mr. Thompson and his family). In the morning returned to Ada, a small but very pleasant village in the valley of Grand River, surrounded by high drift hills.

In the drift of the environs they found very frequently lumps of native copper of which I saw various specimens. The drift contains very few fragments of the coal measures horizon but much of the sub-carboniferous limestone and connected lower strata. The drift is stratified and gravel beds and big boulders are seen in it at all heights. The base however seems to be prevalently gravelly clay beds.

Ada is situated in a level valley of Grand River about 1 mile wide. On both sides high drift hills (100 feet) rise. The drift is of prevalently clayey nature but contains from bottom to top numerous metamorphic boulders. Following the Detroit and Lansing railroad track the river valley is found to be formed by heavy gravel deposits which are principally composed of limestones of the Niagara and Kelderberg group, besides the metamorphic rocks.

Proceeding on this level for about 5 miles along the railroad without a visible change on the surface at once we find a coarse dark rock outcropping which remains over a large space the superficial rock. It is in large thick beds.

Northeast corner of Sec. 27 in Iowa Township. The gravel river runs close to the quarry. The quarry stone in various parts in the neighborhood is found to be from 50 to 60 feet thick. It is in solid beds of various thickness but very remarkably deposited. All the quarry sand ledges are covered with a very rough undulating rounded surface and the best bed above it adapts itself to all the inequalities.

Diagram of above.

The rock is partly dirty white or partly yellowish with some-colored irregular streaks and clouds. The quality is better than of any coal measure stone I have seen. No plants or other organic remains have been found in it.

In the proximity they have been boring Artesian wells to the depth of about 300 feet. The owner of the quarry tells me that Mr. L.B. Johnson of Iowa can give me special information about them. The outcrop of this sandrock does as I am told not extend much over a square mile space.

In the evening I missed to find Mr. Johnson but was informed that Mr. Blanchard, lawyer would tell me the particulars. Mr. Blanchard very politely communicated to me from his memory the following facts. The different bore holes are sunk on Sec. 27 of Iowa Township. They go to some 450 feet depth. First was penetrated the variegated coarse grained sandstone to the depth of 80 to 110 feet. Below a thin layer of shale. Then fireclay 8 feet. Again a few inches of shale. Coal varying from 10 inches to 4 feet. Fireclay 8 feet. Sandstone 40 feet, finer grained than above. Another coal bed but his partner could not inform him of the thickness of it. Further down was alternating beds of shales, sandstones and coal. At the depth of about 500 feet they struck a flowing well of sweet drink water. It still flows over and the quarry men use it for their demands of drink water.

Iowa is a town with a large number of splendid buildings and other great wealth, all of which as Mr. Blanchard says, was made of the sand. All the rich people there have gone to the East.

Monday Aug. 14. Took train to Council City 7 o'clock. The road crosses the high prairie hills to Sanger Station 5 miles distant. Drift is composed of gravel, sand, lean intermingled throughout with large boulders. All forests and much cultivated land, especially well cultivated. From Sanger to Council City a distance of about 20 miles high prairie with all the usual crops. The road I took to Hillville and intersects a somewhat low hilly territory with some ink covered live timber. Near Hillville is a nice (big) rapid flowing creek.

Hillville is a handsome village with a large park. Much lumbering and sawing is done. Early fall. Very little leaves down.

Several miles to beyond the hills and to near the hills. locally abundant in forest, and many interesting establishments along the road. Several small lakes are present. The surface is generally very sandy.

Several miles further has prevalent hard red timber and a more calcareous surface with argillaceous soil.

Several miles further has again very fine forest, extending about the same level with sandy places and small lakes. Several miles ahead is toward City, an opening into a large pine forest on the northern side with about 150 small buildings placed between numerous stone and pine trees. All sand. The soil is small and has a slight amount of signs of argillaceous soil. Also the drift does not show any evidence of a preference of sand, indicating the underlying strata.

At its outlet east to Big Lake. Along the shore several miles through a forest of pine trees with scattered grass with patches. The soil is generally sandy and only has little with the occasional stones and boulders and some stone boulders. Very few signs of argillaceous soil. At Big Lake the landscape has a more level and sandy soil. The drift is not so high as the hills and is generally sandy.

In the lower part of the hill, well identified clay in the bank of the river. Some fine clay is generally gravel and partly, but it is indistinct in the drift as well as of any other clay such in the strata and along the course of the Anishnabek River.

Some reports I have that at Lake Superior north of Big Lake the same material has been dug out of the river. Also south of Big Lake in the basin of Minnesota, gravel is said to be found in digging wells. Anishnabek is considerable of a river, and a fine sand on its banks as the level of Big Lake are about 50 feet high.

By a bright day today is Saturday instead of Friday as I believed.

Saturday, Aug. 14. Went along the Anishnabek and Big Lake. Saw some very interesting facts. The sand deposits with a few gravelly layers are well stratified, but they are a subsequent action by which they were bent and distorted the surface of the stratified sand projects in undulating lines and is covered with a thin layer of alluvial sand, gravelly gravel, or with a calcareous mixture of sand, clay, and gravel and is a large deposit with the clay that is visible.

Diagram of above.

Most all the strata are calcareous or granitic and with few layers of shales. In rocks of the calcareous are tinged with the reddish color. The surface strata are not drift washed while the bottom and surface of the lower gravel deposits are strongly so.

to the north of the main belt of Big Lake the clay beds. It occurs with following layers of sand far as. Several small and large gravel pits, many of them, are scattered over the country. The clay beds are quite thin, but are fairly well developed and are clay shale, silt, which are sand. The clay makes in a great belt. The clay makes in 4 miles long by about 2 mi. It is all the is said to be thin or large. No beds even say, in fact, any part of the clay are anywhere in the surrounding country.

4 miles south of Clay Lake is Lodge Lake which would take one suppose to find rock ledges there but all signs of the inhabitants convinced me that there are none. From Clay Lake the pine forest continues to Lodge Lake. Much of it is burnt since the road. Soil purely sandy.

Leaving Marston the ground is rising and the road cuts through high sand hills and crosses deep ravines. Some strata of hardwood alternate with the pine forest, then Marston to Walton the road crosses over comparatively level ground. Pined hills. After crossing Marston river, exclusively pine forest. Near Walton the road cuts again deeply through sand hills. Walton is a single house.

A few miles beyond Walton, hardwoodland mixed with pine and hardwood begins. Summit station is only the station house is the first of the woods. The road begins from there to take a rapid descent to Fairfield. From Fairfield to Traverse City, a distance of 14 miles the road leads partly through extensive cedar swamps. The surface material continues to be sand with scarcely any pebbles. Only in a few spots a few cuts go through clay banks and fine gravel deposits. The shore portion of Traverse City is of course all loose sand. Arrived there at 8 Saturday evening.

Sunday Aug. 17. Went out with Surveyor Clawson to the hills west of the city/ The marginal portion of which is loose fine sand, while the higher portions backwards are found to be composed of the fine well stratified clay which makes the substratum of the drift sand on the upper peninsula. This clay deposits is very thick there in places it contains pebbles, is of whitish or reddish color and the purer portions of it seem to be well adapted for pottery and brick manufacture, also for improvement of the soil in gardens of the shore and for road making. The clay could very profitably be used and is in small scale applied for these purposes.

On the west side of Carp Lake several years ago they bored for oil to the depth of somewhat over 500 feet. Mr. Clawson informs me that for 500 feet they never came through the drift and only little of the underlying rock beds were penetrated by the boring, the nature of which however he could not tell me. But they struck a flowing well of water which runs yet.

Mr. Clawson is surveying in this district for more than 20 years and is familiar with all the localities.

Also a taste for making geological observations but he describes to me all the land east and west of the head of the bay as drift, mostly sand, sometimes clay, but no rock ledges of any kind excepting those outcropping in the neighborhood of Antrim, north and south of it.

The indications of a belt of light colored clay, Marshall group, (nd) are ferruginous sandstone by Winchell's way, his assertions are mere suggestions not based upon any actual outcrop in those places excepting the before mentioned ones.

In conversation with a lumbering man from Kanistow river I learned that all along this river never any outcrops of rock came to his sight.

Section 3 miles above Norwood. A bluff 10 feet high in bed of lake. Dark bluish gray earthy looking argillaceous limestones with many large lumps of Favosites and some other corals. Above this about 8 feet of alternating beds or seams of flint nodules with limestone beds splitting in fine laminae. Also the flint layers have a fine laminar striation.

Proceeding towards Norwood for a few 100 feet the section is interrupted but in the bed of the lake the lower strata are continued. Short distance further the thinly laminated limestones with flint beds are seen in the lake bed. And above them gradually more solid limestone layers amounting to a few feet follow. And above these about 8 feet of a hard tough crystalline dolomite with cavities filled with petroleum and containing some Favosites and Stromatopora ostr. forming thick massive banks. A stone quarry has been opened in them at the shore but is abandoned.

Above this dolomitic limestone which contains some quite fossiliferous seams after short interruption of the outcrop, black bituminous shales are found containing beds of a nodular but highly crystalline dolomite and shaly calcareous dark layers with Nagelkalker in large masses. With these are found a Lingula and numerous fish remains, also large calcareous or dolomitic and bituminous Leptaria of lentiform shape, some as big as a wagon wheel are found with these strata. Thickness exceeds at the spot not over 12 feet.

The large proportion of calcareous strata connected with the shales and intermediate degrees between shales and limestone are very remarkable.

Tuesday 16. Went south of Norwood along shore. 2 terraces noticeable, one about 15 feet above the lake, further back one about 50 or 60 feet above the lake. Both terraces are composed of drift containing large granitic boulders but otherwise exclusively fragments of the limestones of the Hamilton group and coralliferous limestone with some few Niagara limestone fossils such as Catenipora.

The lower terrace is underlain by black shales containing large quantities of sulfurous nature besides iron pyrites. The shale is seen in a thickness of about 25 feet, the upper layers are more thinly laminated and above them green shales with some arenaceous layers are beginning to set in. At near Hersey the green shales are only little exposed. Further down near Brownstown there is a large exposure of them. In a small ravine the superposition of the drift clay over the black strata is well exposed. South of Herwood no limestone ledges are visible under the shales neither in the banks nor in the lake bottom.

Tuesday noon returned to Traverse City. Observing the shore line on the return the outcrops of black shales was limited to the portion south of Herwood and about 1 mile north of Antrim. All the remainder of the shore is a sand beach until near Brownstown, 1 mile above it where the green shales make their appearance on limited spots and I believe also to have noticed them in the bottom of the lake while sailing over them in clear water.

The intermediate land spur of the bay and the islands are all composed of drift. Old Mission is situated at the north part of the (e spur surrounded by a very fine harbor with deep water. The land there a sandy loam is highly cultivated and several fine farms with orchards are noticed. The shore on the north end of the spur forms partly brick bluffs 50 or 60 feet high. A lighthouse stands at the end point. The bluffs there are not so much elevated. The bluff material is sand and gravel with prevalence of the sand. Greatest elevation of the hills surrounding Traverse Bay about 175 to 300 feet.

Wednesday Aug. 30. To Reed City on south half of Sec. 3, T. 17, Range 16, close south of Hersey Creek.

Hersey 4 miles	Reed 5 miles	Coleman 4 miles
Evart 10	Farwell 5	Sanford 3
Orient 5	Clare 5	Averill 3
Lake 10	Lewis 3	Midland 3
		Lreland 9
		East Saginaw 11

To Hersey gravelly or sandy loam. In the creek under the last bridge before arriving at the station I believe to have noticed a ledge of rock but I did not stop to ascertain its nature.

Towards Evart a level country with gravelly sand soil sometimes more argillaceous. Forest of mixed hardwood and pine timber. Much of it burned. Evart is a poor village situated on the west side of Mackinac river. On the east side of the river a more fertile sandy loam partly hardwood, partly pine. Level country to Orient. At Lake station prevalent pine forest. Low land between Lake and Farwell, all forest. Some large boulders spread over the surface. Soil sandy. Clare a small village. Level partly swampy land underlain by gravelly sand and with scattered boulders. Timber mixed hardwood and pine. Same character of country continues to Lewis and Coleman. Saw hills on all stations.

From Columbus to Sanford very low wetland. Sand soil. Crossed Maitlawassee river at Merrill. River bed about 12 feet below general surface. All forest land trees rather of small size.

At Midland the soil is of better quality. Some cultivated lands begin to be seen. From Midland to Saginaw an entirely flat country extends overgrown with hardwood timber. The land is considerably cleared and good farms on it. The soil is more of clayey nature than before and seems to be productive. Arrived at East Saginaw at 7 o'clock. Michigan Central train northwards leaves after 8 in the morning.

Thursday Aug. 31 to Oscego. Kawkawlin to Ferry Station low hardwood lands with some pine interspersed. A flowing artesian well near the Station house about 300 feet deep. From Ferry to Jennings (rincoring?) a desolate burnt swampy forest with pine, low land with mixed timber continue to Standish. Sandy soil with occasional outcrops of gravel and clay strata.

Beyond Grand Oak Station much pine forest. Sawmills at all stations. No farms except at Clyde, a small clearing. To Wells Station all pine swamp or low land. This continues to West Branch, 3 miles this side of Ogemaw.

Ogemaw is a single sawmill with a store. It is situated in a springy bog land with low hills on both sides from which everywhere copious springs come out with very good cold clear water. One spring is strongly impregnated with hydrosulphuret gas. The land onwards from there continually rises and after some miles, high dry plains spread out where they have to dig 30 feet for water. The soil of Ogemaw is a light sand underlaid by clay.

3 miles beyond Ogemaw the road ascends a high plain with sparsely growing stunted pine, Norwegian and Banksian pine. This level pine plain extends for many miles in all directions. Further on very tall densely growing young pine timber with interspersed birch trees is noticed for a good distance along the road. The same character of landscape continues to Rosseron and all the way to Oscego Lake.

In places low sparsely growing Banksian pine allows a sweeping view over the slightly undulating high plain. Other times a dense forest of tall pine trees is passed. The surface is over the whole extent of the plain a yellowish coarse sand occasionally mixed with small pebbles and in some instances a few granitic boulders. In the depressions peat bogs have formed partly overgrown with tamarack and birch and populus tremula. At Crawford Station we cross Sable River which is there a small creek flowing in a shallow depression of the general level and surrounded by pine forests. Oscego Station is close to the lake. The lake is 3 miles long and about 1 mile wide the yellow sand of the surface is the only visible rock material. The soil of this whole plain is not adapted for agriculture. Nothing grows on it but low ferns and some surices.

